DESIGN OF PROCESSES

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Abstract: The paper discusses decision-making processes in design of complex systems and questions the traditional understanding of design as centralized decision-making process. Further on it also compares design to evolution, which is considered as the best explored example of design based on decentralized decision-making. On this basis the parallel between designs and genotypes as opposed to materializations of design and phenotypes is based. In the conclusion design in complex systems is seen as design of processes rather than design of forms.

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1 NETWORKS AND HIERARCHIES

There has been a breakthrough in science about networks in recent years. We are now beginning to get a picture about the world that is constituted by populations of connected components that are constantly adapting to each other. The components are active themselves but the networks as systems are evolving and changing as well, driven by the activities or decisions of those very components (Watts, 2003, page 28). Once we start thinking about it we see these dynamic ever-changing networks everywhere.

Yet, before the knowledge about networks expanded notably, the structure of the world has often been explained through hierarchical levels and relations between them. Research in the field of emergence has even shown how hierarchical levels emerge from the non-linear interactions between the simple components (Holland, 1998) and evolutionary theories have shown how

higher level components learn to manipulate simpler components within the constraints of lower level laws.

Most often these two concepts, networks and hierarchies, are seen as two basic types of structures that we encounter in real world complex systems. In cities for instance, which are typical cases of complex systems, the dichotomy of networks vs. hierarchies finds its expression in urban form. The network structure typically results in "spontaneous" urban pattern, while the product of the hierarchical structure is typically a "planned" urban form. As De Landa (1997, page 30) has emphasized though, the basic distinction between "spontaneous" and "planned" is not the one of form, but of the *decision-making processes* behind the genesis of form. He points to the crucial distinction between decentralized and centralized decision-making in urban development. Decentralized decision-making takes place when components in a network are adapting to each other, while in a centralized one all of the components are only adapting to one higher level component.

Traditional understanding of design would characterize it as a clear case of centralized decision-making. It involves a plan, a purpose, an intention of a higher level structure. It involves a population of components and relations among them that are selected for specific purpose by a central decider. The case of cities is again a good illustration. When built form is manipulated to conform to a plan this involves a central decider, a governing body for instance (Kostoff, 1991, page 43). Urban patterns are chosen in advance in order to achieve the purpose of urban design.

As our everyday experience or also deep understanding of certain phenomena can teach us, most complex systems in the real world are neither pure networks of adapting heterogeneous components nor pure hierarchical structures of homogeneous components. As De Landa (1997, page 260), who names the two types of structures "hierarchies" and "meshworks", wrote in the concluding chapter of his *A Thousand Years of Nonlinear History* "we repeatedly saw that hierarchies and meshworks occur mostly in mixtures... Moreover, since meshworks give rise to hierarchies and hierarchies to meshworks, we may speak of a given mixture as undergoing processes of destratification as well as restratification, as its proportions of homogeneous and heterogeneous components change."

Kostoff (1991, page 46) confirms the difficulties of a simplified dichotomy between networks and hierarchies when he describes the development of urban form: "When the two components are not quite as discrete ... the need to interpret the city as an intricate mesh ... is especially pressing. Most historic towns, and virtually all those of metropolitan size, are puzzles of premeditated and spontaneous segments, variously interlocked and juxtaposed... We can go beyond. The two kinds of urban form do not always stand in a contiguous relationship. They metamorphose."

As many designers will witness, in design process we can also find a genuine central decider only in most straightforward (or linear) situations. In more complex cases designs are at best centrally moderated, but very often the decision-making is actually decentralized and the designs are eventually negotiated between the different parties involved. Examples of this can be

found from the designs of industrially manufactured objects to the designs of motorway networks or again cities. We can therefore say that designs in complex systems are just as well typically mixtures of centralized and decentralized decision-making processes.

2 DESIGN AND EVOLUTION

The issue can also be approached from another perspective. Design has often been compared to evolution of organic life. It has been used either to prove that a Grand Designer exists or that it doesn't. The scientific arguments in evolutionary biology support the latter standpoint and compare evolution to "the blind watchmaker" (Dawkins, 1986), that is to the designer without a purpose. For our purposes evolution in the Darwinian sense is the best explored example of design based on decentralized decision-making. We can now also use evolutionary theory to illustrate that very similar processes, or the same "engineering diagrams" (De Landa, 1997, page 58), underlie both "blind" and "sighted" designs.

For this we can continue the metaphor of the watchmaker, where one has to admit that no watch is designed completely from scratch, no matter how brilliant the designer. Its design involves many prepared components from different separate design processes and also a lot of prior knowledge about watches and existing watch designs. We can say that every watch design has an ancestor and if it is successful it also has off-springs. The contemporary quartz watches did not appear at once but developed very gradually from the first watches and clocks that preceded them. There's a whole development tree of watch designs including the now almost extinct "digital" watches.

Seen in this broader perspective, we can hardly still claim that design has a purpose. We can have no idea what purpose does the whole evolution of watches have, for instance. It is only clear that a particular watch serves a purpose within a particular context, where its success is defined through certain characteristics. It should show time as accurately as possible, it should be small, light, cheap or appealing to the eye. In different contexts these characteristics can have very different weights. Sometimes the price, for instance, is the most important characteristic and it works in reverse direction – the more expensive, the better. Similarly, in the evolution of organisms their success (or "fitness") depends on how well their characteristics fit their environments. As environments change, and very often they change faster than organisms, some characteristics become unimportant or obsolete while others get emphasized.

We can say that, like organic evolution, design is a blind search process, exploring the immense search space of all possible designs, only that the search is generally much faster, because through designers designs are much more efficiently informed about possible "useful" components and do not rely on direct encounter with them. Designers are therefore efficient catalysts of the search process.

3 GENOTYPES AND PHENOTYPES

Another meaningful parallel can be made between design and evolution of organisms. The role of design towards its materialization, a product for instance, is adequate to the role of genetic description of organism or its genotype towards the resulting organism or its phenotype. It describes the process of morphogenesis, the way how the final product comes into existence, by defining its constituent components and relations among them. It is therefore not entirely inaccurate that the DNA is often referred to as the "blueprint" of organism.

There is one very important distinction though between the "blueprint" of a building for instance, and the genetic description of organism in DNA. While the former aims at describing the end stage of the future building to the last detail, the DNA rather describes the *process* of building an organism. Specific development subroutines are left to many other molecules and the development of an organism even responds to the environment to some extent and allows for modifications and variations in the final outcome. On the other hand the development of a building is supposed to refer to the blueprint directly in every detail. We use the word "supposed" because the blueprint typically doesn't say much about the process of building. It depends heavily on the knowledge and skills of construction site staff, which actually decides the development details in an attempt to arrive at the end result described in the blueprint.

The process of development of a form typically involves several stages and in each stage a kind of feedback is often necessary for the next stage. In the development of a building, for instance, the initial conditions of the terrain might be just a little bit different than expected which can cause the consequent building stages to be much more expensive. The constructions site staff will report this to the investor who might then ask the designer to change the design for a cheaper option. This will affect all subsequent development stages. These kinds of feedbacks are more a rule than an exception when designing buildings and yet blueprints cannot offer any help in such cases.

Besides the design in architecture some other formalizations of design also don't take much account of the processes leading to their materializations but rather focus on the desired end result or the phenotype directly, like urban design for instance. This is particularly unsound when these processes are very complex, when they involve feedbacks in certain development stages or when they are very slow and so the context of the design can change in the meantime.

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On the basis of what was said above we can conclude that in design of complex systems it is necessary to shift the focus from the design of forms to the design of the processes of development of those forms or their morphogenesis. Instead of describing the form designs could describe the components and the relations between them, and the rules defining their development in specific stages. The components in this sense could be the

results of separate design processes, results of self-organized processes or established routines.

The shift to processes might benefit the design in two important ways. First, it would enable variation and adaptability to differing economic, socio-cultural or environmental contexts of designs. It is important that these variations would be self-generated, bottom-up. This would strongly reduce the risk of an unsuccessful design. And second, the focus on processes would emphasize the decentralized character of design in complex systems. This may not seem as such an important issue, but understanding of actual development details can help improve the designs themselves.

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