POSTMODERNISM AND CONTROL ENGINEERING

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Abstract

This article intents to discuss the relation between modernism and postmodernism as a reaction to modernism, from the point of view of the science and technology. It makes a parallel between the intelligent control and the new trends in intellectual thoughts. It also addresses the relationship between postmodernism and the fuzzy set theory.

Keywords: Modernism, postmodernism, intelligent control, heuristics, soft computing, fuzzy logic.

1 Modernism and Postmodernism

Modernism is defined by some important features: *rationalism* (the belief in knowledge through reason), *empiricism* (the belief in knowledge through experience) and *materialism* (the belief in a purely physical universe). Postmodernism is a recent movement and a reaction to modernism.

The term Postmodernism was coined in the early 60s to describe the dissatisfaction with the modern architecture and became than a term for reaction to modernism in other fields as well [1]. Postmodern ideas in arts have influenced the philosophy and the analysis of culture and society. As engineers, we are interested to find out if a cultural movement, namely the postmodernism, is able to mark the scientific and the technological visions of our society, or at least, if similarities caused by the same social environment can be revealed in both fields. Since even the architecture, the domain that generated the term has an inevitable technological component, positive answers to the above mentioned quests are natural. The vice versa question is also challenging: are science and technology able to initiate and to determine global trends of the intellectual thinking?

Positive answers have been already given to these questions; our paper is meaning just to bring some personal arguments and opinions.

2 Modernism and Science

Science and society are intimately linked, although the science is often proclaiming its perfect objectivity. Scientific adventures, as the achievement of the atomic bomb, are proving that the society is able to take over the scientists. In the same time any society is depending of its scientific and technological platform. The modernism was initially supported by the mechanization of the industry, fired by the invention of the steam engines. The portrait of the modernist science has some corresponding features: a rigorous mathematical (numeric) support and formalism, a continuous search for abstracting and precision, etc. Further on, the electrical engineering was able not only to value another form of energy, but also to control the industrial processes. The same person, J.K. Maxwell built the theoretical pedestal of the electromagnetism, as well as a milestone for the automate control systems. Electricity made also possible the telecommunications. The electronic computing, analog as well as digital (based on the Boolean logic) emerged. A more than 2000 years developing and growing civilization, seeded by the ancient Greek philosophers, was by now ruling the Earth. The time to look at the stars and to put the foot on the Moon, and why not on other planets, has come.

The modernism best times may be considered as centered on the so called "la belle époque", around 1900. The technological progress in all domains was finally bringing a significant improvement of the quality of life for everybody (well … almost). The young generation was educated with the help of the science-fiction authors J. Verne and H.G. Wells and the perspectives were bright. One of the last modernist cultural items that is fully containing the modernist science vision is considered to be the well-known G. Roddenberry's TV series "*Star Trek – The Next Generation*." Unfortunately the human mentality couldn't match the human intelligence, and the euphoria of the new acquired technological breakdown generated two disastrous world wars and a subsequent long term cold war. These tragic events scattered away the general trust in science and technology, that could be

put in the position to invent and produce global destroying devices. The reactions against modernism began to structure themselves. Writers such as John Ralson Saul among others, have argued that postmodernism represents an accumulated disillusionment with the promises of the Enlightenment project and its progress of science, so central to modernist thinking.

2 Which is the Postmodernist Vision

Constantin Virgil Negoita and others consider Paris as the Postmodernism's birth place, "bursting full-blown" from the brains of Jean Baudrillard and Jean-Francois Lyotard.

Jean-Francois Lyotard understood modernity as a cultural condition characterized by constant change in the pursuit of progress, and postmodernity as the culmination of this process, where constant change has become a *status quo* and the notion of progress, obsolete. Following Ludwig Wittgenstein's critique of the possibility of absolute and total knowledge, Lyotard also further argued that the various "master-narratives" of progress, such as positivist science, Marxism and Structuralism, were defunct as methods of achieving progress. One of the most significant differences between modernism and postmodernism is its interest in universality or totality. While modernist artists aimed to capture universality or totality in some sense, postmodernists have rejected these ambitions as "metanarratives". "Simplifying to the extreme," says Lyotard, "I define *postmodern* as incredulity toward metanarratives" [1].

Postmodernism has features as the tolerance of ambiguity and disorder, stressing on skepticism and nihilism, the mixing of styles and manners, rejection of ultimate reality and absolute truth, lack of determinism and dogmatism. These features are not representing a simple fashion, they are not just "a rage against the machine", their origin is rather linked to the increasing complexity of our perception of the world.

The complexity of some problems created and leaven by the modernist era is now so high, that simple yes/no solutions are not any more possible; for instance the global heating can not be handled with the simple removal of its causes, we simply can not suddenly stop burning fuels. The more we know about a certain subject, a yes/no decision is harder to take about it; in a postmodern society, with a higher rate of educated people, even the public debates are more nuanced, the *pros* and *cons* list is longer.

As a typical postmodernist cultural item we can point again "*Star Trek*", but in its later versions "*The Third Generation*", etc. The popular and impressing futurist technology that was the asset of the first series is now often beginning to fail, of course in the worst possible moments. The members of the Enterprise crew, that were originally pictured as classical stone curved characters, are now beginning to manifest occasional psychic alienation symptoms.

We think that the postmodernist vision can be naturally associated with futurist Alvin Toffler's "*Third wave*" – the post-industrial society, that was characterized by demassification, diversity, knowledge-based production, and the acceleration of change. In 2007, we can say that Toffler's score is 3-1. From the four claimed items, he was mistaking (partially) only the demassification, the other are perfectly matching the actual postmodernist vision. The diversity is now an obvious attribute of the globalization, the knowledge-based society is the postmodernist developed version of the previous modernist information based society and the changes continued to accelerate.

Although useful distinctions can be drawn between the modernist and postmodernist eras, this does not erase the many continuities present between them. As noticed by A. Toffler, the three waves (pre-industrial, industrial and post-industrial) are coexisting. In a certain sense postmodernism is not as much a choice as a conviction.

3 Postmodernism and Science

Some scientific discoveries undermined the very essence of the modernist ideology: the rationalism and the materialism. We will name only two such scientific shocks: *the Relativity Theories* of A. Einstein and the *Big Bang Theory* on the beginning of the universe, of G. Lemaitre. The relativity put in cause the classical mechanics, one of the poles of modernism, a typical yes/not scientific discipline. A. Einstein itself failed to offer a deterministic explanation of the material world. On its side, the big bang theory shacked the idyllically image of the classical materialism: the matter was not created and will never disappear, the time has no beginning and will last forever and the space is endless.

As an anecdote, some (many) years ago, when we asked our Marxist philosophy professor, who was torturing the theory of the expansion of the universe (which was inducing the idea of a possible Creation of the Universe), what explanation can be however be given to the Hubble's law by the Marxism, he answered approximately that "we didn't find yet an acceptable explanation, but we are sure to find it sometimes, in the future." Of course, after a deeper analysis of the big bang's consequences, the materialism of the postmodernist era accepted the big bang idea, because this is not necessarily a proof of the existence of God, as some Marxists were fearing.

The XXth century quantum physics and astronomy showed tensioned evolutions, where thesis and antithesis were constantly emerging. This is also true for anthropology, medicine and biology. All these facts build the belief that truth is more relative than the Enlightenment thinkers had believed [2].

3 Postmodernism and Control Engineering

"Whereas modern science had previously dealt with matter and energy, postmodern science focuses on form and pattern" [2]. This is leading us towards a new fundamental vision of the Universe, as a triad *matter – energy – information*, where the information has a leading role. This vision is much older, even the first words of the Gospel of St. John can be interpreted in this sense, but only Claude Shannon offered a scientific model of the Information.

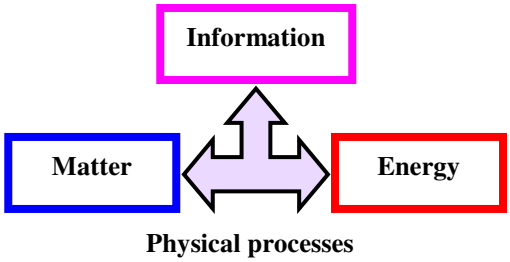

Figure 1. The *matter – energy – information* triad

We think that is not a coincidence that Postmodernism is contemporary to Electronics, the first technology that allow us to control as well energy and information. In industrial processes information is acting by means of the *intelligent control*. The intelligent control at its turn is powered by the Artificial Intelligence AI. Although the modernist shaped minds are objecting the approach, the only notable advances in AI are linked to a typical postmodernist concept, the *Soft Computing*, that is clustering fuzzy logic, neural networks, genetic algorithms and evolutionary computing [3], [4], etc.

The electrical engineering disciplines: electronics, computers, automate control, etc. can illustrate some effects with subversive influence on the modernist rationalistic scientific common sense, we will name only three:

- the Chua's circuit, essentially with only two capacities and one inductivity, is able to generate a chaotic dynamic;

- the precision of the electronic amplifiers is not depending at all of the components, excepting the feedback network; the precision is given essentially by the feedback reaction; a quite similar effect is characterizing the close loop control systems: the precision of the steady regimes is not depending of the components' precision, except the transducer; the simple presence of an integrative device in any point of the loop is eliminating the steady errors.

- the switching controllers' effect: a switching system can be potentially destabilized by an appropriate choice of the switching signal, even if the switching is between a number of Hurwitz-stable close loop systems. This phenomenon can produce catastrophes. For instance, in rare and unpredictable situations, the perturbations produced when switching between automate pilot and manual pilot may cause fatal airplane crashes. Reliable reports on such accidents are not easy to find, but it is unanimously accepted that the on-line switching of two different controllers may produce uncontrollable transient regimes and instability. This effect can not be explained by the conventional system theory in terms of frequency analysis, because its basic tool, the transfer function, is defined for null initial conditions, while the real applications has usually non-null initial conditions. Studying the systems by considering null initial conditions is simplifying a lot the manipulation of the equations, is revealing the specific behavior of the systems and it helps the comparisons between systems and the construction of the general theory of systems. But on the other hand, this quest for generalization can produce unexpected failures in specific conditions.

This is perhaps the most illustrative of the previous examples. The operational calculus (Laplace) is offering a comprehensive image for all the linear systems. The linear system theory established the conventional linear PID control and it can be easily associated to the modernist vision (universality, coherence, etc.) For nonlinear systems on the other hand, frequency analysis has few chances to produce satisfactory results, considering the huge diversification of the problems and the lack of a unified theory. In the case of barely controllable systems (highly nonlinear, time varying, etc.) the only unified approach is, for the time being, the heuristic one. Despite their inherent lack of rigor, the heuristic solutions can be always applied and may be very flexible and comprehensive. The theoretical tool that can help us in this matter is the phase trajectory, a time analysis [8], [9]. This kind of analyze is not able to reveal too much information on the internal structure of the systems, but is very helpful in applications, supporting the heuristic control decisions. The heuristic approach is totally opposite to the Cartesian rigorous modernist vision, but it is relevant for postmodernism. Although it can not be mathematically proved, the heuristics are bringing extremely positive results in most of the applications.

The classical mathematical approach: *hypothesis→conclusion→demonstration* is now beginning to be replaced by a less elegant but more pragmatic methodology: *hypothesis→conclusion→computer simulation*. Instead of solving the differential equations, one let the computers to integrate them, numerically. As a result of this, most of the industrial products, including the 15 million items Airbus 380, are, in our postmodernist days, designed with the help of dedicated software, that are embedding general and specific knowledge of the domain, often acquired by simulations and represented linguistically by expert systems. The lack of a rigorous theory is compensated by serious experimental tests for validation.

4 Postmodernism and Fuzzy Logic

The Postmodern truth is fragmented, subjective and stemmed from approximate reasoning [2]. Epistemologically, this nuanciation of truth is unanimously associated with Lotfi A. Zadeh's fuzzy logic [2], [5], [6], [7], etc. The Aristotelian two valued logic, *true* and *false*, was dominating more than two millenniums the philosophy. After George Boole described it mathematically it get involved into technology, most of all, into control engineering, by the sequential control (relays, electronic digital circuits, PLCs, etc.). The climax of the Boolean logic was the conceiving and the development of the *digital computers*, the particular item that changed the world more that the landing on the Moon. The achievements of the digital technology are obvious and undeniable; however in certain situations it showed some limitations. These situations are generically characterized by the presence of different types and levels of *uncertainty*. If we are not able to classify a concept as true or false, the Boolean logic simply collapses. The uncertainty is anyway a constant of the human reasoning, which operates in a symbolic and qualitative manner. That is why before fuzzy logic, AI encountered enormous difficulties at the computer implementing stage.

Fuzzy logic is able to cope with uncertainty because it accepts not only two values 0 (false) and 1 (truth) for the membership functions, but all the interval bounded by 0 and 1. If the membership function of an element to a certain concept is 0.5, it means that we are not at all sure if the element is belonging to the concept or not, and the fuzziness is maximum. Using fuzzy sets we can represent world knowledge affected by uncertainty in digital computers, as fuzzy linguistic variables, perfectly compatible to human reasoning. Further on, fuzzy logic is able to produce inferences using fuzzy variables and specific yet very simple operations: *min-max*, *prod-sum*, etc. The specific software items that are producing logic inferences by control rules, based on previous human expert knowledge, are *the expert systems*. The postmodernist version of the expert systems are the *fuzzy expert systems*.

In science and technology uncertainty may be caused by our poor knowledge or incorrect information on the system we are dealing with. This is happening when we are not disposing of an appropriate mathematical model of the system, by different reasons: too much complexity, inappropriate sensors, insufficient experimental data, etc. In these circumstances fuzzy logic is producing feasible solutions. Besides the uncertainty caused by our qualitative reasoning and our lack of knowledge, the result of our senses - our perceptions - are uncertain too [6]. Generally speaking, uncertainty is an fundamental attribute of life. That is why fuzzy logic may be successfully applied whenever applications address human beings, or any other biological system. This is the case of air conditioning systems, greenhouses and other related applications. For instance the flexibility offered by the very nature of the fuzzy expert systems and the vague perception of the "comfortable temperature" concept can be converted into energy savings, by means of few specific very simple control rules. Here is an example of such a rule:

IF **temperature** is ***moderate*** **low** AND **change of temperature** is **positive** THAN **save energy**

As a conclusion, we think that what Constantin Virgil Negoita was writing about the echoes of fuzzy concept in Eastern Europe, was crisply true [7]:

"In Eastern Europe, everybody liked the idea of a fuzzy set. Probably because it was coming from California, promising liberties."

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