Relationship of art and technology: Edward Ihnatowicz's philosophical investigation on the problem of perception

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At the earliest stage of computer's history more and more scientists as well as artists were vividly interested in the usage of advanced technology which was available that time. I would like to show that Ihnatowicz's motivation for using computers in the field of art was not strictly artistic or scientific, because he was more interested in resolving the problem of movement but in a slightly different way than other artists representing kinetic art. His investigation of the role of movement in the field of art led him to the more philosophical problems of the body engagement into the perceptual processes and, finally, to the problems of artificial intelligence. He considered the definition of artificial intelligence, which was then elaborated by researchers from computer science labs, not really operational and manageable. Ihnatowicz claimed that any system, natural or artificial, in order to be able to deduce anything about any object simply by looking at it, must at first be able to interact with the perceived object in some mechanical way. Basing on the Ihnatowicz's papers, his book proposal, archival materials and technical documentation I would like to argue that his cybernetic sculptures (i.e. SAM, Senster and Bandit) were not only artefacts, which may be considered as pieces of art, but also very important thought experiments in the field of philosophy of perception and AI.

In the papers of *PAGE,* the bulletin of the Computer Arts Society established in 1969 in London, debate raged about the originality of computer art, triggered by a text by Frieder Nake, published in October 1971. In his manifesto-like statement titled *There Should Be No Computer Art,* Nake said that he did not want to create computer art any more, as "the repertoire of results of aesthetic behavior has not been changed by the use of computers."[1]Nake did not have to wait too long for an answer. In the next issue John Lansdown responded with a text title *Computer Graphics does not equal Computer Art* in which he wrote that Nake's position might be true in case of computer graphics, but is not universally true about the rest of computer art. John Lansdow defined the work of computer art as a process rather than object, and claimed that at least three works come to mind that could not exist without the computer, namely the works of John Lifton, George Mallen's *The Ecogame*, Gustav Metzger's unfulfilled project *Five Screens with Computer* and Edward Ihnatowicz's *Senster*. The latter is described as "computer-controlled, 'intelligent', responsive to its environment in a way which makes other Kinetic art works seem like a toys".[2] During this debate, which lasted for about two years, the name of Ihnatowicz was featured regularly, as his cybernetic sculpture was given as the example of the first genuine computer artwork.

Edward Ihnatowicz claimed that the reason why he wanted to communicate his ideas about perception is that they are valid not only in the field of art but also in the field of science. In my paper I would like to propose a thesis that they were also valid in the field of the philosophy of perception. When we take into account that Ihnatowicz was a pioneer and one of the most outstanding figures in cybernetics and robotic art, it is not an exaggeration to say that he also pushed forward the philosophical understanding of such concepts as perception and intelligence. In this study I would like to show the process in which Ihnatowicz's ideas of mobility and physical interaction as the function of perception and intelligence evolved from the idea of motion in art. Ihnatowicz as an artist is the one of the finest examples of the interactions between art, technology and philosophy.

Ihnatowicz's involvement with computing started when he was working on *Senster* in 1968, one year before the Computer Arts Society was established and "before the possibility of using a computer was even considered", but for him it was such an important experience that even several years later he recalled it in

1 Frieder Nake, *PAGE,* May 1970, all issues of *PAGE* are available here: CACHe Project, Birbeck Collage, London, http://www.e-x-p.org/cache/CASarchives.htm

2 John Lansdown, „Computer Graphics. # *Computer Art", PAGE* 19, December 1971, p. 2.

the article published in the book *Artist and Computer* edited by Ruth Leavitt:

[This] experience has left me thoroughly entrenched in the computing field and apt to regard any present-day artist unfamiliar with computer with some concern![3]

Ihnatowicz studied at the Ruskin School of Art in Oxford, UK but he gave up art as his art activities and achievements dissatisfied him to date and he was dissatisfied by it, and for many years had been working for a company designing furniture, before he decided to leave this business and return to art in 1962. He felt that his art activities and achievements dissatisfied him to date, but in the same time he has resisted the temptation to join any of art trends, which was caused by his disillusionment with figurative art and the mistrust for the abstract one. While working with the old motor cars he made some abstract sculptures on the base of parts from dismantled cars and was hoping to find his own way to create fully genuine art.[4]

It is highly important to stress his artistic background here, as in the time when computer art was in the margins of artistic production and artists working with computers had a lot of trouble defining themselves as artists, Ihnatowicz claimed that he did not care about labels and defined himself simply as an artist interested in technology.[5] He treated the involvement of artists in science and technology as a natural phenomenon, which is not something new, because artists were traditionally involved in the investigation of nature, specifically those aspects of nature which were made accessible by the current technology.[6] His reflection on the relationship between art and science is faithful to the conclusion drawn from the discussion initiated by C.P. Snow's influential 1959 book *Two Cultures.* Snow distinguished there between the scientific and humanistic attitude[7]; the latter were described as being pervaded by scientific method, which is seen as embedded within language and culture, while to the first stance Snow ascribed a belief that the observer can objectively make unbiased, non-partisan observations about nature. Ihnatowicz differentiated between what he considered as a scientific and artistic approach as well, defining the first one by such elements as vision of the world as a vast natural system, operating on absolute and immutable laws which can be discovered by measurement and deduction, searching for firm data and immutable frame of reference; whereas the second one by acceptance of the instance of artist as the only reference point and demonstration of the way in which the world appears, instead of explaining it in an objective way.[8] The paradox of this differentiation exists in the fact that the artistic point of view is very often affected and influenced by scientific and technological enthusiasm and discoveries, so the impact of digital computing, control engineering and research in artificial intelligence is highly noticeable.

Ihnatowicz was fascinated with the concept of motion and methods of generating it. His work was up to a certain point influenced by Jean Tinguely, who was well-known for inventing machines able to move and to perform some imaginary functions as well as by kinetic art. Ihnatowicz's goal was, however, to create pieces capable of moving not in a repetitive way but more in a natural, animal-like way. It was a reason why he was especially keen on stripping a hydraulic breaking system from a car and its reconstruction because of its impressive smoothness and precision in moving heavy objects. This new idea of art was paradoxically a return to his previous interest when he created a number of sculptures out of parts of old motor cars. At that time, he did not treat them as serious or genuine pieces of art, but he simply enjoyed making them. He continued dismantling cars and thus he discovered that the shapes of the highly engineered components of cars are more interesting from an aesthetic point of view rather than his abstract sculptures. He even claimed that they are having "more conviction an air purposefulness and suitability for the task for which they were

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3 Edward Ihnatowicz, "Towards a Thinking Machine", in *Artist and Computer*, ed. Ruth Leavitt (New York: Harmony Books, 1976), pp. 32.

4 Cf. For more biographical details about Ihnatowicz: Richard Ihnatowicz, „Forty Is a Dangerous Age: A Memoir of Edward Ihnatowicz", in White Heat, Cold Logic. British Computer Art 1960- 1980, ed. Paul Brown, Charlie Gere et all. (Cambridge: MIT Press, 2009), pp. 111-118.

5 Brian Reffin Smith, *Soft Computing: art and design*, (Addison-Wesley, 1984), p. 148.

6 Edward Ihnatowicz, "Towards a Thinking Machine", in *Artist and Computer*, ed. Ruth Leavitt (New York: Harmony Books, 1976), p. 32.

7 C.P. Snow, *Two Cultures*, (Cambridge: Cambridge University Press, 1998).

8 Edward Ihnatowicz, "Towards a Thinking Machine", in *Artist and Computer*, ed. Ruth Leavitt (New York: Harmony Books, 1976), p. 33.

intended."[9]
Ihnatowicz tried to discover some methods for controlling the valves automatically and his first attempt to solve this technical problem were hydraulic pistons, which he tried to implement with a little success. After quite a long series of trials he found some pistons together with some servo valves.[10] In 1968 Ihnatowicz was finally able to complete his first cybernetic sculpture, which was in his opinion, the first genuine piece of art he ever made. *SAM (Sound Activated Mobile)* was exhibited at the *Cybernetic Serendipity*, an exhibition curated by Jasia Reichardt in the Institute of Contemporary Art in London.

Ihnatowicz`s idea was focused on constructing a sculpture capable of moving in an animal-like way, therefore he contacted several engineers working with powered prosthesis. He learned that when they want to create a prosthesis, they analyze with maximal accuracy the human limbs during the performance of various tasks. He discovered for example that the motion of a human elbow, when performing well-rehearsed movement from one point to another, can be simulated by an analogue computer because it consists of nearly constant phases of acceleration and deceleration. Ihnatowicz wanted to design a shape that had an air of "purposefulness and suitability for the tasks for which they were intended"[11] and eventually created spine-like sculpture. Zivanovic gives more details:

The microphones were arranged in two pairs, one vertically and one horizontally. For each pair, an analogue circuit was used to measure the phase difference between signal on the microphones (effectively measuring the difference in time of a sound arriving at the microphones, and thus direction of the sound). This output of circuit was used to control the hydraulic servo valves so that the head turned to face the sound source.[12]

This circuit was designed by John Billingsley, a researcher from Cambridge University, and it worked to some extent though not yet perfectly. The sculpture was sensitive to quiet but sustained voice rather than squeals or screams. Jasia Reichardt reflects that "shrieks failed to provoke a response, but quiet words did, and a great many people spent hours in front of SAM trying to produce the right level of sound to attract its attention."[13] She wrote about Ihnatowicz`s sculptures (*SAM* and *Senster*) in the context of deliberation about possible perspective of ultimate machines, which will have desires and needs. Jasia Reichardt treated *SAM* and *Senster* as predecessors of machines that will respond to the environment, move, have means to restore their energy, and participate in dialogue with others.

Although it is very important to have at least minimal technical background to understand his technological ideas, the most interesting point is idea stands behind such experiments and invention. I will skip most of the historical and biographical information about the artist, as one can find them easily in articles by Alexander Zivanovic and Richard Ihnatowicz, but as far as the work of Edward Ihnatowicz is concerned it is impossible not to mention his second sculpture, the worldwide known *Senster* for it may

9 Edward Ihnatowicz, *Portrait of the Artist as an Engineer*, unpublished book proposal, pre-1988, http://www.senster.com/ihnatowicz/articles/artist_as_engineer.pdf

10 Cf. Aleksandar Zivanovic, "SAM, The Senster, The Bandit: Early Cybernetic Sculptures by Edward Ihnatowicz," papers presented on the "Symposium on Robotics, Mechatronics and Animatronica in the Creative and Entertainment Industries and Arts," AISB 2005 Convention, April 13, University of Hartfordshire, Hatgield, UK, 2005, http://www.senster.com/ihnatowicz/articles/articlesabout.htm and Brian Reffin Smith, Soft Computing: art and design, (Addison-Wesley, 1984), p. 150:

> "I can be very precise about when I discovered technology – it was when I discovered what servo systems were about. I realized that when I was doing sculpture I was intrigued or frustrated when I was doing sculpture, because I was much more interested in motion, I was trying to make my figures look as if they were about to take of and start doing something. We respond to people's movements to a much greater extent than we aware of".

11 Edward Ihnatowicz, *Portrait of the Artist as an Engineer*, unpublished book proposal, pre-1988, http://www.senster.com/ihnatowicz/articles/artist_as_engineer.pdf

12 Aleksandar Zivanovic, "SAM, The Senster, The Bandit: Early Cybernetic Sculptures by Edward Ihnatowicz," papers presented on the "Symposium on Robotics, Mechatronics and Animatronica in the Creative and Entertainment Industries and Arts," AISB 2005 Convention, April 13, University of Hartfordshire, Hatgield, UK, 2005, http://www.senster.com/ihnatowicz/articles/articlesabout.htm

13 Jasia Reichardt, „Art at large", http://www.senster.com/ihnatowicz/articles/articlesabout.htm

be perceived as the next step in the process of developing a sculpture that would imitate natural motion of animals or any other living organism. Ihnatowicz discovered that the neck-like shape he designed for SAM imitates somehow the natural form of the neck, however such an effect was not originally intended. He was amazed and astonished when he discovered that an almost identical shape exists in the nature in the joints of a claw of a lobster. It was the similarity in the shape that struck him so much, although the functional parallelism of these mechanisms turned out to be the real discovery:"In the lobster all the joints are simple pivots, but in spite of this apparent limitation and in spite of having only six of them in any leg, the leg can perform all the required motion with the perfect ease."[14] Struck by this idea, Ihnatowicz started sketching a full size sculpture based on such a leg. He planned to use miniature hydraulic actuators, introduced to Phillips by James Gardner in 1967. He used also a digital computer, which ran all the technological devices implemented into Senster. Like SAM, Senster was an interactive work, but in addition to responding to people`s voices it also responded to their movements. It was presented permanently in the Evoluon, a museum dedicated to science and technology in Eindhoven in the Netherlands, from 1970 till 1974 when it was dismantled.

Ihnatowicz was of the opinion that the way we perceive the phenomenon of life is influenced by the new discoveries in the fields of computing, space exploration, genetics, and especially robotics. People cannot ignore the fact that machines become extraordinarily clever and that "we seem to be in the imminent danger of losing our souls."[15] According to Ihnatowicz, an artist should embrace all the changes and follow them; he admitted that he appreciated the differences between scientific and artistic approach but did not care about the labels because although they have different criteria they have also a common goal: finding out what the reality is. In the interview with Jasia Reichardt he admitted that he is closer to the artistic point of view which is more close to life than scientific models.[16]

After *Senster* was shown at the exposition in Eindhoven, Ihnatowicz was invited to join the Mechanical Engineering Department of University College London as a research assistant. He felt a little bit disappointed that it was not a department of computer science since his main area of interest were the problems of intelligence and he considered that the ability of programming had more relevance to the problems he was addresing at that time. He discovered quickly that researchers in A.I. were concentrated on completely different problems and they applied different criteria and methods.

In the interview by Brain Reffin Smith, when asked about plans for the future he answered modestly:

I've done too much thinking and not enough doing, which is what I always complained about other artist.[17]

Ihnatowicz's statement is probably a sign of his disappointment with the fact that due to financial constraints he was able to complete only three works. It might be true from the artistic point of view, but his considerations about intelligence as equally important as his artistic realizations. He claimed in his personal statement that all his efforts were concentrated on the problem of motion but that he wanted to ponder this problem in the wider sense as the epistemological inclination of the idea of motion must be considered at the intersection of engineering and philosophy. Ihnatowicz wrote that the limitation of robotics is the fact that robots cannot deal with any unpredicted changes in their environment and the reason why the scientist cannot solve this problem is our lack of understanding of very complex processes of perception. According to Ihnatowicz, we are not able to learn anything about any object by looking at it, because instead of simple observation we must be able to interact with it in a mechanical way. Moreover, only these

14 Edward Ihnatowicz, *Portrait of the Artist as an Engineer*, unpublished book proposal, pre-1988, http://www.senster.com/ihnatowicz/articles/artist_as_engineer.pdf

15 Edward Ihnatowicz, „Art and Technology today they should be on better terms", brochure published by Edward Ihnatowicz in 1968, http://www.senster.com/ihnatowicz/articles/index.htm

16 Cf. Stephen Wilson, *Information Arts. Intersections of Art, Science and Technology* (Cambridge-Massachusetts: MIT Press, 2002), p. 60.

If I had to determine Ihnatowicz's approach to the relation of art and science, I would describe it, according to criteria established by Steven Wilson in the book *Inforamtion Arts*, as an exploration of new possibilities, because his works function as a research into new capabilities opened up by a line of inquiry.

17 Brian Reffin Smith, *Soft Computing: art and design*, (Addison-Wesley, 1984), p. 147.

aspects of objects that can be modified by such actions can everbe successfully interpreted and understood. This presupposition lead him to important implications in the field of visual data processing as the claim that future "thinking machines", as he called them, will be not just computers but robots. He assumed that the most obvious manifestation of intelligence would be the ability to learn, and he tried to work out the simplest manifestation of that.

Ihnatowicz figured out that if he wanted to work on the problem of intelligence inartificial systems, first he had to solve the problem of defining such concepts as perception, knowledge and information, because he used them without really understanding their meaning. He considered all attempts creating such definitions impossible and the existing definitions unmanageable and came to the conclusion that the only way in which one can define these concepts is to create an ostensive definition which conveys the meaning of terms by pointing out examples, because the nature of the terms is difficult to define verbally. His idea was to rely on case-based reasoning so he decided to abase his research on simple biological organisms like bacterium *Eschericha coli*, lice or maggots, hoping that patterns of their behavior would be so simple that it would serve well as explanation for more complex systems.

What he found illuminating, was the difference in behaviour between the woodlice and maggots which both orient themselves to their environment with very simple sensors. Woodlice like moist places and have a simple device of slowing down their random movements when there is increase in humidity whereas maggots find light by single, non-directional light-sensing organ at the end of their body which they are able to swing from left to right, allowing the amount of light gathered during each swing to determine the extent of their forward motion. The simplest animals respond only to immediate influences such as temperature, brightness or salinity, whereas the higher forms are searching actively for most advantageous conditions, as they are aware of themselves as separate from their environment, which is the acceptable manifestation of intelligence. In the case of maggots they keep altering their course until the amount of light sensed on both sides is equal, so they behave with more efficacy and can direct themselves towards light much more purposefully than the woodlice who will reach its objective only if there it is a continous gradient between the moist and dry areas.[18] The other and more important difference between these two organisms is that maggots are probably able to work out the direction of the light and have the ability to move in its direction. Ihnatowicz speculated on this basis on the relation between perception and the physical motion as its indispensable condition.

Rodney Brooks in the article "Intelligence without representation" wrote that early works in AI concentrated on games, geometrical problems, symbolic algebra, theorem proving and other formal systems, semantics of which were fairly simple, whereas following development in the traditional approach in AI in the late sixties and early seventies has emphasized the abstract manipulation of symbols.[19] Ihnatowicz's criticism of AI research is based on the conviction that looking at the information in abstract way in which we attach meanings to formal arrangements of elements within some set of data is useless in the ground of research of intelligence and perception, because any abstract rules or laws of nature "constitute information only to the extent to which they can be interpreted by specific cognitive system".[20] He investigates this problem starting with the classical argument of the philosophy of perception known as the "Molyneux Problem".

In the letter addressed to John Locke, William Molyneux asked a question whether a man who has been born blind and who has learnt to distinguish and name a globe and a cube by touch, would be able to distinguish and name these objects simply by sight, once he had been enabled to see.[21] Locke used this thought experiment in his *An Essay Concerning Human Understanding*, and gave his own explanation, arguing that a person who lacks some sense will never be able to acquire the ideas pertaining to it, as he distinguished between the ideas we acquire by means of one sense and those we acquire by means of more

18 Edward Ihnatowicz, "Maggoty Intelligance", unpublished, http://www.senster.com/ihnatowicz/articles/maggoty_intelligence.pdf

19 Rodney A. Brooks, "Intelligence without representation", Artificial Intelligence 47 (1991): 139–159.

20 Edward Ihnatowicz, "Maggoty Intelligance", unpublished, http://www.senster.com/ihnatowicz/articles/maggoty_intelligence.pdf

21 "Molyneux Problem", in *Stanford Encyclopedia of Philosophy*, http://plato.stanford.edu/entries/molyneux-problem/

than one sense. Among the ideas that are acquired by combination of senses, Locke reckoned those of space, rest, motion and figure.

I have mentioned Locke in the context of the "Molyneux Problem", as Ihnatowicz's investigations on perception and intelligence is congenial to his philosophical position, his consideration of the maggot's behaviour proved that the minimum requirements for the cognitive system are: one-directional sensory input, one proprioceptive feedback and a motor output, as he claimed that the ability of physical interaction is indispensable in any cognitive process. Ihnatowicz has written about the information processing in relation to a one-input system:

Can the term „information" have any meaning in such situation? In the first place, what is tramsmitted via any communication channel is not information but data. To consider data information implies that the data is on its way to some processing system which is in a position to interpret it by correlation with other data from different channels either arriving simultaneously or previously stored in some memory. In a single-input system such a possibility clearly does not exist.[22]

Ihnatowicz was convinced that most of our appreciation of the world around us comes out of observation, interpretation or sense of physical motion. These are the particular areas where technological innovations and investigations can open a completely new way of perceiving the world and in the same way of understanding of reality. His general argument consists in the claim that all our perceptions depend somehow on the interpretation of physical movement, which we are accustomed to attribute the purpose or intention.[23]

The technology provides us with a variety of sensing systems which, at least theoretically, enable us to construct the machines that mimic the motion of living organisms but in fact the real problem turned out to be more complicated that anyone could have ever expected because as Ihnatowicz claimed: "The essential difficulty lies in the fact that the computers are merely glorified calculating machines and have only memories while what we really need are machines that have understanding." [24]

22 Edward Ihnatowicz, "Maggoty Intelligance", unpublished, http://www.senster.com/ihnatowicz/articles/maggoty_intelligence.pdf

23 Cf. Edward Ihnatowicz, "Towards a Thinking Machine", in *Artist and Computer*, ed. Ruth Leavitt (New York: Harmony Books, 1976), p. 36: "I am planning to make aim ultimately at making the spectator aware of just how refined our appreciation of motion is and how precisely we are capable of interpreting the intention behind even the simplest motion. For an artificial system to display a similar sense of purpose it is necessary for it to have a means of observing and interpreting the state of environment".

24 Edward Ihnatowicz, „Art and Technology today they should be on better terms", brochure published by Edward Ihnatowicz in 1968, http://www.senster.com/ihnatowicz/articles/index.htm