GRID

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Einig zu sein ist göttlich und gut; woher ist die Sucht denn
Unter den Menschen, daß nur Eines und Einer nur sei?
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THE IMAGINARY OF THE ARTIFICIAL: AUTOMATA, MODELS, MACHINICS

- Remarks on promiscuous modeling as precondition for postmodern ontology

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1. "The image of man": approaching the imaginary of the artificial.

In the book *L'image de l'homme* (1995) (1) Philippe Breton proposes to view the historical invention of the computer as a process circumscribed by unacknowledged imagination. Even if imagination is often acknowledged e.g. in 'progressional' accounts of the history of the computer as acts of 'trivial' genius, somehow linked - the real importance of creative imagination is most often covered over by the need to grasp the momentous 'determinable' impetus of the inaugural technology: logic, computation, programming, signal processing, components, engineering etc. Also in constructivist account of science and technology, the issue of invention in the sense of a constitutive ontological "ordre de contenu" (Dumouchel & Dupuy) (2) is left untouched.

Breton aims at re-situating the question of creation primarily by an inquiry into what he terms a "foundational narrative" 'grounding' this artifact in an ontological parallel to man. The computer is *created* in "the image of man," he argues, as devised indirectly in the early 'parallelism' of first order cybernetics, and explicitly in the agenda of "android epistemology" (Ford et.al) (3) in the AI-programs. More importantly, however, Breton somewhat unintentionally comes to introduce a much more radical problem of constitutive creativity in relation to a particular *misconception* which leads to a

complication, first in the ontological understanding of this machine, and, more radically, in the notion of the machinic *eo ipso* and *in extenso* in the postwar era. The 'imagining' of the machine is constructed on a principal *paradox*:

"There is not anywhere in the world a form of intelligence which can not be considered human and no contemporary computer program can pretend to be assimilated to the human brains functionality [functionnement]. This leads to a paradoxical situation: for each time *artificial intelligence obtains results it ceases to be of concern to this field, to the extent that it achieves a significance in another sense* [my italics, A.M.] (…) (4)

What the early group of mathematicians, engineers, scientist, psychologist etc struggles with from the 30s to the 50s, from Alan Turing's universal machine to the milieu of the Macy-conferences co-defining the development of computer science, technology and applications, is thus something *more*, or to be precise something *different*. The "image of man" leads somewhere else.

For one thing, the genealogy of the computer in the postwar era becomes a force without precedent because it establishes the artificial in a new manner, e.g. as related to the piecemeal and still more comprehensive issuing of a "cosmology of information" (Daniel Parrochia) (5) from cybernetics to complexity science. Secondly, the genealogy of the computer becomes distributed in a variety of creative forms - "cybernetics as metaphor" as Klaus Bartels demonstrates in a study of the connections between cybernetics and structuralism and post-structuralism (6) - not necessarily restricted to computer science, technology and applications. The issues of machine, information, code, communication surges forth within other 'ontological regions' - Marshall McLuhan's Canadian medium theory still being one of the most influential.

We may thus interpret the early struggle as a *critical issue* of how to conceive of an artificial form of Being, that is, as the image of an object "X" in the double sense indicated by Breton: as a process of creative positing of something according to a certain image apprehended from a tradition, e.g. 'man' in a flat and unmitigated sense, yet something different *ex nihilo*, that is, as a "force without precedent" (Breton) (7), which immediately returns to question the very creation that posited it.

From the vantage point of man the issue of 'imagery' or 'imagining' may lead to an *imaginary* which is substantially distanced from the inherited anthropocentric and transcendental bias of creation. From the vantage point of the mechanical, it may lead to an approach to the artificial *de facto* displaced from inherited definitions of the artifact, e.g. as an 'object' or a 'system of objects', that is, more or less determinable and distinguishable from e.g. nature. The net result, however, should not be seen as a simple juxtaposition – as a 'new' image representing a 'new' artifact to somebody, in some capacity. It seems more pertinent to focus on a different relation between the imaginary and the artificial, that is, as an inexplicit and poorly understood impetus for the creative articulation the artificial. What I will term the *imaginary of the artificial,* in the following:

(a) While the android 'definition' has, of course, a long history preceding the computer, within "that intermediate zone, that shadow realm" (Carsten Thau) (8) which unfolds between the dream of humanizing the inhuman and the making of man into a transparent entity through the production of a man-machine, it gathers a particular force at the time of the computer in the sense of a *qualitative* repercussion of a *gradual 'sedimented'* creation of made artifacts with a 'well defined' regime (e.g. the automobile transport system).

In this sense of 'cumulative' history, the *imaginary of the artificial* is not the making transparent of a "shadow realm" but the ongoing creation of forms of the artificial, which, we may say, take on an specific *raison d'être* as an "artificial environment" (Ezio Manzini) (9) towards the closing of the 20th century.

(b) On this background, the notion of the computer comes to relate seriously to a *quantitative* consequence of a *qualitative* specificity and variety of the created, i.e. a *critical radicality* of the complexification of made artifacts. Or, in more cautious terms: the crisis of the artificial will not be solved within the inherited sense of 'invention' of 'mechanism'. It questions the very notion of invention and creation, and comes to lend a new heteronomy to the term genesis: it posits a dire need for an account of the genetics reinforced by the crisis of the artificial because the artificial seems to be taking on a new unacknowledged meaning.

In this sense of territory, if one likes, of 'other-spatial' dispersion - the *imaginary of the artificial* indicates an explicitly novel "shadow realm." To put it differently: we may change the settings of the early debates on the computer by taking them as a point of departure for a specific study of the artificial as something which is not *primarily* divided by the inherited dichotomies of man-machine, mechanism-organism etc., but *imagined*, thus created, from the standpoint of an organizational *novum* with an *ontological contingency beyond inherited determinations and constraints*.

The imaginary of the artificial may thus be put precariously in perspective as a new form of heteronomy. For one thing, it is not at all clear what the 'determinability' of this imaginary 'being' is. For another, the determinability in fact appointed to it may be mistaken, one consequence being that the artificial and the imaginary are confused. What I am talking about is this: the early debates on the computer display a new attitude in relation to the *possible* and the *feasible* which increasingly comes to settle within unclear but unquestionable explicit schemes of the artificial as we see e.g. in the use of terms such as 'cyberspace', 'the network society', 'the cyborg' in the 'construction' of everyday language and culture, or, within the fields of science and technology, e.g. in the projects for nanotechnology, 'weather modification' and biotechnology.

The artificial – the machine - the 'machinic' - in a broad, yet specific sense, the lines of force instrumented by artifacts and by artificial instrumentation - is increasingly becoming a reference for creative conceptions, for creativity *eo ipso* whether one views, for instance - to let 'les extrêmes se touchent' - the tragic schemes currently being set up for commercial marketing of *artificially* cloned children, or the tragicomic ideas to move the Earth by *artificial* means from it's course in order to solve the problems with the Greenhouse-effect.

This may lead to the *thesis* of the present paper: the imaginary of the artificial attains its radicality because it is predicated on *a schism between formal machinic organization (in a post-objective artificial sense)* and *creative constitution (in a new imaginary sense)*. In the following I will discuss this by focusing on two aspects of the imaginary of the artificial:

(1) Machinic self-production: promiscuous modeling. First I will deal with W. Ross Ashby's focus on spontaneous self-organization and the ambiguity of John von Neumann's work with *models* for self-reproduction of automata, pointing forward to extended issues of the artificial.

(2) Modeling and artifact: simulative reality? By the 90s the early ideas of modeling have fed into the impressive momentum of complexity, e.g. self-organization, connectionism, networking. However, the early ambiguity founding the notion of the model within the agenda of the computer and the automaton becomes a peculiar force of the imaginary of the artificial, pointing to a 'neo-cybernetic' impetus in postmodern ontology .

2. Machinic self-production: promiscuous modeling

The complication of the computer is obvious to anybody who can (or cannot) use an ordinary word processing program. The functionality of such a program seems an endless maze of machinic options, which in strange ways bring something 'alive' – often because the support of the GUI-design is highly questionable. However, such trivial problems of complication suggest generic issues of much larger complication and with a much different bias.

In a note from 1946 (published in 1947) W. Ross Ashby – later to be one of the first proponents of 'second order cybernetics' and 'complexity' – debates the possibility of a "self-organizing dynamic system." (10) The widespread denial "that a machine" can be "self-organizing," i.e., that a machine be determinate and yet able to undergo spontaneous change of internal organization, can be critically countered (11) by a look at the human nervous system. This system is both a strictly determinate physico-chemical system and able to undergo self-induced " (…) internal reorganizations resulting in changes in behavior," Ross Ashby writes. (12) On this background one may posit the proposition that a machine can "be at the same time (…) strictly determinate in its action, and (b) yet demonstrate a self-induced change in organization." (13)

Moreover, this may be defined with the particularity of " (…) some real, material dynamic system which we can examine objectively" (14) and yet be specified mathematically, as Ross Ashby

goes on to demonstrate by describing the behavior of what he terms an "absolute system" (15) where " (…) substitutions converting one configuration to the next must form a finite continuous group (…)" Such a system, such a machine, can undergo a "spontaneous change or organization" when one of its variables, "by its physical nature perhaps" Ross Ashby suggests, is "restricted to taking one of two values (…) " (16) thus resulting in different "fields" of organization corresponding to spontaneous change of "certain configurations." (17). In other words, a system with absolute characteristics may yet change spontaneously: a machine may 'produce' spontaneity under well described conditions of configuring.

The early proposition of Ross Ashby is interesting for us, because it is one of the first introductions of the idea of the artificial as capable of self-organizational forms. Moreover, this spontaneity has nothing or at least little to do with the shadow realm of the human, it is defined as a set of *relata* between abstract description and material device: it has the defining characteristic of a model, as this entity is understood from the invention of the computer onwards, that is: it introduces the idea of a *model for artificial self-production*. Thus Ross Ashby is not only questioning the inherited division of the machinic and the organic, these "badly posed questions" (Norbert Wiener) (18), along the lines of early cybernetics. He is *de facto* conjecturing a certain division in the view of how the world is set, by indicating a new machinic order beyond the 'badly' posed questions. Spontaneity is to be understood radically, as the being of a Being which is not, not yet, perhaps not at all, determinable - in any case not easily determinable within the inherited nature-culture dichotomy defining artifacts.

The automaton seems to be prone to a spontaneous 'creativity' of the sort put forward with astounding radicality by John von Neumann from 1945 onwards as a wholly new type of generic artificial form, with the logic and semi-material capacity of self-production across the spectrum of "natural and artificial automata." (19) Even if von Neumann's point of departure is the parallelism of early cybernetics, and even if he never finishes the attempt, and takes great care not to overstep what he sees as the line between scientist and demiurge, he appears quite aware of the prospects of such a singularly new "body of experience" (especially as a form of mathematics) as he puts it in his last attempt at "automata theory," the posthumously published "Silliman Lectures," *The Computer and the Brain* (1958). (20)

Von Neumann's ideas is first indicated in his well known study of the electronic calculator, the ENIAC, the famous "First Draft of a Report on the EDVAC" (1945) (21) outlining the architecture of a serial and stored-program computer – the "von Neumann architecture" - by analogy to the human neurobiology. Inspired by Walter Pitts and Warren McCulloch's idea of a possible outlay of a "logical calculus" of ideas "immanent in nervous activity" Von Neumann outlines the architecture of the EDVAC by comparison to organs in human neurobiology, e.g. "memory" (much to the chagrin of the machines engineering fathers J. Presper Eckert and John Mauchly). (22) However, "The Draft" also displays, from the very beginning, that von Neumann's conjecture is radical in a peculiarly ambiguously manner. On the one hand he does not hesitate to apply aspects of Pitts and McCulloch's neurobiology in stricter terms of logical definition, but on the other, he indicates a motivation for engaging with something that clearly achieves "a significance in another sense" (Breton).

While the significant parallel between neurobiology and computing is to be found at a specific, yet quite abstract level ("it is worth mentioning," he writes, "that the neurons of the higher mammals are definitely elements [computing components] in the above sense. (…)) - primarily in the "all-or-none character" - the digital 'nature' - of both neuron and digital computing components (for attaining two distinct states, ""Quiescent and excited" (23)), he nevertheless goes on:

"Following W. Pitts and W.S. MacCulloch ("A logical calculus of the ideas immanent in nervous activity" (…)) we ignore the more complicated aspects of neuron functioning: Thresholds, temporal summation, relative inhibition, changes of the threshold by after effects of stimulation beyond the synaptic delay, etc." (24)

In other words: von Neumann is merely interested in the potential of the neurobiological analogy to the extent that it may help to devise aspects of the artificial, which consequently comes to linger ambiguously *in between* something more or less well defined (e.g. in relation to the "all-to-none character") and something much more precarious. After all, it is not - and cannot be - very clear how the parallel, e.g. between neuron and vacuum tube in the ENIAC (as indeed the later history of component-miniaturization from transistors to microprocessors, will show) can be conceived 'outside' the realm of the 'digitalism' of von Neumann's model proposed in "The Draft," and, more importantly, how this model will appear as a 'real' embodied apparatus with an assumed parallism to a neurobiological 'object' (e.g. as instrumented with 'organs', 'neurons' etc.).

But in fact von Neumann never hesitates. In his idea of a "general and logical theory of automata," first presented at the 1948 Hixon Symposium (25), he expands on this problematic, first by comparing computers and biological information processing systems (26) in more general terms, then by suggesting, in the concluding sections, a "Broadening of the Program to Deal with Automata That Produce Automata." (27) He asks:

"Can one build an aggregate out of such elements in such a manner that if it is put into a reservoir, in which there float all these elements in large numbers, it will then begin to construct other aggregates, each of which will then at the end turn out to be another automaton exactly like the original one?" (28)

In the draft for a "theory of and organization of complicated automata," from 1949 (29) he continues this dispersal of ideas by aligning the automaton with notions of complication and complexity, and debates whether it is possible to conceive of a reproduction of automata as the emergence of a threshold level issuing a higher degree of complexity, in abstract as well as material form, which is "inconceivable" when looking at the initial state:

"There is thus this completely decisive property of complexity, that there exists a critical size below which the process of synthesis is degenerative, but above which the phenomenon of synthesis, if properly arranged, can become explosive, in other words, where syntheses of automata can proceed in such a manner that each automaton will produce other automata which are more complex and of higher potentialities than itself." (30)

Arthur Burks (who continues aspects of von Neumann's work after his death, especially on cellular automata) reports that von Neumann in the Summer of 48, before the Hixon Symposium, considers a range of components or parts in self-reproducing automata, "eight kind of parts," (31)which demonstrate not only a continuing ambiguity but also a discrete 'slide' from "artificial and natural automata" to something which may well be characterized as an inexplicit and poorly understood impetus for the creative articulation of the artificial. He conjectures the parts in question as; a "stimulus organ," a "coincidence organ," an "inhibitory organ," a "stimuli producer," a "rigid member," a "fusing organ, " a "cutting organ," and a "muscle." (32) If Neumann's sketch is to be taken seriously the actual status of these parts is unclear. It is not clear what status a "muscle" of the kind devised will have in itself (will it be organic, will it be mechanical, will it be … ?) vis-à-vis an "inhibitory organ" (will it be organic, will it be mechanical, will it be … ?) even if Burks and von Neumann defines e.g. the inhibitory organ within the realm of logic and the muscle as belonging to the material 'side'. (33)

Arthur Burks sees this model - a 3-dimensional "kinematic model" - as being one of the most detailed outlay of von Neumann's automaton (together with the 2-dimensional cellular model which he goes on to develop) but in fact it points further to a new territory of abstract/concrete modeling (34). Burks thus specifies and generalizes von Neumann's conjectures in five models of "self-reproducing automata": the "robot model," the "cellular model," the "excitation-threshold-fatigue model," the "continuous model," and the "probabilistic model of self-reproduction and evolution." (35) Even if these models are carefully defined by by recourse to known entities and definitions, it is quite clear that these models point to a step-by-step like entry into a singular territory – a new "body of experience" as von Neumann puts it. Moreover, they belong in fact to a new range of embodied forms: i.e. something pointing towards the modeling of a new class of complex phenomena, which by way of this modeling in itself gains a new complex status: that is, as a possible new 'species' or better, type, or, token of Being.

Overall taken, these manuscripts presents a comprehensive and *promiscuous* (in a non-moralistic sense) vision of how the organic-machinic (analogical) parallelism of early cybernetics can be developed in radical ways by introducing ideas of new artifacts with notions of digital computation, the "digital procedure" (36), in fact an outline of a potential – virtual we would say today - self-production of artifacts within a " (…) coherent body of concepts and principles concerning the structure and organization of both natural and artificial systems, the role of language and information in such systems, and the programming and control of them." (37) Burks summons this in his introduction to von Neumann's papers on computing and computer theory:

"Von Neumann thought that science and technology would shift from a past emphasis on the subjects of motion, forced, energy, and power, to a future emphasis on the subjects of communication, organization, programming and control. He began a theory of automata that would contain the general principles common to artificial automata (computers, robots, complex automated systems) and natural goal-directed systems (cells, organisms, evolution)." (38)

It is clear that the conjecture of the self-reproduction is also a conjecture of self-production, that is, leading to the 'actualization' of, or 'interaction' with, something properly 'virtual'. Although von Neumann in his drafts, as indicated, often situates this as a primary problem of a "general mathematical theory" (Arthur Burks) (39) which may "alter the way

in which we look on mathematics and logic proper" (40) and explicitly attach less importance to the material, this cannot reduce the emphasis on the artificial conjectured as an ambiguous ontological contingency.

As it is clear from Ross Ashby's note, and von Neumanns' work, as well as from conjectures made by Norbert Wiener and others within the founding milieu of computer science and technology, the idea of formal machinic self-organization is not simply, and perhaps not even primarily an abstract form, i.e. a mathematical artifact, but just as much the outline of a state of self-production, circumscribing notions of structure, organization, organism, machine, program, control, communication, redundancy etc. "Automaton" should to be taken 'literal' in any one sense of 'artificiality'. It is not really a well-defined ideal and mathematical issue, or better, the relation between mathematics and materiality is predicated on a whole range of notions and applications with a number of consequences. Thus it stimulates and articulates the conjecture of an *ontological contingency beyond inherited determinations and constraints*, leading, moreover, to a schism between formal machinic organization (in a post-objective artificial sense) and creative constitution (in a new imaginary sense. To put it differently: it is never clear exactly what/who will result from production of this artificiality and what/who is to be seen as constitutive.

3. Modeling and artifact: simulative reality?

In the contemporary science of complexity the emergence of spontaneous behavior for a system is also the production of something new, something un-expected, "surprising" (John L.Casti) and this may be modeled in computer-created "would-be worlds" (Casti) (41) covering a far ranging class of systemic properties – from stock markets to the human brain. Systems:

" (…) that are completely inexplicable by any conventional analysis of the systems' constituent parts. These phenomena, commonly referred to as emergent behavior, seem to occur in many complex systems involving living organisms, such as a stock market or the human brain (…) Complex systems are not new, but for the first time in history tools are available to study such systems in a controlled, repeatable, scientific fashion. (…) with today's computers, complete silicon surrogates of these systems can be built, and these "would-be worlds" can be manipulated in ways that would be unthinkable for their real-world counterparts." (42)

While modelers as Casti observe a Kantian distinction between 'in sich' and 'für sich' (Casti discusses a principal circular diagrammatic of "encoding" and "decoding" of complexity) (43) the modeling of spontaneity may not *in principle* leave out something 'in excess' of the more or less strict formal modeling dynamics of the "science of surprise," e.g. emergence, catastrophe, chaos, connectionism etc.

It may be analogous to other 'surprising' states of the artificial in the sense of Borgesian 'geography' where the model comes to exceed the territory in surprising states because it coincides 'too well' with it, as demonstrated with almost baffling provocation in the fashionable experiments with "Terraforming", e.g. "Biosphere II," in the early 1990s. (44) That is, as the bringing forward of a reality *eo ipso*, as a process of creation *ex nihilo* with an ontological contingency beyond inherited determination. We may thus argue, to put it short, that complexity-modeling *continues* the options, and importantly, the implications, resulting from von Neumann's drafts in the 40s and 50s.

In his book on the origins of cognitive science Jean-Pierre Dupuy debates the importance of the notion of modeling for early cognitive science and artificial intelligence but also, for the question of what sort of artifact the computer can be seen to be (45). The notion of modeling has importance in the sense of "*Verum et factum convertuntur,*" meaning that humans can " (…) have rational knowledge only about that of which we are the cause, about what we have ourselves produced." (46) The production of a model is at the same time a product of and a transcendence of human finitude, because it produces something:

"A model is an abstract form (…) that is embodied or instantiated by phenomena. Very different domains of phenomenal reality (…) can be represented by identical models, which establish an equivalence relation among them. A model is the corresponding equivalence class. It therefore enjoys a transcendent position, not unlike that of a platonic Idea of which reality is only a pale imitation. But the scientific model is man-made. It is at this juncture that the hierarchical relation between the imitator and the imitated comes to be inverted. Although the scientific model is a human imitation of nature, the scientist is inclined to regard it as a "model," in the ordinary sense, of nature. Thus nature is taken to imitate the very model by which man tries to imitate it." (47)

The model abstracts from phenomenal reality "the system of functional relations" (48) putting aside everything else. Models come to obtain a life of their own, " (…) an autonomous dynamic independent of phenomenal reality." (49)

Now, the principle of *Verum et factum* gains a particular emphasis with the invention of the computer from the 1930s onwards. With Alan Turing and Alonso Church's alignment of computation and mechanics a new significance of the machinic is conjectured as the issue of "effective computability:"

"It seems plain to us now that the notion of effective computability that was being sought [in the 30s A.M.], involving only blind, "automatic" execution procedures, was most clearly illustrated by the functioning of a *machine*. It is due to Turing that this mechanical metaphor was taken seriously. In his remarkable study of the development of the theory of automata, Jean Mosconi makes an interesting conjecture about the nature of the resistance that this idea met with in the 1930s: "Considering the calculating machines that existed at the time – the perspectives opened up by Babbage having been forgotten in the meantime -, any reference to the computational possibilities of a machine was apt to be regarded as arbitrarily narrowing the idea of computability … If for us the natural meaning of "mechanical computability" is "computability by a machine," it seems likely that until Turing came along "mechanical" was used in a rather metaphorical sense and meant nothing more than "servile" (indeed the term "mechanical" is still used in this sense today to describe the execution of an algorithm)."" (50)

Thus the idea of Turing and Church *not only* expands on the notion of computability, it expands *on the notion of the machine*. A machine will hence have all the options of computation at its disposal, in more than one sense: one being issues of demonstration of logic, modeling in stricter mathematical terms, one being the actual mechanics of the computing machine, i.e. the computer as working artifact. The ambiguity of the model, of modeling *in extenso*, thus derives directly from the issues of constructing a real computer, hardware and software-wise, if one likes, but it also derives from the issue of application, that is *how* and to *what ends* such a working artifact may be set: the machine may, as concrete instance of the artificial, turn back on the real as "an autonomous dynamic independent of phenomenal reality." It may create something, not in its capacity for incorporated mathematics or in its capacity of calculating mechanics, but in its capacity of *mathematical mechanism*, i.e. in the sense of effective computation, thus *foregrounding 'effect'*.

The ambiguity of the model, of modeling, thus derives directly from the issues of constructing a real material computer, but it also derives from the issue of settings, that is how and to what ends such a machine may be set to work. The machine might just do more than allowed for within the inherited servitude. The machine could, with Ross Ashby's note, be seen to establish a spontaneity which meant that this application had the capacity for spontaneous organization, self-organization, as applied abstract/concrete modeling.

The notion of model thus obtains a disposition for a much wider application – a much wider instantiation of the automaton in a new sense: the computer could in ontological terms be seen to be an artifact with the implication of being disposed to creativity, as indeed the artificial intelligence programs would see it in the 60s and later – "Machines will be capable, within twenty years, of any work that a man can do." Herbert Simon states in 1965 (51). In radical terms: the computer was a model brought alive outside the laboratory: not as some sorcerers apprentice gone wild, but otherwise, in the sense of the laboratory set free, the equipment come alive, wandering about in the world, self-creating and auto-imagining. Dupuy points to two important implications of this problematic:

(a) First, the principle of *Verum et factum* comes to embody a constructive condition for simulative reality. Since the experience with the computer seems to support that we can only know what we can construct, the notion of *factum as* manifested model, becomes the condition of truthful knowing. The principle is turned upside down so to speak, and the fact that science is 'making up' something is qualified as a new form of the real.

(b) Second, and perhaps more importantly this leads to a broader philosophical and historical evaluation of the idea of complexity (and cybernetics as a founding impetus). Dupuy makes clear that notion of machine, simulation, modeling, etc. can be affirmed on a new level which consider the proposition that mechanics as complexity make up a higher principle of 'mechanisation' of the real, that is the disclosure of a third "type of order" – " (…) non reductionist without having to accept holism." (52) Following Friedrich von Hayek, Dupuy argues that the idea of complexity points to an order which albeit humanly created is to complex to be humanly governed, " (…) human beings bring society into existence through their actions," but the ensuing order, is " (…) beyond their control, because it is (infinitely) more complex than they are: " (53)

" (…) spontaneous social order constitutes a third type of order, along with natural order and artificial order. It signifies an emergence, an effect of composition, a system-effect. The "system" is obviously not a subject, endowed with consciousness and will. The knowledge that the system exploits is irreducibly distributed over the set of its constituent elements: it cannot be synthesized in one place, for the system has no "absolute knowledge" about itself that is localized somewhere within it. This

collective knowledge resides in the social order of the system insofar as it is the "result of human action but not of human design"" (54)

For Dupuy there is no question that the cybernetic 'heritage' pervades and informs many contemporary conjectures. Even if this heritage has been passing quite unacknowledged, Dupuy discusses a series of cases and arguments from structuralism and post-structuralism which he sees as mistaken elaborations of cybernetics e.g. mistakingly focused on "a "symbolic" level," "structured like a language." (55)

In the context of this paper, however, the issue of the artificial stands out in a different manner: how is the relation between the artificial order and the third type of order to be understood, once the artificial is seen as something potentially creative? And moreover, if this potential is questioned as related to a form of the imaginary, how will this then affect the idea of a third order?

Or to put it differently: how is the third type of order, the social, to be seen when questioned from the hypothesis of the imaginary of the artificial? That is, when complexity is not only the property of the factual *as* model, but an expression of a reality permeated with these very same principles. Insofar that the third type of order is the social and historical complement of complexity proper, the argument may soon be settled and the artificial is merely an application, or an appendix, of this spontaneous order, as often indicated in contemporary arguments for the network society, socio-cybernetics etc. However, if we acknowledge that the conception of the complex is inherently relayed by the "factum" *of* modeling, that is as an "arte-factum," the solution may become much less transparent. Why these artifacts, why this perspective, why at this time, we may ask: how, and why, is the "ordre de contenu" of complexity actually instantiated, not in the capacity of modeled organizational efficiency, so to speak (e.g. vis-à-vis 'data') but in its capacity of constitution, of deliberate human design (at some level at least).

Dupuy acknowledges this by touching the problem of methodological individualism inherent in von Hayek's approach, but in the light of the artificial we may argue somewhat different. The objectionable post-structuralists becomes an interesting case in point, because they tend to disclose another dimension of a 'neo-cybernetic' complexity. The postmodern ontologies of the artificial in the 90s may pass as neo-cybernetic, not just in a metaphorical sense, but in a painstaking strict sense, since neo-cybernetic means modeling in the sense of effective computability, that is of effective 'incorporated' action. The machines do not abolish man, they wander about among men, they relate to men, they in turn change the entire setting of man, not as a rational Leviathan, the monster of a

"machine à gouverner" the computerized state apparatus of a "cold mathematics" as Wiener quotes Père Dubarle for fearing ironically in the 50s (despite Wiener disagreeing, not without a certain icy 'thermodynamic' approval on his part). (56) But in the much more presumptous sense of *Wired*-editor Kevin Kelly from the mid-90s as "machines with an attitude" (57) counting on a whole new world of the artificial as all-encompassing context for the sadly human "little androids" (Ford et.al) (58) at the mercy of artificial Being. Thus Kelly with zealous enthusiasm describes how the humans in the future will be in need of 'recommendations' from the machine, which they will receive only under certain conditions, as the robot Frederick Hayes-Roth makes clear :

"In summary, humans have a lot going for them. They are not a panacea, but they are the right solution for a class of important and challenging employment problems. Consider this human carefully. Yours truly. Frederick Hayes-Roth." (59)

Nevertheless, we need to be extremely careful: is this the appearance of the third order conditioning artificial creation, or is it something created by a radical new positing of artificiality with an ontological contingency beyond inherited constraints, that is, not necessarily to be summoned by a third order? To revert to this papers thesis: is the ambiguity of modeling persisting in the third order, *because its ultimate 'recourse' lies somewhere else?*

To put it differently: may the sense of ambiguity within cybernetic modeling – 'cleared' as the affirmation of *factum* as a new form of simulative reality leading to a third order, by Dupuy - translate into an idea of auto-imagination and in turn disclose that this translation is in need of constitution – thus questioning the creativity of the third order explicitly, by way of the artificial?

Before we go on, let us remember that postmodern ontologies for all their complacency find an important source in the trajectories of social critique and critical theory from the second half of the 20th century. This may in part explain the particular and deliberate stress of perspectives of " (…) technologies [that] enable us to become directly involved in our transformation, and are bringing about a qualitative change in our being" (Roy Ascott). (60) Such technologies are more often than not seen as potent critical instruments of a new and radical nature – e.g. as pointing to qualitatively new forms of e.g. "abstract machines" with the famous notion of Gilles Deleuze & Felix Guattari - establishing a comprehensive *translation* of the cybernetic heritage, which, in turn, comes to put the inherited technology-pessimism of critical theory, from Adorno to Heidegger, upside down in an act of *de facto* affirmation.

The existence of what Roy Ascott calls an "Inter Reality," a " (…) fuzzy state between the virtual and the real in which our everyday social, cultural and educational interactions takes place." (61) can be promoted and embraced as a highly critical conjecture that aspires to an "imagery" of a new utopian world. Postmodern ontology thus " (…) constitute[s] a multi-layered system of metaphorical and material relays through which "life", "nature" and the "human" are

being redefined" (Kaherine Hayles), (62) but it is *de facto* perhaps more of a 'metaphor' for an ontological contingency beyond inherited determinations and constraints.

Thus one reads in one of the founding manifestoes of neo-cybernetics, Donna Haraway's "A Cyborg Manifesto" from 1984 (63) – a radical appraisal of one of the most presumptuous notions introduced within early cybernetics, Manfred E. Clynes and Nathan S. Kline's idea of a "cybernetic organism" - that the machine promises us a way out of the modern dichotomies between man and machine if only we stop considering it as an "*it*," "to be animated, worshipped and dominated" (64):

"High-Tech culture challenges these dualisms in intriguing ways. It is not clear who makes and who is made in the relationship between human and machine. It is not clear what is mind and what body in machines that resolve into coding practices. In so far as we know ourselves in both formal discourse (for example, biology) and in daily practice (for example, the homework economy in the integrated circuit), we find ourselves to be cyborgs, hybrids, mosaics, chimeras. Biological organisms have become biotic systems, communication devices like others. There is no fundamental, ontological separation in our formal knowledge of machine and organism, of technical and organic. The replicant Rachel in the Ridley Scott film *Blade Runner* stands as the image of a cyborg culture's fear, love, and confusion." (65)

Now this imagery is clearly a constitution of something which departs radically from the mathematical modeling of systems, but it is no less a step into the uncertain. It aspires not "to certain points where cybernetics impinges on religion," i.e. *God & Golem, Inc.* with the title of Wieners book from 1964, (66) but to a creative act of translative imagination, an imaginary of the full-fledged convergence of technology and non-technology, in the radicalized sense: within such schemata this is what *may* and *can* be thought and done: the machinic is seen as 'auto-imagination', i.e. as an auto-creation set at large, or if one likes, as a convergence between artificial imagination and the imaginary of the artificial. The lesson to be learned – and questioned - seems to be:

(a) Self-production. From the early postwar years onwards the issue of artificial self-production is not infeasible or preposterous. This needs to be understood in an expanded sense: the artificial created may be without any or at least very many preconditions whatsoever, it may initiate a field of equally post-human and post-natural 'originary' creations such as it comes to linger with ever-increasing intensity form the 80s onwards, e.g. in the focus on "cyborgs, "monsters" etc.: a radical "reconfiguring" of and by technology, in which "... posthuman creatures equal to but different than humans..." (67) populates a world seen to be equal, but different: but in what sense different and with what specificities?

(b) Cross-breeding. This issue is developed by a continuous and extended 'cross-breeding' of reflections on organic and mechanical phenomena inspired by the pioneers of the computer, establishing a new type of simulative relation between and abstract and concrete. One example:

M.V.Gandhi and B.S.Thompson report on “smart materials and structures” in 1992 (68) (and resonates von Neumann) that these forms to a great extent will be defined through a 'mimesis', "biomimetics": "... exhibiting nervous systems, brains, and muscular capabilities" including organic features such as “Self-repair, self-diagnosis, self-multiplication, and self-degradation (…) ” (69) But how are these ‘creatures’ to be acknowledged except for the fact that they proliferate as an organizational *novum* with an *ontological contingency beyond inherited determinations and constraints* .

(c) Ambiguity. Perhaps, the state of nature – humans and non-humans alike – one of two ‘essential’ starting points for the early cyberneticians, may be the most interesting indicator of the ambiguity following five decades of promiscuous modeling. Gerhard Böhme writes in the early 90s that natures self evidence [Selbstverständlichkit] is disappearing due to artificial reproduction in an expanded yet unclear sense. We still use "classical dichotomies [Entgegensetzungen]" (70) such as "nature and the established [Setzung]," "nature and technique", "the natural versus the artificial and contaminated," "the original versus the civilized," and the "outer and inner," Böhme argues, and yet it has become unclear what nature is, what we will designate as such " (...) whether what we consider as nature, is nature at all, what nature we desire" (71):

"In the dimensions of˙a Terrestial history, a colonization [Besiedelung] of the World’s space is possible without limitations, i.e. the idea of a separation of the human species in artificially adapted life conditions for subspecies or even a dissolution of the art man as species. It is possible to conceive of living beings that only reproduce themselves in a continuous symbiosis with machines. Within such perspectives the expression "artificial nature" in fact comes to designate an intermediate phenomenon, a boundary [Grenze], and perhaps also the point of evolutionary decision" (72).

I believe that these points circumscribe what I have proposed as a schism between formal machinic organization and creative constitution: it is not clear, or better, it is not necessarily a given premise that the self-production resulting from the heritage of the automaton in cybernetics can overcome this schism. But this being so, it is neither very clear that the notion of the human can easily be ‘transcended’ as creative instance. In fact the schism seems to appear in a number of modalities: ad. (a) as the self-production of something with unclear effects; ad. (b) in the complication or complexification by cross-breeding in various ways; ad. (c) in the impossibility to decide what comes from the artificial and what comes from the natural, in turn leading to a need for rephrasing the relation between human and ‘arti-factual’ creativity.

4. Conclusion: ontological conversion?

In closing I would like to turn to Cornelius Castoriadis and his philosophy of the imaginary institution of society. Cornelius Castoriadis’s idea of “the imaginary institution of society,” (73) that is, his plea for an ontological conversion by way of acknowledging the importance of the creative imagination – the *imaginary* - hitherto mostly placed within the more or less

narrow confines of the humanities, e.g. as the aesthetic, the ideological, or the psychoanalytic, or, as indicated above, simply ignored ("occulted" in the terminology of Castoriadis). Nevertheless, he argues that anything that happens to be in the social and historical world which make up the reality of humans is inconceivable without recourse to a "defunctionalized" imagination, instituted as social and historical meaning.

At the most principal level Castoriadis distinguishes between (1) imagination as the formation of images - forms - in the most general sense, including this formation's connection with the idea of invention and creation, and (2) a "radical imagination" which is "*before* the distinction between 'real' and 'fictitious'" (74) :

"(...) it is because radical imagination exists that 'reality' exist *for us* - exists *tout court* - and exists *as* it exists." (75)

However, the imagination is not a free play of faculties, emerging from the depth of the human soul or elsewhere, it is not transparent, so to speak, it is itself a newly engendered form of organization, defined as a social and historical "magma" of significations, a " (...) a type of organization unknown until now (...) " (76) which demands to be dealt with in a 'proper' way, thus pertaining to a specific 'mode', or a specific conditioning, of the human strata of the real. To follow Castoriadis, it must be elucidated by reflection, in order *not to become* heteronomous.

In *L'auto-organisation. De la physique au politique* (1983) Paul Dumouchel & Jean-Pierre Dupuy situates Castoriadis's thought within the 'paradigm' of self-organization as predicated on particular version of this paradigm, that emphasizes "autonomy." (77) The point of departure is the question of whether the social is prone to a concept of self-organization, that is, the question of whether and how social and historical forms may attain a status as self-organized. To put it differently: of how the theme of self-organization seems to both give and attain a distinctive dimension within social and historical reality. The tradition within social thought to conjecture this particularity as a form of autonomy, e.g. vis-a-vis nature, points, they write, to a unique relation between the issue of formal organization and "the order of content" [l'ordre du contenu] (78): the question to be asked is how an assumed universal organization of the real can be translated into the issue of autonomous constitution of the social.

To this end Dumouchel & Dupuy indicates a peculiar *paradoxality*, which they present in three versions (79):

1) The issue of "closure" of autonomy [l'autonomi-clôture], where social and historical self-organization comes to attain a closed form of self-reliance, by way of paradoxical constitution by the external, such as seen in pre-modern religious societies.
2) The autonomous self-organization of modernity [l'auto-organisation du social telle qu'elle est conçue par la modernité] which presents a variant of the theme, where the internal of society is seen to constitute a peculiar autonomy but only in a binding relation to the external.
3) The open or revolutionary autonomy [l'autonomie-ouverture ou révolutionnaire] as conceived by Cornelius Castoriadis, which raises the question of social and historical form's independence *ex nihilo*, that is, a translation of paradoxality into relations between formal organization and constitutive and creative imagination, i.e. "the imaginary institution of society".

Now, this points to what Castoriadis elsewhere terms "ontological conversion" pertaining, among other things, to an answer to a question he poses this way, "How do new social-historical forms emerge?" (80) and answers himself: " (…) the social-historical does not only create, once and for all, a new ontological type of order characteristic of the genus "society." (81) This type is " (…) each time "materialized" through different *forms*, each of which embodies a *creation*, a new *eidos* of society (…) and moreover, " (…) creation, as the work of the social imaginary, of the *instituting* society (…) is the mode of being of the social-historical field, by means of which this field *is*. Society is self-creation deployed as history " (82)

I hope to have indicated that across the historical 'space' that is made up by five decades of promiscuous modeling, the computer may be seen as an inexplicit and poorly understood impetus for the creative articulation the artificial – from von Neumann's automaton to the neo-cybernetics of postmodern ontologies. The issue of creation, as debated in the 90s – from the various (more or less postmodern) ideas of 'autopoiesis' over Bruno Latour's radical relativism of the translative "quasi-object" to Felix Guattari's *de facto* appraisal of computer media as a form of machinic heterogenesis – to mention some 'programmatic' positions – seems to converge in their view of creative self-organization as somewhat machinic and autonomous. However, our brief excursion into details of these ideas possible 'origin' (alas) seems to indicate a highly difficult schism between a proliferating number of machinic organizations and their creative constition(s) (approached with almost feverish energy in postmodern precursor-work such as Guattari's *Molecular Revolution* (1984/1977/1972)) (83) which in their ultimate definition need to become attached, or better, coupled with the ontological form of the human strata of the real in order for this creativity to be possible: to *give or project meaning related to us*. If the *inverse projection* of the imaginary of the artificial in artificial imagination makes sense in such a context it is only as a certain expression of an ontological contingency beyond inherited determinations and constraints, elaborating on a peculiar autonomy pertaining to this strata.

To conclude: the imaginary of the artificial is exposed but not elucidated by the promiscuous modeling debated in this paper. Thus it points to momentous prospects, developments, and challenges in the 21st century: I have alluded to a few of them above. The neo-cybernetics of postmodern ontologies may be used as a highly informed conjecture: but only if it is used to indicate how machines 'fill up' this world in surprising ways, and how they do not constitute it, but complexify it in the proper sense of 'couplings', e.g. nodes, or perhaps relays, "lines of force, a cohesion, the unfolding of something in part systematic" (Castoriadis) (84) within the spectrum of self-organization, or to be precise: to indicate the intricate workings of the imaginary of the artificial as a specific mode of organization on the human strata of the real (in this paper I have made some indications). Or with Gilbert Simondon's early, but highly apt, definition of the computer from 1958: the computer is "marginally indeterminate" because of its potential for universality: because this machine is so highly applicable, it has to demand "perpetual innovation" from a cultural context in order to translate into use, (85) not the converse as tend to be the real argument within neo-cybernetics.

Ezio Manzini has argued along the same lines, significantly, for the existence of what I have termed a *schism* between the creation of the artificial *and* the lack of insight into the distinctive character of the artificial, not least as a dedicated 'layer' of the human strata of the real. "To man the artificial is a completely natural activity," he writes, but the resulting artificiality, nonetheless appears as "an unknown artificial world that we must examine to discover its qualities

and laws." (86) It is necessary to establish positive connotations for the artificial, Manzini argues. When reflected, the neo-cybernetic ontology of postmodernism may become such a connotation.

Notes:

(1) Philippe Breton, *À l'image de l'homme. Du Golem aux creatures virtuelles*. Paris: Éditions du Seuil 1995.
(2) Paul Dumouchel & Jean-Pierre Dupuy (dir.) *Colloque de Cerisy: L'auto-organisation. De la physique au politique*. Paris: Éditions du Seuil 1983, p.17.
(3) C.f. Kenneth M. Ford, Clark Glymour & Patrick Hayes (eds): *Android Epistemologi,* Menlo park/Canbridge/London: AAAI Press/MIT Press, 1995.
(4) Breton, *op.cit*., p.102.
(5) C.f. Daniel Parrochia, *Cosmologie de l'information. Pour une nouvelle modélisation de l'univers informationnel*. Paris: Edition Hermès 1994
(6) C.f. Klaus Bartels, "Kybernetik als Metapher. Der Beitrag des französischen Strukturalismus zu einer Philosophie der Information und der Massemedien", in Helmut Brackert und Fritz Wefelmayer, *Kultur Bestimmungen im 20. Jahrhundert*. Frankfurt a.M.: Suhrkamp Verlag 1990, p.441ff.
(7) Breton, op.cit., p.101.
(8) Carsten Thau: "Menneske-automaten. Levende statuer mellem barok og romantik" [The man-machine automaton. Living statues between the baroque and the romantic], in *Kritik 105* (Copenhagen: Gyldendal) *1993*, p. 46 ff., p. 47.
(9) Ezio Manzini: *Artefacts. Vers une nouvelle écologie de l'environnement artificiel.* Les Essais. Paris: Centre Georges Pompidou 1991.
(10) W. Ross Ashby, "Principles of the self-organizing dynamic system", in *The Journal of General Psychology 1947, Vol. 37*, pp.125ff.
(11) Ibid., p.125.
(12) Ibid.
(13) Ibid.
(14) Ibid.
(15) Ibid., p.126.
(16) Ibid., p.127.
(179 ibid., p.128.
(18) C.f. Norbert Wiener: *Cybernetics: or Control and Communication in the Animal and the Machine,* Cambridge, Mass.:The MIT Press, 1991 (1948), p. 44.
(19) C.f. Arthur Burks, "Introduction", in William Aspray & Arthur Burks (eds), *Papers of John von Neumann on Computing and Computer Theory*. Cambridge, Mass.: The MIT Press 1987, p.367. The collection consists of original papers and notes from von Neumann, as well as text edited and supplemented by Arthur Burks. The chronology of the papers is clarified in "Biographical Notes", p.xiiiff.
(20) John von Neumann, *The Computer and the Brain*. New Haven and London: Yale University Press 1969 (1958), p.2.
(21) John von Neumann, "First Draft of a Report on the EDVAC", in Burks et.al., *op.cit*., p.17ff.
(22) Ibid., p.24.
(24) Ibid.
(25) C.f. John von Neumann, "The General and Logical Theory of Automata", in Aspray et.al., *op.cit*., p.391ff.
(26) Ibid., p.399ff.
(27) Ibid., p.418ff.
(28) Ibid., p.418.
(29) C.f. John von Neumann, "Theory and Organization of Complicated Automata", in Aspray et.al., op.cit.,p.432ff.
(30) Ibid., p.483.
(31) Ibid., p.484ff, p.484.
(32) Ibid.
(33) Ibid.
(34) Ibid., p.485ff.

(35) C.f. Burks, *op.cit*, p.374ff.
(36) C.f. John von Neumann, *The Computer and the Brain*, p.6ff.
(37) Burks, *op.cit*. p.364
(38) Ibid., p.365.
(39) Ibid., p.363.
(40) von Neumann, *The Computer and the Brain*, p.2.
(41)) Cf. John L. Casti: *Complexification*. HarperPerennial 1994; John L. Casti: *Would-Be Worlds*, New York: John Wiley & Sons, Inc. 1997; John F. Casti, *Reality Rules: I. Picturing the World in Mathematics - The Fundamentals* -. New York: John Wiley & Sons, Inc. 1992; John F. Casti, *Reality Rules: II. Picturing the World in Mathematics – The Frontier* -. New York: John Wiley & Sons, Inc. 1992.
(42) John L. Casti, "Complexity". Encyclopædia Britannica http://search.eb.com/eb/article?eu=108252 [Accessed May 14, 2002]. © 2002 Encyclopædia Britannica Inc.
(43) C.f. John L. Casti, *Reality Rules: I. Picturing the World in Mathematics – The Fundamentals*-, p.28ff, p.29.
(44) C.f. See John Allen et al.: *Biosphere 2*. Space Biosphere Ventures, 1991; Anders Michelsen, "The artificial environment: Smart design - Design semantics and designer-intelligence", in Peter Weibel (ed), *Olafur Eliasson: Surroundings Surrounded. Essays on Space and Science.* Cambridge Mass.: MIT Press 2002, p. 394ff.
(45) Jean-Pierre Dupuy, *The Mechanization of the Mind. On the Origins of Cognitive Science*. Princeton: Princeton University Press 2000.
(46) Ibid., p.27ff, p.28.
(47) Ibid., p. Ibid., p.29-30.
(48) Ibid.
(49) Ibid., p.31.
(50) Ibid., p.35.
(51) Ibid., p.39.
(52) Ibid., p.157.
(53) Ibid.
(54) Ibid.
(55) Ibid., p.158.
(56) Norbert Wiener, *The Human use of Human Beings*. Cybernetics and Society. New York: Doubleday & Company Inc. 1954 (1950), pp.178-180.
(57) Kevin Kelly, *Out of Control. The New Biology of Machines London*: Fourth Estate Limited 1994. Ibid., p.37ff.
(58) Ford et.al., *op.cit*., p.xvii.
(59) Kelly , op.cit., p.71.
(60) Roy Ascott: "The Architecture of Cyberception", 1994, p.1. This text has circulated in a variety of versions on the Internet. The quotes in this article is based on a version presented at the Conference "Cybersphere", Stockholm 1994 kindly relayed to the author by Ascott.
(61) Ibid.,p.3.
(62) N. Katherine Hayles: "Narratives of Artificial Life", in Anders Michelsen & Frederik Stjernfelt (eds.): *Billeder fra det fjerne. Videnskabelig visualisering - en antologi/Images from Afar. Scientific Visualization - an anthology.* Copenhagen: Akademisk Forlag 1996, p.180.
(63) Donna Haraway: *Simans, Cyborgs and Women. The Reinvention of Nature*. London: Free Associations Books 1991.
(64) Ibid., p.180.
(65) Ibid., p.177-178.
(66) C.f. Norbert Wiener, *God & Golem, Inc. A Comment on Certain Points where Cybernetics Impinges on Religion*. London: Chapman & Hall 1964.
(67) Chris Hables Gray et. al.: "Cyborgology", in Chris Hables Gray (Heidi J. Figueroa-Sarriera & Steven Mentor) (eds), *The Cyborg Handbook.* New York/London: Routledge 1995, p.3.
(68) M.V. Ghandi and B.S. Thompson, *Smart Materials and Structures*. London: Chapman & Hall 1992,
(69) Ibid., p.ix., p.58ff.
(70) Gernot Böhme, *Natürlich Natur. Über Natur im Zeitalter ihrer technischen Reproduzierbarkiet*. Frankfurt a.M.: Suhrkamp Verlag 1992, p.11ff.
(71) Ibid., p.15.
(72) Ibid., p.196.

(73) Cornelius Castoriadis, *L´Institution imaginaire de la société*. Paris: Éditions du Seuil 1975; Cornelius Castoriadis:*The Imaginary Institution of Society,* Polity Press 1987. See also biography, bibliography, and mail updates on http://aleph.lib.ohio-state.edu/~bcase/castoriadis.
(74) Cf. Cornelius Castoriadis, "Radical Imagination and the Social Instituting Imaginary,"in David Ames Curtis (ed), *The Castoriadis Reader.* Oxford: Blackwell Publishers Ltd. 1997, p.319ff, p.321.
(75) Ibid.
(76) Cornelius Castoriadis, "The Imaginary: Creation in the Social-Historical Domain", in David Ames Curtis (ed), Cornelius Castoriadis: *World in Fragments. Writings on Politics, Society, Psychoanalysis, and the Imagination*, Stanford: Stanford University Press, p.12.
(77) Dumouchel & Dupuy, op.cit., p.21ff.
(78) Ibid., p.17ff.
(79) Ibid., p.21 ff.
(80) Castoriadis, "The Imaginary: Creation in the Social-Historical Domain", p.14.
(81) Ibid., p.13.
(82) Ibid.
(83) Felix Guattari, *Molecular Revolution. Psychiatry and Politics.* Harmondsworth: Penguin Books 1984.
(84) Cornelius Castoriadis, *Les carrefours du labyrinthe.* Paris: Éditions du Seuil 1978, p.303
(85) Gilbert Simondon, *Du mode d'existence des objets technique.* Editions Aubier 1989 (1958), p.11ff.
(86) Manzini, op.cit., p.44, p.52.