Palacký University Olomouc
Faculty of Education
Department of Art Education

USEFUL SYMBIOSIS: SCIENCE, TECHNOLOGY, ART & ART EDUCATION

Petra Šobáňová et al.

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Reviewed by:

doc. PhDr. Michal Miovský, Ph.D.

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Project's Principal Researchers: Mgr. Petra Šobáňová, PhD., Mgr. Tereza Hrubá, Ph.D. Mgr. Lucie Tikalová
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Preface

The relationship between art and science is very delicate. Equally difficult to answer is the question of where the boundary between geniality and insanity lies. Actually, not even this one can be precisely and clearly defined. However, in my opinion a more difficult question yet is to identify the boundary between art and science. A sensible solution is perhaps to abandon the thought of finding the answer all together, for the question itself appears to me rather misguided almost neurotic.

There are certainly a number of reasons for that. As a psychologist interested in psychotherapy since the very beginning of my career, I was confronted with the statement which held that psychotherapy is a science but its application an art. However, I had no problem accepting it and being in agreement with it until today. Perhaps the same statement could be applied to the whole of psychology. A perceptive observer of this immensely rich and beautiful field of study is inclined to arrive at the conclusion that there is no area on which art, beauty and emotions would not leave their impressions.

Even in the most precise areas of psychology, if such a nomenclature could be used to denote e.g. neuropsychology or methodology, we see in practice that there is an enormous room for clinical 'feeling' and intuition as well as experiential learning, etc. Mutual interconnection of both approaches – both ways of perceiving world and its discovery – is very important for our life. One makes no sense without the other, and separating them or giving preference to one over the other is not very practical. Equally impractical is to try to separate a figure from its background in Gestalt psychology. A figure is visible precisely because of its background and vice versa. Boundaries and the unity of both actually constitute a requirement for their correct recognition and perception as a whole.

It was a pleasure to dive into the lines of this book. I was faced with old and fundamental issues and questions, which cannot be answered once and for all, but on the pages of the book, were subjected to discussions at new levels. These issues and questions must and will continue to have a provocative impact today, as well as tomorrow and every new generation will have to deal with those in their own way. In different levels, authors of particular chapters touch on fundamental Gnostic dilemmas, and they search for the connection between science and art on different levels and in different applications.

I enthused over the flow of the texts, in the background of which the recent project of Pavel Forman and Tereza Hrubá was prominent. I myself embarked on similar projects in my own field of study. I was thrilled to see a new epicentre of authors and colleagues based in the Palacký University in Olomouc, where I worked for 12 years at the Department of Psychology, dealing with such difficult questions as cognition and the relationship between art and science. *Useful Symbiosis* is clearly a useful provocation following a broad line of not only a foreign, but also a domestic – and certainly original – stream of texts.

Authors of this publication are finding more and more inspiration, just as Josef Viewegh fascinated the readership with his *Psychologie umělecké literatury (Psychology of Artistic Literature)* and his older works in the area of suicidology. My attention was captured immediately with the texts of Petra Šobáňová (*Science and Art as Paths to Discovering* and the following chapters of *Scientific Approach and its Limits*) for their comparison of older texts with contemporary ones often represented by interesting domestic works. This inspired me to go back to Kuhn, revisit the positions of Fred N. Kerling and Karl Popper, and search for their alternatives, or for compatible, though different, positions. It made me think of when it was that I gained certainty that both of these entities – qualitative and quantitative (though I am aware of a certainvulgarising notion present in this dichotomous scheme) were an item. Or better still, when it was that I lost the certainty that there was a certainty in dividing matters into art and science, and when I lost the certainty that I was on firm ground in science.

And then I remembered. In my case, the last pieces of certainty were taken away by Professor Pavel Machotka, who was introduced to (not only) me by my colleague and friend, Professor Ivo Čermák. It was Pavel Machotka who helped me accept the fact that science is rather an uncertain certainty, and who, using a unique analysis of the relationship between the life and work of Paul Cézanne (1839-1906), was able to demonstrate the importance of the intersection between science and art.

The process of discovering the world is a firm interconnection of these two worlds, and marginal topics in particular demonstrate this fact perhaps more convincingly than mainstream ones. Machotka succeeded in uncovering enormous depths in which it is possible to analyse the relationship between the personality of the author and their work. He moved the horizon of my perception which had

been set by the above mentioned Josef Viewegh, e.g. by the way he defines himself against structuralism. A thorough attitude and scientific systematic nature left no room for doubting the quality and deeper purpose of a scientific work, and confirmed that it is all just science. Science with a soul, though.

And that is where I see the value of the book you are holding in your hands right now. It does not lie in its minor imperfections or in the lesser 'penmanship' of some authors, etc. It lies in the thorough approach to this difficult and most provocative topic which was adopted by the authors whose texts were not motivated by the potential amount of points in the *RIV* system (R&D Information System of the CZ). I also appreciate the fact that the whole team was willing to invest their time and effort into creating *Useful Symbiosis*. They gave rise to somethingthat is worth contemplating on and has the hallmarks of originality. A reader may navigate through the texts in various directions. For example, the last chapter, which deals with the process of education and makes use of the previous chapters, offers a kind of a conclusion. However, it can also act as an introductory text. It is because one can follow the line from the chapter on the question of art as the self-interpretation of a human being to the subsequent epistemological questions resulting from the interpretation. At the same, projects such as *Ants, the Queen, and Little Ants*, and *A Tree in the Midst of Trees* support the fact that good ideas, when adequately developed and used, are valuable in themselves, as well as adding value to this work.

It is my wish that similar ideas and the enthusiasm of my colleagues will be sustained, and I hope they will continue navigating their vessel with these attributes. This work also gives us hope that living science is the subject of study at university, and that there are people who truly love their work. I appreciate the fact that it is done in the context of such an important area as education, to which almost defamatory feedback and scarce recognition and appreciation were attached (not only during the previous regime) and still are today. The book will certainly be interesting and stimulating material, and not only for students and academia.

Prague, 18th March 2015

Prof. PhDr. Michal Miovský, Ph.D.

Introduction

The *Useful Symbiosis: Science, Technology, Art & Art Education* monograph is one of the outcomes of the research project of the pedagogues and PhD students at the Department of Art Education at Palacký University in Olomouc (Czech Republic). The researchers of the project followed the research activities of Pavel Forman, Tereza Hrubá, and Petra Šobáňová, as they decided to resume the research into non-traditional relations of visual arts. One of the objectives of this book is to ignite a productive debate on the overlapping tendencies of art and the exact natural sciences, as well as to address the educational dimension of these intersections. The outcome of the research, in which the principal researchers gradually involved many of their colleagues from Palacký University in Olomouc as well as Masaryk University in Brno (Czech Republic), and the University of Southern Indiana in Evansville (USA) is the presented monograph addressing the relations between visual arts and sciences and their technical applications. It is highly gratifying to see experts from various corners of the world coming together and starting a fruitful cooperation.

First of all, special thanks must go to the members of the team of authors and other colleagues. We also wish to thank the expert reviewers, Hana Myslivečková and Michal Miovský, for their kind comments that led to the improvement of the text, and to Viktor Sýkora (who selflessly made his microphotographs of plants available for publication) and to many other authors of reproduced works and photographs.

The *Useful Symbiosis: Science, Technology, Art & Art Education* book is written in an art and art-educational environment, which on the one hand readily accepts applications of science and employs them in artistic expression. However, on the other hand, it keeps its distance from the scientific approach to the world and is quick to point out the negative factors and limits of this type of discovering. Symbiosis is not possible without understanding. Therefore, the authors of the book, among who are also art historians and pedagogues, believe it beneficial to first analyse the concept of the scientific approach without any preconceptions to demonstrate its advantages and limitations. They adopted the same approach to the issue of art. The comparison of both approaches brings – as we believe – better understanding of the specifics of both areas of human culture, as well as a platform for searching for other useful intersections between science and art.

Apart from introductory and rather theoretical overviews, the book also lists particular examples of 'useful symbioses'. Thus the reader may verify that science sometimes 'does art' as well as art can 'do science'. Sometimes the borders between art and science disappear altogether. Individual subchapters describe and analyse the impact of new paradigms of exact fields of study on the transformation of animal iconography in modern art, the infiltration of social sciences into art, the transformation of photography as a typical example of the invasion of technical applications into art, or, the close relationship between painting and art material, which is – quite naturally – an achievement of science and industry. Such symbiosis can be also seen in art of new media, 3D printing and computer generated visualisations. Examples of new media art (video art or netart in particular) but also sculpture using 3D printing show the way new media expand expressive possibilities of contemporary artists. However, examples of symbioses of science and art can be found deep in the history as the chapter document in which a reader can discover remarkable similarities between mathematical visualisations and some art expressions, among others. Through the prism of science we also perceive the works of some classical authors, namely C. D. Friedrich, and John James Audubon, etc. The book also bears the testimony of some authors who discuss the overlapping tendencies of their own work and the influence of science on their own art expression. These studies show that science can also be the muse for artists.

The overlapping tendency of science and art is also topical in education. An individual chapter was therefore dedicated to the issue of science and art symbiosis in an educational context. Apart from theoretical readings of the related issues (the ways to overcome the dichotomy of the scientific and artistic approach to the world, the role of educator in this process, creative integration of isolated educational contents), it also offers particular examples of realised educational projects. The common trait of these projects is that they either integrate educational content of various fields of study (artistic and natural ones), or they organise in themes some of the media resulting from the application of science and technology (mainly photography). The examples of educational projects are completed with texts on the integration of artistic approaches

to education in technically-oriented universities. While widely opening a colourful fan of observed intersections between science and art and their mutual influence, the authors of the book also hope it will bring nourishing food for thought to their readers.

On behalf of the team of authors –

Petra Šobáňová

Olomouc, 6th January, 2015

'I've studied now Philosophy
And Jurisprudence, Medicine,—
And even, alas! Theology,—
From end to end, with labor keen;
And here, poor fool! with all my lore
I stand, no wiser than before:
I'm Magister—yea, Doctor—hight,
And straight or cross-wise, wrong or right,
These ten years long, with many woes,
I've led my scholars by the nose,—
And see, that nothing can be known!
That knowledge cuts me to the bone.'
(J. W. Goethe, Faust, 1831)

The Theoretical Context of the Symbiosis of Art, Science and Technology Topic

Science and Art as a Path to Knowledge

Petra Šobáňová

Even though art and science are separate areas today, they both aimed at discovering and the comprehension of reality. As P. Bourdieu reminds us (1998), these differentiated worlds today (apart from art and science, also philosophy, religion and others) were in ancient societies undivided. The advancement of society brought about the establishment of their mutually separated fields as autonomous worlds with their own laws independent to the laws of the others. First, science (the natural area) was singled out from the common roots of magic relatively early in ancient times. Art, on the contrary, had long remained in close relation with religion and it reached its full independence only in the modern era. (Henckmann, Lotter, 1995) No matter the angle we take on the permeation of both areas, there are a number of significant differences between them, which need to be understood completely when considering

'useful symbioses'.It is often emphasised that the medium of art is sensuality, while the medium of science, as well as of philosophy, is a conceptual apparatus, a network that can ensnare the world. The well-known French thinker, G. Deleuze (2008), a representative of post-structuralism, was fascinated by the relationship between art, science, and philosophy. He maintained that none of these disciplines is superior to the other and that each of them is creative. It is important to point out that creativity is a complex of many talents, the list of which clearly demonstrates the key points of both artistic and scientific approaches. We particularly associated it with originality (authenticity), which means the ability to produce unusual solutions; fluency or the ability to quickly produce relevant ideas, concepts, or certain categories of answers. Flexibility, which refers to the flexibility of perception and imagination, as well as to the flexibility of meanings and contents or the ability to restructure some images or to adapt quickly to limited conditions, is another aspect of creativity. Creative solutions are necessarily associated with a high degree of development, which means the quality of processing, which manifests itself in many ways, e.g. in a large amount of details. (Guilford, 1956, Nakonečný, 1998) Creativity, however, also requires a capacity for abstract thought and an 'open mind' as psychologists refer to the resistance of an individual against early withdrawal from an alternative solution to a problem. (Torrance, 1966) We also associate the creative artistic and scientific process with intuition, a kind of hard-to-grasp lightning of insight and a sudden creative idea beneficial to solving the problem.

If creativity and intuition are common traits to the observed areas, there will also be significant differences. Deleuze (1998) saw the different areas as having different purposes: according to him, the purpose of science is creating functions, while the purpose of art is the creation of sensory aggregates, and the purpose of philosophy is to form concepts. In these three general categories, Deleuze saw also a source of enriching interactions between different fields of study. (ibid)

The significant Czech artist, František Kupka (1923), believed that the difference between science and art is in the absolute or, conversely, the relative nature of their subject matter. While the subject matter in science is 'positive' with the purpose to analyse and define, it is also unconditional and absolute; the scientific interpretation and the method of presentation are only relative.[1] Conversely, in art the only thing which is positive, which means positively ascertainable and definite, is the manner in which the means of implementation were employed in order to express the subject matter or the way it was presented. (ibid, p. 182) However, this subject matter or content is always relative, and therefore, ambiguous. Furthermore, in the case of art, the manner of presentation and the content are inextricably linked and cannot exist separately, unlike in science, where the manner of presentation can be arbitrary and it still will not have any effect on the message.

Both areas, science and art, can be regarded as the path to knowledge. Both methods are characterised by their specificity, by different but also identical elements. Let us briefly ponder upon the issue of knowledge itself. The metaphysical problem is its origin but also its absolute, or, relative significance. Knowledge refers to both the theoretical function of a spirit and its result. During learning, a certain object becomes apparent to the senses or the intellect – whether internal or external – with its specific features (which distinguish it from others) and relations. (Durozoi, Roussel, 1994)

In the course of the history, the relationship between sensory stimuli and knowledge has been refined, and the reliance on common sensory certainty soon proved to be unreasonable. Knowledge is not mere perception or experience. What R. Descartes brought to epistemology was a questioning of all that can be questioned, and because our senses can deceive us, this was an important method of radical scepticism. Nothing shall be taken for granted; all hypotheses must be subjected to questioning, all seeming facts, all knowledge.

I. Kant further clarifies epistemological theories by pointing to the fundamental fact that although knowledge is directly dependent on our sensory perception, when this perception remains undivided, and not accompanied by critical thinking and adequate concepts, we cannot talk about real knowledge. The fact that sensory input must be defined by concepts and incorporated into the existing system of knowledge, was confirmed by genetic epistemology and cognitive psychology (especially in the work of J. Piaget - see Piaget, Inhelder,

[1] Surprisingly, this is also confirmed by the theory of science in the influential work of T. Kuhn (1997) or P. K. Feyerabend (2001, 2004) published in the second half of the 20th century.

1997, Piaget, 1999) in the 20th century. These sciences examine the mechanisms and development of the cognitive abilities of humans and carefully address the relationship between thought and sensory perception.

Knowledge (as a result of cognitive processes and learning processes), which is primarily dependent on thinking (Průcha, Walter, Mares, 2003), does not follow from mere observation. J. Piaget even came to the realisation that the mechanisms of perception and thinking are completely different. According to Piaget, thinking can be neither translation nor a simple continuation of motor and sensory into imaginary. (Piaget, 1999, p. 116) This is a much more difficult process, during which thinking must reconstruct everything at a new level. Structures of intelligence must be rebuilt from the ground up, before it can be supplemented by new knowledge. (ibid)

Foucault (2007) points out that knowledge has its anatomical and physiological conditions, and that the 'nature' of human knowledge determines not only its forms, but also manifests itself in its own empirical contents. Knowledge is determined historically, socially and economically, it is created in the midst of interpersonal relationships, and it is not independent of a special form, which may take on here and there. (Foucault, 2007, p. 245) Not only is there a history of human knowledge that can be empirically examined but this history also directly determines the form of this knowledge. All knowledge of the world is also mediated by the prevailing paradigm, as shown by T.S. Kuhn (1997). Scientific findings and broader knowledge of a particular culture and time are not universally valid, as pointed out by the imaginary Dr. Cole to his seminarians in the first of the famous Feyerabend's *Three Dialogues on Knowledge* (Feyerabend, 1991): certain knowledge makes sense to a man, if they belong to the particular civilisation, it is 'relatively valid to the procedures and standards developed by the civilisation' – but in a different culture the same knowledge does not make sense, nor can it be considered true. (ibid, p. 17)

Foucault (2007) identifies a human being as an odd empirical transcendental doublet, which is able to acquire only such knowledge, which is allowed to be acquired by the nature of human knowledge. Vertigo gets the better of a human being, when thinking about what is not possible to think, what is beyond our thinking. In terms of knowledge, the world then turns into a space

covered by signs that a human tries to decipher. God tests the wisdom of man and only such forms are inserted into nature that need to be (and can be by humans) deciphered.[2] Knowledge therefore refers to interpretation – it is necessary to navigate through the visible signs to the very concept they actually express. (Foucault, ibid)

Knowledge can also be considered as a representation of what exists outside our minds. It also includes the understanding of the very fact that knowledge is possible, and the effort to understand how the human mind can construct representations of the world (Rorty, 1979). It is clear that over the centuries the methods of construction of representations of the world in both our observed fields have became different. They differ even to the extent that today they are perceived by many as antagonistic. The world of art is connected with an intuitive, random, or even chaotic knowledge – as opposed to the sober rationality of the sciences. Although there are hundreds of pages covered by various theories of art, art itself remains hardly describable by precise categories. It is the world of inaccurate units, but sometimes of unexpectedly deep insight. It is a world of experiences without precise boundaries, the world of hints and references, the world of contexts and coincidences. (Štětovská, Straka, 2010, p. 31) On the other hand, we associate the world of science with rationality, system, continuousness, the need to categorise, and to organise precisely. (ibid)

The American philosopher Ch. Peirce (cit. in Buchler, 2011) distinguished four general ways of knowledge, 'ways of fixing certitudes'. The first is a method of traditions within which people hold certain truths simply because they consider it to be the truth – just like their predecessors did. The representation of what exists outside our mind is fixed mainly by repetition. Another method, a method of authority, is based on accepting a fixed opinion, resulting from the findings of a universally recognised individual, an influential group or organisation. Religious knowledge works rather successfully with the method of authority (and a method of tradition), but even art and science do not dismiss this method completely. With the advent of modernity, an authority in art is overshadowed by the requirement for uniqueness and originality, but an authority in science still represents one of the most influential factors. After all, if we quote in profes-

[2] Adam, when he imposed their first names upon the animals, did no more than read those visible and silent marks. (Foucault, 2007, p. 36)

sional texts a sufficient amount of renowned personalities from the field, the text seems not only of higher quality and 'more specialised', but more believable and more precise for the community of the field of study.

Another method of knowledge that is defined by Peirce (ibid) is a method of *a priori* – knowledge acquired by some sort of pre-sensory experience that is very close to an artistic activity. It is a method of intuition; a direct and clear seeing of the truth. Knowledge obtained thusly is difficult to verify, it is subjective and hard to logically conceive, however, it can be unexpectedly complex. Psychologists considered intuition to be part of the creative process, which – as we know – can be associated not only with art. Today, no doubt, intuition and creativity are also used equally in science and other areas of human activity.

Finally, the fourth method of human knowledge, and a highly sophisticated one, is the method of science. What is its nature?

'Knowledge! – Science! – Nature!
No one has ever marvelled at you
as much as scientists have,
always anxious, precise observers,
bowing before you in awe.'
(F. Kupka, Tvoření v umění výtvarném, 1923)

Scientific Approach – its Specifics and Limits[3]

Petra Šobáňová

Using scientific approach, humans seek to find out the way the knowable world works, and try to understand it. While knowledge of the world and nature was still considered of little value in the Middle Ages, everything changed with the advent of the modern era, when interest in a world perceivable by the senses and intellect was developing rapidly. Mathematics enjoyed a special respect in the 17th and 18th century, which gradually permeated all the emerging sciences, including biology and medicine. For the purpose of studying nature, it acquired the status of law: as aptly expressed by I. Kant later, in any special doctrine of nature there can only be as much proper science as there is mathematics therein. At this time, there were famous scholars, who became the prototype scientists: Galileo, Newton, Boyle etc. They proclaimed the necessity of studying and exploring reality directly, they pursued empirical, not mediated knowledge. They urged to study the facts, observe, discover new things, and not just repeat the words of others. (Rádl, 1999, p. 75)

The 18th century brought the emergence of new disciplines such as experimental physics and chemistry; biology was slowly abandoning old concepts of organisms as mechanical instruments, and as a way of continuing the earlier tradition of monumental natural history surveys (see e.g. famous Aldrovandi's herbaria and compendia of animals, mythical creatures or human body deformations) extensive works were completed, the purpose of which was to encompass and reclassify the whole of nature (Linnaeus, Buffon). The French

[3] The chapter is one of the outcomes of the project titled *Czech Museum Teaching in the Context of Contemporary Trends (Česká muzejní edukace v kontextu současných evropských trendů)*, P407/12/P057 funded by the Czech Science Foundation (Grantová agentura ČR).

Fig. 1 *The Alchemist*, 1640s by David Teniers the Elder.

Enlightenment gave rise to the famous *Encyclopédie* project, coupled with names such as d'Alembert, Diderot, Voltaire, or Rousseau. In 1859, Ch. Darwin comes with his work *On the Origin of Species*. The work became a pledge of naturalists and the impetus for the creation of one of the most influential movements of the 19th century: Darwinism. With a new understanding the world emerged as increasingly complex and diverse.

1.1 Rational and Sceptic Ants

Scientists of that time resemble ants that collect material and process it. (Rádl, 1999, p. 110) Using scientific activities they strive to obtain real images of nature, and much more. F. Bacon, the father of the then new inductive method, which consisted in deriving general conclusions from concrete data, predicted other possibilities of science, which were fulfilled much later, e.g., discoveries of new economic plants, effective medical procedures, and even technical applications of scientific knowledge in the form of aircraft or submarine vessels. (ibid) It was believed that if the 'ants' are diligent enough, science will soon bring mankind progress, activity which will free them from existing false images of the world.

The new world condemns magic and superstition. The new world is rational. Strictly logical I. Kant concludes that sense can see only that which it had previously conceived of. It is therefore necessary to compel nature with all available means to reveal itself and to answer our questions. Rationality – the human's ability to think (use their intellect) and to act on the basis of reasonable practices – was promoted during the modern era to a universal, culturally and historically unconditional human quality, and also to the fundamental scientific method.

French and English positivism rises from the tradition of the great personalities of science of the 18th century, the basic thesis of which is that natural sciences refer to the accumulation of facts. The theory consists of formulas or models for larger amounts of knowledge. The belief of positivists (ostensibly despising religious beliefs and all metaphysical facts) was the belief in facts, experimentalism, and immaculate exact precision. Everything is a purely natural phenomenon, including humans, and there is nothing else which is worthy of attention. The leading figure of the 19th century positivism was A. Comte, who saw the purpose of knowledge in the description of similarities and the succession of natural phenomena as well as the formulation of natural laws as an accurate image or a reproduction of nature.

In the spirit of the positivist tradition we understand scientific theories today as a structured system of laws of certain phenomena or as a systematically organised complex of propositions or hypotheses. Science sustained its emphasis on reason as the basic support of human knowledge. The author of an influential book titled *The Logic of Scientific Research*, the contemporary Austrian philosopher and theorist of science, K. R. Popper (1997), defines scientific knowledge as accentuated common sense, and considers issues of scientific knowledge to be extended issues of the common sense method. To him, science is permanent, critical and the search for truth regardless of the consequences. The purpose of science is to proceed towards an infinite and remote goal of discovering new

issues and questions and of the repetitive subjection of our tentative answers to severe tests. (ibid, p.306)

The scientific approach to reality, however, certainly has its specifics, which are different from natural learning. First, we assume that a scientist abounds with intellectual qualities and they should also have moral qualities, especially qualities such as impartiality and honesty. (Durozoi, Roussel, 1994) While cases of scientists who have violated and influenced the code of researcher's ethics or even manipulated their results appear in the media from time to time, these are always banished from the community of scientists – either realistically or symbolically.

A scientist presents their theses or their systems and gradually tests them all. A scientist constructs a hypothesis or theory which is subsequently verified by the means of observation or experiment. Scientific knowledge thus differs from natural knowledge in the fact that it has been subjected to testing and it has withstood that testing. A scientific system is only such a system that can be tested by experience. (Popper, 1997, p.19)

Kerlinger (1972, pp. 19-21) defines a scientific approach as follows:

- a scientist builds systematically their theoretical structures, verifies their internal consistency and subjects their constituents to empirical verification; a scientist reflects upon the fact that the concepts, which he/she uses are human creations that may or may not have a close relationship to reality;
- a scientist verifies their theories and hypotheses in a systematic, controlled and empirical manner;
- a scientist carefully observes their own interpretation of the observed phenomena, i.e., he/she does not give preference to those explanations which are consistent with their original (possibly biased) perceptions;
- a scientist is interested in the relationships between phenomena and pursues them intentionally and systematically;
- a scientist strictly dissociates themselves from 'metaphysical' explanations, which are such claims that cannot be verified. Science does not deal with those, nor does it adopt an attitude towards them as it does not pertain science to do so.

If all scientific claims should be in some way verifiable, it also means that it should be possible to determine whether the claims are true or not. From this fact, Popper (1997) concludes that logically it should be possible not only to verify the claim, but also to falsify it or refute it, as he maintains, an empirical scientific system must allow for its refutation by experience. (Popper, 1997, p.20) According to Popper, refutation is an even more appropriate demarcation criterion than verification: scientific systems are in this way exposed to the cruelest struggle for survival (ibid, p.21), which in effect only produces results which are truly durable.

Popper (1997) characterises the path of science as a path of theories of the lower level of generality to the theories of the higher level. The current theory can be overcome by a theory of a higher level of generality which the author considers to be a theory that can be verified better. Various ideas and scientific hypotheses are visualised by Popper (ibid, p. 301) as particles floating in a liquid and settling on the bottom in layers. Layers of newer theories are more universal. Unlike Kerlinger (1972), Popper recognises that apart from science, metaphysical areas can also settle in the fluid. He does not exclude these areas from knowledge – they can help (as they did in the past) bring order to the human image of the world and in some cases even lead to accurate predictions. (Popper, 1997, p.302) However, an idea can be proclaimed as truly scientific only when presented in refutable form – that is, when it is possible to empirically decide between this and a potential rival theory. (ibid)

Science also contains an important self-correcting element, as pointed out by Kerlinger (1972). Self-correcting means that in the process of scientific knowledge, when arriving at new knowledge, various control instances are employed. However, these are not random, but on the contrary, they are integral parts of the system of science and serve to monitor and verify the activities of a scientist, so that its conclusions are reliable and independent of the particular scientist. In practice, this means that a scientist also verifies an alternative hypothesis, the result of research is not considered true until it is tested and verified in the context of publicly verifiable procedures. That is also why the operation of science includes various types of review procedures and evaluations. Their function is – in addition to providing feedback to the author and the potential improvement of scientific communication – to make the publishing of poor results close to impossible. Published results are subsequently considered relevant by the scientific community.

As a way to conclude my attempt to specify the method of science let us recall the view of the famous Austrian philosopher of science, P. K. Feyerabend (1975). Our efforts to define a universal scientific method are dispersed when in his famous *Against Method;* he concludes that scientific procedures and results do not have any kind of common structure. He believes that there are no elements that would be present in every scientific investigation, but absent elsewhere. The principle of all scientific activities is usually considered to be reason or rationality, though Feyerabend thinks it to be too coarse a definition. In addition: rationality is also present in other types of learning including arts. According to the author, not even a scientific achievement can be easily explained – there is no universal path to scientific results. If scientific activity is a creative activity, then it seeks paths yet unproven, not the conventional and describable ones. Therefore Feyerabend (1975) can define science literally as anarchic enterprise: theoretical anarchism is more humane and contributes to progress more than its alternatives based on law and order.

The Issue of the Truth

Between the lines of the above, we read the obvious assumption that using a scientific method we can achieve the objective truth of reality. L. Valenta (2002) points out that the analysis of the concept of 'truth' has two poles. At one pole there is the intuitive meaning of this term, which does not need to be defined in everyday life due to its commonplaceness. At the other pole, however, its problematic nature arises – particularly in the cases associated with a more profound interest in its relationship with the world, i.e., in cases of empirical science. If we did not understand what it meant to be true for some of our mental states or linguistic entities designed by us – ranging from ordinary life to those most theoretical attitudes – we could not talk about discovering this world. (Valenta, 2002, p. 32)

The ancient scholars sought above all to contemplate the truth; it meant 'a source of happiness and life fulfilment to them. The ideal was to discover what really is, and act accordingly, i.e. to live in harmony with this discovered truth. (Rádl, 1999, p. 7) Also the Middle Ages were defined by the pursuit of the truth more than anything else – of the last, absolutely certain and proven truth;

it was believed that the truth is the same from the beginning of the world that a man can rise to it, and that the pinnacle of happiness is in its vision: 'sicut erat principio et nunc et semper, et in saecula saeculorum!' (ibid)[4]

With the advent of modern times, however, the meaning of the concept of truth is changing – rather than transcendent, eternal and absolute truth, we pursue facts of reality, and not of a constant reality but of a variable, incidental and constantly changing reality. The source of truth is now nature in her many countless truths waiting to be discovered. Galileo and his followers referred to these truths not as knowledge of the metaphysical tripersonal Originator of the world and his work, but as knowledge about nature. The new faith of Europeans becomes faith in nature for the time to come. The truth lies only in nature and that is where the search must be conducted. Kant and Bacon ask 'to put nature on the rack,' and force the truth out of her by having her put to the question. (Rádl, 1999, p. 294) Truth is the purpose of a scientific activity which presents its hypotheses as proverbial 'candidates' to be true or false. (Kuhn, 2012, p. 135)

Science has given to people the idea of progress and hope that with its help we will liberate ourselves from ignorance, prejudices and superstitions. It has been hailed as one that will discover the 'truth' about the world. This assumption is also the essence of the traditional scientific approach to the world. The word scientism today, however, has a pejorative tinge – we associate the word with the positivist movement of the 19th century which lead science towards dogmatic, closed, and non-rational facts of a blind system. It was believed that progress of intellectual knowledge will gradually replace not only religion but also philosophy and poetry. (Durozoi, Roussel, 1994) Science laid 'total claim' to an exhaustive and definitive understanding of reality, its gospel was 'good news' about the objective knowability of the world and the 'promise of salvation through science.' (Neubauer, 2001, p. 23)

How do we perceive the ambition of science to discover and verify the 'truth' about the world today? Contemporary theorists conclude that the notion of truth does not actually have such importance as had been previously assigned by philosophy (of science). Truth was previously attributed value that

[4] The correct version of the Latin text is as follows: 'sicut erat in principio et nunc et semper et in saecula saeculorum.' (As it was in the beginning, and now, and always, and to the ages of ages.)

this term does not have at all. Current theories are therefore called inflationary, while philosophical views rejecting the importance of the concept of truth are named deflationary. Among the so-called deflationists are, for example, P. Horwich, British philosophy professor and author of the work entitled *Truth* (1998), and D. Davidson, American philosopher and author of the work *Truth and Meaning* (1967).

In his book, Horwich (1998) analyzes the current conception of truth and then concludes that each problem area determines its own conditions for what is called true; veracity is a property of propositions, i.e. the contents of thoughts and linguistic acts. Therefore he finds truth to be an empty and trivial concept, which is no longer practical to work with. There is no need to eradicate it, or mark it as redundant, but it is quite banal.

The American philosopher, Rorty (1979), explains that, unlike the general perception of truth, it is not something that would represent the 'reflection' of the world. While it is good to believe in it and to pursue it, it should not be perceived as a true reflection of reality: the pursuit of truth is merely a self-delusive attempt to 'immortalise the existing discourse.' (Rorty, 1979) It is no longer possible to believe in the grip of the world by means of one 'correct' theory. It appears that the truth about the world is not some impersonal referential entity – it is only a matter of a concordance and the result of human consensus. (Peregrin, 1994) As Feyerabend (2004, p. 60) maintains, something is only true if a certain style of thought says that it is true. It was thus once true that the Greek gods existed, today it is of course nonsense for many people.

However large and original the issues that science (as well as philosophy) deals with appear, in fact, it is only a mere acceptance and reproduction of historically contingent ways of thinking and writing styles. Scientists demonstrate their competence and derive their scientific authority on the basis of mastering these ways. (Balon, 2012, p. 276) The notion of trans-contextual truth is thus blown into pieces not only by deflationists and Rorty, but also by T.S. Kuhn (2012, p. 134) who actually encourages us to continue to do without anything that would resemble a correspondence theory of truth.

If the concept of truth does not deserve attention and loses its central position, what are the implications for scientists? Kuhn (2012) believes that

the concept of truth needs to be replaced – by something that resembles the (unnecessary) theory of truth at least in those aspects that retain a minimum of laws of logic (e.g. no contradiction should occur) the respecting of which maintains rational scientific activities. The role of the concept of truth is to require a choice between acceptance and rejection of any claim or theory based on evidence shared by all. (Kuhn, 2012, p. 134) In other words, Kuhn says that a scientific claim should have the status of 'candidate to be true/false' (i. e., it is impossible to claim something along with another statement that would be the opposite of the claim), and at the same time the presentation of the argument should be rational. The latter condition can be fulfilled on the basis of 'evidence shared by all,' such as a professional dictionary as a shared conceptual or taxonomic structure.

Still today science is to many authors the search for truth (see e.g. Popper, 1997). In the context of contemporary epistemology, however, we ask with new urgency: *Can we ever know anything?* (Popper, 1997) What is certain is that the illusion of safe and undoubted knowledge is henceforth denied to us. This fact calls for intellectual modesty of today's scientists – our knowledge is merely critical guesswork; a network of tentative hypotheses; a mere fabric of conjectures. However, we can learn from the mistakes of our predecessors and from our own, and we can get closer to the truth by a scientific approach – if these scientific theories cannot be verified, they can be more or less proven at least, they can be more or less truth-like. (Popper, 1997)

Science – Islands in Chaos

Nothing seems more empirical and scientific than an attempt to implement an order. An order is established on the internal law of things, it is a kind of secret network (Foucault, 2007), by which things are mutually compared and grouped. Z. Neubauer (2001, p. 36) considers the creation of islands of the bright, order, regularity and clear clarity amid the drama of being as a direct purpose of science. Also M. Foucault (2007) sees the essence of a scientific activity in the introduction of 'order', and not in the process of expressing phenomena in mathematics and physics. 'The science of order' establishes between all departments of its domain a clear and concise system organising them in order from the elementary to the most complicated ones.

The acceleration of the human 'desire to classify' – to organise phenomena and objects into a meaningful whole, can be observed in Europe already since the 16th century, when the first comprehensive scholarly works as well as a study collection depicted by drawings of the time as a microcosm, a miniature universe were created. (Burke, 2007) Understanding the world as a meaningful system is the method by which a human being fought – and still does today – against the threat of chaos. According to this attitude, a human being is placed into an ordered world – into an identifiable and knowable cosmos. The scientific approach to the world – though rejected by many scientists today – works on the premise of intelligibility of the world created by God. (Pospíšil, 2003, p. 26) It was based on a firm conviction of the fundamental integrity and fundamental harmony of the world. It is from this premise that the painstaking search for permanently valid laws of nature sprang, the foundation of which is a tripersonal Originator. (ibid)

The need for security, which was given to the society by science, urgently arose particularly in unstable times of religious disputes and uncertainties of the 17th century Europe. R. Descartes as a representative of the modern rationalist attitude, originating from a proud confidence of a thinking entity, presents Europeans with a new and reliable certainty: it is the sum of generally accepted scientific facts which are general and the veracity and validity of which can be experimentally verified by anyone. Natural science based on mathematics has a big advantage: it is (apparently) completely neutral to the diversity of human interests in power, politics, religion, morals, or society. (Rádl, 1999)

An objectivist approach to the world is based on the conviction that despite the chaos on the surface there is an inherent, rational structure in all things which can be perceived with intellect and accessed by anyone. (Havelka, 2010, p. 128) At the time of the Enlightenment, the integrity of the world was guaranteed by the principles of reason, and was attributed the form of a system. Knowledge is only what can be grasped through subsumption under the principles of unifying reason, and what can be integrated into the system of knowledge. (ibid)

A scientist strives to understand the world, increases the accuracy of human knowledge and expands the areas in which the world is seen as structured.

(Kuhn, 1997) All the secrets of nature are explored by science to the smallest detail. If during this investigation an area without a clear order appears, it is a challenge for a scientist to refine observational techniques and further articulate the theory. (ibid, p. 52)

However, as Popper (1997) points out, the progress of science certainly does not mean to accumulate more and more perceptual experiences. We are already very far from the Platonic idea of science as a system of statements, that can be permanently multiplied by new observations and experiments, and which is maintained in a single system by means of unchanging rational standards. (Feyerabend, 1975) It is impossible to distil science from uninterpreted sensory experiences no matter how hard we collect and organise them. (Popper, 1997, p. 304) We understand nature only through interpretations, and we can interpret it only through ideas, anticipations, and speculative thoughts. And only by those who participate in the scientific game and are willing to subject their ideas to the danger of refutation. (Popper, 1997, p. 304)

2.3 The Issue of Objectivity

We believe that everything that has been said is not as significant for the defining of the specifics of the scientific approach as well as the differences between the two observed fields – the art and science – as the scientific pursuit of objective understanding of the world is. Objectivity can be defined as the agreement between different observers of a phenomenon and as a concordance of our knowledge with external reality. (Kerlinger, 1972) The pursuit of a complete knowledge of reality and the partial successes of science in the form of accumulated findings about nature has led to the identification of being with objectivity of the modern age. (Neubauer, 2001, p. 23) To us, science is the same as a generator of objective, indisputable and verifiable data to which we turn our attention in the desire for progress and a better life.

Also Foucault (2007) firmly connects scientific knowledge and objectivity – along with the aforementioned systematic nature. In the modern age, the objective basis for knowledge became nature and new knowledge about impartial natural science, which is completely neutral to life, and which became the philosophical beliefs of scientists until our time. (Rádl, 1999, p. 90) Modern sci-

ence has focused the attention on a purely observable given fact of the surface of things. (Neubauer, 2001, p. 21) It perceived phenomena in terms of their passive occurrence in reality and pointed them out with the premise of describing them separately from other phenomena – as permanent, independent and invariant. In the background there is an implicit belief that natural laws apply (and will continue to apply) and a human being will be able to discover and name them through their intellect and efforts in no time.

However, the growing amount of facts, and new, increasingly complex theories and research tools unintelligible to laymen moved science away from natural discovery, which gradually resulted in a general bifurcation of a human being and the world, i.e. of subjectivity and objectivity, reason and human inwardness. (Havelka, 2010, p. 128) Objectivity along with rationality as the foundation of positivist thinking, had to abandon the quest for the meaning and for the whole, which was lost in the one-sidedness of both bifurcated approaches to the world (ibid, p. 129) – the objective and subjective approach. Being in the sense of objectivity is a direct antithesis to beings to which we are related in the natural world of human experience and the experiences of being, which is, for example, reflected in art. For the natural experience comes to the fore peculiar and revived activity of things, their self-exceeding openness (transcendence) and friendly, partner relatedness to others (relativity). (Neubauer, 2001, p. 22)

The opposite of objectivity and subjectivity seems to be of utmost importance for the purpose of defining the difference between scientific and artistic approach. The cited philosopher (Neubauer, 2001, p. 16) defines subjectivity as an ontological experience of the natural world. He considers it to be perhaps the most original and also the most natural human experience, since birth, a human being is identified with his subjectivity, there lies his/her nature: a human being is a subject. (ibid, p. 16) The discovering of a philosopher and artist is subjective and natural. It is based on the internal seeing of purpose as it enters the personal experience of understanding (ibid, p. 19), which, as we know from Deleuze (1998), a philosopher expresses in concepts, and an artist in sensory aggregates. However, philosophy – just like art – is not subjective in such a way that its findings and ideas had only an individual character, and that they would not be generally applicable. (ibid) Indeed, their relevance and validity is verified in the process of a live communication, in the case of art in the art scene.

However, science striving to express the essence of things in abstract theories and laws, blurs individual facts and subjects things to only general contexts. It seeks clarity of statement, while the constructive nature of art is in ambiguity or 'openness' of its meanings. Not only does art expect the subjectivity of its creator, but it is also dependent on the interpretation, and thus depends on the subjectivity of the recipient and historical contexts of reception. (Henckmann, Lotter, 1995, p. 194) Science is objective at all times; a certain fact has its validity regardless of the entity or socio-cultural circumstances. Or is it just an illusion?

2.4 The Deconstruction of Science

With his distinctive and provocative manner, Feyerabend (1999) declares that the personal, subjective judgments are present as well in science as elsewhere. However, they are hidden and automatic, and that is why they escape our perception. Everything seems to be automatically both a calculation and experiment, and it is precisely thoughtlessness, which creates an impression of objectivity! (ibid, p. 40)

A scientific approach that has long been accepted as trouble-free, or even normative ('something is an unquestionable truth, because it is scientifically proven'), is now subject to discussion and attacks, as it is increasingly evident that between knowledge and culture (not to mention power) there is a complex relationship, previously not reflected upon. Science is proving to be a context-dependent cultural and social phenomenon – similar to other phenomena. Knowledge, whether obtained by the scientific or non-scientific method, is to be understood primarily as a social and cultural fact. In any case, science lacks the key to the gate of truth, and neither is it superior to other forms of discovering.

These important changes were brought to the existing concepts of knowledge and science by a pluralistic postmodern discourse. It was a postmodern era that brought deconstruction of mechanisms of new concepts and theoretical schemes. Changes in the paradigm of scientific knowledge were significantly influenced by M. Foucault and by his way of exploring the process of developing today's consciousness, knowledge or discourse. Foucault defines *epistémé*, that is the system or procedure, which regulates in advance what our

knowledge deals with and how. (Petříček, 1997, p. 168) It shows that our interpretation of the world depends on this *epistémé* because it not only determines the area of our culture, but it even forces us to think that way and not any other. (ibid, p. 169)

Foucault (2002, p. 211) attempts to define discourses in their specificity, to show in what sense a set of rules that are being activated, is non-transferable to any other, defines the types and rules of discursive practices. In his analyses, he does not directly address the history of ideas and science, but rather the quest for what made knowledge and science possible and according to what order knowledge was constituted. (Foucault, 2007) All analyses lead to the conclusion that people – whether through science or any other way – reach only such an amount of knowledge which human nature allows them to reach. We only think what is possible to think.

It is therefore not surprising that earlier uncritical admiration for exact knowledge is now replaced with doubt. It is impossible not to see a fundamental weakness of scientific knowledge, which was dependent on its time-period, which can be easily proven by opening old textbooks or pseudoscientific archaic writings.

Limits of exact knowledge were also revealed by T. S. Kuhn (1997), an American theorist of science and scientific knowledge. He engaged in the structure of scientific revolutions and showed that the development of knowledge (or of science) does not happen continuously, but in a way of 'leap changes' (Kuhn, 1997, p. 115), in which the current paradigm is replaced by a new one in reaction to the new crisis of science. The most important finding is the very fact that science is always looking at nature through some kind of paradigm. (Petříček, 1997, p. 171) In the postmodern situation, it is no longer possible to believe in the understanding of the world by means of the 'right' theory. Instead it is evident that the truth about the world is 'a congruence' and human consensus (Peregrin, 1994), rather than an impersonal entity.

Science knows no 'bare facts', rather it perceives all 'facts' that relate to our knowledge in a certain pre-determined way – therefore they have primarily ideation character. (Feyerabend, 2001) The history of science therefore reflects the ideas it contains. Complex, chaotic, full of mistakes – and interesting. Interesting, just as the minds that developed and formulated them were. (Feyerabend, 2001, p. 23) Science ceases to be a rational antipode of metaphysics – it is revealed that paradoxically science needs metaphysical arguments to keep going (Feyerabend, 1999, p. 11); without a philosophical dimension it could not be what it is now.

The dynamics of today's social development also reveals – certainly more than to previous generations – early obsolescence of acquired knowledge. Only the blind cannot see the limitations of our knowledge and rapid lagging of acquired knowledge. In this context, Petříček (2009, p. 242) asks: if twenty-year old knowledge of science is today hopelessly outdated, it means that what we know now is actually already in this moment worthless? Certainly not worthless, but it is necessary to know that each spring is a confluence: science is a moment of knowledge that arises in cultures, and therefore it can hardly be so homogeneous, independent of the technology or power as it might have seemed until recently. For what is referred to as knowledge, is not objective facts or things themselves, but the reality as it is more or less systematically incorporated into our social and cultural life. (Petříček, 2009, p. 243)

Therefore, Bourdieu (1998, p. 160) suggests that theorists look at the theoretical aspect from the theoretical point of view and draw consequences from the fact that the researcher is inseparable from their social and historical situations, or, that this intangible, but influential situation is directly reflected in their activity. Scientific science is based on the premise that things are independent of knowledge (Neubauer, 2001, p. 16), but in reality a researcher changes their object. Unexamined socio-cultural influences and historical circumstances lead to significant scientific errors. That is why scientists are criticised for not thinking about the basics of their science, that they work mechanically within the boundaries of a certain paradigm – because fundamental discoveries often arise from questioning these foundations.

2.6 The Fundamental...

We have already mentioned Kerlinger's (1972) warning that the scientist strictly dissociates themselves from all 'metaphysical' explanation, namely that which cannot be verified.[5] Science does not deal with these, nor does it take a stand towards them, as it is not for science to do so. Instead science deals only with the things that can be observed and empirically verified. It means that if there are no implications for empiric verification in any given statement or question, they cannot be considered as scientific problems at all. But this also means that despite the successfully induced illusion of its omniscience, the reach of science is limited by its precisely specified field of scope and that it is unable to comment on different levels of reality, such as on phenomena, which cannot be observed by today's means anymore, or that are of metaphysical or spiritual nature.

It cannot be said, however, that science would not affect the metaphysical area or that it would clearly declare its dissociation from it. On the contrary – during the Enlightenment, reason together with science as an independent and powerful force began to ever more vigorously intervene into these purely human affairs, from which it began forcing out values and cultural patterns reinforced by long tradition. (Havelka, 2010) Science crossed the boundaries of mathematics and physics (the theory), so that rational arguments and logical extrapolation ceased to be a matter of purely abstract subjects or matters of evidence in scientific knowledge, and began to be requested in matters of life, in arts, and ultimately, in society and politics. (ibid, p. 127) Scientists have presented a number of arguments in favour of science, but when analysing them carefully, we find that 'many of their arguments are nothing but dogmatic assertions about matters of which they have no knowledge whatsoever.' (Feyerabend 1991, p. 93) These seemingly valid arguments are imposed by scientists not only as part of their own discourse, but also of others. The development of science has thus fatally contributed to the unfair discrediting of traditional religions or non-Western cultures.

Let us also emphasise that modern science has distanced itself quite deliberately from metaphysical questions and philosophy itself (especially from theology). It permits only objective natural facts and mathematical formulas, nothing else, as indeed illustrated by the historically symptomatic statement of D. Hume (2011): 'If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? No. Does it contain any experimental reasoning concerning matter of fact and existence? No. Commit it then to the flames: for it can contain nothing but sophistry and illusion.'

However, it is important to add that these were not only metaphysical questions that were 'given to the flame': the enlightened mind came up with a method the basis of which was in rational partitioning of wholes into individual objective components. (Havelka, 2010, p. 127) This corresponds with the tendency to interpret a whole through its seemingly relevant, independently controllable elements, which nevertheless have a simplifying effect on reality (as well as emptying). (ibid)

The result is an increasing suspicion that science is not able to really understand the world or life, that something important eludes it, something which is not possible to express in rational terms. This serious suspicion always returns despite science's undeniable successes. Science ignores the fact that man is an empirical-transcendental doublet (Foucault, 2007), and that the spirit has been fatally neglected by the study of nature. Science is not able to follow many major phenomena of human existence, or to understand them. Science is not able and probably never will be able to define and analyse by means of its methods our world, so complex and impossible to reduce to mathematical formulas, without simplifying and emptying this changeable and complex reality.

Searching for the original cause of the world and its principles is certainly more difficult than defining a triangle or describing the behaviour of insects. Aforecited D. Hume and others were aware of this, but they lacked humility before the fact. The confusion from the ambiguity of life and the world and the uncertainty in fundamental human issues is what in fact lies behind the adoration for exactness and the calling for indisputable objectivity by the scientific method of obtained data. It also reveals another of Hume's statement: 'An oval is never mistaken for a circle, nor a hyperbola for an ellipsis. The isosceles and scalenum are distinguished by boundaries more exact than vice and virtue, right and wrong.

[5] Let us recall at the very beginning also Feyerabend's (1999) sarcastic thesis according to which science is now our favourite religion (ibid, p. 67) and that it cannot do without metaphysical arguments, even though, it keeps convincing us otherwise.

[...] But the finer sentiments of the mind, the operations of the understanding, the various agitations of the passions, though really in themselves distinct, easily escape us, when surveyed by reflection; nor is it in our power to recall the original object, as often as we have occasion to contemplate it. Ambiguity, by this means, is gradually introduced into our reasoning: Similar objects are readily taken to be the same: And the conclusion becomes at last very wide of the premises.' (Hume, 2011) This ambiguity creeping into this way of thinking could not be admitted and therefore the founders of modern Western science have displaced everything which is beyond senses, and gone into obscurantist collections of curiosities.

The limits of science are therefore grounded precisely in the fact that nothing substantial can be said to the questions of the last, existential truth. (Petříček, 1997, p. 20) It can therefore be observed that despite the current importance of Western science, people turn away from it and if it is no longer possible to seek spiritual support in the discredited traditional religions, they find solutions to their problems in life by attaching themselves to a variety of alternative spiritual movements, superstitions, occultism, or pseudo-sciences.

Not only is science unable to conclusively address the question of the value and meaning of human existence (Petříček, ibid), but it also fails to reflect on itself. It fails to ask how knowledge is possible, and boldly creates constructions of the world, which move considerably away from the natural world experiences. The development of modern science thus caused a sort of split of our world: on one hand, there is a world in which we live and which we naturally understand, the world in which we can act, move, and create. On the other hand, there is a world of science as an impersonalised world of mathematically formulated entities and mathematically expressed relationships between these entities. (Petříček, 1997, pp. 51-52)

This fundamental fact stands in the background of current challenges that scientists face nowadays. It is not just about humility and respect for other ways of understanding the world. The authors Štětovská, and Straka (2010) advocate the rehabilitation of 'the art of science', which according to them is precisely in the questioning of meaning and coherence of scientific problems. To them, the way to the art of science is in fostering the ability to ask questions about meaning and context and to seek a deeper understanding of the world. (ibid, p. 37) It is necessary to overcome the constraints given by narrow specialisation, to also take into account other perspectives and to develop interdisciplinary contacts with other professionals. Although seemingly impossible in times of economic pressure, it is necessary to gain distance from the topic, and engage in the beneficial questioning of the chosen path and valid 'truths', to imbalance their bases or procedures.

The destructive impact of natural science, which is the other side of its achievements, is explicitly summarised by E. Rádl (1999, pp. 594-595) who maintains that natural science had gradually deprived humans of many rights: they were cast out from the heart of the universe and turned into residents of one lost and tiny star; they were deposed from the domination of the world; equated with monkeys; deprived of souls; it was found that there is no substantial difference between them and fools; their will was crushed; and it appeared as if some sort of subconscious forces move them like marionettes, and ultimately all that is left of them is just a kind of 'das Es,' a mere pile of natural properties, sexual instincts and that is all. Such a pathetic down-and-out of a man returned from the expedition to conquer the world and to the titanic overthrow of God himself from the throne!

Fig. 2 Henri Testelin, *Colbert introduces the members of royal academia to Louis XIV in 1667*, without a date

We hasten to add that we deal with the limits of the scientific approach to the world not because we want to demean science and its way of exploring reality, but because we aspire to denominate its limits and to clarify the competence of individual fields of human culture. We cannot accuse science of having nothing to say to the immeasurable spiritual or intellectual problems, but it is important to know about this fact and to work with it.

2.7 Science Today

As wittily observed by Vašíček, the famous Greek scholar Aristotle would be absolutely stunned by the breadth of today's knowledge. It is estimated that over the next decade, as many scientific papers will be published as there were from the beginning of the ancient world until today. (Vašíček, 2003, p. 151) From ancient times to the present day, the West has generated a highly organised operation of science, science centres, funding agencies, and countless generations of experts. What was in the 16th and 17th century a few scholars' thing and a private hobby of their restlessly sober spirits, mathematical science is today the bridge, the bond and the power of planet. (Foucault, 2007, p. 300)

Over the centuries, science has differentiated, so that today we should rather talk about sciences. Comte once divided sciences into the theoretical, which pursue knowledge for knowledge and impartially define facts, and the practical, which pursue knowledge primarily because of practical activities. Today, we divide sciences primarily into natural and social, or, humanities, in which the scientific object is a human being. The interesting fact itself is that a human being was constituted as a positive object in the field of knowledge and that they had moved from natural science to think for themselves (Foucault, 2007), to examine themselves, would deserve a separate chapter. We have not taken it much into consideration so far and have talked mainly about natural sciences, although a rich spectrum of social sciences was gradually established in the 19th century[6] and they continue to expand. The centre of social sciences and humanities is a human being in different dimensions of their existence traditionally constituted by ethnology, history, sociology, political economy, psychology, and linguistics. (Durozoi, Roussel, 1994)

[6] As Foucault (2007, p. 263) says, they appeared when man constituted himself in Western culture as both that which must be conceived of and that which is to be known.

The current division of disciplines by the *Rada pro výzkum, vývoj a inovace* (Council for Research, Development and Innovation), a training and advisory body to the Government of the Czech Republic, is the following: social sciences, engineering, mathematics and computer science, physical sciences, chemical sciences, earth sciences, biological sciences, agricultural sciences, medical science, and the humanities and art subjects. (Rada pro výzkum, vývoj a inovace, 2012)

Today all sciences have – despite the huge diversity of their themes – some universal structure. Firstly, they contain a theory by which to systematically describe and explain the subject of their research, and in the conceptual apparatus of which they formulate findings learned. It also contains a methodology, a set of research methods and procedures, set in the field, and last but not least also the information base and organisational infrastructure, without which it would be impossible to generate knowledge, collect, disseminate, discuss and offer them for further use. (Průcha, 2000, p. 12)

Original largely qualitative cognition of reality (associated with the emergence of science that was shaped inside philosophy) was replaced by the fascination of the measurability of phenomena and their classification during the development of science. Continued specialisation of science and the development of mathematical methods have shifted science towards a quantitative position. (Štětovská, Straka, 2010) This means that various phenomena are compared, their characteristics are supplied, quantification is placed on a pedestal as a guarantee of reliability, objectivity and indubitability. (ibid, p. 33) The accumulation of an increasing amount of knowledge, however, cannot be perceived as a major and desirable contribution to science – as these are rather new views of nature and the universe and the role of man in it. (Feyerabend, 2004, p. 69)

Ignoring the fact that quantification of data does not eliminate the fact that the data are to a certain extent influenced by the researcher is rather serious. (Štětovská, Straka, 2010, p. 33) As expressed by Feyerabend (1975), one needs to know that the so-called facts are constituted by negotiating and the final product, which is e.g. a report published in a scientific journal, is influenced by many factors: physical events occurring in research, data processing on a computer, the compromises that the researcher is forced to do, his/her exhaustion, the amount of money allocated to research, as well as other social, cultural, and ethnic influences.

Current science is characterised by symbols, many of which are certainly undesirable: an attempt to obtain quick results, established a strictly hierarchical and often impermeable community of researchers, the possibility of commodifying results, unwillingness (or inability) to work in the long term (absence of longitudinality), the illusion of omnipotence, and related resignation to the ethical dimension of research. As a shield, scientists use objectivity, which can often be understood only as an unconscious defence against uncertainty. Relentless scientific traffic and the attempt to remain in this highly competitive environment, however, do not prevent a relatively frequent phenomenon, which is 'doing science for science.' (Štětovská, Straka, 2010, p. 35)

Feyerabend (1975) criticises science for the consequences of its actions in relation to politics and power. It recognises that Western science reigns over the whole globe today, but believes that the reason for its success was not so much in its brilliant insight into the inner rationality of nature, but rather in the game of power and politics of several dominant states. Many of the achievements of Western society, which we attribute to science, were created only as by-products of power (and not of altruistic) efforts in Europe. To exercise power, weapons are necessary: therefore also Western science has created yet the most deadly tools. Feyerabend (1975) proves the science of hypocrisy: no matter how much scientific disciplines boast about meaningful goals, e.g. to help the third world, the fact remains that they themselves share the blame for many of the problems. It must be repeated that despite the undeniable achievements, e.g., in the field of medicine, Western science is not the only tradition that offers good things and other forms of understanding the world and its exploration are not without merit. Science of 'the first world' should therefore be regarded as one among many. If it is claiming more, according to Feyerabend, (ibid) it ceases to be a research tool and changes into a (political) pressure group.

From the modern era, science heads towards applications, technical progress and the control over nature. If we turn to the second observed field, which is art, we see that it does not set similar goals. It is rather concerned with the formation and self-interpretation of a human being in its historical and cultural climate. (Henckmann, Lotter, 1995, p. 194) The following chapter is dedicated to the attempt to define the specifics of artistic fields. In conclusion, we would like to add that despite all the reservations and restrictions, science is now understood as a driving force of social changes and prosperity. Its task remains to be the detection and formulation of laws governing the phenomena around us, and the formulation of theories based on these foundations. (Durozoi, Roussel, 1994) The definition of its limits and the consequences of its actions may serve to benefit not only science itself, but mainly the society over which science has a dominant power.

'There are no fixed aesthetic rules. The artist creates a work, in obedience to his nature, his instinct. He stands before it surprised and others with him.'
(E. Nolde, 1927)

3. The Art – of Self-interpretation of a Human Being

Petra Šobáňová

Art as well as science constitutes another basic form through which a human being recognises and interprets the world. (Zhoř, 1998) Art, just as is science, is a specific, socially, and culturally determined kind of human activity. In the sections dedicated to science, we characterised the main general features of a scientific approach, which aims at producing and applying new knowledge obtained by a rational approach to the world and multi-step verification of facts with the aim of uncovering truth, objectivity, and a meaningful and complex arrangement of reality. Can the same be done in the case of art?

Before attempting to do so, it should be emphasised that art is a cultural phenomenon that not only exists, develops, and takes many different forms, but has also been studied by the scientific method for many centuries – traditionally by aesthetics and art history; more recently also by the psychology of art, the sociology of art, semiotics and other sciences. In contrast, science – either as a method or as a set of specific scientific knowledge – has avoided a critical reflection for a long time. Although the theory of science bore some interesting fruits especially in the 20th century, the actual scientific operations seem to be affected by them only slightly. This is not true for art, which, as we will see later in one of the chapters, is not only influenced by the theory, but actually established by it. (Liessmann, 2012)

As opposed to the logical-scientific relationship to the world that we associate with science, the specificity of art is beauty and sensory pleasure associated with sensory cognition. Cejpek (2007) sees the difference between science and art in the application of a different method when seeking to explore the world: while science processes reality primarily in a rational way, art tries to capture it in a wide range of sensations and emotions. The author also draws attention to the traditional prejudices commonly passed on in regards to the relationship between science and art. While we associate science with exactness and logic, art has to rely on the world of imagination and fantasy, which the artist 'invents' and which are not in (almost) any way connected with reality. (ibid, p. 15) We have shown, however, that in reality scientific knowledge and theories also exhibit considerable socio-cultural conditionality. Therefore it does not apply, that they stand above their field and are once and for all 'true' and objective. And of course in science, not only in art, a considerable degree of intuition and creativity, which is customarily equated with artistic meeting, is also applied.

On the other hand, there are many artists who work entirely rationally and apply scientific procedures in their work. Kupka (1923) categorises the range of different approaches to creating and to nature as follows: according to him, one group of artists lean on a mere imitation of nature with absolute objectivity and excludes any subjective interpretation. Another group primarily pursues an expression of emotional aspects. There is also an additional category, the involvement of scientific knowledge, which is coupled with intellectual reasoning resulting in efforts to extract a vital mechanism from the theme, the 'soul of things', to penetrate the surface and reach the very essence of creative power. (Kupka, 1923, p. 39) A single artistic process or method simply does not exist – this applies equally in art, as in science, where we have confirmed this statement by the words of Feyerabend (1975).

3.1 When Is Art, and What Does it Do?

Art is a kind of creative human activity which, through a particular cultural content, is communicated by the means of visual, verbal, spatial, or audible aids, either in the form of real phenomena or subjectively experienced events, abstract ideas, higher emotions (intellectual, moral, aesthetic), or emotional relationships and bodily sensations. To create a work of art, a complex of certain creative skills is necessary, or competence in a particular field of artistic creation. Completely different types of activity may apply during artistic activities: an experiment, a game, but also a challenging intellectual work. However, nowadays the assessment of art depends on social consensus and the functions of art objects rather than on the artist's practical creative skills, the means employed and the content of art works.

It means that some socio-cultural human activity is perceived by one group as a creative work while other groups believe it is not. The result of such an activity is then in a particular society deemed to be a work of art (no matter their design and theme), the role of which it plays. Sometimes, we even ahistorically determine something as art whose creation resulted from an entirely different purpose. (Vašíček, 2003) The fact that a certain phenomenon is referred to as a work of art depends mainly on social usage, and the relationship of people to art is determined by conventions that have been created over the centuries. Art without conventions is hard to find, after all to be unconventional is also a convention. (Vašíček, 2003, p. 214)

Therefore, it is much more topical to ask 'when, or under what circumstances is art' rather than 'what is art'. The artist and their work are in fact crucially influenced by the whole system of social relations in which the creation of art operates as an act of communication. (Dopita, 2007, p. 11) Every artistic realisation arises in the midst of certain historical and social circumstances – the 'objective' truth, against which it compares itself, is not nature and its laws (cf. the scientific concept of phenomena, which are independent of human cognition), but the intellectual, which is to say, artistic field. The term 'field' is an extremely useful means which is employed by the famous French sociologist P. Bourdieu (2010) when answering the question of 'what makes art, art'. According to him, the artistic field is established by the gradual historical development of society (there is no need to search the ontology of art, but the historical circumstances of its establishment). Within this field, the value of art is then constantly produced and reproduced. Only with the operation of this field is the aesthetic disposition established, without which the field – or even art as a separate category – could not function.

It is therefore the social conditions that allow the 'creation' of the artist and their products (which acquire interesting features of a fetish requiring a separate analysis); the operations of this field, however, is crucially affected not only by the artist – but mainly by other influencers, i.e. art historians, critics, curators, and art lovers. An artistic field is the space in which the belief in the value of art is shared and constantly renewed. (Bourdieu, 2010)

Goodman (2007) asks a similar question to Bourdieu, but in search of an answer to 'when is art,' he emphasises its symbolic function. He argues that there is no art without symbols, or, without any of the three modes of symbolisation, which he denominates as a representation, expression, and exemplification. If an object functions as a symbol, it does not mean, of course, that it can be immediately referred to as art. However, because of the fact that a certain object functions as a symbol (or is able to function as such), it can become art. When analysing symbolic functions, Goodman (2007) defines in detail the features of a symbolic functioning of artworks, and characterises five symptoms of 'aesthetics': syntax density, semantic density, relative fullness, exemplification (a work as a sample of characteristics), and multiple and complex reference. This quite complicated issue can be simplified in a limited space into a fundamental conclusion: a work of art always functions as a symbol, i.e. it represents the properties related to something else, and using certain modes of reference it contributes to our picture of the world and its creation.

What the symbol stands for might not have to be necessarily and always outside the symbol itself. This is important when considering modern art and especially non-figurative art. Furthermore, the development of art shows (and the logic of the process of symbolisation admits it), that virtually anything can serve as a symbol of anything else that relates to it almost in any way. However boundless and ungraspable the symbolic functioning of works of art, as well as the very process of symbolisation, may seem, the actual recognition of the symbolic function of the creative works considered provides an answer to the question of when it is a work of art, and when it is not.

Unlike other non-artistic symbols, such as traffic signs, now so popular emoticons or even mathematical equations and graphic representation of research results, in the case of art, attention is to be permanently paid to the symbol itself. (Goodman, 2010, p. 266) The primary and most remarkable factor is not what the work refers to, but the work itself. Furthermore, it is emphasised that the focus of our interest should be the function of art: whether an object is art depends on the purpose and also on whether the object functions as such sometimes, usually, always, or exclusively. (ibid) A feature of symbolisation is also that it can occur under certain circumstances, and it can cease to exist

under other circumstances. A particular object is able to symbolise different things in different periods. In other period it may not symbolise anything at all. A banal or purely utilitarian object can acquire the function of art and a work of art can act as a banal or purely utilitarian object. (Goodman, 2010, p. 267)

3.2 Fine Arts

To write about art and to claim anything in its regard means to battle with basic uncertainty: there is no generally accepted definition of art which would apply in any circumstances and which all the participants of the given field would arrive to. The term *art* itself is connected to the late classical terms *scientia* and *ars* and had been developed by being defined against science and religion which had gradually become independent areas of human culture. In medieval times, the term arts or liberal arts referred to subjects which were taught in schools of philosophy. Grammar, rhetoric, and logic were the liberal arts (i.e. trivium), as well as arithmetic, geometry, music, and astronomy (i.e. quadrivium); the majority of which are now among traditional academic disciplines.

Art in the contemporary sense was in the past referred to as *fine arts*. It was a classical form of art which formed the content domain of the traditional discipline of aesthetics, which deals with issues of beauty, the techniques for art creation, and the nature of art. Historically, the main fine arts were architecture, sculpture, painting, dance, music, and poetry. To merge some of these into one category can be perceived today as problematic for their diverse characteristics and methods. Nowadays, we could add many other categories, such as visual arts (graphic design, art photography, action art, conceptual art, applied art) or the whole area of art literature, theatre, and film.

The term fine arts and the traditional definition of aesthetics as an academic subject, which deals with issues of beauty, could lead to a definition of art as an attempt to create forms that bring about aesthetic pleasure. Beauty has often been the main objective of art. However, its definition presents difficulties. In the ancient world, beauty was seen in utility. Therefore, an object suitable for its function was considered to be beautiful. The concept of beauty as a matter of function and accurate proportions derived from nature, and has over the course of time come back and it keeps coming back.

Christianity contributed with its beliefs that the highest beauty is God and all the beauty in the world – whether created by God or by a human being – is therefore derived from God and compared to his attributes. Beauty was also associated with truth and was considered to be the shining of the truth, a sign of inner fullness and success, something extraordinary which occurs only when existence itself is fulfilled up to its deepest essence. (Guardini, 2009, p 44) Apart from the truth, beauty was also associated with good (Shaftesbury), suitability, capability, or charm (Hogarth). Also Baumgarten, the father of the term aesthetics, associated beauty with the truth, and he believed that aesthetic cognition can be obtained through the application of thought to art rather than sensory immersion in an artwork.

Kant considered beautiful such objects that are presented without labels solely as objects of general fondness. (Kant, 1975, p. 57) Beauty triggers liking in a human being, which he in his *Critique of Judgement* referred to as disinterested fondness, an inclination with no practical interest in the object. Liking is triggered by the complex of cognition powers – and it is determined by revived imagination as well as by consideration which stimulate an actual free human activity. The characteristics of beauty are according to this philosopher the ability to trigger liking (as a state of mind represented by an object being in accord with cognitive ability) and an awareness of utility – not of an aesthetic object, but the utility in the activity of cognition powers. (ibid, p. 38 and so forth)

While in the antique world, an artist was not considered to be different from a good craftsman, Kant believed that the ability to create fine art is determined by the presence of human genius, the ability to employ tangible tools in a way that puts them in sync with perceivers. Sensory stimulus that comes from the form and shape of a beautiful object stimulates the emotions, intellect, and imagination of a perceiver. (Freeland, 2011)

Because of the lack of space we will make only one more reference, and that is to the perception of H. Read who defined beauty as the unity of formal relations between our sensory sensations. However, he was aware of the fact that beauty is a very relative category, after all, this changeable phenomenon has assumed various forms in various historical eras (and of course in various cultures). Furthermore, we cannot identify art with beauty: not only are there beautiful things which are not art, but there are also artworks which cannot

be considered to be beautiful. (Schönau, 2004) Hence does an artistic activity equal creating beautiful things? As we can see, it does not.

Beauty as one of aesthetic categories means quality that may be present in different existences, not only in art, but for example in nature or abstract ideas. Many aesthetes have published numerous papers on aesthetic values of nature, and have solved in detail some issues such as the specifics of the aesthetic relationship to the natural objects, the complexity of the aesthetic object of nature, or the relationship between nature and art.[7] We are also amazed by the aesthetic quality of many visual expressions created by human hands or from the activities of machines outside of the field of art, e.g., because of science – from scientific illustrations through various phenomena to photomicrographs of parts of plant or animal bodies. Some will be mentioned later, and their usage in education will also be demonstrated. Nowadays, we perceive beauty as an irrelevant character of a work of art not only because of the presence of beauty outside arts, but also for the relative nature of categories of beauty and their dependence on conventions. Therefore, the efforts to seek other characteristics articulating the essence of an artistic approach to reality continue to be undertaken.

Fig. 3 Sébastien Le Clerc, *The Academy of Sciences and Fine Arts*, 1698

[7] Their overview can be found, e.g., in works dealing with Czech 'aesthetics of nature' from the authors of Stibral, Dadejík, and Zuska (2009).

3.3 Uniqueness Perceptible through the Senses

Art is a particular part of human culture. It is important to point out that its meaning is fundamental for culture and is carefully coded into effective media perceptible through the senses. (Freeland, 2011, p. 77) According to Kupka (1923, p. 10), an artist gives us a kind of 'reading', which is built not from concepts, but from plastic and coloured elements united in distinct sets. Regarding the content of an artwork, Kupka emphasises that no matter how serious the content is, it does not constitute an artwork – what is necessary is an expressive power with the ability to act on human senses. As Kupka maintains, let all sensitivity (of an artist) and all manner of creative desire be inseparable from direct spiritual assimilation in the shapes of technical possibilities. (Kupka, 1923, p. 166)

Elements perceptible through senses are crucial for the reception of content and the value of artistic objects. While the content of scientific results can be communicated in any form without their meaning being affected, an artistic statement is tightly bound to its particular form as any other form would fatally change it.

It means that formal elements in art actually form meaning. The perception of the viewer may be offered different formal aspects of an artwork in the form of basic construction blocks of the artefact, which are lines, spots, materials; elements of shape in varying degrees of correlation with reality (the degree of stylisation, exaggeration); colour and light quality of the work (characteristic colours, colour chords and relationships, comparison of colour with reality, the degree of departure from reality, expressivity of colours and tones and their relationship to the topic, colour symbolism, dynamic contrasts and harmony); surface quality of an artwork (the surface of an artwork, its material, structure, texture, facture, author's manuscript and their traits, the relationship to the topic), and finally compositional principles of an artwork, the relationship to space and environment, the organisation of spatial relations, the illusion of space, the peculiarities of spatial construction of an image, prevailing character of the composition, the principles of individual elements organisation – rhythm, symmetry, balance, suspense, the expression of motion in an artwork, internal construction of an artwork, basic construction diagram, dimensions, main proportional relationships. (Gero, 2002)[8]

[8] Many theorists have attempted to assemble elements in an artwork that could be analysed. H. Read (1964)

The informative value of the form of art is not the only difference when comparing the specifics of science and art. It is also important to consider the fact that while scientific results are subjected to further sorting, application, and reassessment; and are not in this sense final, artistic results; on the other hand, they are unique, forming certain enclosed totalities. (Henckmann, Lotter, 1995) An artefact is endowed with authenticity, and connected with the personality of its creator and the history of its origin – and unlike a scientific result, the birth of an artwork under different conditions or by the hand of another author is not possible. Another artwork would be created.[9] Although the interpretation of artworks is changing along with the social and historical context, their aesthetic value is not measured through the lens of linear evolution towards progress – which is, as we know, desirable and constitutive in science. (Henckmann, Lotter, 1995)

In other words, it even applies that while the value of ancient art rises, truly scientific (not historical) value of the old professional writings now equals zero – and is interesting only for historians. In science itself, old knowledge is no longer being communicated. While Caravaggio's works from the 16th and 17th century is part of the artistic discourse permanently, the scientific relevance of Aldrovandi's natural works from the same period is forever gone.

Fig. 4 Guercino, *Allegory of Painting and Sculpture*, 1637

refers to those as physical elements of visual artwork that include the rhythm of line, the set of shapes, space, light, shadow, and colour. All of these elements are in mutual relationship – ideally creating a perfect unit.

[9] If it were not so, a perfect forgery could be equated with the original – for more see Goodmann (2007, chapter *Art and Authenticity*).

3.4 Mainly the Fundamental...

As already mentioned above, art employs individualities that are expressed by sensors – in which certain universality and semantic completeness is expressed despite their subjectivity and uniqueness. We will make only a brief reference to objectivity which we have identified in the previous chapters as the target of scientists – and which is not binding for artists, though they do pursue it at times as well. While the scientist works with an objective inquiry, as observed by Kupka (1923), the artist works with inter-sensory activities; he/she feels more than thinks. As Kupka explains, when recording what the artist feels objectively, it is manifested in the technical aspects of an artwork which they plan to create. In this process of recording, it is easier for them to force themselves to generate the emotional concentration necessary for increased awareness rather than just saying to themselves: 'I want to do it.' The real objective footholds are for them only in the logic of their artwork organism. This is the only artist's objective reality, as a fact that is being pursued for scholars. (Kupka, 1923, p. 177) The artist him/herself is a guarantor of their subjective truth, meaning authenticity. (see Petrusek, 2008)

An artwork organism is a distinctive territory with its own laws. Therefore Guardini (2009, p. 38) is allowed to claim in his book *On the Essence of Art Work* that a true artwork is not immediately perceived as a sole cut-out part of what exists but as an independent entirety. Here we can see another difference between science and art. Art – just like philosophy – is aware of the reflexive nature of its findings and with full intention it employs subjectivity. And perhaps because of that it manages to convey the experience of wholeness and the way an individual's life is intertwined with the whole world or human community; an experience that often borders with spiritualism and mystique.

In his quest for what triggers aesthetic liking, I. Kant (1975) employed two theories of beauty: a formal beauty and the beauty of content. According to the latter, art represents the essence of things in an exemplary, non-labeling manner. The fact is that a work of art often touches on important issues of human life and therefore it acts as a particular symbol of human existence. (Slavík, 2001) On their symbolic level, works of art can therefore be perceived as particular mediators between the personal experience of an individual and the generalised experience

of the human kind or cultural entity. (ibid, p. 166) Part of the existential aspect of arts and facts, which processes significant cultural content following the entire history of human kind and are characteristic of people of particular cultures, is also power and the timelessness of artistic statement.

Similarly, Read (1954) explains the specific power of an artwork pointing out its origins in remote imagination which have burst through the layers of unconsciousness and become part of a work of art. (Read, 1954) By a rather intangible method, an artist connects to a current, flowing from the area of their dreams and the unconscious, and nourishes their creative process from this hidden depth, whose outcome in the shape of an artefact subsequently touches a sensitive recipient. This is Guardini's (2009, p. 38) very explanation of the peculiar importance which art has for people. Motifs and shapes that are depicted in a piece of art are entered with remote elements which facilitate the feeling of the world's immensity from both the outer and the innermost depth. Although it is an unconscious process, it is precisely in our unconscious where the life of remote time flows. An artwork has the ability to access it, to propagate an oscillation of deep layer in our psyches and thereby causes a deep emotional or intellectual reaction. A particular work of art therefore assumes importance reaching far beyond its explicit meaning.

The power of works of art lies in their offering to explain our existence: the unconscious perceives ancient wisdom and feels strengthened for the never-ending fight against chaos. These ancient shapes even carry strictly formal elements, such as a circle as a composition form of a painting, or rhythmical repetition as a segmentation of a song. It is these ancient shapes where the power with which art works affect our mind comes from. (ibid, p. 38)

A communication with a work of art awakens in a human also other parts of their personality and not just the rational one. As opposed to science, whose objective is unambiguity and precision, it is ambiguity and vagueness of expression in a work of art that is considered in art to be constructive. And that is why art depends on the interpretation and subjectivity of a recipient as well as a historical context of its reception. (Henckmann, Lotter, 1995) Although it might not be possible to completely uncover the particular method of understanding the world, in the most general sense it is a method that facilitates meaning, quality, and value

based on specific operations with visual or tactile expressive structure. (Klusák, Slavík, 2010, p. 198) As opposed to the meanings science deals with, these have a metaphysical dimension, they relate to cultural values and social structures, to important facts of human existence and existential questions which are inherent parts of human life. They represent a universal human experience.

3.5 Art as Imitation

Throughout history, there have been several different theories seeking to clarify the phenomenon of art. All major periods of human thought have entered the field of theoretical discussions, starting with antiquity through the teachings of philosophers, such as D. Hume, I. Kant, F. Nietzsche, J. Dewey, or M. Foucault. The history of art and aesthetics has a long tradition, from G. Vasari to G. E. Lessing, D. Diderot, J. J. Winckelmann, and others. The 20th century has also brought a number of aesthetic theories: the theses of formalist aesthetics, phenomenology, American naturalism, the so-called critical and semantic school, sociological influences, and a number of other theoretical approaches.

The American philosopher A. Danto (1964) believes that this convoluted amount of theoretical concepts of art can be well simplified into two following theories: the theories that conceive of art as imitation (which actually applied from antiquity until the rise of Impressionism), and a theory of art as 'reality' or artefacts whose primary purpose is not to induce illusion of reality, but rather to have the force of peculiar real objects with their own independent meaning.

Plato and his contemporaries considered truly artistic creation to be a craft activity, whose main purpose is *mimesis*, imitation. This is extremely concisely expressed in mythical stories about the origins of drawing (a Corinthian girl copied the silhouette of her lover leaving for the war on the wall) or of artists competing with one another to create works, whose value is measured by precisely a perfect imitation. The Roman author Pliny the Elder talks about a number of those in his *Chapters on Nature* (see the Czech edition 1974): one painter has reached such perfection that ravens were coming to sit on his depiction of roofing tiles for stage sets, in another place he tells a story of the famous art battle between two painters – Parrhasius and Zeuxis.[10] The stories show that the main

[10] At an arranged time, Zeuxis brought a painting depicting grapes that had been painted so faithfully that birds

requirement for anything 'to be art' was an illusion of nature, respectively, its imitation. Christianity gave rise to a fundamental shift in the theory of beauty and art. In particular in the teaching of T. Aquinas, who addressed the questions of art in his theological system. Art, such as other human creations, should glorify God, follow Him and with the influence of God's grace strive to achieve divine virtues. The period of middle ages associated art with the divine creation of our world, and the attention thus devoted to the creative act, which had – just as the art itself – religious significance. The artist spoke inspired by the Holy Spirit; an artwork expressed eternal, mystical content and required contemplation.

But how to depict God? How to capture the intangible spiritual content? Here the 'imitation' does not concern only the externally visible properties that normally surrounds us (though real objects remained expressive media of artists) – art sought to point out the general principles – the divine nature. It attempted to 'imitate' spiritual experience by means of sensory perception, to depict the facts of spiritual nature. The character of medieval art was therefore quite different to the above mentioned illusive paintings and sculptures of the Greeks – we can find a rich use of symbols, stylisation, timelessness; ravens surely did not fly towards a medieval painting.

The modern age was a turning point not only for science but equally for art. Though, in many aspects art has remained equal to an artistic craft (the final separation will be made by the development of industrial production in the 19th century), it gradually constitutes itself as a separate field of human culture. The Renaissance brought a rediscovery of nature, and not only as an object of imitation, but also as a topic for creation as an individual, specialised activity. (Pospíšil, 1994) That activity was, henceforth, performed by an artist, who was no longer referred to as a mere craftsman; the ideal was an artist-philosopher, respectively, an artist-scientist, who is initiated into the essence of nature, is able to derive its laws and apply them to their work. (ibid) This reinforces its relationship to the external parts of reality perceptible by senses, and the imitation of an ancient type is coming back on the scene.

started to fly towards them to eat them. Parrhasius, on the other hand, painted a curtain, and so perfectly that his opponent asked him to pull it back to reveal the painting under it. Parrhasios became the rightful winner and Zeuxis congratulated him for accomplishing to deceive a painter, while he only deceived birds. As an addendum to the story, Pliny also mentions that Zeuxis then painted a picture of a boy carrying grapes and when birds started to fly towards it again, he was angry with himself for painting the fruit better than the boy – who the birds should be afraid of (Pliny the Elder, 1974 , p. 272).

A certain change is brought by romanticism, when the previously neglected periods were celebrated, particularly the Middle Ages, and the emphasis was once again placed on spiritual topics. A high degree of subjectivity and emphasis on the individual are newly implemented. Romanticism liberated the land from the divine power and placed it in relation to the subject, and the social taboo for the content of the painting was then also badly damaged. (Vančát, 2009, p. 94) The romantic image of artistic individuality and the power of a free creative act formed a persisting general awareness about the elusiveness of talent and exclusivity of an artwork that are incompatible with the common, practical life.

A clear relation to the visual aspect of reality remained in art present until modern ages; art dealt with the depiction of nature, although the means for its representation began to be significantly differentiated. A completely new way of depiction was discovered by e.g. P. Cézanne, who was one of the first to conceptualise the leading concept of 'art as imitation' and concluded that the artwork should not be limited to simple imitation of the outer world. In his summary he offers an explanation to his efferts poiting out that he wanted to copy nature, but whatever technique he chose, he could not succeed. He succeeded, however, when he discovered that nature is necessary to be represented by another way, namely colour. Nature cannot be reproduced, but it can be represented. (Cézanne, cit. in Lamač, 1968, p. 31)

With the advent of Post-Impressionism, there is an increase in episodes that – as in the development of science – began the erosion of the reigning paradigm. 'Being an imitation' – to copy nature, ceased to be a sufficient requirement for the inclusion of a specific artefact in the category of art. (Danto, 1964) Artists began to deviate significantly from the well-established ways of representing nature, and this departure from the art of the classical type (which are represented by ancient traditions along with the Renaissance and Classicism) was completed in the 20th century, when artists abandoned reality altogether. (Morpurgo-Tagliabue, 1985, p. 143) Danto's art as imitation, that is, art guided by the effort to depict reality, factually ends here, and a new type of art is born, which, with the help of experiments, tries to capture neglected or new aspects of reality and attain an understanding of its meaning.

Various forms of modern art were based on life and responded vividly to the boom of technology, industrial production, and science. They opened topical issues such as the issue of the plurality of human personality, the multifaceted nature of human consciousness, the relationship between consciousness and sub-consciousness, the issue of the relativity of time, the issue of dreams etc. (Gombrich, 1995) The cult of artistic personality was even more strengthened. Within a highly developed artistic field, this personality establishes (along with other factors) what art is and where art's borders lie. A new type of art, induced by the changes in society and the expansion of technical applications of scientific discoveries, finished the turnover from the ancient concept of art as craftsmanship with a sense for depiction, that is, art as imitation.

In this regard, Danto (1964) notes an interesting fact: while artists were dealing with imitation, the shortcomings of this theory of art went unnoticed. It was definitively disproved by the invention of photography, when the depicting – imitating function of art was revealed as further unnecessary. Imitation ceased to be a sufficient requirement for the definition of an artwork and once mimesis was rejected as a sufficient requirement, it was quickly discarded as not even necessary. Since the success of Kandinsky, the mimetic properties of a painting were pushed to the periphery of a critical interest so that some works have survived in spite of these virtues, whose perfection were once acclaimed as the essence of art, and were almost degraded to mere illustrations. (Danto, 1964)

But we know that imitation, respectively, the depiction of nature can take various forms – on one hand, it can be what photography rightfully refers to as the dead end for its inability to faithfully reproduce the outer face of the world, people, events, but it may also be a battle of brave imitators of nature (said by apt words of Kupka, 1923), in which the artist 'attacks' nature armed with their personal vision. In this case (which describes well what is meant by art being a unique object with its own meanings) an artist turns to viewers by means of shapes of an objective world, in a way, it still imitates them, but nature is portrayed here in a profound way as a kind of symbolic complex, an absolute element, an integral value independent of the perfection of illusion.

It is no longer a mere imitation, but certainly it is still a 'true' depiction. However, is it objective? And can one ever depict nature objectively, as was sought by mimetic art? Kupka (1923, p. 43) believes that it is not. Artists are always doomed to an approximation, to mere fictions; by which creators impose technical means. An artist cited in different parts of this book exacerbates his claim arguing that if anyone wants to depict nature completely objectively, he/she stands directly opposite to the arts. (Kupka, 1923, p. 56) An artwork builds its own organism, it has its own special organic design – completely different to nature. Objectivity is reserved for science, artists rather observe the side of association and they make use of their core capital, namely imagination a conglomerate of earlier impressions, remembered, and already associated forming units that are piling into infinity.' (ibid, p. 56)

Naturally, this conglomerate finds its application also in mimetic creation, and such art can have and certainly has a deep meaning. If the mimesis was once a sufficient requirement for something 'to be art', it does not mean that we find nothing else in this 'old' and 'older' art. What becomes apparent through a depicted object is also what is outside the object, the complete whole of being. (Guardini, 2009, p. 39) V. van Gogh described similarly his method of creation, in which he brought into light the human soul. As he explains, he knows not of a better definition of art than the following: Art is a person assigned to nature; he/she draws the fact and truth from it, but he/she also lends it a certain importance. (van Gogh, cit. in Lamač, 1968, p. 34) Also an 'imitator' of nature may be able to depict it not as a technical image, but as vibrant and varied whole, in which every detail is organically and deeply connected with others.

In the course of art making a special process takes place: a unity, which originated from a displayed object and the person who depicted it, gives a vivid picture to the whole being. All objects, nature, and all of human existence, history, they both stand there in a living unity. (Guardini, 2009, p. 39) Thus the power of vivid picture is created in an artwork, in an original 'world' – regardless of whether its subject is a simple still life or a heroic scene. For Cotán's quince, artichokes and carrots, as well as Morandi's bottles, or Wyeth's young bull[11] serve, despite their banal themes, as profound and important existential statements that it is not absolutely essential, 'what' is portrayed, but 'how'.

[11] The reference is made to the following works: Juan Sánchez Cotán, Still Life with Artichoke and Carrot, after 1603, oil on canvas; Giorgio Morandi, Still Life, 1948, oil on canvas; Andrew Wyeth, Young Bull, 1960, drybrush.

3.6 Second Nature

If Danto (1964) is correct and art-imitation has been replaced by art in terms of real, distinctive artefacts that do not strive to imitate reality, it is useful to uncover in more detail what direction these artefacts are taking. An artwork as an object with its own meanings certainly can also deal with the imitation of nature, but it has its own value, which does not determine the level of imitation.

This is not a case which would be similar to the contest between the two painters – Parrhasius and Zeuxis, which we mentioned in a footnote of the previous chapter. We no longer expect a faithful depiction of the face of a British monarch Elizabeth II in the portrait by Freud (2001) – as it had been expected by many commissioners of portraits in the days when portrait art was born. Today, this task is performed with greater success by a camera. If Freud's painting were to only imitate its model, it would not be a sufficient reason for its inclusion in the category of art today, but rather for its marginalisation. A shocking and unflattering portrayal of the Queen, in which an uncompromising view of the model is applied, brings to present rather more symbolic meanings and asks questions in relation to the painfully complex whole of a human existence. In short: the quality of a picture is not measured by the degree of its optical conformity with reality, but by the depth and strength of its meanings. It is therefore not entirely apposite that artists actually left reality – they seek rather different, primarily non-depictive ways of its depiction.

If artists no longer seek a mere imitation, what are they aiming for? It is perhaps an individual expression, of self-affirmation and the understanding of the world. (Přibáň, 2008, p. 98) What is the impact of this on the issue of imitation and depiction? Goodman (2007) shows that for the depiction, or, pictorial representation, the similarity with the object that represents the work is surprisingly not substantial or necessary. He states in full words that almost anything can represent almost anything else. (ibid) The core of the depiction is in denotation (i.e. 'a' relationship of the image to what it depicts) which does not depend on similarity.

The question, of whether an artwork should be a depiction or not, is not considered by Goodman (2007) as particularly essential. However, when studying the functions of symbols in art, he deals with the nature of depiction, respectively, with pictorial representation at the very beginning of his book *Languages of Art* (2007). He asks what it means exactly when we say that artists imitate reality, or, that depiction means to portray a certain subject as close as possible to how it looks in reality. The answer to the nature of a true depiction of reality or mimesis is not at all clear. Goodman demonstrates this in a simple example: the object, which lies before me is a man, a cluster of atoms, a complex of cells, a fiddler, a friend, a drinker, and by no means just that. If nothing of these constitutes the subject as it is, what will? If all of these are just different ways in which that object is, then none of them is the right way in which the object is. I cannot imitate all of them at the same time, and the more I could do it, the less it would be close to reality. So it seems that what I am to imitate, is one such aspect, one of the ways the object is or how it appears to be. (ibid)

The development has shown that both ways of working with reality are permissible and very fruitful in art: the pursuit of an 'innocent eye', i.e. the artist's efforts to be impartial and not to give way to a personal input, or, alternatively to let one's own imagination run riot. The most ascetic and the most extravagant way of seeing, such as a sober portrait and a crude caricature differ from each other not by the degree but by the manner of interpretation. (Goodman, 2007) To achieve given poles of the work with reality is not possible, for nothing can be depicted with all properties nor can it be depicted without any of them at all. (ibid)

While ideal forms of classical art have gradually collapsed, the empty place is filled with the principal ideal of modern art, which is the originality of a form and the expressive abilities of a creator. (Přibáň, 2008, p. 98) Art no longer has to be created to depict objects as they appear in reality, but rather as they appear to the artist in his own way of seeing. František Kupka (who himself in his work arrived at abstraction, an intellectual grasping of elements of the real world and their smelting into non-figurative forms) divides artworks into those which manifest a firm will to capture an impression of natural forms (1923, p. 10), and into those in which a speculative idea is contained, i.e. an intellectual content that is presented to us to be read.

In the first case, an artist focuses exclusively on perceptions received from the external world, in the second case, he/she focuses on the transformation of their speculative ideas into their plastic images. An artist then seeks to blend

the mass with a supersensory idea. (Kupka, 1923, p. 10) The conclusion is clear: the art is not about the depiction of nature, but above all about a happy expression of the movement of the soul and heart – creating images that become the second nature. (ibid, p. 172)

In the 20th century, the departure from rationality and from a close relationship with reality was completed. Many artists go even further: they give up reality entirely in the spirit of Mondrian's succinct statement, according to which things may give us everything, but their depiction no longer gives us anything at all. There is the discovery that art does not have to work with forms of objects, that it can create its own 'second nature'.

What exactly is meant by the reality which artists are departing from? Things, people, nature as a whole? In his essay on modern art, Ortega Y Gasset (1994) refers to the desolate reality as images of nature, human lives and passions. It is rather a resignation from the depiction of what viewers can know from the outside world. The author notes that as long as art shows real facts, people like it precisely because they find familiar things in it. If a work raises illusions which are much needed in order to perceive imaginary figures as being alive, among others, we consider the work to be communicative. In the broadest sense, depictive art is that which provides a contact with reality and is related to the human sensory experience. The 20th century brought also such art forms that do not work with these real experiences.

What art is it that does not provide a contact with the object's reality? How does it differ from the 'art-imitation' and what does it tell us about the specifics of artistic knowledge, which we pursue in this chapter? We talk about abstract art, the creation of pure art forms, which are dominated by purely aesthetic moments and structural elements in the form of lines, dots, and colour spots. Abstraction appears as a fruit of the 20th century and due to the experiments in depicting reality its first symptoms can be found in Cubism. While cubists observe nature closely, they do not imitate it nor do they seek illusion. P. Picasso expresses it succinctly when he says that the meaning of painting is peculiar, and not dependent on the material depiction of subjects. (Picasso, 1926, cit. in Lamač, 1968, p. 99) By his iconic work of *Young Ladies of Avignon* from 1907, Picasso broke the established face of art and gained independence from objective

truth for Western painting, which was common in the art of other, non-Western cultures. He pointed out that reality can be 'dislocated from its joints', changed, and adapted to the artist's intention. (Beckett, 2001, p. 357)

It is interesting for our topic that the emergence of Cubism and abstraction was stimulated by scientific discoveries of the disciplines, such as physics, optics, and psychology. For example, Cubism was influenced by the theories of A. Einstein on the basis of which Cubists tried to incorporate a fourth dimension and the concept of infinity into their artistic experiments.

But let us continue with abstraction. The important thing is that it is not a single stream. In the 20th century, it impacted a number of different artistic styles: constructivism, neoplasticism, the Bauhaus and de Stijl movements, Suprematism, kinetic art, op-art, abstract expressionism, and minimalism. In some of the works of its main representatives, it continues to maintain contact with reality and works with it through the methods of reduction and stylisation. However, other forms of abstraction have completed their separation from reality, and are based only on fundamental elements of visual language such as colour, light, shape, line, without being bound to real objects. P. Mondrian, a member of the Dutch artistic movement De Stijl, characterised his method as follows: in the composition, which is realised in the spirit of pure creation, the unchanging, spiritual value is manifested by means of tools for universal creation, namely by absolute contrasts of horizontals and verticals conflicting rectangularly, and by spaces with no colours (black, white, gray). This new creative process makes use of variables (natural) consisting of different proportions, rhythm, proportion of colours, the relationship of colours to 'non-colour'. (Mondrian, 2008)

If Ortega Y Gasset is correct and aesthetic values linked to the daily life of people are not at the core of 'artistry' which we try to ascertain here – it is the result of his thesis that an art object is art only to the extent to which it is not real (Ortega Y Gasset, 1994, p. 12) – then the opportunity to reach 'artistry' is provided by the analysis of this 'artistic art'. Unless there is no trace of imitation of nature or representation of perceivable reality, then there remaines only this aesthetic marrow in the art object.

The above cited theorist metaphorically describes it as the glass of a window, through which people observe the garden while enjoying the

beauty of its flowers and leaves. These real elements employ the eyes and mind of the observer so that he/she does not perceive the glass, which provides him/her with this view. We are not used to focus our attention on the glass (read on a painting or sculpture), because relating to a known reality is easier and does not require special adaptation of sensory organs. Therefore most people are not able to focus their attention on the glass and transparency, which is the work of art. (Ortega Y Gasset, 1994, p. 12) Instead they focus their attention on the human reality, a pictured story, a portrayed person, or the beauty of a particular landscape. If observers are to break free and focus their attention on the actual work of art, apparently they do not see anything – they do not see any human affairs, but only artistic transparency, pure virtuality, which they are unable to contemplate. (ibid, p. 13)[12]

While abstract art behind this glass does not offer subject forms, it does not mean it does not relate to facts that it does not comment on it. Mondrian (2008) gives his opinion on this issue when he describes his method of work with nature and his understanding of reality: he sees constant pure reality behind volatile natural forms. It is therefore necessary to convert natural forms of reduction to very pure constant ratios. In this description we find a more accurate description of the relationship between abstraction and reality and nature – the reality is not the same as nature, a universal, pure reality is somewhere behind nature.

Authors such as Kupka, Delaunay, Kandinsky, Mondrian represent transcendent forms of abstract art, which combine in different ways artistic elements, as well as illuminated and colourful areas. Their art reflects the ideological and intellectual world of modern man in a difficult meditative reflection, interconnecting the terrestrial with the cosmic in a whole new way. (Lamač, 1968, p. 141) Abstract art stands in opposition to the established illusive view of things, but not in opposition to nature. It is the antithesis of what is in people uncouth, primitive, bestial, and it is associated with a real human

[12] For lack of space, we mention only as a footnote that this 'purist' thesis encourages a lively discussion, and is certainly not accepted without reservation. According to the thesis, it is necessary to separate the artefact from the representation of the real, and a perfect genuine work is considered to be so only if it represents a 'human' reality. For example, Goodman (2007, p. 256, etc.), however, proves conclusively that the 'purist' work such as this Gasset's 'clear transparency,' also has a symbolising role for it exemplifies some of its own properties. Although we do not find representation or expression in this type of works, they still remain a symbol even though the thing they symbolise, are not things or people or feelings but certain patterns of shapes, colours and textures that they demonstrate. (ibid)

nature. (Mondrian, 2008) In art, a clear content increasingly appears, which can be classed as universal, as laws of nature hidden to human senses. In an artwork, these are developed by their own way and not only Mondrian stresses that they are hidden somewhere behind the outer aspect of the phenomenal nature. As if art alluded to the limits of human knowledge, to what is, according to Foucault (2007), impossible to think, what is outside of our thinking.

It is also possible to see in abstract art a surprising connection with an earlier conception of art as a contemplation of the eternal, unchanging metaphysical content. Even here the spiritual quality is emphasised. Finally, it is not important whether it is possible (and desirable) for art to have only the form of Gasset's transparency and virtuality, or to be imaginary 'pure' art, from which human elements were completely expelled. More importantly, abstraction showed independence of art on perceivable reality; art can extend somewhere beyond these human elements – although it still remains a socio-cultural fact and the product of its own defined field. It has the ability to touch on the borders.

As a way of conclusion, we would like to return to the topic of modern art (as well as to contemporary art) which cannot be simply characterised as a development path to abstraction. On the contrary, artists continue to work on the depiction of real objects and try to re-address the issue of pictorial representations of reality. Some approach their model even with such intense objectivity that they resemble scientists with a microscope or even a pathologist with a scalpel – such are the paintings of the aforementioned L. Freud. (Beckett, 2001, p. 152) However, rather than the illusion, we appreciate the uniqueness of vision and their ability to make present the complex set of human existence. Whether it is the depiction of simple motifs or serious social themes, art allows us to peek at the mystery of the universe, the mystery of creation through its tools: on a piece of painted canvas or deformed material the whole of human life is being brought into the present – joyous and heart-rending, humble and wild, its delicate corporeity and deep spiritual dimension.

3.7 (Art)science Makes Art

Liessmann (2012) sub-titled one of his essays as *The Way Theories Create Art.* He deals with the fact that contemporary theoreticians play a significant part in the process of constituting arts, and in creating the content of the discourse of art as well as in facilitating the understanding of particular types of art, and they also have an effect on the level to which art is implemented in social communication. Previously, Danto has been led to similar ideas by the work of the pop-artist Warhol, who introduced wooden duplicates of the Brillo soap boxes, which were practically indistinguishable from the factory made products. (see Danto, 1992, 1964) Based on this initiative, he wondered where the power of artistic personality comes from, which effectively creates a theory of art by presenting something as an artwork.

According to Danto's (1964) own words, to mistake an artwork for an object of another kind is nowadays nothing outside the ordinary. If the only condition for something 'to be art' is the fact that it is a particular meaningful conglomerate, then anything placed in the art field that proves to be viable, can be art. These can be Velázquez's or Rembrandt's masterful paintings, as well as Duchamp's readymades, Hirst's cut-out animals, Koons's porcelain sculpture of Michael Jackson, a flashing source code on the monitor of a computer, a change in landscape, or, various interventions into public space.

If they had not been anchored in the artistic scientific discourse, people would not think of considering as art many artefacts that today represent this field of human culture. As Liessmann (2012) clarifies, 'the right theory' can turn even a factory made shovel into an extraordinary piece of art. Only a theory and only the right one can pull objects out of the universe of things and place them in the universe of artworks. Artworks do exist. How is this possible? We present them as such. (ibid, p. 52) That is why many established artworks depend solely on theoretical conceptions and the broader, the more elaborate, and terminologically richer these theories are, and the more privileged they can be applied, the bigger the chance for aesthetical constituting there is. (Liessmann, 2012, p. 52)

And how is this possible? As already mentioned earlier, an artist and their art are influenced by the system of social relations in which art activities take

place. Art comes into existence among particular historical and social circumstances – which have produced the characteristics of the particular intellectual i.e. art field. We already know that art is created in this field (it is constantly produced and reproduced there), and thereby it confirms its laws.

A situation that Liessmann and others aptly describe has not occurred from one day to another. What proceeded was a long development, which has been most evidently influenced by modernism. Just as in the development of science, in the development of art, major paradigmatic changes also occur, and such changes have been brought about by a process in which Danto's 'art as imitation' ceases to exist. It started off with a generation of impressionists and post-impressionists and it is continued by heterogeneous movements such as symbolism, cubism, futurism, fauvism, suprematism, Dadaism, Bauhaus, constructivism, surrealism, and various forms of abstract art. During these periods, the traditional laws of formal and content values of artworks have vanished (defined by some theoreticians as the principle of unity), and context has gradually gained in importance; in the postmodern situation it ultimately decides the relation of a particular phenomenon to art.

In the confrontation with contemporary art works, postmodern theoreticians finally reached a conclusion, in which the role of art theories is not solely based on theoretical reflections of art and its explanations – but is far more important because it is the theory which enables the world of art and the art itself. (Danto, 1964) It is the pillar of theoretical discourse on which the difference between any imaginable object and an artwork stands. This fact explains clearly the growing chasm between people and the art world – similar to the one we claim in the case of science which is so remote to the natural way to learn about the world.

The border between art and other objects or phenomena (art does not have to have a form of some object) was fatally disrupted by the conceptual art in the 60s, when artists by presenting seemingly irrational and absurd art projects subjected functions and borders of art and its expressive means to a close analysis. Thereby it was discovered that visual art imagination can also be confirmed conceptually, denominating. (Vančát, 2009, p. 71) A good example of conceptual art is a 1958 exhibition of Y. Klein called *Emptiness* during which the artist informed the viewers in front of empty rooms that all his paintings are invisible, or the act of R. Rauschenberg who erased a drawing of another artist and

presented it as his own with the title *Erased de Koonig Drawing* (1953). The icon of conceptual art is the work of J. Kosuth who in 1965 created an installation called *One and Three Chairs*, which consisted of one real chair, a picture of a chair and a text with a definition of the word 'chair'.

These examples demonstrate the fact that art continues to assume forms so distant from the classical forms of fine arts that a layman or less informed person may not be sure anymore whether something is an artwork or not. Let us paraphrase the words of Goodman (2010) on symbolism: if an object can function as a symbol, it can become an artwork – regardless of its form, origin, or even physical (non)existence. And that is why a theory, a professional reflection, continues to assume more importance because it is the theory that describes, explains, and defends these forms.

The peculiarity of this state of things is well revealed by comparison with science. Let us imagine that the theory of science would decide what a scientific result is, that a (new) theory would be needed to defend its validity. Not that a scientific result would not depend on theories, but it depends on the theories of the given field, not on meta-science. The application of specific research results – of an academic writing, a research report, a patent, an article published in a peer-reviewed journal – in the field of science and their relevance may be questioned, opposed, corrected or rejected, but only by the means of corrective tools with which this field systematically works not by means of the theory of science. In this context, its own theory is not needed or necessary for scientific results – neither does it require a meta-interpretation. The theory of science deals with a range of problems, starting with the classification of scientific disciplines and their methods up to complex philosophical questions concerning knowledge – however, it does not produce scientific results.

While science is accused of little self-reflection, art, on the other hand, is literally self-obsessed. It has reached a quite common situation, inconceivable in science, that the existence of an artwork sets the rules of art. (Vašíček, 2003, p. 154) In contrast to conservative and strict self-corrective procedures of science, an artist puts their work of any form into the space of their field without any limitations, and other participants, such as art historians, critics, curators, and art lovers confirm this status, turn a given work into a fetish while they continue to share and renew the faith in the value of this art. (Bourdieu, 2010)

3.8 Art Today

The emphasis on artistic individuality and the power of an independent creative act, which romanticism brought to art in reaction to the spiritual limitations of positivism, constitutes today a general idea of art connected with the incomprehensibility of talent and the exclusivity of an artwork which are incompatible with a normal life. We also associate art with sentimentality, though we tend to appreciate its ability to test the functioning of human society, to verify and irritate the communication channels represented by the human senses. (Bokes, 2007) From the social point of view, it should be emphasised that art performs – in addition to its many other functions – also a special role of challenge. (Horáček, 2010, p. 11) Horáček understands this challenge as the fact that art brings to public life questions that change a steady discourse of thinking, and disrupt established stereotypes of individuals' lifestyles and opinions, and of society as a whole. (ibid) Přibáň (2008, p. 120) tells the same in similar words: art forces society, to address the real issues that it would rather like to deny or push into the realm of fantasy.

Contemporary art is in many ways beyond the traditional criteria applied to art up until the early 20th century. In all articles on contemporary art, we find primarily the mentions of Duchamp, who started the tradition of establishing entirely new artistic criteria. This seemingly insolent and provocative transfer of industrially produced artefacts in the gallery environment fashioned a new postulate: it showed that any work can be considered art as long as we intend to regard it as such.

In contemporary art, all rules ceased to apply, and no theory of art can claim a universal validity. It shows that an essential element of art making is an intellectual reflection, but this intellectualism can also, as a consequence, hinder the creative power of artists. (Walther et al., 2011) Today's art does not specify any direction; it pursues orientation, it does not preach any wisdom, it asks questions of an ever more confusing reality – and of itself. (ibid, p. 390) The category of the so-called worldwide art, which was unified by a common principle, no longer applies either. This illusion has been discarded and only vainly we try to navigate through the cultural and ideological diversity of a broad artistic field. Nor is the question particularly interesting anymore, to which we have devoted considerable space in the previous chapters, i.e. objectivity and abstraction.

Přibáň (2008) notes that art is today often reduced to creating scandals, which is becoming more difficult year by year because the amount of taboo areas is gradually decreasing in Western society, as is an infantile resistance to the convention. Some artists have completely resigned from the permanence of their achievements, and focus more on stimulating media coverage. As Přibáň explains, we live in an age in which the dictate of immediate attention replaced aesthetic judgment. (ibid, p. 99) Artists become cultural heroes and they desire to become publicised social critics – however, they do not wish to be bound by any genre or formal norm. The idea reigns above expression and visual art is being considerably conceptualised.

A human body is being rediscovered as a remarkable creative medium, especially in action art. Also, the 'old' theme of nature is being newly experienced and defined in land art and works of art reflecting environmental contexts. The use of new media, technology, and cyberspace is growing, and information and communication technologies are now an integral part of contemporary visual art. Interactivity and intermediality are being established as principles of art; an up-to-date characteristic of art is again involvement, so art works as provocative, social or political criticism. Artists, who have the ambition to garner public awareness and influence the society, must publicise their message effectively.

There has also been a change in the understanding of the roles in the artistic process – not only has the position of an artist in the creative process changed, but also the role of a viewer in the process of interpretation. The understanding of the role and values of visual art as well as art in general have also been subjected to a complete transformation. The communicative function is being emphasised and the timelessness of the message is being abandoned. Pluralism, multiculturalism, global and environmental contexts, the manipulative potential of television culture and advertising, the infantilisation of Western man, and the cult of entertainment are being conceptualised. Art responds to the rapid development of information and communication technologies, to the dominance of popular visual culture, and the manipulative potential of media.

Although the state of art may seem problematic – especially due to the increasing barrier between ordinary people and the artistic field (which applies equally to science) – a return to art of some ideal forms of the past is not possible. Ortega y Gasset (1994) noted that the division of the audience into two groups – those who have the ability to understand, and those who do not, had already begun with modern art. Contemporary art is simply not meant for all, as was the case of ancient art. Only an elite minority is able to understand its complex contexts, and this fact can also explain the irritation, which art sometimes causes in viewers. Contemporary art is incomprehensible – just as is the time in which we live. However, as long as it manages to provide us with the opportunity to distance ourselves from the well-established forms of life and to awaken in the audience the ability to perceive culture as something un-automatic and valuable in itself (Přibáň, 2008, p. 102), then art performs its social function well. As Kupka says, in art, nothing is to be orthodox and nobody has had the last word in its regard. Art lives by foliation, its springs, and revivals. (Kupka, 1923, p. 41)

Fig. 6 Jean-Baptiste-Siméon Chardin, *The Attributes of Art*, 1766

Between Art and Science

'Some activities require a person to be more passionate, dedicated and enthusiastic than others. It seems that the same is true of science and art. [...] It seems that there is a long way from science to art. At least in one aspect, however, they are similar: people indulge in both with passion.'[13]
(Kerlinger, 1972)

4. When Art Makes Science and Science Art

Petra Šobáňová

Symbiosis, which stands in the title of our book, comes from the terminology of science, where it indicates the close and intimate coexistence of different organisms. Perhaps only metaphorically we may refer to science and art as notional symbionts representing two different fields of human culture, which we have tried to address and compare in the previous chapters. However, if the given symbiosis is a mutually beneficial coexistence, does our metaphor not have feet of clay? Do indeed both observed fields cooperate and use the 'good of' the other for their own benefit? As we may suspect, in the case of art it is certainly so. Artists have always used scientific techniques, knowledge and engineering applications to a great degree. However, is this symbiosis useful also for science? Does art after all not act just like its parasite? And anyway: is it desirable to continue interconnecting both fields, or is it more beneficial to rather refine their borders? This chapter and the following ones provide a number of examples of this symbiosis, and we believe that the answers to our questions will be revealed more clearly.

While we have shown many fundamental differences between science and art, it happens quite often that both observed fields sometimes produce a result that could easily be categorised as the outcome of the other field. Due to the separation of the world of science and art and their different specifics, it is surprising, but not rare. If we remember what we have previously stated

[13] Translation of the Czech text that reads: *'Některé činnosti vyžadují na člověku více zaujetí, oddanosti a nadšení než jiné činnosti. Zdá se, že je tomu tak i s vědou a uměním. [...] Zdá se, že od vědy k umění je daleko. Aspoň v jednom ohledu však jsou podobné: lidé se jim vášnivě oddávají.'* (Kerlinger, 1972, p. 11) – translator's note.

about art, namely, that under certain circumstances it can be anything, it is not exceptional when science produces art or a result of considerable aesthetic qualities. This applies to scientific activities performed far in the past (remember the (proto) scientific writings of the past, which we appreciate today for their contemporary literary culture and the aesthetic value of their illustrations rather than for their scientific content) and it applies equally to the science of today.

A good example of a product that originated primarily from study, rather than out of artistic efforts, and yet entered the centre of the art field with surprising vigour, may be represented by the book titled *Art Forms in Nature*, which was published in 1928 in Berlin. In the book, the author, a professor of drawing, Karl Blossfeldt, published his large-format paintings of plants and their details, which he created using the relatively new medium of photography. The book became a sensation because Blossfeldt (1928) in his naturalistic photographs reached an unexpected effect: enlarged details of plant bodies and their fruits, their tendrils and stem cuttings acted virtually as apparitions from another world. Their aesthetic value and sculptural grandeur on one hand, and the perfect geometric forms and sobriety on the other caused quite a stir in the former modernist intellectual world, which perceived those as images on the border of the New Objectivity photography, science, and Surrealism. (Hubatová-Vacková, 2011) Even today when looking at these photographs, an unavoidable question keeps being raised: In this case, is it a document of objective observations of professional scientific nature, or a monumental work of art?

What made Blossfeldt's photographs disquieting was the fact that the zoomed image, perhaps too materially and with a palpable urgency showed what was actually outside the natural human visual perception. Only optics of purely technical means are able to capture such perfect, abstract geometry of an unknown yet quite real and natural world. (Hubatová-Vacková, 2011) For the author himself, these images were the symbols of universal laws of life forms, the image of the creative act of nature and its 'will to a form'. (ibid) The photographs show that every art has its prototype in nature; the fruit of which is also human beings themselves.

Goodman's (2007) belief is thus confirmed yet again. He proposed that if an image, object, or phenomenon has the ability to symbolise, it may become art. And it is exemplified by not only Blossfeldt's photographs, but also by other originally purely scientific images that gained the attention of the participants in the artistic field for their extraordinary visual power and the ability to acquire rich symbolic meanings.

Fig. 7 Images from the book *Art Forms in Nature* by Karl Blossfeldt, 1928

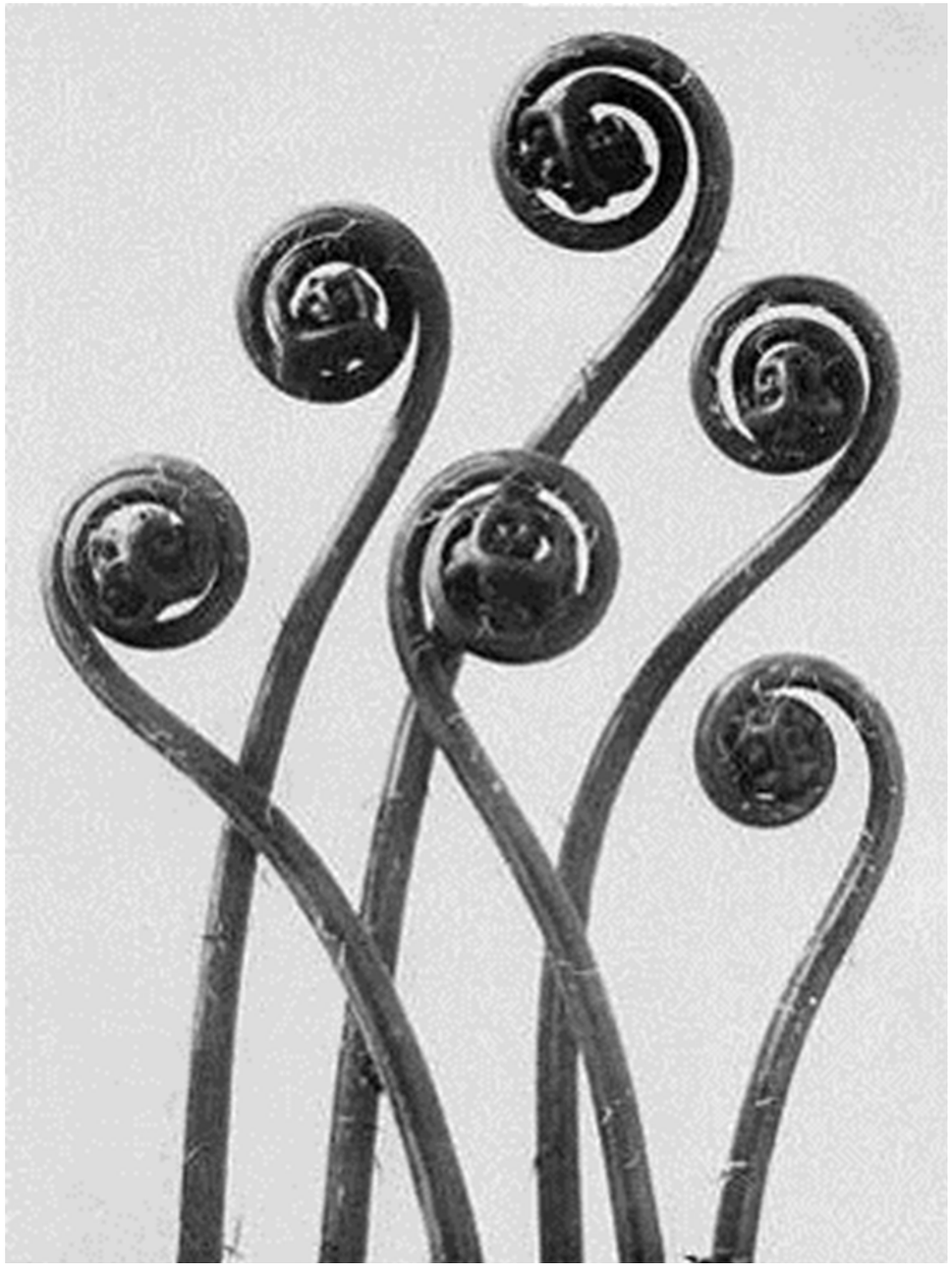

Fig. 8 Images from the book *Art Forms in Nature* by Karl Blossfeldt, 1928

It is not even a hundred years since Blossfeldt published his *Art Forms in Nature*, and we can witness still more surprising and accomplished depictions of nature. To achieve depictions of such quality, optical microscopes, CT scanners based on tomography, micro X-ray based on X-ray radiography, or complex mirror telescopes adapted for astrophotography are being employed.

As an example of contemporary extention of science to the field of art, we would like to present works by Czech scientist Viktor Sýkora (Sýkora, Hroudová, 2009), who is the author of numerous large-format microphotographs of plant seeds, fruits, and other plant parts. His pictures were created using light and scanning electron microscopes, and they offer a fascinating insight into the almost surreal world that remains hidden to the naked human eyes. The author does not use only microscopes, but he also experiments with microradiography.

Micro X-ray with high resolution allows one to view not only the external appearance of an object, but also reveals the hidden internal shapes and unexpected structures of millimeter-sized natural products.[14] Fine fibre clusters, bright coloured surfaces, unexpectedly complex linear systems – is it really nature, a natural world, or rather a mysterious 'second nature', the world of fantasy shapes and dreamlike imagination?

Current scientific knowledge and advanced imaging and reproduction methods reveal intriguing and sophisticated ingenuity of the structure and evolution of both individual terrestrial organisms, as well as the entire universe. We can just 'marvel with increasing qualification' at this ingenuity. (Grygar, 2001, p. 10) And paradoxically it is far more mysterious for us than it used to be for our ancestors.

[14] It is for these photographs that Viktor Sýkora (1st Medical Faculty at the Charles University) along with his colleagues Jan Žemlička, František Krejčí and Jan Jakůbek from the Institute of Experimental and Applied Physics (ÚTEF), at the Czech Technical University in Prague were awarded in the 10th prestigious international competition titled *International Science and Engineering Visualization Challenge*. This competition is annually announced by the National Science Foundation, a key organisation for funding and research organisation in the USA. The competition annually announces the best scientific results, which help bring science closer to the public by means of its visual forms. The above-mentioned scientists, whose photographs are published in our book, succeeded in this competition with their images of plant seeds taken by X-ray radiography with high resolution and contrast in combination with images from the optical microscope. The images from the competition demonstrate how the development in the field of semiconductor pixel detectors, which the Czech Technical University in Prague ÚTEF intensively engages in, opens up completely new possibilities for research in other fields, such as biology or medicine. These scientists won second place in the category of Photographs and are the first representatives of the Czech Republic, who succeeded in this competition (Sýkora, 2013). Results of the competition, including the images themselves were published in the February issue of the prestigious journal *Science* and are available – along with other fascinating visualisations of scientific knowledge – also on this website: (http://www.sciencemag.org/content/339/6119/510.full).

At the same time, these perfect images raise doubt: if this is a previously unknown form of reality to humans, what else remains unavailable to our senses? Current scientific discoveries and their visualisations not only demonstrate new and surprising forms of the order of nature, but they also necessitate humility before the unknown.

Fig. 9 Viktor Sýkora,

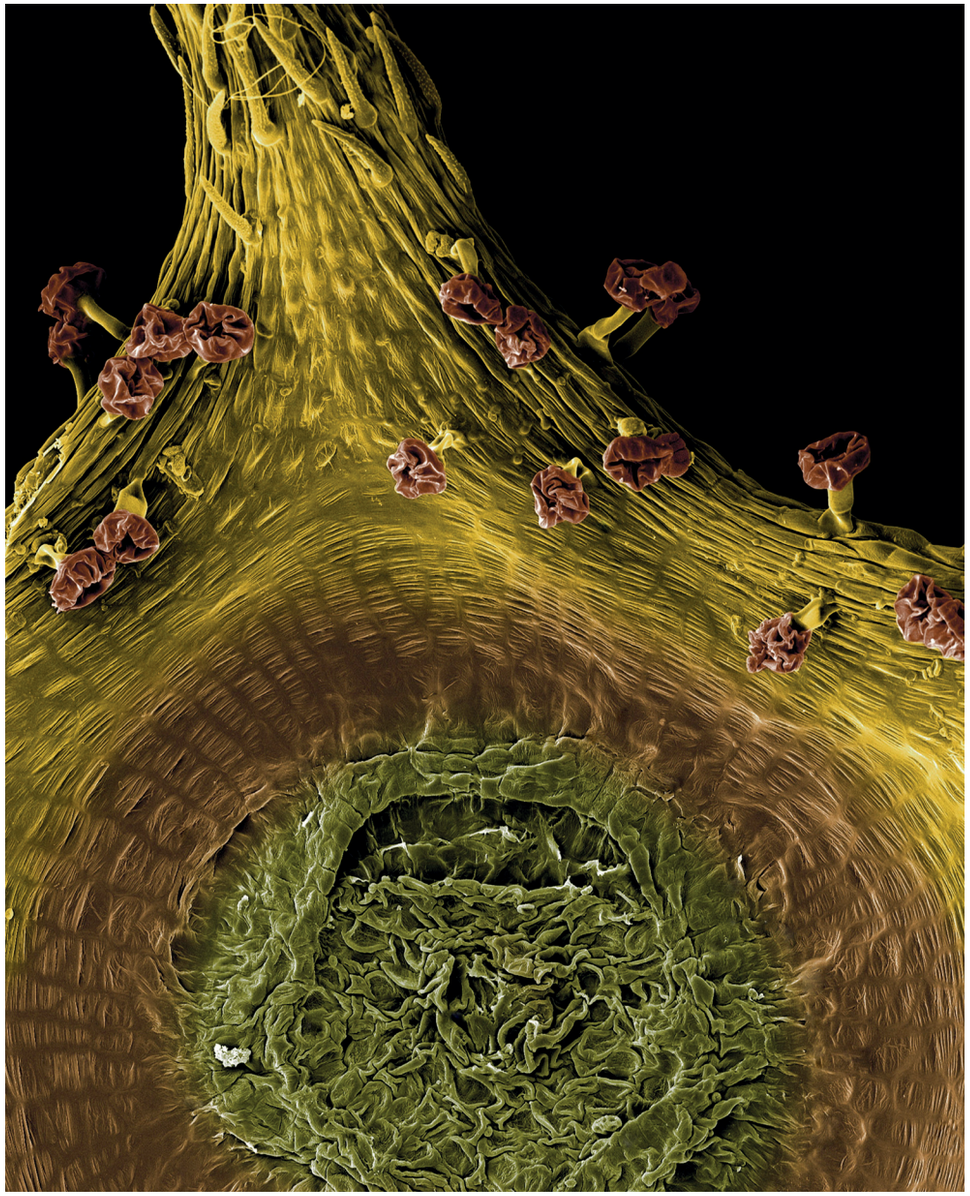

Fig. 10 Viktor Sýkora

Fig. 11 The winning photograph of the team of authors: Viktor Sýkory, Jan Žemlička, František Krejčí, and Jan Jakůbek, 2012.

If science can make art, is conversely art able to produce science? Examples of art that not only uses scientific methods, but could also have scientific relevance (if that were the objective of the artists) may be represented by biotech art, usually abbreviated to bioart. It uses 'biological material' for creative activities, such as cells, DNA, bacterial cultures, tissues or animals, and yet it works with various empirical methods. In addition to observation or measurement, it also uses an experiment in particular, which in combination with genetic engineering techniques, special laboratory equipment and current technologies often brings shocking results.

One of the best-known bioart representatives is Adam Zaretsky, who, for example, realised a humorous performance in which he exposed the culture of E. coli in Petri dishes to 48 hours of hits played by a certain Anglo-Indian pop star. The result of the experiment confirmed the artist's hypothesis about the negative effects of this type of music because the bacteria responded to the music by an increased production of antibiotics. (Pasko, 2007)

Another artist named Eduardo Kac, went much further when he genetically manipulated a fertilised rabbit egg into which he brought the gene for a fluorescent protein from jellyfish. The new born kit, a female rabbit Alba, then had the ability to luminesce in green colour in the appropriate light.[15] Earlier the same artist had a microchip implanted in his body in order to start a debate about the impact of technology on people's lives. (Mihulka, 2007)

Also the artist Julia Reodica, originally a student of the Faculty of Medicine, is willing to use her own body for her artistic projects. In the project *hymeNextTM,* she brought together a rat tissue culture and her own vaginal cells, and thus grew a series of virgin membranes. In this work she not only addressed a female body, but also modern sexuality and the value of virginity in the contemporary Western society. Unusual effects are exerted also by her large replicas of muscle cells or sculptures in the form of embryos – a kind of mythical creatures. (Pasko, 2007) Surely it is no coincidence that similar visualisations can be often found in contemporary sci-fi films, which also address the impacts of current technologies on the world and human beings, or, the possibility of genetic manipulations and artificial cultivations of living tissues.

[15] In the context of iconography of animals and its changes as the results of new paradigms of exact sciences, Eduardo Kac will be mentioned again in chapter 8 (New Paradigms of Exact Sciences in Contemporary Artistic Expression).

Also the artist Marion Laval-Jeantet deals with the theme of body and biotechnology. During the performance titled *May the Horse Live in Me?*, she had a serum with horse blood injected in her body. The author wanted to explore its therapeutic effects – which could be considered a regular scientific experiment – if at the same time she did not confirm her blood brotherhood with a horse by walking by his side wearing prosthetic horse legs, and if she did not open a rather general problem of the boundaries of individual species, the possibilities for their crossing, and the dominance of humans over animals. (Batinić, 2011)

It is clear that these artistic experiments – but also the experiments of scientists – can provoke a controversy. According to some, these are highly unethical activities during which artists take living organisms as mere material and arrogantly interfere with natural life forms and genetic processes just to gain attention. According to others, these attempts are useful – unlike scientific results, understandable only to the community of the given specialisation, they have a metaphorical dimension, wit and ability to generate the necessary discussion on the current possibilities of humanity. With their help, society can gradually accept possibilities that still remain rejected (e.g. genetic manipulation of crops, the use of stem cells from human embryos, etc.), and take advantage of new technologies to pursue an unbridled development, or conversely to identify ethical boundaries that to be respected.

Not all art projects on the border of art and science, however, must be controversial. Many make use of new materials and observe and visualise natural physical phenomena 'only' in an unusual way. A good example might be the work of Prokop Bartoníček titled *Worlds as Fragments* that utilises nanotechnology and carefully studies the dynamics of the behavior of materials used in the work when changing the magnetic field. The author created a microscopic 'space' installation, in which intangible formations move in a dreamlike manner reminiscent of space vessels and underlying the assumption that it is a different world and has different extra-terrestrial laws of physics. (Vidlička, 2010)

The universe attracts more and more attention – the more we know about it, the less knowable it seems. Andy Gracie uses data from the universe in his artistic experiments and observations, which are still supplied to us by space probes

sent decades ago. In particular he works with information about magnetic fields in space and on the basis of these data he simulates the conditions prevailing outside the Earth. A. Gracie subsequently exposes earthly life forms to these conditions, namely the culture of tardigrades, micro-organisms, which have special skills, such as resistance to extremes, the ability to withstand high radiation or stay in a vacuum. In the project *Deep Data*, the author exposes these microorganisms to strong magnetic field and monitors their reactions and extraordinary ability to survive. This seemingly purely scientific experiment, however, becomes art, thanks to its ability for symbolisation. The cultures of tardigrades become the image of earthly life or the image of humans, which addresses the secrets of life on Earth, the chances of survival of an apocalyptic event or the impact of various types of radiation, to which we increasingly expose our bodies. (Gracie, 2009)

Let us conclude this passage by the latest example, from the workshop of the Portuguese artist Marta de Menezes, who uses biological laboratory material to create genuinely 'live' images. Inspired by the work of Piet Mondrian, whose geometric composition she reinterpreted using agar (i.e. a natural polysaccharide, which is commonly used as a nutrient medium for the cultivation of microorganisms) and bacteria. Images were formed as enlargements of Petri dishes in the form of geometric shapes, in which the colours of individual forms were gradually changed by the activities of a certain type of bacteria which are able to degrade, respectively, to eat polluting textile dyes. Part of the life of Marta de Menezes's paintings is demise, which is especially demonstrated at the exhibition. By slow activity of bacteria the images gradually disappear before the eyes of visitors and the principle of modernist abstraction and reduction is thus brought to ad absurdum. (Tomaides, 2008)

5. Science and Its Applications in Art, Art in Science

Petra Šobáňová

The past decades have changed the relationship between art and science a lot. These two areas, which had until recently been understood in the spirit of positivism as contrary to one another, continue to influence each other and create a number of intersections. Some experts (esp. Feyerabend, 2004) show that a clear theoretical division of study fields does not comply with their practice, and they believe that there are no 'purely scientific' areas, or, 'pure art'. In his texts titled *Science as Art,* Feyerabend (2004, p. 7) points out that artistic experience precedes sciences, especially where new and surprising discoveries occur. It is interesting that the differentiation of study fields and art works, and the today's extremely narrow specialisation result in the fact that some of the practices used in various disciplines may be more distant to each other than some procedures that are inherent to art. (Goodman, 2007)

From the modern era, science is aimed at applications, technical progress, and the mastery of nature. (Henckmann, Lotter, 1995) Art does not have such objectives; as already indicated, its domain is symbolisation, the transmission of cultural meanings, the development of a human being and his/her self-interpretation in a specific historic environment, and culture. To achieve these objectives, art makes use of all the available advancements with extraordinary ingenuity, including findings of various fields of expertise, scientific discoveries and technological inventions and applications. For example, in the days when the objective of art was to imitate nature (Danto, 1964), artists employed various measuring instruments and optical devices to make this task easier. Well-documented examples can be traced back to the 15th and 16th century. (see Dürer's engraving from 1525 in Fig. 12)

Mathematical principles, geometry and arithmetic were introduced not only in the creative process, but also in art. Numerous examples of the creative visualisation of simple mathematical, or combinatorial principles from the Baroque period to the present constitute the pictorial part of our book which will be briefly commented on in chapter 7 titled Visualised Combinatorics.

When looking at the reproduced works, we understand that throughout history, beauty has been often linked with perfection of mathematical order.

Fig. 12 Albrecht Dürer, *Depicting a Head*, 1525

This order has been sought after in the nature, and artists have sought to study it in detail and to transfer it to painting, sculpture, and architecture. Grygar notes that some empirical methods (not only artistic) confirm the aesthetic dimension of nature: experience in science clearly points to the mathematically elegant description of natural events – aesthetic criteria play a surprisingly important decisive role in the process of formulation of scientific laws: if for some interpretation of a given phenomenon we choose various types of mathematical description, then regularly the most elegant method wins. (Grygar, 2001, p. 10)

We can therefore find abstract natural numbers and their ratios not only in nature but also in arts. The most advanced ratio of all is the so-called golden section – artists have been implementing perfect proportions between different lengths in their works at least since the Renaissance period. Mathematics and physics have also affected the study of colours and the development

of perspective. The 'invention' of perspective visualisation is considered perhaps the most striking result of the collaboration between science and art.[16]

The creation of an artwork was often an issue mainly of geometric nature, and painting was part of the emerging sciences. It was necessary for a painter to study geometry for creative activities – not only painting, but also sculpture and architecture – to have scientific foundations. (Feyerabend, 2004, p. 16) This was also reflected in the establishment of the first professional art school called academies (see Accademia delle Arti del Disegno ve Florencii).

Although you can find examples of artists who deliberately avoided reason and technical applications,[17] industrial products and technologies were always implemented into artistic creations soon after their discovery. We can say that artistic creations always use the best available technology – it applied in the past and it still does today as well.

Not only are technologies being increasingly used, but they even become a work of art themselves (see net art projects, software art and various readymades). In its historical imaginary arc we can interconnect Renaissance artists (led by Leonardo da Vinci, who was convinced that painting is a science in itself) with surrealists, who were inspired by the findings of psychology; op-artists, who used physics (resp. optics); or conceptual artists building on semiotics.[18]

Scientific knowledge and technical inventions have an immense influence also on creative materials and art techniques. Thanks to science and technology, new materials such as glass, concrete, steel, and electricity have entered the field of art. An artwork can use light, it can move, make noises, and disseminate and communicate via the Web. Also, the dynamic development of the reproductive art is done only through science and technology. Without it there would be no graphical techniques, or photography, film or digital media, i.e. audio, video or photographical content in digital compression, which opens further possibilities.

[16] Ingerle offers a detailed version of the *Příběh perspektivy* (Story of Perspective) to the readers. (2010)

[17] For example, the 18th century, in which reason clearly won, brought to art paradoxically a few mystics and visionaries, such as W. Blake, who apparently feared and hated the compass, as well as the malicious tools of Newton and the 'smarties' of his kind who he believed wanted to rob life of his poetry. (Beckett, 2001, p. 40)

[18] It is important to note, that literature was influenced even by genetics, sociology, and psychology which was demonstrated by the emergence of naturalistic and realistic literature. (Henckmann, Lotter, 1995)

In generative art, artists even leave part of the creative process to be performed by a machine. A computer becomes not only a tool, but also a co-creator, because even though the artist 'sets' and starts a specific algorithm of the computer software, he/she does not (and cannot) predict the results of the computer's activity according to this algorithm. In such a way, a computer can visualise and set to music the supplied data; produce results using chemical, biological, mathematical or robotic systems; experiment with artificial intelligence, while realizing autonomous creative processes. Why could Kubrick's HAL 9000 not be an artist?

We can illustrate the above phenomenon by at least several examples concerning the process of setting data to music. For example within the scientific field, experiments to convert into sounds physical and biological data that do not originally have an audio form have been performed. Example of this can be the transfer of DNA into a musical score (scientists from the University of California), or setting the Higgs boson (the hypothetical assumption which is currently recognised as a physical idea about how the world works) to music, which is being pursued by a nuclear physicist, Lily Asquith, who uses tones to reproduce the physical characteristics of particles and simulates the sound of the stream of particles and their energies. Another example is the attempt to convert the electromagnetic recordings of the Voyager probe into an audio format. In the past, NASA used to popularise their results in this way, and have released the recordings on CD, although it is a certain mystification: after all, sound does not travel in a vacuum. Other data, this time of the solar plasma oscillations of various modes were used by astronomers from the British University of Sheffield. Scientists have artificially increased the frequency of the seismic waves so that listeners can hear them, because seismic and sound waves have the same physical nature. (Pink, 2010) Many details, along with links to audio recordings of the above mentioned experiments can be found on the website Osel.cz (see e.g. Pazdera, 2007, Gregorová, 2010, etc.).

Similar experiments have also been done within the field of art – again, these mainly concern the transfer of data into an audio form, but in this context the data are used as a deeper statement about contemporary society. As the composer Luke Dubois says, our century is the century of data and their analysis – in which only a few really engage – is deeply informative. Aiming to understand data from our culture, this artist tried a creative approach to statistics about

the war in Iraq. He formed a string quartet in which each dead person becomes one note and each year of the conflict constitutes a minute of the piece, which copies the conflict in a disturbing and ominous way. (Dubois, 2012)

Also in the field of visual arts many examples can be found, whether it is automatic content generated on net art web pages or the creation of generative computer graphics and videos. Artists are also venturing into software creation, a variety of alternative browsers or screen savers, or into programming computer games. Using the most up-to-date technology they test the attention span of internet users and contextualise problematic or risky moments of our life in cyberspace and media reality.

While art is closely linked with science and its applications, what is the case of science? Does it use art? Does it apply artistic methods or results?

There is certainly less influence of art on science, but it can be traced. Leaving aside the well-known research method of empirical science, the experiment, which was created in painting and music, and only from arts was it taken into science (Henckmann, Lotter, 1995, p. 195), we sometimes hear the cry after an overall 'artification' of science. The author of one of them is Feyerabend (2001), who, after his criticism of a well-established understanding of science, invites scientists to pursue a free formulation of hypotheses that will contradict validated and accepted theories in an anarchic way. In this context he asks: is it possible to continue using outdated terms for the description of perceptions? Would it not be better to introduce and apply a new language? And could poets not help with finding such a language? (Feyerabend, 2001)

While in natural sciences it is difficult to find influences of art, another situation occurs in social and human sciences. This is not just about today's extensively discussed artist-led research, but also about finding alternative ways of presenting research results. It turns out that these can be presented in a different, experimental form, e.g. involving fictional, literary texts, which are verified especially in psychology. (see Lášticová, Petrjánošová, 2010, p. 39, Neusar, 2010, p. 54) A literary text, namely a poem can also be used as a primary source of information about the observed entity (i.e. as research material) or it can be a kind of semi-finished product, i.e. an analytical tool with several useful advantages. These include a shortening of the text, its more concise encoding, and the presentation of an emotional content. A poem, however, may also

be the result of the research itself – representing a complementary, or even the main result. (Neusar, 2010, p. 54)

Whether or not similar ideas sound more or less peculiar, attempts to give academic texts other forms such as the one of fictional prose or auto-ethnography appear on multiple sides. They all readily admit that most scholarly articles cannot be read at all, because the current convention dictates to write in a disorganised and unreadable manner. Besides classical academic texts, which van Maanen (1988) referred to as realistic stories (these are the well-known texts formulated impersonally by an expert authority), various reflective confessional tales are also used, in which the author explains his views, the perspective when observing a selected phenomenon, and its interpretation. In similarly tuned texts, the researcher does not avoid a personal presentation of the issues or doubts that accompanied his research. This way of writing responds to the disillusionment of the strict objectivity of the researcher, it admits the impossibility of the achievement thereof, and intentionally reflects the subjective 'personal' circumstances of the research.

Another type of similar texts is the so-called impressionist tales. They are written in a dramatic form and their aim is to comprehensively and with a high degree of subjectivity deliver to the reader the 'story' of the research and everything the researcher saw, heard, and felt during his research. Knowledge is therefore presented in a fragmentary manner, often using narratives and the reader is kept in suspense. (Lášticová, Petrjánošová, 2010, p. 46) Today there is even an entire spectrum of genres different from traditional academic texts: fictitious (ethnographic) prose, poetic representation, (ethnographic) plays, mixed genres. (ibid)

The aspect of strict objectivity is deliberately abandoned here in favour of authenticity and communicability. There is even talk of artistic evaluation criteria of qualitative research. (Patton, 2002, p. 432) Research that has artistic quality and the ability to evoke the given phenomenon opens the way to a deeper vision of the world. It is creative; it has aesthetic quality, interpretive liveliness; it is based on lived experience; it is stimulating and provocative. It has the ability to reach a recipient of the message and change them; the expression of the text is unique and expressive; the reader feels that research is authentic and true – that it truly captures the multidimensional reality. It is assumed that objective

concepts and utterances can hardly grasp the complex human entities or capture the world as perceived by these entities. (Feyerabend, 2004, p. 96) It is all about understanding, and this objective is better achieved by these processes than the classical ones.

Although in psychology or sociology and the humanities, similar 'artification' may be natural, the question is the efficiency of these processes in natural sciences. For example, in medicine, however, such methods appear – a narrative approach also occurs along with the prevailing evidence-based medicine. Narrative-based medicine, for example, works with the patient's narrative about the disease, which can become a key factor not only for the relations between the attending medical staff and the patient, but also for the therapy itself. (see Adámková, 2010, p. 157) Stories are used in the diagnosis, in the therapeutic process, and in research where they help to identify a patient-oriented approach, to create new hypotheses and provide an enriching confrontation with the results obtained by classical methods of research. (ibid)

The presented examples certainly do not bring down the differences between science and art. As Goodman (2007) believes, the declaration of indissoluble unity – whether of sciences, arts, art and science and humanity – only highlights the differences between them. (ibid, p. 234) The same author points out, however, that the relationship of these cultural expressions is very deep despite their many differences. He sees their differences especially in the predominance of certain specific features of the symbols, not in the difference between feeling and fact, intuition and judgment, enjoyment and pondering, synthesis and analysis, sensation and thought, concrete and abstract, passion and action, and intermediacy and immediacy, or between truth and beauty. (ibid, p. 234) Just understand that art and science work with symbolic systems, i.e. graphical symbols, words, texts, images, diagrams, maps or models – as well as these two areas create, use, read, transform, and dominate them. It is more than obvious that science and art are part of a single culture and are specific human efforts in pursuit of knowledge. That will continue, and further their mutual influences – completely natural, yet surprising – which already occured, will continue to grow through the uncertain borders between the two cultural fields.

6. When Art and Science is One

Jana Jiroutová

In every dynamic culture, art and science constitute a twin engine of creativity. The clear demarcation of each of these areas is becoming increasingly difficult to define the issue of which has been frequented at many debates. Science tries to understand natural phenomena using scientific methods including observation, experimentation and testing, formulating hypotheses and their confirmation or denial. The field of science is focused not only on science, but it also extends to the sphere of social and formal sciences. Art, on the other hand, was especially in the past characterized by the applications of time-honoured media such as painting, printmaking, and sculpture, and was created primarily for the purpose of aesthetic experience. With the advent of new artistic means and courageous even daring experiments with the latest technological advances including also those which were not in the least artistic, the boundaries between art and science have been gradually disappearing. In his book *Art + Science* (2010), Stephen Wilson draws on the institutional theory of art according to which the definition of art is 'dynamic, being formed by whatever the network of art-world participants – artists themselves, curators, historians and critics – consider to be acceptable.' (Wilson, 2010, p. 8)

Although much has been said about the differences between the two entities, Stephen Wilson is inclined to think that their separation can be fatal. He maintains 'the partitioning of curiosity, inquiry and knowledge into specialized compartments is a recipe for cultural stagnation.' (ibid, p. 6) His argument rests on the fact that cave painters were already intense researchers in the area of zoology, anatomy, and physiology; 'their paintings reveal a sophisticated understanding of animal life processes.' (ibid, p. 13) As Stephen Wilson further agues, 'open a history of science or a history of art, and you will find prehistoric cave paintings as a first significant milestone in both.' (ibid) He points out that as much as Leonardo da Vinci was considered a genius, he was not by far the only versatile personality of the Renaissance. 'He was in fact participating in a culture, one of whose core values was that artists and scientists could not succeed without being vitally interested in each other's work.' (ibid)

As Wilson further explains, 'Leonardo, as well as others had a notion of 'deep seeing', which meant understanding the underlying processes of the world (somewhat in the way scientists would) and which was seen as an essential tool for the making of art. For example, studying flow dynamics helped when an artist wanted to paint water; studying flight mechanics helped when painting birds; and investigations of anatomy and dissection enabled artists to be better painters and sculptors of the body.' (ibid) Seeing, as Stephen Wilson emphasizes, includes more than just perception, but also the attempt to penetrate the essence of hidden forces and principles of the world around us. (ibid, p. 14)

Edward O. Wilson, and American biologist, researcher, naturalist, and author also believes there is a close connection between science and art. In his book *Consilience - The Unity of Knowledge* (1998), he explains the way in which to generalize a subjective experience. Just as a colour-blind person cannot know what it is like to see colours, people are equally unable to empathize with the feeling of a honeybee when it senses magnetism or with what an electric fish thinks as it orients by an electric field. (Wilson, 1998, p. 127) What we can do, however, is to convert the energies of the magnetic and electric fields into images and audio tracks – the sensory modalities we biologically possess. Imaging sensory organs and the brain activity of bees and fish, we are able to monitor activities of the nervous system. But we will never be able to feel the same way as they do. Edward O. Wilson points out, that the distinction that illuminates subjective experience does not lie in incapacity but in the respective roles of science and art. (ibid) While science perceives who can feel colours and other sensations and why, art transmits them among persons of the same capacity. (ibid, p. 127) Art, as Edward O. Wilson maintains, 'is the means by which people of similar cognition reach out to others in order to transmit feeling.' (ibid, p. 128) The author explains that the new basic information comes from scientific knowledge by studying the dynamic patterns of the sensory and brain systems during episodes when feelings are evoked and experienced by means of art. Edward O. Wilson postulates that scientific fact and art can be translated into the language of one another. He argues that 'the common property of science and art is the transmission of information, and in one sense the respective modes of transmission in science and art can be made logically equivalent.' (ibid)

In this chapter, we attempt to show works where this connection succeeded and which thus forms an important bridge between these seemingly different worlds.

6.1 Immersive Art and Telepresence

Canadian artist Luc Courchesne is a representative of immersive art and cofounder of an art movement focused on media art. In his article 'Experiential Art: Case Study' (2002), Courchesne speaks of interaction and immersion as the two key deadlines for media artists who deal with installations. (Courchesne, 2001, p. 12) It monitors the projected information on computer screens whereby it meets the potential of an interactive media. Immersive imaging frees the viewer's body, because it creates countless possible angles; the viewer chooses what he wants to watch, they choose subjects from which they want to create something. Any immersive media is therefore inherently interactive transforming a mere observer into a real visitor. (ibid)

His first projects focused on interactive portraiture, which was a technique with a long artistic tradition to which he has assigned a new form. In particular, we should make a reference to his important project titled *Portrait One* (1990), which was exhibited in Montreal Museum of Fine Art in 2007. It is an interactive video installation for a computer with a touchpad, a laser disc player, and a screen. The original version is in French, subtitles in English, German, Italian, Dutch, and Japanese language. Marie, who speaks to the visitors from the screen, is a French-speaking resident of Montreal, she is approximately 30 years old and is embodied by actress Paule Ducharme. Marie seems to be in a dreamy state from which she can be awakened by a visitor clicking on 'Excuse me ...' on the screen. At that moment Marie engages in a conversation with a visitor, which evolves according to the visitor's curiosity and Marie's mood. A conversation may be shorter if the visitor is tactless or fails to display sufficient interest, or, it may develop into a lengthy polemic about love in the context of virtual relationships. The author explains that one of the motives that led to this project was the desire to answer the question, what symbol would link the technology and content so that visitors will have the desire to immediately become part of the work. (Courchesne, 2001, p. 5)

Currently, the subject of his work is the area of landscape. His installations consisting of 'panoscopic' displays and devices, created on the basis of his own design, stimulate in-depth experience transforming the members of the audience into real visitors, participants, and residents of his experimental vessels. In July 2000, he presented his iconic work, *Panoscope 360°*, at SIGGRAPH conference. Thanks to this work, Courchesne can offer visitors an all-senses immersive experience. This project is based on a single channel hemispheric projection system (a monitor), which consists of a large inverted dome, hemispherical lens, a computer projector, and a surround sound system. Inside this device with a manually operated pointer, visitors can move in the 3D environment in real time. Visitors are surrounded by a visual field, which covers an area the size of 100 degrees vertically and 360 degrees horizontally. Visual immersion is achieved through a single source image; a distorted anamorphote view of the entire visual field is projected on the inner wall of the inverted dome. (Courchesne, Luc, Guillaume Langlois, and Luc Martinez, 2006)

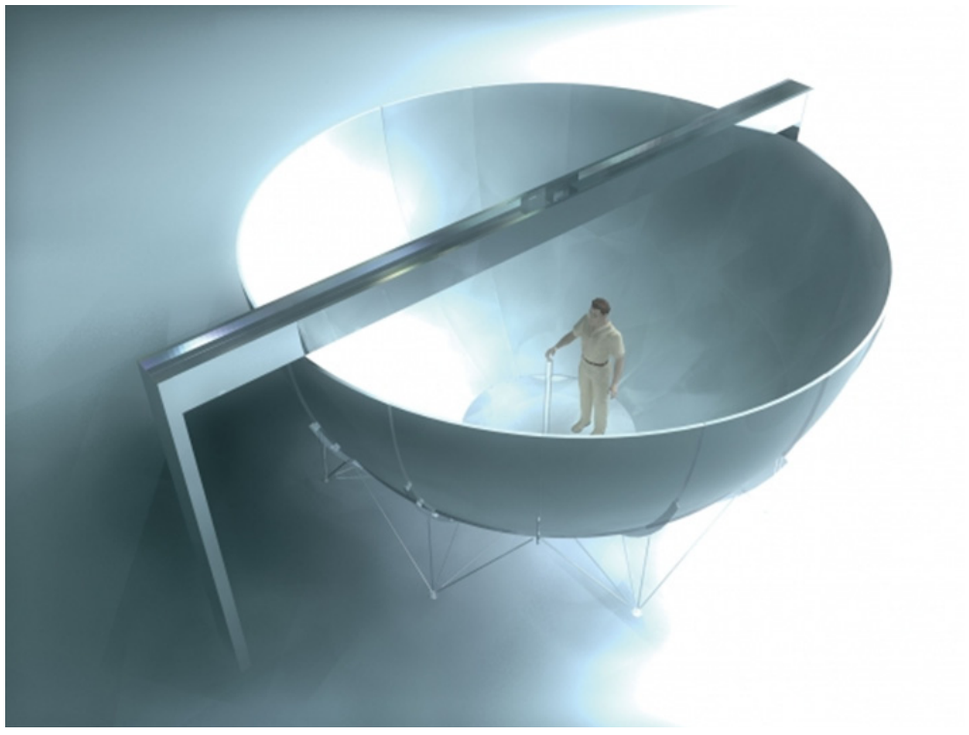

Fig. 13 A digital image of Panascope 360°[19]

[19] Source: http://courchel.net/#

Another important project which has pushed the technology of this device further is titled *You Are Here* (2010). The device Posture Platform for immersive telepresence is composed of the Posture network, that is, a server which links several Posture bases together. To navigate inside a base (also of copular shape) through virtual terrain, participants use an application for the iPhone. Subsequently an array of video cameras positioned horizontally around the participant have been added to the device; video streams from these cameras are multicast in real-time to all other bases and used to compose the photographic likeness of each participant in their relative position. Speakers built into the immersive screen are used to render the soundscape within the projection space; open headphones allow noise to freely pass in and out because they are made from sound permeable material. The participant is therefore not isolated from the outer sounds (as in the case of closed headphones) and the sound which reaches the participants is more natural and is as if it were really coming from the surrounding area.

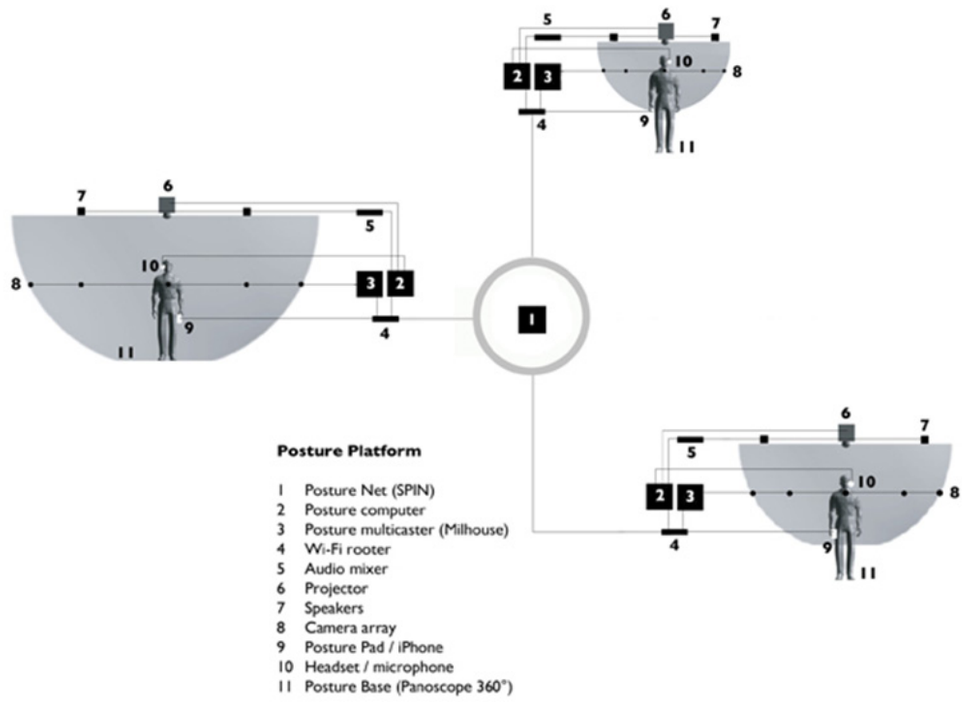

Fig. 14 A scheme of Posture Platform[20]

[20] Source: http://courchel.net/posture/

In Posture, terrains are created as contexts for exploration, encounters, and interaction. The initial terrain *You are here* invites participants to play with scale. Scale x1 blends the physical reality with its exact virtual representation allowing participants to seamlessly enter and exit Posture Bases physically or virtually. Scale x2 takes participants into imagined or documented remote landscapes. Scale x3 morphs landscapes into a humanscape formed with portraits of registered participants. Scale x4 opens a participant's personal archive saved on their iPhone. In *You are here*, as in any other terrains in the Posture platform, encounters with other participants in distant Posture Bases can happen anywhere and at any moment. As in the physical space, participants are first seen from a distance, and decisions and strategies concerning the process of approaching each other have to be mutually decided and executed to create a face-to-face encounter. In a narrative characteristic of increasing fluidity between folds of the real, a number of friends or colleagues could decide on a rendez-vous at a certain time and place within a Posture terrain and then individually search for a nearby Posture Base to spend time together.

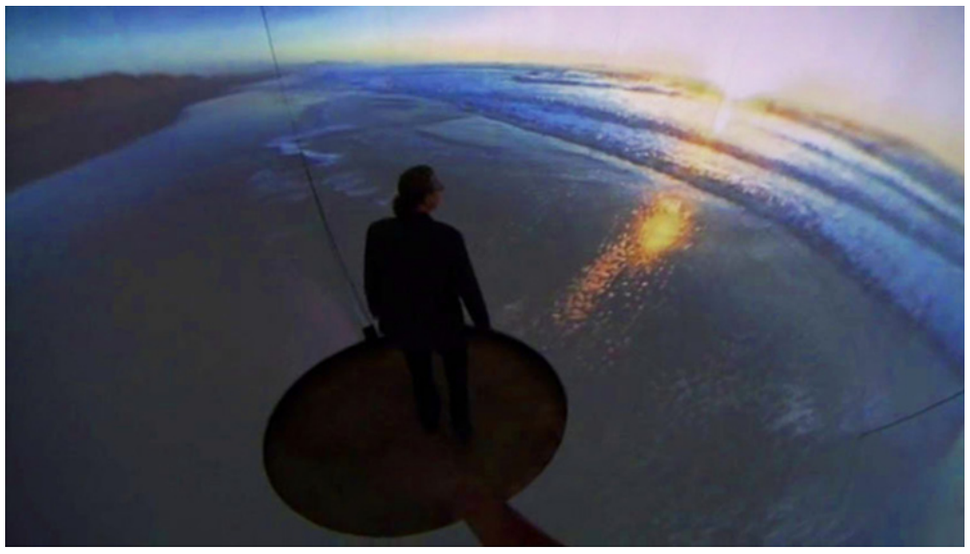

Fig. 15 Inside the Posture[21]

[21] Source: http://courchel.net/posture/

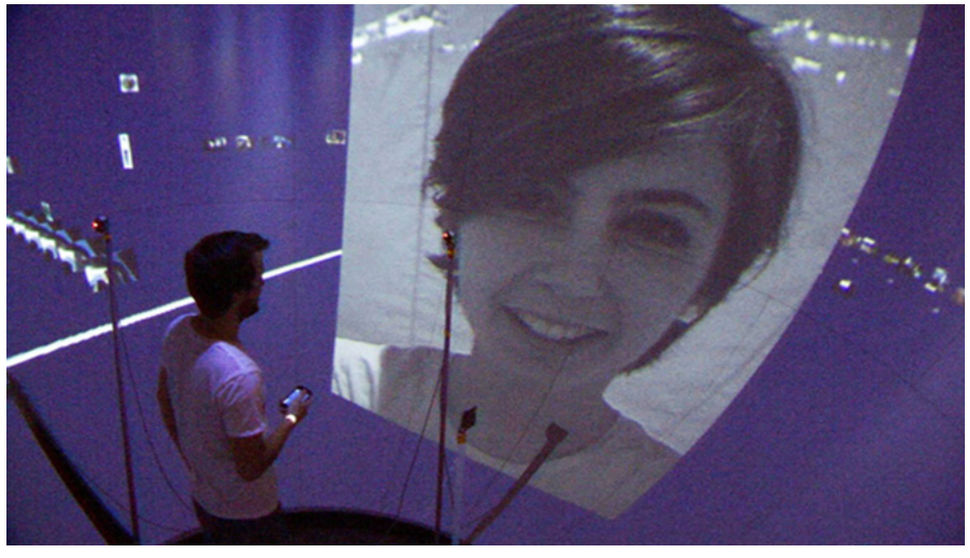

Fig. 16 The encounter of participants in a Posture Base[22]

Also Ken Goldberg engaged in his famous project, *Telegarden,* in telepresence. In 1995, he realised together with his collegues an important project which made it possible for internet users across the world to take care of a real garden. They have decided on the application of a garden because they believe it is an environment which is immediately very natural, tactile, and familiar to people. This project thus brings together old traditional agricultural technology with the latest internet technology.

This robotic interactive installation consists of a physical garden of circular shape in the center of which is a robotic arm which executes tasks given by internet users. The robotic arm is connected to a web camera, a water container, and planting and spading tools which allow the visitors of on-line garden not only to explore it, but also to take active care of it as community members. After executing 50 simple tasks, a member of the community is given the right to plant a new plant. Goldberg emphasises that it was interesting to see the strength of the relationship that the people built with the plants they had planted themselves. In the village square forum, the telegarden members had the chance to communicate with each other and to share their knowledge and experience gained from their own gardening. As Goldberg explains this project is a direct contrast to the projects of the latest technology the purpose of which is to primarily gain an immediate

[22] Source: http://courchel.net/posture/

response and result. (The Telegarden, online) Conversely, nothing can be rushed in *Telegarden* – Mother Nature cannot be forced into a faster performance. Goldberg discovers another of the subtexts of the work when he points out the fact that even though we live in the information technology age, we cannot rely on it to solve all our problems. (ibid) The creators of the project have another message to pass on to their audience which is to leave the internet and go out into the garden.

In her book *Internet Art* (2004), Rachel Greene observes that the project cannily alludes to the other side of 'telepresence' which is easily missed in the context of new media culture. As she explains, 'the haze of press about the revolutionary capabilities of the net, and the relentless attention paid to the stock prices of internet-related businesses occluded, for a time, certain realities. In fact, most of the world's cargo continued to travel by sea (not high-speed internet access lines), packed and accompanied by people, and the production of computers and related equipment followed the same patterns as other electronics; the toxic materials that form these devices were moulded by factory workers in Third World countries.' (Greene, 2004, p. 68)

Fig. 17 *The Telegarden* (1995-2004, networked art installation at Ars Electronica Museum, Austria.) Co-directors: Ken Goldberg and Joseph Santarromana Project team: George Bekey, Steven Gentner, Rosemary Morris Carl Sutter, Jeff Wiegley, Erich Berger. Photo by Robert Wedemeyer[23]

[23] http://goldberg.berkeley.edu/garden/Ars/

6.2 Projects Inspired by Nature and Environment

Another project which also draws attention to the hastiness of the era we live in, and in which the natural environment is wedded with the environment of modern technology was realised in a digital design studio named *boredomresearch*. The studio was founded by two artists and researchers at the University in Bournemouth in England – their names are: Paul Smith and Vicky Isley. This group is well known across the world for their software art projects which are of a high aesthetic value, not only in terms of visual aspects but also audio. All their work is based on computers and it includes interactive as well as public works, online projects/environments, and generative objects. Their works draw heavily on nature and its diversity. Using computer technologies, they try to analyse this diversity as well as simulate processes occurring in nature, modes of behaviour, and complex forms which change over time.

Their iconic project is titled *Real Snail Mail* (2008). It makes an immediate reference to 'snail mail' which refers to the traditional post service and is used by internet users. The authors observe that sending an email or on-line messages is very fast, effective, and accurate. By means of this project they try to point out that people tend to expect the same speed, effectivity, and accuracy from others who are to respond to their emails or on-line messages. The boredomresearch group thus allows people to think about the kind of messages people send to each other while returning into this process of communication the aspect of life which is inherently connected with the unexpected and the arbitrary. (Real Snail Mail, online)

Opening the web pages www.realsnailmail.net anyone can send an email to anyone. However, it is very uncertain how long it will take and if the email will be delivered at all. In the *Real Snail Mail* enclosure the snails are equipped with miniaturised electronic circuits and antennas enabling them to be assigned messages. The moment an internet user clicks 'send' on the realsnailmail.net website their message travels at the speed of light to a collection point where they wait for an RFID (Radio Frequency Identification) equipped snail to pass by. Once collected the message is carried by the snail until it happens to pass by the drop off point and is finally forwarded to its final destination. One of the lucky receivers of an email sent by a *Real Snail Mail* said to the authors of the project that the email she received was sent by her boyfriend

who had deceased in the meantime and she wanted so much to get in touch with him. The email though arriving with a huge delay thus came at the right time. (Real Snail Mail, online)

Fig. 18 A snail with a chip attached to the shell[24]

Fig. 19 The *Real Snail Mail* enclosure[25]

[24] Source: http://www.boredomresearch.net/realsnailmail.html

[25] Source: http://www.boredomresearch.net/realsnailmail.html

Another experimental and innovative artist and active fighter for the rights of the natural environment is Natalie Jeremijenko based in New York. She blends art, engineering, environmentalism, biochemistry and more to create real-life experiments that enable social change. In a review of *Creative Biology: A User's Manual* (2007), Brandon Keim from Wired Science described her as 'probably one of the three or four most dynamic people on the face of the earth'. She was also granted a Most Innovative People award in 2013, a Most Influential Women in Technology award in 2011, has been named one of the inaugural top young innovators by MIT Technology Review, and one of the 40 most influential designers. In her online portofolio we can read that her doctoral studies include biochemistry, engineering (mechatronics, space-systems and precision engineering), neuroscience, and History and Philosophy of Science. Jeremijenko's practice develops the emerging field of socio-ecological systems design (or xDesign) crucial in the Anthropocene, using attractions and ongoing participatory research spectacles that address the 21st century challenge to reimagine our collective relationship to natural systems. This integrates diverse strategies to redesign energy, food, and transportation systems that can contribute to the common good; increase soil, aquatic, and terrestrial biodiversity; and improve human and environmental health. (Natalie Jeremijenko, online)

Currently, Jeremijenko directs the *Environmental Health Clinic* at the NYU – facilitating public and lifestyle experiments that can aggregate into significant human and environmental health benefits. In her lecture on TED titled *The Art of the Eco-Mindshift* she explains the impetus behind the project which starts with redefining health. She works with the phenomenon of health that has a great advantage because it is external, shared, and something can be done about it, as opposed to health as internal, genetically predetermined or individualised. People who come to her clinic are not called patients but impatients as they are too impatient to wait for legislative change to address local environmental issues. With her medical prescriptions and the help of courageous volunteers, little islands of green which hoe grey areas covered with concrete and asphalt and help the environment to rid itself from road-born pollution are being created in various spots in the city, for example near fire hydrants which have a non-parking area adjacent to them as depicted in Fig. 20.

Fig. 20 One of the cures prescribed by Natalie Jeremijenko at the Environmental Health Clinic – a no-park park in front of a fire hydrant.[26]

6.3 A Human Body as an Art Tool and Medium

A human body as a medium for art making is used by Stelarc, with the birth name of Stelios Arcadiou. He is a significant multi-media performer and the representative of body art whereby he interconnects a human body (usually his own) with modern technology. He thus creates projects in which his body becomes a cyborg controlled by a machine and a modern digital technology. In the scope of his projects which border with the fields of prosthetics and robotics, Stelarc is willing to pierce his body with hooks in order to suspend himself in the open space, to connect his body to the internet whereby he visualises his body movements, or, to place an artwork in his stomach and to subsequently swallow an endoscopic camera in order to display it.

Paolo Atzori and Kirk Woolford in their article *Extended-Body: Interview with Stelarc* (1995) observe that through Stelarc's work, 'we reach a second level of existence where the body becomes the object for physical and technical experiments in order to discover its limitations.' (CTheory, 1995) Stelarc's artistic strategy, as they maintain, revolves around the idea of 'enhancing the body' both in a physical and technical manner. It originates as a polarity between the 'primal desire' to defeat the force of gravity with primitive rituals and a low-tech and hi-tech performance with the third arm and the related cybersystem. His intention in both cases is to 'express an idea with his direct experience.' (ibid) They also address Stelarc's reference to 'obsolete body' by which he means that the body must overcome centuries of prejudices and begin to be considered as an extendible evolutionary structure enhanced with the most disparate technologies, which are more precise, accurate, and powerful. (ibid) And Stelarc explains, 'the body lacks modular design ... technology is what defines the meaning of being human, it's part of being human ... especially living in the information age, the body is biologically inadequate.' (ibid)

Stelarc goes on to say that, 'we shouldn't start making distinctions between the brain and the body. This particular biological entity with its proprioceptive networks and spinal cord and muscles, it's the total kinesthetic orientation in the world, it's the body's mobility which contributes towards curiosity. The desire to isolate the brain is the result of a Cartesian dualism. It's not really productive any more to think in that sense. We have to think of the body plugged into a new technological terrain.' (CTheory, 1995)

This idea is emphasised in his net art work titled *Ping Body* (1996). This project demonstrates a way in which the body can be controlled by a system which is not one of its inherent parts. 'Pinging,' a computer networking term for a signal sent by one computer to determine the presence of another, is made corporeal in Stelarc's *Ping Body*. (Art Electronic Media, 2009) A remote audience could access, view, and actuate the body of the artist via the internet. As illustrated in the schematic diagram below, a website provided an interface to a computer-based muscle-stimulation system that permitted those logged on to 'ping' various limbs with an electric signal, causing involuntary movements in the artist's body. This resulted in a haunting dance made all the more dark by the loud electronic music generated live from network data. While the artist's body became a robot controlled by the internet, Stelarc retained control of the robotic third arm, introducing multiple levels of control and communication in the system. (ibid)

[26] Source: http://www.inspirationgreen.com/natalie-jeremijenko.html

In his book *Crisis of Transcendence: A Theology of Digital Art and Culture* (2011), J. Sage Elwell further analyses this project when he says that 'in forfeiting his autonomy to be 'jerked like a puppet' by distant strangers acting on and through his digitally programmable flesh, Stelarc becomes a visible expression of the otherwise immaterial potency of code. In this respect, to suggest that 'the forfeiture of the body to code is the basic subject matter of the piece, which it arguably is, nonetheless affirms the fact that the coded form ultimately makes the subject possible at all. Stelarc disappears as he is transfigured by and transformed into, digital code.' (Elwell, 2011, p.6)

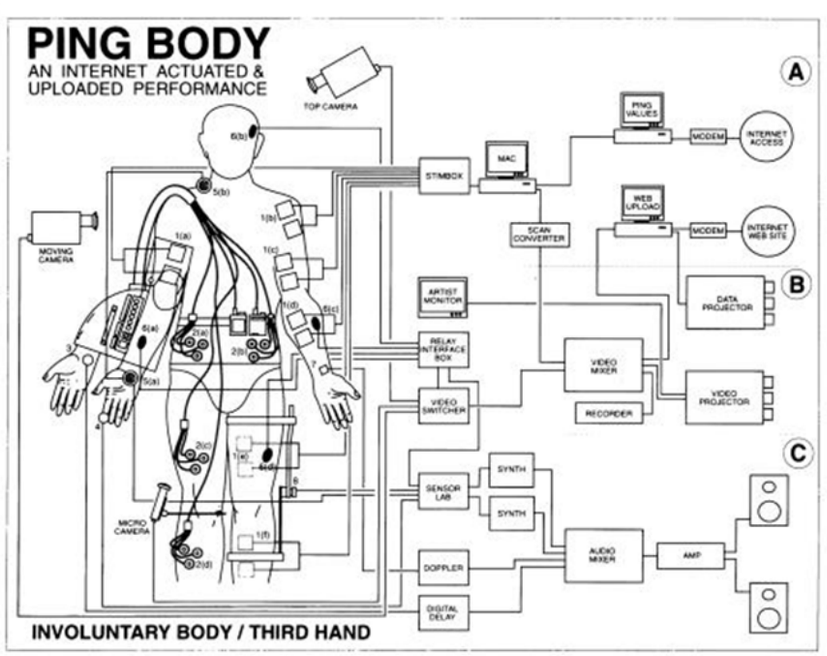

Fig. 21 Ping Body, Artspace, Sydney 1996, Diagram – Stelarc, Stelarc

In his next project, Stelarc significantly intervened with his body. In the project *Ear on Arm* (2006), Stelarc had a silicon ear surgically attached to his left forearm. This ear can not only hear but can also transmit sound. The objective of the project was to create a replica of a part of a human body and replace it, connect it, and assign new functions to it. In the last phase of the project, the ear was equipped with a remote eavesdropping device for internet users across the world, thus making it the first internet organ for a human body. (Stelarc, 2015)

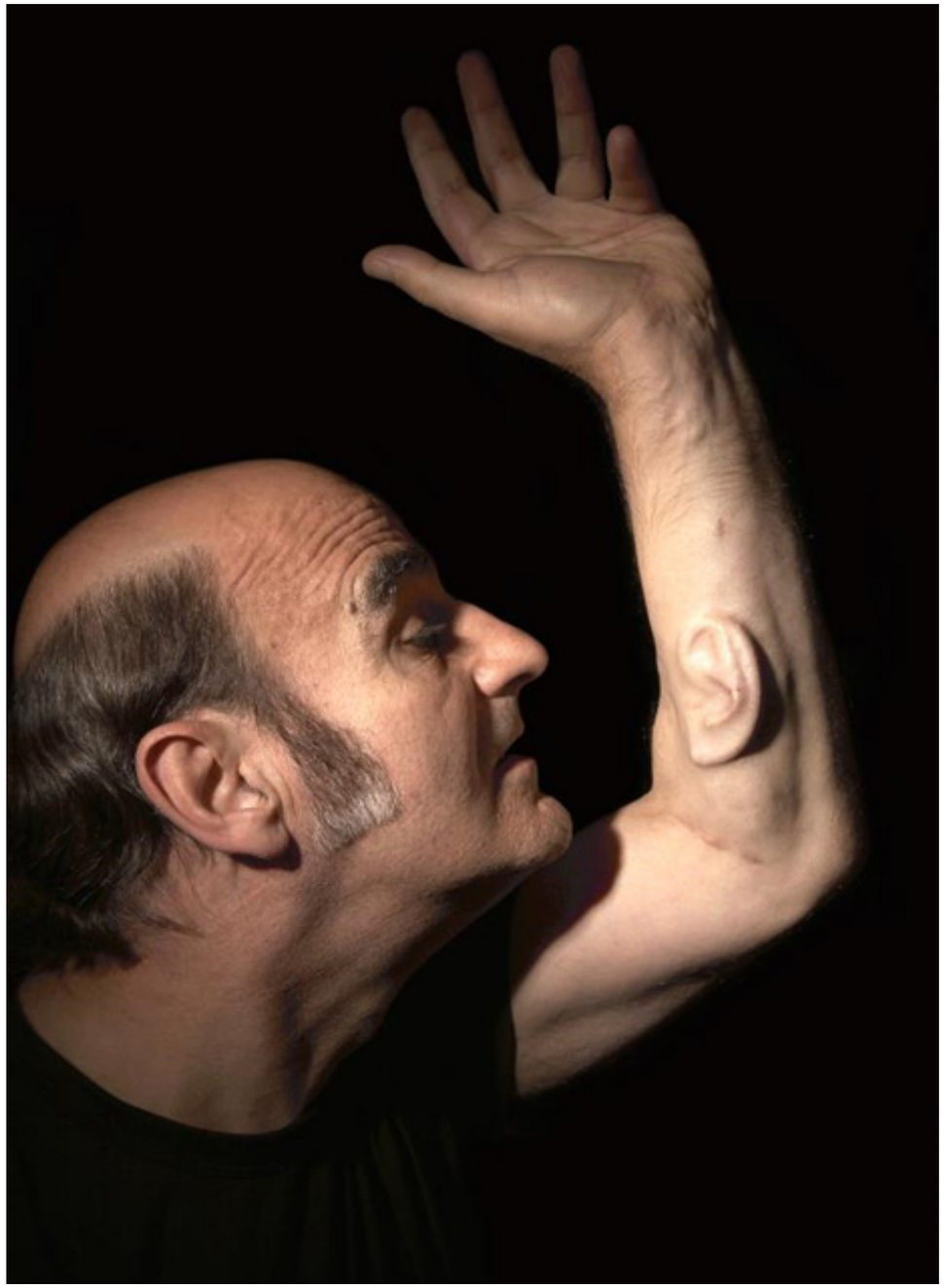

Fig. 22 Ear On Arm, London, Los Angeles, Melbourne 2006, Photographer – Nina Sellars, Stelarc

6.4 Visualising Data

Benjamin Fry who completed his studies at MIT specialising in the field of Aesthetics and Computation Group, dedicated his research to computer science, statistics, graphic design, and data visualisation, with which he tries to facilitate better understanding of information. He is considered an American expert in the field of data visualisation, a subject matter on which he finished a book in 2007 titled *Visualizing Data* (2007). (Ben Fry, online)

Benjamin Fry's iconic data visualization software *Valence* (2002) creates visual constructions from large bodies of information that are both interesting and help us understand them in new ways. As the author maintains, *Valence* originated as a project for his master's thesis which focussed on 'using properties of organic systems as a method for dealing with large amounts of data from dynamic sources.' (Ben Fry, online) In *Valence*, individual pieces of information are represented visually according to their interactions with each other. *Valence* can be used for visualizing almost anything, from the contents of a book to website traffic, or for comparing different texts or data sources. The resulting visualization changes over time as it responds to new data. Instead of providing statistical information, *Valence* furnishes a qualitative feel for the perturbations in the data and builds a self-evolving map driven by patterns.

In the 2002 Whitney Biennial, *Valence* was used for comparing the genomes of the fruitfly, mouse, and of man. Several 'genome' projects are now nearing states of completion, and for biologists, a primary use of the data is to search for a gene sequence and see if it is found in the genome of another organism. If the sequence is found, it is then possible, based on what is known about the sequence as it is found in the other organism, to arrive at conclusions about the function of that particular sequence.

Fry's project is based on the premise that the best way to understand a large body of information, whether it is a 200,000 word book, usage data from a website, financial transactions, or genomes, is to provide a feel for general trends and anomalies in the data by presenting a qualitative slice of the information's structure. *Valence* functions as an aesthetic 'context provider,' setting up relationships between data elements that might not be immediately obvious, and that exist beneath the surface of what we usually perceive. (Whitney Art-Port, online)

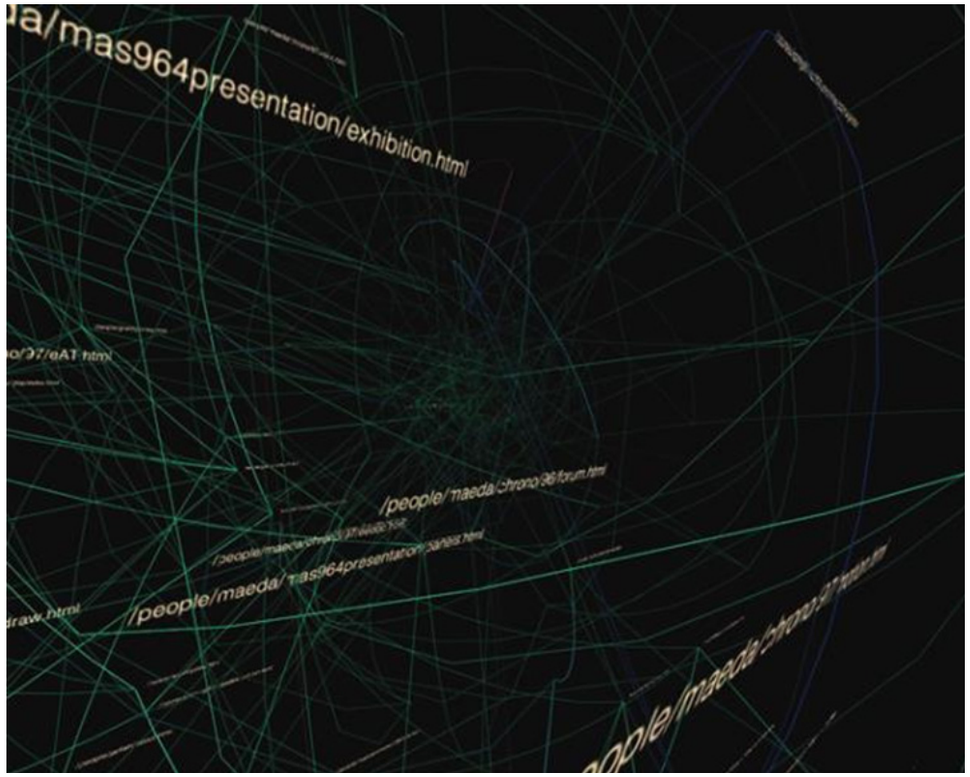

Fig. 23 Using *Valence* to visualize web site usage[27]

Ben Fry is also actively engaged in the field of genetics. On his web pages, we can work on interactive imaging of genetic code, study isomeric haplotype data, or, download an application called *Bifurcator* which creates a bifurcation plot suitable for publication from a set of haplotype data. (Ben Fry, online)

Data visualisation has also been a key factor in the work of Swedish artist Lisa Jevbratt who specialises in system and internet art. Her projects explore data mining, organisational structures, information filtering, data organisation and mapping, aesthetic, political, and cultural implications of the languages, and protocols of emerging technologies. (Medien Kunst Netz, online)

Her work is concerned with collectives and systems, the languages and conditions that generate them, and the exchanges within them. Jevbratt's works and collaborations essentially create new imagery by reorganizing the oceans of data on the internet and other created networks in unique ways. Theory becomes concrete using data as the medium. (ibid)

[27] Source: http://benfry.com/valence/index.html

1:1 was a project created in 1999 that consisted of a database that would eventually contain the address of every web site in the world and interfaces through which to view and use the database. *1:1(2)* is a continuation of the project including a second database of addresses generated in 2001 and 2002 and interfaces that show and compare the data from both databases. As the author maintains in her article 'Coding the Infome: Writing Abstract Reality' (2003), 'Crawlers were sent out on the Web to determine whether there was a Web site at a specific numerical address. If a site existed, whether it was accessible to the public or not, the address was stored in the database. The crawlers didn't start on the first IP address going to the last; instead they searched selected samples of all the IP numbers, slowly zooming in on the numerical spectrum. Because of the interlaced nature of the search, the database could in itself at any given point be considered a snapshot or portrait of the Web, revealing not a slice but an image of the Web, with increasing resolution.' (Dichtung Digital, online) On the pages of Rachel Greene's *Internet Art*, Jevbratt interprets the striation patterns depicted in Fig. 24 as follows: 'the variations in the complexity of the striation patterns are indicative of the numerical distribution of web sites over the available spectrum. Larger gaps in the numerical space indicate an uneven and varied topography, while smoother color transitions and more consistent layers are indicative of 'alluvial', or sedimentary, flat-lands in the web's IP space.' (Greene, 2004, p. 141)

Fig. 24 Striation pattern produced in Interface: Every (IP)[28]

As already said above, the project titled *1:1(2)* is a continuation of the *1:1* project enriched with another database and more addresses which were generated in the years between 2001 and 2002. This project has five various interfaces (*Migration*, *Hierarchical*, *Every*, *Random*, *Excursion*) which depict and compare data from both databases. Using only one single image, the *Migration* interface depicted in Fig. 25 illustrates the way in which web has developed in recent years. (1:1 (2) Lisa Jevbratt, online)

[28] Source: http://jevbratt.com/1_to_1/banff.html

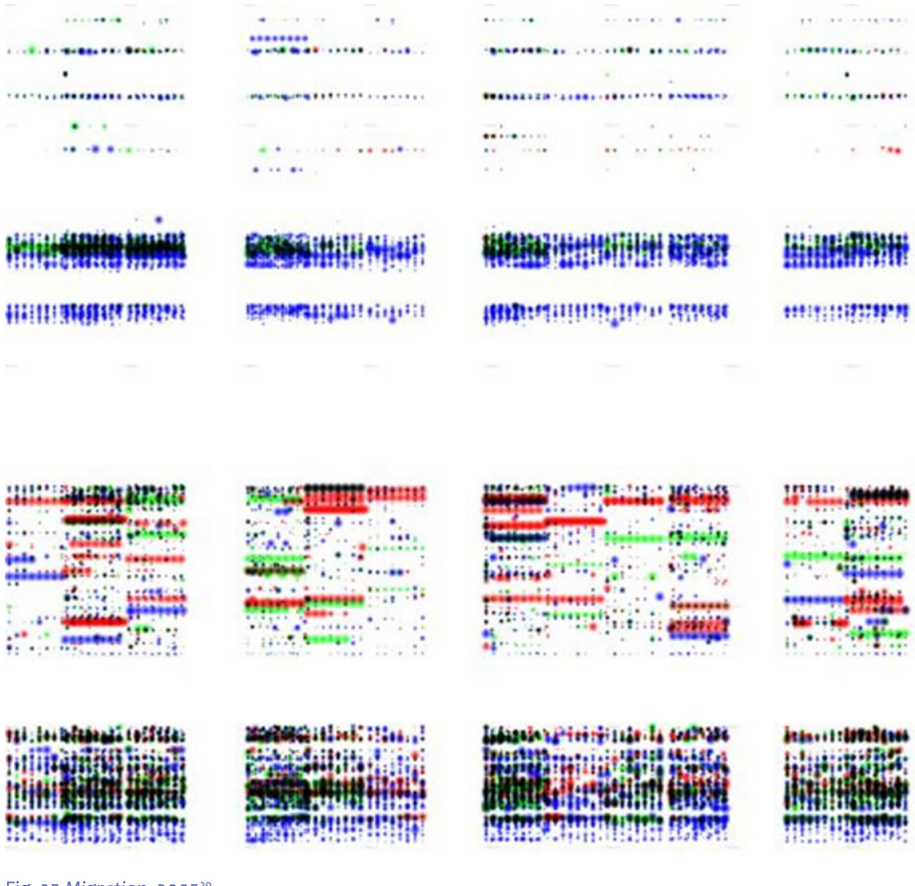

Fig. 25 *Migration*, 2005[29]

As Jevbratt explains on the project's website, '*Migration* is an image of the Internet and the part of the Internet we call The Web (the Web is defined as the collection of computers connected to the Internet that are running an http server software, i.e. Web servers). Each pixel represents two hundred and fifty-six IP addresses (An IP address is the numerical address of computers connected to the Internet). The top left corner of the image represents the two hundred and fifty-six lowest IP addresses (0.0.0.0 to 0.0.0.255) and the bottom right corner represents the two hundred and fifty-six highest (255.255.255.0 to 255.255.255.255). The colored blobs represent IP addresses of computers that host a Website. The size of the blob indicates the amount of Websites represented by the blob (more precisely by the pixel in the middle of the blob). The smallest blobs represent one Website and the largest blobs represent two hundred and fifty-six Websites. The white pixels are areas of the Internet where there are no Websites.' (1:1 (2) Lisa Jevbratt, online)

[29] Source: http://128.111.69.4/~jevbratt/1_to_1/3/migration/

The objectives of these projects as Jevbratt goes on to specify in her chapter ‚Inquiries in Infomics' published in the book by Tom Corby *Network Art: Practices and Positions* (2006) was to map the internet in its entirety using IP addresses which are hidden behind internet domains .com, and .org. (Corby, 2006, p. 78) In the chapter, Jevbratt also tries to ignite a new perception of computer code. She no longer wants to perceive it as a symbolic language which creates images of the real but as a formative and potentially managing aspect of reality itself. Jevbratt also invites us to consider 'artists-programmers to be more of land-artists than writers; software [to be] more earthworks than narratives.' (ibid) In this sense, she understands that 'the "soil" we move, displace, and map is not the soil created by geological processes. It is made up of language, communication protocols, and written agreements. The mapping and displacement of this "soil" has the potential of inheriting, revealing, and questioning the political and economic assumptions that went into its construction'. (ibid)

6.5 Relational Architecture

The work of Mexican artist currently based in Canada, Rafael Lozano-Hemmer, can be characterised as both architectural and performative art. His name became synonymous with relational architecture which is a term coined by the artist in 1996. In the interview with Alex Adriaansens and Joke Brouwer for the book titled *Transurbanism* (2002), Lozano-Hemmer explains that he first heard the term in the context of relational databases in the 1960s in connection with two Brasilian artists Lygia Clark and Hélio Oiticica who used the term in reference to the installations and objects activated by the users. (Brouwer, Mulder. 2002)

He decided to use the term 'relational' because he wanted to avoid 'interactive' which he believes has become too vague, while 'relational has a more horizontal quality; it's more collective.' (Brouwer, Mulder, 2002, p. 150) Through relational architecture, the artist attempts to create an anti-monument. A monument, as the artist explains, expresses a power, or, selects a certain historical moment and tries to materialise it always from the point of view

of the elite. On the other hand, an anti-monument is an action, a performance. Everybody is aware of its artificial nature. There is no connection between an installation and the site. For him, the anti-monument is an alternative to the fetish of the site, the fetish of the representation of power. Lozano-Hemmer goes on to explain that the objective of his work is not the history of a given place but the participation of public. Relations are the center of interest in his work, not historical sights. In his work, he attempts to introduce 'alien memory' as an urban catalyst. He prefers to say 'alien' instead of 'new' because the word does not have the pretension of originality and simply underlines the fact that 'it doesn't belong'. (Brouwer, Mulder, 2002, p. 146)

An example of this phenomenon is his sixth installation titled *Body Movies* as part of the Relational Architecture series which transformed the Schouwburgplein in Rotterdam in 2001. Lozano-Hemmer introduced huge portraits of people only matched in scale by the amplified shadows of passersby. As the artist explains, 'with this piece you see constant realignments taking place. For example, there is the movement in the square to embody the portraits, to "become" the alien representations, which is frustrated by the fact that the portraits change automatically the moment total embodiment happens.' (Brouwer, Mulder, 2002, p. 147) Lozano-Hemmer also draws attention to the fact that there is an encounter between the dominant culture, which is Hollywood films being shown inside the cinema building, and shadow representations of the participants outside in the open space. As the author believes, this makes people look at the cinema building potentially as a membrane where two realities are co-present. (ibid)

His significant work titled *Vectorial Elevation* (2000) is an interactive art project originally designed to celebrate the arrival of the year 2000 in Mexico City's Zócalo Square. The website www.alzado.net enabled any internet user to design light sculptures over the city's historic centre, with eighteen searchlights positioned around the square. These searchlights, whose powerful beams could be seen within a 15 kilometers radius, were controlled by an online 3D simulation program and visualised by digital cameras. A personalised webpage was produced for every participant with images of their design and information such as their name, dedication, place of access, and comments. In Mexico, the project attracted 800,000 participants from 89 countries over the course of its two-week duration.

On the day, when the European Union decided to take yet another 9 European states under its wings, the city center of Dublin, Ireland was lid by slightly more powerful searchlights. Participants could also send their proposals to the web site dublinelevation.net, which also livestreamed the Dublin's night sky.

As Stephen Wilson observes in his book, 'Lozano-Hemmer's projects investigate innovative web interfaces to control physical devices in spectacular events that explored the concept of public space.' (Wilson, 2010, p. 11)

Fig. 26 *Vectoral Elevation* in Mexico City's Zócalo square in 2000[30]

[30] Source: http://www.alzado.net/efotos.html

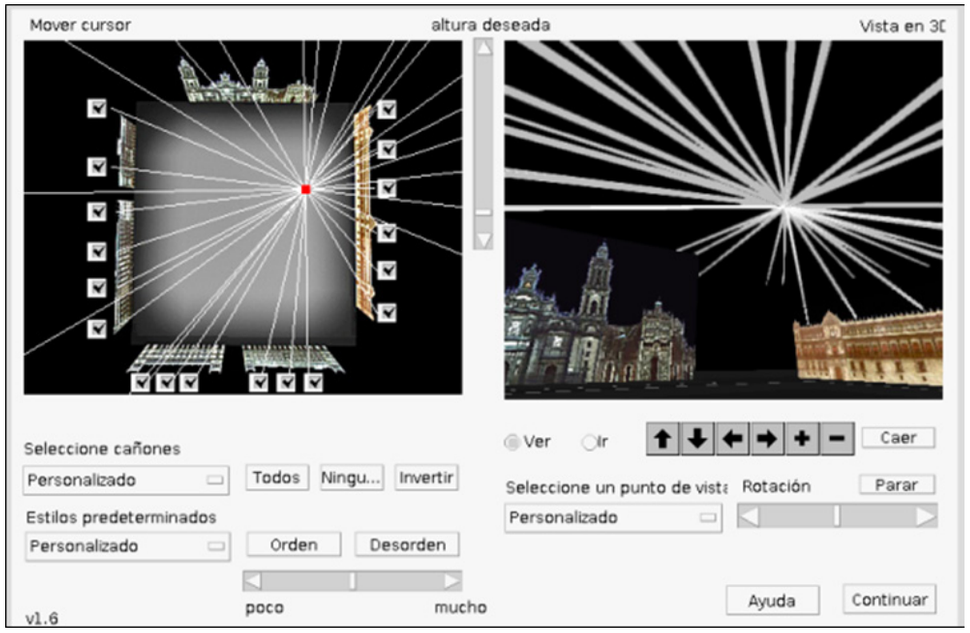

Fig. 27 A screenshot of the *Vectoral Elevation* software application[31]

6.6 Conclusion

The above listed examples show that contemporary art production not only redefines the boundaries between art and science but they also redraw the line between viewer and creator. In many cases, a viewer plays an important part in the work, in other cases, they even inform its final form. Similarly, the advances of science and technology not only influence every aspect of our everday life, but they also represent new art media used commonly in the process of art making. Therefore, works are being created which according to Stephen Wilson cannot be characterised as either art or science but rather as a new category of cultural experimenting and innovation. (Wilson, 2010, p. 9) Stephen Wilson also presumes that in the coming decades we will see astonishing and provocative developments in science and technology which artists will be ready to ponder, celebrate, and critique. (Wilson, 2010, p. 201) He goes further to consider some of the areas we may confront: 'invention of new species; advances in cloning techniques; "post-human" enhancements to human bodies and brains; access to the insides of brains; worldwide monitoring of the health of the oceans and skies; computers that can read gestures, speech, and thoughts; autonomous, intelligent everyday objects; robot companions; visits to other planets, etc.' (ibid) Just like technological progress, also the art production which will react to them will be revolutionary, experimental and determined to venture into unexplored terrain. We can only wish their shared efforts and the mutual influence of art and science will give rise to many art works which will inspire further scientific research but also new knowledge which will lead to new art production.

[31] Source: http://www.alzado.net/cdb/index.html

7. Visualised Combinatorics

Jan Andres

The following chapter consists mainly of pictorial parts. It documents visualised combinatorics starting with Athanasius Kircher up to the so-called theory of everything. In particular, the chapter addresses its controversial cosmological interpretation of Anthony Garrett Lisi. (see Lisi, 2007; Lisi, Wheatherall, 2010) It thus includes the time period from the baroque to the present day.

Similar visual effects were also achieved independently by artists such as Emma Kunz (1892-1963), František Hudeček (1909-1990), Adriano Graziotti (1912-2000), Leo Novotný (1931), Eleanora Pražáková (1953), Mark Dagley (1957), Ladislav Daněk (1958), Gabriel Dawe, Robert Urbásek (1965), Chiharu Shiota (1972), Sébastien Preschoux (1974), Ludovic Le Couster (1978), Sean Slemon (1978), Devin Powers (1980), Laura Battle, and many others.

The first two reproductions go back to the 17th century. They were also used as illustrations for the book of a German Jesuit Athanasius Kircher (approx. 1601-1680), who used them to demonstrate the basic combinatorial principles. It is interesting that the first of the illustrations was used by Umberto Eco (1991) in the second part of his book *Foucault's Pendulum*. Kircher's *Ars Magna Sciendi* presents different variants of linearity connecting the points.

Drawings of the contemporary artist Mark Dagley (see Fig. 30) are strikingly similar to the Kircher's illustrations above. However, they were created – unlike the previous ones – as purely artistic matter, as geometrical artefacts. This also applies to other reproduced works of various artists that are similar to illustrations in *Ars Magna Sciendi,* not only externally, but also to each other. (see Fig. 28)

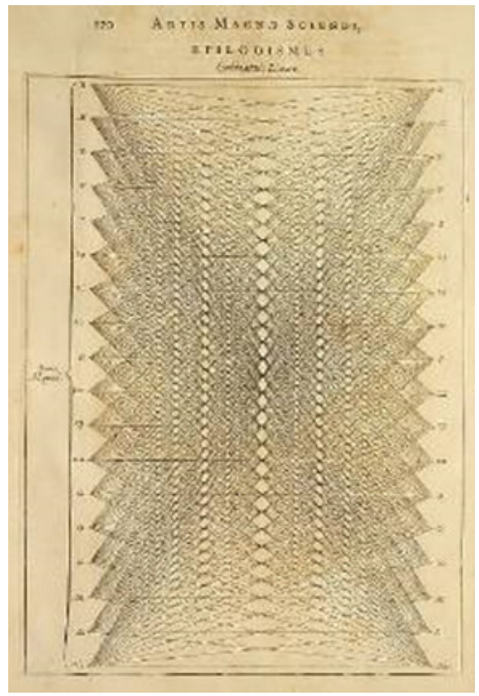

Fig. 28: Athanasius Kircher: *Ars Magna Sciendi*, Amsterdam, 1669, Combinationis Linearis, p. 170

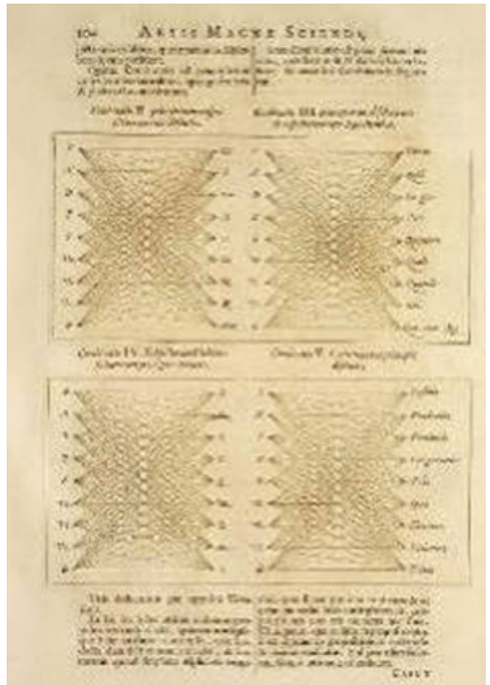

Fig. 29: Athanasius Kircher: *Ars Magna Sciendi*, Amsterdam, 1669, p. 104 Combinatio II. Principiorium respectivorum cum absolutis, Combinatio III. Principiorium absolutorum et respectorum questionibus, Combinatio IV. Subjectorium Universalium cum principiis absolutis, Combinatio V. Virtutum cum principiis absolutis

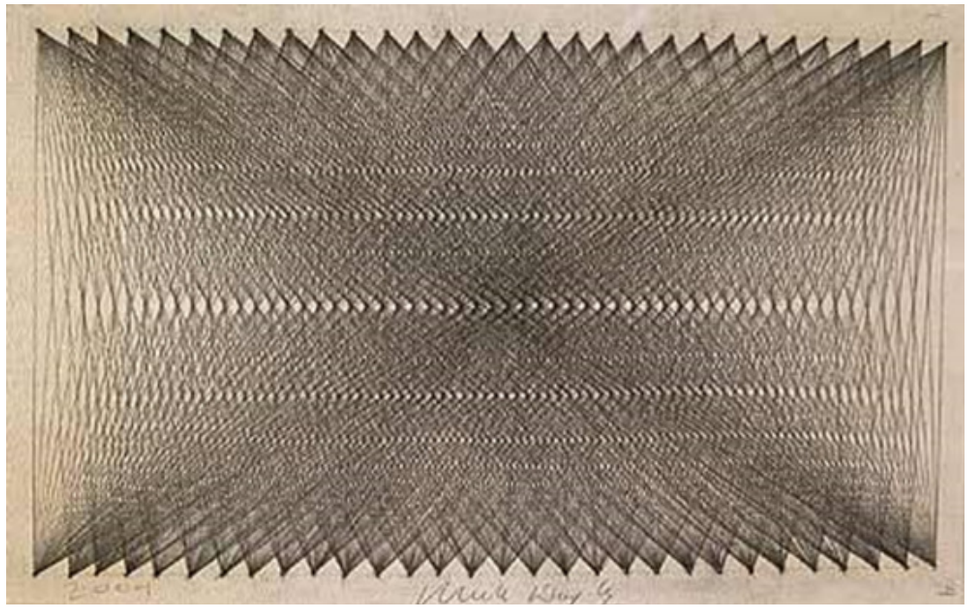

Fig. 30: Mark Dagley: without title, 2004 (pencil and paper, 17 X 21 1/2 inches)

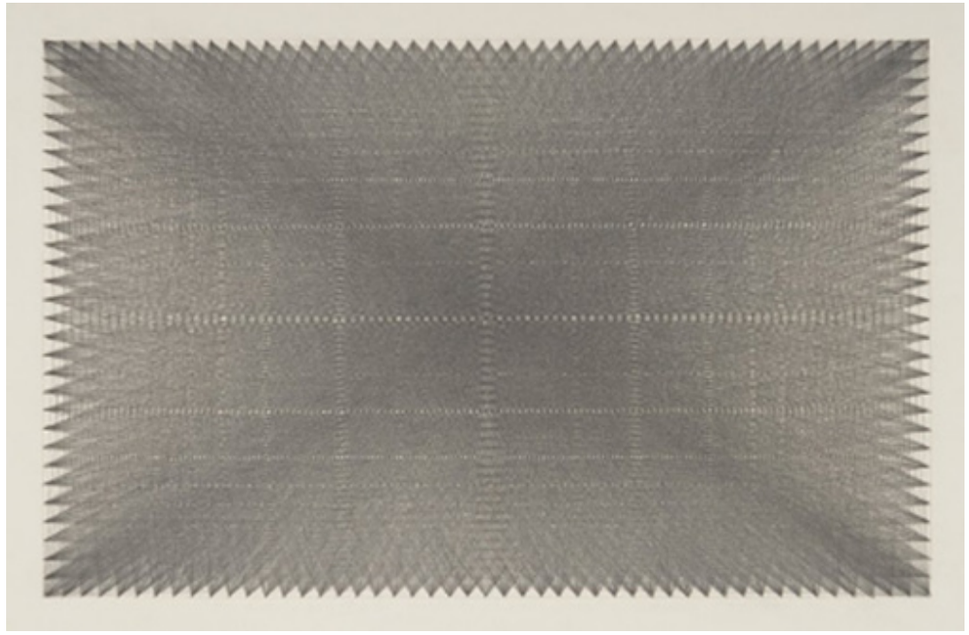

Fig. 31: Laura Battle: *Crossing*, 2007 (graphite on grey paper, 22 X 30 inches)

Fig. 32: Ladislav Daněk: without title, 1998 (pencil on a graph paper, 29, 7 X 21 cm)

Fig. 33: Devin Powers: *Back*, 2009 (acrylic on canvas, 42 X 30 inches)

Fig. 34: Ladislav Daněk: without title, 1990 (coloured pencil on graph paper, 29:7 X 21 cm)

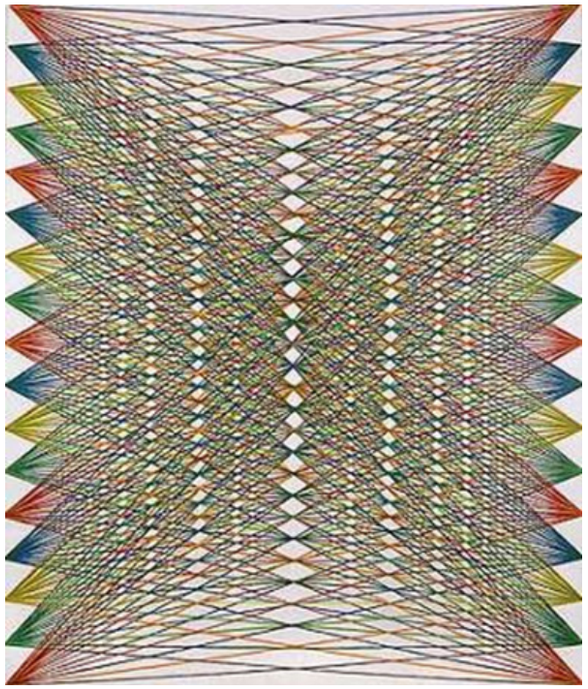

Fig. 35: Mark Dagley: *Spectral Presence*, 2006 (acrylic and pencil on canvas, 64 X 54 inches)

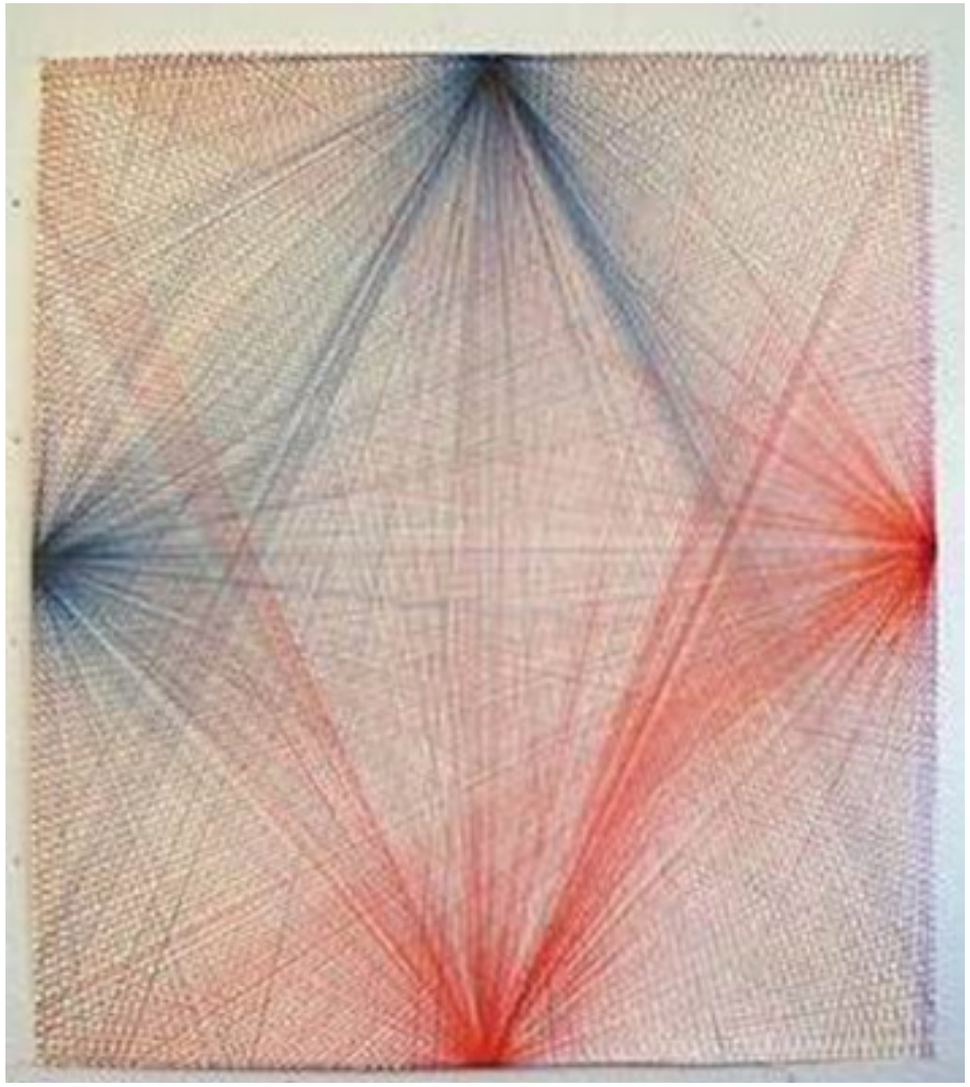

Fig. 36: Devin Powers: without title, 2008, (marker on paper 48 X 36 inches, without signature)

The above works were related to two-dimensional objects. The other examples present also spatial realisation – the application of the same principles, but in a three-dimensional design. The following authors are represented in these works: Gabriel Dawe, Sean Slemon, Ludovic Le Couster, Sébastien Preschoux, and Chiharu Shiota.

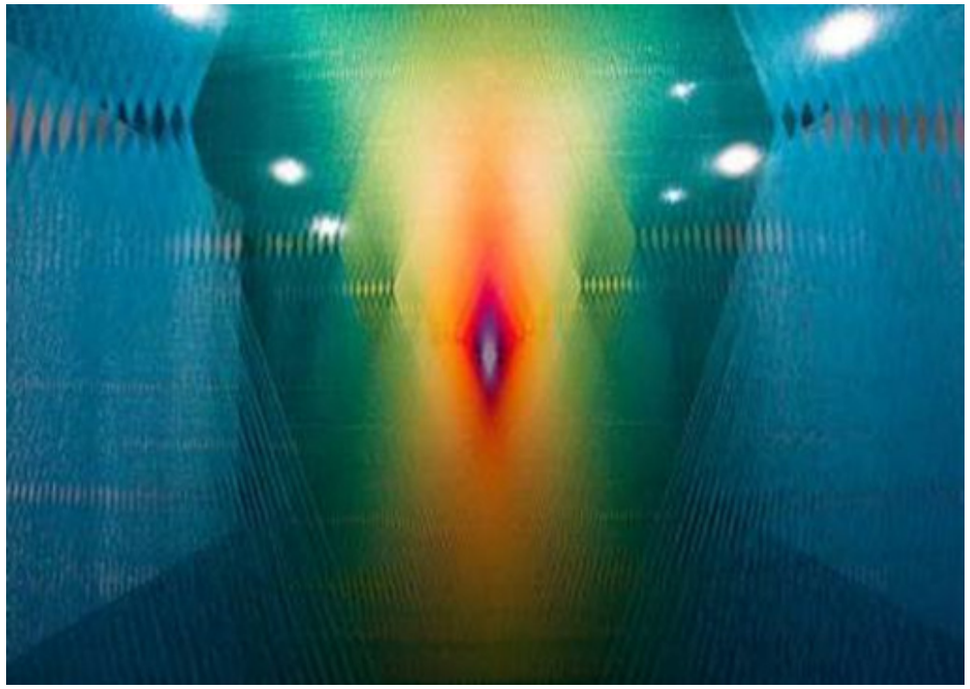

Fig. 37: Gabriel Dawe: Images of the piece *Plexus no. 3*, 2010 (installation using threads, wood, and nails)

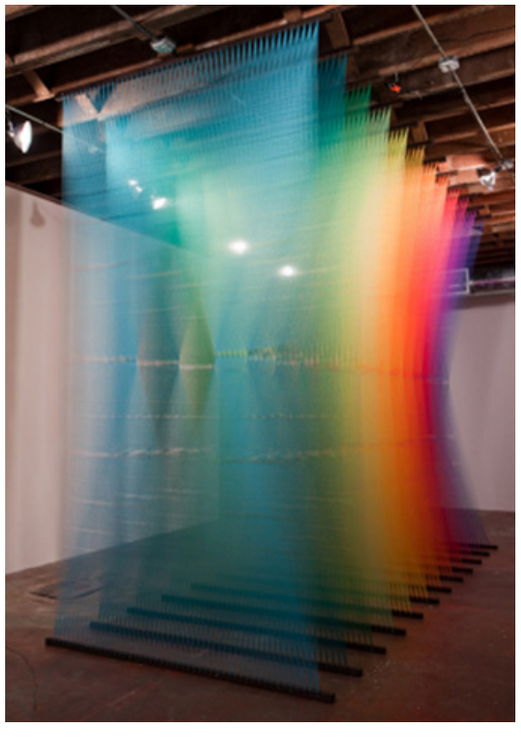

Fig. 38: Gabriel Dawe: Images of the piece *Plexus no. 3*, 2010 (installation using threads, wood, and nails)

Fig. 39: Sean Slemon: *Sunlight tracked for a day: May 10*, 2010 (Site specific installation, Paterson, New Jersey for the Escape From New York exhibition, tape)

Fig. 40: Ludovic Le Couster & Sébastien Preschoux: *Forest Art* (in the Auvers Sur Oise forest in France)

Fig. 41: Ludovic Le Couster & Sébastien Preschoux: *Forest Art* (in the Auvers Sur Oise forest in France)

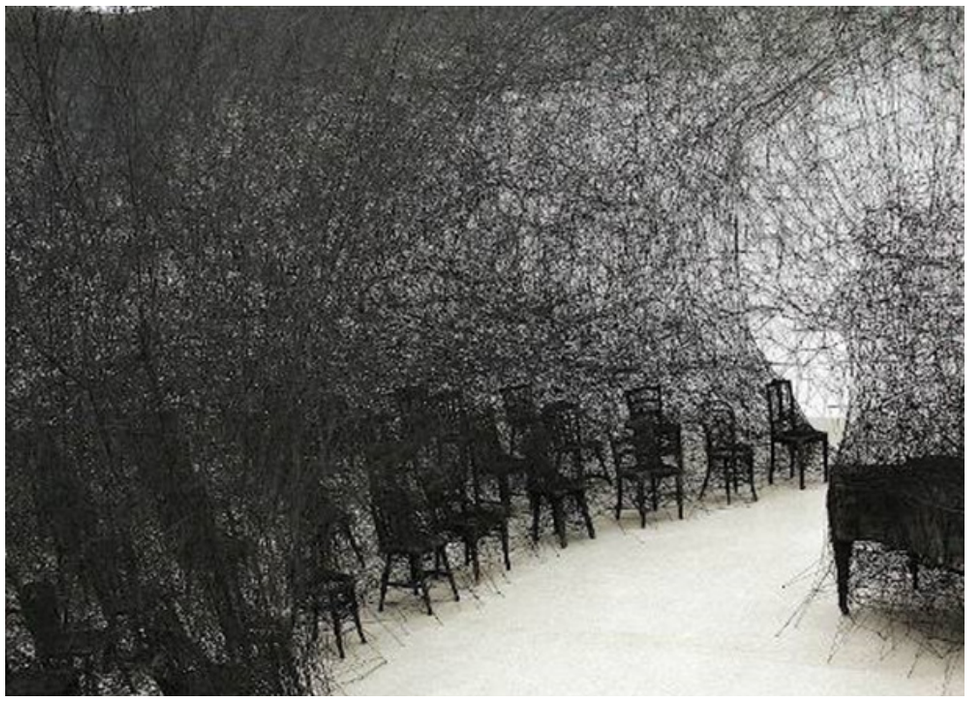

Fig. 42: Chiharu Shiota: *In Silence*, 2008 (elastic ropes and black wavy threads)

Fig. 43: Chiharu Shiota: During Sleep 2, 2005 (elastic ropes and black wavy threads)

Other examples bring us back to a two-dimensional environment. As an additional piece of information it is interesting to point out that the author Ugo Adriano Graziotti (see Fig. 49) was a mathematician as well as an artist. In his works, however, the artistic side prevailed – unlike Peter McMullen, who created purely algebraic illustrations of a particular object rather than artworks. The reproduced image (see Fig. 51) is a two-dimensional projection of a multi-dimensional object.

Fig. 44: Sébastien Preschoux, *Starcow Skatedecks*

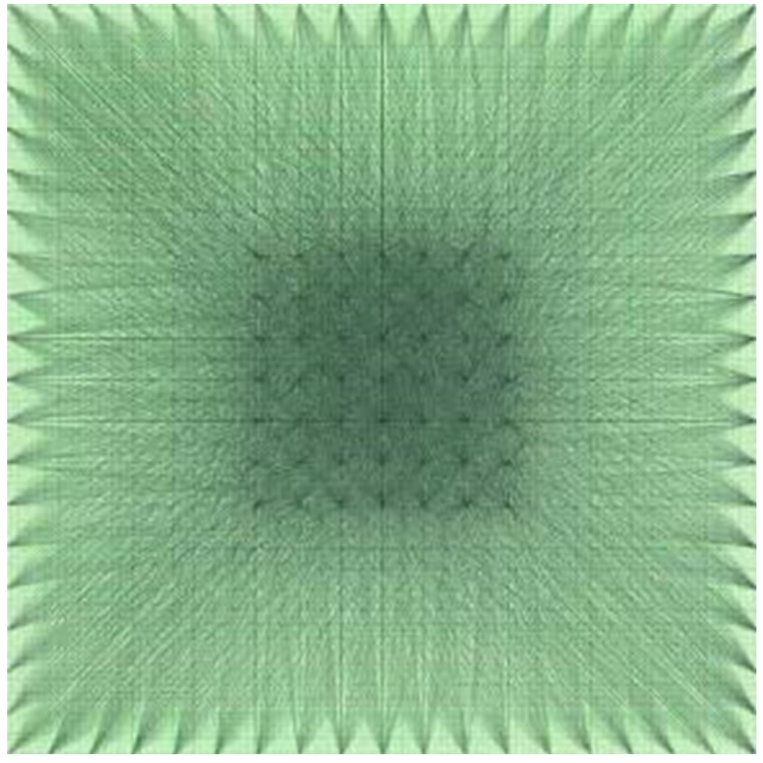

Fig. 45: Ladislav Daněk: without title, 1984 (pencil on graph paper, 18 X 18 cm)

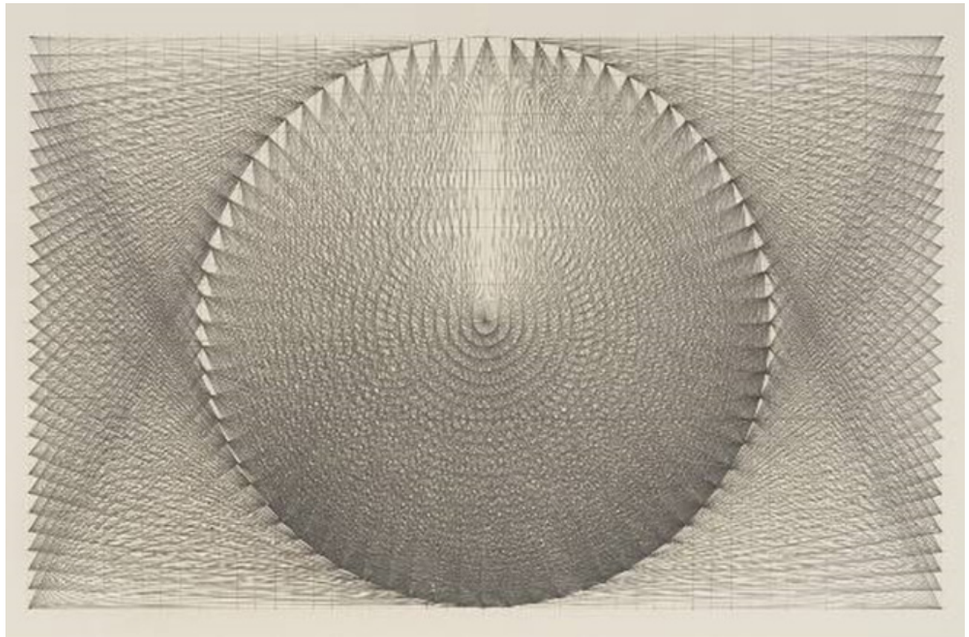

Fig. 46: Laura Battle, *Time Piece* (for Emma Kunz), 2007 (graphite on the Reeves BFK paper, 22 X 30 inches)

Fig. 47: Mark Dagley: *Cul de Sac*, 1997 (acrylic and pencil on canvas, 60 X 60 inches)

Fig. 48: Mark Dagley: *Ruby orb*, 2008 (oil and pencil on canvas, 11 X 11 inches)

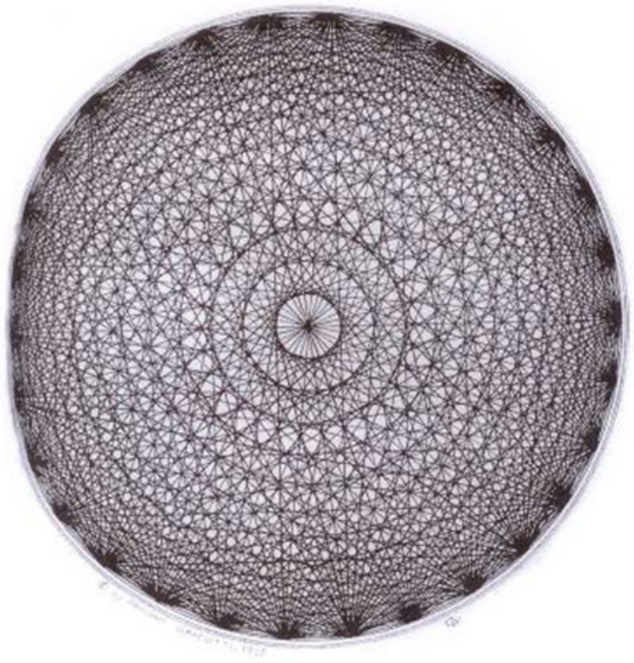

Fig. 49: Ugo Adriano Graziotti: drawing of the regular polygon, 1975, I

Fig. 50: Ugo Adriano Graziotti: drawing of the regular polygon, 1975, II

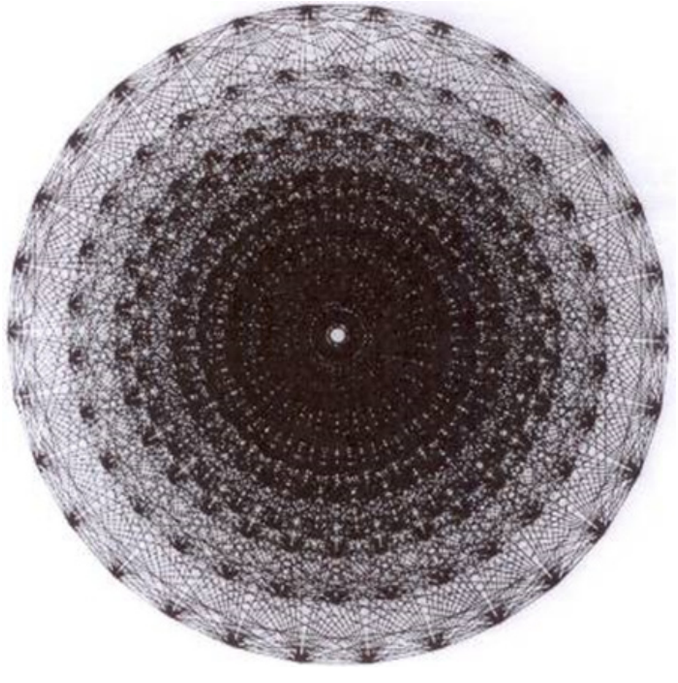

Fig. 51: Peter McMullen: Drawing of the Coxeter polytop 3 3 3 3 3 3 3

The last series of images reproduced here have special names *Flower* E_8. It is an indication of a mathematical object that was computer simulated. These computer or machine generated graphics are two-dimensional projections of objects that have the nature of the so-called special simple Lie group E_8. This group consists of a cycle of 240 points, which are symmetrically arranged in eight-dimensional space. The same object then shows an unbelievable 696,729,600 symmetries – it is therefore the 'most symmetrical' mathematical structure. It was subjected to a detailed examination of 18 mathematicians, which took over four years. The complexity of this structure is illustrated by the fact that its supercomputing genesis took about 77 hours.

The E_8 group describes symmetries of a 57-dimensional object that can be rotated in a total of 248 different ways without being altered. According to some scientists, this remarkable object can itself determine the internal structure of the universe. According to a rather controversial theory of Anthony Garrett Lisi from 2007, it may be the basis of the model for the so-called theory of everything, or, the only theory describing the fundamental interactions in physics.

When looking at the works, it is not possible to distinguish those that are pure mathematical visualisations of combinatorial principles from those that were created intuitively as artistic artefacts, without the knowledge of the circumstances that led to their creation. Both approaches – natural-scientific and artistic – however, carry a strong aesthetic charge, which can be perceived without any context. It is also worth mentioning the interesting artistic expressions of artists of a concrete or generative art that achieve similar results. While the so-called concrete art as a form of abstraction falls into the category of classical art activities, generative art uses computer software to create similar results. All these methods consistently illustrate the remarkable aesthetic qualities of visualised mathematical order and geometric objects.[32]

[32] The author of the chapter would like to thank to all authors for providing reproductions of their works. Other reproduced works are available on the internet under public license.

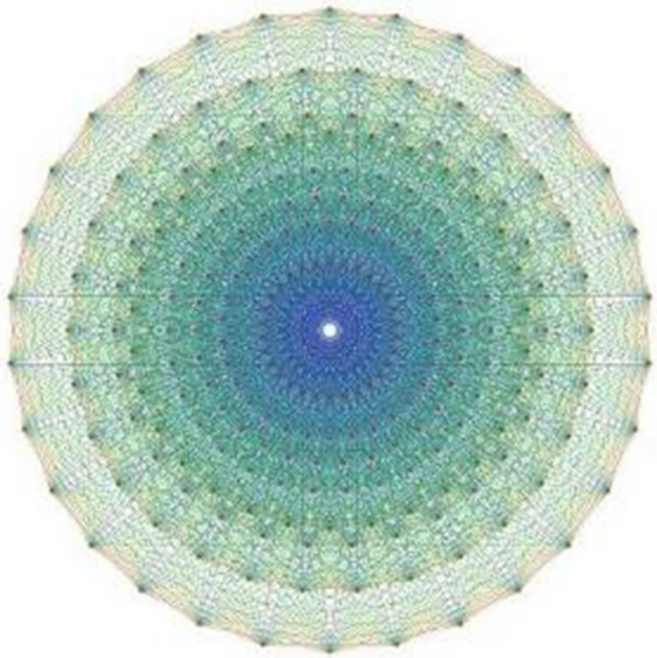

Fig. 52: Flower of E_8 No. 1 (computer graphics)

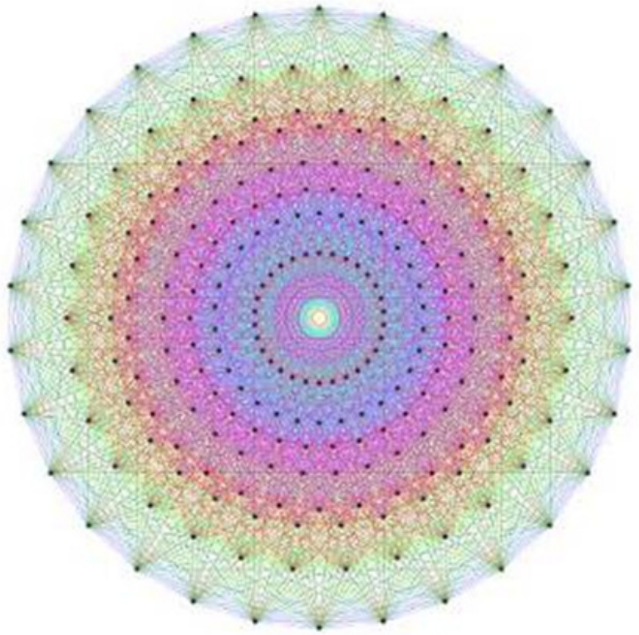

Fig. 53: Flower of E_8 No. 2 (computer graphics)

8. New Paradigms of Exact Sciences in the Contemporary Visual Expression

Olga Badalíková

The end of millennium in the area of artistic expression is characterised not only by the phenomenon of intermediate penetration and convergence of artistic disciplines, but it also brings a surprising cooperation between arts and exact sciences. To look for and to consider the meaning of the wonderful expressive metamorphoses of artistic expression today means to consider artistic expression as a way to overcome oneself and to relate to the ideas extending beyond material determination. To understand this phenomenon well, animal iconography offers remarkable historical comparisons.

In many cultures and in some stylistic periods, an animal has become the primary and multifaceted art object carrying a wide range of diverse meanings that remain partly hidden to us until today. In terms of formal aspect, the animal has been depicted as an aesthetic element in the composition of the human figure, as an ornamental motif, as part of multi-figure especially in mythological scenes, as an attribute or as an isolated artefact. It formed a characteristic motif in a number of communities in relation to their religion and mythological tradition. This was the case in the Palaeolithic, in Crete during the Minoan culture, during the culture of the barbarian tribes and steppe communities, as well as in Islamic areas. Later, when the depiction of the human figure prevailed, as was characteristic for large civilisations, an animal motif became rather a secondary element. Its typology was closely linked with the relevant doctrine, which was reflected in the diversity, specific and distinct, both for the area of the Orient and the Hellenistic period, or for Baroque artists. Morphology has been transformed from extreme naturalism to the schematic stylisation, when an animal was shaped and deformed to the brink of abstract, geometric, almost unidentifiable shapes, as seen, for example, in the Chinese bronzes from the early Middle Ages, and in the sculpture of Islamic countries. These changes were certainly significantly influenced by alternating waves of iconoclasm. In the periods when it was not required to show the human body, fauna and flora were preferred often stylised into ornamental motifs.

In the context of the historical development and based on the acquired knowledge, the link between three starting lines, to which attention is paid in terms of the given subject matter, is becoming increasingly evident. It is the interaction between the relationship of the given society towards an animal, the symbolism of that animal, and its depiction. Developmental metamorphoses of the animal's symbolic function in relation to the correlation of the relationship between anthropomorphic and zoomorphic worlds, and the impact of these changes on the expressive modifications of animal motives appear to be conclusive. Particularly in the example of animal themes, the role which is attributed to or taken away from the animal in our community is evident, and it thus becomes apparent that although we do not attribute a clearly defined social context to art, it remains latently present in it.

It is a fact that the relationship between human beings and animals is a widely observed phenomenon in philosophical, anthropological and behavioural literature. However, the impact of the changes it has on artistic expression is reflected only sporadically. Animal – formerly the symbol of strength and positive or negative energy, a subject of concern and admiration for its elegance and variety of shape, becomes an object of compassion and the semantic essence of existential tension at the end of the second millennium. This transformation has been culminating since the early 20th century, when the path was started in which the artist began to move away from nature. The avant-garde, mainly surrealist artists worked with the theme of animals symbolizing inner experience. In their work, they covered the interiorisation of animals symbolizing irrational components of human existence. The withdrawal of negative experiences in the innermost part of oneself, accompanied by traumas, neuroses, and frustrations was related to the darkness of the animal world. To release these, they may be subsequently triggered by artistic expression, or revelation, rationalisation, or by an outer grip of internal pressure. In parallel with the search in one's own unconscious, other artists on the contrary sought and accepted an abstract mathematical model of the world. Thanks to abstract depiction, art works gradually broke out of the constraints of space and time, while organic forms brought back liveliness, spontaneity, concern, and mystery into geometric clarity. After a long period during which abstraction prevailed in artistic expression, a time for a change in conception of animal themes

came. If we go further in these considerations, a subsequent extension into the previously restricted area towards the movement, action, real object, and real living creature seems inevitable. A plastic form of animals is disappearing with the gradual transformation of symbolism receding from the original, deep-rooted levels of meaning.

Efforts to increase the persuasiveness of artistic expression have grown to the extent in which the living human body as well as animal have been dynamically entered into visual perception. In the 1960s, artists were starting to work with human and animal bodies as material in the spirit of the new concept for the first time. The key to understanding is also the need to liberate art from aesthetic boundaries and to push it into the realities of life. Art has significantly gone on the path of tautology. This transformation has been heavily influenced by the new social and life prospects. Interest in disappearing fauna is growing, which was enhanced by a number of environmental factors, including the work of Konrad Lorenz and Desmond Morisse. Besides historically proven depictions of animals as objects of beauty, elegance, and dignity, and their portrayal as a carrier of both positive and negative symbols, animals are now perceived as a highly visible object of our interest and compassion. Through countless brutal and naturalistic means of expression, the depiction of the animal is associated with concerns about the natural world. Artists use these drastic interventions to aim their spatial objects, actions, and video installations against anthropocentrism relativising the ingrained assumption that a human being is, according to the traditional notions of the world, to be preferred only on the basis of their increased brain capacity. The subtext of a wide range of expressive means is humility, as the underlying premise of mutual coexistence.

The desire to move in yet unexplored areas of organic and inorganic faces of the world lead also to the need to draw lessons from the return to a time when science, art, and philosophy offered surprising results of joint efforts. The subsequent separation of these disciplines has resulted in the loss of the society's ability to conceive comprehensively of its existence, making modern efforts to re-establish a common path very desirable. By incorporating the scientific and technical progress in the daily rhythm of life, scientific findings penetrated also into forms of artistic expression. Because what many contemporary artists wish to communicate is possible to mediate precisely by the current means of expression, based on newly acquired experiences.

The link between the intensity of interest in rendering animal themes and the new scientific results became the subject of numerous modern studies. This comparison is based on the ideas originating in the 1960s, especially in the book of Thomas Kuhn *The Structure of Scientific Revolutions* (1962). In this book, the author points out that scientific knowledge is not acquired continuously, but by way of critical turns in response to changes that bring new insights into the deep-rooted paradigms. In this context, he also emphasised the continuity of a correlation between scientific knowledge and turns and changes in artistic style. A new paradigm of exact sciences thus creates an initiation environment suitable also for the search for new artistic expression. This change in paradigm is clearly reflected in the iconologic and expressive physiognomy of an artwork.

Natural science explorations searching for new knowledge constitute only one part of the truth about the recognisability of the world. However, there are still a number of options and directions in which to expand the research and gain new dimensions conducive to its understanding.[33] The socio-biological theory of an American scientist Edward O. Wilson (1975) increased the interest in the bond between humans and nature. It also pointed out that while in the first stages of the industrial revolution, animals were used as machines, in the post-industrial era, they became a material, a product, a subject or object. Contemporary scientific research based on the belief that people are at the origin of evolutionary changes and consider art as part of the natural evolution derived from the nature. There are new theses pointing to the fact that a biological process of evolution in synergy with computers can produce wide simulations that pull down the boundaries between art and science bringing both of these areas closer to each other. One of the promoters of this idea is Bredekamp, a follower of Gottfried Wilhelm Leibniz.

In recent years, an interdisciplinary path, whose roots date back to the Renaissance, has been outlined in the form of uniting scientific disciplines with artistic expression. A good example might be a project called *A Symbolic, The Art and Science Collaborative Research Laboratory,* conducted in the Department

[33] For more see Pavel Houser (2005).

of Anatomy and Human Biology, University of Western Australia, carried out by the professors Oron Catts, Stuart Bunt and others. (Zaunschirm, 2005, p. 91) Here, artists can work in the laboratories of molecular biology, tissue cultures, neurology and biomechanics. This is the so-called bioart project, where artists work with biological material and scientific apparatus. The team works on the development of new organic shapes rising from the bodies of various animate beings, or they make readymades from naturally growing tissues. In parallel, several research and artistic groups seeking diverse biological and aesthetic effects are appearing. The result of their collaboration is the need to analyse the changes which are brought about by biotechnology into the formation of flora and fauna.

One of the artists, who worked here on gene mutations, was the Brazilian artist Eduardo Kac (1962). An animal, surpassing any hitherto knowledge, became *GFB Bunny 'Alba'* (*Das Kaninchen 'Alba'*, 2000), a live rabbit glowing fluorescently in the dark, as it was implanted with a fluorescent jellyfish gene. (Witzgall, 2003) Kac connected its origin with the concept of transgenic art. Genetic manipulations lead the path to the unstable boundary between animals and plants, animals and humans, humans and robots. Animals, that the author of the experiments transform (bacteria, ants, fish or mice), are prepared for him in the laboratory at Arizona State University. His projects are called *Genesis* or *Der Achte Tag* (The Eighth Day) assigning to himself the role of the creator of new, sophisticated, and more attractive nature. Marta de Menezes (1975), the Portuguese artist, changes the colors and patterns of butterfly wings using genetic manipulation.[34]

The Belgian artist Koen Vanmechelen (1965) also works with genetic crossbreeding. He is attempting to transport the issues of globalisation on a number of variants of interbreeding poultry, the symbol of his homeland. The early works include Mechelen Cuckoo (Mechelse Koekoek), later he focuses on creating hybrids characterizing the cultures of individual countries such as Brazil – *Samba Chicken* (Samba-Huhn), or Germany – *Dresden Chicken* (Dresdner Huhn). The author considers these hybrids to be symbols of a cosmopolitan society, its interbreeding and blending – *Cosmopolitan Chicken* in 2000. Vanmechelen, together with the gynaecologist Dr. Ombelet, publishes an English journal

[34] Denisa Kera (2005, p. V) points out that in May 2005 in the scope of the Entermultimediale festival the panel titled the *Future and Art Among Codes and Genes* was focused on the projects on the border of biotechnologies. Luba Lacinová, an expert based in the Institute of Molecular Physiology and Genetics AV SR (*Ústav molekulární fyziologie a genetiky AV SR*) presented a concise history of these genetic manipulations.

The Walking Egg, which deals with the philosophical and ethical issues related to science-based research. It is the ethical issues that Mike Kelley's installations are concerned with. He was strongly inspired by Harlow experiments with primates, which he incorporated in a project called *Monkey Island* in 1982 and recorded on a video called *Banana Man*. The evidence of these is also the deeply moving documentation titled *To My Mother* (around the year 2000).

In the art of the 20th century, there are various forms of discourse between art and science, however, no clear strategy or horizon of mutual cooperation has been created until now. In the relationship of science to artistic works, Thomas Zaunschirm (2005) returns to the default premise that artists may indeed be interested in genetic technology and biological and physical research, and they may in their own way profit from it, but they cannot be full partners to scientists. Artists themselves refuse a direct relation to scientific knowledge. Their reflection appears to be largely unconscious and contingent to a wider range of additional stimuli such as social issues, politics, religion, or philosophy. Some of the initial creative principles include deconstruction or aesthetic transformation. Above all, artistic creation is characterised by a widely differentiated method, the scientific use of which has not yet been fully discovered. The development of the entire spectrum of scientific disciplines is also accompanied by a range of technical resources.

Since the early 1990s, art accepting new forms of communication presented on the internet is developing. This movement was significantly influenced by artists from Eastern Europe (Olia Lialina – Russia, Alexei Schulgin – Russia, Vuk Ćosić – Slovenia), and founding groups are created, such as C3 in Budapest, *TO* in Vienna or *Backspace* in London.[35] In the period of 1993-1996, young artists begin to present their works via e-mails, webpages, using audio and video, in the form of text messages, photographs, graphics, comics or visual recordings.

The desire of artists to protect nature and to be interested in its functioning is based on creative and aesthetic needs to which a rational scientific systematisation is not really open. However, it is a fact that the separation of science, art, and philosophy which was brought about by the rational movements of the 19th century, deny us the ability, but also the possibility

[35] For more see Rachel Greene (2004).

of a comprehensive understanding both in terms of cognition and creativity and ethical conduct. In the future, we must consider not only how art and science can cooperate again. According to the warnings of many experts, it is necessary to know how art, science, and we all will be incorporated in this space. (Beckman, 2002, p. 68)

While it is clear that art remains a way of creating new thinking, it is not omnipotent. One can only hope that the transition from the role of an artist-observer to the role of a participating party also results in the opening of our minds, thus directing us towards a progressive exceeding of our own limits and the ability to empathise. Inquiry into the future form of the depiction of animals in the spatial representation is therefore also the inquiry into the future of art as a whole, and perhaps even of human existence in general. It is tempting to believe theories that, just like a living form, art also can experience crises, but not ends, and that there are spiral returns back to the needs to release a creative potential and to intensively develop our own creativity by classical methods. So far, we actually have not come to a zero point from which we would embark on a new path. Not even now, in spite of many sceptical arguments, art has reached its dark end. Artists of today not only accept, but even anticipate the sometimes malevolent spirit of the time, and still act as the precursors of things to come. They have changed their expressive means significantly. After all the twists and turns we can come to understand that because of their inquisitive nature, artists not only accepted but embraced as their own the time of boundless communication opportunities, heading toward virtual reality. The cooperation with exact sciences is one of the many paths they have already embarked on.

9 From Budding Scientist to Blossoming Artist: Science as Muse

Robert Millard-Mendez

I have always had a strong interest in science. This paper briefly recounts how I went from being a pre-med student to being an art student and how science influences my art. I have made a number of sculptural forms that act as metaphors for scientific phenomena or processes. In addition, some of my sculptures refer to scientific data and research that cast light upon some of humankind's unwise choices and failings.

Science and art have always been partners. Imagine trying to learn anatomy from a text without pictures; it would be terribly difficult. The formation of complex molecules from individual atoms would be hard to visualise without physical models to look at and manually re-arrange. How hard would it be for a non-specialist to understand *A Brief History of Time* by Stephen Hawking if there were no illustrations in the book? Hawking understands the importance of quality illustrations. In 2001 he released *The Universe in a Nutshell*, which was a heavily illustrated update of *A Brief History of Time* (which had been released in 1988). I know that without pictures and animations, I would never have understood special relativity

In high school, I took all the biology and chemistry courses I could. But art had always been my secondary calling. Biology was a great subject for a visual learner like me. My notes were always full of sketches and diagrams. I was enthralled by the complexity of living things and how it seemed every part had a purpose to which it was evolutionarily tuned. My lab reports featured well-developed drawings of specimens in various stages of dissection. Thinking back, that comic strip I made up about the Krebs cycle should have been a sign that I would leave science behind and eventually take up art as a vocation.

I have shown my art in over 400 exhibitions, and have shown work in each of the 50 states as well as abroad. The first competitive exhibition my work was ever shown in happened in my senior year of high school. I sent an image of my work to a nationally juried student exhibition entitled 'The Art of Science'. My piece was two inked and colored pages from a short allegorical story I had

written about a dystopic future in which scientists preside over all policy decisions with (overly) cool rationality. The piece travelled to eight different exhibition spaces around the United States for a year.

My accomplishments in high school were rewarded with a full academic scholarship to my undergraduate alma mater University of Massachusetts Lowell. The scholarship was funded by Dr. An Wang, the head of Wang Laboratories in my hometown of Lowell, Massachusetts. I enrolled as a biology major on a pre-medicine track. During the second semester of freshman year, I took a class in three-dimensional design to fulfill a core requirement. Over the course of the semester, my love for art became re-kindled and the call of the art studio grew too strong to resist. In one of my exams in Anatomy & Physiology, I was required to draw a diagram of how blood and electrical impulses flow through the heart. My professor enjoyed my drawing of the heart, even going so far as to write 'You should have illustrated the text'. By the start of the next semester, I had changed my major to art with an emphasis on sculpture. By no means had I left my interest in science behind. I continued to take science courses and consume science & technology lectures from The Teaching Company. Audiobooks about science-related topics can sometimes be heard blasting out of the studio radio in the summer, competing with the whirring saws and buzzing sanders.

Many of my earliest large sculptural works dealt with scientific topics ranging from The Manhattan Project to evolution. My Bachelor of Fine Arts thesis show included two large kinetic wooden sculptural works on the theme of atomic power. The sculptures were made in a purposefully simplified, ironic folk art style.

My current work often includes references to scientific topics while employing sculptural media to dramatise scientific phenomena. Last year I created a work called *Molecule Chair* (see Fig. 54) for an exhibition entitled 'Appetite for Destruction' at lion vs. gorilla in Chicago, IL. The premise of the exhibition was interesting. All the works in the show were meant to break down over the course of one evening. I was inspired by the entropic nature of the exhibition concept and created a work that would fall into a pile as visitors to the show took the piece apart. The *Molecule Chair* sculpture is an archetypal seating form made up entirely of smaller chairs linked together by simple tabs and slots. No adhesives were used to keep the small chairs connected to one another. The piece also has a reference to fractals in that it is a large form made up entirely of smaller elements that each individually echo the large form. The piece was comprised of 70 chair pieces, each of which was numbered and signed. As visitors arrived at the exhibition, each of them was encouraged to pick a chair. As the chairs were pulled from their places, the form of the large chair fell to the gallery floor, a perfect example of the second law of thermodynamics.

A recent sculpture that relies on scientific data to point out human foibles is *Climate Change Plan B Boat.* (see Fig. 55) The inspiration for this piece comes from a number of sources, including my interest in global warming and environmental concerns. The piece is part of a large series of sculptures that uses boats as starting points. I currently live in Evansville, Indiana, which is a city situated on the banks of the mighty Ohio River. The Ohio River is a major artery for the transportation of tons of coal, and the region around Evansville is highly dependent on coal for electrical power. The coal mining industry is a major source of employment in southern Indiana, southern Illinois, and Kentucky. Many coal-laden barges pass by Evansville every day, their length and sheer mass are overwhelming at first. Seeing one of these coal-burdened, gray whale-sized behemoths make a 90° turn in a narrow ox-bow is unforgettable.

As a continuation of the environmental theme, every piece of wood in the sculpture is recycled/re-purposed. The hull of the boat is made from 100+ year old poplar that was salvaged from a partially burned, razed building in downtown Evansville. The painted wood on the base and tower of the piece was rescued from the curb on trash day. Even the thick blue plastic 'water' on the base of the piece was made out of worn-out storage totes pulled from the trash. The boat carries a heavy load of coal that was unearthed from a nearby mine in Kentucky.

The science aspect of this piece is that a surprising number of people who live in my region refuse to believe in the reality of climate change. Quantifiable evidence overwhelmingly illustrates that the climate is changing and that carbon levels are dangerously high in the environment. The tower at the center of the boat is meant to be darkly humorous. The height of the tower implies that if our current use of coal (and other fossil fuels) continues, our only 'plan B' will be to move to higher ground as rising sea levels make many low-lying areas uninhabitable.

Appropriately, nearly all the materials used to create the tiny, picturesque 'world' at the top of the tower are made of petroleum-based plastics. (see Fig. 56) The choice to put an archetypal, white-clapboarded, one-family home on the tower is also important. The seemingly healthy trees on the 'island' are fake (they are made of plastic, wire, and dead moss). Even in the face of sweeping environmental change, this family has chosen to continue an obviously unsustainable lifestyle (except at a higher elevation than before). Worse yet, the boat itself is powered by a miniature coal plant that billows out a heavy, sprawling cloud of dark grey smoke.

Another of my works that contains a reference to science and technology is *Phaëthon Mask (NASA Allegory)*. (see Fig. 57) This work is part of a series of mask pieces inspired by an array of topics including teaching, alchemy, and mythology. One of my most vivid childhood memories is sitting in my seventh grade classroom watching an old CRT (cathode ray tube) television and seeing the *Challenger* fly apart into several white plumes of smoke and fiery debris. I had, like many people my age, never watched a person die in real time on live television. I am not sure if I understood the gravity of what I was seeing at first. This sculpture relies on a reference to the Greek Myth of Phaëthon. In the myth, Phaëthon foolishly asks his father Apollo if he can have a try at piloting the sun chariot across the sky. The young man is obviously not up to the task and he crashes the chariot into the Earth leaving behind a sizeable charred swath of land.

The imagery in the sculpture makes references to the construction of the Space Shuttles. The mask is sheathed in protective ceramic tiles. Extending from the nose of the mask is a small figure holding a large steering wheel. (see Fig. 58) The small figure floats tenuously on a thin steel rod and he is completely covered in matches, a reference to his fragility as he shoots skyward. The wearer of the mask is provided with a convenient pair of oven mitts as protection from the heat of friction as s/he travels through Earth's atmosphere. The obvious inadequacy of the oven mitts is meant to be a commentary on hubris, and the dangers of travel beyond the safety of terra firma.

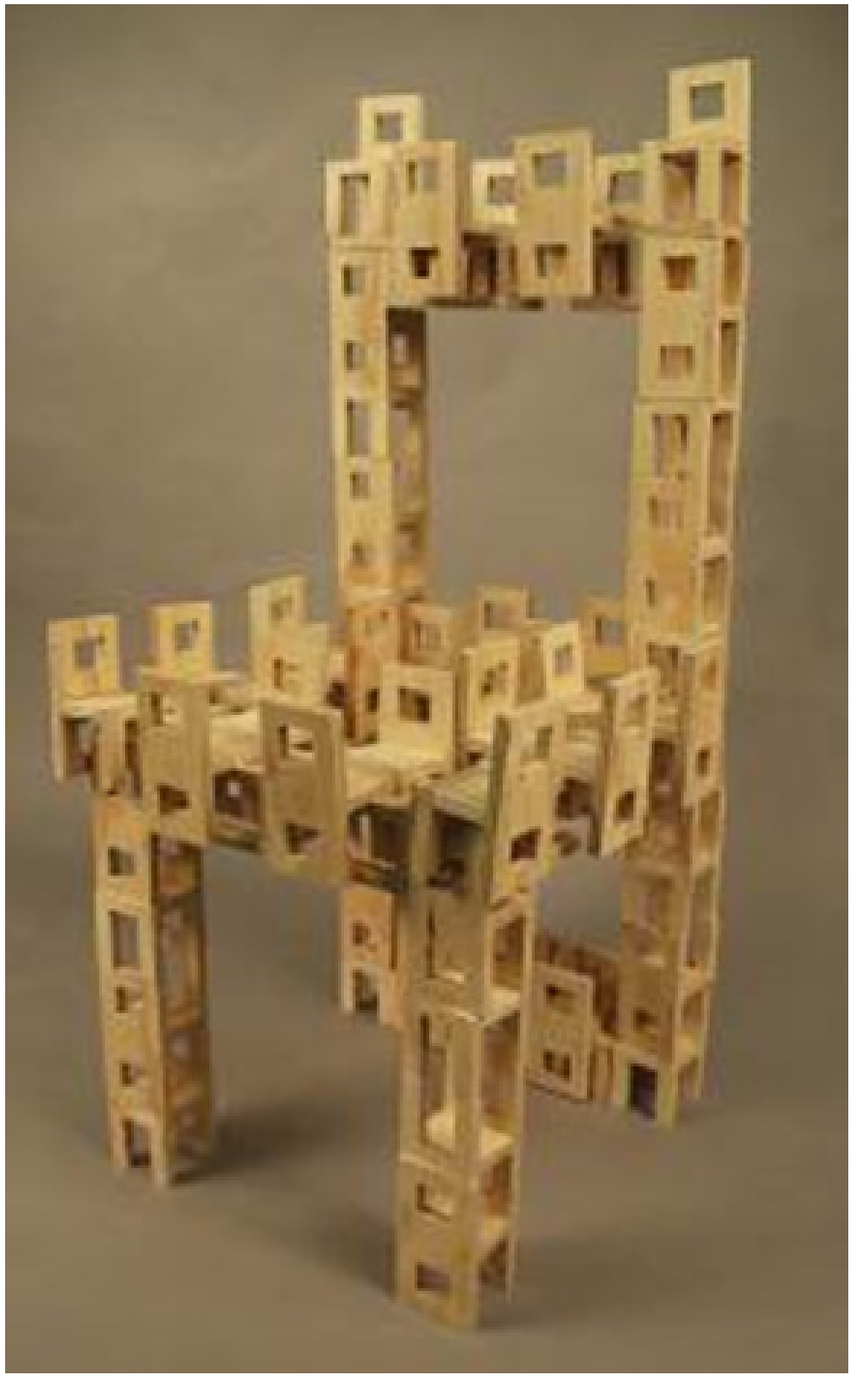

Fig. 54 Rob Millard-Mendez: *Molecule Chair*; 2013; plywood, ink; 38"h x 22"w x 22"d

Fig. 55 Rob Millard-Mendez: *Climate Change Plan B Boat*; 2012; wood, paint, plastic, coal, aluminum, steel; 34”h x 30”w x 12”d

Fig. 56 Rob Millard-Mendez: Detail of *Climate Change Plan B Boat*; 2012; wood, paint, plastic, coal, aluminum, steel; 34”h x 30”w x 12”d

Fig. 58 Rob Millard-Mendez: Detail of *Phaëthon Mask (NASA Allegory)*; 2004; wood, tile, steel, paint, oven mitts, matches; 37”h x 34”w x 35”d

Fig. 57 Rob Millard-Mendez: *Phaëthon Mask (NASA Allegory)*; 2004; wood, tile, steel, paint, oven mitts, matches; 37”h x 34”w x 35”d

10. Mycological Musings and the Meaning of Crowds

Nancy Raen-Mendez

Mushrooms are seductive. The artist John Cage returned time and again to this fascinating subject. Cage dealt with the scientific classification of mushrooms as well as the depictions and conceptual idea of mushrooms in his artwork. 'Cage's quirky obsession with mushrooms may seem like nothing more than a career side note, but his contributions to the field of amateur mycology were actually quite significant. Mushrooms, for Cage, served as a muse of sorts.' (Small, 2011, p. 19) While perhaps not as widely noted, Cy Twombly also seemed beguiled by mycology. There is a great deal of mythology and even mysticism associated with mushrooms and their uniqueness is astounding. One interesting fact is that mushrooms are closer in structure to being animals than plants. As a longtime vegetarian I am a little conflicted by my consumption of these protein-packed meat-like fungi. The mushroom is a fascinating subject and, as an artist who is also interested in the natural world, I entirely understand how one could develop a mushroom obsession.

At first, the art of hunting mushrooms seems to have little to do with art making. But 'Twombly viewed the study of nature as a prerequisite for making meaningful art objects.' (Walls, 2014, p. 56) The act of searching for mushrooms is similar to how artists stalk meaning in their work. Identifying the problem, ideation, data collection, categorizing, documenting, and analyzing visual information: all of these tasks are practiced by visual artists. Art and science have long been intertwined. Leonardo DaVinci, M. C. Escher, Ernst Haeckel, Mark Lombardi, Karl Blossfeldt, John James Audubon, Irving Geis, and Eveline Kolijn are among the thinkers who have crossed the art-science line.

During the Italian Renaissance, artists and scientists often followed intermingling paths. '…Leonardo da Vinci, the Renaissance artist-naturalist [was] renowned for, among many other things, his extensive notebooks containing descriptions of inventions, anatomical features, and materials and organisms of the natural world.' (Walls, 2014, p. 64) By the time Cage and Twombly were mushroom-obsessed, the relationship between artists and scientists had been severed in a formal sense. Despite this fact, mushrooming was very much an art and a science for both of these artists. 'As with Twombly, Cage's mycological vision embraced three central features of the hunt—ground survey, identification, and openness to extra-fungal stimuli—to explore consonances between making nature and making art.' (Walls, 2014, p. 58) When considering art making from Cage's perspective, most (if not all) visual artists make artwork that relates to scientific inquiry, but there are also some distinct differences.

To some degree all artistic work relates to scientific inquiry but there certainly are differences between these disciplines. 'First of all, we should not forget that art has a freedom to go where science cannot follow. Art is not restrained by scientific protocol. This gives a tremendous creative freedom, to make lateral and alternate connections, which can trigger new insights.' (Kolijn, 2013, p. 606) The freedom that artists are allowed is often what produces their most innovative and creative solutions. The creation of new methods and/or ideas enables art to give back to all other disciplines including science. 'Twombly's mushrooms are metaphors, organisms, material evidence of being. But they morph as quickly into something else — a gesture, an action, an event, a passing thought, connecting natural and artistic exploration.' (Walls, 2014, p. 67) For Twombly and Cage the mushroom becomes something other than its factual parts and functions. 'Even given these different strategies for portraying mushrooms, from Renaissance images to modern field guides, naturalists sought a precision and clarity in their visual descriptions that Twombly, who regularly obscured his lithographic fungi, eschewed.' (Walls, 2014, p. 56) In this way mushrooms become mythological ideas that transcend what scientists would note as their natural life cycles. '[Twombly] could take a species and turn it into a generalised mushroom form and then imbue it with atomic or phallic suggestiveness, for example. Without an empirical burden of proof, he could more easily explore what naturalists and scientists, with their imperative to arrive at objective truths, could not.' (Walls, 2014, p. 62) Both science and art chase the truth but the way artists recognise and uncover the truth of a subject is less restricted.

I incorporate the natural sciences and environmental issues into my work. A scientist might document the decline of the Monarch butterfly by tracking its migratory path and collecting population data from consecutive years whereas I create artwork (see Fig. 59-61) out of delicate and biodegradable materials that bring to viewers' attention the fragility of winged creatures and which also

reference the structure of the insect. I make much of my work out of relatively natural and humble materials (e.g. tea bags, paper, willow and vine charcoals etc.). My work is displayed unframed and thus the edges of the work have no permanent protection. I see the fragility as part of the work as there is always a chance of it being damaged. In cases of actual damage, I see the mending of my artwork as an opportunity to add more organic forms. Damaged/mended areas can serve as reminders of the constant presence of entropy. Since the themes in my work revolve around the ebb and flow of people, ideas, and issues concerning the natural world, the fragility of the drawings adds to the multi-layered content of the work. In these ways I highlight the tenuousness of organisms that often goes unnoticed and reveal how human consumption endangers them. My work also serves as a reminder that we may have the power to make some changes in the ultimate fates of organisms with whom we share this planet.

My most recent artwork still possesses delicate, biological elements but the themes relate more to the social sciences. This body of work explores the social dynamics of the assembly of physical groups of people as well as the implications of online interactions. I am particularly interested in swarm theory, crowd science, and flock theory. (see Fig. 62 and 63) I walk through these fields of research seeking interesting items to pluck for use in my work. And while I do not take a strictly scientific approach in investigating these ideas, my work is influenced by my findings related to these areas of research.

I confront power dynamics (see Fig. 64) and my drawings *Do More* and *Trickle Down* comment on top-heavy power structures. (see Fig. 7 and 8) In the book *The Wisdom of Crowds* by James Surowiecki, the author found that diverse groups of people of average intelligence had greater wisdom (accuracy in answering certain kinds of questions) than a small group of experts did. (Surowiecki, 2004) With the ability to use the internet as a way to organise and 'congregate' we are shifting how we solve problems (e. g. crowdsourcing). Perhaps in the future we will even see the breaking down of older systems and the restructuring of power dynamics into a more egalitarian system.

Micro blogs, online forums, live twitter updates of protests etc., are some of the ways that disparate people have come together to deal with global social and political issues. Crowds have the ability to change legislation, to bring

to light certain abuses, and even to start and/or stop wars, but governing powers can also use these same methods to predict and disrupt civil unrest. Groups have been successful in disseminating information online in some countries, but in other countries this access is blocked. 'The reaction of world governments to civil unrest has in the past extended to the blocking of social networking and/or web access, restricting the dissemination of information by the public.' (Lock, Cooke and Jackson, 2013, p. 231) Since online groups can be created and accessed easily, they can also be infiltrated, enabling governing powers to disrupt flows of information and even use archived online exchanges as evidence to punish digital 'participants' in online subversive actions.

Flock theory offers a bevy of interesting visual possibilities. The concept of '*Homogeneity*' shows how every bird in the flock has the same behavioral model so the flock moves without a leader, even though temporary leaders seem to appear. In the idea of '*Locality*' the nearest flock mates influence only the *motion* (italics mine) of each bird. Individual birds rely on vision — the most important sense for flock organisation — to avoid colliding with nearby flock mates which explains the notion of '*Collision Avoidance*'. While flock mates are avoiding collisions they also implement '*Velocity Matching,*' in which they attempt to match velocity with nearby flock mates. Finally, the notion of '*Flock Centering*' points out how the individual bird attempts to stay close to nearby flock mates. (Banerjee and Agarwal, 2012, p. 525) While some of the visual elements in my work do follow these ideas, the grouped elements in my work are added in a more intuitive way and there are always contradictions in my work. In scanning my work (as a mushroom hunter might scan the countryside or woods), the viewer will find rebellious structures that flow counter to the flock. Hidden like mushrooms in the woods, these delectable elements are often not apparent at first glance. (see Fig. 67 and 68)

Like many artists who came before me, my work relates to the natural and social sciences. I think of the insects (and insect-like forms) in my work as Cage and Twombly may have considered mushrooms. We are like scientists exploring the physical attributes of form. But our main contributions come from the fact that we are artists. We consider our subject through many different lenses and are not burdened by restrictions and replication. Artists, like mushroom collectors, are astute observers and tenacious gatherers of rare and coveted specimen.

Fig. 59 Raen-Mendez: *Meditation to Honor Subtlety and Encourage Compassion*, hand sewn reclaimed tea bags, variable size

Fig. 60 Raen-Mendez: *Meditation to Honor Subtlety and Encourage Compassion*, hand sewn reclaimed tea bags, variable size

Fig. 61 Raen-Mendez: *Meditation to Honor Subtlety and Encourage Compassion*, hand sewn reclaimed tea bags, variable size

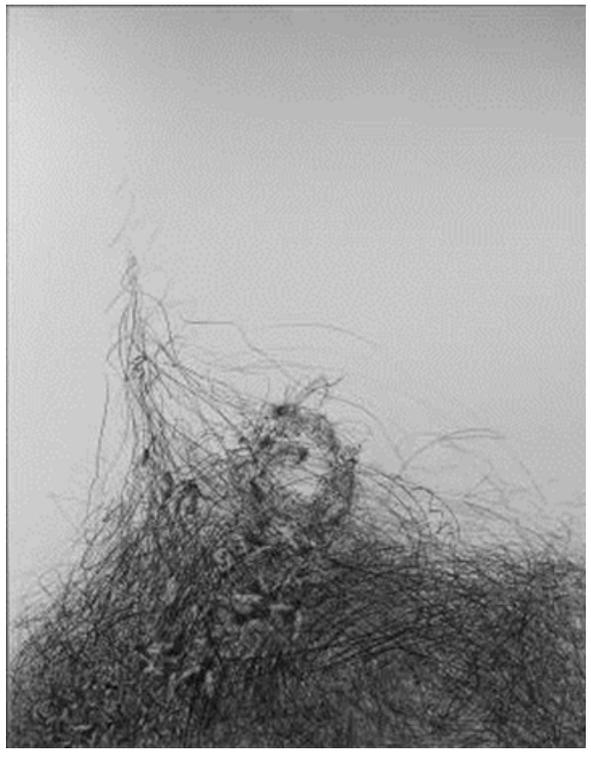

Fig. 62 Raen-Mendez: *Swarm*, graphite, charcoal, and ink on paper, 38” x 50”

Fig. 63 Raen-Mendez: *Swarm* (detail), graphite, charcoal, and ink on paper, 38” x 50”

Fig. 64 Raen-Mendez: *Big Power Intimidation*, graphite, charcoal, and ink on paper, 38” x 50”

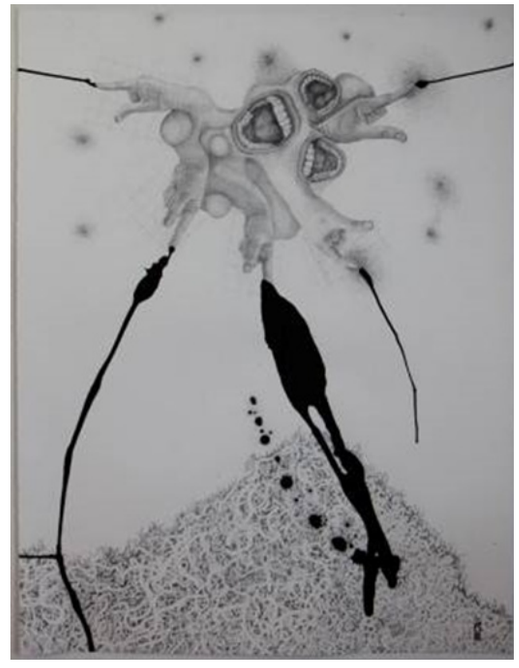

Fig. 65 Raen-Mendez: *Do More*, graphite, charcoal, and ink on paper, 38” x 50”

Fig. 66 Raen-Mendez: *Trickle Down*, graphite, charcoal, and ink on paper, 38” x 50”

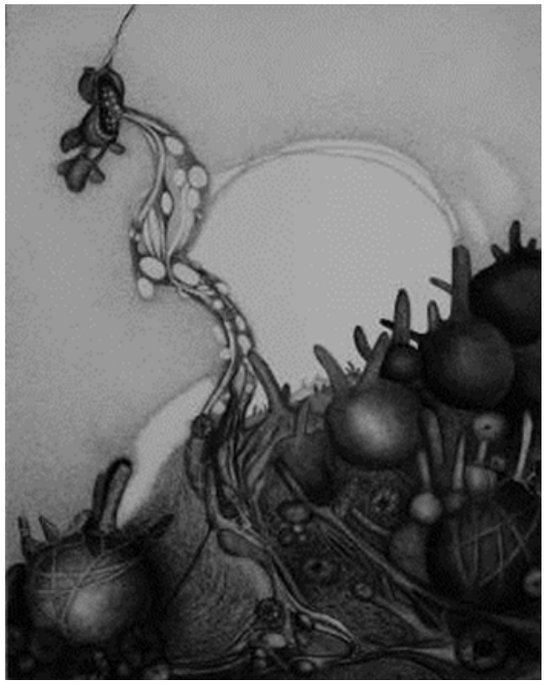

Fig. 67 Raen-Mendez: *Pearls Before Swine (re-visited)*, graphite, charcoal, and ink on paper, 38" x 50"

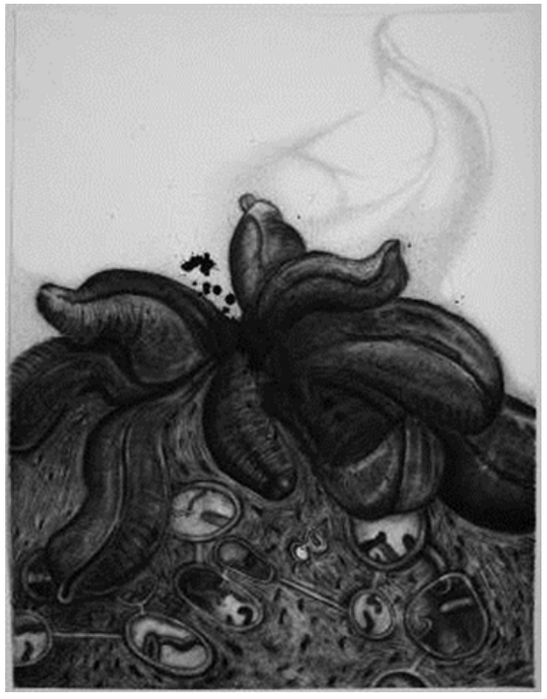

Fig. 68 Raen-Mendez: *(I Did it For the) Dopamine*, graphite, charcoal, and ink on paper, 38" x 50"

11 C. D. Friedrich's Ruine Eldena im Riesengebirge: a Fatherland United by Science and Art

Hilary A. Braysmith

During the lifetime of Caspar David Friedrich (1774–1840), the yearning of many Germans for political unity remained unassuaged. But Friedrich, in works like *Ruine Eldena im Riesengebirge,*[36] ca. 1830–34 (Fig. 69), aesthetically conjures a united Germany in two ways. First, Friedrich depicts the geological truths that shape both southern Germany – represented by the *Riesengebirge* mountain range – and northern Germany – represented by the ruin of the Gothic cloister Eldena located near the Baltic shore in Greifswald, Friedrich's home town. Second, he uses Eldena to reiterate the widely held belief that the pan-German culture that southern and northern Germany share derives from the ancient Goths, a tribe that originated in Friedrich's home state of Pomerania.

Friedrich's interest in science conformed to and derived from the German Romantic reverence for nature and their practice of observing it. Friedrich, like other German Romantics, believed that God communicated to human beings in three different languages: Biblical, historical, and natural. (Lankheit, 1950, p. 447) For the Romantics, nature was a divine symbolic language in which each natural object served as a hieroglyph (Volkmann, 1926, pp. 177–178; Lankheit, 1950, p. 447; Kluckhohn, 1953, pp. 28–29, 128), and every new observation of nature was a divine revelation. (Kluckhohn, 1953, p. 135) Art's purpose was to recognise this meaning and to make it clearer, i.e., to reveal God's message. (Volkmann, 1926, p. 180) To Romantic painters like Friedrich, it made more sense for a visual artist to depict nature and its history, thus translating from God's visual language into the human visual language of art, rather than to give the Bible, the verbal language of God, a visual form. (Braysmith, 2003, pp. 97–107)[37] Friedrich wrote, 'Art is the mediator between nature and human beings.' (Hinz, 1974, p. 90) Friedrich's conviction that artists translate the language of nature into

[36] *The Eldena Ruin in the Riesengebirge*. The *Riesengebirge*, more familiar outside of Germany as the Sudeten mountain range, today lie partly in eastern Germany, the Czech Republic, and Poland.

[37] For a fuller discussion of the religious pantheism in the work of Friedrich, see Braysmith, 2003, 'Motifs with Meanings or the Lessons of *Imitatio Christi* and *Imitatio Naturae* in the Work of Caspar David Friedrich', *Preussen: Die Kunst und das Individuum*, Akademie Verlag, Berlin, pp. 97–107.

the language of art confirmed in him the importance of direct observation of nature, eventually leading him to render directly observed natural phenomena, develop the signature characteristic of his compositions, and depict geological evolution as a motif in some of his works. *Ruine Eldena im Riesengebirge* substantiates these aspects of Friedrich's creative practice.

Friedrich moves away from featuring dominant human figures accompanied by generic supporting natural symbols in works such as *Frau mit Spinnenetz und kahlen Bäumen (Melancholie),*[38] ca. 1803, to rendering observed natural phenomena in works such as *Kreidefelsen auf Rügen,*[39] ca. 1818 (Fig. 70) in which the island's famous steep chalk cliffs and surrounding sea become the protagonists. In this and similar works, Friedrich selected his motives from the point of view of a *vedute* painter, focusing on the striking or unusual characteristics of specific places. In making a *vedute*, the artist concentrates on the individuality or unique physiognomy of a specific place or natural formation, including the capturing of distinguishing features of natural objects and unusual or striking natural forms. (Mitchell, 1982, p. 415) Friedrich's aesthetic practice mirrored the contemporary practice of geology, which also relied on 'direct evidence' and primary geological truths. (Mitchell, 1984, p. 460)

In addition to driving his mature motif selection, direct observation of nature informed the signature characteristic of his mature compositions, as well. Helmut Börsch-Supan (1960, pp. 65–108) traced and provided a periodisation for Friedrich's stylistic development,[40] proving that Friedrich derived his composition of extreme contrasts, e.g., between fore, middle, and background as in *Kreidefelsen auf Rügen*, or in the case of *Ruine Eldena im Riesengebirge*, between middle and background, from actual visual experiences in his native Pomerania, especially on the island of Rügen. (Börsch-Supan, 1960, pp. 77, 82)

[38] *Woman with Spider Web and Barren Trees (Melancholy)*

[39] *Chalk Cliffs on Rügen*

[40] According to Börsch-Supan, the periods of Friedrich's stylistic development are
1. Frühstil bis 1801 (p. 65)
2. Vorbereitung des Kontrastreichen Stils 1801–06 (p. 70)
3. Kontrastreicherstil 1806-1816 (pp. 77–78)
4. Stilkrise 1816–c.1820 (p. 92)
5. Stil der Assimilation c. 1820–1830 (p. 98)
6. Spätstil c. 1830–37 (p. 108)

Friedrich's sketching trips and experiences on Rügen impelled his compositional development and were crucial for his iconographic citing of significant geological phenomena. Contemporary writings by Friedrich's compatriot, the poet Ludwig Gotthard Kosegarten elevated Rügen, with its peculiar coastal geology of towering chalk cliffs, first to pan-Pomeranian and then to pan-German significance and reverence. (Grotte, 1944, p. 6) Friedrich provided an equivalent paean in *Kreidefelsen auf Rügen*, and in *Morgen im Riesengebirge,*[41] ca. 1810–11 (Fig. 71), he selects other geologically significant motives, such as the Riesengebirge to bespeak primeval Germany and its geological origins and evolution.

The practice of historical geology, a discipline founded by the Germans, encouraged Friedrich to expand his *vedute* approach from depicting individual geological phenomena to portraying the sweep of geological history in a single work. Intellectual discourses in Pomerania, notably at the University of Greifswald, claimed that the ocean was the primal geological cause out of which mountain peaks and their geological stratification developed. (Schwartz, 1745, pp. 4–5; Dalin, 1756, pp. 3–10; Franck, 1817, pp. 30–32; Kosegarten, 1827, pp. 60–63) These ideas corresponded with what Timothy Mitchell (1984, pp. 453–455) demonstrated as Friedrich's reliance on commonly held truths of historical geology and especially on the theories of Abraham Gottlob Werner. Consistent with his Pomeranian colleagues, Werner also based his geological theories on 'Neptunism,' which held that mountains originally came from a primeval ocean, which as it receded, revealed the peaks. Mountains were generally divided into two types. The 'Urgebirge,' or the primeval kind – those which the *Urozean*, i.e., the primeval ocean, formed first through crystallisation – and the 'Floetzgebirge,' those formed later by sedimentation (Mitchell, 1984, p. 461):

'Granite was the name given to the mineral that formed these original mountains. The distinctive nature of the `Urgebirge,' as Werner defined them, made granite a mineral of unequalled importance and a keystone of his entire theory. Because the `Urgebirge' were both the highest and the oldest formations upon which all subsequent mountain chains ultimately had to rest, granite was seen as a uniform mass extending unbroken from the loftiest peaks to the lowest depths thus unifying the earth's crust.' (Mitchell, 1984, p. 460)

[41] *Morning in the Riesengebirge*

The Riesengebirge are Urgebirge and evidence of primeval Germany's emergence out of the sea. Relying on observed visual analogy to convey scientific truths, Friedrich cites the primeval ocean itself, first in *Morgen im Riesengebirge* and later in *Ruine Eldena im Riesengebirge*. The analogy between mountains and waves enables him to compress eons into one image — thereby summarizing how these Urgebirge rose out of the Urozean, or sea. In fact, the Riesengebirge have a striking visual resemblance to ocean waves and, compositionally, are horizontal like the sea, rather than vertical (Grundmann, 1930, p. 418); it is these features that Friedrich translates into art. The resemblance of this mountain range to the sea was so striking that the Prussian King, Frederick William III, who later (1812) purchased *Morgen im Riesengebirge*, not only remarked upon it but also confirmed that the wave-like quality in Friedrich's painting corresponded to the actual appearance of the mountains:

'That is a beautiful picture; as I travelled toward Töplitz, I was awake early and thought to see the beautiful area; the tops of the hills loomed out of the valley, and this effect made the impression of the surface of the sea, and my original plan had disappeared; whoever has not seen it in nature thinks that it is not true.' (Hinz, 1974, pp. 11–12)[42]

Their sea-like resemblance links the Riesengebirge to northern Germany and to Pomerania, specifically, because the term 'Pomeranian,' in Friedrich's time, had the meaning and association of dwellers by the sea. (Micraelii 1723, p. 273) The renowned Pomeranian historian, Johannis Micraelii (1723, p. 273) stated, 'And because it stretches itself out along the sea, it was given in ancient times the name that one called 'Pomorswa,' that means more or less, next to the sea.'[43]

Eldena, located an easy walk from the Greifswald harbour, does not lie on the shore, but Friedrich often depicts it near the sea or sometimes emerging out of rolling, wavelike hills. In both cases, he alludes to the primeval ocean and to Pomeranian geography and Pomeranian sea culture. In order to reinforce the pantheistic idea of nature as divine language, Friedrich plays on the

[42] Hinz, 1974, pp. 11–12: 'Das ist ein schön Bild; als ich nach Töplitz reisete, war ich früh auf und gedachte die schöne Gegend zu sehen; aus dem Tau ragten die Hügelspitzen hervor, und machten gerade diese Wirkung einer Meeres-Oberfläche, und meine eigentliche Absicht war vereitelt; wer es nicht gesehen hat in der Natur, denkt, es ist nicht wahr.'

[43] Micraelii, 1723, p. 273: 'Und weil es sich am Meer her strecket, hat es von Alters den Nahmen bekommen, das mans Pomorswa geheissen, das ist so viel, als nächst dem Meere.'

German word 'das Schiff' which means 'ship' and 'nave'. This fusion is quite obvious in the prow-like shape of the interior of Eldena and its proximity to the ocean in *Winter* (1803) and *Winter* (1834), and it fits the Pomeranian legend that the ancient Pomeranians descended from God's chosen sailor, Noah. (Dalin, 1756, pp. 15–16, 37) In *Ruine Eldena mit Begräbnis*, 1803 (Fig. 72), precursor to *Ruine Eldena im Riesengebirge*, Friedrich shows the Gothic cloister rising up from the advancing and receding waves of the hills the artist adds to its site.

To the scientific, cultural, and religious import of his artworks, Friedrich adds another layer of significance in his use of the Gothic style. Beginning in the Italian Renaissance, it was widely, though erroneously, believed that the Goths, a German tribe, had invented the Gothic architectural style and civilisation. In fact, the terms 'Gothic' and 'German' were synonymous. (Braysmith, 2002–2003, pp. 263–270)[44] Furthermore, according to multiple historians and sources, the Goths originated in Pomerania (Braysmith, 2002–2003, pp. 263–270),[45] and as they migrated, they spread their 'German' style and cultural achievements throughout Germany. The aesthetic transporting of Eldena to the Riesengebirge, along with the peasants who were actually living in the ruin, completes Friedrich's cultural and geological unification of northern Germany/Pomerania with southern Germany. As the sea gave birth to the physical space of Germany, with its imposing Riesengebirge, so too, did it nurture German culture, signified by the Gothic monument, developed by the ancient Goths, those dwellers by the sea.

[44] For a fuller discussion of the widely held conviction that the Gothic style was German in origin, see Braysmith, H. 2002–2003, 'Caspar David Friedrich: A Pomeranian Cultural Portraitist', *Zeitschrift des Deutschen Vereins für Kunstwissenschaft*, 56/57, Sonderdruck aus Band, pp. 263–270.For a fuller discussion of Pomeranian and other sources claiming Pomerania as the homeland of the Goths, see Braysmith, H 2002–2003, 'Caspar David Friedrich: A Pomeranian Cultural Portraitist', *Zeitschrift des Deutschen Vereins für Kunstwissenschaft*, 56/57, Sonderdruck aus Band, pp. 263–270.

[45] For a fuller discussion of Pomeranian and other sources claiming Pomerania as the homeland of the Goths, see Braysmith, H. 2002–2003, 'Caspar David Friedrich: A Pomeranian Cultural Portraitist', *Zeitschrift des Deutschen Vereins für Kunstwissenschaft*, 56/57, Sonderdruck aus Band, pp. 263–270.

Fig. 69 Caspar David Friedrich: *Ruine Eldena im Riesengebirge*, ca. 1830-34, Oil on canvas, 72 × 101 cm, Pommersches Landesmuseum, Greifswald, Germany.

Fig. 70 Caspar David Friedrich: *Kreidefelsen auf Rügen*, ca. 1818, Oil on canvas, 90.5 x 71 cm, Museum Oskar Reinhard, Winterthur, Switzerland.

Fig. 71 Caspar David Friedrich: *Morgen im Riesengebirge*, ca. 1810-11, Oil on canvas, 108 cm x 170 cm, Alte Nationalgalerie, Staatliche Museen zu Berlin, Berlin, Germany.

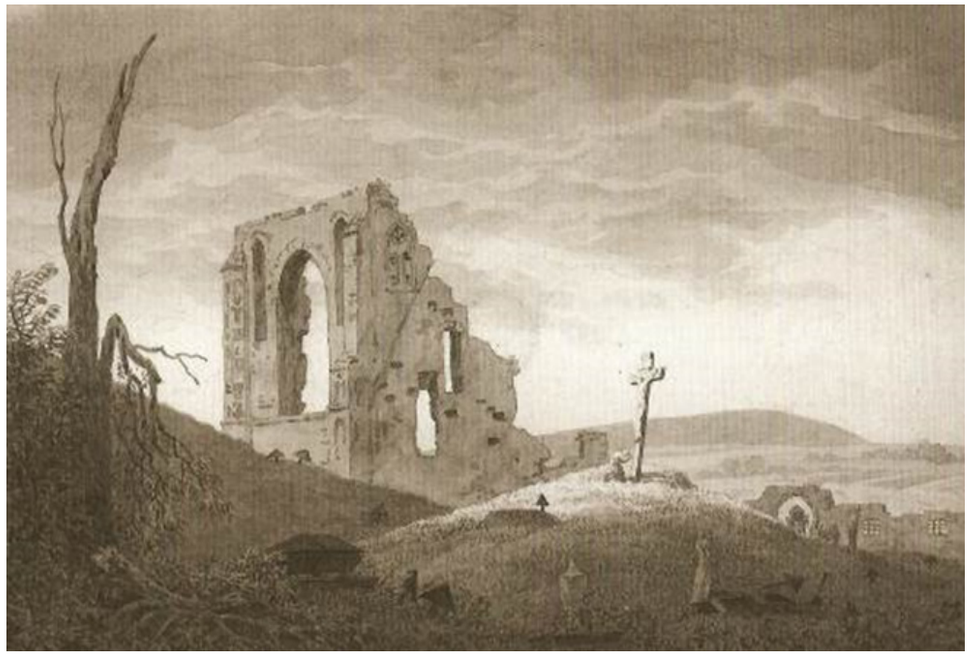

Fig. 72 Caspar David Friedrich: *Ruine Eldena mit Begräbnis*, ca. 1802/03, Sepia. 15.5 x 21.9 cm, Kupferstichkabinet, Staatliche Kunstsammlungen, Dresden, Germany.

12 John James Audubon's New Spirit of Inquiry: A Dual Legacy for Art and Science[46]

Leigh Anne Howard and David Black

Over the years John James Audubon has been described as a naturalist, merchant, entrepreneur, and conservationist; however, he is best known for his mammoth book, *The Birds of America.* In his pursuit of science through art, John James Audubon has been named 'America's Leonardo' and should be counted as one of America's greatest artists of the 19th century. (Olson, 2014, pers.comm., 19 May) His *The Birds of America* (*TBOA*) has been called the 'Sistine Chapel of American Ornithology.' (Heitman, 2008, p. 6) Throughout the 20 years he took to produce his *TBOA*, Audubon the naturalist straddled the fence between the exacting expectations of the nascent field of scientific study and the personal creative journey of artistic expression. His work amazed and annoyed; he was both acknowledged for greatness and rejected as inferior by similar circles of intellectual thought. His work exemplified the age-old conflict between the mind and the heart. He was forever pushing his creative talents to advance the science of ornithology while simultaneously through the rigors of scientific discipline raising the level of aviary art.

John James Audubon and his avian watercolours are a site of scientific research and creative technique, and as a partnership that used science and art in the service to each other. Recognised for his creative and innovative artistic approach to ornithological studies, Audubon has received attention mostly from natural historians as a result of The Birds of America. This four-volume double-elephant folio edition of 435 colour plates (measuring 29.5 x 39.5 inches) represents Audubon's goal of discovering as many birds as possible, then documenting those discoveries by drawing them to the size of life. (Blaugrund, 1993, p. 37) And *TBOA* is still regarded as one of the most important works in American art and ornithology. What has received less attention are the original watercolours used for engraving the plates, as well as Audubon's role in transforming natural history illustration into art. (Olson, 2012, p. 99) Although Audubon had little formal scientific training, he accomplished what few ornithologists at that time had: He ventured into the field for direct observations of avian behaviour and physiology, and then created an 'exhibition of fine art that captured the life force of each species as well as their place in it.' (Olson, 2012, p. 100) In fact, his position outside scientific communities freed him from the conventions that stifled natural history illustrations at the time; consequently, he generated exciting works that exceeded anatomical description.

Audubon provides an interesting case to examine the relationship between art and science. As a discipline of study, ornithology was in its early stages in Europe and to an extent absent in North America when the teenage Audubon arrived in the U.S. from France in 1803. Upon immigrating to the U.S., Audubon spent a great deal of time enjoying nature and observing the natural world that surrounded him. His art came as a result of his interest in nature, and it initiated a new standard of realism to ornithological portrayals. He became dissatisfied with the work of other artists because they were not depicting nature in all its dimensions and with the liveliness he noted in his rambles. Consequently, he set out to draw in detail as many American birds as possible and to record information about those birds in his journals. That information was later published as the narrative *Ornithological Biography.* (Audubon, 1831) This union between artistic and scientific pursuits situated the artist as scientist and generated a new spirit of inquiry. In the process, Audubon became an accomplished artist with a keen eye for documenting the natural world.

12.1 The American Woodsman

Born on April 26, 1785 in Haiti, John James Audubon (Fig. 73) was the illegitimate son of Jean Audubon – a French officer, merchant, and plantation owner – and Jean Rabine, a French chambermaid who died shortly after his birth. Recognizing an impending revolution on the island, Audubon's father sold most of his holdings and moved his family to Nantes. Audubon's education while growing up in France started him on the path as an artist. His father and stepmother nurtured his intellectual development, and he was tutored in painting, the natural sciences, and the arts. Audubon spent much of his early years in France exploring the woods and fields, collecting bird eggs and other

[46] This research has been supported, in part, by a University of Southern Indiana College of Liberal Arts Faculty Development Grant.

specimens, and drawing what he observed in nature. Audubon collected many books throughout his life, and beyond drawing and painting he was a voracious reader as well as writer. (Olson, 2014, pers.comm., 19 May; Partridge, 1996, pp. 269–270) He owned a book of avian illustrations, probably the *Histoire naturelle de Oiseaux* (1770–86) by George-Louis LeClerc, Comte de Buffon. (Audubon, 1831, p. 2; Olson, 2012, p. 42) His father encouraged him to watch birds, and Audubon claimed to have studied for two years with Jacques-Louis David, who visited Nantes in 1790. Audubon was familiar with the Old Masters (Stebbins, 1993, p. 3) and while scholars have debated Audubon's connection to David (see Ford, 1988, p. 40), Albert Boine argues Audubon could have been enrolled at the Ecoles de Beaux Arts without being admitted. (1999, pp. 731–32) Audubon's famous claim can also be seen in his illustration, *Golden Eagle* (Fig. 74), which clearly reflects the stylistic dramatics of David's iconic *Napoleon Crossing the Alps*.

To avoid conscription in the Napoleonic army, Audubon's father sent him to the family farm in Mill Grove, Pennsylvania in 1803, where he met Lucy Bakewell whom he later married. At eighteen years of age, Audubon was unfettered as he roamed and hunted the woods of his new world. He recounts in the *Ornithological Biography* his immediate desire to learn and document nature:

'I arrived in the United States of America where prompted by an innate desire to acquire a thorough knowledge of the birds of this happy country, I formed the resolution immediately on my landing to spend, if not all my time in that study, at least all that portion generally called leisure, and to draw each individual of its natural size and scope.' (Audubon, 1999, p. 753)

'... no sooner had I landed, than I set myself to mark every object that presented itself, and became imbued with an anxious desire to discover the purpose and import of that nature which lay spread around me in luxuriant profusion' (Audubon, 1831, vol. 2, p. x).

The idea of publishing these drawings, however, did not occur until a few years later, and the actual venture that would become *TBOA* would take several decades to launch fulltime. Audubon later settled in Louisville, Kentucky. Here, he started a mercantile business, and in 1810 he encountered Alexander Wilson, an ornithological illustrator seeking subscriptions for his own work, *American Ornithology* (1808–14). He eventually moved the business down the Ohio River

to Henderson, which was less developed and offered more opportunity for his business to expand; however, with the economic collapse of 1819, Audubon was pressured by his creditors and put in debtor's prison. Upon declaring bankruptcy he was released, and relied upon hunting and the sale of charcoal portraits to take care of his family and put food on the table. It is likely his failure as a businessman liberated him to embark on his greatest adventure: drawing the birds of North America. Audubon, though, explained he failed in business because of his passion for birds:

'I tried various branches of commerce, but they all proved unprofitable, doubtless because my whole mind was ever filled with my passion for rambling and admiring those objects of nature from which I alone received the purest gratification' (Audubon, 1831, vol. 1, p. x).

Over the next several years, Audubon travelled the young American nation and depicted every bird he could find. In the process he identified twenty-three new species and twelve subspecies (Olson, 2012, p. 63), and he developed a battery of artistic techniques that would enable him to render lifelike illustrations of the birds he encountered. In 1824, Audubon travelled to Philadelphia, Pennsylvania, to garner support to publish *TBOA*. At that time Philadelphia was at that time the intellectual capital of the United States and home to the naturalist Charles Willson Peales' Philadelphia Museum and the Academy of Natural Sciences of Philadelphia. Unfortunately, the Academy's leader, George Ord, was a supporter of Audubon's rival, Alexander Wilson, whose own work had been published in Philadelphia in 1808. Failing to obtain financing or a publisher in the U.S., Audubon sailed to Liverpool in 1826 with an impressive portfolio of drawings. In contrast to his reception in America, Audubon quickly found fame and recognition. After a successful exhibition at the Liverpool Royal Institute, he travelled to Edinburgh to meet Sir Walter Scott before traveling to London. John Chalmers sees this detour as fortuitous, since upon arrival with letters of introduction in hand, Audubon was embraced by the scientific community. (Chalmers, 2013, pers.comm., 26 July) Members of the Royal College of Surgeons and the Wernerian Society — Robert Jameson, William MacGillivray, Patrick Neill, Robert Knox, and John Wilson, among others — met with Audubon, admired his work and facilitated his acceptance among Edinburgh's intellectual elite. (Chalmers, 2003, pp. 37–82, 113–119) With support from medical and natural history scholars, Audubon was

invited to mount an exhibition of his work at the recently completed Royal Institute in Edinburgh. During this time, he also met William Home Lizars, who would engrave the first ten plates of *TBOA*. When Lizar's watercolourists went on strike, Audubon approached London artist and engraver Robert Havell, who spent the next eleven years working with Audubon complete *TBOA*. In addition to securing endorsements from the Wernerian Society in Edinburgh and the Zoological and Linnaean societies in London, Audubon met with prominent British scholars — including William Whewell and Adam Sedgwick from Cambridge. (Meyer, 1993, p. 43) He secured William MacGillivray as his editor and collaborator for the *Ornithological Biography*, a written description of each species depicted in *TBOA*; he also began acquiring subscribers for *TBOA*.

12.2 Audubon and Natural History Illustration

Roberta Olson explains that John James Audubon was aware that his lack of scientific credentials was his 'Achilles Heel,' and so he credited ornithological illustrators for creating taxonomies he could follow while venturing from their prosaic artistic techniques. (2012, p. 41) Natural history illustrators typically created highly technical, static drawings with the sole purpose to document the 'epic building of a system of natural history.' (Judd, 2006, pp. 7–8) At that time, the pictorial style depicting wildlife practiced by naturalists – Georges-Louis LeClerc, Comte de Buffon; Mark Catesby; and Alexander Wilson – reflected a representation marked by a formal, rigid, silhouetted stance, presenting birds 'as an Egyptian relief' and what Audubon referred to as 'Stiff meaning profiles'. (Olson, 2014, pers. comm., 19 May; Audubon 1999, p. 759) This approach was a convention of ornithological practice presenting the visual documentation of birds in a consistent, accurate form without the distraction that any variety of natural posturing might introduce. These illustrations presented a practical point of view attempting to capture scientific or *a priori* knowledge rather than to generate new insights. (see Marshall, 2004, p. 139, for a discussion of science in visual culture) However, this practical stance was tempered with the awareness that to have an impact their illustrations also needed to capture the interest and imaginations of popular audiences. (Judd, 2006, p. 5) Natural history illustrators, focused on the aesthetics of their subjects; however, they excluded the context for what they observed, a context that generated the discovery and excitement associated with the image they recorded.

The exclusion of context for various species differed greatly from other types of scientific illustration of that time. Expeditionary art, which in addition to achieving military and geopolitical motives, obviously had scientific aims. Like naturalists, these artists varied in skill, and like Audubon, they had little formal scientific training. Their sketchbook was the only way to provide pictorial documentation of what they observed in the field (Balm, 2000, p. 586); consequently, it was important for expeditionary art, like illustrations of various species, to be mimetic, objective, and rational works in order for it to be regarded as evidence or proof of their observations; illustrators of both types, then, were merely describing what they saw devoid of interpretation. Also, expeditionary artists had a symbiotic relationship with texts; government reports and travelogues, in addition to scientific data, accompanied their art (Balm, 2000, p. 587) just as Audubon's journals and extensive field notes for the *Ornithological Biography* supplemented his drawings. These explanatory texts — not usually characteristic of western art — enabled a more complete understanding of what was encountered in the field. Despite these artists' attempts to be objective, as Christoph Irmscher explains, natural history hovers between scientific impartiality and artistic subjectivity; it refuses to commit itself to either way of representing the world. (1995, p. 1) Audubon took advantage of such liminality, and he succeeded by capturing accurate and informative portraits of each species in its natural habitat while creating beautiful, inventive and interesting depictions.

12.3 Realist and Romantic

Audubon's illustrations represented a definite shift from the cool, analytical compositions used to codify the natural world toward a more dynamic sensibility that encompassed how various species lived and behaved. The realism Audubon worked into his depictions was marked by distinct, bold imagery and dramatic forms. (Olson, 2012, p. 50) Audubon wanted to present birds as they lived, and so more often he showed how one might see birds in nature: preening, reacting to other birds and animals, flying, engaging combat, fleeing, eating, and so forth. Others before Audubon had similar interests. Maria Sibylla Meri-

an (1647–1717), for instance, documented exotic butterflies and their activities. (Marshall, 2004, p. 2) Buffon's field guide also briefly described animal habitats in addition to the physical description of the birds he illustrated. English naturalist Mark Catesby, likely Audubon's most important nineteenth century predecessor, painted birds alive rather than from taxidermied specimens or illustrations by other naturalists. Catesby, though, insisted his illustrations were subordinate to the science expressed in the accompanying text, and he argued artistic interpretations detracted from their role as scientific documentation. (Irmscher, 1995, p. 3) While others apparently implemented techniques foreshadowing Audubon's artistic style (Partridge, 1996, p. 283), the impulse to depict nature in a vibrant, vivid manner was not fully developed until Audubon, who considered his style accurate and proper.

A key distinction between Audubon and other naturalists at the time entails the extensive fieldwork Audubon relied on when completing his drawings. Albert Boine calls Audubon 'singular among the pioneer American artist-ornithologists for his intrepid forays into the wilderness...' (1999, p. 737) Audubon, in the image of a pioneer citizen of an emerging nation, was self reliant in his work. That is, while he might have relied on other artists to paint the backgrounds, he would not rely on the avian observations of others until he had confirmed the information himself first hand or was offered irrefutable evidence from multiple sources. (Audubon, 1999, p. 754) Since other ornithological illustrators used descriptions from books, taxidermied specimens, and animal skins, they drew birds in stiff profile because they could not see them any other way since they were drawing from static images. Audubon, in contrast, preferred to draw from nature; in fact, on every painting he completed, he included the phrase 'drawn from nature' as a symbol of authenticity. 'Drawn from nature' meant two things in terms of technique. First, Audubon spent countless hours watching the birds so that he could digest their lessons 'which he transferred to his dazzling watercolours that captures the evidence of every bird.' (Olson, 2012, p. 41) He quickly discovered that while he preferred drawing them alive, he could not finish the sketches, and this discovery led to the other interpretation for 'drawn from nature'. Audubon was proud of his ability to hunt. (Judd 2006, p. 23) He tracked birds, observed their behaviors, and then killed them so that he could, ironically, render them as lifelike as possible using animals freshly killed. Because of the

sheer numbers of birds he killed over the years, Robert Penn Warren called him the 'greatest slayer of birds that ever lived.' (Blotner, 1997, p. 382) He usually would shoot them in a manner to prevent as much mutilation as possible (Heitman, 2008, p. 12); however, he must not have been completely pleased with the approach since in a letter to Richard Harlan on 20 March 1833, Audubon reported 'gassing' a golden eagle so he could paint it. Because his works, then, were 'drawn from nature,' Audubon had an important advantage over those with formal scientific training. He had immediate experience with birds — alive and dead — instead of the distance implied by the laboratory of his contemporaries. In his journals, Audubon goes so far as to disdain those who lack direct experience with nature when completing their natural history studies. Audubon wrote, '... nature must be seen first alive, and well studied before attempts are made at representing it.' (Audubon, 1999, 'Account', p. 756) The fieldwork also enabled him to weigh and measure each bird for inclusion in the species notes for the *Ornithological Biography*.

In addition, the fieldwork permitted his primary obsession: to make his birds appear as lifelike in the drawings as they were in nature. That is, the realism that Audubon brought to his subjects was grounded in his practice of personally witnessing in nature a majority of the birds that he painted. He reflects upon this exigence when he describes a conversation with his father who 'constantly assured me that nothing in the world possessing life and animation was easy to imitate...' (Audubon, 1999, 'My Style', p. 759) Audubon noted that his first drawings of European specimens 'were all represented *strickly ornithologically*, which means neither more nor less than in stiff profiles, such as found in the works published before the present century.' (Audubon, 1999, 'My Style', p. 759) Audubon's compulsion to understand the bird in its entirety resulted in the *Ornithological Biography* not only documenting the birds' physical features, behaviors, and habitat, but also describing the comparative tastes of them as well. (Audubon, 1831, vol. 1)

Audubon realised he needed to create drawings 'in the old way, all those parts that are called by them [i.e., naturalists] *necessary characteristics*, are to content these gentlemen...' (Audubon, 1999, 'Method', p. 754) Yet, he also needed to content himself as he was certain a complete understanding of avian life required more than knowledge of the physical characteristics. First,

he drew birds in three-quarter profile, more like human portraits than the typical ornithological illustration. Second, he drew birds to size and scale — thus the use of double-elephant size paper. And third, he displayed birds engaged in various actions so people could ascertain the scope of a bird's life. The birds in his watercolors exhibit an energy ready to jump into three dimensions allowing viewers play with their imagination. The females in *Red-headed Woodpecker* eagerly reach for food offered by their males. (Olson, 2012, p. 372) The two Golden-crowned Kinglets zero in on their tiny flying prey and are about to strike. (Olson, 2012, p. 383) A male and female couple stand and fight for territorial possession in *Common Eider.* (Fig. 75) Even in scenes more tranquil and less energised, there is a sense that these birds were drawn as they were in the wild. Few of Audubon's predecessors showed such dynamics.

Even though he discovered he could draw from freshly killed species easier than live ones, Audubon was still concerned about how to make birds look alive when drawing from dead specimens. Through much trial and error he finally came upon a unique design of pinning his birds in natural poses onto a gridded board, which allowed him to accurately transpose the composition to paper; he recounts the success of his discovery: 'Reader this was what I shall ever call my first attempt at drawing actually from nature, for then even the eye of the Kings fisher was as if full of life before me whenever I pressed its lids aside with a finger.' (Audubon, 1999, 'Method', p. 761) Once he established this system he was better able to further develop his painting skills. Now he could calculate proportions and capture birds on paper in such a way that they were infused with life. This method was a decided improvement over his early days in France when he, too, was drawing from taxidermied specimens, or his time at Mill Grove where he suspended bird corpses in midair to avoid static depictions. (Olson, 2012, p. 44) Olson compares Audubon's system as a 'marriage of science and art' as it 'combines the scientific mounting of specimens with the techniques known since the Renaissance, used by Albrecht Dürer and part of the academic curriculum, to enlarging and transferring images.' (Olson, 2012, p. 54–55) Audubon's extensive fieldwork set him apart from others in the flock of ornithological illustrators. His fieldwork contributed to a vast knowledge of avian life, that when combined with fearless artistic experimentation, allowed him to reach his goal of portraying lifelike images of American birds.

Given *TBOA*'s many realistic portrayals, there are also examples of Audubon's compromises in order to fit the larger birds on the page. Audubon has been criticised for the apparent forcing of birds into contorted positions that looked more caricature than realistic (Peterson 1990, 'Audubon As Artist'). For example, long-necked birds — such as the Sandhill Crane (Olson, 2012, p. 294), Great Egret (Olson, 2012, p. 347), and the American Flamingo (Fig. 76) bow their heads, twist, or glance back to create a more compact arrangement. Just how unnatural these postures appear or whether it matters depends upon whether or not one looks at them as accurate representations of avian behaviour or simply as objects of admiration.

Audubon constantly worked to improve his techniques and expand his use of media beyond established practices of ornithological art, which at the time was marked primarily by graphite and pastels. His primary medium was watercolour which allowed for more complex depictions. But depending on the effect needed for a particular look, he employed any combination of pastels, graphite, oils, ink, overglazing, collage, gouache, glaze, and metallic paints. Using these various approaches, Audubon created finer detail, contrast, coloration, and gradation that brought a greater level of realism to the subtleties of his avian imagery. (Snyder, 1993, p. 57; Audubon, 1999, 'My Style', p. 763)

Beyond the birds themselves there are the background settings in which the birds reside. Previous to Audubon's drawings, ornithological art placed birds on a branch or in some small setting, if anything at all, or they took on the form of a pictorial taxonomy with various illustrations of a species arranged in a grid. Audubon greatly expanded the look and attention to ornithological art and science by attending the backgrounds, which had their own artistic quality. Audubon employed a small handful of talented artists over the two decades to illustrate the settings. Joseph Mason, George Lehman, Maria Martin, among others, created settings ranging from complex natural and urban landscape environments for larger birds, to a smaller amounts of plant foliage for the more diminutive creatures. The enhanced energy and realism Audubon gave to his birds was a key component to the popularity of his art during his lifetime and has remained central to his importance to this day.

As Audubon's birds became more active and lifelike, however, critics associated his drawings with anthropomorphism and charged Audubon with

assigning human characteristics to his birds. (Olson, 2012, p. 52; Stebbins, 1993, p. 19) This charge revealed another schism in scientific thought of the time: the difference between mechanistic and vitalistic theories of animal behavior. The mechanistic school defined animals as machines with instincts while the vitalistic perspective claimed animals were rational and emotional creatures. The American naturalists, including Audubon and Charles Willson Peale, found insects emotionally complex and tended to regard animals as 'capable of learning from past behavior, communicating, tutoring their young, and expressing anger, agony, and contentment.' (Judd, 2006, p. 23)

His works incorporated the emerging style from the Romantic movement noted by a heightened sense of emotion and drama. (Barrow, 1998, p. 11) Julia Marshall argues Audubon saw animals in their natural state as 'apt metaphors for the best human qualities and aspirations.' (Marshall, 2004, p. 144) Amy Meyer concurs, explaining *TBOA* as 'testament to Audubon's belief that the behavior of birds and men is, in the end, essentially alike.' (1993, p. 49) Albert Boine asserts that Audubon's anthropomorphizing is not surprising given his identification with birds: Audubon saw them experiencing what he, himself, had: controversial parentage, being raised by a stepmother, the death of children, and separation from family while pursuing art and science. (1999, p. 745) Irmscher claims that though birds were anatomically different from humans, many – including Audubon – believed avian behavior could teach humans about the use of tools, the importance of neatness, and the value of attending one's mate. (1995, p. 4)

Audubon's anthropomorphism takes form in gesture, expression, and action, such as hunting prey, courting mates, defending territory, feeding the young, and interacting with other birds. As Stebbins notes for example, the Belted Kingfisher (Olson, 2012, p. 375) although still in profile, has a 'human look in its smart jaunty expression.' (Stebbins, 1993, p. 7) The *Northern Flickers* presents two angry quarrelling females. (Olson, 2012, p. 158) The Ivory-billed Woodpeckers clutch a tree and combat for an insect. (Olson, 2012, p 182) The Key West Quail Dove soothingly courts its mate. (Olson 2012, p. 381) The Bluejays brazenly steal (and consume) eggs from another avian species. (Olson, 2012, p. 211) One particularly controversial depiction concerned the *Northern Mockingbird* (Fig. 77) in which the birds are viciously attacked by a rattlesnake which had climbed a tree to raid their nest. Other naturalists criticised this image and argued it was impossible for snakes to climb or for them to have fangs as depicted. Audubon remained unfazed by such remarks, and later he was a vindicated. (Olson, 2012, p. 52)

Much of the drama in Audubon's art, in part, is a result of the influence of Jean de La Fontaine's *Fables* (1704), which Audubon carried while travelling. Like Audubon's drawings, these action-packed stories were replete with species in natural settings. Illustrated by Jean Baptiste Oudry, the fables are 'spiked with moralizing humour in which animals, birds, and insects take on human characteristics in the author's attempt to understand the workings of the universe and sometimes the laws of nature.' (Olson, 2012, p. 48) Audubon, of course, achieves the same effect in his drawings. That is, he observed avian behaviour, processed his understanding of such behaviour through a human lens, then used his art to communicate his understanding of those behaviours. Audubon's awareness of La Fontaine permitted him to 'heighten the emotional colour of the animals' interactions' and to channel 'these qualities in his watercolours.' (Olson, 2012, p. 48) Olson adds, 'To elevate his illustrations to the high drama of the fine arts, he added a dash of hyperbole and emotion and inserted a moral into the narrative.' (ibid)

Audubon's anthropomorphism also accomplished goals beyond his artistic intentions. First, this strategy, as Danny Heitman reminds us, invites the viewer 'to imagine what it might be like to be another creature' and to experience the life of a bird. (2008, p. 45) Second, anthropomorphizing his birds heightens the viewers awareness of the human experience associated with natural history documentation. Anthropomorphizing prompts viewers to see the watercolors as a human story, more specifically Audubon's story, as he engages in the sighting of the birds he illustrates. And third, this device heightens a viewer's recognition that Audubon alone is responsible for providing the beauty we see when we look at his watercolors or *TBOA*. This idea is particularly apparent in his illustration, the *Golden Eagle.* (Fig. 74) The primary image of this watercolor — and the only image in *TBOA* plate – is a golden eagle grasping its prey; yet, in the lower left hand corner of the painting we see a 'tenacious and daring' Audubon complete with a raccoon-skin cap, buckskin clothes, and animal strapped to his back as he creeps over a log to cross a crevasse. Although Havell eliminated this autobiographical portrait when he engraved the plate for *Golden Eagle*, Audubon's presence

in the watercolor is a reminder that he was present at the time of the sighting; that he has provided the splendid image we see; and that without his tenacity, dedication, and sacrifice, viewers would not be able to know avian life or appreciate avian beauty.

John James Audubon has received more attention than almost any other American artist, perhaps because Audubon blends the 'noblest of traditions of European art and European ornithology' with the American wilderness. (Stebbins, 1993, p. 18) This blend resulted in the extraordinary and unique. When *TBOA* was published in 1828, Baron George Cuvier reported to the Academie Royale de Sciences, Audubon's work 'is the most magnificent monument which has yet been erected to ornithology… [W]e shall be obliged to acknowledging that America, in its magnificence of execution has surpassed the old world…' (Olson, 2012, p. 4) When the New-York Historical Society purchased Audubon's original watercolors from Lucy Audubon in 1863, Audubon's aviary was recognised as 'one of the finest accomplishments in American art and one of the most important documents of natural history in the world.' (Hotchner, 1993, p. vii) Audubon's art in product and process reveal him as a fine artist and scientist with an uncanny ability to be one with the natural world he spent his life attempting to document. While other artists of his era were painting cultivated landscapes and the countryseats of the wealthy, Audubon forged into the American wilderness to paint its birds. (Stebbins, 1993, p. 6)

Of course, the illustrations one sees in *The Birds of America* do not look exactly the same as Audubon's original watercolors, nor should one expect it to despite the care and talent that produced the plates, stunning by their own merit. Audubon gave precise instructions on detail work of imagery and coloring for *TBOA*, and Robert Havell, in particular, added to the quality of the final depictions. Audubon was pleased with Havell's work, which included the complex process of aqua-tinting that introduced a greater range of shading and gradation. (Olson, 2014, pers. comm., 19 May; Aakhus 2014, pers. comm., 26 July)

American naturalists, mostly self taught individuals, were constrained by the precepts of Europe's scientific and artistic communities; yet they were determined to develop unique ways of looking at nature and communicating what they observed. Fieldwork, for example, revealed the sometimes brutal laws of nature seen in Audubon's work, and Audubon's experimentation with media, paper size, and dimensionality created an unprecedented realism providing scientific credibility and aesthetic enjoyment. Of course, the science of ornithology has since matured from the mid 19th century and has long ceased to be the place of self-trained naturalists with an emphasis on aesthetics. (Barrow, 1998, p. 11) Bird art, likewise, did not stay on the Romantic track, but rather developed a greater sense of realism than even Audubon achieved. (Peterson, 1990, 'Since Fuertes') Seeing the works of his successors, Audubon would likely be pleased by the attention to realism they have brought to his birds; however, he might miss the drama. Nevertheless, of the many talented avian artists who have come along since Audubon, none stand as high as he, and none have been in such high demand if auction prices are evidence. Until November 2013, when Christies sold a 17th century Bay Psalm Book, John James Audubon's four-volume tome, *The Birds of America,* held the highest price for a publication paid at auction. In fact, Audubon's TBOA actually held the *three* top prices at auction earning $11.5 million in 2010, $8.8 million in 2000, and $7.9 million in 2012. (Barron, 2013; Park, 2012; Gamerman, 2010) Because he was responsive to nature and beauty, John James Audubon created a phenomenal collection of avian illustrations that have captured the imaginations of people around the world for centuries. His original watercolors, the plates comprising *The Birds of America*, and the numerous prints reproduced from those plates — all serve as evidence of the American pioneer spirit and ingenuity; as a meeting place of science and art; as a link between the popular and academic; and as encouragement of a spirit of inquiry that demands intellectual and artistic innovation.

Fig. 73 *Portrait of John James Audubon* by John Woodhouse Audubon. C. 1840. Oil on canvas, 44 ¼ x 33 inches. 1974.46. The New-York Historical Society.

Fig. 74 Audubon, *Golden Eagle*. 1833. Watercolor, pastel, graphite, black ink, and black chalk with touches of gouache and selective glazing on paper. 38 1/8 x 25 ½ in. 1863.17.181. The New-York Historical Society.

Fig. 75 Audubon, *Common Eider*. 1833. Watercolour, graphite, pastel, black ink, gouache and black chalk with scraping on paper. 25 7/16 x 38 3/8 in. 1863.17.246. The New-York Historical Society.

Fig. 76 Audubon, American Flamingo. 1838. Watercolour, graphite, gouache, black ink and pastel with glazes on paper. 33 ¼ x 24 3/16 in. 1863.17.431. The New-York Historical Society.
Fig. 77 Audubon, Northern Mockingbird. 1825. Watercolour, graphite, pastel, black chalk, gouache, and black ink on paper laid on card. 29 ¾ x 20 7/8 in. 1863.17.21. The New-York Historical Society.

13 The Impact of Social Sciences on Art

Tereza Hrubá

It seems almost impossible to separate the activities around contemporary art from social sciences especially from those such as philosophy, psychology or sociology. Furthermore, our individualised society in contrast with globalised visual culture continuously strengthens and contributes to this phenomenon. It was with the arrival of postmodernism, a multimedia society, and global culture, when art became seemingly more and more psychologised.

Also the connection between art making and society, and therefore sociology, is indisputable. The approach of psychology to art could be divided into two parallel lines where one studies mental processes occurring in the course of art making and the other focuses on mental processes occurring in the course of artwork perception. Contemporary art sociology is dominated by two themes. The first one relates to the theory of social dependency of style, while the second one is based on the approach to art as a whole, working mainly with the premise that art is everything that is labelled as such. These labels are the products of the 'worlds of art', comprising critics, artists, museums, art theory, or viewers which thus suggests that art is created through institutions. (Paulíček, 2012, p. 31) Sociology also examines the issues of 'high art', as well as structures and mechanisms of art commercialisation. Especially the social construct of 'high art' constitutes a topic which certainly deserves its own sociological research.

When observing the process of social sciences impact on contemporary art, several principal areas come to light. Artists, just as our postmodern society does, deal with abrupt changes, the absence of principal myth, and search for their own identity. In the first area of interest we can see the effect of social constructivism thought on art.

The mainstream art production is opposed by socially engaged art and street art which takes over public space. While in the past, art hardly knew about sociology, today many ambitious projects deal with sociological aspects and meet with much public acceptance. Also authors themselves often employ technological procedures commonly used in social sciences. Therefore it is social intervention with the environment that can be considered as an interesting phenomenon in the Czech art space. The other prominent area is constituted by the impact of sociology and its procedures on art practice.

The impact of philosophy which would follow the thought of Immanuel Kant and which is worth mentioning is the impact of the thought of social constructivism on art making. (For further detail see Berger, Luckmann 1999) When constructing a social world, not only language but also a sign language, the area of our interest, plays a key role. And it is a role increasingly more significant. Especially in an everyday reality of smart phones, facebook or twitter, textual representations are being replaced by pictorial representations. These condensed pieces of visual information not only depict but also co-create reality. Reality is not invariable, it is continuously being made and strengthened. An artist continues to fight not only with his own understanding of 'what art is' but also with the virtual construction of reality. Therefore a more topical question is not 'what is art' but 'when or in what condition art is art'. Both artist and their artwork are significantly influenced by the whole system of social relations in which art making takes place. The origin of every artistic realisation lies in certain historical and social conditions and its quality is being compared to rules valid in the given culture rather than to universally and forever applicable criteria. (Šobáňová, 2014) There are lots of areas in art production where the impact of social constructivism thought is clearly evident; individual consideration should be given to the arrival of new media, media reality or 3D reality. The two most important realities in the personal relationship between artist and social constructivism could be the following: an artist's attitude to myth, and their quest for their own identity.

13.1 Myth and Art

A myth gave rise to philosophy where it still plays a central role. Especially cultural anthropology deals with myth as a traditional narration. According to the contemporary psychology, the concept of myth reflects on the human need for harmony, story, and images. The relationship between myth and images can be observed throughout the entire history of art. The principal and continuous relation is born with the myths of Greek ancient culture especially with drama, which is the base for all narrations of epic character.

At first, Christianity adopted a dismissive attitude towards the classical approach and replaced it with the concept of the so-called salvation history followed by the process of re-discovering its own mysticism in the 18th century. We can find an abundance of biblical themes in the European Renaissance and Baroque art and the power of the biblical story slowly disappearing until the 20th century. In our cultural environment, Christian content in particular, is still in some way kept present.

However, association and paraphrases of classical and biblical myths are one of the theme sources in contemporary art production. While Christian mythology is not vivid or well-known for the contemporary generation, it is not as important because citations of classical themes can appeal to the viewer whether they are familiar with the content or not. Viewers can communicate with pictures on the bases of collective and emotional experiences. They are understandable to them also because often it is technically demanding art and a viewer evaluates the result as being 'real art' in the sense of demanding 'truly remarkable skills'.

The self-taught Dutch photographer Hendrik Kerstens intentionally mentions Dutch masters while searching for classical themes. In the past years, he has been realising a cycle of photographs in which he depicts his daughter Paula not only in period stylisations but also with modern stage properties. The resulting prints are full of inner mysticism, non-superficial innermost contents with certain distant formal coldness around them.

Up to a certain extent, Kerstens' visual expression is comparable to the work of Hiroshi Sugimoto and a Dutch photographer Desiree Dolron. She is interesting mainly for her portraits from the *Xteriors* XVI 2001–2013 cycle where based on digital composites of various faces she constructed an inner life of painted Flemish portraits. The theme of myth pervades through all her work. In her previous cycle titled *Exhaltation*, Dolron opens up the theme of religious ritual, mystical emotion and death. Regarding the Czech context, the name of Michal Ožibko is very important. He focuses on realistic painting and his canvases show not only the paraphrases of famous paintings but also classical lighting, hyper realistic positioning of contemporary attributes into paintings and existential uneasiness. As an example we can name his work titled *Girl with...*

(a portrait of Frederike Höppner), oil on canvas, 2008, or a depersonalised portrait of a woman with a naked man lying on her lap which gives a viewer space for searching their own basic content (canvases: *Escape*, 2011 and *Essence of Escape*, 2013).

Fig. 78 Michal Ožibko, *Girl with...*

The absence of strong myth in the European cultural environment is closely related to art production. With the arrival of pop culture, the missing social myth is replaced by the myth of mass media and the cult of famous people. The motifs for art making come newly not only from the inner quest for oneself and one's relationship with the absolute but also from the outside being triggered by the need to come to terms with a media construction of 'success'. Authors are influenced by social environment, media, perpetual movement and the activity of a global social network. Thus we see reminiscences of biblical themes in the work of David LaChapelle, who combines these themes with the decadent culture of celebrity and in essence puts both of the areas on an equal footing. While Hussein Chalayan offers to viewers an unusual and alienated view on the world of famous people and the cult of media. A similar position between a commercial, a promotional photograph, and a strong free artwork is assumed by a Dutch portrait photographer Erwin Olaf. In his photography cycles, we can find both paraphrases of classical themes (Gijon, Apolonia, Zurbaran from 2008) as well as classical portraits in a purely commercial environment such as photographs of the model, Ymre Stiekema, for the Dutch edition of Vogue (October 2013) or white-and-red portraits of 'the famous deceased' in the series titled *Royal Blood*, 2000. Among the Czech photographers, David Kraus stands out for his *debauched* visuality, portrait concepts, and promotional photography.

The quest for a myth in oneself, uprootedness, the desire for intimate spiritual experience, intensive changes in values in the period of motherhood are often the domains of women-artists. In a Czech context, Tereza Vlčková is well-known for focusing on such portraits. On one hand, her photographs are dreamy, and on the other they are slightly scary for their detachment. In the world context, we could classify her in the same category as Loretta Lux or Hans Op de Beeck. The German photographer Loretta Lux works with similar themes of twins (Sasha and Ruby) and a dreamy intimate landscape (The Rose Garden). Her portraits appear as if there is some other content of their own which remains hidden to the viewer. An open landscape, a view from a window, an empty interior are motifs which can be perceived as archetypal and which can easily be filled with personal experience. Even though the approach of Hans Op de Beeck is different, his portraits emanate a similar detachment. The extent of his work goes from painting, drawing, sculpture and installation, up to photography. His monochromatic colours and work with light sometimes evoke fear and inner uneasiness.

Fig. 79. Tereza Vlčková, *Untitled*

The impact of the philosophy of social constructivism, its relativisation of reality, the quest for myth and its determination in the reality of the 21st century is directly reverberated in contemporary art production. The above listed authors not only reflect on a given state of things in a given period but mainly they employ principal constructions of myth for themselves and the viewer. Another equally significant influence of social sciences on art which is the quest for personal identity is also connected with myth, quest, and integrity up to a certain extent.

13.2 The Quest for Identity

Identity is not just self-conception, the consistency in time and space but also the independence of sign representation. Luxuriant visual space together with the pressure exerted by the market focused on consumerism overwhelms the viewer with idols with whom the viewer is to identify themselves from early childhood. To get one's bearings in this visual maze means to be able

to understand and read hidden information and visual signs and to find one's own identity regardless, what we might call, the culture.

Identity in art comes into focus with the individualisation of a society, the absence of common myths but also as a result of political changes. A significant motif at the end of the 20th century was personal identity in contrast with or in a direct opposition to group community. The issue of identity is a boundary theme of social and developmental psychology. The topical questions which have a bearing on contemporary art production relate to the concepts of social categorisation, social identity, symbolic boundaries and identity from the social constructivism point of view. Also contemporary sociology works with identity. Having historical experience, it tries to attain ambiguity of collective identities. While it admits that certain historical social structures give rise to the kind of identities which are easy to recognise in each example (Berger, Luckmann, 1999, p. 171), it also warns us about the fact that when talking about dialectics of identity we automatically avoid unambiguous collective identities.

An artist enters the realm of uncertainty when searching for their own identity. In our cultural environment the concept of national identity and the emphasis put on it is perceived as something inappropriate. Projects, which reflect on the sensitivity of themes perceived stereotypically, stir intense emotions. As a significant example, it is worth to mention the project of Lukáš Houdek titled *The Art of Killing* (Umění zabíjet, Fig. 80), which is a series of staged photographs depicting tragic injustice which took place during the expulsion of Germans from the Czechoslovakian borderland. The photographs aroused outrage in Czech viewers and subsequently triggered a discussion across generations. We can observe recurring significant and controversial topics in the artist's work focusing mainly on transgender and minorities, and the analysis of one's own identity.

Darina Alster has been focused on the quest for national and personal identity, personal space, belief, archetypes and forms of femininity for a long period of time. Not only does she search for a myth and works with her own identity, but she is also socially engaged in her work. Her project titled *Imago Dei* is inspired by traditional biblical sources. In her photographs, she introduces seven archetypal figures of the Christian world which are placed in today's urban environment. According to the curator Zuzana Štefková, the *Imago Dei* project

Fig. 80 Lukáš Houdek, *Orlické hory, 26. květen 1945*
vražda jedenadvacetileté učitelky mateřské školky Anny Pautsch bitím a oběšením

by Darina Alster constitutes an ironic alternative to witless colourful billboards promoting prefabricated eastern festivities. With her embarking on maternity leave, she addresses the theme of woman-mother mainly by using a dialogue on her personal experience and personal mythology with ancient myths of fertility and motherhood. (E.g. the realisation for the gallery titled *Galerie NoD Novodobé formy zaříkávání reality* – the Gallery of New Form of Enchanting Reality.)

Similar traits of exhibitionism, working with identity and gender can be found in the work of a British conceptual artist Tracy Emin. With unusual lightness, Emin unveils her thoughts, her personal tragic and positive experiences and thus presents her personality in a rather lavish manner. Even though we can say that in the Czech context gender identity does not evoke such emotions as it does elsewhere in the world, the work of Lenka Klodová certainly pushes further the boundaries of what a viewer perceives as acceptable. With a slight exaggeration, she analyses physical existence, femininity, motherhood, sexuality, sensual imagination, and the male body. Focusing on what media dictates, the cult of beauty and the abuse of the female body in advertising, Klodová moves

Fig. 81 Alster, *Novodobé formy zaříkávání reality*, 2014

closer to socially engaged artists and art groups. Another artist who also deals with identity from the gender point of view as well as from queer activism viewpoint is Tamara Moyzes whose work is on the borderland towards engagé art. In her work, she mainly focuses on video art and new media while she produces fictional documents full of exaggeration. Topics, which put her in a similar category of artists regardless of gender affiliation, comprise racism, nationalism, xenophobia, and the position of minorities in society. A similar form is assumed by the Czech group *Pode Bal* which deals with a wide spectrum of approaches from performances and pseudo-advertisement campaigns to political activism.

Another area, in which the boundaries between social sciences and artistic expression fade away, is characterised by the application of procedures common in sociology such as direct intervention into the surrounding environment, sociological experiments or the analysis of media reality and subsequent intervention in it.

13.3 Socially Engaged Art and Artistic Activism

Activist art and protest art is connected with political art. However, W. Benjamin (2004) points out that there is a difference between aestheticising of politics and politicising of art. While aestheticised politics cover up the reality, political art exposes it. Political art deals with social and political topics. As opposed to politics, its objective is not to gain in power but to make the fight over power visible. An extreme case of political art is activism, which employs violence to a certain extent but not to push through their decisions but to call the established ones into question. This is how we can perceive movements such as guerrilla marketing, adbusting and art sabotage. Activism works with media infiltration, subversion, play, and mystification. According to Pachmanová the disadvantage of political art lies in its political nature. Perhaps the Czech culture accepted the conception of art as the transcendental and timeless creativity of art genius too hastily, and after the Bolshevik era laden with an ideological approach to engagé art, the majority of socially responsible, critical, and even collective art is today viewed with scepticism and perceived as a product of fashion propaganda which in fact has nothing to do with art. (Pachmanová, 1998)

On the other hand, it is innate to the Czechs to have a sense of humour, while retaining a certain feel of mystification, and succumbing to media manipulation. This kind of humour is evident through Švejk and Jára Cimrman as well as through the works of the contemporary art group *Ztohoven*. This group bears the stamp of vigorous subversive conflict with the world around us and the world of media. Their project titled *Občan K.* (Citizen K.) is introduced by their statement in which they proclaim that we are not numbers, or biometric data and therefore we should not be chess pieces of big players on the playing field of the modern day. (Ztohoven, 2011)

Perhaps the most common form of art in the public space in the Czech geopolitical context is an invasive way of interaction with the surrounding environment, also referred to as social intervention. This kind of intervention is surprisingly well accepted and understood. In 2008, Eva Jiřička changed the seating order in one of Brno's trams by asking passengers to change their seats from one place to another in her action titled *Seating Order*. She also breaks the established concept of one's own property and the property of others by washing the cars of other people (*Zaparkované cizí věci* – Parked Things of Another, 2006) and before that in 2005 she intervened in a well-arranged public space, by planting a nettle into ornamental gardens in Vienna. She keeps accurate records of all her activities.

Artists and art groups work directly with sociological procedures and often monitor the long-lasting impact of their actions on the given social group. The pioneers of such procedures are the foreign duo called *The Yes Men* who on the premise of identity correction pass themselves off as other individuals (e.g. representatives) or companies. Some of their most subversive projects comprise their appearance on the BBC in the post of the representative of the Dow Chemical company, or, their distribution of a false edition of The New York Times.

In the Czech context, we associate social interventions with the artist Kateřina Šedá. She also works in the spirit of the motto Think Global, Act Local. Her collective projects: *Výstava za okny (Exposition Behind Windows), Nic tam není (There's Nothing There), Furt dokola (Round and Round)* or *Duch Uhystu* (The Spirit of Uhyst) are based on the interaction with village people and neighbours. In 2011, she realised one of her most significant project in which she brought the people from the Bedřichovice village to London's Tate Modern to spend a typical day there. (*Od nevidím do nevidím* – From Sun-up to Sun-set) It seems as though her work is closely connected to the region and in the broader context may be perceived as such, but according to the author, it is real and true. It is general in its essence and therefore there is no reason to perceive it as national. (Šedá, 2010, p. 57) Šedá has also used her person to realise an interesting and sociological experiment. In her personal story titled *Mami, dívej se na mě!* (Mum, Look at Me!) from 2013, she monitored herself and her current and previous partner together on holidays from the viewpoint of her daughter and a video camera lens.

It is her projects and their great impact which indicate a shift in the communication with a viewer through an artwork. It is also worth contemplating on the process of artworks' perception and the construct of art from the very conception, through the author, curator to the recipient or art historian. Currently, social sciences are saturated with artistic activities and therefore it is pertinent to ask when or in what conditions is production still art and where the boundaries between art and sociological or psychological experiment lay. At this point, numerous art projects confirm the sociological thesis mentioned at the beginning of the chapter which says that art is above all a social construct. (Paulíček, 2012, p. 33)

14 Art Seen through a Prism of Contemporary Psychology, Education and Sociology

Lucie Tikalová

'Art is made to disturb, science reassures.'
Georges Braque

14.1 Art Seen through a Prism of Contemporary Psychology, Education and Sociology

The purpose of this chapter is to approach art from the psychological and pedagogical standpoint. It will attempt to reflect on those areas in which art meets psychology and pedagogy. Some of the areas in which art blends together with psychology include art therapy and the psychology of art. In art therapy, art is perceived as a tool for remedy. The psychology of art, on the other hand, analyses the human psyche in relation to art making. Another domain is education through art (also art education) – a field which combines pedagogy and art and in which art serves as the tool of education, and unlike art therapy, it has a preventive character. We will ask ourselves whether there is a strict line between art therapy and education through art, and we will also think about where to find such a line.

14.2 Art in the Context of Psychology and Psychiatry

14.2.1 Art Therapy

Psychology is a science of the human psyche. It is a scientific field which stands on the border between natural, social, humanistic, and philosophical sciences. A space for art therapy is created in the area where psychology meets with art. Art therapy is a discipline which employs visual expression as the main tool by which to learn about and influence the human psyche in order to reduce mental and psychosomatic difficulties, as well as interpersonal conflicts. (*'Definice a cíle arteterapie'*, 2012) Art therapy is rather a young psycho-therapeutic discipline, which has been spread all over the world. The term art therapy includes not only art expression through art making but also through music, dance, theatre – in such cases we are making reference to music therapy, dance therapy, and drama therapy.

In art therapy, art expression becomes a tool for communication in order to cure mentally ill patients. As Kulka maintains, art expression is one of the ways by which we release hidden creative powers and other experiences, personal characteristics and attitudes to world. (Kulka, 2008, p. 65) When a mentally ill person can no longer express their feeling in words, art making as a language begins to be used in order to impart what seems to be impossible to express. The result of such an expression (a work created by the process of art making) becomes the tool which overcomes the barrier between a therapist and a patient, opens up other possibilities in psychotherapy, and also serves as a diagnostic tool[47].

14.2.2 Raw Art – Art as an Expression of Mentally Ill Patients

The idea to use art expression in therapy goes back to the 18th and 19th century and is connected with the psychopathology of schizophrenics. The idea came when it was clear that mentally ill people express themselves artistically in a different way than healthy people do and that the nature of their work differs with the type and progress of their illness. (Šicková, 2008) The work of the mentally ill artist, Adolf Wölfli, who lived in the years from 1864 to 1930, is the evidence of this. This Swiss artist with a powerful life story spent almost all his life in an institutional care. In 1895, he was transferred to a psychiatric clinic in Waldau near Bern, where he spent the rest of his life. Wölfli started to draw four years after being hospitalised. At the beginning, his drawings attracted

[47] As Davido maintains, it has recently become apparent that it is the technique of drawing which seems to be the most adequate approach to learning about children's personality. A drawing is not just a play or dreaming, it contains both play and dreaming but also reality which cannot be therefore neglected. (Davido, 2008) These are the opening ideas of the publication written by a French psychologist with 30 years of practice and many years of experience as a school psychologist. The author brings a comprehensive image of children's drawing. She approaches children's drawing from the developmental point of view while considering the language of colours and fundamental symbolism. She connects drawing to terms such as intelligence, emotionality, and sexuality. She dedicated a separate chapter to drawings done by abused children and children with different types of disabilities.

no attention, but they had a therapeutic effect to his aggressive behaviour. However, the doctors of the clinic had a different opinion on the way in which art making can affect patient's behaviour – as can be ascertained from the existing documentation dated November 1900 in which the doctors reported that the patient's behaviour had been exemplary when he had been drawing all the summer. In another instance from October 1902, the doctor reported that the patient had been drawing the whole summer, using up one pencil a week, and concluded that his drawings made no sense. (See Zemánková, 2012, p. 7)

Fig. 82 Adolf Wölfli: *A Shop with Foodstuffs – feeding of fish*, 1911, 49,7 x 37,4 cm.

In 1945, a French artist Jean Dubuffet used the term Art Brut (art in its raw state) for the first time referring to art works created by mentally ill patients. Dubuffet strictly excluded from the world of raw art such art works which were intended for art business. Ironically, Art Brut is currently very popular among art collectors and the value of these works is comparable to the production of today's most significant artists.

14.2.3 The Psychology of Art

Besides art therapy, another field in which psychology meets with art making is the psychology of art – an applied scientific discipline. As Heller explains, the psychology of art is often defined as a field of psychology which focuses on general psychological aspects of the making and perceiving of art works, the personality of an artist, aesthetic sense and other psychologically relevant themes. (Heller, 2010, p. 126) We cannot doubt that art leads to a deeper knowledge of a person – the psychology of art analyses both the human mental expressions and the human mental experience when interacting with art. The psychology of art seeks the specifics of mental functions and processes in the area of art, and observes the way the psyche affects one's artistic activity and the way an artwork is perceived in connection with the mental experiencing of an individual. The starting point of this field can be found in philosophy, aesthetics, psychology, and art and science fields.

There are different views of individual psychological movements on the perception of art – e.g. behaviourism and its main representatives. J. B. Watson refers to artworks and the perception of art as a special type of behaviour, in accordance with the basic elements of mind – the so-called element psychology. W. Wundt believes art to be the product of fantasy which is characterised by spontaneity, illustrative nature, and productivity in the sense that it always brings something extra to the reality. Gestalt approach to art has helped discover a number of laws in which to perceive art. As opposed to the previous psychological movements, it suggests that an artwork is easier to understand as a structure, as an organic unit, and not as a group of elements. (Kulka, 2008)

14.3 An Artist or a Patient? ... Or Searching for the Boundaries

As already mentioned in the introduction, this chapter attempts to address the issue of searching for boundaries between artphiletics and art therapy. Artphiletics is a concept of the Czech art education which has been used together with other art education concepts (rows and projects, multimedia educational projects) since the beginning of 1990s. The founding father of this concept, Jan Slavík, explains that the objective is to lead children to the

interpretation of art expression through their personal experience, and thus avoid narrowing of interpretation into one explanatory framework 'forced' on the children by their teacher. This concept allows children or students to actively look for their own personal position on the particular interpretation and to compare them among each other. (Slavík, 2004) These are areas that have much in common. For instance, both of these disciplines use an artwork as a tool to achieve the objective, be it educational or therapeutic. The differing traits of these disciplines are their objectives. While art therapy focuses on curing a patient, artphiletics focuses on cultivating an individual through education. However, both disciplines can be an inspiration to each other.

At the border between art therapy and art making (without the intention for remedy), we can ask ourselves questions such as: When does a patient become an artist? Can we refer to a patient as an artist? A visit to the Gugging Art Brut centre, which is near Vienna the capital of Austria, can give us some answers. The very beginning of the centre and its activity involved in an ongoing experiment taking place since 1950s in the former psychiatric sanatorium have changed the existing medical relationship with the local patients. Their originality lies precisely in different approach to mentally ill patients. They are not perceived as patients who use art making as a remedy to their illness but as artists who create art and coincidentally are also mentally ill. One of the establishers who came up with the idea to build a House of Artists in 1950 was a local psychiatrist, Leo Navratil, who became interested in the artworks of the patients and wanted to learn more about their illness. The first public exhibition of the Gugging artists took place in 1970 in the Viennese gallery of St Stephen. In 1981, Navratil gathered talented patients into the Centre for Art Psychotherapy and organised exhibitions around Europe. Navratil's successor, Johann Feilacher, renamed the centre to today's House of Artists. Feilacher chose such a title because he focused primarily on the talent of the clients and not their mental illness. The success of the Gugging artists became official in 1990 when they received the Oskar Kokoschka Prize. (Musilová, Tikalová, 2014, p. 125)

The result of the work of the Gugging artists is art which is not perceived primarily as a tool for diagnostics and therapy but as a result of creative processes of artists.

Fig. 83 The work of the Gugging artists placed in front of the entrance of the Gugging Art Brut Centre near Vienna, 2013. Photo by the author.

14.4 Art and Education

The subject of pedagogy is the education of a person. Art through the path of creativity enables to reach educational objectives – that is, to help develop the personality of a person in all aspects. As already mentioned above, artphiletics is a relatively new concept of art education which is increasingly applied to both the theory and practice of the field. Artphiletics, as well as other concepts of education through art, offers an approach to education through art. It also focuses on the healthy core of an individual, supports self-regulatory abilities by means of artistic experience, contributes to self-acceptance, self-realisation and personal development through art making and expression. In terms of the observed issue, the application of artphiletics can have a preventive effect on psycho-social failure through artistic activities reflected in a group of students. Artphiletics is not primarily focused on curing the students' psyche but on their education, expressive cultivation, the development of artistic creativity and also

on positive prevention directed at the origin or progression of mental and social issues. (Slavík, 2006) That is how it differs from art therapy.

Hence what is the role of art in pedagogical sciences? Art in pedagogy constitutes either educational content or a tool by which to reach an educational objective. Art education, art history, and aesthetics are not the only disciplines in which art is the domain of knowledge.

Also the content significance of artworks found its place in education regardless of the form of an artwork. A scientific discipline, which deals also with the understanding and analysis of art works in a broader sense, is called hermeneutics. This discipline is based on philosophy and is part of art history.[48] As Burke explains, hermeneutics gradually widened its focus to also include the interpretation of human behaviour and human culture. In the 1920s and 1930s, art historians turned away from formal analysis and began to study the meaning of pictures. (Burke, 2013, p. 98) A deeper meaning of pictures is the subject study of iconology which represents one of the levels when analysing artworks. According to Panofsky, iconography is part of art history which deals with the theme or the meaning of artworks and not with its form. (Panofsky, 1981, p. 33) Panofsky defines the method of iconography in the context of three phases of a meaning:

- primary or natural meaning (divided into factual and expressive meaning – the world of artistic motifs) – corresponds to the pre-iconographic description of an artwork,
- secondary or conventual meaning (the world of pictures, stories and alegories) – corresponds to the iconographic analysis,
- inner meaning (content – the world of symbolic values) – corresponds with iconographic interpretation.

Art is in specialised literature perceived as a tool of communication, knowledge, and self-knowledge. We can encounter collocations such as 'art expression as a tool for pedagogical communication' (Babyrádová et al, 2014), 'art expression as a way to self-overcoming' (Badalíková, 2013), 'art making as way to learning', 'artefact as a result of cooperation and communication' (Slavík, 2013), and many others. Slavík perceives the term 'artefact' and 'art making' in a broader sense than is generally known. According to him a real result of every art making process regardless of its purpose or objective is a product which can be perceived by our senses: work-thing, artefact. The term 'artefact' as an outcome of art making includes everything which can be created, perceived and finally named and described, starting with a physical appearance, such as electronic or printed books, sheet music and instructions to dance and music production, steam engines, computers, vacuum cleaners and sculptures or paintings to nanotechnologies.[49] An artefact can have both a relatively static but also dynamic and changeable existence. According to its nature or based on the situation it can be perceived as a process or a product or both. An artefact is a medium through which art making takes on a real form whereby it also assumes a potential value. The potential value of an artefact is factually confirmed when the artefact remains in time not only as a physical thing but primarily because it has social and cultural consequences: it has an effect on the state and development of social knowledge and the means of communication and cooperation among people. (Slavík, 2013, p. 46)

By way of a circuitous route we arrive at the question which currently often gives rise to controversy not only among art educators but among the wider public: Where are the boundaries of art? Hence what is and what is not an artefact? What is and what is not art making? What do people consider to be art and what not?

The reasons for these discrepancies are the developmental tendencies in art education of the past decades. The field of arts is penetrated by other scientific disciplines, not only by psychology and pedagogy but also sociology and others. Today, art increasingly more often assumes social dimension. There are attempts in the art-making sphere during which an artist

[48] Hermeneutics according to Hermes (in Greek mythology the son of Zeus and Pleiad Maia, the god of numerous human classes). In a narrower sense, hermeneutics is the art of interpretation, the study of literary interpretation. The classical work of hermeneutic literature is a document written in Greek and titled *Corpus Hermeticum*. (Baleka, 1997)

[49] Author's note: Nanotechnology is generally a technological field which deals with the production and use of technologies of the order of nanometers (commonly 1-100 nm), i.e. 10^{-9} m (a billionth of meter) which is about one thousandth of the width of a human hair. However, it is also a study of the possibilities of manipulation of matter on an atomic and molecular scale, while applying quantum-mechanical phenomena which are rather opposed to the way in which we understand the world visible by the naked eye. Thanks to these phenomena, which are described by quantum physics, new perspectives are opened in the field of magnetic recording media, computer technology, electronics, optics and other sciences. (https://en.wikipedia.org/wiki/Nanotechnology).

employs sociological procedures and assumes the role of a sociologist, but still the result is an artwork.

Examples of such an approach are the realisations of the artist Kateřina Šedá. In her work, she focuses on socially involved events during which she employs up to tens and hundreds of people who have nothing to do with art. These events take place in completely non-artistic environment. The objective of experiments with interpersonal relationships is to take the participants outside their everyday stereotypes or social isolation. Her projects have very personal character. E.g. in the project titled *It doesn't matter* she focuses on analysing the life of her grandmother. She made this seventy-five year old resigned woman try to remember her life. As a long-time manager of a warehouse in home appliances shop in Brno, she remembers 650 different products including their prices. Under the direction of her granddaughter, she began to draw them and thus they found a purposeful activity for her. And while doing this, her famous *It doesn't matter* began to fade into a distance which was also an important point of the project. 176 drawings from the 'warehouse' are accompanied by a long dialogue which Šedá held with her grandmother. (Šedá, 2005) Another project of Kateřina Šedá titled *There is nothing there* has a local character – in this case Šedá works with the people of a tiny village. Regardless of this personal aspect, the work of Šedá is generally and even internationally easy to understand.[50]

A young artist, whose art production also has a social dimension, is Eva Koťátková. In her work, she analyses the role and position of a person in a social system and the personal environment in which they move every day. Any deviation from a harmonious state triggers a series of causalities which return through a difficult path back to a new harmony. Koťátková sees a friend in a viewer who she attempts to initiate into a colourful yet somehow limited world. Rules, rituals, stereotypes or isolation obstructs an honest and open perception. In terms of her generally transferable theme of childhood, school, and group behaviour, the viewer is immersed into her world where they can put themselves in her position. She uses different media – drawing, performance, sculpture, installation. By means of reconstruction of events, she does not try to primarily analyse the medium or the change of reality but the change in the behaviour of the participants. In her event titled *Red Table* (2006-2007), children at children's party were to imitate themselves in an artificial situation which would resemble as much as possible the one which has just took place. A similar structure was also applied in her project titled *The Journey to School* (2008).[51]

The objective of an artwork is to provoke society, to ask questions which surround a society. As Slavík points out, art gives up traditional genre and material classification. It works carefully and intentionally with contexts, with a wide range of visual and performative expressive languages. The non-commercial and commercial sphere of art making are intertwined making it difficult to distinguish what is still *free art making* and when significant artworks are done by social order or in terms of an *artistic star system* and its economical and institutional rules. (Slavík, 2013, p. 379)

Useful symbiosis is a fitting collocation for cohabitation which is highly beneficial. Our publication deals with art and science. The purpose of this chapter was to illustrate how useful the symbiosis of art – psychology, art – pedagogy, and others is. The symbiosis of art and science is a coexistence of two seemingly different worlds, yet there are common areas in psychology, pedagogy, and sociology which give us enough space for personal development, education and therapy through art. Our task is to seize these opportunities in the most effective way and afford ourselves a brief moment of touching the spiritual world of art which elevates and disturbs, and the rational world of science which brings us not only occasional disturbance, but mainly much needed certainty.

[50] http://www.artlist.cz/?id=2651

[51] http://www.artlist.cz/?id=2651

The following chapters deal with the individual areas of art making while attempting to answer the question of what impact the development of science and technology has on classical disciplines such as painting, sculpture or architecture. They also illustrate the way technologies have helped establish new areas: whether we talk about photography or the labyrinthine area of new media art.

15 Painting in the Context of Some of the Contemporary Trends

Pavel Forman

15.1 Painting as a Sum of Physical Quantities

The physical existence of a painting is often ignored. The material on which we paint is part of the painted picture. It is either looked over (covered), or, it becomes part of interpretation. It constitutes one of the expressive tools. Just like the painting (a tool), it can be manipulated in order to achieve a large number of effects. While these effects are rather difficult to see in reproductions, they exist in reality, and the author certainly employed them with some purpose in mind.

A paint, be it a matte or glossy one, consists of the same basic components. What we perceive as a shade is a pigment which most commonly has the form of organic or inorganic fine-grained powder. This powder is added to a liquid which allows us to spread the paint on a surface, and subsequently it also connects small grains of the powder together as well as with the material on which it is spread. This liquid which is called a bonding agent can be anything from the long list of oils, eggs, gums or synthetic polymers such as acrylates or alkyds. Bonding agents are diluted, dissolved in water and oil.

After that the paint is applied to materials which can have the form of a stretched linen or cotton canvas, plastic or metal boards, or walls and ceilings. Paint can be applied to practically anything. However, foundation materials naturally influence the appearance and interpretation of the painting. For instance, canvas brings about different emotions and feelings than metal does. And in this way we could continue the detailed description of tradition-

al painting procedures which come before the first stroke of a brush. There are many different strategies by which to prepare foundation material so that we achieve the desired effect, which, even though we are often not fully aware of it, is based on the principle of a falling and reflecting ray of light. This ray of light either reaches right to the very foundation, primed canvas or varnished wood, or, it is reflected from some other, higher layer of paint.

But of course we will stay with the traditional approach to painting techniques. One of the questions to answer is whether we can reach different physical values if we paint using one of the hundreds of available 'painting' programs on a monitor. Are we using Apple or PC? The traditional craft of painting has rather worthy competitors from Adobe and many other companies.

Quoting Postman loosely, he explains that technologies do what they are created to do. Our task is to ascertain what it is, and when letting them enter the realm of culture we have to be very careful.

An artist has a vast range of possibilities and must make decisions which depend on their knowledge, craftsmanship, judgement, opinion, vision, and many other aspects. In today's economical and technological context, painting (materials) is much more accessible than it used to be in previous centuries. The number of artists (creative people) has increased considerably just as did the variety of materials which can be used in art today. An artist searches for the right material to help them achieve the desired effect and there are materials which await the right artist to come along and discover their real potential.

Another important source of technical information about paintings is the artists themselves. But no longer do we have to go directly to the master's studio as there are many high-quality publications and sources based on scientific research and interdisciplinary cooperation. Some of the key authors are Ralph Mayer, George Stout, Max Doerner, and we should not forget about those who laid the foundation stones centuries ago - Giorgio Vasari, Cennino d´Andrea Cennini, and others.

15.2 Electronic and Electric Paint

A group of students from London's Royal College of Art has developed a conductive paint, that is a paint, which can transmit an electric current. The application of such a paint is not only in technical fields but is also in fine art. The paint has the function of a liquid conductor, a liquid 'wire'. However, as opposed to regular wires, this paint can be applied to almost any surface – paper, plastic, metal or canvas. The developers of the paint, fresh graduates of RCA, Isabel Lizardi, Matt Johnson, Bibi Nelson and Becky Pilditch, have named their paint Bare Paint. They might not be the first to develop a conductive paint but they most likely are the first to push the boundaries of its application further, reaching also the area of fine art.

Matt Johnson (2013) said for CNN: 'We started this project in earnest in 2009. We were originally interested in trying to apply electronics to the skin ... so we arrived at this idea of applying them as a coating and eventually we got this idea of a conductive paint.' The research team began by investigating how electronics were being used in the body. 'In 2008 -- and probably still today -- there was a lot of work around electronic textiles,' Johnson explained. 'And though we really liked the idea of having a jumper (a piece of clothing) that has some intelligence in it, we didn't like that it was so bulky and that once you took it off the functionality disappeared.'

Around the same time there was a lot of 'extreme work' being done by people who were injecting electronics beneath the skin. For their final project, the RCA students began to search for something less intrusive, looking for a substance that could be painted onto the body. Eventually, as Johnson maintained, 'that idea transformed into the material we have now, which is very safe though it's not specifically intended for the body anymore.'

As Arion McNicoll and Stefanie Blendis explain, after graduating from college, the team collaborated on a video for DJ and producer Calvin Harris. The resulting project was the *Humanthesizer*, a performance which literally brought the paint to life, with dancers whose movements triggered audio loops from Harris's song *Ready for the Weekend*. 'Making a new material was a bit daunting for our designers,' Johnson added. Instead of returning to school

and studying chemistry for four years, the team turned to Wikipedia which provided them with almost everything they needed to know about crafting conductive materials.

Once the paint's formula was finalized, the team had to consider how it might be applied to real-world products. Today, Bare Paint jars and pens are sold on the internet and stocked by Radio Shack electronics stores across the United States. Projects being done by Bare Paint users include everything from interactive colour wheels to homemade electric toys. Johnson said that conductive paint opens up an enormous range of creative opportunities offering a future where billboards talk back, walls are interactive, and greeting cards come to life in our very hands. As Johnson concluded: 'Devices no longer have to look high tech to be high tech. Our goal is to put interactivity onto objects you don't expect.'

15.3 Painting as Installation

Thousands of contemporary painters use painting as an installation because we can perceive an installation as any kind of handling of paint in a particular space. We mention Richard Jackson[52] for the overstrained formal manner in which he handles painting. Painting is a medium and therefore it is more likely to evoke formal co-existence in our minds.

Since the 1970s, Jackson has been 'interrogating' painting, combining conceptual procedures, humour, and chaos in space. He faced a growing formalism in abstract painting of the 1960s. In his works, he frequently employs space and walls while still heavily relying on traditional canvases, which he places variously on a wall, floor or in the space of the gallery room. In 1978 in the Rosamund Felsen Gallery in Los Angeles, Jackson exposed the following artefact: a canvas in the shape of a diamond (of a very large scale) was propped aslant against a wall onto which he subsequently pressed another canvas of a rectangular shape painted with basic colours. He thus created something between an architectonical object and an abstract painting. Until the end of the 1980s, Jackson worked on barriers and sculptural forms based on thousands of small painted canvases of various sizes.

[52] Richard Jackson is an American contemporary artist born in 1939 who now lives in Los Angeles, California. He studied Art and Engineering at Sacramento State College (completing his studies in 1961) and taught Sculpture and New Forms at UCLA Los Angeles 1989 - 1994.

Usually, we perceive painting (paint) as a medium and a created painting as an art artefact – as one of the elements of art production, communication, a final product. Richard Jackson simply pushed the boundaries between a medium and a final product. A painted work still belongs to the category of a medium and serves as a 'material' to use for assembling other objects which in reality cannot be classified in traditional disciplines. Is it a painting, sculpture or installation? Is this issue and this classification important at all? What is important to us is useful formalism – not as formal flogging a dead horse but as experimenting with form.

Jackson expands the material dimension of painting to extremes, abandoning its traditional boundaries for the surfaces of machines, vehicles and objects of everyday use. His works were introduced to Europe mainly at the Venice Biennale in 1999. He openly subscribes to the Dada movement. His work titled *The Maid´s Room-The Dining Room* from 2007 is homage to Marcel Duchamp. His action from 2012 titled *Accidents in Abstract Painting* performed in Pasadena in the The Armory Center for the Arts has been described as both humorous and interesting. In this spectacle, Jackson flies and crashes a radio-controlled, model military plane with almost five-meter wingspan and filled with paint, into a six-meter wall in front of the public. (Rubinstein, 2005)

15.4 Generation Flash, Neen and the Manual for New Painting

Miltos Manetas, a Greek artist who emigrated to Milan twenty years ago is an example of how we can react to the upcoming era of the dominance of visual culture both effectively and wittily. His artistic scope is very wide. Considering painting, we can conclude, that in Manetas' case it is about new technologies, that is, the content of his paintings reflects on new technologies. He paints them. If it was not for the Neen group, which he established, we would not need to mention him in this chapter. The dogma of this group gives clear instructions on how to paint today. Perhaps it is the Neen group and Miltos Manetas who benefit from the phase of change – they are the generation which can really make most of the transformation from analogue to digital. Lev Manovich refers to this generation as Generation Flash.

Manovich maintains that this generation is not interested in whether their work is called design or art; they are not even interested in 'media critique'

which has been close to the authors of the past two decades. Instead of using samples of commercial media, they write their own software code to create their own cultural system. The result is a new modern style in the data visualisation, vector networks, pixels, and curves: Design Bauhaus in the service of information intelligence. Instead of attacking commercial media, Generation Flash offers modern software aesthetics and rationality. Information intelligence is used as a tool to create a sense of reality while programming serves as a tool to gain control over it. (Manovich, 2002)

Miltos Manetas goes on to explain that the concepts of the past century on cyberspace, fashion, and contemporary art and style have fused with us until today; they are the same as before but still a little bit different. This universe is livelier in different ways than it was before the year 2000, and Neen is undoubtedly an element of this new Lively World. (Manetas, 2006)

But why Neen? One member, whose name we will not mention, describes vividly the way Neen was established. Apparently, it was around 1998, when he was called to join the Serbian army in Kosovo just as many of his peers were. And just as many of his peers, he fought but also used a lot of cocaine, alcohol, watched VHS videos, and spent his money on local prostitutes. However, the important moment came when he once ran into the forest as if trying to run away from it all and suddenly all that he perceived as beautiful and all that he perceived as disgusting, he began to love. And the whole evening he heard one word echoing in his mind. After the war he moved to Milan where he met with Manetes who told him the he is a Neen. And after that everything was fine.

Manetas's book from 2006 is a Neen book. Neen is not what we see in pictures, and it cannot be described by words. Neen is bigger than pictures and words together. The word Neen starts with oneself as the words of its very own. It is a sound which was bought by the Lexicon company. It is a feeling which resulted in an activity of people who share the same feelings. (when you say about someone: the person is such a Neen!!)

Mai Ueda describes the origins of the word Neen explaining that she has chosen the word Neen from hundreds of names which the company offered to them. After the name had been selected, Mai Ueda decided to become Neenster which was supposed to be a new concept for a star – no matter what the star does, be it music, art or fashion, he/she will always be a Neenster as long as they do Neen things, as Mai maintains.

Also the Neen Dogma of Painting is interesting for this chapter. When reading it, we feel a certain exaggeration in the approach to painting. Nevertheless, we are forced to lessen the effect of the exaggeration by saying that the dogma can still be perceived as generally valid and fully applicable to today's paintings and painting techniques.

There used to be time when painting produced beautiful and fresh works just like flash animation and web pages today. But perhaps there is still a way by which to paint beautiful artworks. Here are the rules for painting according to the Neen Dogma:

- In order to paint a large canvas, buy large brushes, and buy many of them, because you will need clean brushes to smooth the line where the different colours meet. Only Oil on Canvas is allowed. Never mix the colours with anything else than linseed oil. This will add 'shine' to your painting similar to the one of a computer monitor.
- *Use a projector to display the picture you want to paint on the canvas. If you know how to draw, do not make paintings: make Flash Animations or Fashion instead.*
- *Abstract paintings are prohibited unless you invent an 'automatic system', such as those of Jackson Pollock and Lucio Fontana. That is cool because anybody can use their systems and successfully produce Fontana and Pollock pictures. Abstract Art is interesting only when it originates from a machine or from a person who emulates a machine.*
- *Use the most expensive material, so you will feel the urgency to make something valuable in order to get your expenses back.*
- *Composition, colours, and size of the painting, should be copied from other paintings in the museums.*
- *Deal with the brush stroke as if you were a hairdresser.*
- *You should use assistants. They should have no experience or any interest in painting. Just hire the people whose features match the characters you want to paint and ask them to fill your canvas as if they were painting a wall: without any passion. Command your assistants to use the wrong colour so you will feel the urgency of taking over and save the work from them.*

- *Paint many pictures at the same time and let them dry before you apply a new layer of colour. Sometimes, you will notice that the colour you prepared for a painting should go to another painting instead. A picture may take many years until it will be completed and actually, it's not your job to finish it. If people want to buy it before its done, just sell it to them.*
- *The most important instruction: try to discover and represent something that has never been painted before. If you find such a subject, you will produce a masterpiece whatever the manner you may use to paint it.*
- *Make copies of your most important paintings and permit others to copy them. All important painters of the past were making copies and that's why their work has survived today.*

The 'Neen Dogma of Painting', was written by Miltos Manetas, in the occasion of the 50th Venice Biennial.[53]

15.5 Denying One Dimension and Trompe L'oeil

When walking through the history of art from Pompey to Baroque and going even further, we would find an abundance of mostly wall paintings which attempt to create space illusions using perspectives, architectonic elements and flawless depiction of reality. And if we say that these efforts also work the other way around, we will surely not commit any mayhem for all we photograph, be it a sculpture, painting, or, a building, we always transfer it to a flat form.

Alexa Meade is a very young American artist born in New York in 1986, now living in Los Angeles. She plays with an ancient effort to create a space illusion of trompe l'oeil that draws a viewer into the painted field. Alexa works in an opposite direction: she makes portraits of people by way of painting directly on them, that is, on the portrayed, living and real people, which she tries to transform into 2-dimensional objects, and thus creates a flat effect as if when looking at a painted picture while observing living and moving people. In this way, she manages to confuse the eye of a viewer completely who does not know how to view these objects in a certain space.

Alexa Meade never obtained art education, she completed studies in politics but was still interested in painting. In one of her interviews she said

[53] Published on www.francescobonami.com

that she never thought of painting as something that is painted on a canvas because she never learned how to do it. Therefore she has always been interested in painting and paint as an artefact, as something, which is real in space and time. (Meade, 2011) One of the interesting aspects in her paintings is the fact that she applies paint directly on people, on artefacts, while following 'painting' techniques. We can see the strokes of her brushes and shadowing. We must therefore conclude that even though she approaches painting rather conceptually and in a performative manner, her painted field does not lose any of the qualities of painting. We can walk around her painted areas, observe closely painted people and the environment around them from different angles and they will always look flat. Similarly flat do her paintings look when being photographed – naturally, without using Photoshop or any other of the post-production software and effects. Meade paints realistic portraits directly on the surface of real people.

Even though her techniques may be considered too appealing in contemporary fine art, her works attract our attention without knowing exactly why. It is perhaps because she exchanges media (*The Artist in Action*, 2012), which a viewer expects in places where they are accustomed to encounter them. Where we usually expect a painting, we see a photograph and instead of a photograph, we see a painting. It is a rather obvious interdisciplinary approach as well as a simple gesture which works primarily because of its simplicity. Apart from painting and photography levels, we also see her works show elements of sculpture, installation, and performance.

15.6 Painting and Cooperation with Computer Viruses

Joseph Nechvatal is one of the pioneers who started to use computers to reimage their own painting. He has been using new media in his work since 1980s when he started to enlarge his post minimalistic drawings by photo-mechanical techniques. Since 1986, he has been using computers to make his paintings. It is surprising how little we know about his work in the Czech Republic considering his origins are there. However, his works are in several private collections such as the one in Olomouc.[54] From our point of view, it is interesting that he had

[54] His works were accessible to European viewers at Documenta in 1987 and the Venice Biennale in 2013.

no fear of using and cooperating with computer viruses which he allowed to freely manipulate with his paintings. He employed a similar approach when combining virus systems with digital animations while in France on a scholarship (The Computer Virus Project). Therefore he is one of the pioneers of today's rapidly developing field of post-human aesthetics.

At the end of the 1990s, Nechvatal engaged in his concept titled *Viractualism*. In essence, it is a conceptual approach as well as an effort to combine biological and technological aspects which was, according to Nechvatal, considered a new and topical research area at that time. He also kept confirming this idea by his work on digital drawings and paintings, digital audio-installations, and two (live) virus-driven installations.

As Nechvatal explains, his concept of viractuality and viractualism is based on the research into virtual reality which he carried out at the Centre for Advanced Inquiry in the Interactive Arts in Great Britain. (Nechvatal, 2002) He draws on the fact that every new technology disrupts previous rhythms of consciousness. He believes that the viractual realm is now the authentic domain of art in the information age. This concept was at the heart of his work.

Nechvatal explains his concept of viractual as follows: 'The basis of the viractual conception is that the production of computer technology has become a significant means for making and understanding contemporary art and that this brings us as artists to a place where we find the emerging of the computed (the virtual) with the uncomputed corporeal (the actual). This merger, which tends to contradict some dominant techno clichés of our time, is what I call the 'viractual'. The blending of computational virtual space with ordinary viewable space indicates the subsequent emergence of a new topological cognitive-vision of connection between the computed virtual and the uncomputed corporeal world.' (Nechvatal, 2002)

It is the viractual element which distinguishes and uses the power of digitalisation while being culturally aware of the value of monumentality and permanency – that is, the qualities which can be found in some of the analogical works. Therefore we cannot avoid the feeling that it is a significant concept which describes and puts into motion the communication of a proto-plasmatic body with the conditions of virtual space. As Roy Ascott pointed out in his essay titled The Architecture of Cyberception: 'To inhabit both the real and virtual worlds at one and the same time, and to be both here and potentially everywhere else at the same time, is giving us a new sense of self, new ways of thinking and perceiving which extend what we have believed to be our natural, genetic capabilities.' (Ascott, 1994) And as Nechvatal concludes, consequently, the viractual articulates a new techno-digital sense of life and art. (Nechvatal, 2002)

Nechvatal further suggests 'that the term (concept) viractual (and viractuality) may be a concordant entrainment conception helpful in defining our now third-fused inter-spatiality which is forged from the meeting of the virtual and the actual – a concept close to what the military call augmented reality that is the use of transparent displays worn as see-through glasses on which computer data is projected and layered.' (Nechvatal, 2002)

As we have already said, viractual refers to the incessant development of computer technologies which have become an extraordinary and significant medium in the system of art and art education which offers students and teachers such situations in which the virtual merges with the actual. Digitalisation is one of the key metaphors for viractuality in the sense that it is the most important interpretational process. It translates the old, analogical language into the new and digitalised one.

15.7 MobiLenin said: 'My mobile phone is my greatest art tool.'[55]

Jürgen Scheible, a.k.a. MobiLenin, works with graffiti. Leaving the aesthetic value of his works aside, we will focus on the 'medium' he uses in his art making. His attempt is to replace one medium with another one, a new one. Scheible is a German (media) artist, theorist, and musician. He often uses the pseudonym of MobiLenin. He is the author of MobiSpray which is the alpha and omega of his work. His portfolio contains works such as 'MobiSpray live performance' suitable for various events, beginning with cultural festivals, fashion shows up to business meetings and VIP parties. (see MobiSpray, 2014)

Ignoring the artist's – entertainer's – somewhat 'music-hall' feel to his array of works, his performances are clearly very popular and not only

[55] Jürgen Scheible a.k.a. MobiLenin

at company parties. He has realised over a hundred projects in more than fifty cities around the world. In his projects, he has 'painted' in public space, e.g. on the Guggenheim building in New York or London's parliament buildings, etc.

Scheible has worked for several years in Nokia which had impact on both him and his artistic carrier. He has developed and patented his own tool, his painting tool, that is, a mobile phone application. As the traditional painter uses a pen and a linen canvas for painting, Scheible in contrast uses the building as canvas and his mobile phone as pen. The spray-painting follows his hand gestures in real-time, while spraying intensity and colour change via keypad. Scheible uses his tool to purposefully change the appearance of facades and surfaces of buildings, airplanes, and nature, without inflicting any permanent damage to property. (MobiSpray, 2014) He considers himself to be a media artist who interacts with public space.

Nevertheless, his work is not revolutionary; a lot of artists nowadays work with light and large-scale projections on the environment. With the name of his patent – MobiSpray – Scheible makes reference to street art, graffiti, and, as the case maybe, painting. Instead of an ordinary spray, Scheible uses a digital spray in his mobile phone (a smart phone with the Symbian OS). Just as in Photoshop, but in this case Scheible paints in real time and space. Projected and lightened interventions and installations in public space are a common part of the contemporary art system. Claudio Sinatti[56] uses a forty-inch touch-screen monitor for painting and the subsequent projection on large-scale areas. Wodiczko projected his large-scale, political videos onto facades of buildings. He is also known to Czech viewers, as one of his largest exhibitions took place in Prague's Centre of Contemporary Art DOX in 2013.[57] Some of these light installations use interactive technologies such as GRL Laser Tag and others. (Scheible, Ojala, 2009)

Scheible has found a witty answer to the debate on art which was started by Walter Benjamin and others in the first half of the 20th century.

[56] Claudio Sinatti (born in 1972 in Milan) is an Italian artist who specialises in video and installation and who often pushes collaborative and collective projects to a commercial level.

[57] Krzysztof Wodiczko: OUT/INSIDE(RS), DOX, 2013, Curators: Jaroslav Anděl and Krzysztof Wodiczko

It is a simple gesture. He managed to reach primacy, which he confirmed by a patent. His work is seen as a playful example of how painting can coexist with new technologies. His contribution to the debate offers both formal (logistic, material) and content aspects while citing and referring to other fields of artistic activities (light art, light graffiti, land art).

While this kind of work loses its spontaneity (any bad spot, bad stroke can be reversed by the classical Undo, Ctrl+Z command), it offers other possibilities such as the use of templates, combination with photos in a fast and effective manner. The author has no formal responsibility for the intervention into the public space. He is only in charge of the content. While entering the realm of legal matters, a digital sprayer, a painter, feels strongly about the experience itself gained from the process, from the visual and temporal intervention into the environment without inflicting any permanent damage or alteration to property. An interesting issue in this case is the ownership of such an artwork, which is most likely of intellectual nature only.

Scheible (2008) for Sky News said:

'I believe that the future will be about creating something, not only about getting information to your phone and interacting with other people. You go out and create because the phone has so many features. It has the video camera, the normal camera, the motion sensor, GPS and all that kind of stuff enables you to create. It's about empowering the people, empowering the users. What I have seen people around the world doing, they create very powerful mobile applications based on their own ideas and the key here is that these applications are based on real needs of people and they can share it.'

MobiSpray as a product offers new possibilities to artists at many levels. Just as a sprayer is an artist who bought Scheible's mobile kit, he/she can start painting at any time and any place. The only key ingredient is darkness – night – in case he/she lacks a sufficient projector. MobiSpray allows artists to work in such places and areas which would not be commonly possible to use or to reach. Heights and other obstacles are no longer problem which is particularly interesting for guerrilla artists and activities.

The 'painted' surface is a technical advancement which can be applied to any surface, be they traditional ones such as buildings and walls or more com-

plicated ones which are offered by nature such as treetops, clouds, etc. Sculptures and other artefacts have been painted since ancient times, but not nature which gives this technique an ecological dimension. An author does not leave a single footprint a single blotch of paint. We can talk about one hundred percent recycled art, an interesting branch of non-engaging eco-art.

Digital graffiti can be thus created from the comfort of our sofa. The Nintendo company has built a Wii controller directly into a can of spray thus allowing to paint independent of time and space.[58] MobiToss, another mobile phone application which transforms analogical forms to digital, can take a picture or a video from a phone and place it in another visual space with the possibility of manipulating it and adding various effects. Garner, Rashid, Coulton and Ewards have employed mobile phones in the original street-art RFID tag writing, in its digital version which is friendly to its environment. As can be seen, technologies push the boundaries of formal possibilities further. They can also affect the content, in which case we can trust them as co-authors. (for more see Zhang, Harrell, Ji, 2012) 'Computational Aesthetics' deal with the efforts to put into harmony the aesthetic decisions of a machine and compare them to human ones. Artificial intelligence is very 'talented' and its works are for many authors inspiring and comparable to manmade ones.[59]

Citing Machada, Romera and Manarise: 'We are interested in the development of Artificial Artists (AAs), i.e., artificial systems with artistic capabilities similar to their human counterparts. In our view, an AA should be able to perform aesthetic and/or artistic judgments, i.e., be able to assess the merits of the artworks it creates, as well as the works

of other, artificial or human artists, and to adapt to the requirements of a dynamic hybrid society, populated by artificial and human agents. Taking this into consideration, our architecture for the development of AAs comprises two modules: a Creator and an Artificial Art Critic (AAC).' (Machado, Romero, Manaris, 2007)

[58] (viz www.wiispray.com)

[59] 'While this definition is yet very general, it emphasizes two major aspects. One is the use of computational methods and the other is the enhancement of applicability. Of course many researchers did follow the holy grail of universal aesthetic measures, but it seems appropriate to generally focus on very restricted situations of aesthetic decisions.' (Hoenig, 2005)

In their chapter titled 'Experiments in Computational Aesthetics', the authors focus not only on fine art but also music. However, the text is several years old and we now know some of the results of the research. A smartphone distinguishing music authors is one of them. Art is perceived and distinguished by pointing a smartphone at speaker boxes and it will tell us the name of the artist. Such an outcome could have a far-reaching impact in art education and other fields of study.

The field of computer aesthetics is developing at incredible pace and in many cases with most interesting outcomes which contribute to our debate on painting and its context. The fascination for technological possibilities runs through the history as a red thread. Monmarché, Penosual, Machado and others continue eagerly with their research. Even though it may seem as though we need profound mathematical knowledge for such research, many texts are comprehensible to non-professional readers. It is because this field of study in which mathematics and aesthetics merge is still in its cradle, and the future possibilities are still far out of reach.

16 Photography in the Role of a Progressive and Communicative Medium

Štěpánka Bieleszová

In the course of art history, we can find many examples which are the result of the mutual influence of art and science. Be it the study and application of methods of musical composition in the work of Wassily Kandinsky, or even earlier, Goethe's knowledge of the effects of warm and cool tones on the human psyche.

Also Arthur I. Miller addresses the inspiring turning points in the 20th century in his recent book *Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc* (2011). In his study, Miller (2011) presents evidence of the influence of the French mathematician Jules Henri Poincaré (1854–1912) to both of these personalities. Einstein developed his knowledge in physics, Picasso in art. The first one came to the formulation of the theory of relativity, the latter portrayed visually new ideas about the structure of space and time. It is clear that the development of modern art was influenced by scientific knowledge, whether it is related to space, colour, sound, or the arrangement of matter.

A medium, which had long struggled with indifference, even contempt of art theorists and filmmakers was photography – due to its direct link to the technical world. Since its inception, photography as a medium has undergone a complex of difficult pathways. Whether it was a question of adopting photography among art groups or the question of whether it belongs to high or low art. However, the discussion about photography is not only linked to the world of art, but also to other discourses, such as science, society or power, and also it may be in some way a part of the current theory and practice of art education.

In this context, the subject of research may not only be the technology behind photography, but also its specific expressive language. We continue searching for the answer to the question of how photography impacts our senses, how it works e.g. in the area of media and advertising, and thence penetrates back into our visuality. We are trying to understand photography theoretically and to define and discuss it as a progressive and communicative medium. All these and many other observations point to a clearer distinction between the equipment of photography, the images of photography, and the media of photography. It is clear that it is not enough to talk only about taking photos and viewing them, but also about their functions at the practical, visual, and symbolic level. To think today about photography only in terms of a plain technology versus art is shedding the context of any such work.

16.1 Communicative Nature of Photography

For example, a German film theorist, sociologist, and historian Siegfried Kracauer (1889–1966) works in the area of photography with the premise that each medium has specific characteristics which facilitate certain kinds of communication while making others impossible. (Kracauer, 2004, p. 27) And it is the question of the form and type of communication in particular which is closely linked to the very nature of photography. Since the beginning, photography has been oscillating between the categories of high and low art. Fortunately, the lesson of the postmodern era taught us to look for sources of inspiration among all kinds of depictions, not only in high art. Therefore it is not important, what category is currently assigned to photography. Moreover, we as viewers, informed by the avant-garde movements of the 20th century, have partially escaped from the shackles of conventional perception. Photography, although usually classified as a technical image, does not deny emotions a prominent place in the way of thinking about viewed input. In particular, momentary, documentary, and publicistic photography is the initiating device that triggers emotional reactions, or even enforces viewer's empathy. The perception of depicted reality by traditional media is not quite immediate – be it the external one or the internal world of the artist. It requires a certain interpretation of the viewer, the knowledge of composition, figuration, and iconography. A gap is being created between the author and the viewer.

We are accustomed to discuss visual art in a sophisticated, well educated, and 'learned' manner. As opposed to free perception, we tend to suppress an immediate emotional reaction in verbal address and further processing of the experience. We seem to have lost the sense for immediacy and spontaneity. However, photography offers easy reading, at least according to its initial plan; in many cases a viewer is able to identify themselves with the situation cap-

tured and to emphasise and immerse themselves in it directly. A depicted character is convincing, he/she reminds us of someone. Just as the environment and the depiction of details are known, the buildings are habitable, cars are mobile. One would almost like to exclaim along with Gertrude Stein that 'a rose is a rose is a rose.'

A photographic image draws its aesthetic power from the process of discovering a mediated reality, be it a reality directly perceived or a reality virtually transformed in a new way. The viewer, at least in the case of positive images, imagines themselves as being a part of the situation, or even identifies her/himself with the model. A photographer, who plays the roles of both an actor and a documentarian when creating a photograph, offers the viewer participation in the ritual. A photograph can create such an atmosphere that is revived by a new reality; it becomes a medium, a means of communication and interaction.

16.2 The Virtual Nature of a Photograph

Currently, however, we are increasingly more likely to be presented with a photograph as a virtual medium. Furthermore, digital photographs often exist only in cyberspace, they no longer bring information primarily about the world that surrounds us, but more so about the virtual world, which confuses us. Digital recording and reproduction technologies reproduce and mediate the visual image of the world. The reality which we get to know this way and which we examine and experience by means of virtual and cybernetic tools is false, it is not for real.[60]

Susan Sontag (1933–2004), an American author, theorist of photography, essayist, and publicist addresses the impact of photography on the perception of the masses very aptly: 'Knowing a great deal about what is in the world (art, catastrophe, the beauties of nature) through photographic images, people are frequently disappointed, surprised, unmoved when they see the real thing. For photographic images tend to subtract feeling from something we experience at first hand and the feelings they do arouse are, largely, not those we have in real life.' (Sontag, 1990, p. 131)[61] In her text *Dva druhy vizuality – vizualita „primární" a vizualita založená na „obrazech obrazů"* (*Two Kinds of Visuality – 'Primary' Visuality and Visuality Based on the 'Images of Images'*), Hana Babyrádová (2008), for example, goes even further, when she draws our attention to the complete deception of our senses and feelings by mediated virtual photographic images instead of addressing only the distortion of reality and our feeling of disillusionment caused by a direct confrontation of reality. In this context, she refers to the conception of multiplication and reflection of visuality in the work of a French cultural theorist Paul Virilio (*1932), who considers the 20th century to be the century of optics and optical illusions. (Virilio, 2004) Babyrádová complements the concepts of Virilio with the findings that we live among non-native images and sounds that are not characteristic of us and that are not based on our physical nature and do not reflect the world nor us. According to her, we wander not among the mirrors reflecting our appearance, but rather among the 'mirrors of the mirrors of worlds' that are moving further away from our simple existence. (Babyrádová, 2008, p. 8) In the same way, she also questions the authenticity of the information obtained in this virtually manipulated world. It no longer applies that the seen corresponds with the real.

16.3 Emotions and the Power of a Photographic Image

And although the early photographic era was marked by the photographer's effort to only document and not to produce artefacts, at the end, when being presented with the image, we classify photography as a medium, useful for further work, e.g. as well as in art education. A photograph initiates our emotional, instinctive, and physical reactions. Therefore, it is good to take a photograph to help us incorporate a new experience of a reality into a broader spectrum of visual arts reception in general.

As David Freedberg maintains, we suppress the evidence pointing to our reactions to all kinds of images, because we feel embarrassed... and we are afraid of their effects and their power. (Freedberg, 1997, p. 169) David Freedberg, an American scientist who deals with the interpretation of artworks at the border of psychology and art history, develops this idea in his paper titled *Zobrazování*

[60] For further reading on this subject matter see H. Babyrádová (2002).

[61] For more see S. Sontag (2002).

a realita (Visualization and Reality) published in Czech anthology. He refers *inter alia* to the additional, historical value of an image or formal qualities of the work to which we flee in panic from our own reactions. He points out the loss of a sense of immediacy, while warning against the excessive intellectual load of any subsequent interpretation of the seen. (ibid)

William J. Thomas Mitchell (*1942), an American theorist of language and art history, who currently works at the University of Chicago, focuses on our approach to contemporary media, and the mode of intermediate communication which is based on it. (Mitchell, Hansen, 2010) He assumes a critical attitude towards media, but he also appreciates the diversity and the possibilities of new languages, codes in which all types of media speak to us (including photographs). Mitchell follows not only how modern technology is changing our understanding and mediation of reality, but also the way they help to formulate questions important for media practice. Above all, it is the issue of obsolescence of the body and the changing role of the senses and memory (in these terms he resembles McLuhan's sensory theory). Mitchell (ibid) explores the sensory experiences of the individual and the possibility of entering the spectrum of new media and technological concepts through these experiences, and especially our ability to navigate through them. To include and to deepen sensory and aesthetic knowledge of an individual, he recommends not only for the study of media, but also for their understanding. New media, including photography, cover a wide range of fields of study and disciplines, create a new language with a new vocabulary that is equally rational and intuitive.

In general, the golden thread of his work is the idea that images respond in the same way as living organisms. This idea has its origins only in Freud's psychoanalysis. In addition to sensory components, Mitchell stresses not only an aesthetic component, but also an intuitive one in the process of understanding. In his essay *What do Pictures Want?*, he emphasises the importance of our emotional reactions to the images that we can see in our everyday lives. He asks why we treat them as if they were alive and real images. He focuses on paintings and images that have the strength and power to influence us, to convince us, or even lead us astray. According to Mitchell, we must treat images primarily as animated – revived – creatures with desires, needs and requirements, rather than only as inert objects that simply purvey information and have their own meaning. In the field of visual culture, Mitchell (2005) opens a new view in which to perceive the world of images. He offers a profound reflection on the relations between the visible and legible, between the real and the experienced.

16.4 Visual Literacy

The issue of visual literacy, which should undoubtedly also include the issue of photographic literacy, represents one of the key issues surrounding not only the current practice of art education, but the process of perception in general. (Horáček, Zálešák, 2008)

William J. Thomas Mitchell, who in his work addresses, among other things, the issue of communication of digital culture through media, especially film, video, and photography, in his essay *Visual Literacy or Literary Visualcy* published in Visual Literacy edited by James Elkins (Elkins, 2008), for example, compares the ability of visual perception with the ability to read text. He considers reading to be far more challenging, being preceded by the process of preparation and learning the basic elements – alphabet, syllables, words. On the other hand, the ability to see is an innate ability. With increasing knowledge of the outside world it also includes the ability to distinguish objects from space, to observe a moving object, to distinguish foreground from background, a figure and background. We share these abilities, which form the foundations of what George Berkeley called 'the language of seeing,' with most primates. However, Mitchell further elaborates the issue of seeing and reading in the language level. According to him, the vision is the universal language of nature, as opposed to spoken and written natural languages, which are cultural constructions based on conventions. And this language must be learned, as it is not innate or a part of an organism. (Elkins, 2008)

In her article mentioned earlier, *Two Kinds of Visuality – 'Primary' Visuality and Visuality Based on the 'Images of Images'*, Hana Babyrádová (2008) deals with the necessity to ensure a visual literacy education. In the field of art education, the author puts emphasis not only on the transfer of knowledge and experience with art, but mainly she recommends to complement it with the reflection of reality through other senses, not only through one individual sense, for example, sight, which would lead to the stagnation of one style of perception. On the contrary,

she directs her attention to a comprehensive method for creating and perceiving a work of art based on the syncretism linking several senses, especially sight and hearing. In the process of education, she deems their cultivation necessary for a better sense of direction, if not defence against the attacks of the mass media. In this context, she refers to education as the preparation and cultivation of an individual who will be able to collate and assess the value and quality of received visual information. As Babyrádová maintains, art education aims to make available and to initiate self-expression dependent on two main senses – sight and hearing, enabling us to experience the function of these senses in the adventure of creating and developing critical attitude toward receiving completed audiovisual commercial codes distributed by mass media. (Babyrádová, 2008, p. 23)

16.5 Photographic Literacy

As is apparent from the above-indicated approaches to the visual language of art and media in general, the need for education in visual literacy is currently more than imperative. Already Walter Benjamin (1892–1940), one of the first theorists of photography, shows the way photography transformed our understanding of perception and reality, art and artworks. As he points out, the illiteracy of the future, someone has said, will be ignorance not of reading or writing, but of photography. (Benjamin, 1999, p. 527)

An important moment for receiving a photograph, for its perception by the audience and for reading a photographic image in general, is to accept the fact that photography is a double-edged medium. A medium, which may or may not be true. A medium that displays, captures, and reflects the real world or the newly emerging virtual one. It is only up to the viewer whether they decide to undergo the adventure of uncovering the origins of a photograph and the artist's intent. Whether they are willing and able to engage their senses, feelings, experiences, and knowledge in this risky process of perception. To do this, and not to slip on this perilous journey of perception of a photographic image, we as viewers must master a set of skills, which an American artist and critic of photography Allan Sekula (* 1951) calls photographic 'literacy' necessary to 'read' a photograph. This skill has to be learned. Therefore, a photograph has its own language, 'it says the unspeakable', it is a 'universally valid' message. (Sekula, 2004) Based

on the practice, it is evident that what must be taken into account primarily are the perception skills of viewers – their ability to know the circumstances of the time and origins of the work. In other words, it is important to analyze historically specific conditions of the production, reception, and function of the work in specific contexts.

Michaela Syrová pointed out other pitfalls associated with visual literacy at the *Veřejnost a kouzlo vizuality (The Public and the Charm of Visuality)* conference. In general, she refers to visuality as a dominant mode of perception and communication in the modern world as she believes that modern people communicate to a large or even major extent in visual language. (Syrová, 2008, p. 54) We perceive the world through images, we get information through them; in a nutshell, we communicate through images. In this context, the author mentions again the words of Walter Benjamin, who was greatly concerned with the increasing passivity when perceiving the world primarily through sight, through one's eyes. He warns about putting a perceiver into a passive position should this type of information perception become mainstream. (Benjamin, 1999) Words and texts compel us to action, awaken our imagination, words are represented by images in our minds, they motivate our minds to create something, as opposed to a visual perception during which we receive a complete and finished picture, which compels us to continue to think about the newly received (or sent) information. In this sense, the seeming communication through images does not become a dialogue, but only a monologue. An active recipient of information becomes a passive consumer.

A photograph in this context, as previously stated, becomes a very problematic medium. On the one hand, it is still traditionally embraced and understood as a credible source of information about the outside world; on the other hand, it confuses us. It lulls the audience into comfortable passivity, intoxicating our insights with images of irrational and unreal worlds, emotions of non-existent characters, and unrealistic situations.

16.6 We Change our Tools and Then our Tools Change us

A complicated photographic medium has been the subject of research of many experts and philosophers since the 1960s. For example, a Canadian scientist Harold Adams Innis, who undoubtedly was an important pioneer

in the field of communication studies, has attempted to extensively analyze the crisis in Western civilisation with all its sub-elements in his texts. He believed a change in attitude to various types of communication and media, which decisively affect the nature and development of society to be the way out of the crisis. His statement, 'we change our tools and then our tools change us' and his widely extensive platform of thoughts were taken up by his intellectual disciple and university colleague, Marshall McLuhan (1911–1980), who radically changed the traditional view of a photograph as an intermediary of reality and emotions.[62]

McLuhan, as a theorist of communication, focused primarily on media criticism, and in the 1960s he became a respected arbiter on the impact of mass media on our thinking and behaviour. (McLuhan, 1964) Innis inspired McLuhan primarily by his conceptions on the inclination of different media to transform our perception in different ways, more precisely, to have a space-time experience of the world. McLuhan developed Innis's ideas in many ways. He made a major contribution to the initiation of the discussion on the nature of the media alone. He expanded the generally accepted belief of a strong influence of media on society adding the fact that a more important role is paradoxically played by the medium itself rather than the content delivered through it.

McLuhan was convinced that all media as such, regardless of their informative content, have a serious impact on humans and society.[63] Media, or more precisely technological breakthroughs extend human abilities and sens-

[62] He based his theoretical writings on the groundbreaking studies of Harold Innis (1894–1952). Until today, Innis is still regarded as one of Canada's most original thinkers. He engaged in the theory of communication, the influence of the media on shaping of culture and the development of civilisation. Based on his in-depth knowledge of Greek civilisation, in which he primarily valued the balance between oral and written communication, he warned Western civilisation about the threat posed by advertising and an overall media obsession that is systematically and ruthlessly destroying previous harmoniously shaped cultural foundations of civilisation. As a defence against the destructive pressure of media, he suggested cultivating critical rational thinking necessary for the survival of Western civilisation. Innis's theoretical work was not based only on media and culture. He was primarily a theorist in the field of economic sciences. In his economic studies, he analysed the influence of certain individual (and seemingly unimportant or hidden) elements and phenomena on economic development. In his study of economic systems he focused on a broader context, be it a cultural, geographic or political one. For more information, see e.g. Innis (2003) with a foreword by Marshall McLuhan. The biography is available, e.g. at an encyclopedia portal The Canadian Encyclopedia, password: Innis, Harold Adams, available electronically at:
http://www.thecanadianencyclopedia.com/index.cfm?PgNm=HomePage&Params=A1.

[63] In McLuhan's studies, the concept of media includes, besides mass media (television, radio and print), also writing, book printing, the invention of the wheel, weapons, cars, electricity, etc. According to him, A medium is especially a technology that expands the possibilities of human beings, both physical and sensory (a wheel –the improvement to legs, clothing – the extension to skin, etc.). All media, as such and regardless of the message they bring, have considerable influence on humans and society.

es, and thereby interfere with sensory balance. McLuhan talks about the extension of the senses, the creation of an imaginary exoskeletal technological apparatus, which significantly changes the possibilities of human sensors. The change of sensory perception does not affect only individuals, but also transforms the society which created the new technology.[64] One of his major findings is the realisation that new inventions are not only passive means, but they reactively act on people, by its content but mainly by the mode (form) of its message. If the society (but also the individual) cannot resist the captivating charm of media, or rather they do not realise its suggestiveness then the double-edged nature of a technical progress could end up out of our hands.

In his scientific work, McLuhan thoroughly studied electronic media. It was precisely there that he saw the possibility of returning to a state of balanced sensory perception and a balanced conception of the world. He particularly commented on the revolutionary media – in his time, computers and especially television were already in existence – which according to him do not function as a simple extension of one sense, but shape our entire central nervous system, and thus transform all aspects of our social and mental existence. (McLuhan, 1964)

McLuhan (ibid) draws attention to the ability of electronic media to draw the viewer into itself through all their senses. At the same time, when presented with a low-resolution image, media force the viewer to think and to imagine and thus become an active participant in the production process. McLuhan attributes these creative qualities to media which he characterises as 'cold', a television, telephone, computer, etc. At the other extreme, there are the so-called hot media that extend only one sense with high-resolution, as it does for example in photography. While in societies before the electric (or now more electronic) era a functional medium was mostly hot, which means they expanded the sensory part of perception only little, in the electric (electronic) era the use of the properties of cold media prevails. People are being pulled into the new media, and suddenly they find themselves back in an area,

[64] McLuhan (ibid) mentions three basic technological breakthroughs: the creation of the phonetic alphabet that interrupted the balance of auditory and visual sensations of tribal man; book printing, and the increasing compactness of the amount of information with the consequence of strong individualisation and specialisation of an individual; and the invention of a telegraph (1844), which signalled an electronic revolution that could bring people back to sensory balance.

which is not dominated by sight, but in which all senses cooperate, as it was in the time of an early tribal coexistence.

McLuhan criticises the photographic medium for its unilateral orientation and the ability to cause extension of only one sense – sight. He classifies it as a hot medium, filled extensively with data and therefore not inspiring an active use of our complex sensory systems.[65] However, he does not deny a photograph the ability to act as a reflection of the world. It is a medium that transmits to a viewer an exact and repeatable image of reality. Therefore, he does not doubt the role of photography in the development process of artistic approaches. He appreciates the revolutionary role of a photograph that allowed artists to abandon the idea of a true representation of reality, and thus expand their ability to detect the internal development of a creative process. However, the danger of a photograph was the quality; it expanded and multiplied an image to such an extent that it began to resemble a mass-produced good. McLuhan first mentioned this danger nearly 40 years ago, at a time of mechanical production of an analogue photograph using light.

Currently, however, a digital photograph exceeds the frame of old mechanical devices. A photographic medium started to cooperate with other media, in particular the computer, and thus reached the level of extensive complex media. A digital photograph easily overcomes time and space. Not in the least does it remain in the stage of an accurate image, or rather a reflection of reality, as was the case in pre-modern times of mechanical appliances. The current photograph no longer attempts to depict observed facts in the most accurate way, but it works increasingly and partly deliberately with the difference between the depiction and a model – reality. In the present postmodern times, the distinction between reality and the image of reality is disappearing. In the words of the French philosopher, sociologist, and photographer Jean Baudrillard (1929–2007), a photograph creates a 'simulacra', reflections of reflections, new virtual scenes and situations. (Baudrillard, 1994)

[65] McLuhan differentiates between hot and cold media. Examples of hot media are radio and film. Cold media are characterised by e.g. telephone and television. A hot medium extends senses by means of 'high definition', i.e. a state of extensive fulfilment by data. A photograph is visually of 'high definition' offering a vast amount of visual information. While hot media are characterised by low participation, cold media lead to high participation. It is therefore natural that the effects that a hot medium, such as a radio, has on a participant differs in many aspects from those exerted by cold media, such as a telephone.

The new extended digital computer tools of current photography allow us to replace the literal, to reduce data overcrowding, and to unload the kind of literary style which makes space for the active participation of the viewer, for their cooperation, and for their completion of the process of perception. A French postmodern philosopher Francois Lyotard (1924–1998), who also dealt with the issue of identifying and finding multiple meanings, referred to this process as a game that can be part of not only art or philosophy, but is practically applicable also in the process of cognition and education. (Lyotard, 1993)

16.7 The Misinterpretation of the Natural View of the World and Outsmarting of Apparatus

In history, McLuhan (1964) defines three basic technological breakthroughs that fundamentally shaped the development of an individual and their sensory system. He welcomes the currently ongoing electronic revolution and the related new media with the hope that it could return human beings to their sensory balance.

Vilém Flusser (1920–1991), a philosopher of Czech origin finds similar milestones in the history. He, just like McLuhan, dealt with the theory of media. In his works, he focused on the influence of the media (specifically media abstraction) on daily life. (Flusser, 1994, 2001) In the course of human evolution, he follows significant turning points, which he subjects to criticism in terms of abstracting and coding of images and texts. He refers to these collectively as media abstraction. The first type of coding and media abstracting of reality occurred at the beginning of human civilisation, when a prehistoric man began to create paintings that helped them understand the outside and inner world. However, over time images became distanced from man and were broken away from reality to such an extent that people were no longer able to perceive them correctly – to decode them. More precisely, people were not able to perceive reality 'correctly' through them. Images created a veil. In addition, people began to follow and obey these images. They began to create idols, godlings, and artefacts. With the emergence of texts and the medium of linear writing in general, that veil was torn. Texts have moved the process of coding of reality to the next level and created a new veil, misinterpreting the natural view

of the world.[66] The prime example of textolatry, and this applies also to the present, is cleaving to science, scientific texts, metatexts. Just as before, images as well as texts entered the critical 'unreadable' stage where it is no longer possible to read and interpret them correctly. In this context, Flusser (ibid) refers to a new, third form of abstraction, the media abstraction or the abstraction of a technical image. A typical example of a technical image he sees in a photograph.

A photograph is created using an apparatus controlled by its own program within the apparatus. The program is so complex and independent that it does not give any room for the user's input and determines their behaviour. Flusser (1994) points out the absence of human freedom and invention in the field of automatic, programmed, and programming devices. The task of a human consists in searching and finding ways to open up space for freedom. Flusser considers freedom and the role of an individual in a world dominated by apparatuses. He sees the meaning of an individual's endeavours in overcoming programmes in the apparatuses. According to him, this can be done by changing the program. However, it is only a temporary success because by doing so the program is actually being improved. Another, more creative option is to find new procedures for working with devices; Flusser (ibid) refers to the outsmarting of apparatus. A good example is the creation of experimental photographs, which can be done only by exceptional and gifted individuals, i.e., artists. Here it is possible to find a space for free expression, for the imagination and presentation of creativity, and display of emotions and relationships, as it had been attempted by humans at the beginning of our civilisation, when quite innocently covering the walls of their cave.

It is the conception of artistic creation as a primitive ritual which represents one of the solutions to departing from the current media-overflown visuality. Elements of a ritual that can transform from the position of purely personal experience to the position of generally understandable messages, and simultaneously to the experience with emotional, relational, and aesthetical aspects are subjects of the general studies carried out by Hana Babyrádová (2002) on art in general. The point at which her theory meets with the reflections

[66] Flusser (ibid) refers to textolatry, the critical culmination of which text-based religions are – Judaism, Christianity, Islam. Each of these religions draws its basic ideas from the book, while allowing for no deflections.

of V. Flusser, among others, is the attempt to form free spaces for creation, even with the help of modern technology. Interaction, expressivity, and sensory experience are all the ingredients essential for the current approach to any creative work, including photography.

All the above outlined theoretical knowledge of researchers in the field of photography and media in general clearly indicate, despite the diversity of their bases, that the basic elements in the perception and also in the process of art making (a photograph), are the necessity to work with variables, such as creativity, imagination, and interactivity. The primary mission of art production of any type is the need to not only defend, but also create (and teach how to create) conditions for free and creative gestures in art, and in the work, which is not only individual and subjective, but which also represents a possibility to initiate further experience, knowledge, and understanding, and to give rise to mutual influence and enrichment. Photography as a medium working mostly with the veristic options of depiction, and thus with relatively well-understood intelligibility, is also the ideal medium, challenging us to further experiment and creatively 'outsmart' its technological solutions. Therefore, as will be further explained below (see chapter 23 titled The Possibilities of Contemporary Photography in the Process of Experience Education for Adults), it is appropriate to include photography into the educational process of visual and art education.

16.8 Solutions for Working with Photography in the Process of Education

Photography uses a specific visual language which offers different possibilities than a verbal language. A photographic language, like every visual language of art works, is complex, multi-layered, and internally differentiated. If we do not try to know the specific components, colours, elements, we deny ourselves the opportunity to fully understand and utilise its distinct possibility to understand and mediate the world. Michaela Syrová points out the necessity of acquiring visual (hence photographic) language and the perils associated with its ignorance in her text titled *V bludisku vizuálnej spoločnosti (In the Labyrinth of Visual Society)* which was already mentioned above. In the text she maintains that if we cease to express the depth of our life, it will indeed slowly disappear, leaving only the surface, non-depth. On the other hand, if we identify

the wrong language in which we communicate, we may be parties to errors and misunderstanding and be even easily deceived. Thus we get entangled in the labyrinth of the world that uses language which in fact we do not understand, though we somehow use the language for communication. And she goes on to ask: how can we get out of the labyrinth? How can we know the terrain and find strong points in it? (Syrová, 2008, p. 54) As previously noted, a visual language resembles a verbal language in many aspects. At least in one, that although it is partly innate to us, we must learn how to use it. It is not enough to observe what is happening daily around us, but we must try to purposefully understand the process of operating such a distinctive language, especially to know its structure, and individual elements of expression.

The author answers the question of where we can study a visual language as follows: Based on human activities, where can we study well the visual language? Where is the visual language necessary, almost inevitable, where do we work with it in a natural, cultivated, or demanding manner? The source of such cognition is visual art. A visual language has its history here. We find there are many ways and styles that use a visual language. Visual art is contemporary also for the point in which many intellectual, emotional, rational, and social areas of the human community and its activities interconnect. (Syrová, 2008, p. 54)

It is clear that the communicative scope of photography is wide. It ranges from the very narrative position to a pure abstraction; a photograph just like any work of art creates relationships with its surrounding. And that is what we should make good use of. Therefore, the participants in the process of communication are the work (a photograph) and the viewer, complemented with the personality of the author – creator. According to the specialisation of its author, a photograph can be either documentary, artistic, or journalistic etc. and is tied to 'reality' in varying degrees. Beware, a photograph may even lie and convince the viewer of an illusion. When working with a photograph and identifying its language, we must be careful and take into account the fact that the language of photography mixes in varying proportions the elements of introspective message with real and virtual image. Photographic images are not objective descriptions after all, but to some extent they are the constructions of an author in a historical context. The understanding of relationships and connections within the context gives us the opportunity to interpret, which can be used practically in the process of teaching and interpretation of the theme.

17 From Pioneers to Digital Wizards: the Metamorphosis of Art under the Influence of New Media

Petra Šobáňová

The following chapter, on the topic of new media art, begins with a review of the first pioneers of this kind of art, and an evaluation of their work and the impact they have had on the society and culture. It traces the history of new media art back to its roots, examining the origins of the use of computers in artistic creation and providing examples of the early experiments with computer graphics and animation. It takes note of the special role of recording techniques in action-oriented art and provides examples of artistic activities at the intersection of performance and video art. It focuses on the period from the 1990s to the present, when digital technology, the internet and sophisticated software for the creation of computer graphics and animation began to be increasingly used in art. It introduces net art and software art which fully exploit the potential of computer technology and network media. Moreover, this study explores how the aforementioned content of new media art is reflective of the problematic features of the online digital culture; such as art that addresses the security of cyberspace, freedom, piracy, plagiarism and/or the blurring of the boundaries between the private and public. In addition, the study provides an overview of technological advances likely to be further refined and developed in the future (e.g. – video art, computer graphics and animation, experimentations with virtual reality). The concept of generative art is also mentioned; that is, artwork created by computers acting with a high degree of autonomy. In the study, new media art is presented as a phenomenon which will effect massive transformations upon both public and private life. Said transformations will likely subvert our preconceived notions and lead us to reflect on the risky and thought-provoking landscapes of today's computerised world.

17.1 Introduction

The domain of art is symbolisation, the transmission of cultural meanings, the formation of man and their self-interpretation in a particular historical setting and culture. For these and other objectives, art takes advantage of all avail-

able options with extraordinary ingenuity, including the expertise of the various disciplines, scientific discoveries and technological inventions and applications. It can be said that art always uses the best of available technology – it has been so in the past and is also the case today.

In order to identify artistic activities, which use digital technologies, the term new media is employed in the context of the artistic field. (e.g. Rush, 2005) According to Kera (2013), new media art is characterised by combining technological innovations with various new forms of artistic expression. Kera also classifies photography, film, radio, TV, satellites, video, and other technologies (which in their time influenced and transformed the traditional forms of artistic creation) as new media.

Obviously in each period 'new' technologies arise, and it is difficult to establish fixed boundaries which would precisely define the use of the term new media. In the past, technological developments and the application of scientific knowledge greatly inspired avant-garde artistic movements, especially in the first half of the 20th century. These included, for example, movements such as Constructivism, Futurism as well as Dadaism. Avant-garde movements also enabled the emergence of the so-called Kinetism and also shaped post-war electronic scenes, when radio art was created or the first video performances, videotapes, and experiments with satellite and telecommunication technology occurred. The use of computers, which we today associate with new media art, began in about the 1960s, when computer art first began to be discussed. Computers were initially used mainly for experiments with algorithmically generated sounds and images. Later the concept of art changed completely, which, thanks to digital technology and the internet, could take the form of an interactive system open to the outside interference of users. (Kera, 2013)

Lev Manovich (2001), a well-known media theorist, defines new media in a greater detail expanding on the definition of a merger of technological innovation with forms of artistic expressions. (See Kera, 2013) According to Manovich, new media (and not only in art) is characterised by five principles, which he further elaborated on in his work *The Language of New Media* from 2001. The first two principles are numerical representation and the related modularity. Three others are then derived from these: automation, variability and transcoding.

Numeric representation means that new media objects are numerically coded, or they themselves are actually numeric representations. From the numeric character of new media works (whether images, shapes, or videos) it follows that they can be described mathematically as well as further modified, or manipulated. For example, one can relatively easily improve the sharpness or brightness of digital photography, crop a film image or convert it to another format or resolution.

Modularity then, according to Manovich, means that each specific new media object always has the same modular structure everywhere. It is referred to as modular ('building block') because it is comprised of independent components, which in turn may consist of smaller parts, up to the smallest parts, such as pixels. The elements of this structure, such as sound or image of the audiovisual objects, are represented as files of discrete, unconnected samples. Thanks to the modular structure, the handling of new media objects is very easy, whether it is replacing specific parts or making any other alteration to them.

Numerical representation and modularity are associated with new media regardless of whether the specific objects have an analogue origin (and were later digitised) or were created directly on the computer by the creator. For example, many of the objects that we mention in the section about the beginnings of new media art were originally created as analogue objects and were not digitised until later. In light of the fact that Manovich does not classify analogue works as new media, it would be beneficial to briefly explain the actual difference between analogue and digital devices and content.

Analogue devices (e.g. record players) work with a continuously variable signal. For this type of signal, the values are changing continuously – unlike the jumping variable signal, with which digital equipment works (e.g., computers or mobile phones). The most significant way that digital content differs from content produced by analogue technology (i.e. - phonograph records or analogue video tape), is the manner in which this data is stored. In essence, digital information is represented by a certain value in the form of a binary number. For example, a digital image – in its essence – does not exist physically, but 'dwells' in the form of numerical data governing the way it should appear in a browser window or in print. Therefore, when transferring an image,

the image itself is not transferred but only the numerical data or the information regarding the colour, brightness, size, and location of each pixel. The same highly sophisticated technical process occurs during the transmission of sound and 'moving images'. (Poisl, 2006)

The above characteristics stand in contrast to those of an analogue videotape ('video tapes' as a phenomenon of the 1970s and 1980s will be discussed below) which contains a work of art owned by the author in physical form and thus must be surrendered in order to be played at an exhibition. Thus, videotapes existed physically, even if they were – compared to classical images, such as oil paintings – very easy to copy. A digital artefact, by contrast, can exist in many places at the same time in the same quality and its physical existence, for instance, in the form of a DVD is not necessary. It is sufficient if it exists in the form of a data file stored on a computer or on a network. Due to the aforementioned fact, analogue data is uninterrupted or continuous; hence, it is not possible to separately edit parts of a whole (e.g. video), such as text, image or sound, as we have quickly become accustomed to in the case of digital data, where this is made possible by the aforementioned modularity.

We associate the existence of digital data and especially the digitisation process with the end of the 20th century and the beginning of this century, when the digital method of recording audio and video quickly developed and the mass availability of digital storage media, such as CDs, DVDs, flash discs as well as a variety of other compressed (and thus easily portable) formats occurred.

The third characteristic feature of new media, which Manovich (2002) assigned to numerical representation and modularity is automation, which greatly accelerates and facilitates the creative process using new technologies. Numeric coding and modular structure actually allows one to automate many operations that had, prior to the advent of said technologies, been slow and demanding. Currently, automation is of crucial importance and a key priority in the context of technological development. The goal of automation-related research and development is the creation and deployment of various automatic devices. Automation in connection with new media means that the human element can be replaced by a computer in certain phases of the creative process. In computer hardware or software, a variety of user-friendly and accessible templates are available to easily edit algorithms of digital data. In art, automation is utilised to aid in the production of the so-called generative art.

The high variability of new media (the fourth of the principles elaborated by Manovich) is also associated with automation. Variability is a positive consequence of numerical coding and modularity. As Manovich explains (2002), a new media object is not something fixed, but exists in endless versions, resulting from the activities of computers. Variability thereby expresses the ability to generate a number of versions of an object, such as colour variations of computer graphics or compositional variations of a net art collage. It is obvious that variability arises from the modularity of new media: components and elements of a specific media, which exist relatively independently of one another and therefore make it possible to combine and assemble said components and elements into new units at will. The variability of new media (not only new media works of art), however, is also reflected in the everyday operations of computer and internet users. The interactivity of web pages, the process of selection from many options on a menu of choices, the use of hypertext and regular updating of programs or web pages: all of this can be included under the principle of variability. After all, web pages appear in endless versions on the monitors of its visitors, by using the menu or hyperlinks each new user creates more variants of those pages.

Manovich (2002) further draws attention to the fact that the expression, or more precisely, the result of the 'computerisation of media' is a progressive cultural recoding. This fifth principle means the transcoding of cultural forms and contents (understandable and intelligible to a human being) into computer data (customised and especially comprehensible to the machines). The characteristics of a digital data file do not have a priori cultural significance (content, meaning, aesthetic quality, etc.), but rather have a fully technicistic meaning belonging primarily to computer communication (file type, size, format, etc.). We can see that new media fall into two separate layers, into the cultural ('human') and the computerised. (Manovich, 2002)

The issue of cultural transcoding speaks to the core of the overall impact of new media on human culture. The depth and profundity of the cultural changes that will result remains an open and urgent question, to be answered in the future as well as in the research focused on this phenomenon. However,

undoubtedly, the computer and the cultural layer mutually influence each other and the result of this influence is the current computer culture, in the words of Manovich, the mix of human and computer meanings, a mix of traditional beliefs and world views and the computer environment of its display. (ibid)

17.2 The pioneers of new media

Given that new media is being used in art more and more often and in a variety of rapidly changing and rapidly obsolete forms, it is worth recalling the first attempts to use it in the visual arts. The first artefacts that we have chosen from the rich field of new media art for this text would not be considered as new media objects by Manovich – since they are analogue in nature. Nevertheless, we shall briefly introduce them: they are characterised by a lively interest in the use of the new possibilities offered by technological inventions in artistic creation and their extension into the daily life of people. The technical fads, (at the time, items such as camcorders or the first desktop computers), were actually appropriated by artists almost immediately after they became widely available, which demonstrates that the arts never stop looking for new possibilities to aptly and authentically demonstrate the problems of man and human society at a time more permeated by technology and 'electronic culture' than ever before. (McLuhan, 2008)

As already indicated, the roots of new media art can be traced to the interwar avant-garde movement. For generations, theorists and artists have enthusiastically mulled over which artistic means and media to utilise in order to best express the life, problems and joys of modern man. For example, the Czech theorist Karel Teige in his reflections on 'absolutely contemporary ways' proposed the use of cinematic projection in art, which could then develop into a still image at that time and give it another layer of rhythm and cadence. According to Teige, contemporary art should develop the human sensory experience and be inspired by new media art and modern technologies. (Teige, 1927–1928)

Teige's vision was further realised by Zdeněk Pešánek, a representative of kinetic art and the author of the book *Kinetismus* (Kinetism) (1941). Long before subsequent attempts, which are listed below and which extend back into the 1950s and 1960s, he used symbiosis, movement, artificial light, colour, and non-traditional material in his work. For example, he constructed a model of a light piano (the first version comes from the beginning of the 1920s) or he designed an unrealised monument to fallen aviators where he sought to link geometric forms with music, the sound of aircraft engines and the projection of a film, whose script he also prepared (1924–26). (for more detail, see Angel, 1993) In Pešánek's time, the new modern technologies were electric power and artificial light, which to Pešánek symbolised modern life, and which he therefore wanted to use in his works. His most significant creations were luminous objects in which he innovatively combined electric light, plaster, cables, wire, metal and glass, as in for example *Světelně-kinetická plastika* (Luminous-kinetic Sculpture) from the years 1932–33 or *Torzo* from 1936.

The kinetic or cybernetic sculptures of Nicolas Schöffer can also be considered as pioneering new media objects. The creator used photoelectric cells, sensors and microphones for their creation. The sculptures, created during the 1950s, were able to respond to noise, silence, movement, light and darkness, thanks to their electronic control system. Soon after the invention of television, (a typical and truly representative modern technology due to its mass utilisation), television receivers became an object of interest to artists. Wolf Vostell, a significant representative of action-oriented art, destroyed and/or 'modified' televisions (*Televisio Decollage*, 1963) during the creative process. He also attempted to interfere with their image (*Sun in your head*, 1963) and bury television receivers (at the Yam Festival in 1963). It is worth noting that, for Vostell, a television was still an object, a cuboid physically produced from different materials, and not a medium or technology. The main interest of Vostell was 'happening,' during which he tried to put participants in paradoxical situations emanating from contemporary life. (for more detail Zhoř, 1992)

The Vienna actionists, who in the 1960s focused on experiments with photography and film, are also worth noting (certainly in the context of Viennese avant-garde film). In the history of new media, the Fluxus movement is certainly worth mentioning. Fluxus members freely mixed different media and, among others, also the seeds of new media in their events. Thanks to their connection with the avant-garde music scene, the creators greatly relied on multi-media in their productions, which we strongly associate with new media art. The concerts of this movement became famous. Performances consist-

ing of various visual and audio stimuli were referred to as *events* or *activities*. It is essential that Fluxus broke through the barriers between the so-called high art and the wider audience, which is another feature of contemporary art marked by new media.

Fluxus inspired many younger artists, one of them being Nam June Paik, a founding personality of video art. He started with a staged release of his music tracks, which were irritating and shocking for audiences. He knew how to work with the available technological fads and also had ideas for unexpected experiments with them. He created abstract electronic images on televisions and, unlike Vostell, he used television and its broadcasting content in his work as a new creative medium. Paik introduced his audience to a completely new aesthetics of technical images, visual phenomena created directly in the device (and are notable in themselves), or are artist-altered (with the help of technology). Paik's work was entirely influenced by his keen interest in technology. It is known that in 1965 he acquired a video camera and immediately began using it to record his taxi rides during the Pope's visit to New York in 1965. It is also alleged that Paik collaborated on the development of a video synthesiser that allowed creators to mix moving images and sounds. His *TV Buddha* (1974) installation is well-known, in which a statue of Buddha meditates above his own television depiction.

Although various technical 'tweaks' in the form of photoelectric sensors, microphones, electronic control systems, video cameras, synthesisers or media in the form of photography, film and television have transformed art-making, the source of the biggest changes has become the computer. At first, its potential was not obvious and the use of computers for artistic creation was prevented by their unavailability. The first computers (built approximately in the middle of the 20th century) were used to solve scientific and technical issues and their potential was seen in their ability to perform complex mathematical operations in a short time with a minimum number of errors. People were fascinated by the ability of computers to quickly and flawlessly execute taks beyond human capabilities or requiring the full and long-term deployment of a team of people.

17.3 The advent of computers

The first computers were, however, too large, demanding to operate (they required special facilities and consumed large amounts of energy), were difficult to use and their price was high. Moreover the actual implementation of operations on the computer was initially complicated, because to work with them it was necessary to know the specific programming language. Therefore, at first, little thought was given to the mass utilisation of computers (certainly no one envisioned the type of user-friendly operation that we can enjoy today), or their application in art.

From approximately the 1960s, in the context of scientific and technical disciplines, the use of computers for creating computer graphics began to be experimented with and soon its potential in the creative artistic process began to be considered. When talking about computer graphics, we are referring to both informatics as well as practical disciplines, now widely used in art, science, education and industry. The principle is that computers use information obtained from the real world to create artificial graphical objects or for adjusting images. These are usually digital photos, scans, or video footage. In today's art it is already a separate category, covering many areas, for example creating digital drawings, videos, computer animations, digital photos, or more recently improving 3D graphics.

What were the origins of this field? Experiments with the use of computers for creating graphics began to be carried out in the 1950s and 1960s, but only with the development of computer technology in the 1970s was their extension and initial applications in art enabled. Due to the high cost of technical equipment they remained rarely used at first. However, that changed with the advent of microprocessors in the 1980s and VLSI technology and the internet in the 1990s. The quickly rising performance of computers gradually affected the parameters that influence the appearance and quality of computer graphics, which include the resolution or the size of the raster from which the image is created (number of elementary points, pixels), colour depth, and/or the number of colours that can be displayed on the screen, as well as the technical parameters such as the refresh rate (the speed with which the image is renewed on the monitor), and the type of system bus, on which the amount of data that is pos-

sible to transfer from the memory of the computer to its video memory at a given time is dependent. (Vývoj počítačové grafiky, 2014)

The development of computer graphics has evolved in direct proportion to the availability of technology, which is why the ASCII art, 2D graphics and finally 3D graphics are discussed as separate and distinct developmental stages. The oldest type of computer graphics is ASCII art, in which the image is created by using the letters and characters of the ASCII table. ASCII is the acronym for the English term 'American Standard Code for Information Interchange,' which indicates the code table that defines the 128 characters of the English alphabet and other characters used in informatics. The table contains letters, digits, parentheses, mathematical characters, punctuation symbols, special characters and control codes to control peripheral computer equipment, such as printers, for example.

A procedure in which images are created from graphemes was used back in the 19th century, when mechanical typewriters functioned in this manner. Many examples of the aforementioned phenomenon (which were called visual poetry or pictorial poetry) can be cited from the history of literature. From around the 1960s, this method of creating images was also used in the area of computer communications due to the fact that text characters appeared more easily than graphics limited by the low quality of the first generations of graphics cards. Today, Joan Heemskerk and Dirk Paesmans (see below) create the graphical elements of their website www.jodi.org using this anachronistic method, so reminiscent of the early period of computer culture.

The development of 2D graphics (meaning graphics working with two-dimensional objects, such as pictures, text and 2D geometric models composed of lines and curves) built upon this simple but limited way of creating images. From the beginning, two ways of making graphic information were developed, namely raster (bitmap) graphics and vector graphics. The principle of the first of these is a regular grid of pixels, which acts as a two-dimensional array of pixels, each of which carries specific information about brightness, colour, or transparency of the point. We encounter this way of creating and transmitting an image on a television screen or on a digital camera. Images in raster graphics have a limited resolution, which is specified by the number of rows and columns.

The second type of graphics, vector graphics, uses analytical geometry. A vector image is composed of geometric forms, i.e. points, lines, curves, and polygons. It is not made up of individual points, but rather curves, vectors, defined by the anchor and control points. The benefits of vector graphics are that any image can be zoomed in on without a loss of quality. In addition, it is possible to work with individual components (objects) of the image separately. (Vývoj počítačové grafiky, 2014)

From the 1960s to the 1990s, new areas of art-making were gradually created and the future scope and significance of computer art was speculated on: Will the computer become a source of profound paradigmatic change?; What can be considered as an invention and expansion of photography in the art field? Thanks to the regions rapid technological and economic development during that time period, more and more Asian countries became involved in new media art – particularly so in Japan, home of the man who is generally acknowledged to be the first pioneer of digital art, Hiroshi Kawano. In 1966 the Computer Technique Group was founded in Japan. It was an association of students which organised a symposium on *Computer and Art* in Tokyo in 1967. The goal which this art group set can be seen as emblematic of the vision of the new media general art movement at the time: 'to tame the computer's appealing transcendental charm and restrain it from serving established power. This stance is the way to solve complicated problems in the machine society.' (CTG, Haruki Tsuchiya, Masao Kohmura, Kunio Yamanaka, Junichiro Kakizaki, 1966)

Despite the fact that the group soon disbanded in 1969, Masao Kohmura (*1943), one of the founders of the group, continued his activities in the field of computer art and became an influential professor of new media art in Japan. In his works, he used randomly generated numbers and experimented with the possibilities of the algorithm. For Kohmura, the identical features of the digital environment and language systems were especially fascinating. He understood programming as a tool of expression, and he was one of the first to comprehend that through a good understanding of computers, programming could become a medium for self-expression, for the expression of the human experience. (Compart, 2013) Some examples of his work are the computer generated drawing *Optical Effect of Inequality* (1968), for which he used a computer algorithm modifying a composition consisting of small graphics, or, the computer drawing *Running*

Cola is Africa! (1968), in which the outline of a man is gradually transformed into a bottle of Coca-Cola and a map of Africa.

In general, we can say that in the field of computer art, artists at first mainly focused on two types of activities: programming of algorithms, and, the creative processing of image files, such as scanning drawings and other interventions to them on a computer monitor. (for more detail, see Lieser, 2009) Besides Kohmura, another one of the first creators working with computers was the artist Vera Molnar, who created multiple series of drawings using a graphic software. Her non-figurative objects (originally pencil drawings on paper) are made up of combinations and simple, repeating subtle geometric elements. As the author herself states, carrying out such artwork manually is tedious and slow and, moreover, it is only possible to create a limited number of modifications. (Molnar, 1975) The computer helped her to increase the speed with which she changed dimensions, proportions and a number of elements, to change and increase their density and composition as well as to minimise the effort required for this method of progressive image generation. Molnar also points out an interesting fact that is also true to a large extent for the works of other artists: the creative principle of generating variations of images has long been known from art history, the same as erasing, scratching, retouching images, or returning to the original versions, etc. Although Molnar considers her creative process to be 'traditional,' the artist would not have been able to generate the 27 thousand images that she created during her experiments with the program RESEAU-TO if she had had to create them manually. The creative principle may remain the same, however, something substantial changes, thanks to the use of computers. (Atariarchives, 2013)

Another of the first artists who successfully tried to use the computer to create works of art was A. Michael Noll. His early works were created at the beginning of the 1960s and have a minimalist form of black and white drawings consisting of lines or clusters of pixels. The author was inspired by compositions from well-known artists (Picasso, Mondrian), but at the same time his drawings visualised mathematical principles or expressions (quadratic equations). Examples of his early style include the work *Gaussian – Quadratic* from 1962 (99 lines connecting 100 points) and *Computer Composition With Lines* from 1964, which was inspired by a famous Mondrian painting. Noll also created computer-generated animations. Prints of his works are represented in a number of major museums collections. Noll was also widely published; for example *Computers and the Visual Arts*, or, *The Digital Computer as a Creative Medium* (Noll, 1967a, 4) are testimonies about his early experiments with digital art.

Yet another pioneer of digital art was Charles Csuri. One of his most famous works is the computer modified artwork of an old man entitled *The Sine Curve Man* from 1967. Csuri began to create animations at the end of the 1960s. These were initially simple efforts, as is evidenced by his animation entitled *Hummingbird*. As with this early Csuri work, other early era animations were built on drawing and simple, computer-based experiments that easily allowed one to distort and transform graphic records of facts in interesting ways.

A significant experimenter in this area was John Whitney, who created graphics and animation with a computer – initially with an analogue computer and a film camera. Whitney is the author of the important works of art titled *Catalog* (1961), *Permutations* (1966), and *Arabesque* (1975). Coloured dots, lines and geometric shapes are in motion in his colourful animations, which are accompanied by classical music. Their previously programmed movement is the source of various effects, such as crossfade moving colour areas, or the illusion of space. Whitney uses the multiplication of points and their aggregations, whose magical whirling creates moving ornamental compositions similar to a living kaleidoscope. Events organised in advance on a monitor by algorithm (Whitney also admitted that he derived inspiration from mathematics) created events remote from our natural experience. This became a feature of computer-generated art which, at the time, fascinated both the creator and the audience. For today's computer users, for whom elaborate screen savers are nothing special, these types of effects are commonplace, but in their time they provided an entirely new visual experience. Viewing these early experiments with the then new technology makes one consider how dependent digital art is on rapidly aging technology as well as the persistence of the value of digital artefacts.

17.4 Recording Techniques and their Application in Action Art

It took a long time before computers became routine equipment. Meanwhile, other technology entered into people's lives, including a camera, but

also a video camera, which allowed people to record images, as well as movement and later sound. The actual video camera became important to artists due to its ability to record video. Artists had already begun venturing into the production of 'objects' totally removed from the classical category of art. They had created a variety of performance, events or happenings. However, thanks to the new technical possibilities, it was no longer necessary for such events to take place in the presence of the audience, and it was possible to present them to audience vicariously. First, thanks to the camera and later due to the video camera, viewers could become witnesses to otherwise fleeting and forever vanished 'works' such as land art. If video camera-created art consisted only of the making and the use of a recording, perhaps the technology would not belong in an overview of new media, but sometimes the recording medium did not remain confined to this primary function and began to take on a life of its own. Sometimes the result of an artistic event is not considered to be the performance itself, but actually its recording. At such a point, the object more or less clearly belongs in the field of video art.

The work of Robert Smithson is particularly illustrative of the aforementioned genre. For Smithson, the famous creator of land art events, presentation became an integral element of his plans. He relied on it in advance and utilised it. An example is his famous work entitled *Spiral Jetty*, from 1970. During the artistic intervention into the landscape, a half-hour 16 mm film *Spiral Jetty* was created, which is now presented in galleries, even though the work itself has been destroyed. (for more detail, see Fricke, 2011, p. 546) Smithson, as well as many others, was fascinated by the possibility of the transmission of information to an infinite number of people and contemplated on how his land art activities would be transmitted to the whole world via television. (ibid)

Performances are a separate area: they usually have a completely 'non-media' character, but with the help of new media can gain greater reach and significance. We shall not forget that in the case of performances they concern one-off events during which the live performing of some action occurs in front of an audience or with audience participation. As Fricke points out (2011, p. 602), it was the use of the possibilities of photography, film and video that enabled the further expansion of expressive forms of creative expression. Many artists only carry out their performances in front of a camera (without the direct participation of the audience), which allows for the preservation of the intimacy of the moment. Eventually, however – by using a record of the performance – the transmission of the 'work' through mediation to viewers can occur. A performance can thus take place virtually anywhere even without an audience (if it is a performance for the camera), but it still is – thanks to the recording and use of network media – communicated. In some cases, it can be hard to distinguish whether a work should be classified as a multiple series of performances or as video art. One example is the well-known performance by Jochen Gerz entitled *Calling to the Point of Exhaustion* from 1972. Although the camera was the only witness to the event, in which the artist keeps shouting 'Hallo' until he goes hoarse and breaks off the performance, viewers can watch it and vicariously experience it through the still powerful black and white recording.

Although video has become an important means of recording and has positively affected the communicative value of performances, it has itself gradually become a creative medium. As artist John Baldessari aptly expressed, one should not say: 'Now I'm going to do something on video', but rather: 'What I am going to create can be best expressed by video.' (In Fricke, 2011, p. 604) John Baldessari is known as the creator of the video with the name *Folding Hat: Version I* from 1970. On this black and white tape with audio the hands of the artist are captured squeezing, kneading and re-shaping a hat in various ways. It is essential that the result of the action of his hands is not the sculptural processing of the material (hat), meaning the object, but rather the video itself. Also worthy of mention is another Baldessari's video entitled, *I Am Making Art* from the year 1971. The black and white grainy tape shows the artist standing in front of the camera, moving his arms and repeating the phrase 'I am making art'. The artist thus illustratively shows that art can be 'done' through actions, and their recording, and he plays with this new reality in a fascinating way.

Since the 1970s, artists have been experimenting with the expressive possibilities of new media as more and more completely new aesthetic forms have been coming into existence. Bruce Nauman, a creator of video performances, is considered to be an important representative of conceptual art. In his videos, the body plays an important role and the artist poses and handles various objects on video. The viewer focuses particularly on the movement of the artist's body and on his actions. The tapes have a special atmosphere as a result of the use

of an inverted image, static scans as well as detailed long shots. In the 16 mm film, *Walking in an Exaggerated Manner around the Perimeter of a Square* we watch Nauman as he intently walks around the perimeter of a square. *Art Make-Up* was originally a forty-minute recording on 16 mm film (later converted to video) consisting of Nauman applying white, black, pink and green makeup to his face as his actions are captured by a still camera.

The famous video of Richard Serra titled *Hand Catching Lead* from 1968 has a similar effect as well. It is a black and white silent film, in which we constantly see the same shot: the artist's hand, which is trying to capture a free-falling piece of lead. The hand is constantly clenching and opening; sometimes the falling object is caught, sometimes not, other times the hand becomes gradually tired. Serra is primarily known as a sculptor; he also experimented with lead and a variety of non-traditional materials in his sculptural work (for more detail, see Marzona, Grosenichová, 2005); more relevant to the theme established herein, however, is the fact that from the end of the 1960s he experimented with video and created a series of short films similar to those mentioned in this study.

What the videos we have mentioned thus far all have in common is that the artist is their main actor and that the movies are a record of some of his or her activities. The recorded event acquires a different meaning through video and its potential for communication is exponentially multiplied. This observation also applies to the well-known video artist Marina Abramović, who was known mainly for her performances. In her video *Art must be beautiful* from the year 1975, the most important role is played by the body. The same is true of many of her other performances such as, *The Fall of Ulay*, during which she screamed until she had reached a state of utter exhaustion (along with Ulay, AAA-AAA, 1978) and in which she let a snake wind itself around her head. In another work of hers, she left things completely up to chance with the public during a performance tinged with sado-masochism. In the video *Art must be beautiful*, the artist is filmed naked, as with rising intensity, she gradually, brutally and self-injuriously combs her hair, constantly repeating the phrase 'art must be beautiful, artist must be beautiful'.

With the further development of technology, colour video footage began to be used, which completely transformed the future character

of the resulting works. One of the first to take advantage of colour recording was Peter Campus in his six-minute videotape with sound titled *Three Transition* from the year 1973. This artist was already using video as a creative tool, or 'material' and he combined video projection with the movement of the body in a novel way. Campus's work was influenced by the fact that he studied experimental psychology. His early videotapes examine the possibilities of video and explore the relationship of video to the human mind and perception. The author points out that the camcorder can connect an external focus simultaneously with the viewpoint of the individual and that gives us a new experience beyond natural visual perception. As Campus himself says, he uses video in conjunction with projectors and monitors to investigate and clarify the new perceptual situation of man.

17.5 The further use of video and the beginnings of animation

The development of technology enabling the recording of movement and sound, that is, video, was an important milestone in the development of new media art. Technology has been influencing art since about the 1960s. In 1965, the Japanese product Portapak was launched on the American market, which enabled the electronic recording of images. Until that time this had only been possible in the professional studios of the major television companies; from the 1970s onward, this technology became progressively more accessible and cheaper. Of course, it also soon began to be used by electronic lovers among artists.

Larry Cuba was a key pioneer in this field. In the 1970s, Cuba was one of the artists exploring the potential of abstract computer animation, which today is one of the core genres of new media art. He utilised digital, rather than analogue computer technology, collaborating with the aforementioned pioneer of computer animation John Whitney sr. and working for Hollywood Studios (e.g. - in 1970 he created the computer graphics for the first Star Wars). His later work from 1985 titled *Calculated Movements* is also worth mentioning. This sample of early video art illustrates the use of software developed in the Electronic Visualisation Laboratory (EVL). Cuba also used recordings on 16 mm film, as was previously common. Others also engaged in experiments with film, for example Ed Emshwiller (Sunstone, 1979) or Steina and Woody Vasulka. At this point, it is relevant to mention the video entitled *Noisefields* from 1974,

an emblematic example of the work of Woody Vasulka and Brian O'Reilly's titled *Scan Processor Studies* (a collection of works from the 1970s).

As video and animation became more and more widely used, attempts to use the artistic testimony of television broadcasting and its communication potential continued to unfold. The first art television production is considered to be the *Black Gate Cologne* (1968) from the authors Otto Piene and Aldo Tambellini. In January 1969, these authors created a 23-minute black and white fairy-tale play on a German television broadcast, formed by the fusion of several recordings of the artists' performances, as well as various documentary films and slides. However, due to the length of the transmission, this attempt proved to be too expensive. Indeed artworks on the television screen never become commonplace. Television was to remain a medium of popular culture, not an art one. In the ensuing years however, video, in the form of video tapes, continued to develop.

It is relevant to note that video is not the same as film (i.e., a sequence of frames with images that can be individually observed). Videotapes contain image information recorded electronically, and thus are different from classical work 'material'. This new 'work' materialises exclusively thanks to a player and screen. Although this fact was perceived as a problem in the beginning (and some artists – similar to photographers – put limited editions of these tapes on the art market), today we have already accepted the fact that electronic (or digital) images have a completely different character than classical artefacts and have ceased to be a commodity of the art market. The advent of new media has brought substantial democratisation of the art field (virtually everyone can be the owner of objects such as videos on YouTube), while new media is teaching us to come to terms with the transience and impermanence of these new forms of art.

Video is also used by artists to create the so-called video objects, video sculpture or installations. The object in this case is connected with integrated software, so a three-dimensional whole of a material nature is intertwined with a video image forming a single complex. An example is the well-known video sculpture by Shigeko Kubota entitled *Duchampiana: Nude Descending a Staircase* from the years 1975 and 1976, formed from plywood structures in the shape of stairs, four monitors and a VCR. The object is especially interesting due to the special tension between the dynamics of the moving image 'imprisoned' in the solid, plywood steps. An example of a work that stands on the boundary of a video object and video installation is the work of Marie-Jo Lafontaine called *Victoria* 1987/88. It consisted of 19 dark modules with integrated screens in a spiral arrangement; videos with two male characters were played on the screens. The video installation entitled *Les larmes d'acier* (1987) has a similar character. It consists of 27 dark modules with integrated screens on which parallel images of male bodies working out with a slight time lag are projected.

An installation, unlike an object or sculpture, is characterised by a very close relation to the venue of the exhibition. It is always linked to a given area; although its transfer to a different place is sometimes possible, the nature of the installation is thus changed and a new installation is created by the new space it inhabits. Video installations have the ability to shape the space in a special, compelling way that is unattainable without the use of new media. In this context, we will mention a special type of installation, the closed-circuit-installation, which vividly captures or records images and simultaneously transmits them on a monitor or monitors. An example is the work of Nan Hoover, who projects various light effects and images and also records the movement of viewers, who then enter the installation. In this type of work, the viewer becomes a co-creator of the event. Two emblematic examples of Nan Hoover's works include an older work from 1984 (*Returning to Fuji*) and a newer, closed-circuit-installation from the year 2001, which was created for the exhibition Dialogue: The Work of Nan Hoover at the Netherlands Media Art Institute.

17.6 Other manifestations at the end of the 20th century

In the 1980s, the new media art scene or more specifically video art was still not regarded as a dominant phenomenon; it was still standing on the periphery. However, that gradually changed with the influence of ever more affordable techniques and emerging technologies. During the 1980s, radical changes in Western culture were occurring; companies were 'computerising' and were increasingly influenced by new information and communication technologies. This transformation culminated in the expansion of the internet and the web

(especially after 1990), and the emergence of new ways of communication. The phenomenon of the clip emerged, which began to dominate the television and entertainment industry. The clip, featuring fast cuts and full use of image communication, even gives a name to the new generation of young people. The habits of entire masses of television viewers changed, VHS cameras and players became standard equipment of western households. The advent of computers and their progressive expansion created a new platform for art production. Although clip aesthetics are not the same as independent art, the two areas mutually influence each other.

A new generation of artists, who grew up in a media-saturated environment of television and were not only technically literate, but also extremely capable, gained a voice and a communication platform. One can therefore say that newly emerging art production is technically better and constantly improving hand-in-hand with the technology. The boundaries between the disciplines or between independent art and popular culture is being redefined. A heated discussion is taking place about whether the connections with the world of the commercial entertainment industry harms the autonomy of art fields, and it is often stressed that video art has to be independent of commerce, although that causes it to lose the attention of a mass audience.

The use of new media has another important secondary consequence: art ceases to dwell in an imaginary ivory tower and increasingly advocates for current social issues. In this manner, art enters more tangibly into the sphere of life; artists are activists and are appealing to the public. The monitor has definitively become a space for creative work and experimentation; artists are exploring the possibilities of a new language of art and completely new, as yet untested possibilities. *Perfect Leader* (1985), created by the artist Max Alma, provides an illustrative example of work from the abovementioned period and genre. It is a videotape, with colour and sound, which was created with the involvement of a computer, using visually compelling, and (at that time) new colour filters and image effects. It is a colour activist tape created in the context of the U.S. presidential campaign attacking the world of the commercial media and showing how the media 'generates' a photogenic and overall perfect political leader. Computer and video containing elements of computer graphics or animation was used to edit this tape. The influence of computers on art

production in the 1980s rose rapidly because of the expansion of their availability and ease of use for creative work. The first computers with a graphic-user interface gave rise to new standards and expectations and were of interest to artists immediately from the very beginning.

Artists also began working with robotics. For example, the Canadian artist Norman White compiled and programmed the popular *Helpless Robot* in 1987. We mention this artefact mainly because it is one of the first truly interactive works using robotics. Its interactivity lies in the fact that the device tries to evaluate and predict human behaviour and reacts to it. Norman White continuously improved his work and gradually presented its enhanced versions at various shows. Version No. 2 is an object created from a few rounded plywood boards on a metal frame that is mounted on a rotating base, allowing the robot to move around its own axis. White himself did not describe his work as a robot, but as an electronically controlled kinetic sculpture (even though *The Helpless Robot* can speak and mimic human behaviour). In interactions with people it is at first polite and asks them for help; as soon as the person approached reacts to its request and turns him in a certain direction, the robot expresses its dissatisfaction which further intensifies. It gives people more commands and deplores and curses the unreliability of people. This humorous artefact works, among other things, thanks to the synergy of the two computer systems and three infrared detectors.

In the 1980s, first artists started experimenting with 3D graphics and generative software. They are allocated a separate area of generative art in which the artist transmits a greater or lesser degree of control to a computer program or machine over the art production. Galanter (2003), who himself is an important representative of generative art, points out that generative art appears in more contexts than in just computer graphics and animation. It is also developing in the field of electronic music, and composing using algorithms in the environment of public performances of electronic music, or, in industrial design, and architecture.

Yoichiro Kawaguchi and Yoshiyuki Abe became well-known creators in this area. Yoichiro Kawaguchi began his experiments in 1975, when he programmed simple linear drawings. He did research and worked on the problem of graphic software and completed his first animated film *Pollen* in the same year. His work

Embryo from 1988 is also worthy of mention. Kawaguchi was also interested in 'growth' (algorithms simulating growth) and the software that enables the creation of three-dimensional forms. Another Japanese pioneer of 3D animation is Yoshiyuki Abe, who has been working in this field since the late 1980s.

Since the 1990s, interactively applicable media, which can be classified as CD-ROMs, on-line technology and digital technology, has been increasingly competing with classical mass media. They are gradually replacing analogue technology and changing the reality of Western man. The practice of sharing files among users of a site and downloading files, especially music and films, gradually supplemented by the so-called streaming, which provides the possibility of watching media on-line without having to download the file to your computer, has become an interesting phenomenon of today. The current cyberspace environment is characterised by 'rich applications', the use of animation, sound, video, interactivity; it is indeed a struggle for innovation, about moving a little bit ahead every day. (Chatfield, 2013)

Since the end of the 20th century, it has also been possible to identify new media art which employs digital and network technologies in a creative manner. (Kera, 2013) The internet is becoming a network in which most contemporary digital culture exists, and art culture is merely one component of the broader whole of this new digital culture. The internet began to be used very quickly in artworks. As a result, the emergence of a specific form of art, called net art, has occurred. Artists are beginning to create their own sophisticated software and applications, using real time effects (easily available thanks to the web) and the advanced technology of virtual reality. Creators are also generating other typical products of digital culture, such as computer games and various databases. By using a computer, they can visualise their concepts, use wireless and mobile technology, robotics as well as emerging biotechnology and nanotechnology. (Kera, 2013)

In addition to the different technological processes at the interface of science, artists continue to use video and create video installations. The separate categories are computer graphics, computer animation, but also digital music or the so-called sound art (often in conjunction with images). Intermediality, meaning the interfusion and mixing of different kinds of art

in a common whole is becoming typical for contemporary new media art. Thanks to new technologies, new spaces are also opening for performance arts. As Vladimír Havlík points out, digital technology offers layered and immediately shared creation of multimedia projects (objects, installations, performances, interactive environments, or virtual spaces). Direct transmission, handling a recording in real time, and immediate sharing in various places in the world, are just some of the wide range of revolutionary changes in the process of sharing communication. (Havlík, 2012)

Digital technology is definitely changing our idea about what a work of art is and what characteristics it has. As described by Kera (2013), digital art is procedural and unstable, the works are often dependent on interaction with the audience, or are not even man-made.

17.7 The Cluttered Present – the Spirit of New Media Creativity

In this brief section, some interesting representatives of contemporary new media art will be presented. Let us begin with net art, which combines most of the content and formal features of contemporary new media art. First, it is necessary to explain that net art, in the case that the art 'object' or project emerges directly in the space of the world wide network, concerns the use of its communication resources and possibilities, and it is also distributed through it. (Freeman-Vlková, 2000) Initially, the term net art denoted projects or objects that worked with computer aesthetics; the content itself was mostly the internet medium and experience with its use. One can, of course, imagine that intoxication with the given medium, exploring its nature and limits, always occurs with the beginnings of each new form of art expression – and that after a pioneering phase, at the beginning of the 1990s, the internet was not the only or main theme of net art. Among its pioneers are Vuk Ćosić, Alexei Shulgin, Olia Lialina, Heath Bunting and the couple Joan Heemskerk and Dirk Paesmans. They quickly took charge of new media and worked with its possibilities and shortcomings in a truly innovative and critical manner. (for more detail, see Green, 2000)

How can one imagine internet art? From a technological point of view it usually concerns websites using HTML, Java Script, QuickTime or Flash. However, net art can also include different projects using electronic mail (mail art)

or some form of action-oriented art organised over the internet, or shared. Intermedia projects for which the internet is a means for presentation, (e.g. – a gallery in which to 'hang' the artwork), stand at an intersection – they can be videos or performance projects that would otherwise not be shared and disseminated.

Uninformed users are often scared or shocked by their chance encounters with net art. This is usually the case because net art is not something which ordinary internet users are accustomed to. The pages often lack any clear structure, links can be unusually hidden within moving graphics or the events on the monitor cannot be controlled at all. However, web projects may also take the form of seemingly reputable sites containing disinformation, or conversely, a completely chaotic endless labyrinth. Others may cause the malfunction or appearance of disorder in the user's browser, or the rampant spreading of a virus.

Several authors – such as Freeman-Vlková (2000), Zbiejczuk (2003) and Isanovic (2003) – have attempted to classify net art projects. Net art, no matter how it defies simple description, analysis and subsequent classifications, manifests itself in two different principle forms. Either there is a specific content primarily intended to be read or listened to, or to disseminate information, or it primarily concerns a visual product that works mostly with pictorial information and is designed to be watched. Of course net art projects can today use the completely common combination of all available resources, such as audio, image, video, animation, text, etc. However, the dominance of the image, or conversely, the dominance of text as a means of expression is a relatively simple distinguishing feature.

The first projects cited below used text as a basic means of expression (meaning a written record of linguistic expression) and thus transmit a certain communication through the written medium. They also use one of the most characteristic features of the website, which is hypertext. When reading a literary text, hypertext makes the previously impossible possible: the abolition of linearity or hierarchy, the development of alternative storylines or the linking of various sections of a text. Hypertext literary texts develop interactivity, so that a story can wander at the will of the reader, and so that it is possible to choose between the options by which the story takes shape or how the story should end.

One of the variations of text-based net art is the hypertext story and poem titled. *Grammatron* (www.grammatron.com) created by Mark America, whose first version was completed back in 1993. *Grammatron* – as well as other hypertext novels – uses an impressive combination of text, graphics, and music. It is a kind of cyberpunk maze of more than seven hundred individual web pages, which, besides the story itself, also consists of theoretical texts, pictures, animations and features the author's music. An example of a Czech net art project is the hypertext novel *Město* (City) (mesto.html), which was written by Markéta Baňková. Hypertext is of course also used in most other types of net art projects – in the case of those works mentioned above, however, the main distinguishing feature is the dominance of meaningful, or, literary text in conjunction with audiovisual elements.

Another example of a project that is built on text (literally), includes the text video from the group Young-hae Chang Heavy Industries. It is basically a graphic video, in which the major role is played by simple black text running or blinking on a white background. The videos are underscored by jazz music and some also contain voice accompaniment that simultaneously reads the text running across the screen. The described videos are, in effect, put on the internet independently. They could also be presented offline, however, the internet is used as the best medium for their dissemination and presentation. These projects combine themes with net art that deal with and express the modern human condition, such as the question of the meaning and essence of the internet (and art on internet), the cultural identity of contemporary Western man, the role of transnational corporations in the modern world, etc. (Zbiejczuk, 2003)

Engagement and activism are nothing unusual in net art projects – for example the group 0100101110101101.org advocates the absolute freedom of the internet and free access to a maximum of information, while other authors support gender and human rights. It is not only net art projects that are activist, also contemporary artists – no matter what means they work with – very often comment on current social issues. However, the internet gives artists entirely new opportunities and tools. Probably the most famous activist group is the already mentioned 0100101110101101.org which involves the authors Eva and Franco Mattes. In 1998, they did not hesitate to copy the official website of the Holy See (www.vatican.va) and redirect visitors to their own website

– originally identical with the official one (www.vaticano.org). The whole scam was allegedly discovered after one year, thanks to a fictional statement of the Pope on traditionally publicised topics.

The authors also faced off with the multinational brand name Nike, whose official website they copied in 2003. The creation of a website to which visitors were directed, was part of an elaborate event called Nike Ground, in which the group successfully misinformed residents of Vienna that the world-famous Nike corporation 'was buying squares and streets of the city'. An information stand located directly in the city informed citizens that Karlsplatz, one of the main squares in Vienna, will be renamed Nikeplatz (0100101110101101.org, 2010).

While this type of page copying is technically not defined as hacking into a foreign server, and therefore not a crime, another action of this group can be clearly designated as direct hacking. In 2001, the members of the group hacked into the web site of the Korean Art Festival, held in Seoul, where they exchanged the names of the works and of the artists presented. For a long time, the group has been concerned with the freedom and security of the internet, plagiarism as well as the absolute availability of information. Primarily, they provoke by applying the proposition that information and all of the contents of the internet, can be freely copied, changed and spread uncontrollably.

The aforementioned Nike Ground project can be classified among disinformation or mystifying projects, of which many can be found on the internet. Such projects enable the almost complete concealment of the identity of a given content creator. This anonymity has attracted artists from its inception, giving rise to many sites that, at first glance, look like an official and reputable presentation of various companies, firms or shops. For instance Alexei Shulgin, a well-known pioneer of net art, created a site offering a device for having sex at a distance. A number of magazines for the IT community were taken in by this joke and very seriously informed their readers about the existence of this device.

Another type of net art consists of works that are primarily pictorial in nature. They most often take the form of graphic collages and labyrinths and represent the variety of net art that is closest to the classical fine arts. These are typically any number of linked pages, consisting of a combination of graphics, animation, video, audio and text. Some of these projects are very similar to

the intermedia art projects, which were well known even before the mass expansion of the internet. A typical representative of the net art image labyrinth is *Superbad*, whose author is Ben Benjamin. After entering the address www.superbad.com we come to a simple entry page emblazoned with the inscription *Superbad*, consisting of small characters. By double clicking on any of a number of active elements we get to a chaotic maze, whose exploration seems impossible at first. On some pages, we find a number of classic hyperlinks; on others, we have to search in the graphics or moving animations.

Similarly, some of the projects of the previously mentioned group 0100101110101101.org, categorised under the name *Hybrids Online Net Art collages* and created in the years 1998-1999, take the form of pictorial labyrinths. Text is also present there, but it is often impossible to read it because the pages blink chaotically or move with such speed that it is impossible to perceive them. In addition, copies of other existing pages can also be found on the internet. It is therefore a real net collage – after all, snippets of various sites are layered over each other (for example we can find a copy of pages of other net art creators), computer games, graphics, text, and 'unruly' HTML codes.

The page www.jodi.org, created by Joan Heemskerk and Dirk Paesmans, is likewise built as a chaotic collage. When entering the address, you do not know where you will actually be redirected and what will appear on the monitor. Their well-known project *404* employs the symbolism of this number (meaning an error message on a computer). Jodi are one of the authors fascinated by the aesthetics of programming languages, or simple fonts and symbols on a monochrome background. Characters, numbers or icons are used either in 'pure' form, or as a 'material' for creating simple images, reminiscent of the 'pre-flash' era, in which pictures were created by using slashes, dashes, zeros, and other characters (called ASCII graphics, see above). So Jodi, together with some works of 0100101110101101.org are classified among projects which work with the aesthetics of HTML code, and whose main feature is the use of text, not primarily to transmit information, but to create a visual effect.

Software art the outcomes of which include a variety of programs such as browsers, games and applications, began to be included within the framework of net art in the 1990s. Thus, software art involves objects that are created when

the artist him/herself programs them, while their actual startup can occur off line. As Lieser points out (2009), the writing of a program can be one of the aspects of the work of art or the display on a monitor, arising as a result of this activity. Such outputs can be an aesthetic subject in motion or at rest, or a modification of existing computer or web content. There is software that modifies already existing data or changes the HTML code of Web pages. Alternative browsers, in turn, undermine the common perception of a web page, causing its blinking or some other visually interesting destructions/deconstructions. An example is the *% Wrong Browser* by Jodi or the *DSTRKTR* browser, whose name suggests what can be expected from it.

A typical example of software art is the virus programmed by Franco and Eva Mattes for the 49th edition of the Venice Biennale. It is probably one of the first art experiments with a computer virus. The previously reported actions broke out on the opening day of the exhibition: a program called *Biennale.py* (2001) was activated and began to gradually spread to companies that, for example, deal with selling anti-virus software. It is essential that the virus was programmed to not be destructive in nature. The creators themselves had the following to say about their deed: 'This is about an art form, which finds you by itself. You do not have to go to museums, the work will find you in your homes.' This act also demonstrates that new media art may sometimes take a provocative and controversial form – especially if the artist just releases it into the world, without a thought given to what the further life of the project will be.

The philosophy of this genre of computer art, in which there is a belief in the free sharing of content and a new concept of privacy, also appears in its fullest effect in the project, *Life Sharing*, which was also created by Franco and Eva Mattes. In order to show that their attacks on the privacy of others are not meant unilaterally, they offered any visitors to their site unlimited access to the contents of their own computer for a period of three years: to the hard drive with all the programs, to the private email correspondence, photos, and information about the accounts. Meanwhile, they characteristically referred to this project as something that creates their 'digital self-portrait on the internet emerged in real time,' and added: 'Privacy is stupid.' (for more detail, see Lieser, 2009)

There is a whole range of net art projects and due to limited space of this section, it is only possible to present a fraction of them. Most, however, share their fascination with the phenomenon of the internet, which the artist exploits in order to verify and investigate its possibilities and limits. Net art creators play ad absurdum with many of the problematic phenomena that characterise or accompany the internet. This involves, in particular, the anonymity of content creators, blurring of the boundaries between public and private, virtual reality, plagiarism, hacking, deception and misinformation. Between the lines, some of the projects also draw attention to typical problem of modernity such as rapid obsolescence and ephemerality.

Artists capture what it means to live under new and changing conditions of technological modernity, and, in their works, increasingly apply the element of interactivity. The viewer is not only the audience, but intervenes in the work, launches and modifies it. For some interactive artefacts (objects, installations) the viewer must expend considerable physical activity to operate and/or perceive the work. As when they use a computer, people become more than mere 'users' or consumers of art. The typical linearity is disappearing from works of art (see the aforementioned hypertext subverting the linearity of text and audio-visual content); and non-linear collages of texts and images are emerging as well as other 'media material,' such as images, film, videos, music and sound tracks.

Virtual reality technology is also entering the lives of people and art. On one hand, people expect a lot from it; on the other hand, they are also afraid of it. It seems that we are entering an as yet unexplored, artificial, computer-controlled space in which we are actively doing something without first thinking about the consequences. The close interaction of man and machine, and the 'moving' of humanity into the virtual world is being reflected in art and subjected to examination. (Fricke, 2011) In this context, one can mention the artist creating under the pseudonym Gazira Babeli. Babeli is a virtual character that 'exists' in the virtual world known as Second Life, (Second Life is a sort of computer 'game' which gives participants the opportunity to start living a second life in the form of an artificial personality). She is known for her animation (most notably her work entitled *Save Your Skin* from the year 2007).

In 1995, an interactive computer installation by Agnes Hegedüs named *Between the Words* was created, which reflects the problem of new methods of interpersonal communication. It concerns a machine through which people enter into virtual communication, they can partly see each other, but cannot talk to each other directly. They communicate using joysticks, which control their virtual hands and their gestures. The work is a reminder of how dominant communication via a media network or through electronic mail and/or other various applications has become. Artists show us this reality in a somewhat excessive or exaggerated form and force us to ask whether (and how) this way of communicating is definitively changing us. (For more detail, see Fricke, 2011)

New media art is becoming a very eloquent means of expressing the feelings of contemporary man and often has an existential tone. The videos of Bill Viola exemplify this (e.g. *Silent Mountain (The Passions)*, 2001 or *Acceptance* or 2008) as do those of Bruce Nauman (*Clown Torture (Dark and Stormy Night with Laughter)* from 1987) and Fabrizio Plessi (i.e. – *Mari Vertical*).

New media is also being increasingly associated with its specific content: it is very often the kind of art that reflects and criticises commercial or other aspects of new technologies, or, the current media world. We have already pointed out this aspect of new media art in the sections dedicated to net art, but it is also related to other streams of contemporary art. These works of art are extremely valuable in reflecting a significant aspect of today's world, namely the connection of civilisation with the technologies and the pervasiveness of technology. Digital art attempts to show different forms of socio-technological relations and grasp the space between autonomy, dependence and symbiosis of art with media, the same as people with machines. New media in art, in an innovative way, connects different machines, organisms and social structure into common units, while changing the boundary between the natural and the artificial, *fysis* and *techné*. (Kera, 2013)

Computer graphics is a separate but related field that is still developing dynamically. Its leading representative, Roman Verostko, was a sculptor and painter who began working with computer graphics in the 1980s. He significantly contributed to the development of the plotter drawings, which he created on the basis of his own algorithms. The spirituality and philosophical range of his thinking about video tracks plays an important role in his work. Verostko spoke about algorithms as essentially being just a detailed manual for solving problems. A description of each of the steps leading to the solution of a problem always enables the formation of the same result regardless of whether the operation is performed by a human or computer. The artist points out that each clearly defined process is an algorithm, regardless of whether that algorithm is a recipe for baking bread or a code for the creation of his plotter drawings. (for more information see www.verostko.com/algorithm). The subtle graphics of Verostko are based precisely on this principle and demonstrate that a computer algorithm is a tool that can be used for both banal activities and autonomous creative acts.

In the same manner, computer animation continues to develop. The work of the previously mentioned Japanese creator Yoichiro Kawaguchi is a prime example of said development. Kawaguchi creates animated films using the computer and simultaneously programs separately organised basic elements that continue to evolve and ultimately generate a resulting image with a high-resolution structure. The author calls them growth models or 'growth' algorithms (algorithms simulating growth). Kawaguchi also creates installations, a notable example from among his recent work is the computer animation project entitled *Cytolon* from 2002.

Marius Watz is another prime example of a very versatile creator who employs cutting edge new media options to their fullest extent. This artist is known for his diverse projects in the field of generative art: he is the author of a series of laser drawings on MDF boards (*ArcSurf* from 2012) or on aluminium plates (*CircGrid* from 2011). He also prints his plotter drawings on materials based on styrene (*Arc Drawing* cycle #1-2, 2011). In his work Watz uses a visual programming language, Processing.js, which allows him to generate computer graphics and animation. The process of generating graphic cycles can be tested by those interested on the web page http://mariuswatz.com/works/abstract01js/. By clicking on the mouse, or dragging it over the screen, a growing, coloured linear structure (typical of the work of this author) can be produced.

Watz is also the author of a live visual performance entitled *Blocker* (2011), which works on the principle of visualisation of sound using special software and inkjet printing. Recently, this author has been experimenting with

3D printing (*Modular Lattice* and *Probability Lattice* from 2012). Objects resembling cubist design in their morphology are 'printed' from ABS plastic. Using custom software Watz also creates generative video and performs its installation. He is the author of flash animation *220PX* from 2005, which like the rest of his work has the character of visual abstraction composed of sharp, clean geometric shapes of living colours.

Philip Galanter also works employing generative software processes. His cycle *Generative Bodies* from 2009 is made up of digital images printed on panels on which a simple version of the used software is running during the installation. Viewers are also invited to participate; they can develop their own custom variations of the generative variations of the images that simulate the evolution of biological processes and the human body, which are represented by three centres: the brain, the heart and the genitals.

Galanter is also the author of generative animation, intended for projection on a wall. At least two of his animation projects are so significant that it is impossible not to mention them herein: *Untitled* (*Bubbles*) 1996, and *Untitled* (*Blobs*) from 1999.

3D graphics and animation is currently considered to be a completely separate area of new media art. 3D graphics is based on 2D vector graphics, but the geometric data objects are stored in the spatial coordinate system. The basic geometric shapes are called polygons and they are all forms of spatial objects. Groups of polygons are, compared with 2D graphics, capable of carrying other required properties such as surface type, colour and reflection. 3D graphic creators have to calculate the behaviour of light, shadows and reflections, address the issue of perspective distortion, texture and shading on the surface of modelled bodies in addition to many other factors in order to create the illusory effect of a three-dimensional scene. 3D graphics today, apart from the arts and entertainment industry, are also used in science, medicine and technical or industrial areas (e.g. – creating computer simulations of various phenomena, or the three-dimensional display of human organs for the use in medicine). (Vývoj počítačové grafiky, 2014)

For instance, 3D is the theme of Mark Walczak and Rory Solomon's project *[HERE] [NOW]* from 2009. The project examines the phenomenon of space and the perception of space. As they say, what they are interested in are the seemingly invisible effects of the interplay of physical aspects and social and network culture on communities of people. (Walczak, Solomon, 2009) In the aforementioned project, they create parallel 3D environments, which they project in a gallery or in a public space. People can enter into the 3D environment and thereby influence the resulting projection. The original 3D space is empty, barren and infinite; its 'architecture' is created only by the avatars of the people entering. Walczak and Solomon also cooperate on other interactive installations and online projects.

The visualisation of various types of data, such as information in digital form for computer processing, is an area of particular interest to artists. For example, the art duo Fernando Viegas and Martin Wattenberg attempt to visualise data related to weather, seismic activity or popularity of YouTube videos. *Wind Map* from the year 2012 visualises data obtained from the U.S. national database for weather forecast. By using this data, and special software, the authors create a living portrait of wind currents blowing across the territory of the United States. The constantly updated map, on which white lines incessantly flow on a black background of blank maps, can be retrieved at http://hint.fm/wind/. Another example is the collective work *Bloom* (2013), on which Viégas and Wattenberg collaborated together with Ken Goldberg and Sanjay Krishnan. In this project, they attempted to visualise data obtained from a continuously operating seismometer, a device designed to measure the strength and course of seismic waves generated by an earthquake or by the result of human activity. In the visualisation, this information is displayed in the form of coloured circular discs, which unlike seismographic 'drawings' are not ominous, but create a 'joyful portrait of the energy of the planet.' (Bloom, 2013, http://hint.fm/projects/bloom/)

Data, numerically coded images, texts, numbers, or sounds, are now easily available in huge quantities (over hundreds of trillions of GB per year). (Gantz et al., 2008) Viégas and Wattenberg offer new ways of thinking about how data is analysed and a creative way to use it. Their work rests at the intersection of art and science.

It is obvious that new media is fundamentally changing the established boundaries of what was previously considered to be art. Furthermore, the art

organisation related to such objects, namely the exhibiting of new media objects and ways of their archiving is changing as well. Art is also losing its function and value as a commodity. In addition, the meaning of the original is changing completely. Classical forms of art are built on authenticity – it is impossible to contemplate the fact that medieval board paintings or Michelangelo's statue could have their equally valuable doubles; the value of these works is built on their uniqueness, on the 'aura' of the original, which originated precisely and only in hands of the author. In contrast, a digital artwork is – in its essence – a set of ones and zeros by nature. Even though viewers do not perceive it in this form, it does not change the fact that the file of data stored in the computer of the creator is exactly the same as the copy in the computer of the gallery owner or viewer.

Furthermore: while a classic work still firmly and relatively exists in its material form (albeit vulnerable to external influences), digital images, computer animations, or net art projects need a specific and well coordinated context consisting of software and hardware instruments for their existence. (Lieser, 2009) A separate issue is the rapid development of these tools, their permanent modification, obsolescence and impending incompatibility (for instance loading a file from a floppy disk is nowadays impossible).

Variability, as well as other principles of new media, carry with them a serious problem related to the authenticity of works of art and their values. While works of 'old' media were placed firmly on the fixed structure of their individual sensory and perceptual elements and were characterised by them once and for all, new media objects are open, changeable and unstable, because the computer culture replaces every constant variable. (Novak in Manovich, 2002) The question is whether or not it is valid to understand new media objects as autonomous artist statements (as we were used to for the works of the 'old' media), when they, in fact, are equally the work of the artist, the computer and the selections of the viewer. Or, is the medium the message? Is the artistic statement this proffered and prepared algorithm?

The famous social philosopher Gilles Lipovetsky (2013) characterises the present time as a novel period, governed by transience – a period in which time is more and more accelerated. Elsewhere, the consumerist world of Western man and the era of emptiness are common topics. The media may have brought man almost unlimited access to information and more than a rich variety of supply in many areas; however, at the same time, the reality of today is pervasive commercialisation, the risk of manipulation of the media, the rising influence of the commercial transnational sector on policy and the anxiety of contemporary man in the face of the need to be successful, healthy and beautiful. Lipovetsky (ibid) also notes that today only knowledge and information that can be used immediately is desired and that people are usually only interested in their own benefit and few are concerned with society in general.

From this perspective, new media art may be characterised as a response to the 'era of emptiness,' either in the form of a kind of convex mirror, or as a useful, sometimes aggressive counter-current. Many of the art projects that we have presented herein can be described as a 'Dada' of the hypermodern times. They are often characterised in the same manner as was the avant-garde movement of the early 20th century: by anarchy, seemingly irrational deeds, games or a seeming emptiness. Other times they are 'just' a way of creatively testing new possibilities offered by new information and communication technologies, and a means of playing with them. Often, the nature of the creative process remains the 'same as it ever was' with the 'old' media; sometimes, innovations in technology profoundly alter not only the final effect of the art, but also the creative principles and procedures used.

As Igor Zhoř (1992) observed, in the framework of the artistic field there are always three groups of people: the solitary ones standing outside any stream, artists relying on proven creative methods and developing their potential and finally, eternally dissatisfied creators, innovators, inventors and permanent discoverers of new possibilities who pave the way for other followers. The artists that we have presented in our article undoubtedly belong in the latter category among such pioneers. Thanks to them, the art field is further developing and responding to current opportunities, problems and challenges. The presented projects demonstrate a troubling side of modern life, and draw attention to its risks, but they can also bring smiles and joy. Many of them demonstrate that life in cyberspace, over which many wring their hands and moan about, can be filled with play, creativity, and true beauty.

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18. 3D Technology and its Application in Sculpture and Architecture

David Medek

The presented chapter analyses the applications of new 3D technologies such as virtual modelling, optical photometry, and mainly three-dimensional printers – that is, processes which can be included in the category of Rapid Prototyping. The text introduces new approaches and procedures employed in the process of making art spatial objects, while it simultaneously confirms the contribution of 3D technologies to the development of architecture and sculpture.

18.1 Introduction

An artistic expression – in this case, sculpture – has always been accompanied by the quest for new expressional possibilities, other materials or new technologies. In the 1980s, artists started to use digital technologies which enabled them to realise projects previously unfeasible. In the case of some fields of study the application of these technologies has become rather natural – e.g. photography, film, architecture. However, it has been almost impossible to imagine for quite a long time digital technologies to have any kind of impact on sculpture – such a classical art field determined by the use of material.

The medium of a sculpture is characterised by its three-dimensional nature and the tactile quality connected with it. At the general level, we distinguish between a sculpture made from soft materials by modelling the material and subsequent casting, and a sculpture which is conversely made from the process of carving – the removal of solid material such as stone or wood. However, in the past thirty years, a new work procedure has come to the fore. Objects and sculptures are produced by virtual modelling, that is, they are not created haptically but on the screen of a computer with the help of 3D programs managed by an expert or artist.

So what are the tools that sculptors working with virtual space can use today? Primarily, these are specially designed *programs* that enable them to create intangible sculptures and objects, as well as *NC machining* which basically facilitates the transformation of virtual objects to materials, though with certain technological restrains. Another tool is a spatial 3D scanner which transforms finished objects or volumes into digital, intangible forms whereby they can be amended or altered directly in the computer. The biggest advancement for artists working with volumes yet is represented by spatial printers which enable them to transform their designs – made in spatial programs – to a tangible form. However, those printed objects also have their limitations given mainly by the size of the printed area of the 3D printers and by the price of the printing.

As shown by the development through which sculpture has gone since the arrival of modern times and especially during the second half of the 20th century, it can be created from 'almost anything'. It was in this period, in which it gained a new autonomy independent of the particular place, leaving its traditional depictive, cult, and celebrative function. From the beginning of the 20th century, two basic movements came together in the area of sculpture: figural – which respects traditional sculpture procedures, and avant-garde – which systematically departs from long-lasting conventions and employs new creative techniques. Many sculptors of the past century tended to depart from traditional themes and implement new materials and new work procedures into their production – including those connected to new technologies.

In the recent years, it is digital technologies, or more precisely, 3D technologies including Rapid Prototyping – fast modelling – which have been promoted the most in spatial art. Is this new technology, new approach to sculpture just a fad or is it a new impulse for a stagnating art field? We have attempted to answer this question based on research in modern art while focusing on Czech art production in the context of the international art scene.

18.2 Digital Technology in the Context of Art Theory

When trying to interpret and theoretically explain digital sculpture, the theory of Walter Benjamin is often mentioned in which he saw a link between new communication technologies and the decay of artwork's aura. In his essay *The Work of Art in the Age of Mechanical Reproduction*, Benjamin attaches aura to iconic historical objects as their immanent quality. The aura that surrounds a work of art is not a direct result of the artist's creative talent – it is created

by the work itself being placed in time and it expresses its ability to reflect its own history as a material object. Benjamin emphasizes the origin and history of the ownership of an artwork as the source of its aura authority, which has nothing in common with the transformation of the artist's idea. The value of an artwork is thereby given by its history and the awareness of the public about the history. Aura in this sense has the function of a tool legitimizing traditional social functions and relationships. In his key thesis, Benjamin maintains that mechanical reproduction comes between the relationship of the mass public and the historical dimension of an artwork whereby it destroys its aura.

Miroslav Klivar, the pioneer and theorist of Czechoslovakian computer art, repeatedly addressed the issue of digital technologies application in art making in his essays from the 1960s and 1980s. He often came across fundamental and today still topical questions such as: What is the relationship between cybernetics and fine art? Can we refer to the products of machines as artworks? Can we perceive processes in a cybernetic system as artworks? Is an artist to become a mere operator of these machines? (Klivar, 1963, p 430) He also makes reference to the mathematical concepts of John von Neumann from the beginning of 1950s in which he foresaw machines which reproduce themselves. Six decades later, Josef Průša developed self-replicating 3D printers RepRap by which he made these prognoses come true. Even though Klivar's study is mainly focused on non-spatial art, especially on painting, his theses addressing the issue of machine-generated art open up questions of universal nature such as the practical role of a machine in an art process, and the perspective of a human being to be replaceable by a computer in this process.

18.3 3D Technologies: A Break-through in the Sculpture Tradition

The development of sculpture as an art field is dependent on the search for new materials and technologies. It was because this classical discipline was caught in certain stagnation in the 1950s that a lot of sculptors moved away from it and began to focus on installations and actions. A significant impulse for sculpture came from technologies used in mechanical engineering, design, and other fields. The technology was introduced into the practice under the title of Rapid Prototyping, which refers to a complex of technologies used in the production of prototypes by means of computer programs and 3D printing. While ten years ago, only a few American and European universities included this technology in their curriculum and only a few art studios applied it to their art making procedures, today we can see the growing impact it has on the work of sculptors across the whole world.

Among the technological processes used by virtual sculptors and the outcomes of their work include:

- *virtual sculptures* – these are sculptures created in 3D programs and which can be viewed only on a computer screen; it is also possible to print out the image of the object. The final product is 2D.
- *NC machining* – virtual sculptures which are produced by means of the above described process and subsequently milled into various materials (stone, wood, metal, etc.) by NC machines. It is the process of materialising a virtual image by way of creating a sculpture.
- *printing of image on a three-dimensional printer* – a virtual image from a computer is printed as a spatial tangible object. First printers work with non-stable material, cellulose or wax; such prints can be formed and cast in bronze. Contemporary prints can be realised in materials of common use such as plastic or metal.
- *spatial scanner* – one of the significant advancements in virtual sculpture which makes it possible to place a spatial image of a particular object, sculpture or organic matter (such as a human body) into a three-dimensional space.
- *spatial printers with ABS material* – prints from this printer are made from hard plastic; a hot head of the printer melts the plastic in regular rows and layers. Full objects have a honeycomb structure which makes them so hard that they can be used as final products and not only in sculpture. These are commonly used in engineering for testing joints, complex gears, or the correctness of shape.

18.4 The Application of 3D Technologies in Architecture

Architects were the first representatives of art professions using virtual modelling. It was architecture where – compared to other art fields – the most

intensive development of the given technologies took place. In the middle of the 1970s, a group of deconstructivist architects led by one of the contemporary 'star architects' Rem Koolhaas was formed at the London's Architectural Association, School of Architecture. Another centre of this various movement was established in California where the architect Frank O. Gehry performed his first experiments.

The Gehry Guggenheim Museum in Bilbau in Spain (1997) is an architectonical sculpture of its kind. The central atrium reaches the height of 55 metres and dominates the structured unit of the building as an abstracted metal flower. The project was processed by the computer program CATIA designed for the construction of planes. Virtual modelling programs offer several ways in which to arrange space one of which is working with area. This area is variably formed, bended, broken (refracted), or deformed. One of the key advantages of such computer modelling is its connectability to other programs which perform statistical calculations.

A representative work which was created on the basis of the given procedure is the project of the 'architectonical sculptor' Santiago Calatrava whose expressive railway station hall was built astride an existing TGV (high-speed train) track adjacent to Lyon-Saint-Exupéry airport in Satolas in France (1989-1994). This construction proves that steel in the combination with ferroconcrete can, in the computer era, quite perfectly resemble organic forms, in this case a bird about to take off. Calatraya's dynamic projects full of visual tension and constructional bravery iconically demonstrate the possibilities which 3D technologies have had to offer since the 1990s.

In the past decades, the boundaries between individual architectonical tendencies have disappeared bringing the styles together in various projects whereby making it impossible to perceive them in terms of individual styles. We can see the merging of shape deformations, and inclined, convex, or concave walls. High-tech architecture drawing on constructional technologies used primarily in the area of aviation and cosmonautics, as well as on the possibilities offered by computer programs have influenced the establishment and development of architecture of deconstruction which denies traditional tectonics and its horizontal and vertical system. It interferes with its right-angle rule and therefore with its optical balance, which up to then had been the fundamental attribute of architecture.

Both traditional and new expressive tools are now placed in unprecedented configurations; architecture – similar to sculpture – is enriched by the development of the newest technologies and materials as well as by the transformations in the ongoing project processes. The main role in this process is played by computers – not only in terms of individual project methods but also in terms of developing new complex architectonical forms without which many of the contemporary projects could not come to existence. More complex shapes of buildings are modeled as sculptures, which was previously unthinkable for it was too demanding, expensive, and difficult to accomplish. It is thanks to computer processes in projecting and their integration with more advanced technologies that these constructions are rather common in today's global context. The main requirement is the ongoing development of the potential possibilities offered by architecture in connection with computer and construction technologies. New technologies enable unprecedented development of the so-called organic architecture whose representative was Antoni Gaudí, among others, for his application of traditional project and construction procedures.

18.5 Architecture in the Age of Digital Media

In the last third of the 20th century, architecture became essentially the first art field which was gradually penetrated by designers working with digital technologies in the scope of technical disciplines namely the aviation and car industry. As early as in the 1970s, two architectonical groups of international importance and with conceptual practice that employed digital technologies were being established. The first one – Office for Metropolitan Architecture (OMA) – was formed in Rotterdam in 1975 and led by Rem Koolhaas and Eli Zenghelis (the cooperation of the two architects started at the beginning of the 1970s at the Architectural Association, School of Architecture in London where Koolhaas studied and Zenghelis lectured). The second architectonical group, whose members began to interlink computer technologies with the process of architecture projecting, was established in California around the architect Frank O. Gehry. Architectonical nomenclature attached to the constructions which were designed – and sometimes realised – by the members of both of the above mentioned groups corresponds with the style of the then postmodern period: deconstructivism. Buildings, the shapes and construc-

tions of which were designed with the help of computer technology, appear in reality as accidental compositions of various parts with irregular geometric or deformed forms connected in one whole that often stands out for its visual rather than architectonical expressive properties. Expressivity of these constructions is also increased by elements which were not used until then and which are typical for deconstructivism – these are mainly angle transfers and the rotation of parts of the constructions, irregular lines, divergent tendencies, significant rebounds, and sharp angles. It is possible to conclude that high-tech architecture, which makes use of new construction technologies borrowed from technical disciplines as well as the possibilities of open computer processes, have triggered the establishment and development of architecture of deconstruction which denies traditional tectonics and its fundamental attribute, that is, a horizontal and vertical system.

When looking back, the architecture of deconstruction created via digital projecting appears as a springboard for contemporary, unusual, and increasingly popular connections between traditional and new expressive means which is the result of the massive development in the newest technologies and materials but also of the changes in the project process in which computers play a decisive role in terms of creating new complex architectonical forms and spatial relations. In his study *Příběh architektury digitálního věku* (*The Story of Architecture in the Digital Age*), Jan Benda brings a fitting description of today's situation of spatial concepts in architecture. According to him the process of constructing is no longer the art of mutual concordance between two bricks (Mies van der Rohe) but it is becoming the art of mutual concordance between two bits (a bit – a unit of information). He maintains that architecture of digital age can be characterized as architecture which is based on the principle of generating architectonical space in contrast to the modernistic definition of space. The process of creating space is the key to the understanding of its quality, character, and also the principles on which it is based.

Digital technologies have grown in rather unusual popularity in architecture. Not only is their revolutionary impact difficult to formulate today, it is also difficult to predict its future development. It is because each of the new experiments seems to be – considering the ever-so-rapid development – only a mere static point which in the moment of its formulation is already 'outrun' by the new status quo.[67]

It is clear that during the past decade, architecture has been subjected to several radical changes – not only in its expression but also in its spatial concept. As Jan Benda points out, it is the institutional grounding of the profession of architect and the field itself that has also transformed significantly. As he explains, subjected to a change was not only the architect's studio but also their work procedures, and to a great extent also construction technologies, the way houses are built, and the relationship to the application of construction material. Furthermore, also architectonical journals and the issues they address on the pages of the journals have also been impacted by new era. However, the introduction of digital technologies to the process of project making and their impact on the future development of architecture has brought many positive aspects. To name just a few: rapid conceptual solutions and the ability to create matter images in an almost infinite number of varieties, optimisation of each such solution in terms of static, technological and material properties, error minimisation in comparison to the traditional project work procedure, and the possibility of creating unique – often very unusual and dynamic – structures of architecture.

Other advantages of digital technologies in architecture are also the possibility of forming the shape of a construction with a computer simulation in all possible directions while focusing mainly on the visual parts to be optimal (including occasional aesthetic deformations). It is undeniable that the process of project making with the use of new technologies – and in the case of spatial models also with new materials – is much faster and more effective beyond any comparison with traditional methods. When processing a particular architectonical design or art construction project, the final form depends not only on the unique concept of the author of a parametric design but also on the ability to use an enormous amount of data, information, and images which will inform the final character of the work.

[67] It is difficult to define the scope in which new technologies are used in architecture. However, exemplary use of digital technologies in the design of architectonical objects and urban units can be found in the work of the world-known architects: Zahy Hadid, Frank o. Gehry, and Santiago Calatraya. Their works could not materialise without the symbiosis of 'technology and art'.

However, the architecture of the digital age keeps on searching for a general image – not only an expressive one but also a technological one because a new spatial concept still lacks an adequate construction technology for its realisation. The laws of gravitation, accessibility, and the prices of construction materials and technologies constitute the greatest limitation on contemporary development in architecture. The fundamental issue is not the design of particular projects but in their practical use. In other words: the problem is not necessarily posed by the technology but by society. To borrow a metaphor from the world of digital technologies: the problem is not to modernise 'the hardware' of the construction of new houses, roads, infrastructures, etc., but their use, that is, their users. The modernisation of 'the software' – in this case of the traditional thinking – is a far more complicated issue, the solution of which will be a long-term process.

Contemporary architectonical structures and spaces which are created with digital technologies also represent certain negative aspects. One of them, though it disappears in the plethora of shapes and forms, results from the contemporary visualisation in 3D space which enables the imaging of constructions and their part and details from such points of view in which a viewer can never place themselves. Such visualisations, whose practical and technical application (especially in terms of imaging details) cannot be denied, can however lead to distortion of the real perception; the reference is made mainly to view imaging. However, we cannot forget that real changes are at this moment, regardless of the optimism which contemporary architecture designed with digital technologies emanates, coming rather slowly and gradually. However, new spatial concepts also influence the traditionally produced constructions, if only at the level of highly advanced construction technology. The situation of 'the architecture of the digital era' is well evaluated by Jan Benda, who believes that the rapidly growing myth of digital technologies which, on one hand, promise almost miracles while on the other warn about global dehumanisation of the contemporary world, the loss of local qualities, and the diversity of ecosystems, certainly poses extreme ideological antipodes. And it is here, where we could find the importance of contemporary architecture, which is formed partly by the balance of digital technologies and partly by a particular dignified humanity in its works.

18.6 Mathematics as an Inspirational Source of Art

The Rapid Prototyping technology gave rise to many constructions which could be included in the category of 'technical art'. Essentially, these are spatial mathematical fractals and equations. Digital processes also enable us to create forms derived from ultrasounds or other related technologies. One of the founders of the given field is the mathematician George W. Hart. His artworks are characterised by complexity and visual appeal – they are figures assembled from fragments of the same forms comprising parts that are gradually decreasing in size. In fact, these are redundant forms of two-dimensional rotations, studies of geometric properties and spatial relations which are not influenced by an ongoing transformation of the shape, size, and value of given objects. The author works with these models intentionally to demonstrate to his students the way mathematical relations appear in space. These objects are accessible on the author's web pages where they can be printed for free on a spatial printer. The author's own works of art are somewhat different and are defined by his own input and thus protected by copyright.

Similar principle to the one George W. Hart uses in his work can be observed in the work of Bathsheba Grossman who sees the reason for her approach to object/sculpture making in her deep feel for order in three-dimensional space in matrix geometry. The base of each of her work is a symmetrical image dressed in a modelled form which underlines interesting aspects of configuration. Her works are characterised by hundreds of round geometrical shapes which the author subsequently subjects to 3D imaging programs. Her first works could refer to renaissance perspective studies or to the work of Maurits Comelis Escher, to Russian constructivism or op-art. However, in her contemporary works Bathsheba Grossmann partly moves away from prints as final outcomes. The author uses the models made by the Rapid Prototyping method for works which are in the final stage realised using classical materials (such as metal) which are evoked by delicate object jewellery.

Another significant figure in digital sculpture inspired by exact sciences is Kenneth Snelson who reflects his thoughts on the structure of the atom in his work. His work, which has a speculative touch to it, resembles the scene of an orbit of electrons at the quantum level. His work is based on subjective

readings of scientific theses, the evidence of which are also his monumental works accentuating elegance, the harmony of forms, and relations. The accuracy of mathematical terms imaging is relevant; the author operates with exact data which he transforms into polyhedrons which are commonly very close to natural expressions of environment as they are realised by means of repeated regular forms. This procedure is typical for a broader group of artists who work with 3D technologies and use 2D forms which they subsequently transform in a space – 3D software offers distorting and twisting of geometric forms at many levels.

18.7 The Combination of New and Classical Technologies in the Area of Sculpture

Many sculptors cannot imagine creating sculptures without a haptic experience with classical material such as clay, wood, stone or metal, and without a direct physical possibility to form the origins of the work. Nevertheless, sculptors are fascinated by new technologies. This is mainly because they enable them to put their work into a new context and a new visuality. When using digital technologies in sculpture, the procedure which prevails is the one in which the author first makes the object from classical material (clay) or uses a previously created one, and by means of optical digitalisation subsequently transforms it into computer data which he/she amends or processes into more precise detail if necessary. Using a CNC blade machine or 3D printer, he/she then transforms the digitally amended object back into its real form. A representative of such an approach is a Czech sculptor Michal Gabriel. The following text will introduce the works of some of the many foreign digital sculptors.

The application of data and codes scanned into a computer in sculpture is an issue to which an American sculptor Ralph Helmick has dedicated much of his time. Some of his most famous works include the installation of *Jurisprudents* (2000) located in the Melvin Price Federal Courthouse in St Louis in Illinois. The work consists of two opposite spatial portraits which are made from more than three thousand copies of twelve miniature heads of common American citizens as the members of the jury. These twelve heads of jurors were firstly made in live size from clay, then scanned and printed in smaller versions. The work symbolises the reality, on which the legal system is based, that is, on the consensus of citizens – the voice of the people – whereby it makes reference to the fundamental function of the building where it is placed.

Another work, which was one of the first ones to be created with a digital printer, is the *Monument of Jackie and Mack Robinsons* for the city of Pasadena (1997) in California. This uniquely designed monument was created by Helmick in cooperation with his colleagues Stuart Schechter and John Outterbridge. The sculptors made a clay model which they subsequently scanned and the file was then sent electronically to a three-dimensional printer in another city where these were printed in two-inch copies of the originally clay-made models.

The above mentioned projects *Jurisprudents* and the *Monument of Jackie and Mack Robinsons* represent one of the revolutionary moments in the use of the Rapid Prototyping technology in the area of art. As opposed to the classical sculpture technologies, Rapid Prototyping offers electronic transfer of digital files enabling the sculpture to be printed directly in the place of the realisation as well as displayed and sold. At the same time, the issue with preparing the objects of sculpture is eliminated. Thanks to CNC machining, the sculpture can be printed, milled in marble, wood, or cast in bronze while every reproduction strictly reflects the original – whereby the loss of detail or incorrect casting due to the deformation or shrinking of the form (which can be caused by incorrect calculation or insufficient craftsmanship) is eliminated.

Another significant representative of digital sculpture is Robert Michael Smith who creates surreal spatial objects with significant erotic accent. Though it may seem that his work could be realised using traditional processes, the author explains that the virtual environment enables an author to experiment freely with universal organic forms. According to Smith, thanks to three-dimensional viewing of an object the author can develop their imagination fast and in parallel without being limited by the traditional materials. Many of his first virtual 'sculptures' were received negatively, others were further worked on by the author, however, only a few of his works were made in their definitive material. Virtual modelling of space is according to Smith much better then a sketch book mainly because objects can be observed and analysed from all angles. The scale, texture and colours can be modified. The author's work demonstrates the way in which sculptures can be further modified using various scales and subsequently realised in various materials including traditional ones.

It is rather controversial that in some parts of the world, human work is still cheaper than the use of CNC machines. Robert Michael Smith thus had his sculpture titled *Gynefleuroceptor* (2004) made in China. He sent the producer a digital model according to which the sculpture was made by workers from black granite, polished, and shipped to the USA. The production cost accounted for one fifth of the price for which the sculpture would have been made by a machine. We mention the work of Ralph Helmick and Robert Michael Smith intentionally in relation to each other, even though their work is rather different. Smith, who had only a few of his works printed as he mainly works with virtual objects, can be therefore categorised as a 'virtual' sculptor. His sculptures evoke certain randomness which is present in their origins – it reflects a notion of a somewhat heavy-weight computer forming without having a deeper concept in mind. When closely observing the artist's works, one has the feeling that the shape itself is generated by a computer while the author's only input is the selection of a particular shape which is then displayed or printed.

On the other hand, the work from the art studio of Ralph Helmick and Stuart Schechter is based on a conceptual principle. Their projects are based on ideas which could not be realised without the use of new technologies. The works of these two artists require mathematical accuracy, while computer programs represent mere tools which are capable of attaining such accuracy. The art works of Ralph Helmick and Stuart Schechter are linked to the work of Robert Michael Smith only by the way in which the authors use the Rapid Prototyping method. The method of work and technical parameters of the sculpture and its subsequent printing on a geographically remote place is essential for sculpture because it diminishes its uniqueness: it is not only the traditional sculpture procedures that get lost but also the gradual formulation of shape through a haptic experience.

Other of today's world-renowned artists who in their work combine classical and digital technologies are Keith Brown, Michael Rees, or Chris Bumett. These are artists who often find themselves between art fields and sculpture extending their reach into interactive installations, using hypertext and HTML, various visualisations, three-dimensional sculptural forms or other non-traditional forms of art.

18.7.1 Deformation in Digital Sculpture

The combination and permeating of elements of the inner space of the computer virtual world and data acquired by scanning and photographing of the outer reality has opened an infinite number of various forms and meanings for art. One of the movements of today's digital sculpture is focused on the application of various deformations. These artifacts are very interesting for viewers. Even though we already knew the transformation of a form in art from before, and are now quite familiar with it, the deformations in 3D technologies are different. They seem to make much more plausible appeal in the virtual space and in comparison to haptic modeling they appear to be much easier.

The professor Daniel Collins, who is based at the School of Art at the Arizona State University, goes as far as to provoke classical sculptors with his sculptures. Without the knowledge of the work procedure and method applied, his works may resemble superficial plays based on the effect of simple deformation. The projects titled *The Cult of Touch* (1999) and *Pointer* (1999) are part of the group characterized by digitally elongated arms that resemble expressionistic works of Albert Giacometti. The object titled *The Cult of Touch* is attached to a wall – it is a palm opened upwards in the middle of which rests a smaller version of a microscope. Collins began this work by casting his own hand to plaster which he subsequently scanned using a 3D laser scanner where the digital model was deformed mainly in its length. The sculpture titled *Twister* (2003) is Collin's auto portrait. The author had himself scanned by a spatial 3D scanner and when scanning his shoulders and head he turned around thus creating an accidental deformation. In his other work titled *I Can Not Tell a Lie* (2004), Collins pointed the camera at a deformed object in such a way as to be able to amend the deformation in the scanned version. Therefore the deformed head appears completely in order on the screen. The work thus makes a reference to the manipulation with information and reality practiced by mass media. In other variations to the objective reality, Collins plays with entry data – in the above mentioned *Twister* (2003), which was created by rotating a body on a spinning jenny and scanning it while in motion. Another experiment of his based on the work with data of scanned figures is a sculpture called *Forgetting Ourselves* (Sons and Mothers 1, 1995-1999). Using the scan of his own and his mother's bod-

ies, he had the computer generate a bust of a potential (incestuous) offspring. The author's strong feelings about the topic of genetic manipulation are quite apparent in this work.

The American sculptor Robert Lazzarini deforms and transforms objects of an everyday use turning them into an exaggerated perspective. Thereby he intentionally confuses the viewer and makes their perception of space and the displayed objects (such as violins, chairs, phone booths, and so on) much more complicated. However, his deformed skulls have made him famous the most. To increase the plausibility of deformed objects, he makes them from the same material as those in the real world: he makes chairs from wood, a phone booth from stainless steel and plastic, he casts a skull from a mix of resin, bone powder and pigment. The deformations are made in a way that does not offer a viewer any ideal point of view and so the object can never be seen as it really is in reality. In his sculptures, Lazzarini employs two fundamental types of deformation: distortion of perspectivity and the projection of a wave on the object. His work process starts with scanning an object using a spatial scanner after which he makes the deformation in a 3D application. Subsequently, he prints the model on a 3D printer according to which he creates the final version of a sculpture from the adequate material and in the desired size.

18.7.2 The Size Alteration as another One of the Virtual Sculptor Technologies

In the virtual world, it is easy to change the size of the displayed object using computer programs, that is, we can easily make them smaller or larger. However, for a haptic sculptor following a classical work procedure, it is still a very demanding task. Apart from the practical impact on the speeding-up of a creative process, the possibility to virtually change the size of the displayed object has also a great esoteric potential.

The American sculptor Ralph Helmick uses software alterations of the objects' size to create sculptural perspective. An object printed on a 3D printer is subsequently reduced in size by 95% and printed again. Helmick repeats this task until producing a complete sculptural file. Once objects printed in this way

are placed one after another, they evoke a perspective shortcut and they appear as though they are getting bigger the closer the viewer stands to them.

When combined with new technologies which can scan and select the 3D surface in a computer, 3D printers become part of the wider 'digital world'. 3D scanners that allow for the digitalisation of the object's surface, the transformation into an abundance of points and then to a geometric model in the so-called polygonal mesh are commonplace nowadays. Some of the machines are so large that they allow for the mapping of a whole human body. The files with scanned objects or parts of a body can be subsequently turned into a collage using a computer. 3D technologies thus turn the role of the traditional sculptor's craftsmanship into fantasy play, spatial imagination, and technical skills.

18.8 Conceptual Approaches to the Application of Rapid Prototyping Method

It is not only sculptors who benefit from the Rapid Prototyping method. It has offered 'new tools' also to conceptual artists. Using a group of selected works, we would like to demonstrate the various procedures and creative processes the Rapid Prototyping method facilitates. However, it is important to point out that the final work is not always tangible. Without the knowledge of the particular creative procedure employed for the production of a particular object, one can think that it is a sculpture which is an illusion represented, among others, by Karin Sander, and Michael La Forte. Some of the works are so specific that it is almost impossible for the viewer to see it was made using digital technologies such as in the project titled *Outside Itself* by Federic Díaz from 2011.

In her conceptual and sociological approach to work, a German artist Karin Sander uses the technique of digital sculpture excluding manual modelling. The author has made a series of figural portraits titled *1 : 10*, *1 : 9,6* and *1 : 7,7*. The names of the works refer to the scale between the actual size of a person and their reproduction. The depicted people were selected randomly, in some cases they were the author's friends. Karin Sander let the depicted people choose their own posture and clothing which, according to them, best express their personality and occupation. She then sent her 'objects' to imaging laboratories to scan them and print using the Rapid Prototyping method. The series titled

1 : 10 (1999) comprises a collection of miniature individual personalities each of whom could choose their own way in which they wanted to be laser-scanned. Laser scanning is an objective tool for data recording. A final sculpture is thus characterised by delicate and completely realistic details – from facial expressions to the folds of creased clothing.

Similar spontaneity in depiction is typical rather for photography. The work of Karin Sander refers to the work of August Sander who at the beginning of the 20th century mapped German society using photography; employing a similar technique, Karin Sander captures the profile of today's people. Because until recently, Rapid Prototyping processes did not allow for colour printing, Sander sent her sculptures to painting studio where anonymous artists painted them with colour according to the photographs taken simultaneously with the 3D scan of the body. Even though digital sculptures can be altered and improved, Karin Sander leaves their edges intentionally frayed only to explicitly show the digital process of their origin. Also her other work, *1 : 96* (2002) is based on the change of the objects scale made by the Rapid Prototyping method. The artist has also applied her conceptual approach in this work: she invited the visitors of Staatsgallery in Stuttgart, where the exhibition was held, to participate directly in the creative process, and in the art production in the broader sense. For the fee of 80 EUR, every participant could have their body scanned the miniature version of which was immediately donated to the gallery to be included in the permanent collection. The project titled *1 : 96* thus made it possible for every participant to have their image entered in the collection of a world renown exhibition gallery. Karin Sander offers an open space to all participants whereby she allows also those 'authors' who could otherwise never partake in the museum and gallery space to enter it.

The author is also engaged with the art of public space – using the Rapid Prototyping technology, she created a monument work titled the *Column of the Count Maxmilian von Montgelas* (1757-1838) who served as the Minister of Interior and Finance during the reign of the monarch Maxmilian Joseph, and who was considered the founder of modern Bavaria (this monument from 2005 was placed in Promenadeplatz in Munich). While the artist tried to avoid a realistic solution to this formal project, she managed to depict the traces of the statesman's portrait in an unusual way. She decided to eliminate any artistic interpretations, desiring to create a column in the contemporary sense of the word, the evidence of which is the fact that it was placed directly in the terrain without a traditional pedestal.

Karin Sander turned to Tebicon to have the scans and virtual data models of all Montgelas's busts existing in Germany done using the Athos digital optics. Subsequently, the digitalisation of all the statesman's living descendants dressed in historical costume was done as well. The artist next contacted SensAble to have the arithmetic average done of all the acquired data of all measured objects. The result was a virtual digital portrait of the count von Montgelas. The data was then given to Tebicon; however, at this moment these were still not the final parameters for the sculpture as Sander did not want the sculpture to have a smooth finish. The objective was to ensure that when looking at the sculpture from a close distance, it would be impossible to tell who was depicted in it. The image was to come together when looking at it from a far distance similar to pointillist paintings.

For the final realisation of the monument, the artist decided on a glossy aluminium material into which Tebicon (using the Tebis software) milled the final appearance of the count with the blade CNC machine. The object of the height of 6.2m could not be made all in one go, and therefore comprises 15 parts which are connected by a steel construction of the weight of 9.5 tons.

Another artist which also employed the Rapid Prototyping method in her project in public space – though this time 'in the service of the protection of nature' – is an American artist Elizabeth Demaray. She is the cofounder of the Conceptual Art Store.com where she also acts as a curator. At the same time, she also lectures at the Department of Fine Arts at the Rutgers University in Camden. In her work *The Hand Up Project* (2004), using CAD software she created miniature habitats for hermit crabs who lose their shells to take a larger one when growing. People who collect empty shells on the coast thus unintentionally deprive hermit crabs of their natural habitat. The artist made hard plastic shells in various sizes to fit the crabs well. She designed them in a way to create more space for the crab's abdomen inside the shell than the natural shells can offer (new shells are also much lighter). With her project, Elizabeth Demaray helped sea ecology, however, she did so using indestructible plastic.

This work is a free continuation of the work of another American artist Michael La Forte who used digital sculpture similarly in 1998 when he reconstructed tiny parts of urban space using digital objects. The subject of his reconstructions were objects such as a radiator (American Radiator Envelope, 1998), a door bell (Dixie Edwards, 1998), a light switch or fire hose, and other objects of everyday use which the author placed in real architectonical space. The objective of his work was almost invisible, subversive interventions into an exhibition area. His work thus called into question tangibility or intangibility of functional objects in today's virtual culture while they also re-interpreted the legacy of pop-art or the way Dada questioned the reality of things.

18.9 Rapid Prototyping in the Czech Context

The pioneer of the Rapid Prototyping method in the Czech Republic is the sculptor Michal Gabriel. He is based at the Faculty of Fine Arts at the Brno University of Technology where he holds the post of a professor and the head of the art studio of Sculpture 1. Furthermore, he is the first pedagogue in our region to implement Rapid Prototyping in art education. He got engaged with this technology as an experienced artist who has mastered all classical sculptural methods and procedures. Having experienced such a technique, he approaches new technologies with an attitude of seeing how he could benefit from them and how they could facilitate the advancement in his work. However, Gabriel's approach to artistic outcomes differs from those the artists we talked about in the previous part: up to now he has not abandoned clay as the fundamental sculptural haptic medium. In his work, he aims at connecting both of the worlds – the haptic one and the virtual one. Sculptures, which he creates applying a traditional approach are subsequently scanned and worked on in the virtual environment of a computer. A good example of such an approach is a work titled *Sigmund Freud*, for which the author first modelled and cast the sculpture and then scanned it. The scanned images were then made smaller and every other phase turned around to create a mirror image. Apart from adequately expressing the connotations associated with the founder of psychoanalysis, a new technology has provided an important technical aspect: it allowed for the author to avoid one of the difficult and unpleasant tasks which is for a sculptor to make their works smaller, bigger, or turn them into mirror images.

A similar procedure can be observed in Gabriel's intimate group sculpture titled *Ten Men for Five Women* (Deset mužů na pět žen) in which the basic figures get multiplied and their size altered. Similar yet compositionally more complex is the sculpture titled the *Birth of Venus* (Zrození Venuše) which is a multiplied figure of a woman which is gradually coming up to the foreground from a right-angled base. These effects are viable precisely thanks to the possibilities offered by the Rapid Prototyping method which the author confirms when he explains that he has created many sculptures which would not otherwise be possible to create had he not chosen classical sculptural procedures by which to make them. As he says he would have abandoned them immediately from the start as he would have considered them unfeasible. The work of Michal Gabriel shows the way both levels can be practised, that is, both haptic and virtual modelling (some of the artists mentioned previous had already moved from sculptural art studios to computer offices).

The boundaries of computer modelling are also being broken down by the sculptor Tomáš Medek who works as an assistant at the Sculpture Art Studio at the Brno University of Technology. Medek also holds the post of the head of the 3D art studio which was founded in 2007 as the first studio of its kind at an art school in the Czech Republic and as the second one in Europe. The purpose of the studio was to research into the possibilities of digital technologies application in sculpture. The centre of his works lies in the analysis of spatial structures and the characteristics of inner space. He uses Rapid Prototyping to express himself more profoundly in his work and to materialise the observed themes. Technology suits his work so well that it almost looks like it has been designed especially for his works. It helps Medek to form ever so perfectly and continuously more complex structures. In his object titled *New Cube* from 2006, he even went so far as to create such a complicated structure that the print software had to be especially adjusted in order to be able to print the work.

In his work the *Monument of Thomas Alva Edison* placed at the Moravské square in Brno (2008–2010), Medek used the principle of a polygonal mesh

to emphasise the transparent nature of bulbs. However, the polygonal mesh was not generated by a computer as is the case with Antony Gormley's object titled *Exposure* the preparatory studies of which named *Body – Space – Frame* were created in years 2005–2007 and which have been placed at the edge of the lake Zuiderzee in Holland. It was the artist who made the mesh and thus created a much nicer structure – both in terms of density and the size of the fields. This method for spatial structures creating has already been proven previously in the objects named *Tangerine* (Mandarinka) (2000) or *Banana* (Banán) when the Rapid Prototyping technology was not available yet. After the year 2000, the structure of Medek's sculptures was loosened into amorphous shapes, and organic shapes inspired by flora have begun to be present in his objects. He called this serious of works *Nature (bio) Insights.* The starting theme was taken from nature – a pepper, a pumpkin, a pattypan squash, a banana, a mussel, the macrostructure of a seed or a pollen grain – was abstracted by the author into complex shapes with rib-like structures inspired by triangular or square spatial meshes of computer 3D technologies. These works were the first stage before 'real computer sculpture'.

One of his latest projects is a sculpture titled *Twins*. The object of the size 120 x 90cm was printed on a Czech-made 3D printer. Due to the fact, that there are no printers of such a size available in the Czech Republic, the artist cut the work into 360 smaller parts which were printed one by one. The artist subsequently assembled and connected the printed parts. He also applied putty, polished the object and sprayed it with coating so that viewers cannot tell it is a 3D print.

The work of Tomáš Medek is not the result of mere virtual modelling of a selected object – the majority of his works originate from an organic object which is then transformed into a computer by a spatial scanner and further worked on, adjusted, shaped, and deformed while being thoroughly analysed. The created structures are therefore not only computer outcomes but primarily they are the results of time-consuming precise work with complex and intertwined meshes.

Another artist belonging to a younger generation of visual artists employing the Rapid Prototyping method in their work is Helena Lukášová who completed her studies in sculpture at the Academy of Fine Arts and Design in Bratislava. Between 1998 – 2003, Lukášová studied at the Johnson Atelier – Technical Institute of Sculpture in New Jersey where she consequently worked as an assistant to clients when realising sculptures in a foundry and stonemasonry. Apart from traditional procedures, this institute also works with CNC machines the operation of which the artist mastered during her practice in the institute. Since 2003, the artist has worked at the Department of Computer Design at the Masaryk University in Brno.

When making objects by virtual modelling, Lukášová applied a rather different procedure as opposed to her colleagues – digital sculptors who deal with the theme of figures. Her objects are based on the interconnection of the world of the imaginary and the real. As she explains in her dissertation, she is not trying to resemble the real world in her work, that is, she is not using the approach so typical for contemporary 3D programming tools application. Her intention is to find a new world which she searches for herself and which is openly digital. For her, the relationship between the virtual and the real is a synonym to the relationship between the mental image of the world that we create and the real one we live in. A computer is a laboratory, and a software tool is the description of mental procedures, the outcome of which is a work which is yet to find out how it will be articulated.

Her cycle titled *Jelena* is typical of this. Actually it is Lukášová's alter ego, into the technological core of which she draws a human dimension. The name of the being is an alteration of her first name which is not a coincidence because this being also bears some of the author's younger age features. Lukášová makes a number of Jelena's variations. These humanoids, as she refers to them, were born in the bowels of the computer. They communicate, sleep, take care of little ones, fly around and live in their parallel world. In the render called *In my Skin* (V mé kůži), the author uses her virtual being who she dresses in her own skin by means of photographs depicting the surface of her real physical body.

Jelena is the leitmotiv of Lukášová's work – the author makes complex compositions which she labels Landscapes, and into which she incorporates beings-Jelenas. These miniature and imaginary islands are occupied with people-Jelenas and other 'animals' which are connected by mutual symbiotic relationships. The scope and precision of 3D print forms a complete sculptural object which

can make reference to historical alabaster sculptures. The theme is still topical for Helena Lukášová: the surface of Jelena the figure carrying an offspring behind her neck was transformed into a smooth structure which resembles a spider web; the figure of Jelena itself appears as if growing up from the ground in a way that the smooth structure of the surface of the sculpture resembles capillary action with sap or nutrition flowing into her from the ground. After the symbolic link to animals, the virtual being of Jelena thus enters into the relationship with nature. The artist introduced this object in 2013 at the international event of 3D Print Shows presenting spatial prints and their applications in art (London, Paris, New York).

However, she decided for a different approach in her work titled *I'm Venus* (2013). It is a conceptual project in the scope of which sculptures of Venuses are created by way of applying other technology to virtual modelling: the volume of these sculptures is made by the movement of the hand on the very own body of the artist, which is recorded and transformed to computer. The author uses her body as a template for making a series of women. To realise this project, the artist cooperated with Jiří Chmelík from the Faculty of Informatics at the Masaryk University in Brno who developed the VEKVA system and governed its origins in terms of technology.

By way of conclusion it is natural to say that 3D technologies, that is, virtual modelling facilitate a completely new approach to art objects making. They also bring a revolutionary understanding of the work which had been unthinkable up to now. Furthermore, they allow for creating new constructive solutions. Even though the works are usually sculptures or spatial objects, new technologies have an effect on every art field, regardless of the fact that only a few actually employ them in their work. Only the future will tell us whether this new approach to sculpture brings new impulses for the development and application of new technologies and whether it is worth dealing with the Rapid Prototyping technology on a broader scale.

19 Body Motion Visualisation

Jiří Chmelík, Anna Ronovská, Štefan Novosad

In this chapter, we summarise historical as well as more recent approaches to visualisation of human body motion. We briefly address the modern art history and introduce some of the pioneers in body motion capture and visualisation using both technical and artistic approach. We also present two novel approaches to visualisation of human body motion. While the first technique uses low-cost body tracking sensor and creates primarily 2D images, the second technique is based on high-end motion capturing equipment and generates 3D outputs. Both techniques works in real-time and can track one or more users. For both of these techniques, we present short description of technology and visualisation options, along with discussion of possible art applications. At the end of the chapter, we present selected results.

19.1 Introduction

The purpose of this chapter is to focus on visualisation of body motion. This dynamic field of computer technology tends to cooperate with both art and education, trying to explore possibilities of new visualisation and of new approaches to art processes. Also in education we can see many interesting works, ranging from video simulations of human body motions to creative application in art projects.

Human body motion is a subject of research in several fields – medicine, sport, and even criminology (gait analysis). Body motion is also an essential part of many artistic activities such as dancing, theatre, performance art. In all ages, performers such as dancers and actors have used their bodies as the foremost element of their creations. In contrast to painters and sculptors, they use the corporeal form in their work. Regarding their art as being 'real time' experience, unrepeatable and unique in time, they always have been solving the problem of making their motion art recorded. The capturing of elusive events has been dependent on technical possibilities of certain era of human civilisation (drawing, painting, literature, photography, chronophotography, cinematography, motion capture, video, visualisation). Thanks to the progress in digital era, artists

are offered more possibilities of motion visualisation, featuring not only aesthetics, but even more scientific aspects of body motion. Digital tracking of motion offers large field of investigation, extending to ecological psychology, perception psychology, memory studies, creativity studies, media studies, biomechanics, semiology, and the history of ideas.

Just like the composer and performer Joseph Rovan maintains about his project with dancer Ami Shulman in his text titled 'Let us imagine a straight line', exploring movement, motion, philosophy, and science:

'I've learned so much about movement during this process of working with Ami and developing these filming techniques. To come up with a way to capture something that, in a sense, has an analytical quality and also a beauty ... balancing those has been an enlightening project, which will definitely affect the rest of my work. This has opened a window about human movement and how one can translate it into different media forms.' (Rovan, 2012)

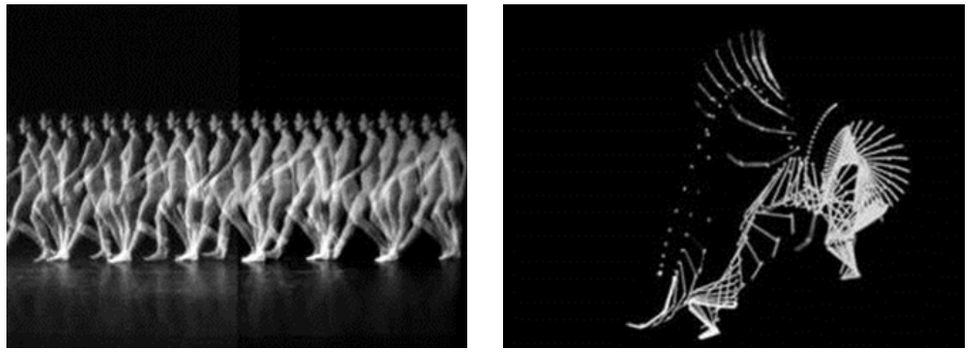


Fig. 1 Movement analysis – Chronophotography of dancer Ami Shulman walking, Montreal, July 2009. A movement analysis of *a* jump, a still image of dancer Ami Shulman.

19.2 Theoretical Knowledge of Motion

The focus on aspects of principle concerning human body movements increases the empirical and theoretical knowledge found among stage artists such as William Forsythe, Jerzy Grotowski, Doris Humphrey, Vsevolod Meyerhold, Daniel Nagrin, Yoshi Oida, and Mary Overlie, as well as among movement specialists namely Moshe Feldenkrais, Erving Goffman, and Rudolf Laban. (Jan-Gunnar Sjölin, 2011)

For example Rudolf Laban's choreosophical studies include a graphic approach to movement analysis, and an analytical approach to dance-movement based on an understanding of human motion as a collection of fixed points in a movement continuum. Central to this approach is the idea that movement can be captured graphically for its analysis via different techniques of graphic representation: including drawing, 3D modelling, graphs, diagrams, and notation. Graphic models play a key role in the development of Laban's theory of harmonic space. Based on a series of geometric and topological models, Laban was able to develop a material method as part of his creative research on movement analysis. Laban's graphic approach encourages the use of visual media and technologies of graphic inscription as inventive methods for the better understanding of movement, which is why Laban's thinking can be adequately reconceptualised using technologies such as video and motion capture. One of Laban's most fundamental and yet least known material models 'the spheric form' presents a much broader understanding of Laban's movement analysis as a form of material thinking, and not only within the context of dance-training, but as part of a vision of the dance that is complete in its philosophical perspectives, and which Laban calles choreosophy. (Sutil, 2012)

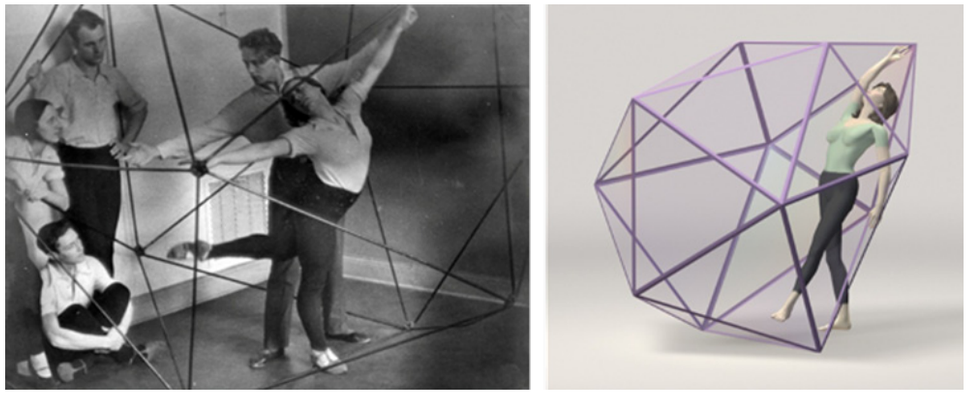


Fig. 2 Rudolf Laban's *Icosahedron*, a part of his theory of movement analysis.

19.3 History of Movement Visualisation

19.3.1 Pioneers of Chronophotography

Chronomatography pioneer Eadweard Muybridge (1830–1904), a brilliant and eccentric photographer, gained worldwide fame photographing animal and human movement imperceptible to the human eye. Hired by railroad baron Leland Stanford in 1872, Muybridge used photography to prove that there was a moment in a horse's gallop when all four hooves were off the ground at once. By 1878 Muybridge had successfully photographed a horse in fast motion using a series of twenty-four cameras. Muybridge used a series of 12 stereoscopic cameras, 21 inches apart to cover the 20 feet taken by one horse stride, taking pictures at one thousandth of a second. The cameras were arranged parallel to the track, with trip-wires attached to each camera shutter triggered by the horse's hooves. Several of his photographic sequences were published in 1980 as coffee-table books under the title *Studies of Animal Locomotion*.

Hoping to capitalise upon the considerable public attention those pictures drew, Muybridge invented the Zoopraxiscope, a machine similar to the

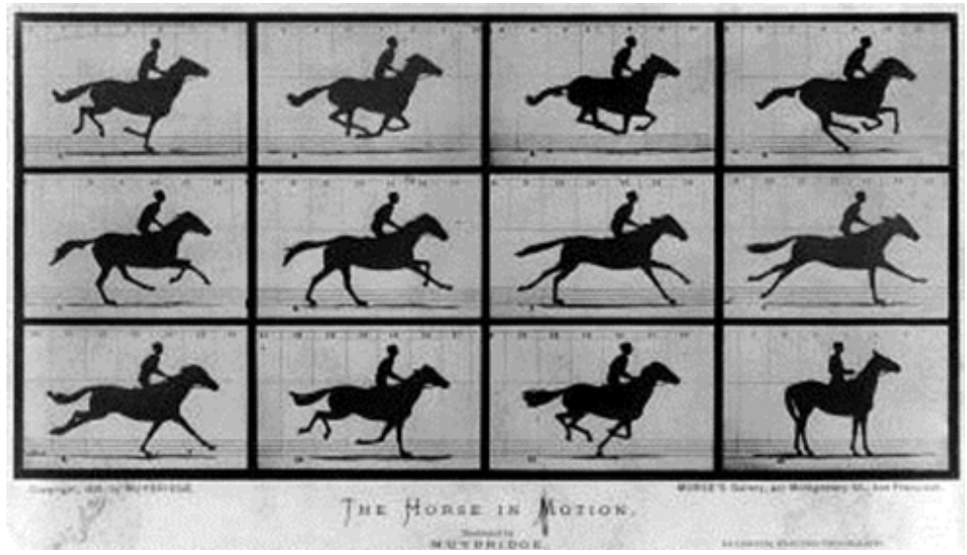


Fig. 3 Eadweard Muybridge: The Horse in Motion, 1872.

Zoetrope, projecting images in a way so the public could see realistic motion. The system was, in many ways, a precursor to the development of the motion picture film. His presentations, in Europe and the United States, were widely acclaimed by both the public, and scientists and artists. For 100 years, historians considered these photographs to be scientific studies of the body in motion. (Solnit, 2003)

The other great mind of late 19th century France was Etienne-Jules Marey – a scientist, physiologist and chronophotographer. His respective visions of motion and time and efforts to measure a beating heart and to capture birds in flight produced the technologies that led to the modern cinema. Marey started by studying blood circulation in the human body. His revolutionary idea was to record several phases of movement on one photographic surface. In 1890 he published a substantial volume entitled *Le Vol des Oiseaux* (The Flight of Birds), richly illustrated with photographs, drawings, and diagrams.

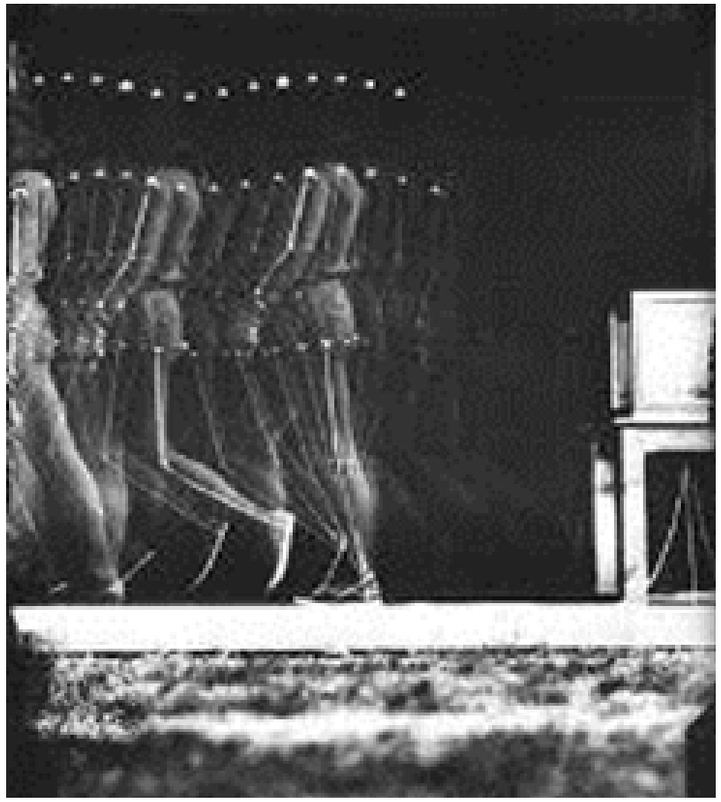


Fig. 4 Etienne-Jules Marey: *The Man Walking*, 1890.

19.3.2 The Impact of Motion Capture on Modern Art

'We declare that the splendor of the world has been enriched by a new beauty: the beauty of speed. A racing automobile with its bonnet adorned with great tubes like serpents with explosive breath ... a roaring motor car which seems to run on machine-gun fire, is more beautiful than the Victory of Samothrace.'
The Futurist Manifesto, 1909

Art created before the 20th century consisted of mostly landscape and portrait paintings. The beginning of the 20th century was a revolutionary time in the history of art, with modern artists for the first time trying to come up with new and often avant-garde ways to capture images on a canvas. The futurist movement in particular was dedicated to capturing both time and motion in art, creating paintings of movement. (Shabi, 2013)

Partly a Cubist, Futurist or Readymade artist, Marcel Duchamp dabbled in many different modern art movements and was responsible for a very good

Fig. 5 Giacommo Balla: *Flight of the Swallows*, 1913.

example of a Futurist painting of implied motion and time titled *Nude Descending the Staircase* (1912). As can be observed, Marcel Duchamp offered his own interpretation of Muybridge's *Woman Descending the Staircase*, with the abstract form of the naked woman identifiable as she moves down the stairs in the painting. (Shabi, 2013)

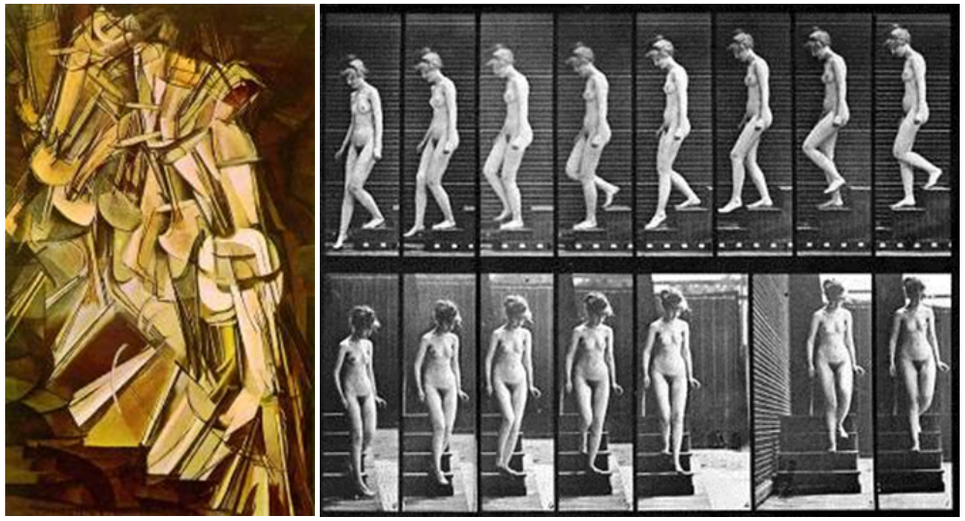


Fig. 6 Marcel Duchamp: Nude Descending the Staircase (No. 2), 1912.
Fig. 7 Eadweard Muybridge: Woman Descending the Staircase, 1891.

19.3.3 Body Motion Visualisation and Dynamic Technology Progress of the 20th Century

There are several basic approaches to visualisation of motion: static (photography, pictures) and dynamic (film, animation). Artists and dancers have been using camera to catch the moment of their performance whereby they have created a specific form and type of photographs, which range from artistic dance photography to performance documentation, and study of movement.

'There is something paradoxical about the link between dance and other visual arts. Dance exists not only in three dimensions, but also along an arc of time. Unlike paintings or sculptures, which sit still long enough for us to study and observe them, dance keeps moving.' (Lyman, 2014)

Furthermore, in experimental art of the second half of the 20th century, there are a lot of examples of using movement as a language of art. Artists started

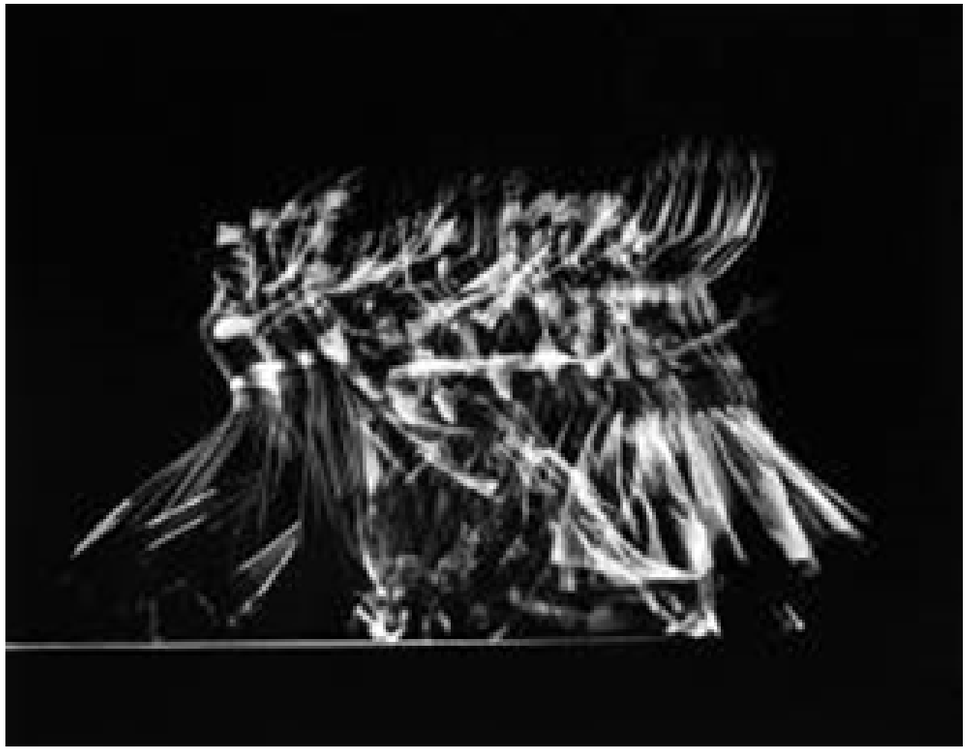


Fig. 8 Martha Graham Dance Company 'Dance', multiple image of choreographer Martha Graham performing her own work at Mili studio, 1941.

using new technology such as a video and film in artistic way: to document and record performances and happenings (Fluxus, Joseph Beuys, Bruce Naumann), or to place the phenomenon of movement visualisation at the centre of their art work (Bill Viola, Nam June Paik, Vasulkas).

In his work, Bill Viola uses ultra-slow motion video, encouraging the viewer to sink into to the image and connect deeply to the meanings contained within it. His art deals largely with the central themes of human consciousness and experience – birth, death, love, emotion and a kind of humanist spirituality.

Experiments with movement of his own body to examine the parameters of art and the role of the artist were recorded between 1966 and 1968 by American artist Bruce Naumann (*Walking in an Exaggerated Manner around the Perimeter of a Square* – 1967). He began using his body to explore the particulars

Fig. 9 Bill Viola: The Raft, 2004.

of space, notably in the 60-minute film titled *Wall-Floor Positions*. Here, Nauman executed various body positions within his art studio to investigate psychological states and behavioural codes. Since 1968, his performances has consisted mainly of performance films such as *Bouncing Two Balls between the Floor and the Ceiling with Changing Rhythms*, or corridors and installations involving a limited degree of viewer participation and exploring effects of parallax, audio-tactile separation, disorientation, etc.

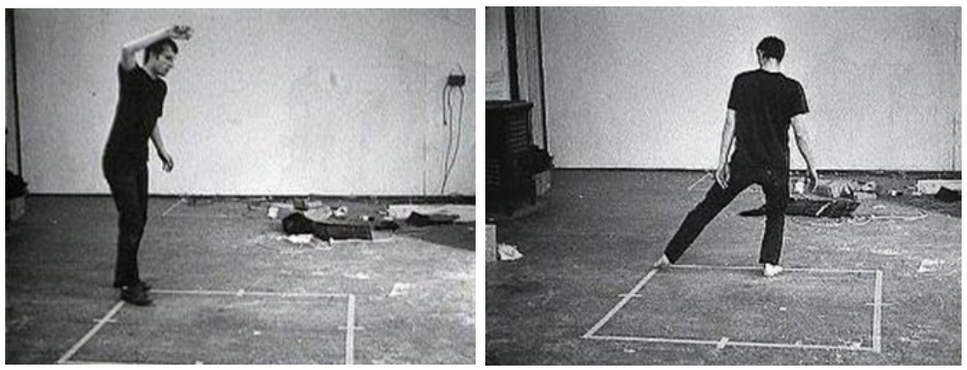


Fig. 10 Bruce Naumann: Walking in an Exaggerated Manner around the Perimeter of a Square, 1967.

19.4 Movement Visualisation and Computer Art

19.4.1 Related Works

There have been attempts to visualise human body movement since the first motion tracking systems appeared. Worth mentioning is certainly the pioneering work of Lee Harrison III and his ANIMAC system from 1960s – using body suit with potentiometers, analogue computer and CRT screen, he managed to create probably the first real-time motion visualisation system. (see Fig. 11)

Fig. 11: A dancer using ANIMAC system by Lee Harrison III.

Since then, wide variety of technical solutions for body movement tracking have been developed, including mechanical, inertial, magnetic, ultra-sound, and optical technology. While they differ significantly in precision, speed and range of tracking, the common factor of all these systems was the necessity of some equipment, e.g. sensors, emitters or markers, to be attached to the performer's body. First generations of these systems also required wired connection to computer and power source, which considerably limited the movement of the performing person.

With technological progress, on-body equipment became smaller and lighter, and no wires are usually needed. Also parameters of tracking (i. e. speed, precision, and range) have been significantly improved. Nowadays, optical systems can track large spaces – tens of square meters with very high accuracy and speed. Tracking about fifty points on an actor's body generates a very rich data set for various visualisations of body movement.

The project titled *Presence* by a group named Universal Everything is an example of artistic movement visualisation based on optical body tracking with markers. A series of life-size video artworks was created, exploring choreography, movement and the human form. (see Fig. 12)

Fig. 12: The project Presence: the process of tracking an actor; one of resulting visualisations.

In the last decade, the so-called marker-less tracking systems are emerging. Based on algorithms of image processing and computer vision, these systems are capable of tracking a human body without any on-body sensors or markers. Tracking can be based on images from a single camera, multiple cameras or specifically designed optical sensors.

The project Forms by Quayola and Memo Akten presents a series of studies on human motion and its reverberations through space and time. Here, visualisations are based on footage from classical TV camera. (see Fig. 13)

'It is inspired by the works of Eadweard Muybridge, Harold Edgerton Étienne-Jules Marey as well as by similarly inspired cubist works such as Marcel Duchamp's "Nude Descending a Staircase No.2". Rather than focusing on observable trajectories, it explores techniques of extrapolation to sculpt abstract forms, visualizing unseen relationships – power, balance, grace and conflict – between the body and its surroundings.' [68]

[68] http://prix2013.aec.at/prixwinner/9728/

Frieder Weiss and Gideon Obarzanek also used marker-less technology in their project titled *Glow*. Data are processed and rendered in real-time and projection of visualisation therefore creates an essential part of the performance. (see Fig. 14) A more detailed description of the technology can be found at The Age website. (Age, 2007)

'Glow is a spectacular 27-minute duet for body and technology, an essay on the relationship of dance and cutting-edge software technology. Glow subtly explores the power structures between man and machine and follows the life-cycle of a new kind of cyborg – from the beauty of a supernaturally, sparkling foetus and the adolescence of logic and lines, to a body hunted in a threatening world of shadows.' (Age, 2007).

Fig. 13 Quayola and Memo Akten: *Forms*, 2013.

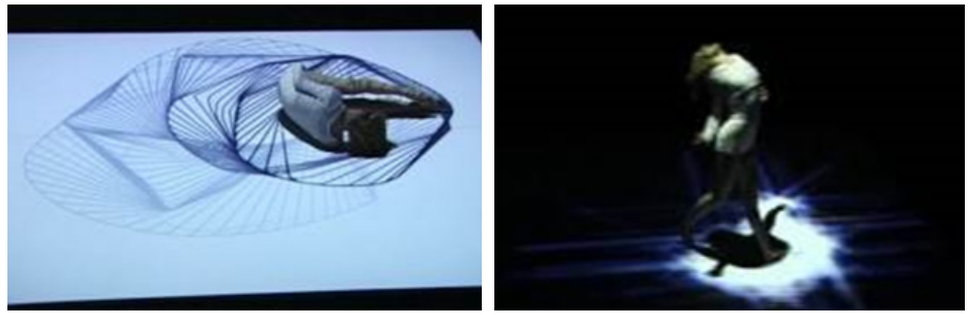


Fig. 14 Gideon Obarzanek, and Frieder Weiss: The Glow performance, 2006.

Examples of usage of marker-less tracking can be found also in works of Daniel Franke. He uses multiple Microsoft Kinect sensors to capture movement of a performer in form of a 'point-cloud'[69]. Using 3D modelling software and advanced rendering techniques, he is able to visualise and track movement

[69] A point-cloud is an un-order set of points in 3D space, usually representing a surface of 3D object – in this case, the surface of human body.

in various visual styles. The basic idea of the project titled *Unnamed Sound-sculpture*[70] is built upon the consideration of creating a moving sculpture from the recorded motion data of a real person. (see Fig. 15)

Fig. 15 Examples of various visualisations of movement based on animated point-cloud by Daniel Franke.

19.4.2 Point-cloud Technique

The aim of this technique is to experiment with different artistic styles of real-time human body visualisation, utilizing only commonly available technologies, such as PC, Kinect sensor and an open-access software.

Technology

It is based on the use of a single Microsoft Kinect sensor for tracking a user-performer in 3D space. This device is capable of recognising and tracking one or more users in a room-sized environment without the need for track markers, or an initial calibration. The tracking is based on images from a colour camera and the so-called depth camera[71]. By processing these images, a point-cloud is created, which serves as the basis for visualisation, similarly to the works of D. Franke. Using only a single sensor, the point-cloud covers only the part of the performer's body which is facing the sensor.

The software of this visualisation system consist of custom made application based on 'Processing' programming language and several open access SW libraries. (For more detail, see Novosad, 2014)

[70] Full video available at: http://vimeo.com/38840688

[71] 'Depth' camera is a pair of infra-red light transmitter and receiver, measuring distances between visible objects and sensor itself.

Visualisation

The primary goal of this system is to provide various styles of real-time visualisation of the user or users in front of the sensor. (see Fig. 16) Some visual styles are based on the combination of colour and depth camera image only. Others require image processing and analysis for a computation of additional information, such as dimensions and distance of the user-performer, or the speed of movement. For some styles, such as 'Sand' or 'Ghost', data from several consecutive frames are combined.

Similarly to D. Franke, it is also possible to export animated point-cloud and use it for post-processing and rendering in 3D modelling software. Fig. 17 shows a still picture of such an animation.

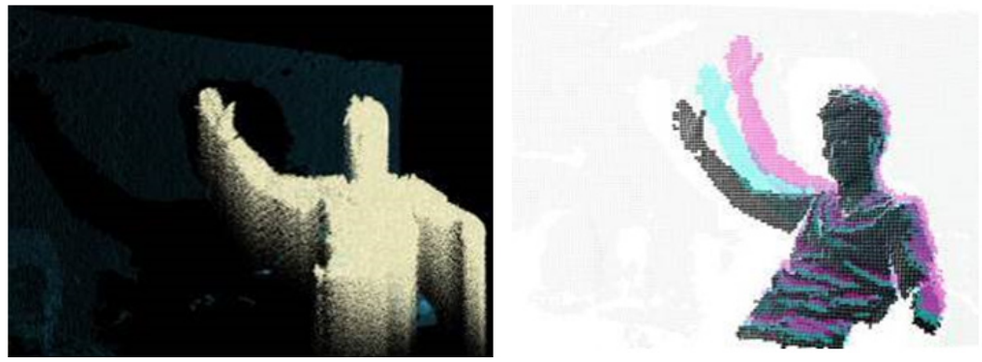


Fig. 16: *Novosad: The PointCloud' project, 2014. Examples of visualisation styles: left: 'Sand', right: 'Ghosts'.*

19.4.3 Motion Trails Technique

This technique was inspired by the Light writing technique where a single photograph captures the motion of a light source as a bright trail on a dark background. See works of Gjon Mili and Pablo Picasso, or Pavel Korbička for more information. The phenomenon of the movement visualisation could be found in works of famous Czech artists such as Zdeněk Sýkora, or, Karel Malich, and Federico Díaz. (see Fig. 18)

Similarly to the Light writing technique, our application also generates trails of movements. Instead of photography, we are using virtual environment (VE), where processes of motion capture and visualisation are realised in 3D space and in real-time.

Fig. 17 Novosad: The PointCloud project, 2014. A still image of an animated point-cloud.

Fig. 18 Examples of human body visualisation resembling 'trails' of movement. Dance calligraphy – series A, 1996 by Pavel Korbička.

Technology

Our current hardware setup is based on an optical system with twelve infrared cameras for motion capture. Several parts of the human body can be tracked simultaneously, using small reflexive markers attached to the user's body. (see Fig. 18) This optical system provides high accuracy (in the order of millimetres) and high speed (100 samples per second) of tracking.

Processing of samples obtained from the tracking system as well as the rendering of movement visualisation is performed in real-time. Therefore, the user can see 'trails' of their movement immediately, during the performance. As a main output, we use a stereoscopic projection wall – thus, users have better depth perception of our incipient three-dimensional artworks.

The software of our system was created as a part of VRECKO virtual reality framework[72]. (see Chmelík, 2013)

Fig. 19 illustrates the virtual environment. The only set-up the user has to do before using our VE is to fasten tracking marks, to put on stereoscopic glasses and to seize control devices. To create a visualisation of movement, a user takes a start posture, presses a button on the control device, performs a desired movement and releases the button.

Visualisation

We have based the visualisation of a body movement on the concept of 'motion trails'. One trail represents the movement of one part of user's body over a certain period of time. Multiply tracking markers may be placed randomly on the user's body, and the user can start and stop a recording of his/her movements at any time. Therefore, the resulting scene can contain any number of trails.

The user can further customise the rendering style of each motion trail after capturing the desired movements. The colour and the cross-section (shape and size) of the trail can be adjusted. These parameters may be constant over the whole trail or may vary, based on computed movement characteristics, such as speed or curvature. (see Fig. 20)

[72] http://vrecko.cz

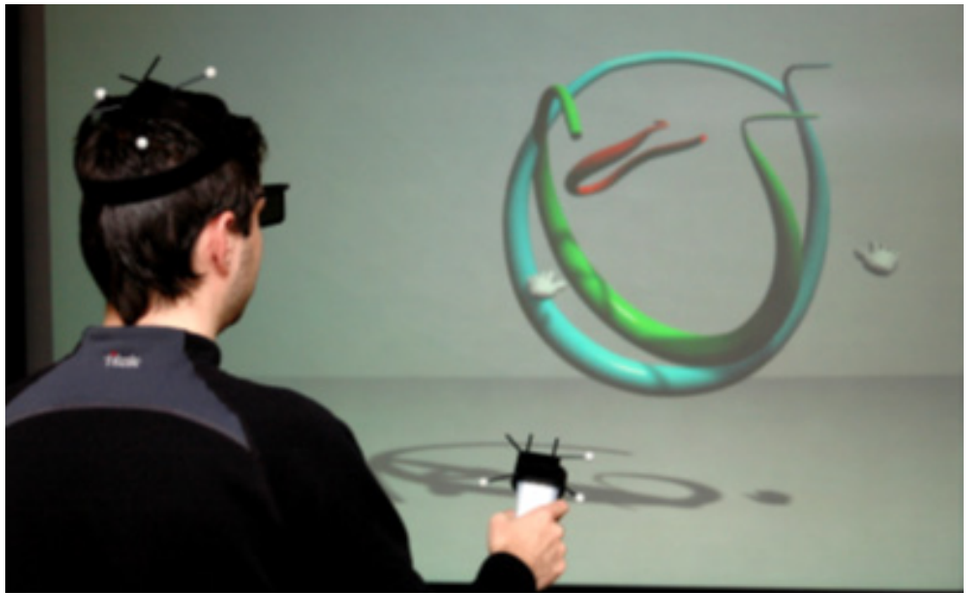


Fig. 19: Virtual environment: the user wears reflexive marks, and uses control devices and polarised glasses for interaction with VE. A projection wall with the image of three motion trails can be seen in the background.

Each trail is rendered as a sweep surface. We have incorporated algorithms for smoothing and interpolation of raw data from tracking system, with the intensity of smoothing adjustable by the user. Therefore, a trail may be rendered precisely as it was tracked, or, it can be smoothed-out to reduce any incidental jitter (e.g. when marks are not fastened properly, or, when the user's hand is shaking while tracking).

A perception of three-dimensional shapes of motion trails is also enhanced by rendering features of the VRECKO framework: real-time Phong shading and shadow casting. These can be seen as reflections and casted shadows as in Fig. 20.

Interaction

All user-computer interactions take place in virtual environment – both the creative phase and the adjustment phase. Beside a work with motion trails, a user can also manipulate with a virtual camera and thus change a point of view, and the zoom level. The ability to freely move and rotate with the camera greatly increases a depth perception of the 3D scene. At any time, user also can add more motion trails simply by starting the tracking, or deleting undesired ones using the eraser tool. We use a pair of wireless hand-held controllers for interaction.

Final visualisation can be saved in VRECKO internal format containing all tracked data, or exported as a polygon mesh for further processing in 3rd party software.

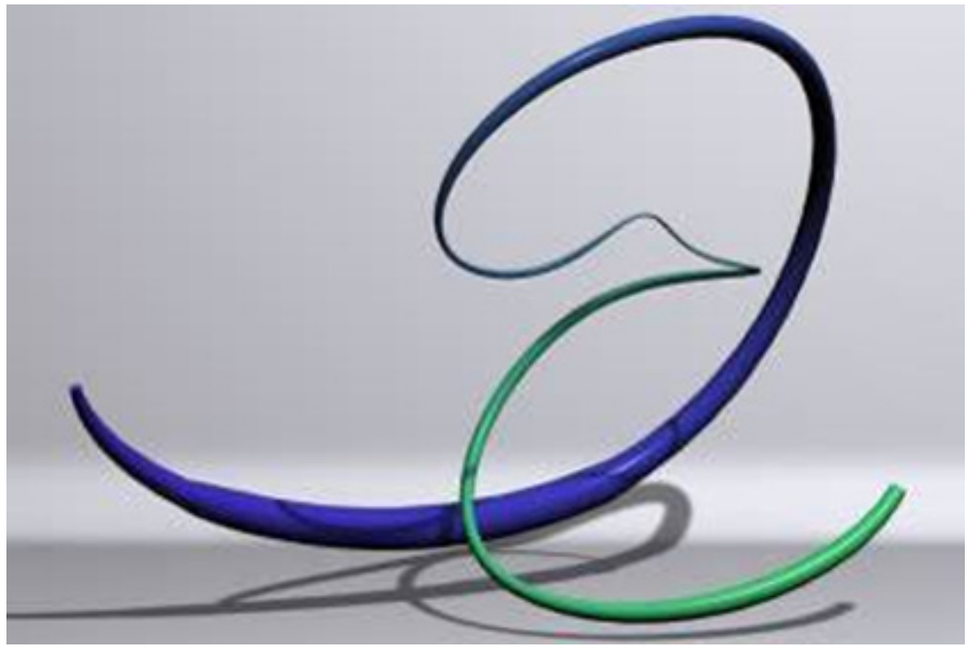


Figure 20: An example of a motion trail rendered with gradients of diameter and colour. The change of diameter encodes a speed of the motion: the faster the motion, the bigger the diameter. The change of colour encodes the direction of movement: blue at the start of the trail, green at the end. A screen-shot from the VRECKO framework.

Presentation

Visualisations created with our system can be presented using various types of virtual or desktop environments (using common mouse and display to interact with the system). For exhibition purposes, we have added an 'audience' mode, in which a user-spectator cannot edit motion trails, but can manipulate with the virtual camera.

Additionally, we added the 'timeline' feature to the audience mode, allowing viewers to see not only the final stage of a spatial painting, but the entire life cycle of the movement. User can start or pause the playback or directly display the visualisation at any moment of the creative phase using a 'play/pause' icon and a 'timeline' slider.

During the play-back, each motion trail is gradually rendered in exactly the same time and speed as was originally created by the author. Thus, the audience can observe author's progress as well as the dynamics of the movement. Even during the playback, a user can still manipulate with the camera and watch the emerging visualisation from an any point of view.

Export of motion trails as a polygonal mesh and further processing of this mesh is another way to present visualisation of movement to the audience. Polygonal mesh can be processed in 3D modelling software to produce high quality images and animations. Furthermore, technologies of 3D printing and CNC can be used to realise motion trails in form of 3D objects. With current technologies, available materials include paper, various kinds of plastics and metals, ceramics and even concrete or marble. (see Fig. 28 and 30 in the following section)

Results

Techniques described in sections 3.2 and 3.3, were developed and tested in the Human Computer Interaction Laboratory at Masaryk University. (for more details, see our web site HCI[73]) In this section, we present selected artworks along with their description.

Fig. 21 Visualisations of body movements. Left: a screen-shot from virtual environment. Right: Rendering from 3rd party software. A model of a coloured avatar was added to visualise proportions of the movements.

Precise 3D tracking of limbs of the user-performer forms a basis of various visualisations styles. In cooperation with Czech artist, Pavel Korbička, and performer, Petra Hauerová, we created series of visualisations of rather short body movements. Tracked markers were placed on the head, wrists and ankles of the performer.

Real-time rendering in virtual environment was used as the first iteration of visualisations. Therefore, an artist and performer could see the resulting 'motion trails' immediately after (and even during) the performance. (see Fig. 21, up) Later, selected performances were rendered using 3rd party software (see Fig. 21, down) and also materialised using 3D print technology. (see Fig. 22) The final realisation of the concept of motion trails is planned in form of life-sized fluorescent tubes.

[73] online: http://decibel.fi.muni.cz/

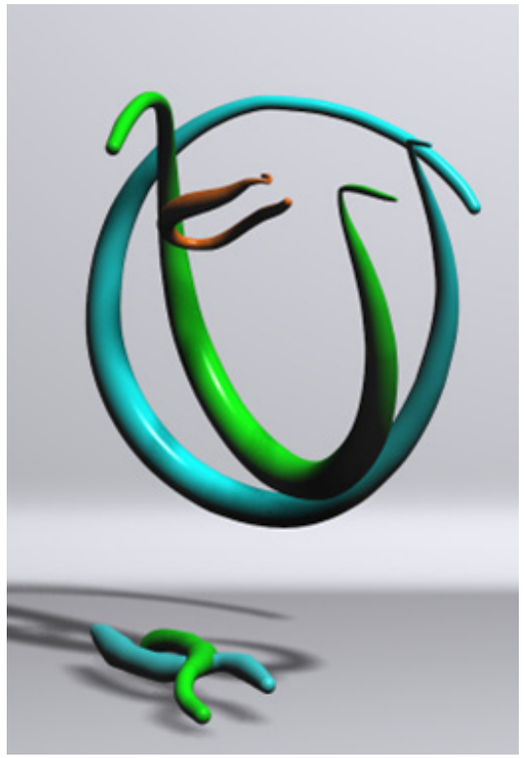


Fig. 21 Visualisations of body movements. Up: a screen-shot from virtual environment. Down: Rendering from 3rd party software. A model of a coloured avatar was added to visualise proportions of the movements.

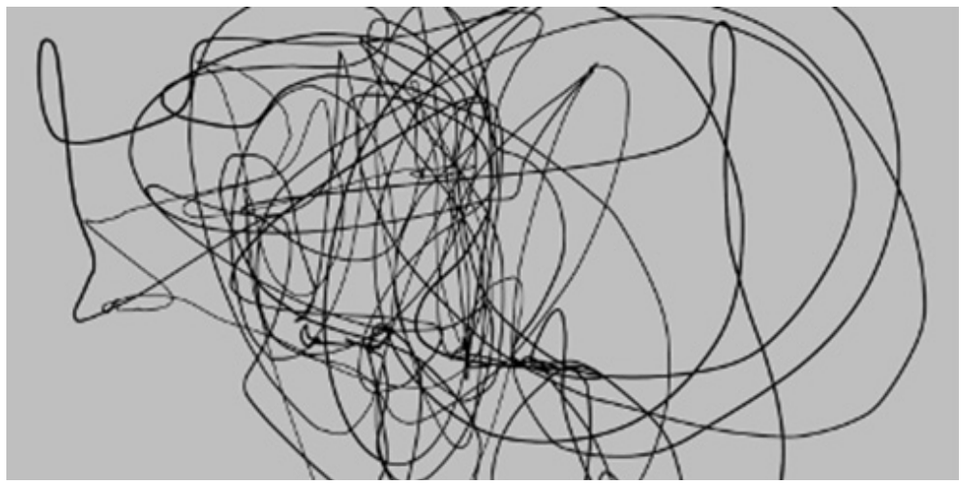
Fig. 22 A photo of 3D print realisation of dance visualisation.

Our system was also used for dance-based artwork of performance artist, Eva Šefčíková. Here is the artist's statement:

> *'The main objective of this project is an attempt to capture the present moment, when the mind does not stray into the past or the future, but remains concentrated only in the present, without memories or expectations. The main medium of my work is dance, which I try to free from the ideal of beauty in my artistic realisation. I let the intelligence of my own body lead me and using the VRECKO system I track my own motion, where everything that I consciously and unconsciously experience is reflected.'*

Fig. 23 depicts the artist during her performance. For this artwork, the artist chose simple thin, black trails for all tracked markers. The length of tracked dance sequences varied from one to fifteen minutes. Therefore a virtual canvas was gradually filled with trails of movements. (see Fig. 24) Aside from the performance itself, this artwork was presented also in form of a stereoscopic video presentation supplemented with large scale stills of movement trails and an actor during the performance.

Fig. 23: A photo of dance performer during the dance visualisation performance.



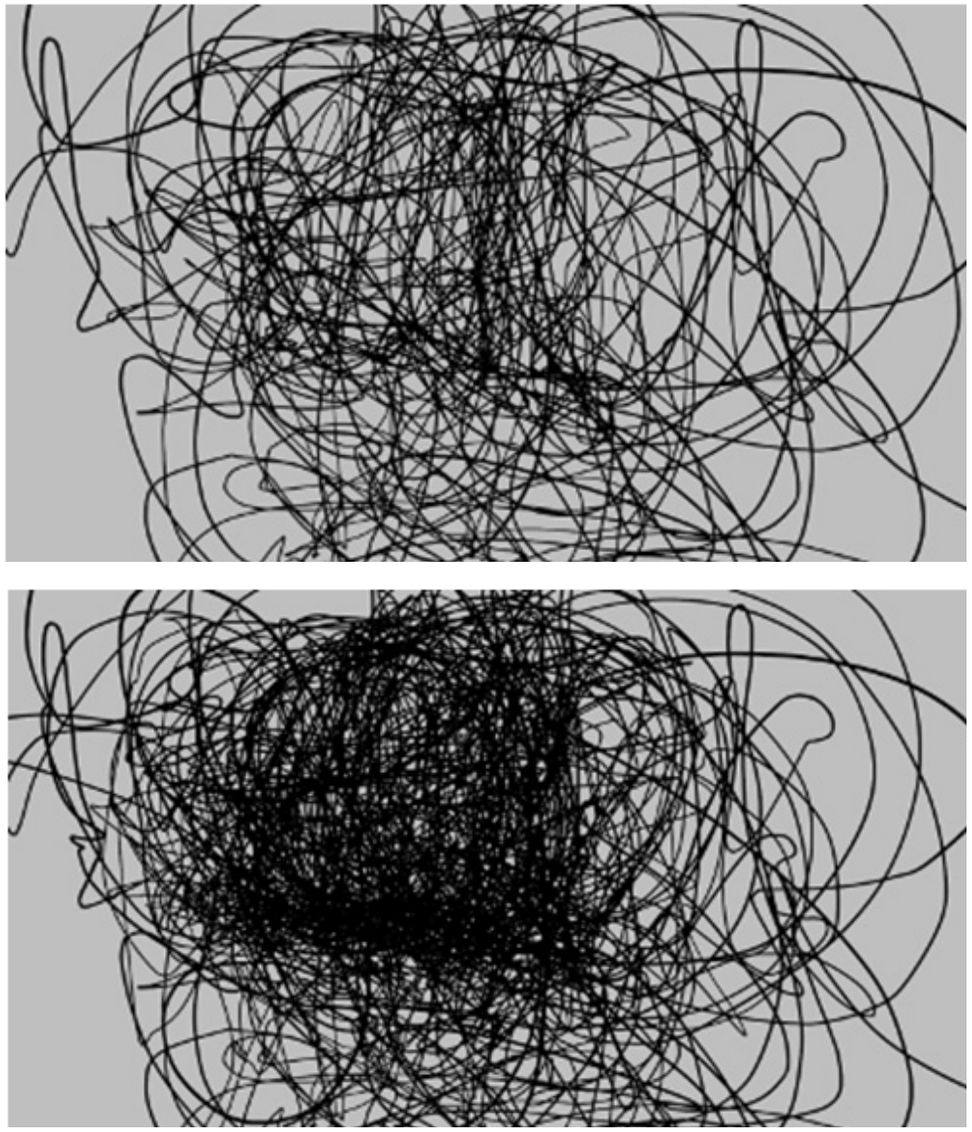


Fig. 24: The visualisation of dance at three different times of performance: 45 seconds, 105 seconds and 225 seconds. A dance performance by Eva Šefčíková. A screen-shots of virtual environment.

We have also cooperated with Czech artist Helena Lukášová on several art projects based on body movement tracking. For a work called *Attack*, a single tracking mark was used. Trails were rendered using gradient of diameter – they are thicker at the start of the motion and sharp at the end. The background colour and lighting of the VE were adjusted according to the artist's requirements. (see Fig. 25) *Here is the artist's statement:*

> *'The body moves imply an attack with a sword-like weapon. Trajectories of the moves of the arm create a structure of spikes which point their sharp tips of the visualised trajectories towards the viewer which could be felt equally aggressive. Body expresses aggressiveness while the drawing expresses the spatial depth of such action.'*

Fig. 25 Helena Lukášová: Attack. A screen-shot of virtual environment.

The *Hemispheres* project was based on mirrored movements of arms. (see Fig. 26) *Here is the artist's statement:*

> *'This drawing is based on mirrored movements of arms. Body moves evoke dance or meditation, while the drawing associates the shape of the brain. This drawing symbolises the concentrated control of the body.'*

Fig. 26 Helena Lukášová: Hemispheres. Rendered in 3rd party software.

I am the Venus is the name of another project by Helena Lukášová. Based on rather thick trails of movement, resulting visualisation can be perceived as a sculpture. *Here is the artist's statement:*

> *'The form of the body is created by moving hands along my own body. Touching is very personal and intimate gesture. The visualisation of movement demonstrates the shape of the body. This associates the spacesuit or mummified body. This work explores the relation between life and death, between a fleeing moment and memory.'*

The series of Venuses were created and presented in various forms. Fig. 27 depicts rendering in 3rd party software, were purposely visible polygons refer to the digital essence of the work. Down-scaled 3D printed version of larger series can be seen in Fig. 28. A large scale version of one sculpture was realised in marble by CNC technology and is currently being finalised by an artist.

Martin Zet, a visual and conceptual artist and teacher of fine arts, have been using conceptual approaches in his projects. His project *I walk around drawing a triangle, a square, a circle* was implemented in HCI in 2013. He describes his idea as follows:

> *'How to consider a moving point in the context of the movements of Earth, galaxy, universe. What do the depicted geometries look like when other movement is projected onto them?'*

Fig. 27 Helena Lukášová: I am the Venus. Rendered in 3rd party software.

Fig. 28 Helena Lukášová: I am the Venus. A photo of the series of 3D printed sculptures.

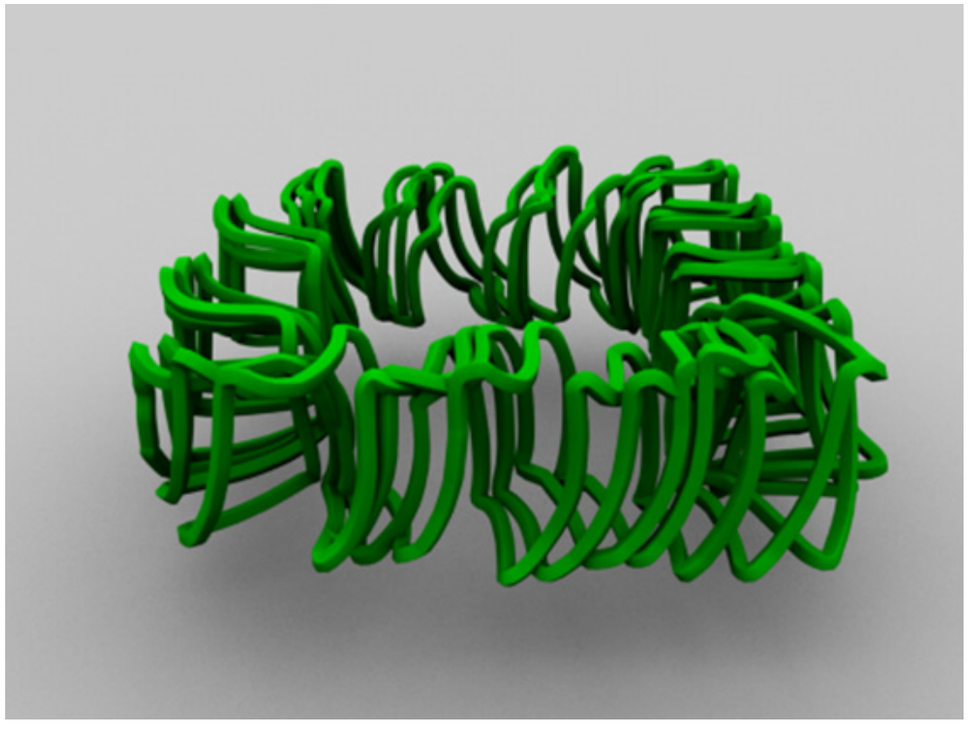


Fig. 29 Martin Zet: I walk around drawing a square, 2013. Rendered in Cinema4D.

Fig. 30: Up: Martin Zet: I walk around drawing a triangle, 2013. A photo of 3D printed sculpture. Martin Zet: Down: three 3D printed sculptures, installed in gallery.

Useful Symbiosis in the Context of Education

'A: So for you education is a way of protecting people
from being educated.
B: Precisely.'
(P. K. Feyerabend, Three Dialogues on Knowledge,
1991, p. 53)

Part of Feyerabend's (1991) second dialogue on knowledge, which became the motto of this chapter, may seem as an anti-educational attitude, which must naturally be the result of our previous analysis of both of the traditional fields of human culture: science and art. After all, we have illustrated that knowledge acquired through science cannot be described as objective and true, and that it is dependent on the cultural and social context. We have examined its limitations and errors. As for art, we were faced with even greater disillusionment: If everything can be art, isn't art ultimately nothing? Does it have any value at all, which can be methodologically transformed into education?

How to deal with these uncertainties in the context of education? What should education in postmodern times be like, and what goal should it have? We believe that in addition to the reintegration of artificially isolated paths to knowledge, an important objective of art is critical questioning. Feyerabend (1999, p. 89) himself points out that education should not manipulate individuals: people should be openly told what is happening in the field of knowledge, they should be protected from 'being amazed by a fairytale', and they should learn to perceive the limits of all systems of thought. The teacher does not have to be a promoter of their views, they should teach their students to think independently and to even question the teacher's opinions. Pupils should not become sheep in the hands of watchdogs. The ideal is to achieve the ability to see in perspective.

'A child should grow up knowing not only various languages but also various myths, the myth of science included.' (ibid, p. 81) According to Feyerabend, the selection of these 'myths' should be made by the group as a democratic whole, rather than by any of its elites or interest groups. It is clear that in education both of our fields of interest should be represented and that understanding of the specifics of science and art should also be pursued here.

This chapter, which develops the issue of the symbiosis of art and science in the educational context will take several directions. First, it will focus on a deep-

er theoretical analysis of important issues, such as overcoming the dichotomy of the scientific and artistic approach to the world through postmodern education, through art, or the role of a creative and artistic educator as the carrier of knowledge. Other subchapters will present concrete examples of educational projects, which integrate educational content of various fields (art and science), or some of the media resulting from the application of science and technology will be thematised (photography). Examples of art and technology merging will be complemented with a subchapter dealing with the integration of artistic practices in the education of technically oriented universities. We will again tackle the problem of the isolation of individual educational fields in contemporary education, the relationship between individual subjects, and overcoming the transmissive approach to teaching.

20 Unifying the Numerous into One (On the Integration of Art, Education, and Science)

Hana Stehlíková Babyrádová

For centuries, humanity has been evolving ever new research tools and extending their worldview into sub-disciplines. Rather mistakenly it believes that the approach of fragmenting the world leads to a better experience, as well as more thorough understanding. But particularly in the time when we find ourselves in the captivity of specialised professions, when we are offered a diverse array of options on how to lead an individual life of philosophy, we often observe that the separate spheres of experience and views of the world not only randomly intertwine, but even integrate. In fields such as arts and education, we often, with a notion of nostalgia, try to 'evoke the spirit' of bygone times when people did not know what science was, and when art and education were part of their daily lives. For example, in the third *Anno Domini* millennium, a graphic artist again carves a statue from wood, works with fire clay, or assembles an installation of stones and branches (see various forms of performance art). Also an art teacher and their pupils perform rituals using similar material. Subconsciously an artist and teacher and their pupils, by way of creating symbols in which they are trying to remember the unity of body and soul, head toward healing the separated components of their intellectual lives.

In the contemporary research of humanities we often deal with theories analysing the so-called possible worlds believing that technological advances such as digital technology allows us to move of our own will from one world to another. However, it is necessary to keep constantly convincing ourselves of how both worlds – the hybrids of reality – work, and whether or not they are mere artificial constructs which ultimately threaten the existential reality of the natural world.

20.1 The Creative Mind and Natural World

Most of these possible worlds are created by our creative mind. In connection with the development of the latest discoveries in science we

are often presented with the view that it is precisely the creative approaches which make it possible to create new worlds in which we can live, and according to rules different from the laws of the natural world. Most often we speak in this context of the virtual world. The pilgrimage of humanity for knowledge reaches its peak by the attainment of a complete split between the scientific and intuitive being affected by the split between the physical and the spiritual. Far too easily has humanity forgotten that spiritual values were, in the early periods of development, directly dependent on the reflection and experience of the natural world.

As Metzner explains, when emancipating ourselves from the oppositional dualism between spirituality and nature, difficulties in terms of what to replace it with may arise. Fortunately, the understanding of the world of the original inhabitants of North and South America, or primary shamanic cultures around the world can help us. Also European civilisation before Christ saw the world differently than modern Western people. Celts, northern Germanic people, Baltic and Slavic peoples worshiped the gods and goddesses and the spirits of nature in the forest groves and at sacred springs, on mountaintops and in the midst of stone circles. (Metzner, 2011, p. 136)

The desire for the above mentioned ancient unity of existence and knowledge most likely cannot be rooted out from the human subconscious. Science alienated the knowledge itself from the sources of existence particularly because for centuries it had been strengthening the need to segregate an entity from the object of observation and investigation in order for knowledge to be acquired only with a certain physical and time detachment. However, this classical model of the process of learning was disrupted by postmodernism, which proposed the idea of relativisation of spatial and time settings and the psychological state of the researching entity: postmodern philosophers have noticed that, over time, the process of cognition does not lead to one definition of the object of cognition, but that it was a creative mind and the variability of external parameters of the learning processes that lead the researching entity to divergent thinking – in other words, the very creative nature of the mind influences the final conclusions drawn over the course of the process of cognition of one object or one phenomenon.

20.2 Science Penetrating Art (Or Art Penetrating Science?) – Personality Analogy of a Scientist and Artist

If we consider the proximity of science, art, and education, the question of what discipline is the closest to art and education comes to mind. We work with the premise, that apart from the fact that we would certainly find examples of artists establishing close ties with natural sciences, it is clear that arts and education are primarily offered the humanities, particularly social anthropology. In publications on contemporary art we find many examples describing the activities of artists, which are strikingly similar to what social anthropologists engage in during field data collection. However, the difference between artists and anthropologists is that artists do not only archive and describe collected data or real objects or photographs but they also work with them.

Nato Thompson dealt with these social interventions bordering with art, social anthropology, and education in his book *Living as Form: Socially Engaged Art from 1991-2011* (2012) in which he characterises one of the well-known (artistic or educational?) groups as follows:

'Cybermohalla Ensemble is a collective of practitioners and writers that emerged from the project called Cybermohalla, a network of dispersed labs for experimentation and exploration among young people in different neighbourhoods of the city. Cybermohalla was launched in 2001 by two Delhi-based think tanks, Ankur: Society for Alternatives in Education and Sarai-CSDS. Over the years, the collective has produced a very wide range of materials, practices, works, and structures. Their work has circulated and been shown in online journals, radio broadcasts, publications, neighbourhood gatherings, and contemporary and new media art exhibitions.' (Thompson, 2012, p. 214)

In the same book the author also mentions the projects of the Czech artist Kateřina Šedá, who initiated a collective action *Tady nic není*[74] (There is Nothing Here) during which she had a dramatic effect on the behaviour of one quite ordinary Moravian village. In another of her works, Šedá often draws (perhaps unconsciously) from social psychology, anthropology, etc. As for mutual competence recognition in understanding between scientists and artists, and vice versa, definite conclusions cannot be made. However, we certainly

[74] For more see http://www.startpointprize.eu/startpoint/komentar_seda.php

see an increasing number of cases in which artists look into the field of science and try to capitalise on some scientific discoveries in their work.

The Universal Museum Joanneum located in Graz, Austria, is a very successful attempt to implement the legacy of science and art in the basic questions of life. Recently, I had the opportunity of visiting this museum, and I found that to understand the analogy between the scientific and artistic view of the world that is documented and exposed in large units, one would need a lot of time. In connection with this museum, I would like to illustrate this with a fragment of the description of one of the many principles of the interconnection between science and art – this time it is the work of Becksteiner (installation) interconnected with one of the key humanities – history. In this description, Grabner maintains that similar to an archivist of his own life and also to an archaeologist focused on the research on the presence, Becksteiner conserves objects of everyday reality and thus gives them the role of historical witnesses. In particular, concrete images with their black and white colours, which are presented schematically on fragments of walls, evoking shades of the past engraved into the concrete, just like human bodies used to imprint themselves in the concrete after the atomic bomb in Hiroshima. (Grabner, 2012, p. 108)

20.3 A Creative Artistic Educator in the Role of the Carrier of Knowledge

Most schools are essentially aimed at transmitting a certain amount of knowledge, even though we have to take into account the fact that the current educational systems recommend teachers not passing on only certain completed knowledge and skills to their pupils, but to lead them to auto-education – i.e. to search for their own approach to education and self-improvement. For subjects that have been in the past called educations (art, music, drama, and physical education), this situation presents new opportunities to evaluate their goals and methods. 'Education' as such, in the context of the current definition of educational objectives and the means of education, is shifted from the position of complementary marginal or even recreational objects to the position of key educational tools, especially because it integrates all the tools of learning. Furthermore, I will limit myself to art education, although I must say that it is precisely this kind of education which currently has a very interdisciplinary

character (image, sound, movement, and work with environment are integrated especially in the action forms of output that theorists still included in visual art). When realising interdisciplinary activities, it often so happens that pupils and students touch on questions related to the search for answers to existential questions of being, they wish to discover the 'definition of truth.' This of course is not offered to them in terms of terminology, as is the case, for example, of moral education, but they have the opportunity to open for themselves the path to the experience of what is only theoretically defined elsewhere. This conclusion can be supported by the words of the philosopher Rorty contemplating the different 'kinds of truth':

'[S]ince there are no meanings or concepts from which truths might be read off. This attitude toward the concept of 'concept' makes it possible to dismiss Kant's distinction between necessary truths which can be determined by looking at concepts alone [analytic truth] or pure concepts and pure forms of intuition alone [synthetic a priori truth]) and contingent truths (which require reference to empirical intuitions).' (Rorty, 1979, p. 193)

Overcoming the dichotomy of scientific and artistic approach to the world by means of postmodern education through art is one of the main features of the present. The priority of art education in primary and secondary schools is interdisciplinarity. Special programs are designed to this end in universities, where future artists and art teachers study. New disciplines such as intermedia, body design, visual communication, syncretic projects, etc. All of these trends mentioned above, resulting from innovation of education through art, lead to the emancipation of cognitive and intuitive approach to exploring the world. Art and education thus move from marginal positions into the very centre of attention, as they almost 'symbiotically' coincide with the sciences that describe the world through the concepts detached from real existence.

21 Ants, the Queen, and Little Ants – An Educational Project for Pre-school Children

Petra Šobáňová

Current curriculum calls for the implementation of interdisciplinary extensions and the development of such educational projects, which would naturally interconnect the knowledge of various disciplines and their methods. Although we have shown in previous chapters, many examples of various fields' interaction and their specific symbioses, in schools the educational content still remains divided into separate educational fields, and it is as such presented to students – regardless of the often felt artificiality of this division. For cognition and learning do not usually lie neatly packed in several boxes, which are to be gradually opened by a teacher and their students. It is rather a confusing pot of interconnected and sometimes even contradictory findings. By opening separate packages, we will certainly not reach the much needed synthesis of knowledge. Excessive specialisation of fields of study and their strict separation leads to the fragmentation of knowledge and the misunderstanding of their mutual relations.

The isolation of individual educational fields can be effectively overcome by a careful combination of educational contents, an issue also referred to in the theory of pedagogy as a problem of interdisciplinary relations. A new curriculum allows interconnection of educational contents encouraging integration formally by way of uniting disciplines into broader educational areas. It determines the obligatory content framework (i.e. the bulk of information that children are to learn), but not the themes, forms, or methods by which the educational content should be mediated. The basis of integrated learning and the challenge for teachers is therefore the development of certain supporting multilayered topics that can be addressed from various disciplinary perspectives. The theme thus fulfils an integrating function, as well as combining educational contents of several fields naturally. This and the following sections will illustrate some concrete examples of implementing both science and art in education and will follow many of the theses that were theoretically developed earlier.

In addition to the isolation of professional knowledge, the contemporary school is also rightly criticised for the still prevalent transmissive approach to education in which the teacher, by means of interpretations, passes already completed knowledge of the given field on to students. In this model, which is not very different from the teaching prototype of early compulsory schooling, a pupil is assigned only a passive role without being actively involved in the process of learning itself. This situation prevails in most of the so-called doctrinal (read science-based) educational fields – as opposed to expressive (read artistic) fields such as visual art education where the act of education is conceived as an active creative process employed in expressive (read art) fields among others, such as visual art education. The projects presented therefore do not illustrate only the interconnection of science and art, but they demonstrate that learning is also possible through the active creative activities of students, as is usual in visual art education.

Although the education system is rightly reproached for giving preference to science before art, artificially isolating individual fields of study, favouring the transfer of finished sums of knowledge before heuristic methods and memorizing before experimenting, it must be said that the power of overcoming this undesirable situation lies largely in the hands of the teachers. As indicated in the previous chapter, the role of a 'creative artistic teacher' whose field of reference (arts) is of a strong transdisciplinary nature is therefore still more important. Projects presented perhaps provide the necessary inspiration and show that it is possible to integrate contents into meaningful units.

Pre-school is the ideal period in which the integration of educational contents of different disciplines happens quite naturally. The project titled *Mravenci, královna a mravenčanata* (Ants, the Queen, and Little Ants) can serve as an example of an educational project in which the contents of art and biology are being integrated in the process of education. The project was realised with a group of fifteen children aged 4 to 6 years in the Olomouc Studio Experiment, and with complementary worksheets that playfully make the theme of life in an anthill accessible to the participants.

At the outset it should be noted that the actual knowledge of insect life serves here as a springboard for broader knowledge – by means of a topic

inspired by nature, questions of purely human character come to mind as an interesting comparison: how do we people live, what do we eat, what work do we do, how do we take care of small children, what makes us happy. Comparing individual testimonies – artistic and verbal – has become another important creative element throughout the entire educational process. Children communicated among themselves, listened to testimonies of their peers, and responded to them – and it is precisely in the process of communication where we can see the greatest enrichment of children and a deepening of their worldview.

The first activity, entitled *What does an ant look like?,* is based on a motivational story about the life of ants, examples of picture books and worksheets. Using elements of visual language, children were to express their own idea of these animate beings. On the basis of the free marker drawings children worked with clay and created simple sculptures. Given the age of the children and their motor skills, it was necessary to check whether the individual elements of the sculptured body holds really well after they had finished working on their projects. Children were eagerly viewing their sculptures telling each other what interests them most in ants, and what their body parts are. They also talked about what it was like to work with clay – a material not so common for them.

Another activity was *the Ant Queen*, where the story of different types of adult ants (female, male, and labourer) served as a motivating narrative along with the use of visual materials and worksheets. By making marker drawings, children expressed their own imaginative ideas about the life of the ant queen. Children were so captivated by the stories about the female ant, about her wings, size, and the role in an anthill that they themselves proposed an extension to the topic by introducing a 'wedding', culminating in the establishment of a new nest. They were surprised to find that males after completing their tasks are no longer important for the anthill. Marker and ink drawings were complemented with watercolour paintings, and children repeatedly returned to this theme during the following activities. During reflection they compared their ideas with each other and developed a dialogue about how we, i.e., people, establish a new home.

Another activity, titled *Ants Working, Ants Sleeping*, continued with the gradual introduction of life in an anthill and roles, which are naturally taken on by ant individuals. Children were told about the types of work which are necessary to sustain the life of an anthill, and children themselves suggested different professions, needed to support the anthill (guards, soldiers, suppliers, childminders, etc.). Children then transformed their ideas into coloured marker drawings, a technique which was used as a means of gradual transition towards painting. In another reflection, children studied their work and talked about the profession their ant in particular is performing in the anthill. They also discussed what profession is most interesting in our human world. What children want to be when they grow up?

When thinking about this subject, children also correctly pointed out that after working it is necessary to relax – the original story thus naturally evolved into ants in their beds which children made from textile material for their – by that time already fired – sculptures of ants. Worksheets were employed to develop this idea. Children were interested in the development of an ant, the developmental stages from egg through larva and pupa to a young ant. In a motivational dialogue, children were enthusiastic about the idea that an ant sleeps in a pupa like in soft sheets. They began to think about what sheets to prepare to make the ants' sleep most comfortable and thus determined the next stage of the activity. The results were small objects from a composite material in the form of insect cribs. These were spontaneously inhabited by fired sculptures of ants, which were at the beginning of this creative art series. Children were extremely interested in this topic and played cautiously with their fragile ants, talked to them, and sang lullabies when putting them to bed.

The final synthesizing activity carried a motivational title *Life in an anthill*. The motivation was focused on leading children into perceiving an anthill not only as an insect world in itself, but also to notice the parallels between the community of insects and community of people.

We talked to children about the organisation of an anthill and using some of the art works of Jean Dubuffet, we updated the theme (see worksheets). When artistically expressing imaginative ideas, we have strived to facilitate complex compositions of a larger size and the application of acquired knowledge when selecting children's own motives. As a background a simple graphic technique was used – we applied wrapping paper and with graphic roller we copied

the texture of needles collected on a walk through the woods. A simple graphic design was created, which children used as a canvas for their wooden sticks and coloured ink creations and on which they even glued sub-themes from their previous drawings. This large drawing canvas gave children the opportunity to apply and uniquely utilise all the newly acquired knowledge. They did not forget about the queen or the workers, and some remembered the ant wedding. Children were proud to present their anthills and to comment on each other's motives.

Mravenci, královna a mravenčata

Pracovní listy k výtvarné výchově

Milé děti,
máte-li chuť, seznamte se s mravenci, podivuhodným druhem hmyzu. V těchto pracovních listech na vás čeká několik zajímavých výtvarných úkolů, při jejichž plnění se o mravencích vždy dozvíte něco nového.

Všimněte si, z jakých částí se skládá tělo mravence. Spočítáte, kolik má nohou? Vidíte jeho dlouhá tykadla?

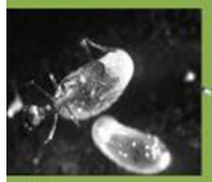
Na hlavě mají mravenci kromě očí a tykadel také ostrá kusadla, pomocí kterých si obstarávají potravu.

Domovem mravenců je mraveniště. Zakládá ho mravenčí samička - královna brzy po své svatbě. V jednom mraveništi žije i několik tisíc obyvatel.

Kolik mravenců pospíchá vysokou trávou domů?

Nakreslete, jak vypadá mravenec. Podle náčrtku vymodelujte sošku mravence z keramické hlíny.

Celému mraveništi vládne královna.
Poznáte ji podle toho, že je z mravenců největší.
Moudře rozděluje práci mezi své poddané a sama se věnuje tomu nejdůležitějšímu: kladení vajíček.
Nakreslete fixem, jak si královnu představujete. Myslíte, že nosí korunu a dlouhé šaty s vlečkou?



Chůva pečuje o larvy.

Kolik dětí má na starosti tato chůva?

Všimněte si, jak starostlivě pomáhají dělnice královně s nakladenými vajíčky.
Díky jejich péči se z vajíček brzy vylíhnou larvy, mravenčí miminka.

Přímo do kukly nakreslete dospívajícího mravenečka.

Larva se brzy zakuklí a po čase se z kukly vylíhne nový mravenec. Vývoj mravence od vajíčka přes larvu a kuklu si můžete prohlédnout na obrázcích Ondřeje Sekory.
Znáte jeho Knížku Ferdy mravence?

O mravenčí děti se chůvy starají neustále: krmí je, napájejí, čistí a přenášejí. Jestlipak víte, jak pečují o své děti lidé?

V mraveništi je každý odpovědný za svou práci. Strážci zajišťují ochranu obydlí, dělnice se starají, aby byl dostatek vody a potravy, chůvy pečují o mravenčí děti. Mravenci jsou velmi pilní a celý den se nezastaví.
Na obrázku vidíte mravence, který utíká s kusem listu rychle domů, do spíže.

Zamyslete se, děti, jaká práce je potřeba v mraveništi, a namalujte mravence při práci. Malujte temperovými barvami na větší papír.

Lidé jsou podobní mravencům
- také každý spěchá za svou prací.
Už jste přemýšlely,
jaké práci se budete věnovat,
až budete dospělí?

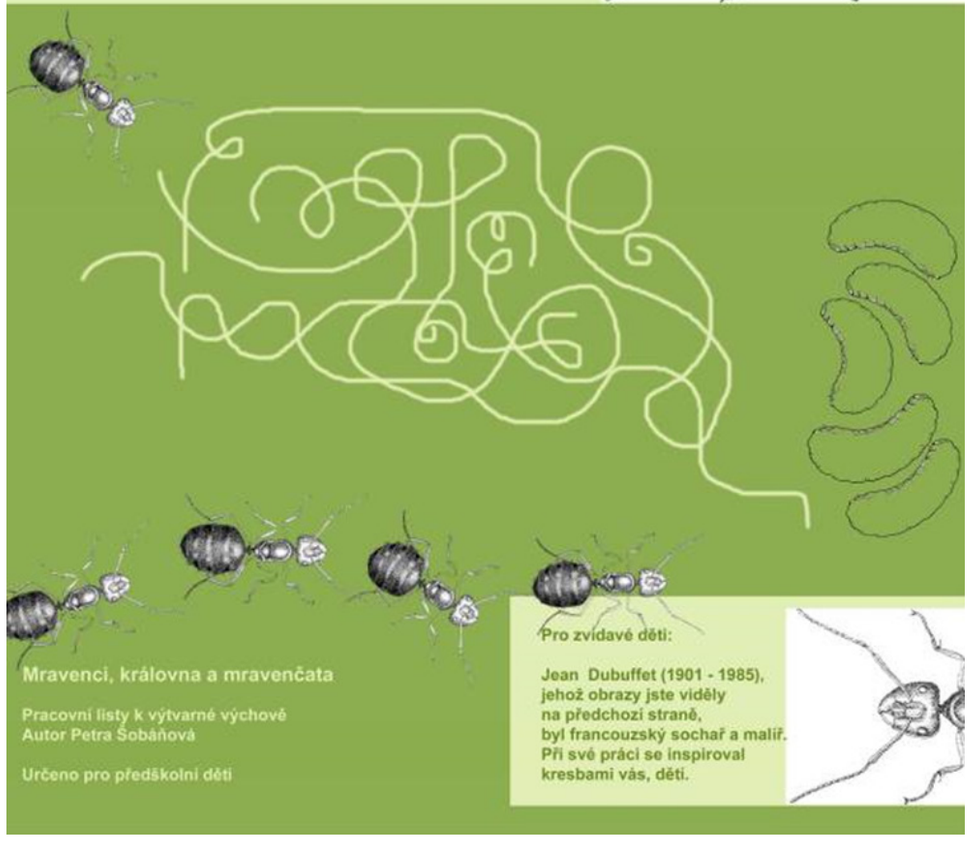
Podívejte se, jaký mumraj namaloval na svém obrazu Jean Dubuffet.
Něco však do obrazu nepatří - poznáte co?

Nakreslete, jak si představujete mravenčí obydlí.
Podobá se v něčem našemu lidskému?
Použijte velký papír a kreslete dohromady dřívkem a barevnými tušemi.

Prohlédněte si dům
na obraze Jeana Dubuffeta.

... a úplně nakonec a na rozloučenou:

Kterou cestou se chůva dostane k plačícím dětem?



Mravenci, královna a mravenčata

Pracovní listy k výtvarné výchově
Autor Petra Sobáňová

Určeno pro předškolní děti

Pro zvídavé děti:

Jean Dubuffet (1901 - 1985),
jehož obrazy jste viděly
na předchozí straně,
byl francouzský sochař a malíř.
Při své práci se inspiroval
kresbami vás, děti.

22 A Tree in the Midst of Trees – An Educational Project for School Children

Petra Šobáňová

Another example of a 'useful symbiosis' of artistic and scientific approach could be an educational project titled *A Tree in the Midst of Trees*, which was implemented by a team of teachers and children of the Olomouc Studio Experiment in the summer of 2012. The project was focused on the children's communication with nature. Besides artistic inspiration (works of Jiří Valoch and František Skála), it also drew on the world of science, specifically the field of semiotics, ecology, and scientific photographs of plants. The project was implemented as a one-week stay in Račí údolí near Javorník (the Czech Republic) and was designed and realised by a team of teachers from the Studio Experiment namely Radka Novotná, Kateřina Pospíšilová, Daniela Smékalová, Petra Šobáňová, Marek Šobáň, Eva Žváčková, etc.

The project was initiated by the so-called visual haiku activity from the workshop of Jiří Valoch. (see worksheet in Fig. XY) In this activity, children were familiarised with the nature around them and their task was to find three visually interesting situations 'in natura', consisting of the confrontation of different, seemingly mundane motifs of nature. Simple, seemingly ordinary, but actually interesting situations were photographed and presented by children at an evening meeting on a big screen (using a projector), along with their verbal commentary. Children made note of many interesting themes in nature, such as interesting clusters of stones, a burrow hole, crossed branches, insect trails in the bark, a plastic cup in pine needles, or a dead animal. The actual picture taking was not new to children, nor did it pose any difficulties. However, what may have been unusual for them was the search for motifs in nature, focusing on the detail and public presentation of enlarged images.

Also, the second theme of the project was a response to the artistic creation of Jiří Valoch. This time it was his conceptual work entitled *Sochy pro Gertu Pospíšilovou* 1973 (Statues for Gerta Pospíšilová), which, despite its title, consists of only a white A4 paper on which simple texts are inscribed:

a tree in the midst of trees
a cloud in the midst of clouds
a lightning in the midst of lightnings
a stone in the midst of stones

The objective of this task was to familiarise children with remote conceptual art as well as the fact that in the scope of visual arts the process of creating a visual image is possible, not only visually but also verbally by a simple nomenclature. The educational situation was designed in a way so that children are lead into the contemplation of the content of Valoch's lines to reach the representation of the contents in their mind and to subsequently create free drawing records of associations which were triggered by *Statues for Gerta Pospíšilová*. Using ink and a wooden stick, children draw into simple leporello books made from a strip of paper. They were invited to continue the activity by inventing other stimulating 'sculptures' and making representations of their drawings. This seemingly highly abstract and intellectually challenging game with the conceptual forms of contemporary art led to a shared reflection on what art is and what forms art can take. Despite educators' initial concerns it was quite naturally met with children's acceptance. Also in this case, they could make use of textual support in the form of a worksheet. (see Fig. XY)

This activity, working with images induced only by simple text lines, was followed by the third, which was an exercise in semantics designed by the same artist and other 'strange' word games. Beforehand educators prepared A3 signs which read STONE, CLOUD, TREE, LEAF, WATER, LINE, CIRCLE, SQUARE, TRIANGLE, etc. They also prepared signs explaining these words with definitions taken from a dictionary. On the basis of the following poems of J. Valoch, the task of children was to install these signs into the landscape. Children were also offered the possibility of shifting the meaning (i.e. to place a sign of the object to something which it does not belong, according to the rules of our language), exactly as the artist's poem encourages us to do:

draw a square.
label it a triangle.

draw a triangle.
label it a line.

draw a line.
label it a circle.

draw a circle.
what are you going to label it?

draw a cloud.
label it a circle.

draw grass.
label it a line.

draw a stone.
what are you going to label it?

(J. Valoch, cit. in Lasotová, 2004)

When playing with signs children made use of their cameras, with which they documented striking interactions between the sign and the object to which the sign referred. The semantic game in which the children are the creators in the process of naming and in which they could experiment with breaking well-established rules, inspired children to reflect on their own (and until then unaddressed) language sign system, and its rules. Younger children found it more challenging, but some eventually spontaneously revealed that they had in fact previously thought about the denomination of certain things (which they considered at some point as strange), or about what would change if things where labelled differently.

The fourth activity of our project was – compared to the previous ones – based purely on craftwork using natural materials. During the project, which accentuated ecological and spiritual aspects, we sought to communicate with nature and to develop a sense of feeling toward it. Our one-week guide who helped us navigate through the project was therefore a 'ritual' tree-friend, at which we met every day and conducted simple ritual practices. During gatherings and simple ceremonies, consisting of decorating and gifting the tree, methods of drama education were widely used. Inspired by the work of František Skála, in particular by his sculpture *Lesojan*, individual groups of children created large objects from natural materials. It was a gift to our tree, this guardian, a fantastic woodland creature made of wood, branches, grass, and hemp. In doing so the desire of boys (not only) to work with tools and materials was greatly stimulated. Smaller children could also create smaller statues or their favourite houses of wood and moss.

The fifth activity is perhaps the best example of the combination of artistic and scientific ways of understanding nature. We drew inspiration from spectacular, surreal-looking microphotographs of plant seeds, fruits, and other parts of plant bodies which were initially produced as scientific documentation, but with unusual aesthetic appeal. The author of the large-format microphotographs is the above-mentioned Viktor Sýkora, a researcher and a head of the Centre for Experimental Bio-models 1st Faculty of Medicine at the Charles University in Prague. His extraordinary photographs, created by combining the media with the possibilities of light and a scanning electron microscope (Sýkora, Hroudová, 2009), were already introduced in chapter *Useful Symbiosis*.

The aim of the educational task was to enter into the microworld and think about the fact that many qualities of nature remain hidden to our eyes as we commonly do not perceive them. Using a magnifying glass, children went off to monitor closely the natural phenomena found nearby. Based on the observation of visual quality they created a large-format painting of the selected theme, e.g. plant seeds, dandelion fluff, needles, and the cut of a stem, etc. They painted with tempera colours on an A1 format. (see Fig. XY)

It was possible to move on from a microview to landscape as a whole. Employing yet another worksheet, children were familiarised with the basic principles of classical landscape drawing, such as the pursuit of complexity, simplification, reduction of details, etc.

An integral part of the project was also exercises in reflection in the form of diary notes. Regular entries interconnected individual themes becoming a means to facilitate reflection and to organise acquired knowledge. To support this reflective technique, diary worksheets were distributed. (see Fig. XY) It was a great stimulus, especially for more active children who were able to add more to their diary in the free time, never running out of ideas. Worksheets along with various drawings and notes could be placed inside the diary, which otherwise took an interesting 'raw' and natural form. It was half-book, half-object: consisted of cardboard plates decorated with bark, rotten splinters, dried flowers, grasses, or pebbles and sand.

Also, a traditional night game was associated with reflection – not only in the conversation, but also in free writings. The game was conceived as a silent night walk through the forest associated with the reading of an African fairy tale showing metaphorically the connection between human beings and nature and its gifts. Experiences from the night walk through the woods were transformed by children into an art letter which was to return to their authors mysteriously in time to come. Letters addressed to themselves were filled with their feelings from the forest and contemplations about what the visit to nature gives to them, how important it is to them to be familiar with nature, and what they would like to archive and overcome in their life.

The art project culminated with a celebration with self-made costumes and dramatic activities. The centre point was the final message, with which the children's friend-tree said goodbye to them. By means of a poetic statement, the main contents of the project were emphasised to children: the importance of nature for humans, the need to respect it, to protect natural values, and to develop children's sense of feeling towards their aesthetic qualities.


trojúhelník


kruh


přímka

23 The Possibilities of Contemporary Photography in the Process of Experience Education for Adults

Štěpánka Bieleszová

In her preface to the collection of essays by Jiří David titled *Století dítěte a výzva obrazů* (The Century of Child and the Challenge of Images), Hana Babyrádová (2008, p. 5), highlights the danger of deterioration of our visual senses. M. McLuhan sees the cause of the numbness in the oversaturation by images which are produced by electronic media. Jiří David (2008, p. 237), for example, points to one of M. McLuhan's theses which deals with the extension and 'externalisation' of our sensory organs by means of technical inventions.

A photographic medium is one of the primary tools that are extrovert in nature, and use a specific expressive language. Every day we look for the answer to the question of how paintings and photographs act on our senses, how they work in the broad field of visual culture, and how they retrospectively affect our way of perceiving and experiencing the world.

These questions are also dealt with in regular exhibitions of contemporary photography which have been held at the Museum of Art in Olomouc, in the premises of *Café Amadeus* since 2009. The growing interest in these kinds of exhibitions has led the author of this chapter, a curator; and Marek Šobáň, a museum lecturer; to the idea of holding regular educational programmes for adult visitors. The first educational programme took place in early 2011 on the occasion of the exhibition of Michaela Spurná titled *Karneval* (Carnival). The curator specifically addressed a group of young artists who, in their spare time attend courses in photography organised by *Česká fotoškola* (www.ceska-fotoskola.com).

The event, which was compiled from several different blocks, was attended by 10 people. The introductory part consisted of information that clarified the interest of the curator and lecturer to visitors, and during which they had the opportunity to meet each other. This was followed by the curator's interpretation of the author's work and its inclusion in the context of Czech and world photography.

At the conclusion of the opening session, the theme of the next part was outlined – a directed discussion. The curator highlighted the position of the artist in a public space and in the art world, the danger of excessive disclosure of private life in works, and in particular she pointed out the thin line between an artistic expression, advertising, and the manipulation of a depicted subject. In all displayed images the subject was a child. Before commencing the discussion, visitors viewed the exhibition thoroughly. Afterwards, a discussion took place about the dangers of handling children in art and advertising, and about their vulnerability and inability to defend themselves. The participants themselves added their own experiences with photographing children.

The author (a university student, 20 years old) described the way she takes pictures of her three-year-old sister, the fact that she realises the danger of her superior position over her, the way she tries to let her sister express herself spontaneously, and tries to record her expressions in the most natural way. Her colleague (a university student, 20 years old) spoke about her childhood, when her father a photographer now deceased used to take pictures of her as a child in the studio, dressed in costumes and various disguises or in a staged backdrop. The girl remembers these as very happy moments with her father which she interpreted as play. Another participant described her experience with children being assigned roles which did not suit them and were turning them into the so-called little adults. As a cautionary example she referred to a child's movie character, which was played out flawlessly with the child reciting a memorised text with the desired expression, the meaning and context of which could not possibly make any sense to him/her. There were also comments on the need for children to be not only provided with a protection, but also freedom.

A serious topic was also the risk of moral and sexual abuse of a child in connection with excessive laxity in presenting a child in marketing and advertising. There were discussions about the boundary each participant would or would not go beyond if given a task within a commercial project to take a picture of a child in a humiliating position or context.

After the discussion, the lecturer explained the method of automatic writing. (Grecmanová, 2007, p. 56) Each participant then selected one photo according to their preferences and in the time limit of 5 minutes wrote a text composed

of free association. Upon completion of the writing exercise, authors read selected passages directly in front of the relevant photo. After some (and understandable) initial inhibitions, the stream of free association was let loose, written from the standpoint of individual participants. They themselves were surprised by the degree of originality of their own texts. A creative atmosphere then spontaneously developed among individual participants, who tried to follow and explain the interesting images depicted in the automatically written texts.

At the end of the meeting the lecturer and all participants arranged to continue the cultural educational programme the following week at the same time and in same place. In the mean time, everyone was to prepare a comparative photograph to the photograph they had selected. It was to be either an actual photograph or an image taken from a magazine, the internet, etc. with a popular theme. After a week, the whole group met with much enthusiasm. Newly submitted photographs were gradually added to the group of the selected and already analysed photographs from the past week. Each participant had to explain the reasons and circumstances that led to the choice. It was also important to find identical or completely opposite elements between the original and the new photographs. Some authors opted to escalate in a rather antagonistic way the relationship between the original and the new photograph, while others sought formal or content concordances. At this stage, not only were the two photographs subjected to a comparison, but they were also re-interpreted indicating a new relationship between the two visual entities.

At the end of the comparative exercise of the two images, the new photographs were placed besides the original ones. An unexpected and improvised exhibition was thus created with distinctive features and contributions of each participant. Therefore, the lecturer and curator decided to brainstorm for an original title for the new version of the exhibition. (Grecmanová, 2007, p. 55) Within a very rapid succession of ideas and thoughts it was possible to generate many interesting and humorous ideas on the given topic (Sweets, I'll Be Your Teddy Bear, In and Out, etc.).

In conclusion, the curator evaluated all phases of the educational programme and positively commented on the performance of individual participants. She also generalised some properties of a photograph. She pointed

out the essential characteristics and objectives of photographs. Above all, she emphasised the nature of a photograph which shows that although its primary objective is indeed to depict, it also depicts on the basis of the individual choice of an author, which refers to phenomenal or virtual reality, as well as to their mental development.

At this point, the curator also introduced to the participants the British writer, journalist, and art critic John Peter Berger (*1926), whose theoretical knowledge and philosophical reflections on the relationship between an individual and society, i.e., culture, politics and the media were at the root of the pilot educational programme. She spoke primarily of the essential element of his artistic method, which is collaboration, whether it be a mutual collaboration between people with similar specialisation and common interests, or in the place of their work or within a local community. All of these elements were fulfilled in the project, without the participants knowing about it in advance. The theoretical subtext was revealed intentionally at the end of the project to avoid the concerns of the participants about the difficulty and competitive nature of the activity in which they would have to prove themselves.

Towards the end, the curator also pointed out a paradox, that was pronounced by John Berger, according to whom a photograph, whilst recording what has been seen, always and by its nature, refers to what is not seen. (Císař, 2004, p. 9) She applied his thought about the extensive nature of a photograph to the recent individual and joint activities, the objectives of which were among other things to interpret and read photographs well, and to find new links to their surroundings, community, environment, and to each other. She reminded participants that, unlike painting, which is mainly (as seen especially from the standpoint of the avant-garde of the 20th century) a reflection of a subjective conception of reality, ego and emotions, photography still points outwards, outside the boundaries of the record. She followed with the idea that a photograph is not just the product of the decision of a perceptive individual, but it is primarily a broader picture of the specific social, historical, or visually attractive situations. A photograph reflects the progress and context of it sorigins.

Participants gained a lot of new knowledge in the course of the two-day educational programme. Above all, however, the lessons summarised that art-

works, including photography, cannot be approached without being prepared, nor from one position only, but comprehensively. It is necessary to understand and compare the terminology of art techniques, methods, and procedures of recording/depicting. It is also necessary to know specialised literature, to perceive everyday events, and to carefully observe commonplace reality, be it from an emotional or social position. When 'reading' photographs it is imperative to follow the links relating to other, perhaps not displayed or captured, contexts. This fact also relates to the current opinions of psychologists and educators who have long been pointing to the importance of the syncretism of senses that supports fundamental processes of understanding, feeling, and thinking, and therefore learning.[75]

The aim of the given activation methods was to actively develop sensitivity, emotions, intellectual properties in relation to creativity, and the ability to symbolically portray themes found in a surrounding world. (Grecmanová, 2007, p. 55-71)

[75] The Czech theorists, who dealt systematically with the topics related to the syncretism of senses, were e.g. Jiří David (integrative sensory education), Kateřina Dytrtová (the combination of musical and artistic expression in the methodology of art education), and Jaroslav Bláha (genesis of integration of visual and musical language in modern art).

24 Visual and Art Education at Universities of Technology

Anna Ronovská

Our contemporary society is going through a dynamic development at all levels, one of which is information technology. Without any exaggeration we can say that information technologies have grown throughout society. We now cannot imagine the whole system working without it. Actually there are only a few areas which remain untouched by information technology (hereinafter referred to as IT) till today. Terms such as globalisation, network society, digital and post-digital era, new media and others are growing in popularity. But how do society, its educational system, and social sciences react to such changes? What is the status quo of art education and its methods in a time of dynamic development of information technologies and new media? And, conversely, what does the integration of art and visual education in universities of technology offer?

24.1 Society and Information Technologies

24.1.1 Changes in the Society as a Result of Information Technologies, Post-digital Era

In the past decades, digital and information technologies have been developing rapidly, and in turn, society is rapidly getting accustomed to these new technologies. Today, we can hardly imagine a world without digital technologies, internet, mobile phones, video, and digital photography. These are productive tools, user-friendly toys, and little helpers in our everyday life. They also determine our time and our perception of reality. They are so ubiquitous that we make use of their services without even noticing their presence. Not to mention the generation of young people who have grown up in this 'IT age', whose lives are intertwined with information and digital technologies. Paul Virilio addressed the changes in speed of digital world events but also the way it influences society when he said that if the previous generation of media was characterised by the format of a novel and a film,

the generation of new media is characterised by the format of a newspaper article and a video. (Virilio, 2012)

In his novel *451 Fahrenheit*, Ray Bradbury offers an even more horrifying vision of the victory of mass culture. Such a society not only gave up on reading books and engaged in superficial entertainment using 'TV-walls' but it also promoted burning books and penalised keeping them. To what extent this motif is absurd and how far the concept of 'making media superficial' as predicted in this novel from 1953 has been accomplished are questions every one of us has to answer ourselves. However, one thing is certain. Bradbury has managed to depict precisely the gradual process of the acceleration of media towards tabloids,

superficiality, and the tendency to prefer a 'substitute' world over the real one. It is a chilling sensation to realise that such a development is not forced upon people by a totalitarian regime, but is a consensual resignation of the society and the collective preference for consumerism.

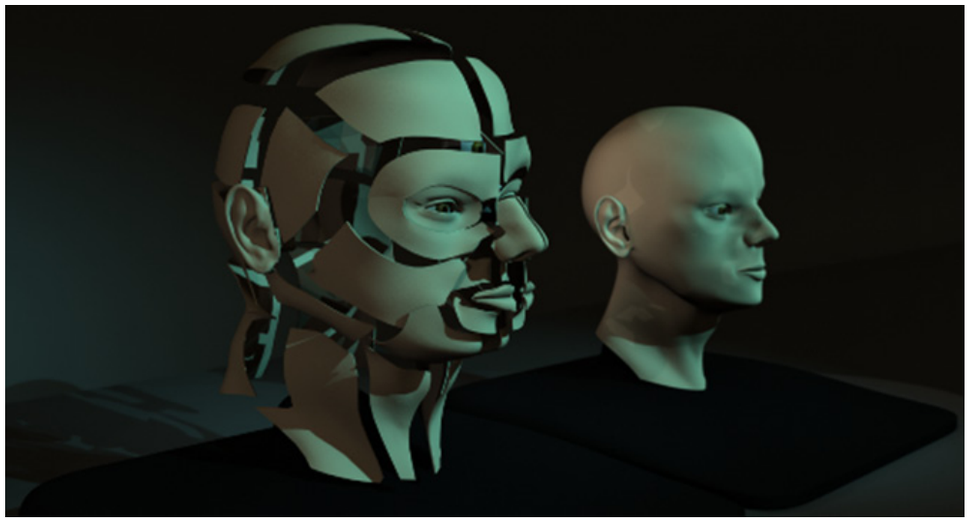
Though massive changes in society are undeniable, we can only hope that the vision of the sci-fi novel author will never be fulfilled. A certain development can always be observed in the process of new phenomena blending into the society. Similarly, the process of IT entering society goes through many visible phases. Starting with a primary fascination with new technologies, through mass use and gradual distribution as the 'standard of the society', up to the response of social sciences

and the analysis of the wider context and impact of new phenomena on society. That is why, we now talk about a 'post-digital' era and 'humanisation and anthropocentrism in IT'.

24.1.2 Anthropocentrism and Humanisation of IT

Vilém Flusser, a significant philosopher and theorist of language and contemporary views, maintains that as a consequence to the impact of information systems and information technologies, the whole base of human perception and thought is being changed. He goes on to explain that epistemology, ethics and aesthetics, as well as the feeling of life itself in particular are overwhelmed by a dramatic change. It is because we live in a world of technological images and the way we experience, learn, value and act is increasingly dependent on those images. (Flusser, 2001)

The perception of the world is rapidly changing and the division between the 'digital' and 'post-digital' world becomes more apparent. John Maeda, an influential American graphic designer at MIT, refers to the 'post-digital' era as the era after a big crash of internet companies. Thereby he aims to imply that the time of fascination with computers as a technology is over and that today the centre of attention is focused on ideas which computers implicate. In other words, new media are now subjected to their socio-cultural reflection.



(Fabuš, 2012) Also Lev Manovich addresses this issue in his definition of new media. He describes five principles of new media: numerical representation, modularity, automation, variability, and transcoding. The principle of variability, as ongoing transformation, and the possibility for mutual transcoding changes the perception of communication and today's world. (Manovich, 2001)

Currently, we talk about 'humanisation and anthropocentrism' in IT. That means that new technologies have moved away from humanistic aspects by the same extent by which they are now getting closer to them. A media theorist, Vin Crosbie, explains that a medium is not radio, television, or mobile but the relationship of producers and consumers and their model of communication. He thus points to the new-age network society in which the internet plays the role of social software as well as the network of relationship of millions of end-users. (Fabuš, 2012)

The return from technological fascination back to humanity, is a phenomenon which is typical for all technological transformations in a society. The industrial revolution completely changed the way society was organised and operated. It also had a great impact on science, education, theoretical disciplines, and social structure. It was followed by a scientific-technological revolution and completed by the contemporary digital revolution. Even though the term 'revolution' may seem radical, it is fitting as it refers to the vigour with which new ground-breaking technologies integrate into a society which then has to come to terms with its presence and react to it for many years to come. The development of media in the course of the whole 20th century is clear evidence of this.

The first half of the 20th century is characterised by the development of media such as photography, film, audio recording, telegraph, telephone, radio. The development of these revolutionary technologies had a direct impact not only on art and media but also the perception of social life, the structures of social relationships, exact and humanistic sciences, the way in which to make wars, industry, politics, etc. Following this, comes the development of communication technologies, electronic, and digital media in the second half of the 20th century, which further accelerates the movement of social structures. It has a similar effect on education and social sciences.

24.2 Information Technologies and Visual Education

24.2.1 Art Education at Universities of Technology in the Czech Republic

Some of the contemporary and central topics of many discussions are the way new media and technologies permeate art, the way new technologies may be applied in artistic and creative processes, in lessons and learning. New media have settled quickly in art education, initiating the establishment of studios at universities and secondary schools focusing on, among other things, new media, multimedia, video performance, audio-visual communication. Schools make use of modern technologies; projects involving 3D printers are being realised at educational institutions.

In the context of new media being integrated in visual arts (in today's well-established disciplines such as videoart, internet art, digital art, 3D printing, virtual art, etc.) we can ask what the role of classical art disciplines is in comparison to these new ones, and how individual creative processes have changed. And also what is the new role of art education which can be simply defined as the process of sharing aesthetic sensitivity, creative approaches, the basics of human culture, and its principles with future generations. It is therefore possible to ascertain how the classical media emulate new ones, how they cooperate, and whether they are able to merge and react to one another. Conversely, we can analyse to what extent art education can enrich lessons at universities of technology, in particular at the departments of information sciences because it is precisely here where the interaction of visual fields is most expected.

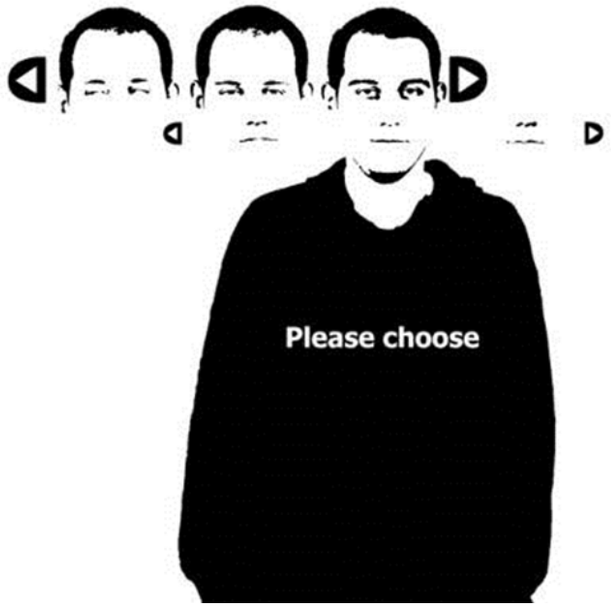
As early as the 1990s, Czech universities opened faculties and departments for the study of information technology, applied informatics, etc. (the first separate faculty of this kind in the Czech Republic was established at the Masaryk University in Brno in 1994 as the Faculty of Informatics). We can see a dynamic development of these departments followed by growing popularity of the field and a huge interest on the part of students. IT studies reflect both technological and mathematical aspects, as well as their applied fields and possible connection to other fields. Naturally, departments of computer graphics and design, multimedia and new media are being established alongside departments focused on computer systems, communications, theories of programming

and classical informatics. These visual fields have always gone hand in hand with digital technology as its inherent part while using the most state-of-the-art developments and possibilities of newly created media. Fields of study such as computer graphics, 3D modelling, visualisation, computer animation and visual effects rise immediately from individual technologies.

Therefore a certain disproportion in visual education has been created between 'technological' fields of study at technological schools, and the classical art education at academies and art schools, or, art-based departments of humanistic faculties. The visual literacy of students of technological fields lags behind their highly developed technological literacy. Is it possible to reduce this disproportion by attempting to integrate art approaches into technological education?

In the context of the above mentioned IT 'humanisation', we can see the emerging trends to support and develop a new and rich range of subjects for students to study, not only in technological areas but also in art and humanistic ones (touching upon philosophy, social and cultural sciences) in the scope of information education. These innovations mainly concern departments and studios of graphic design, computer graphics, etc. Naturally, computer graphics is an inseparable part of informatics just as industrial and graphic design is. However, only a few 'enlightened' departments emphasise the connection to art and aesthetic education. Besides technological subjects, such departments also offer lessons on the basics of classical art-making disciplines, and on the connections between contemporary art and creative processes.

Prof. Jiří Zlatuška addresses the issue of the advantages of combining informatics and visual art and goes on to explain that many original undergraduate but mainly post-graduate works are being produced in the studio (AGD+M FI MU) which could not have been created at purely informatics-based or purely art-based schools. Graduates apply their art skills in advertising agencies, graphic studios, or, they establish their own graphic studios. They also chose to continue their studies at specialised art-based universities, or, they make use of their skills in engaging other fields of studies. They show their ability to make basic art designs and concepts. As valid members of teams, they communicate with specialists in the fields of graphics, architecture, etc. Their knowl-



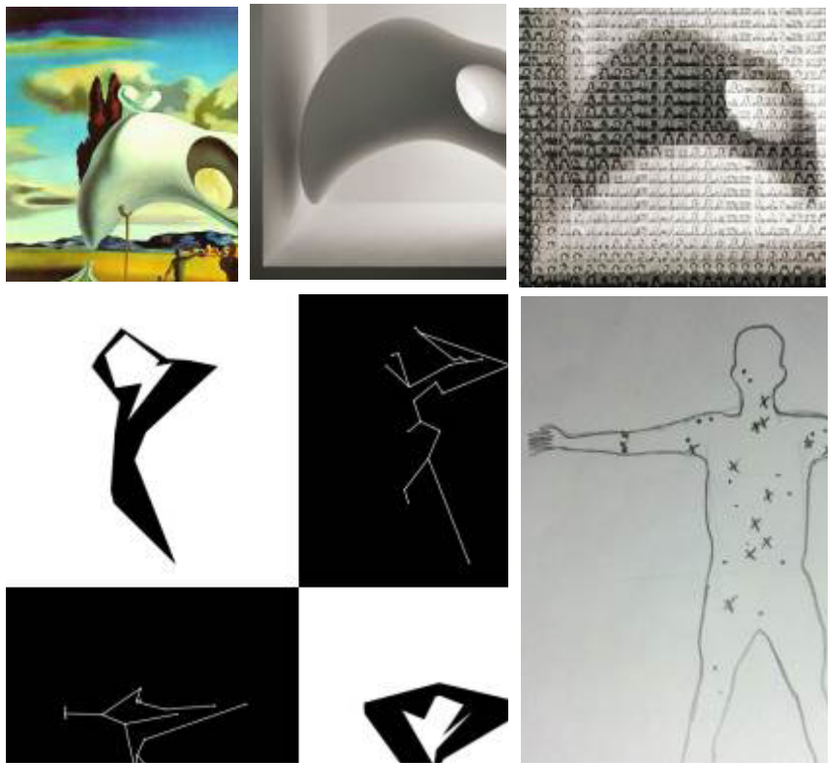
edge of informatics allows them to contribute to art solutions while navigating independently through specialised art fields and art culture being fully initiated into the art issues. (Zlatuška, 2012)

The studio of graphic design and multimedia at the Faculty of Informatics at the Masaryk University was established in 1998 by merging subjects focused on the basics of typography and graphic design. Since then, the staff has been enlarged and more subjects have been introduced: the Basics of Visual Communication, Photography, Art Anatomy, Architectural Space, Digital Photography, Open Air Painting, Conceptual and Intermedia Art Making. I myself have been teaching the last subject on the list since 2012.

The objective of the subject is to make students familiar with conceptual procedures in the creative process, to enrich their art-making by new approaches and to make use of intermedia possibilities. The aim is also to lead students to creative processes by working not only on their own projects, but also on collective ones emphasising team work. Apart from working on projects under the supervision of an educator, the subject is also presented by way of lectures aimed at deepening the students' knowledge of this field of art and helping them to navigate the contemporary and past events of the art field.

This is a group of students who are primarily focused on technology but they are also interested in visual and art-making and to educate themselves. During my two year practice I have experienced interesting results. For me, the most interesting aspect to analyse is not only a direct intervention of students by means of their art-making activities and their focusing on 'artistic' approach, but also the interaction with their technical thinking and work in the field of informatics. Not only are the students happy about extending their knowledge in the field of art (part of the subject is also lessons on select topics from the art history of 20th and 21st century which are connected to practical projects such as conceptual art, land art, body art, happening and performance, video art, site specific street art, etc.) and free creative contribution to otherwise strictly delivered subject, but they have also noticed a change in their approach to problem solving and to organising their task. They have found appealing not only the free and creative moment and inspiration by artworks, but also the basics of aesthetic education (the theory of colours, composition of artworks

and golden section). A conceptual approach to the realisation of art projects has been also beneficial (the approach from concept to realisation, project planning and its structure). They made use of these approaches not only in their work within the subject of 'Conceptual and Intermedia Art Making' but also in others. For example in a conceptual approach to making of logotypes in the subjects of 'Graphic Design' and 'Typography' which reflects current trends of conceptual and generative design. It was this connection of creative approach, informatics, data processing, and a technological approach to design which corresponded with contemporary trends in visual art making.



The technological and creative processes both influence each other. Technological literacy and information education allows students to apply rather exact procedures to their free creations. Not only are they able to use sophisticated software and digital devices from photograph to print but they also integrate principles and IT procedures into their visual works. Interesting and interdisciplinary works as well as visual and conceptual projects are thus being created.

It is here where I see an enormous potential for students of these technical subjects with visual education because their knowledge is anchored in both fields, technical and humanistic. Experience gained from both 'shores' can be put to good use progressively when creating high quality and inspirational works. On the one hand, they have the necessary technical know-how to execute their own new media works but on the other, thanks to their aesthetic education they do not need to succumb only to superficial fascination by technological effects. They are capable of creating mature works which integrate both of these aspects and push the centre of new media to high quality outcomes and informatics to a more humanistic approach.

Perhaps it is the 'humanisation' of informatics which is the current trend that points to the need to react to the ongoing penetration of information technology into society. Going further in out thoughts, today informatics arrogates to itself the right to be the platform of natural and social sciences, similar to philosophy in the 19th century. This tendency of 'anthropocentrism' in IT gives rise to many questions, among others, also those reflecting the need to integrate classical aesthetic education into IT studies. The issue may rise concerning more complex and high quality education of these technical subjects which overlap the boundaries of strictly natural sciences. The combination of informatics and visual art could thus be exceptionally beneficial and unique. It could cultivate not only the subjects but also students and educators. Perhaps we will witness the experiment of making 'homo universalis' of a new age, the human being with a technological and aesthetic education, combining classical knowledge with new technologies, the human being purely of IT-renaissance origins.

Conclusion

Petra Šobáňová

The last pages of our book are dedicated to a brief summary of the results of our research into the relations between art and science and their overlapping tendencies. It seems as though with the influence of post-modern erosion of traditional rudiments of both of the observed fields, their intersections and mutual influence grow more frequent. However, art and science remain independent worlds with their own laws and particular methods. While both of these fields aim at knowledge and independent learning of the reality, the objectives and procedures are different for each of them.

As for science, it continues to be based on rational thought together with doubt and self-correction, as well as the quest for order in nature and its representation in the form of a system of objectively achieved and verified findings. Feyerabend (2004, p. 75) believes that sciences differ from arts (and philosophies) by the efforts they extend to connect qualitative development with quantity. The aim of science is to achieve a large amount of findings and only those that imply further predictions are considered to be the valuable ones. Considering the fact that a large amount of data does not automatically means good understanding, quantification is today rightly subjected to critical evaluation.

We have shown that scientific theories, the formulation of problems and the research questions cannot be excluded from today's discourse which is why we need to be well aware of the complex and often ungraspable relationship that exists between knowledge and culture. Science is to be understood rather as a cultural and social phenomenon dependent on historical contexts. Such a rule can be also applied to art, which is established only by its own activity, that is, the activity of the art field and its players. Despite the difficulty to understand the very essence of art (as every new art expression can easily invalidate the current definition which had been formed with much pains), its fundamental roles and potentials are coming to light. One of them is its ability to symbolise as well as to thematise important social phenomena using media perceivable by senses whereby it contributes to self-conception and explanation of a human being in certain social situations.

It is rather clear that both science and art are part of the same culture and the particularly human quest for knowledge. Both the scientific and artistic activity is one of the most privileged expressions of natural cultural dependence as well as cultural development of an individual. (Pospíšil, 2003, p. 17) However, they differ in many aspects: by the perception of the truth or the different attitude to the objectivity, that is, the subjectivity of knowledge. The truth, which despite the deconstruction of the existing ideas of its relevance and attainability, remains to be the very goal of scientists, has nothing to do with objectivity when it comes to art. The verifier is the very subjective artist himself/herself, and not a scientific academia with the possibility to repeat certain measuring or experiment which led to a given result. Compared to this, the result of an artistic activity is unrepeatable and unique. Art may not be repeated or reproduced without losing its authenticity or aura with which W. Benjamin associated the uniqueness of art works. However, the value of artefact does not lie solely in its authenticity. Art must also be able to reflect on important phenomena of human existence, as well as metaphysical and spiritual issues to which science is completely indifferent. This can be clearly illustrated by examples of art projects employing scientific methods though pursuing symbolisation of an important social issue or an extraordinary phenomenon rather than an exact piece of information. Even art using scientific methods still produces art. However, thanks to its ability to symbolise, every result of science may potentially become art. With further and rapid development of science, we can expect the rise of its new exciting extensions.

In nature just as in culture, symbioses have various functions. Symbionts are mutually beneficial to one another; they share their new knowledge, as well as influence, enrich and help each other. If it proves to be beneficial, also the symbiosis of art and science shall continue to exist and produce remarkable results. Current theories and scientific findings shall create initial environment in which to search for new and unusual art forms while art breaks the existing and potentially dangerous self-confidence of scientists in rather 'anarchistic' way, and names the blind spots of exact approach to learning.

Bibliography

ADAM, Hans Christian. 2010. *Eadweard Muybridge, the human and animal locomotion photographs*. Köln: Taschen.

ADÁMKOVÁ, Tereza. 2010. Styronova viditelná temnota – příběh nemoci. In: M. MIOVSKÝ, I. ČERMÁK & V. CHRZ et al. *Umění ve vědě a věda v umění: metodologické imaginace.* Praha: Grada, pp. 157–169.

ALK, Nell. 2012. The Artist in Action. *Wall Street Journal* [online]. [Retrieved 2013-04-26]. Available at: http://www.wsj.com/articles/SB10001424052702303901504577460742319149810

AUDUBON, John James. 1827–38. *The Birds of America, from original drawings by John James Audubon*. London: John James Audubon.

AUDUBON, John James. 1831. *Ornithological Biography: Or, an account of the habitats of the birds of the United States of America: accompanied by descriptions of the objects represented in the work entitled The Birds of America, and interspersed with delineations of American scenery and manners, Vol 1 & 2*, Edinburgh: Adam Black. Available at: http://www.archive.org/stream/ornithologicalbio02audu/ornithologicalbio02audu_djvu.tx

AUDUBON, John James. 1833. *A letter to Richard Harlan, from Filson Historical Society Special Collections*, Louisville, Kentucky.

AUDUBON, John James. 1999. Account of the method of drawing birds employed by J.J. Audubon, Esq. FRSE. in a letter to a friend. In: *John James Audubon: Writing and drawings*, ed C Irmscher. New York: Library of America, pp. 753–758.

AUDUBON, John James. 1999. My style of drawing birds. In: *John James Audubon: Writing and drawings*, ed C Irmscher. New York: Library of America, pp. 759–764.

BABYRÁDOVÁ, Hana. 2002. *Rituál, umění a výchova*. Brno: Masarykova univerzita.

BABYRÁDOVÁ, Hana. 2008. Dva druhy vizuality – vizualita „primární" a vizualita založená na „obrazech obrazů". In: *Veřejnost a kouzlo vizuality: rozvoj teoretických základů výtvarné výchovy a otázky kulturního vzdělávání*. Brno: Masarykova univerzita, pp. 22–28.

BABYRÁDOVÁ, Hana. 2012. Digitální technologie – umění – výchova a „kůže přírody" ve „virtuální ruce". In: MYSLIVEČKOVÁ, Hana & Veronika JUREČKOVÁ MALIŠOVÁ (eds.). Výtvarná výchova ve světě současného umění a technologií I: využití ICT a dalších nových přístupů ve výtvarné výchově: sborník příspěvků. Olomouc: Univerzita Palackého v Olomouci, pp. 19–27.

BALM, Roger. 2000. Expeditionary art: An appraisal. *Geographical review*, **90**(4), pp. 585–602. Available at: http://jstor.com

BALON, Jan. 2012. Richard Rorty, Filosofie a zrcadlo přírody. *Teorie vědy* [online], **34**(2), pp. 274–278 [Retrieved 2013-02-13]. Available at: http://teorievedy.flu.cas.cz/index.php/tv/article/view/166/160

BANERJEE, Soumya & Nitin AGARWAL. 2012. Analyzing Collective Behavior from Blogs using Swarm Intelligence. *Knowledge and Information Systems*, **33**(3), pp. 523–47.

BARRON, James. 2013. Book published in 1640 sets a record at auction. *The New York Times* [online], 26 November 2013 [Retrieved 2014-02-13]. Available at: http://www.nytimes.com/2013/11/27/nyregion/book-published-in-1640-makes-record-sale-at-auction.html?_r=1&

BARROW, Mark V. 1998. *A passion for birds: American ornithology after Audubon*. Princeton: Princeton University Press.

BATINIĆ, Mirjana. 2011. May the Horse Live in Me. In: *Artyčok. TV* [online]. 14. 04. [Retrieved 2012-12-20]. Available at: http://artycok.tv/lang/cs-cz/7361/may-the-horse-live-in-me

BAUDRILLARD, Jean. 1994. *Simulacra and simulation*. Michigan: University of Michigan Press.

BECKETTOVÁ, Wendy. 2001. *1000 nejkrásnějších obrazů historie*. Praha: Knižní klub.

BECKMAN, Elizabeth. 2002. The Art of Biotechnology? *Visual Resources: An International Journal of Documentation*, **18**(1), p. 68.

BENJAMIN, Walter. 1999. Little History of Photography. In: *Selected Writings Volume 2 1927-1934* Cambridge, Massachusetts, and London: The Belknap Press of Harvard University Press, pp. 507–530.

BLAUGRUND, Annette. 1993. The artist as entrepreneur. In: HATCHNER, Holly & Annette BLAUGRUND (eds.). *John James Audubon: The watercolors for The Birds of America*. New York: Villard Books-Random House, New-York Historical Society, pp. 3–26.

BLOSSFELDT, Karl. 1928. *Urformer der Kunst: photographische Pflanzenbilder*. Berlin: Verlag Ernst Wasmuth.

BLOTNER, Joseph. 1997. *Robert Penn Warren: A biography*, New York: Random House.

BOIME, Albert. 1999. John James Audubon: A birdwatcher's fanciful flights. *Art History*, **22**(5), pp. 728–755.

BOKES, Vladimír. 2007. Hudba – umenie – veda - technika. In: *Kde končí umění a začíná věda, a naopak?: sborník prací z konference pořádané u příležitosti 60. výročí založení Akademie múzických umění v Praze, dne 23. října 2006 v Praze*. Praha: Akademie múzických umění v Praze ve spolupráci s Centrem základního výzkumu AMU & MU, pp. 9–13.

BÖRSCH-SUPAN, Helmut. 1960. *Die Bildgestaltung bei Caspar David Friedrich*. München: Uni Druck.

BOURDIEU, Pierre. 1998. *Teorie jednání*. Praha: Karolinum.

BOURDIEU, Pierre. 2010. *Pravidla umění: geneze a struktura literárního pole*. Brno: Host.

BOWMAN, Doug A., KRUIJFF Ernst, LAVIOLA Joseph J. & Ivan POUPYREV. 2005. *3D User Interfaces: Theory and Practice*. Redwood City, CA, USA: Addison Wesley Longman Publishing Co., Inc.

BRAYSMITH, Hilary. 2002–2003. Caspar David Friedrich: A Pomeranian Cultural Portraitist. *Zeitschrift des Deutschen Vereins für Kunstwissenschaft*, 56/57, Sonderdruck aus Band, pp. 263–270.

BRAYSMITH, Hilary. 2003. Motifs with Meanings or the Lessons of *Imitatio Christi* and *Imitatio Naturae* in the Work of Caspar David Friedrich. *Preussen: Die Kunst und das Individuum*, Akademie Verlag, Berlin, pp. 97–107.

BROUWER, Joke & Arjen MULDER. 2002. *TransUrbanism*. V2_Publishing/NAi Publishers.

BUCHLER, Justus, ed. 2011. *Philosophical Writings of Peirce*. New York: Dover Publications.

BURKE, Peter. 2007. *Společnost a vědění: od Gutenberga k Diderotovi*. Praha: Karolinum.

CEJPEK, Václav. 2007. Věda a umění: dvě strany téže mince. In: *Kde končí umění a začíná věda, a naopak?: sborník prací z konference pořádané u příležitosti 60. výročí založení Akademie múzických umění v Praze, dne 23. října 2006 v Praze*. Praha: Akademie múzických umění v Praze ve spolupráci s Centrem základního výzkumu AMU & MU, pp. 14–16.

CHALMERS, John. 2003. *Audubon in Edinburgh and his Scottish associates*. Edinburgh: NMS Publishing.

CHATFIELD, Tom. 2013. *Digitální svět: 50 myšlenek, které musíte znát*. [Praha]: Slovart.

CHMELÍK, Jiří. 2013. *Virtual Environment Kit for Visual Arts*, Ph.D. thesis. Brno: Department of Computer Graphics and Design FI MUNI.

CÍSAŘ, Karel, ed. 2004. *Co je to fotografie?*. Praha: Herrmann & synové.

CORBY, Tom. 2006. *Network Art: Practices and Positions (Innovations in Art and Design)*. London and New York: Routledge.

COURCHESNE, Luc, LANGLOIS Guillaume & Luc MARTINEZ. 2006. *Where are you? An immersive experience in the Panoscope 360°*. In: MM '06 Proceedings of the 14th ACM international conference on Multimedia. New York, pp. 1027–1028.

COURCHESNE Luc. 2001. *Experiential Art: A Case Study* [online]. [Retrieved 2013-02-13].

Available at: http://ic.media.mit.edu/courses/mas878/pubs/courchesne-02-experiential-art.pdf

DANTO, Arthur C. 1992. *Beyond the Brillo Box: The Visual Arts in Post-Historical Perspective*. Berkeley: University of California Press.

DANTO, Arthur. 1964. The Artworld. *The Journal of Philosophy* [online], **61**(19), pp. 571–584 [Retrieved 2012-11-06]. Available at: http://faculty.georgetown.edu/irvinem/visualarts/Danto-Artworld.pdf

DAVID, Jiří. 2008. *Století dítěte a výzva obrazů: (eseje)*. Brno: Masarykova univerzita.

DAVIDSON, Donald. 1967. Truth and meaning. *Synthese*. **17**(1), pp. 304–323.

DELEUZE, Gilles & Claire PARNET. 2008. *Dialogues*. [Paris]: Flammarion.

DELEUZE, Gilles. 1998. *Rokovania 1972–1990 [Gilles Deleuze]*. Bratislava: Archa.

DELEUZE, Gilles. 2010. *Pusté ostrovy a jiné texty: (texty a rozhovory 1953–1974)*. Praha: Herrmann & synové.

DOPITA, Miroslav. 2007. *Pierre Bourdieu o umění, výchově a společnosti: reflexe sociologie praxe Pierra Bourdieua v české sociologii*. Olomouc: Univerzita Palackého v Olomouci.

DUBOIS, Luke. 2012. Generativní umění. In: *Videa Česky* [online]. Kornhaber BROWN, producent. 30.04. [Retrieved 2012-12-20]. Available at: http://www.videacesky.cz/serialy-online-zdarma/off-book-10-generativni-umeni

DUROZOI, Gérard & André ROUSSEL. 1994. *Filozofický slovník*. Praha: EWA.

ECO, Umberto. 1991. *Foucaultovo kyvadlo*. Praha: Odeon.

ELKINS, James. 2008. *Visual Literacy*. New York: Routledge, Taylor & Francis Group.

ELWELL, J. Sage. 2011. *Crisis of Transcendence: A Theology of Digital Art and Culture*. Plymouth: Lexington Books.

FABUŠ, Palo. 2012. Co jsou to nová média? *Literární noviny* [online], [Retrieved 2013-02-13]. Available at: http://www.literarky.cz/index_o.php?p=clanek&id=3182

FELKEL, Petr. 2009. *Studium na katedře DCGI, sylaby předmětů KPGI ČVUT Praha [online]*, [Retrieved 2013-02-13]. Available at: http//dcgi.felk.cvut.cz

FEYERABEND, Paul K. 1975. *Against Method*. London: Verso.

FEYERABEND, Paul K. 1991. *Three Dialogues on Knowledge*. Oxford: Blackwell Publishers Ltd.

FEYERABEND, Paul K. 2004. *Věda jako umění*. Rychnov nad Kněžnou: Ježek.

FLUSSER, Vilém. 1994. *Za filosofii fotografie*. Praha: Hynek.

FLUSSER, Vilém. 2001. *Do universa technických obrazů*. Praha: OSVU.

FORD, Alice. 1988. *John James Audubon: A biography*. New York: Abbeville Press.

FOUCAULT, Michel. 2002. *Archeologie vědění*. Praha: Herrmann & synové.

FOUCAULT, Michel. 2007. *Slova a věci*. Brno: Computer Press.

FRANCK, B. D. 1817. *Denkmäler der Vorzeit der Insel Rügen und ihrer Umgebungungen*. Greifswaldisches Academisches Archiv, pp. 29–59.

FREEDBERG, David. 1997. Zobrazování a realita. In: *Vizuální teorie: současné anglo-americké myšlení o výtvarných dílech*. Jinočany: H & H, pp. 169–187.

FREELANDOVÁ, Cynthia A. 2011. *Teorie umění*. Praha: Dokořán.

FREEMAN-VLKOVÁ, Michaela. 2000. *AVU.cz* [online]. [Retrieved 2010-04-28]. Internetove umeni vs. Umeni na internetu. Available at: http://www.avu.cz/~vivid/netart.html

FRICKE, Christiane. 2011. Nová média: Umělecké výrazové formy mimo tradiční druhy. In: RUHRBERG, Karl et al., *Umění 20. století: malířství, skulptury a objekty, nová média, fotografie*. Praha: Slovart, pp. 577–619.

GAMERMAN, Ellen. 2010. Birds book soars to record. *The Wall Street Journal* [online]. [Retrieved 2014-10-20]. Available at: http://online.wsj.com/news/articles/SB10001424052748704250704576005751646141670

GANTZ, John F. et al. 2008. The Diverse and Exploding Digital Universe. *International Data Corporation via EMC* [online]. [Retrieved 2008-03-12]. Available at: http://www.emc.com/leadership/programs/digital-universe.htm

GERO, Štefan. 2002. *Verbálna interpretácia výtvarného diela*. Banská Bystrica: Metodické centrum.

GOMBRICH, Ernst Hans. 1995. *Story of Art*. London: Phaidon Press.

GOODMAN, Nelson. 2007. *Jazyky umění: nástin teorie symbolů*. Praha: Academia.

GRABNER, Roman. 2012. Brus – Becksteiner. In: *Zusammenwerken – Zusammenwirke:, Gemeinschaftsarbeiten von Günter Brus mit Künstlerfreuden seit 1970*. Graz: BRUSEUM, Neue Galerie Graz am Universalmuseum Joanneum.

GRACIE, Andy. 2009. Hluboká data. In: *Česká televize* [online]. Petr TOMAIDES. [Retrieved 2012-12-20]. Available at: http://www.ceskatelevize.cz/porady/10121359557-port/veda-a-umeni/499-hluboka-data

GRECMANOVÁ, Helena. 2007. Aktivizační metody v muzejní pedagogice. In: BABYRÁDOVÁ, Hana, GRECMANOVÁ, Helena & Petr EXLER. *Škola muzejní pedagogiky 4*. Olomouc: Univerzita Palackého v Olomouci, pp. 47–76.

GREENE, Rachel. 2000. In: *Web Work: A History of Internet Art.* [online]. [Retrieved 2014-02-11]. Available at: http://www.sfu.ca/~jstockho/courses/iat100/media/RachelGreen_WebWork.pdf

GREENE, Rachel. 2004. *Internet art*. New York: Thames & Hudson.

GREGOROVÁ, Dagmar. 2010. Zhudebněný fyzikální svět. *Osel: objective source E-Learning* [online]. Praha: Osel, 25.06. [cit. 2012-11-06]. Available at: http://www.osel.cz/index.php?obsah=6&clanek=5121

GROTE, Ludwig. 1944. *Caspar David Friedrich: Skizzenbuch aus den Jahren 1806 und 1818*. Berlin: Verlag Gebr. Mann.

GRUNDMANN, Günther. 1930. Schlesien und Caspar David Friedrich. *Schlesische* Monatshefte, 10, pp. 413–428.

GRYGAR, Jiří. 2001. *O vědě a víře*. Kostelní Vydří: Karmelitánské nakladatelství.

GUARDINI, Romano. 2009. *O podstatě uměleckého díla*. Praha: Centrum teologie a umění.

GUILFORD, Joy Paul. 1956. Structure of intellect. *Psychological bulletin*. **53**, pp. 267–293.

HATCHNER, Holly. 1993. Preface. In: HATCHNER, Holly and Annette BLAUGRUND (eds.). *John James Audubon: The Watercolors for The Birds of America*. New York: Villard Books-Random House, New-York Historical Society, pp. vii–ix.

HAVELKA, Miloš. 2010. *Ideje, dějiny, společnost: studie k historické sociologii vědění.* Brno: Centrum pro studium demokracie a kultury (CDK).

HAVLÍK, Vladimír. 2012. *Intermediální tvorba: mezi performancí a videoartem* [DVD-ROM]. Olomouc: Univerzita Palackého v Olomouci.

HEITMAN, Danny. 2008. *A Summer of Birds: John James Audubon at Oakley House.* Louisiana State University Press.

HENCKMANN, Wolfhart & Konrad LOTTER. 1995. *Estetický slovník*. Praha: Svoboda.

HINZ, Sigrid. 1974. *Caspar David Friedrich in Briefen und Bekenntnissen*. Leipzig: Betriebsteil Hildburghausen.

HOENIG, Florian. 2005. Defining Computational Aesthetics. In: NEUMAN, László, SBERT, Mateu, GOOCH, Bruce & Werner PURGATHOFER (eds.). *Computational Aesthetics in Graphics, Visualization and Imaging*.

HORÁČEK, Radek & Jan ZÁLEŠÁK (ed.). 2008. *Veřejnost a kouzlo vizuality: rozvoj teoretických základů výtvarné výchovy a otázky kulturního vzdělávání.* Brno: Masarykova univerzita.

HORÁČEK, Radek. 2010. *Veřejný diskurs výtvarného umění.* Brno: Masarykova univerzita.

HORSKÁ, Eva. 1990. *Československá fotografie*, **41**(12), p. 150.

HORWICH, Paul. 1998. *Truth*. Oxford: Oxford University Press.

HOUSER, Pavel. 2005. *Než přijde vakovlk: dialogy o současné vědě*. Praha: Dokořán.

HUBATOVÁ-VACKOVÁ, Lada. 2011. Vůle k formě: růst rostlin a obrazy vitální síly. *Vesmír*. 90, pp. 666–667.

HUME, David. 2011. *An Enquiry Concerning Human Understanding*. The Project Gutenberg Ebook [online]. [Retrieved 2013-02-13]. Available at: https://www.gutenberg.org/files/9662/9662-h/9662-h.htm

INGERLE, Petr. 2010. *Příběh perspektivy: dějiny jedné ideje: od renesance k modernímu umění a myšlení.* Brno: Barrister & Principal.

INNIS, Harold Adams. 2003. *The bias of communication.* Toronto: University of Toronto.

IRMSCHER, Christoph. 1995. Violence and artistic representation in John James Audubon. *Raritan* [online]. **15**(2). [Retrieved 2013-02-13] Available at: http://web.a.ebscohost.com.lib-proxy.usi.edu/ehost/delivery?sid=e31f2f4c-2c71-4637-92

ISANOVIC, Adla. 2004. *Classification of net.art: Culturally Determined Net.art Is it possible?* [online]. [Retrieved 2014-02-11]. Available at: http://www.cyberaxe.org

JUDD, R. W. 2006. A wonderful order and ballance in natural history and the beginnings of forest conservation in America, 1730–1830. *Environmental History*, **11**(1), pp. 8–36.

KANT, Immanuel. 1975. *Kritika soudnosti*. Praha: Odeon.

KERA, Denisa. 2005. Umělci v laboratořích. *Lidové noviny*. Praha: Lidové noviny, 9.7.,s. V.

KERA, Denisa. 2013. Nová média. *Artlist.cz* [online]. [Retrieved 2014-02-11]. Available at: http://www.artlist.cz/?id=149

KERLINGER, Fred N. 1972. *Základy výzkumu chování: pedagogický a psychologický výzkum*. Praha: Academia.

KLUCKHOHN, Paul. 1953. *Das Ideengut der deutschen Romantik*. Tübingen: Max Niemeyer.

KLUSÁK, Miroslav & Jan SLAVÍK. 2010. Kresba postavy pána – její vývoj v mladším školním věku. In: M. MIOVSKÝ, I. ČERMÁK & V. CHRZ at al. *Umění ve vědě a věda v umění: metodologické imaginace.* Praha: Grada, pp. 187–208.

KOLIJN, Eveline. 2013. Observation and Visualization: Reflections on the Relationship between Science, Visual Arts, and the Evolution of the Scientific Image. *Antonie van Leeuwenhoek*, **104**(4), pp. 597–608.

KOSEGARTEN, Ludwig Gotthard. 1817. *Das Weltgebäude*. Greifswaldisches Academisches Archiv, Mauritius, pp. 60–78.

KRACAUER, Siegfried. 2004. Fotografie. In: *Co je to fotografie?*. Praha: Herrmann & synové, pp. 27–46.

KUHN, H. 1973. Terminal Dates for Paintings from Pigment Analysis. In: YOUNG, W. J. *Application of science examination of Works of art*. Boston: Museum of Fine Arts.

KUHN, Thomas S. 1962. *The structure of scientific revolutions*. Chicago: University of Chicago Press.

KUHN, Thomas S. 1997. *Struktura vědeckých revolucí*. Praha: OIKOYMENH.

KUHN, Thomas S. 2012. Druhé zamyšlení nad paradigmaty. *Teorie vědy* [online]. **34**(2) [Retrieved 2012-11-06]. Available at: http://teorievedy.flu.cas.cz/index.php/tv/article/view/158/166

KUPKA, František. 1923. *Tvoření v umění výtvarném*. Praha: S.V.U. Mánes.

La FONTAINE, Jean. 1704/2007. *The complete fables of Jean de la Fontaine*, trans NR Shapiro, Champaign: University of Illinois Press.

LAMAČ, Miroslav (ed.). 1968. *Myšlenky moderních malířů*. Praha: Nakladatelství československých výtvarných umělců.

LANKHEIT, Klaus. 1950. Caspar David Friedrich und der Neuprotestantismus. *Deutsche Vierteljahrschrift für Literaturwissenschaft und Geistesgeschichte*, 24, pp. 12–143.

LASOTOVÁ, Dáša. 2004. *Čtyři z tváří Jiřího Valocha: [dialogový katalog]*. Ostrava: Ostravská univerzita, Pedagogická fakulta, katedra výtvarné výchovy.

LÁŠTICOVÁ, Barbara & Magda PETRJÁNOŠOVÁ. 2010. Všichni za jednoho, jeden za všechny? O psaní příběhů z výzkumu. In: M. MIOVSKÝ, I. ČERMÁK a V. CHRZ a kol. *Umění ve vědě a věda v umění: metodologické imaginace.* Praha: Grada, pp. 39–53.

LIESER, Wolf. 2009. *Digital Art*. Innovative Logistics Llc.

LIESSMANN, Konrad Paul. 2012. *Universum věcí: k estetice každodennosti*. Praha: Academia.

LIPOVETSKY, Gilles. 2013. *Hypermoderní doba: od požitku k úzkosti*. Praha: Prostor.

LOCK, Russell, COOKE, Louise & Tom JACKSON. 2013. Online Social Networking, Order and Disorder. *Electronic Journal of E-Government*, **11**(2), pp. 229–240.

LYMAN, David. 2014. *Dance photographer* [online]. [Retrieved 2014-02-11]. Available at: http://isphotography.com/2014/03/dance-photographer-studio-photography/

LYOTARD, Jean-François. 1993. *O postmodernismu*. Praha: Filosofický ústav AV ČR.

MACHADO, Penosual, ROMERO, Juan & Bill MANARIS. 2007. Experiments in Computational Aesthetics: An Interative Approach to Stylistic Change in Evolutionary Art. The Art of Artificial Evolution: A Handbook on Evolutionary Art and Music. Springer Berlin Heidelberg, pp. 381–415.

MANETAS, Miltos (ed.). 2006. *NEEN*. Milano: Edizioni Charta.

MANOVIČ, Lev. 2002. Generation Flash. In: *Whitneybiennial.com* [online]. [Retrieved 2013-02-15]. Available at: http://www.manetas.com/eo/wb/files/theories.htm

MANOVICH, Lev. 2001. *The Language of New Media*. Cambridge (USA): MIT Press.

MANOVICH, Lev. 2001. The Language of New Media. *Manovich.net* [online]. [Re-

trieved 2014-02-11]. Available at: http://www.manovich.net/LNM/Manovich.pdf

MANOVICH, Lev. 2002. Principy nových médií. *Teorie vědy*. **XI, XXIV**(2), pp. 55–76.

MARSHALL, Julia. 2004. Articulate images: Bringing the pictures of science and natural history into the art curriculum. *Studies in Art Education*. **45**(2), pp. 135–152.

MARZONA, Daniel & Uta GROSENICK (eds.). 2005. *Minimalismus*. Praha: Slovart.

McCRONE, W. 1990. 1500 padělků. *The Microscope*. (38), pp. 89–98.

McLUHAN, Marshall. 1964. *Understanding Media: The Extensions of Man*. New York: McGraw-Hill.

McLUHAN, Marshall. 2000. *Člověk, média a elektronická kultura: výbor z díla*. Brno: Jota.

McNICOLL, Arion & **Stefanie BLENDIS.** 2013. Liquid lights and musical posters: Welcome to the world of electric paint. *CNN* [online]. [Retrieved 2015-2-5]. Available at: http://www.cnn.com/2013/05/23/tech/innovation/bare-electrically-conductive-paint)

METZNER, Ralph. 2011. *Zelená psychologie*. Praha: Triton.

MEYER, A. 1993. Observations of an American woodsman. In: HATCHNER, Holly & Annette BLAUGRUND (eds.). *John James Audubon: The watercolors for The Birds of America*. New York: Villard Books-Random House, New York Historical Society, pp. 43–54.

MICRAELII, Johannis. 1723. *Antiquitates Pomeraniae, oder Sechs Buecher von Alten Pommerlande*. Johann Kunckels, Stetin and Leipzig.

MIHULKA, Stanislav. 2007. Bio Art spojuje nejmodernější vědu a umění. *Osel: objective source E-Learning* [online]. [Retrieved 2012-11-06]. Available at: http://www.osel.cz/index.php?obsah=6&clanek=2554

MILLER, Arthur I. 2011. *Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc*. New York: Basic Books.

MITCHELL, Timothy F. 1982. From Vedute to Vision: The Importance of Popular Imagery in Friedrich's Development of Romantic Landscape Painting. *Art Bulletin*, **64**(3), pp. 414–423.

MITCHELL, Timothy F. 1984. Caspar David Friedrich's *Der Watzmann*: German Romantic Landscape Painting and Historical Geology. *Art Bulletin*, **66**(3), pp. 452–464.

MITCHELL, William J. Thomas & Mark B. N. HANSEN. 2010. *Critical Terms for Media Studies.* Chicago: The University of Chicago Press.

MITCHELL, William J. Thomas. 2005. *What do Pictures Want? The Lives and Loves of Images*. Chicago: The University of Chicago Press.

MOLNAR, Vera. 1975. In: *Compart: Center of Excellence Digital Art* [online]. [Retrieved 2014-02-11]. Available at: http://dada.compart-bremen.de/item/agent/14

MONDRIAN, Piet. 2008. *Plastic art and pure plastic art, 1937, and other essays, 1941–1943*. San Francisco: Wittenborn Art Books.

MORPURGO-TAGLIABUE, Guido. 1985. *Současná estetika*. Praha: Odeon.

NAKONEČNÝ, Milan. 1998. *Základy psychologie*. Praha: Academia.

NECHVATAL, Joseph. 2002. Voluptuous Viractualism: Hermaphroditic Codes, Robotic Art and Immersive Excess. *Event-Scenes* [online]. [Retrieved 2014-02-11]. Available at: www.ctheory.net

NEUBAUER, Zdeněk. 2001. *Smysl a svět: hermeneutický pohled na svět*. Praha: Moraviapress.

NEUSAR, Aleš. 2010. Báseň ve výzkumu. In: M. MIOVSKÝ, I. ČERMÁK a V. CHRZ et al. *Umění ve vědě a věda v umění: metodologické imaginace.* Praha: Grada, pp. 54–69.

NOLL, A. Michael. 1967a. Computers and the Visual Arts. *Design Quarterly*. (66/67), pp. 65–71.

NOLL, A. Michael. 1967b. The Digital Computer as a Creative Medium. *IEEE Spectrum*. **4**(10), pp. 89–95.

OLSAON, Roberta J. M. 2012. Audubon's innovations and the traditions of ornithological illustration. In: OLSAON, Roberta J. M. (ed.). *Audubon's aviary: The original watercolors of The Birds of America*. New York: Skira-Rizzoli, pp. 41–106.

ORTEGA Y GASSET, José. 1994. *Eseje o umení*. Bratislava: Archa.

PARK, Sung-Hee. 2012. Audubon's The Birds of America achieves $7.9 million at Christie's New York. *Press Release 20 January* [online]. [Retrieved 2014-10-20]. Available at: http://www.christies.com/about/press-center/releases/pressrelease.aspx?pressreleaseid=5335

PARTRIDGE, Linda Dugan. 1996. By the book: Audubon and the tradition of ornithological illustration. *Huntington Library Quarterly*, **59**(2 & 3), pp. 269–301.

PASKO, Jessica M. 2007. Bio-artists use science to create art. *USA Today* [online]. [Retrieved 2012-11-06]. Available at: http://www.ekac.org/pasko.usatoday.html

PATTON, Michael Quin. 2002. *Qualitative Research and Evaluation Methods*. Thousand Oaks: Sage Publications.

PAZDERA, Josef. 2007. Slunce hraje nebeskou hudbu. *Osel: objective source E-Learning* [online]. [Retrieved 2012-11-06]. Available at: http://www.osel.cz/index.php?clanek=2599

PEREGRIN, Jaroslav. 1994. Richarda Rortyho cesta k postmodernismu. *Filosofický časopis*, **42**(3), pp. 381-402.

PETERSON, Roger Tory & Virginia Marie PETERSON. 1990. *Audubon's Birds of America*, Abbeville Press: New York.

PETŘÍČEK, Miroslav. 1997. *Úvod do (současné) filosofie: [11 improvizovaných přednášek]*. Praha: Herrmann & synové.

PETRUSEK, Miloslav. 2008. Společnost jako sociální konstrukce a text. *Teorie vědy* [online]. **30**(3–4). [Retrieved 2012-11-06]. Available at: http://teorievedy.flu.cas.cz/index.php/tv/article/view/4/2

PIAGET, Jean & Bärbel INHELDER. 1997. *Psychologie dítěte*. Praha: Portál.

PIAGET, Jean. 1999. *Psychologie inteligence*. Praha: Portál.

PLINIUS, st. 1974. *Kapitoly o přírodě*. Praha: Svoboda.

POISL, Zbyněk. 2006. Jak funguje analogové a digitální vysílání. *Digizone.cz* [online]. [Retrieved 2014-02-11]. Available at: http://www.digizone.cz/clanky/jak-funguje-analogove-a-digitalni-vysilani/

POPPER, Karl R. 1997. *Logika vědeckého bádání*. Praha: OIKOYMENH.

POSPÍŠIL, Ctirad Václav. 2003. Služba teologie kultuře (teologie v kultuře) a kultura jako teologické téma (kultura v teologii). In: M. ALTRICHTER et al. *Křesťanství a kultura: vědecký seminář pořádaný Katedrou pastorální a spirituální teologie CMTF v Olomouci.* Olomouc: Refugium Velehrad-Roma, pp. 16–37.

POSPÍŠIL, Zdeněk. 1995. O moderně. In: Z. Pospíšil et al. *O kráse a umění*. Olomouc: Univerzita Palackého v Olomouci, pp. 3–45.

PŘIBÁŇ, Jiří. 2008. *Pod čarou umění*. [Praha]: Artlab2007 v nakl. KANT.

PRŮCHA, Jan, WALTEROVÁ, Eliška & Jiří MAREŠ. 2003. *Pedagogický slovník*. Praha: Portál.

PRŮCHA, Jan. 2000. *Přehled pedagogiky: úvod do studia oboru*. Praha: Portál.

PTÁČEK, Milan. 1983. Digitální zpracování a přenos obrazové informace. Praha: Nadas.

RADA PRO VÝZKUM, VÝVOJ A INOVACE. ©2013. Výzkum a vývoj v ČR. *Rada pro výzkum, vývoj a inovace* [online]. [Praha]: RVVI, [Retrieved 2013-02-14]. Available at: http://www.vyzkum.cz/FrontClanek.aspx?idsekce=496

RÁDL, Emanuel. 1999. *Dějiny filosofie. II., Novověk*. Praha: Votobia.

READ, Herbert Edward. 1954. *Education through Art*. Pantheon Books, a Division of Random House.

RHODES, Richard. 2004. *John James Audubon: The making of an American.* New York: Alfred A. Knopf.

RORTY, Richard. 1979. *Philosophy and the Mirror of Nature*. New Jersey: Princeton University Press.

ROVAN, Butch. 2009. *Let us imagine a straight line* [online]. [Retrieved 2011-04-26]. Available at: http://www.soundidea.org/rovan/portfolio_imagine.html

RUBINSTEIN, Raphael. 2005. In a Liquid Medium. *Art in America*, pp. 132–134.

RUSH, Michael. 2005. *New Media in Art*. Thames & Hudson.

SCHEIBLE, Jürgen & Timo OJALA. 2009. MobiSpray: Mobile Phone as Virtual Spray Can for Painting BIG Anytime Anywhere on Anything. *Leonardo*, **42**(4), pp. 332–341.

SCHEIBLE, Jürgen. **2008. Mobile Phone Turned Spray Can.** *Skynews.com* [online]. [Retrieved 208-10-23]. Available at: http://mobilenin.com/mobilenin_news_archieve.php

SCHÖNAU, Diederik W. 2004. Stále objevné vzdělávání prostřednictvím umění.

In: *Výtvarná výchova a mody její komunikace: symposium České sekce INSEA, Olomouc, [7.-9.] listopad 2002*. Olomouc: Univerzita Palackého v Olomouci, pp. 9–19.

SCHWARTZ, Albrecht Georg, 1745. *Kurze Einleitung zur Geographie des Norder-Teutschlands Slavischer Nation und mittlerer Zeiten insonderheit der Fuerstenthueme Pomern und Ruegen*, Hieronymus Johann Struck, Greifswald.

SEKULA, Allan. 2004. O vynalezení fotografického významu. In: *Co je to fotografie?* Praha: Herrmann & synové, pp. 67–91.

SHABI, Katie. 2013. Time and Motion in Art: Futurist Paintings of Movement. *Legomenon* [online]. [Retrieved 2011-04-26]. Available at: http://legomenon.com/time-and-motion-in-art futurist-paintings-of-movement.html

SJÖLIN, Jan-Gunnar. 2011. The body in movement. *The Human Body In Movement* [online]. [Retrieved 2011-04-26]. Available at: http://bodyinmovement.se/

SLAVÍK, Jan. 2001. *Umění zážitku, zážitek umění: teorie a praxe artefiletiky*. Praha: Univerzita Karlova, Pedagogická fakulta.

SMALL, Sabrina. 2011. Harmony of the Spores: John Cage and Mycology. *Gastronomica*, **11**(2), pp. 19–23.

SNYDER, Reba Fishman. 1993. Complexity in creation: A detailed look at the watercolors for Birds of America. In: STEBBINS, Theodore E. & Annette BLAUGRUD (eds.). *John James Audubon: The watercolors for The Birds of America*. Westminster, Maryland: Villard Books-Random House, New York Historical Society, pp. 55–68.

ŠOBÁŇOVÁ, Petra. 2014. When Is Art?: A Theoretical Study to the Frame of Reference in Art Lessons. In: KISIEL, M. & HETMANCZYK-BAJER, H. (eds.). *Integrowanie dzialan pedagogiczno-artystycznych w edukacji elementarnej*. Katowice: Uniwersytet Ślaski w Katowicach, pp. 143–151.

SOLNIT, Rebecca. 2003. *Motion Studies: Time, Space and Eadweard Muybridge*. London: Bloomsbury.

SONTAG, Susan. 2005. *On Photography*. New York: Rosetta Books.

STEBBINS, Theodore E. 1993. Audubon's drawings of American birds, 1805–38. In: STEBBINS, Theodore E. & Annette BLAUGRUD (eds.). *John James Audubon: The watercolors for The Birds of America*. Westminster, Maryland: Villard Books-Random House, New York Historical Society, pp. 3–26.

ŠTĚTOVSKÁ, Iva & Josef STRAKA. 2010. Umění vědy. In: M. MIOVSKÝ, I. ČERMÁK & V. CHRZ et al. *Umění ve vědě a věda v umění: metodologické imaginace.* Praha: Grada, pp. 29–38.

STIBRAL, Karel, DADEJÍK, Ondřej & Vlastimil ZUSKA. 2009. *Česká estetika přírody ve středoevropském kontextu*. Praha: Dokořán.

SUROWIECKI, James. 2004. *The wisdom of crowds*. New York: Doubleday.

SUTIL, Nicolas Salazar. 2012. Laban's choreosophy, Dance Research. *Magazine for contemporary dance*, (30), pp. 147–168.

SÝKORA, Viktor & Věra HROUDOVÁ. 2009. *Tajemství rostlin = Secrets of plants*. Praha: Academia.

SÝKORA, Viktor. 2013. *Tisková zpráva*. Nepublikovaný dokument.

SYROVÁ, Michaela. 2008. V bludisku vizuálnej spoločnosti, In: *Veřejnost a kouzlo vizuality: rozvoj teoretických základů výtvarné výchovy a otázky kulturního vzdělávání*. Brno: Masarykova univerzita, pp. 54–58.

THE AGE: Moving to the algo-rhythm. 2007. *The Age* [online]. [Retrieved 2011-04-26]. Available at: http://www.theage.com.au/news/technology/moving-to-the algorhythm/2007/03/12/1173548107497.html

THOMAS-BAILEY, Carlene. 2011. Body art: Alexa Meade's living paintings. *The Guardian* [online]. [Retrieved 2012-04-26]. Available at: http://www.theguardian.com/artanddesign/2011/aug/31/alexa-meade-living-painting-art

THOMPSON, Nato (ed.). 2012. *Living as a Form: Socially Engaged Art From 1991–2011*. New York: Creative time books.

TOMAIDES, Petr. 2008. Dekonstrukce. In: *Česká televize* [online]. [Retrieved 2012-12-20]. Available at: http://www.ceskatelevize.cz/porady/10121359557-port/veda-a-umeni/270-dekonstrukce/

TORRANCE, Ellis Paul. 1966. *The Torrance Tests of Creative Thinking-Norms-Technical Manual Research Edition-Verbal Tests, Forms A and B-Figural Tests, Forms A and B*. Princeton: Personnel Press.

VALENTA, Lubomír. 2002. K čemu potřebujeme teorii pravdy? In: *Acta Universitatis Palackianae Olomoucensis, Facultas philosophica, Philosophica V*. Olomouc: Univerzita Palackého v Olomouci, pp. 31–39.

VAN MAANEN, John. 1988. *Tales of the Field: On Writing Ethnography*. Chicago: University of Chicago Press.

VANČÁT, Jaroslav. 2009. *Vývoj obrazivosti od objektu k interaktivitě: gnozeolog-*

ické předpoklady analýzy obrazové stránky nových médií. Praha: Karolinum.

VAŠÍČEK, Zdeněk. 2003. *Podmínky volby*. Praha: Triáda.

VEROSTKO, Roman. 1994. Algorithmic Art. In: *Verostko.com* [online]. [Retrieved 2014-02-11]. Available at: http://www.verostko.com/algorithm.html

VIDLIČKA, Jan. 2010. In: *Artyčok. TV* [online]. [Retrieved 2012-12-20]. Available at: http://artycok.tv/lang/cs-cz/4441/prokop-bartonicek-worlds-fragments

VIEGAS, Fernanda & Martin WATTENBERG. [2014]. *HINT.FM* [online]. [Retrieved 2015-02-11]. Available at: http://hint.fm/

VIRILIO, Paul. 2004. *Informatická bomba*. Červený Kostelec: Pavel Mervart.

VOLKMANN, Ludwig. 1926. Die Hieroglyphen der deutschen Romantikern. *Münchner Jahrbuch der Bildendenkunst*, 3, pp. 157–186.

von DALIN, Olof. 1756. In: *Geschichte des Reiches Schweden*, Part 1, trans. J. Benzelstierna and J. C. Daehnert, Hieronymus Johann Strueck, Greifswald.

von GOETHE, Johann Wolfgang. 1982. *Faust: tragédie [ve 2 dílech]*. Praha: Odeon.

Vývoj počítačové grafiky. [2014]. *Multimediální technologie (UMT)* [online]. [Retrieved 2015-02-11]. Available at: http://umt.wikispaces.com/V%C3%BDvoj+po%C4%8D%C3%ADta%C4%8Dov%C3%A9+grafiky

WALLS, Alissa A. 2014. Cy Twombly and the Art of Hunting Mushrooms. *American Art*, **28**(2), pp. 50–69.

WALTHER, Ingo F. et al. 2011. *Umění 20. století: [malířství, skulptury a objekty, nová média, fotografie]*. Praha: Slovart.

WARE, Colin. 2012. *Information Visualization, Third Edition: Perception for Design (Interactive Technologies)*. Morgan Kaufmann.

WILSON, Alexander. 1808-14/2011. *American ornithology; or, The natural history of birds of the United States.* Nabu Press: Charleston, SC.

WILSON, Edward O. 1975. *Sociobiology: The New Synthesis*, New York.

WILSON, Edward O. 1998. *Consilience, the Unity of Knowledge*. New York: Vintage Books, A Division of Random House, Inc.

WILSON, Stephen. 2010. *Art + Science Now, How scientific research and technological innovation are becoming key to 21st-century aesthetics*. London: Thames & Hudson.

WITZGALL, Susanne. 2003. *Kunst nach der Wissenschaft: Zeitgenösische Kunst im Diskurs mit den Naturwissenschaften*. Nürnberg: Verlag für Moderne Kunst.

ZAUNSCHIRM, Thomas. 2005. Die alte und die neue Natur. Kunst als Forschung, Im ZOO der Kunst II. *Kunstforum*, Bd. 175.

ZBIEJCZUK, Adam. 2003. *Net art* [online]. Brno. Bakalářská práce. Fakulta sociálních studií Masarykovy univerzity v Brně. [Retrieved 2011-04-26]. Available at: http://message.sk/text/netart/netart_c.html

ZHANG, Kang, HARRELL, Stuart & Xin JI. 2012. Computational Aesthetics: On the Complexity of Computer-Generated Paintings. *Leonardo*, (3), pp. 243–248.

ZHOŘ, Igor. 1992. *Proměny soudobého výtvarného umění*. Praha: Státní pedagogické nakladatelství.

ZHOŘ, Igor. 1998. Umění, teorie a poslání učitele. In: *Horizonty vzdělávání učitele výtvarné výchovy, Symposium České sekce INSEA 1997*. Praha: Pedagogická fakulta Univerzity Karlovy v Praze, pp. 14–25.

ZLATUŠKA, Jiří. 2012. *Historie AGDaMM* [online]. Available at: http://agdamm.fi.muni.cz/cs/historie

Websites

0100101110101101.org [online]. 2003. [Retrieved 2010-04-28]. Available at: http://0100101110101101.org/home/nikeground/website/index.html

1:1 (2) Lisa Jevbratt [online]. 1999–2002. [Retrieved 2015-09-27]. Available at: http://128.111.69.4/~jevbratt/1_to_1/index_ng.html

220PX [online]. 2005. [Retrieved 2014-02-11]. Available at: http://mariuswatz.com/2005/01/10/220px/

ABSTRACTO01js [online]. 2003/2010. [Retrieved 2014-02-11]. Available at: http://mariuswatz.com/works/abstract01js/.

Art Electronic Media: Stelarc – Ping Body [online]. 2009. [Retrieved 2015-09-27]. Available at: http://www.artelectronicmedia.com/document/stelarc-ping-body

Atariarchives: Software and Info [online]. 2013. [Retrieved 2014-02-11]. Available at: http://atariarchives.org/

Ateliér grafického designu a multimédií Fakulty informatiky Masarykovy univerzity [online]. © 2012. [Retrieved 2013-02-18]. Available at: http://agdamm.fi.muni.cz/cs/historie

Ben Fry [online]. Date not specified. [Retrieved 2013-02-18]. Available at: http://benfry.com/

Bloom [online]. 2013 [Retrieved 2014-02-11]. Available at: http://memento.ieor.berkeley.edu/bloom/Mori.html

Bloom [online]. 2013. [Retrieved 2014-02-11]. Available at: http://hint.fm/projects/bloom/

Česká fotoškola: visual culture [online]. © 2006. [Retrieved 2013-02-18]. Available at: www.ceska-fotoskola.com

Compart: Center of Excellence Digital Art [online]. 2013. [Retrieved 2014-02-11]. Available at: http://dada.compart-bremen.de/

CTHEORY: Extended-Body: Interview with Stelarc [online]. 1995. [Retrieved 2015-09-27]. Available at: http://www.ctheory.net/articles.aspx?id=71

Dichtung Digital: Coding the Infome Writing Abstract Reality by Lisa Jevbratt [online]. Date not specified. [Retrieved 2015-09-27]. Available at: http://www.dichtung-digital.de/2003/issue/3/Jevbratt.htm

FrancescoBonami.com [online]. Date not specified. [Retrieved 2011-04-26]. Available at: www.francescobonami.com

Grammatron [online]. 2000. [Retrieved 2014-02-11]. Available at: http://grammatron.com

Jodi.org [online]. Date not specified. [Retrieved 2014-02-11]. Available at: http://jodi.org

Lev Manovich [online]. 2002. [Retrieved 2011-04-26]. Available at: www.whitneybiennial.com/theories

Medien Kunst Netz: Lisa Jevbratt [online]. Date not specified. [Retrieved 2015-09-27]. Available at: http://www.medienkunstnetz.de/artist/jevbratt/biography/

Mesto.html: Stránka Růženky Šetkové [online]. 1997–1999. [Retrieved 2014-02-11]. Available at: http://www.city.je

MobiSpray [online]. 2014. [Retrieved 2011-04-26]. Available at: http://www.mobispray.com

Natalie Jeremijenko [online]. Date not specified. [Retrieved 2015-09-27]. Available at: http://nataliejeremijenko.com/about/

Osel: objective source E-Learning [online]. 2013. [Retrieved 2012-11-06]. Available at: http://www.osel.cz

Real Snail Mail [online]. Date not specified. [Retrieved 2015-09-27]. Available at: http://www.realsnailmail.net/

San Francisco Museum of Modern Art [online]. © 1998–2013. [San Francisco]: San Francisco Museum of Modern Art, [Retrieved 2012-02-17]. Available at: http://www.sfmoma.org/

Science: AAAS [online]. © 2013. [USA]: American Association for the Advancement of Science, [Retrieved 2013-02-21]. Available at: http://www.sciencemag.org/content/339/6119/510.full

Start Point Prize [online]. Date not specified. [Retrieved 2013-02-18]. Available at: http://www.startpointprize.eu/startpoint/komentar_seda.php

Stelarc: Ear On Arm, Engineering Internet Organ [online]. © 2015. [Retrieved 2015-09-27]. Available at: http://stelarc.org/?catID=20242

Superbad [online]. Date not specified. [Retrieved 2014-02-11]. Available at: http://superbad.com

The Canadian Encyclopedia [online]. © 2012. [Canada]: Historica-Dominion, [Retrieved 2012-11-06]. Available at: http://www.thecanadianencyclopedia.com

The Telegarden [online]. Date not specified. [Retrieved 2015-09-27]. Available at: http://goldberg.berkeley.edu/garden/Ars/

Trends Map [online]. 2014. [Retrieved 2014-02-11]. Available at: http://www.youtube.com/trendsmap

Universalmuseum Joanneum [online]. © 2013. [Graz]: Universalmuseum Joanneum, [Retrieved 2012-02-18]. Available at: http://www.museum-joanneum.at/

Whitney ArtPort: Benjamin Fry [online]. Date not specified. [Retrieved 2015-09-27]. Available at: http://artport.whitney.org/exhibitions/biennial2002/fry.shtml

Whitney Biennial [online]. Date not specified. [Retrieved 2013-02-18]. Available at: whitneybiennial.com/theories.

Wind Map [online]. 2014. [Retrieved 2014-02-11]. Available at: http://hint.fm/wind/

Yoshiyuki Abe: Algorithmic Visual Art [online]. 2014. [Retrieved 2014-02-11]. Available at: http://www.pli.jp/

About Authors:

Mgr. Petra Šobáňová, Ph.D., et al.

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