The Epistemological Turn: Technology, *Bricolage* and Design

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Abstract

The rapid development of technology – especially of information and communication technology – and the recognition of the essential complexity of most systems and phenomena are producing a series of crucial consequences, both theoretical and practical, among which the renunciation of the dream of perfect rationality and perfect control. As science is being surpassed by technology, in the realm of design all this is bringing about a revival of *bricolage*, an apparently primitive design strategy characterized by the use of second-hand materials (possibly already used for other purposes) when more appropriate materials are not available, and by the non conventional use of tools or methods designed and intended for a different use. In *bricolage* rationality yields to opportunism, to small advancements and immediate gain, globality yields to locality. The reappearance of *bricolage* involves not only the practice of design but also the way we learn and understand: in other words it brings about a crucial change in epistemology, the more so as the technological instruments called for in these practices are “mind machines”, i. e. computers and the Internet.

1. Science and technology

In the second half of the XXth century an event of paramount importance took place: science was overtaken by technology. Let me be more precise about this. Ancient Greeks believed that to know something is equivalent to possess a *theory*, i. e. a detailed and thorough explanation or description of that something expressed in a precise linguistic form, e. g. a formula or a sentence. Today we would consider an *algorithm* a proper description: actually an algorithm is a detailed procedure to perform computations or more generally to go from state A to state B of whatever phenomenon or process we are interested in. The basic difference between a closed formula and an algorithm is that the formula is a sort of abstract or résumé and does not always indicate how to act practically, whereas the algorithm is a transparent set of instructions that can be implemented on a computer or executed by hand in a slavish and unimaginative way.

Be that as it may, our Western culture has inherited this propensity for explicit rationality and theoretical precision. In fact, we deem speculative intelligence superior and nobler than practical intelligence: discovering mathematical theorems or building theoretical philosophy is more impressive and awe-inspiring than crossing a street bustling with traffic or driving a car in the chaos of the rush hour. This inclination is at the basis of Western science. Moreover, the top of Western science is attained with the formalism of mathematics.

Today, however, the situation is changing, and the main reason is the rapid and turbulent advance of technology. Technology, especially communication and information technology, is developing so fast that theory cannot keep pace with it. Quite often the speed and complexity of technology prevent science from offering coherent and thorough explanations of the functioning and effects of the tools, devices and systems produced by technology. It is more and more difficult to assess the consequences of technological applications. In our actions, plans, and enterprises, we are driven by our consciuos purpose, but often the results we achieve do not agree with the expected ones. Such an unpleasant situation originates from the interaction of human plans and designs with the *complexity* of the real world, that limits, constrains and opposes the scope, extent and direction of our projects.

As a consequence, *uncertainty* breaks into history, society, market: in particular the relations between society and technology are unpredictable, and the unpredictability is increased by the fact that many innovations are unfinished and do not have definite boundaries. Designers often construct seeds or *embryos* of innovations, that later evolve under the effect both of design rules and of random interactions with the environment. Such embryonic innovations intertwine with existing systems to form inextricable tangles. That is the case e. g. of genetically modified crops that come in contact with traditional plants, triggering unforeseeable developments. Think also of software programs, that are launched on the market to be tested and improved by users. Or think of social networks, whose evolution depends on the contributions of thousands or millions of users and, within the technical constraints, can undergo chancy developments and twists. This is self-organization at work: coherent phenomena emerging from chaos.

When we try to understand (or modify) reality, we usually adopt a Cartesian approach: our cultural tradition urges us to split reality (or a part of it) into separate components, disregarding their interactions. But interactions are always at work and make the results of our interventions unsure and often risky. To make a long story short, our ability to act and construct (and destroy) has now surpassed our ability to understand and foresee. In this sense technology has outdone science. To enter the market and homes, technology does not wait for science and its authorizations.

To some extent, things always went that way: quite often elementary inventions did not need a theoretical justification, they simply were applied and worked (or failed). But starting from, say, the middle of the XIXth century, the increasing complexity of machines and tools demanded a rigorous foundation, that was provided by the parallel developments of science. Science, however, found it more and more difficult to undertake this task. To give you an example, Guglielmo Marconi, the inventor of radio, was looked at with a certain amount of haughtiness by contemporary physicists, who considered the radio as the result of ingenuous improvisation rather than of serious studies on electromagnetism. Actually, some academicians had maintained that radio could not work. As another example, Simon Newcomb, one of the most prominent U.S. scientists of the end of the XIXth century, strongly opposed efforts by Samuel Pierpont Langley to build a piloted winged aircraft, because according to the theory such an aircraft could not fly. History has proven that Newcomb was wrong.

I have not the ambition to disentangle the thorny relations between science and technology, I only remark that today our ability to act has exceeded our ability to foresee the consequences of our actions. And this is due in particular to the dramatic advances in information and communication technology, especially simulation. It is interesting to observe that in general users of technical instruments are not in the least interested in understanding their functioning, they only wish to use them. Technology is important for what it allows us to *do*, not to *understand*.

2. *Bricolage*

The fact that many contemporary technical innovations do not have a (complete) scientific explanation entails a change in the epistemological contents of technology, about which I shall talk later. For the moment I wish to emphasize that many products of technology are not clear-cut individual "machines" or "tools", as in the past, but rather complex "wholes" or "systems" without precise boundaries, often possessing an articulated, almost organic structure, intersecting other artificial products or natural structures in an irregular, even chaotic way, reminiscent of the frontiers of fractal objects. Also, as I have already hinted at, some artifacts are unaccomplished and achieve their evolution in the real world (e. g. genetically modified organisms). This unaccomplished character is shared by several design products, that are launched in a hopefully favourable environment to complete their development, sometimes with surprising end results.

In the light of these considerations, it is appropriate to use the term *bricolage* to indicate many processes and products of contemporary technology. It can be argued that the Internet, a substantial part of software, some parts of biotechnologies and other important technological sectors develop more by virtue of *bricolage* than of rational and organic planning and design. To understand the meaning of the word *bricolage* and *bricoleur* I shall quote a passage from the first chapter (*The science of the concrete*) of *La pensée sauvage*, *The Savage Mind*, an important book by the late French anthropologist and sociologist Claude Lévy-Strauss. In this book he investigates the relations between science, magic and myth, and distinguishes between neolithic science and modern science, the former being based much on percepts and concreteness, the latter on concepts and abstraction. The word *bricoleur* has no precise equivalent in English: he is a man who undertakes all jobs and trades, but is of a different standing from the English "odd job man".

Let me now quote Lévy-Strauss:

> Among us a form of activity survives that, on the technical plane, allows us to realize well enough the characteristics, on the speculative plane, of a science that we prefer to call "primary" rather than primitive: this form is usually named *bricolage*. [...] The *bricoleur* is able to perform a large number of different tasks, but unlike te engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and procured for the purpose of the project. His universe of instruments is closed and the rules of his game are always to make do with whatever is at hand, i. e. with a set of tools and materials which is always finite and is also heterogeneous because what it contains bears no relation to the current project, or for that matter to any particular project, but is the contingent result of all the occasions there have been to renew or to enrich the stock or to maintain it with the remains of previous constructions or destructions.

The set of tools of the *bricoleur* cannot therefore be identified in terms of a project since, as in the case of the engineer, this would presuppose that there were, in principle, as many sets of instruments and materials as there are different kinds of projects. It is its potential use that defines the set of tools, the elements are collected and retained because they "may always come in handy". We can summarize the characteristics of *bricolage* as follows:

- the use of second-hand materials (possibly already used for other purposes) when more appropriate materials are not available;
- the non conventional use of tools or methods designed and intended for a different use;
- recombining components and structures taken elsewhere to construct novel artifacts.

In other words, the *bricoleur* recuperates materials, devices, structures and methods and adjusts them to the current needs when nothing more suitable is available. *Bricolage* is not only a form of design and construction alternative to the classical principles of engineering and architecture: given the unbreakable bond between knowledge and action, *bricolage* is also a *different way to see the world*. In other words it has a deep epistemological significance: actually, since it forces us to rethink the traditional model of rational planning and design, *bricolage* makes us discover cognitive (micro)processes that are typical of design but are usually hidden in the standard engineering model. Furtermore, it allows us to discover contact points among distant disciplines, bringing to light what Gregory Bateson used to call "the pattern that connects".

As observed by Giovan Francesco Lanzara, the classic engineering design pursues an organized order inherent in an intentional explicit plan, established in advance and deriving from conscious purpose; on the contrary in *bricolage* order emerges *a posteriori* and ensues from the *interpretation* of a series of contingent actions and improvised interventions. Intentions, plans, actions, and results are connected, but weakly, as weak is the connection between the methods and materials used and the result achieved. The design is local, contingent, quick to adapt to the new conditions stemming from the use of a given material, and that material is used because it is at hand, hence it is useful and cheap, although it may not be the best in general.

As in biological evolution, the order and meaning of *bricolage* derive from interpretation, but while evolution is blind, the *bricoleur* is directed by a purpose or aim, although vague and approximate. Purpose and interpretation alternate in the production of meanings, schemes, uses. *A priori* purpose and *a posteriori* interpretation result in the continuous emergence of meaningful structures and forms, in an interesting, albeit partial, parallel with biology. Central control yields to local initiatives, unity of design to variable and coordinate multiplicity, rigidity to flexibility, stiffness to dynamical change. It should be stressed that by virtue of such characteristics *bricolage* can be the wisest course of action in conditions of uncertainty, when one is not willing to take excessive risks or to endanger limited and precious resources.

An interesting example of *bricolage* concerns the construction of software. Especially in the case of "open source" software, programs are corrected and debugged, but also modified, amended and partly re-written by users according to their personal needs. Actually, software is not a finished product, rather an open and incomplete one, susceptible to changes and improvements, to violations and infringements relative to the original design. Such innovations, often performed by trial and error or in a random way, represent a sort of "cognitive coupling" between user and program, in which the variants being developed around the original core of the program are tested, abandoned, taken again, recombined, in an ongoing *bricolage* process at the edge of the standard procedures and plans. Sometimes the most successful software is the one that has undergone most such transformations, as if a certain amount of incoherence, evolutionary plasticity, disorder and redundancy were of use to these "organisms", whose complexity is such that it is difficult to know and to dominate them once and for all. Software construction is a particularly convincing instance of *bricolage*, since at the beginning usually computer programs are so poor quality and need a lot of improvement to be utilized.

The clearest example of *bricolage* in the domain of software is offered by the so-called genetic algorithms, that are implemented in a computer simulation of abstracts representations of candidate solutions to a problem. Such candidates evolve towards increasingly better solutions: the process starts from a population of randomly generated individuals and takes place through generations. In each generation the fitness of each individual is measured, the best individuals are selected and modified (either recombined or randomly mutated), thus yielding a new population that undergoes the next iteration of the algorithm. Termination of the algorithm occurs either when a maximum number of generations has been realized or a satisfactory level of fitness has been reached in the population. The similarity with the Darwinian mechanisms of biological evolution is obvious, as well as the local character of the selection procedure, which confirms the *bricolage* nature of genetic algorithms.

Another important characteristic of *bricolage* that confirms its kinship with biological evolution is its dependency on history: actually, the successive structural configurations of its products depend on previous situations and patterns, although more or less loosely. On the other hand, *bricolage* can also be considered as a *technique for planning the future*, and this interpretation is supported by the indisputable fact that our ability to act, construct and operate has developed much more than our ability to foresee, ponder and theorize. As we cannot foresee the outcomes of our actions accurately, often it is better not to conceive vast and thorough plans, radical revolutions, far-reaching changes, but rather navigate inshore, advancing little by little, without sailing on the open sea. In the light of all this, it can be said that *bricolage* is a form of creative and contextual improvisation of paramount importance.

3. The advent of *homo technologicus* and the Planetary Creature

Technology has always had a big role in shaping the intimate nature of humans. The evolution of technology has caused the evolution of *homo sapiens*, and, in turn, has been caused by it, in an interactive process in which the two evolutions have become closely intertwined and have formed a “bio-cultural” or more specifically “bio-technological” evolution. The evolutionary unit of this evolution is a hybrid creature, *homo technologicus*, a sort of symbiont that undergoes a continuous transformation. Actually, in this perspective, *homo sapiens* has always hybridised with technology, hence has always been the symbiont *homo technologicus*.

In the past the hybrid and transformative character of this creature was not very visible: as a consequence, in many philosophies and religions, human nature was considered invariable. Today, however, the rapid development of technology has made the continuous evolution of *homo technologicus* rather evident.

The invention and use of instruments appears as a hybridisation: grafting into humans, each new technological apparatus brings about a novel evolutionary unit (or symbiont), that exhibits novel perceptive, cognitive, and active potentialities. The limits of such an ongoing process are difficult to imagine.

As novel potentialities appear or intensify, other capabilities weaken or even disappear. In other words, technology acts as a *filter*: it is selective and does not enhance all existing abilities equally. This is seen very clearly in the case of information and communication technology, that tends to enhance efficiency and analytical capabilities and to reduce expressive capabilities (poetical, theatrical and the like).

In the high-technology world that we are building around ourselves, the old *homo sapiens* (or rather the successive low-technology symbionts that history has constructed from it) is not at ease and is replaced by other creatures, i. e. by higher- and higher-technology symbionts that tend to adapt to the corresponding sequence of more and more artificial environments.

As regards the *selection* mechanism, it is often assumed that by virtue of technology humans have weakend or even cancelled it. This is not true: *homo technologicus* does undergo selection, except that the selective pressure acts differently. In each human-machine symbiont the selective pressure shifts its center of gravity with respect to the previous one. E. g. selection acts in different ways upon man-with-a-firegun and man-with-a-sword, since it insists on, and selects, different abilities. Also the mechanisms of *mutation* change, since they do not depend only on biological randomness but also on goal-driven techno-scientific inventions and cultural innovations.

In the long run, selection transforms the symbionts as well, and the perceptive, cognitive and performative change can become phenotypical and even genotypical, i. e. can become rooted in the body and in the genetic material of *homo technologicus*.

Differently from biological inheritance, cultural inheritance is not limited to parent-offspring transmission: it works also among individuals of the same generation by imitation and learning processes. Hence cultural novelties can spread very quickly through society and among societies, thus cultural evolution is much more rapid than biological evolution, although its products are more fragile and volatile. It should be emphasized again that the two evolutions are not independent: on one hand cultural evolution is conditioned by biological constraints, on the other hand every cultural novelty can play a role in biological evolution, especially - but not only - when it concerns the reproduction process: new fertilization techniques, social mating rules, retention and support of handicapped children, genetic manipulations, etc. Bio-technological evolution is ruled by a mixture of Darwinian and Lamarckian mechanisms and forms a composite tangle, that becomes even more complicated as the human-machine symbionts connect to each other to form a sort of global (cognitive) organism, the *Planetary Creature*, heralded by the Internet. As the Internet develops a sort of *connective* intelligence of its own, some scientists maintain that we are approaching a post-human era in which men and intelligent machines will cooperate even more strictly than today.

From a cognitive viewpoint, the Planetary Creature represents a further evolutionary stage with respect to *homo sapiens* and *homo technologicus*, a stage where collective or connective intelligence holds sway over individual intelligences. The whole of mankind seems on the way to become rapidly a virtually single organism, or a single community like a bee-hive or an ant colony. Social insects exhibit a collective intelligence, and a collective behaviour, that depend on the intense and permanent communication activity among the units. The same is happening to human beings connected by language and by information and communication technology.

Sure, mankind will continue to evolve, more and more rapidly, but intellectually rather than physically. There is, however, a basic difference between the Planetary Creature and an ant or bee colony: as far as we kwow, the individual intelligence of social insects is scanty, whereas human individuals have high cognitive abilities and also feelings, emotions, and consciousness. This raises the question whether humans are willing to give up these characteristics, partly or totally, to merge into the Planetary Creature. They might oppose a diffuse resistance to renouncing their most intimate and personal qualities and experiences, including free will. Moreover, certain ancestral traits, such as competition and aggression, could oppose the formation and development of the Planetary Creature.

If the scenario I am sketching here is correct, and if *homo technologicus* is to emerge from history and evolution, what are the consequences likely to be? I am interested in the discontinuities and in the mismatch between the organic and the artificial components of the symbiont, rather than in the continuity aspects of the shift from biological evolution to bio-technological evolution. No doubt, the two evolutions are somewhat heterogeneous and, consequently, the two components of the human-machine hybrid are heterogeneous. This mismatch could cause certain kinds of suffering that would add to those resulting from our organic nature, although technology has contributed to relieving some "conventional" forms of pain.

The deepest human characteristics, those associated with emotions, communication, expression, the atavic inheritance linked to the body and rooted in the most ancient layers of evolution that played a fundamental role in the survival and development of our species, such primitive traits would not disappear just because technology inserts its nanometric prosthetic devices in our bodies and brains. And in the contact area, at the interface between "us" and "our" prostheses, serious rejection processes could take place. Even today, when *homo technologicus* is still at an early stage of development, problems and difficulties arise from the mismatch and incompatibility between humans and machines. As an evidence of this, note that a great deal of research efforts is being devoted to the construction of user-friendly machines, that should create an anesthetized zone in which the artificial components are allowed to sneak in. In other words, we purposefully try to weaken the resistance of the ancient body components to the encroachment of the newer mind constructions. The consequences of this course of action are difficult to predict, but could be problematic.

4. Mind machines

As I said, since the middle of the XXth century, technology has been developing so quickly as to prevent science from explaining and justifying the functioning of several technological devices and systems. Moreover, the roots of the technology acceleration are not to be found in the scientific advancement, but within technology itself. In particular the instrument that has really boosted the advance of technology is a technological device, the *computer*. Around the middle of the XXth century, technology began to produce machines quite different from the traditional ones, that processed matter and energy: the new machines process symbols and information, and can be aptly defined as "mind machines". The computer has modified design deeply since it has opened the way to a particular branch of *simulation*, a sort of virtual mixture of planning and construction that is halfway between theory and practice. Computer simulation is easy, cheap, rapid, in this sense it is to be preferred to many traditional design tools. It extends mental simulation out of our minds. Thanks to computers the saying "easier said than done" has been somewhat reversed: today it is easier to do (virtually) than to understand and explain.

The influence of computers on our culture at large is of paramount importance. Even mathematics, whose status and rules seemed to be immutable, is undergoing changes in the way it is practised and tought. Also, the use of computers has led to discovering great amounts of uncertainty, complexity and disorder in the world, thus contradicting the hope that deeper and deeper investigations would reveal an extreme underlying simplicity, to be reflected in one simple formula. In some areas, like medicine, we have to give up the hope to reduce the practice to the rational and rigorous application of a simple mathematical model, following the example of classical physics. Rather we have to resort to intuition and creativity, using technology in an opportunistic way, combining scientific data and *bricolage*.

I have the impression that today technology is more important than science in shaping our *weltanschauung*. For an overwhelming majority of people, cell phones are more important than relativity theory, not only because they use mobile phones more often that relativity theory, but also because the picture they have of the world and of themselves in the world is shaped by cell phones much more than by relativity theory. Furthermore, the distinction between pure and applied research is becoming vague and blurred, also by virtue of the financing mechanisms and the market. All this might convey the impression that science is not an ultimate and absolute achievement of mankind. Actually science as we have known it might well be a transient historical phenomenon: the Roman empire has fallen down, science, sadly, could also fall down one day. Science arised from the conjunction of many rare conditions, and might be a sort of statistical fluctuation, limited in space and time. On the contrary technology is part of the nature of man, is linked to primary human needs, even to survival, it is rooted in the very evolutionary process that caused the origin of *homo sapiens*, or better *homo technologicus*. This is why technology has always been with man and is not a temporary episode.

5. Toward a technological epistemology?

Of course the possible decline of science in its present form would by no means entail the end of mental activity and knowledge development, that could take on surprising and unprecedented forms, connected with technological advancement. Actually, technology appears to be deeply involved with *epistemology*, i. e. the forms and ways of knowledge. Today the very speed of technological innovation, with the accompanying enthusiasms and concerns, tend to obscure the epistemological value of technology. But it is to be kept in mind that acting and knowing are deeply intertwined. Tools, apparatus and instruments are always catalyzers and filters of knowledge, thus technology is a source of culture.

In fact, our body, that is our first instrument, is a repository of knowledge larger than the conscious knowledge that science has made explicit so far. As an evidence of this, consider the fact that humans were able to construct mathematical tools permitting them to formalize some critical or “pathological” phenomena, like the paradoxes of quantum mechanics and chaos, that we do not really understand in the traditional sense: this might be an indication that the unconscious descriptive ability of our *biological* *structure* exceeds the ability to describe and interpret in clear and rational forms, an ability that we have been able to explicit so far at the mental level.

As a consequence, there is no reason to think that the instruments we are constructing, once they exceed a given threshold of complexity and communicative interaction with humans, will not be able to (make us) take a cognitive leap. They might indeed be able to (make us) discover something radically new and original either in the natural world or in the artificial world we are constructing. Our instruments could be the protagonists and catalyzers of a dramatic *epistemological turn*.

To summarize, the epistemological void that science might leave behind will be filled by technology, albeit with different implements and unexpected methods. Technology and science have different approaches to knowledge: technology produces mechanisms that we use without understanding their inner functioning, and often we are not intersted in understanding it: everything goes, provided it works. Science tries to make the underlying complexity emerge to reduce it and to give a simple description of it by means of theories; on the other hand technology tends to hide the complexity of artifacts under a surface or "interface" of great simplicity. Sure, technology simplifies the artificial world, not the entire world, but to *homo technologicus* the world more and more coincides with the artificial world. *Homo technologicus* tends to use artifacts with the same ease and casualness that he exhibits in using the organs of his body.

To conclude these notes, I wish to emphasize once more that we are witnessing a dramatic epistemological turn. After a long and important history of progressive abstracion and formalization, science begins to *embody* in the new man-machine symbiont *homo technologicus* and in the Planetary Creature whose first core, or nervous system, is the Internet. In this sense, technology, specifically information and communication technology, points to a new approach to knowledge and practice, in particular in the area of design. *Bricolage* is a major part of this new approach.

6. The humans-and-city symbiont

As I said, the productions of technology are not only machines or well-defined instruments: more and more often technology produces large *systems*, scattered in space, having no precise boundaries, that in some cases are evolutionary and intertwined with other systems, both natural and artificial. A city is a good example of such systems.

More precisely, a city is a complex bio-technological system in which human beings (or better human-machine symbionts) and various artificial components are present and interact stricly. Moreover, this system is embedded in a historical and environmental *context* with which it co-evolves symbiotically. Often by “city” one refers to the material container of humans and their activities: hence here I prefer to use the expression “inhabited city” to refer to the humans-and-city system and the expression “inhabited city in its context” to include also environment and history into the picture.

In this sense, the city as a container is a complex *technological apparatus* that, like any other, offers the possibility to express the latent potentialities of humans. Therefore the inhabited city is a symbiont in the sense illustrated above. That symbiont is a co-evolutionary unit that co-evolves with the context: hence the changes of the city along time must in fact be considered as changes of the system “inhabited city”, or better “inhabited city in its context”. If one fails to adopt this systemic viewpoint, the risk arises of misunderstanding the notion of inhabited city, of confusing it with the much more restricted notion of city as a container. Hence the risk is to misunderstand utterly the importance and delicacy of planning. Planning should refer to the inhabited city in its context, whereas often, with a (perhaps unconsciuos) reductionist move, planning refers to the city as a container.

Such a reductionist move is actually performed in two steps: first of all one neglects the historical and environmental context of the inhabited city; second of all, one neglects its human components. This leads to what I would like to call *rational planning*, that tends to exclude both human beings and the wider context.

7. Urban planning and *bricolage*

In this section I have in mind such celebrated architects and urban planners as Le Corbusier, whose obsession for machines is well known (to him, a house was *une machine à habiter*), and such typical cases as the “ghost city” of Brasilia, planned *ex nihilo* and outside any context. It is interesting that Brasilia began to live in a non-artificial way when it was occupied by a “real” population, different from any abstract model of population.

Considering these cases, and many similar ones, I am inclined to think that there has been, and probably there still is, a certain difficulty in perceiving the system “inhabited city in its context” as the real evolutionary unit, hence the real object of planning. The idea persists that it is possible *first* to plan the city (out of any context) and *then* to introduce the inhabitants, suitably planned and designed! In so doing, actually one ignores the nature and needs of humans, and designs an abstract and simplified model of them, based on a reductionist ideology.

Humans become just another object to be designed, a variable among others, of which one builds (or has in mind) an abstract model (this reminds me of the abstract and rational players imagined by von Neumann in his theory of games). It is true that human are so unpredictable and unruly, so difficult to cope with! How beautiful, neat and orderly would cities be were they not inhabited by real persons! Many urban planners have indulged in such a purified vision... Once the container is planned and the model of inhabitants is accomplished, it suffices to insert the latter into the former. But in general this does not work.

The procedure of suppressing the context and separating the inhabited city into two components, designed separately, stems from the rationalistic Cartesian approach: it is a particular and perhaps dangerous case of reductionism. I do not know which one of the two reductionistic steps is more harmful, but certainly cutting the bonds with the context yields an abstract monster that is much more tractable but bears no resemblance with any of the real cities of our history and geography. A fake city is created in which the concepts of space (landscape, climate etc.) and time (history, evolution, vocation etc.) are so weakened as to provide an absolute, unconditioned product that can be inserted neatly in any context. This is illustrated by Brasilia, but also by the appalling uniformity of so many big cities, the only differences they exhibit being, at least for the moment, the colour of the skin and the language of their inhabitants.

There is another characteristic to the rationalistic and reductionist approach: in planning the city as a container, the planner usually takes an *external* stance: he sits *in front* of and not *within* the object, thus taking for granted that object and subject are separable without any consequence. It is interesting to remark that this hypothesis is typical of the old-style mathematical physics. In so doing, the planner can delude himself into thinking he possesses *perfect rationality* and is able to exert *perfect control* on the object he is planning. The resulting planning will be lame, privileging what is clear and rational, measurable and computable, and neglecting the most delicate and vague components linked to the presence of humans. But not all measurable quantities are important and, conversely, not all important components are measurable: hence such an approach can cause pathogenic distortions and mismatches, and hence suffering.

The claim to perfect control readily comes to a standstill, since it is impossible to take all the variables of the system "inhabited city" into account. Hence this approach fails whenever it runs across an unpredicted situation (a disturbance, a contingency, a pathology), which always happens in the long run.

The city as a container is a mere abstraction, and it would not exist were not for the presence of the human component. But if we insist in considering this extravagance, we are forced to acknowledge that also the container is a *complex* system in the sense that it is made up of a rather large number of interacting sub-systems. In general, such interactions are nonlinear, exhibit threshold effects and give rise to emergent phenomena. Crossing a quantitative threshold often yields a qualitative change in the functioning of the relevant variables. The sub-systems making up the city are not defined uniquely, hence a city can be ideally decomposed into sub-systems according to several different criteria. Urban zones, communication routes, transportation, immaterial flows, commerce and so on correspond to as many ways of decomposing the city. Each decomposition privileges a particular point of view, and points out a different family of thresholds and of emergent phenomena. Decompositions are not necessarily independent, often they are correlated, hence also the corresponding thresholds and emergent phenomena are more or less stricltly correlated.

Decomposing the city as a container into a particular family of sub-systems yields a more or less formal description of the city. At this point, also each sub-system can usually be decomposed into sub-subsystems, and so on, as long as such decomposition is of some use and significance. As a consequence, the city can be described in different ways and each way lends itself to several levels of description. Each level of each description is the basis for a different planning that privileges a particular viewpoint. Consequently, this multiplicity of descriptions opens up a variety of possible plannings, each of which can be entrusted to a specialist. Each specialist deals with a particular aspect of the overall problem and usually tends to neglect even the limited object "city as a container." In the end, when the various plans are inserted again into the general context, mismatch phenomena can come out.

Such mismatch phenomena can go as far as to cause rejection, as in the case of organ transplants. The city as a container, and the more so the inhabited city, can reject the planned sub-system because it is not compatible with some of the basic relationships that the original sub-system had with its various contexts before the planning. On the other hand, the reductionistic approach might be the only possible one because of the enormous complexity of the whole system.

The mismatch may become serious when it concerns human beings within the city:

although the mismatch is always dangerous for the correct funtioning of the system, in that case it can become pathogenic, i. e. it can cause *suffering*. Summarizing, we have to do with a hierarchy of mismatches and (possible) sufferings that derive from a hierarchy of neglected contexts: from the historical and environmental one down to the contexts represented by the subsystems of the city as a container.

The mismatch between the city and its inhabitants, and between the inhabited city and its environmental and historical context could be alleviated if urban planners gave up the rigid approach of rational planning, irrespective of context, and used procedures and methods typical of *bricolage* instead. As it privileges locality rather than centrality, *bricolage* emphasizes the flexibility and dissemination of design processes: that corresponds to a sort of *diffuse creativity* whose most appropriate topological model is the Internet. The Internet has no centre, rather each point is both centre and periphery at the same time.

Thanks to *bricolage*, one could smooth out the discontinuities between the different sub-systems of the inhabited city and between the latter and the environment, thus preventing discontinuities from becoming sources of serious mismatch and suffering. The interface between the city and its inhabitants is similar to the interface betwen the artificial and the biological components of *homo technologicus*, and our efforts should concentrate on this frontier; we should resort to analgesic and anaesthetic instruments and practices able to enhance flexibility and mutual fitting.

8. Conclusions

Drawing inspiration from *bricolage*, urban planners should set up and respect a distributed ensemble of spontaneous and flexible autopoietic centres. Problems should not be solved *a priori* but coped with as they present themselves, resorting to resources distributed in a web-like - and not hierarchic - manner. Planners should give general directions, letting responsibility for decisions distribute among agents located at different levels, each one having its own limited range of action and influence. Planners should also interact with the various human components that inhabit or will inhabit the city, considering their wishes and needs, and should take into account the spontaneous production of forms able to adapt to each other in a harmonic and organic way.

The functioning of new technologies can give some hints in this direction. Much like the most primitive organisms, traditional machines come into being complete and finished, ready to accomplish their function forever in the same way. New technologies are more like mammals, or even humans, in that they come into being flexible and incomplete and then develop for a long time through learning from the interaction with the environment. So planners should limit themselves to set the stage, creating the initial conditions for a process of development, learning and evolution. The city would then emerge from these initial conditions as a spontaneous, pluralistic, unpredictable and never finished product of such an ongoing process. This is what happened in the past: a city never came out accomplished and finished from the planner's hands: rather it was always an incomplete entity, in need of development and constantly seeking adaptation to the changing environment, able to modift through the coevolution process that linked it to the context.

In this evolutionary sense, the organism metaphor is neither trivial nor obsolete. The "organic", dynamical and integrated vision of technology opens up interesting conceptual perspectives concerning the relation between humans and the environment mediated by instruments, including the city. Such a vision hints at the profound unity between container and inhabitants, and the immersion of that unity in an environment and a history rooted in the world. In the beginning that history was physical, then also biological and finally - today - cultural and technological as well. In such a vision, perhaps, the advent of the (always unaccomplished) human-city symbiont would not be seen as a denaturalization or decay of the traditional city (or of humans), but rather as an auto-organizational emergent completion of it. That co-implication circle is similar to others that have been brought to our attention in recent times and have made our vision of humans-in-the-world more complex and complete.

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