Morphogenetic Designing in Architecture
resolving controversies in and between
design, research and development

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ABSTRACT

There is a dearth of software able to support the working styles of all types of designers and design scholars, spanning the whole spectrum of hermeneutical and empirical traditions. The development of morphogenetic designing in architecture opens new possibilities to bridge the gap between the different traditions. It can support the birth of forms evolving one from the other with the help of local and global rules in genetic algorithms and neural networks which translate the wishes of the designer. It can also support the communication about these forms and the testing of their adequacy. On the other hand the design process which is reflected in the sequence of form generating acts can be studied by design researchers better than by protocols alone.

1 INTRODUCTION

Morphogenetic designing is concerned with the breeding (or replication, mutation, selection and survival) of forms and structures according to a fitness evaluation function and the emergence of more complex systems out of the produced aggregations. The recent arrival of evolutionary, behaviour based design systems brought us the prospect of creative design assistants, capable of generating unexpected, useful and valuable conceptual designs with emergent innovative properties. As compositions, they might be equipped with local and global rules, genetic algorithms for breeding and selecting, and neural networks to capture and apply fuzzy expert knowledge within the evaluation mechanism of the genetic algorithm. With the arrival and acceptance of the morphogenetic approach and the accompanying possibilities of computer simulations, the deeply rooted controversies between both empirical and hermeneutical scientists and artistical and technological designers might be resolved within a generation in a way acceptable for all.

2 TYPE 'A' & 'B' CONTRADICTIONS

2.1 Controversies between type 'A' and 'B' scientists and designers

Morphogenetic development gives rise to a new vision of the world in science and elsewhere, in terms of 'Complex Adaptive Systems' (CAS, Holland 1995). In architecture we seem not only capable to express this vision, but also to implement and simulate CAS in morphogenetic design tools and techniques. The new outlook also has the potential to narrow the gap between the hermeneutical 'A' and the empirical 'B' approaches to design as put forward on both our hermeneutically and artistically 'A' inclined architectural schools and our more scientifically and technologically 'B' influenced university faculties.
For the 'A' approach a stylistical level of understanding is needed to keep up with the architectural movements of our decade: the organic, bionic or post-Darwinistic

architectures of tectonics, fractals, bends, twists, waves, folds, blobs and so forth. Style is about expression, the application of a geometrically defined outward form (a 'surface structured' appearance or packaging) as a sign to communicate meaning. This type of expression will be served best by (un-conscious) associative and (pre-conscious) perceptive modes of depictive thinking and representation.
For the 'B' approach, a typological level of understanding of CAS is required to define, elaborate and explore the universes of forms intended. Type is about basic or intrinsic shape or structure, the ('deeply structured', topological) order between the elements of form, without the entanglement of extrinsic cultural meaning. As such this type of structure is served best with (consious) logical modes of propositional thinking and representation (see Kosslyn 1990 for a discussion about depictive and propositional representations).

2.2 'A' artists and hermeneutists

For the majority of architects, working within the artistical & hermeneutical tradition, the morphogenetic approach to designing will feel strangely familiar. The morfogenetic software programs developed so far for artistical purposes are able to breed whole generations of variants, suggesting new directions to explore and enjoy. For instance, the artistical software of Latham (Todd and Latham 1992) and Sims (1991) are able to breed whole generations of unexpected alternatives. The generated variants are 'surface structured' and stylistic-geometric in character. The programs leave the designers-artists all the freedom and flexibility of judging, selecting, steering and harvesting the variants breeded. In so doing the software makes a strong appeal to the unconscious-associative and pre-conscious-perceptive abilities of the artists-designers. However, perhaps depending on their hand and/or computer design sketch experiences, the artistically & hermeneutically oriented artists-designers will either refuse or accept the new software-based possibilities of morphogenetic designing. But if this majority group of practising architects will engage themselves in morfogenetic breeding we might anticipate a great variety of original, valuable and even useful design proposals. In the same vein hermeneutically oriented critics, researchers or even users may also contribute to these varieties of design alternatives.

2.3 'B' technicians and empiricists

From some of the few architects involved in both teaching and research, and therefore more or less influenced by the empirical culture of our universities, a deeply anchored resistance to these new ideas may be expected. Raised and influenced as they are in the Newtonian clockwork world of physical and mechanical predictability and repeatability, it is not allways easy to see familiar concepts upside down all at once. But if those empirically inclined researching and teaching architects are able to make this paradigm shift, they will be in the best position to contribute substantially to the conscious 'deeply structured', typologically based development of these newly emerging, biologically inspired 'sciences of the artificial'. And in this case not based on a top down, knowledge based artificial intelligent design system as Simon (1969) once expected, but on the contrary founded on a bottom up, behaviour based, complex adaptive system approach.

3 'A' & 'B' OPPOSITIONS

3.1 Resistance from 'A' artists and hermeneutists

For both groups, some hands-on experience with the new types of exemplary morphogenetic design software will perhaps work like an eye-opener to get them over their various aversions. Firstly, there is a disparagement that prevents a majority of artistically and practically oriented architects to use computers for their early sketch design work (or that may hinder hermeneutically and theoretically inclined reviewers in their criticisms). Most CAD packages require a well structured way of performing tasks and do not allow a restructuring of their internal representation automatically to accommodate new interpretations. Morphogenetic designing however, permits this flexibility to explore and reinterpret the pre-defined but still extremely vast solution space given. This type of designing delivers within its selection process plenty of freedom to exercise the seemingly subjective idiosyncratic and irrational ways of designerly thinking.

3.2 Resistance from 'B' technicians and empiricists

Secondly there is an aversion that may prevent technologically and empirically influenced academic architects and researchers to think with a holistic mindset, instead of the trustworthy logical, analytical and rational approach they used so far. A morphogenetic approach implies the consideration of emergent properties, possessed by the whole and not shared by its constituent parts. As such, emergent properties defy analysis and remain invisible in explaining and predicting with models of both linear and non-linear equations. Designers have always intuitively sensed this impossibility to reduce their design work to its constituent parts alone. It is within the interactions of those parts, that makes the design work as a whole.
In the same vein, morphogenetic research simulations either 'about' (1), 'through' (2) or 'for' (3) architectural designing do not separate the parts, but on the contrary, forces those parts to interact with each other in order to get useful insights about the mechanisms of emergent properties.

4 'A' & 'B' SIMULATIONS

4.1 Simulations, a new way to perform design research

Morphogenetic research simulations are achieved by visualising genetic based algorithmic driven behaviour on screen. With those visualised simulations we have the capacity to experiment empirically in virtual worlds of action. In artificial life for example populations of virtual creatures are unleashed into a simulated environment to replicate, mutate, cull, survive, evolve and prosper or fate away in extinction. By running the simulation, the creatures interact according to local rules and out of all those interactions global behaviour emerges independently. The mechanisms of evolution involved might thus be studied, discovered and manipulated over many generations.
With visualised morphogenetic simulations, all three design research approaches mentioned above are possible. Design research (1) 'about' architectural designing could use the automatic registration facilities of the morphogenetic programs involved to automate empirical observations for quantitative or qualitative analysis.

Design research (2) 'through' architectural designing could use the generating capacities of the morphogenetic software to explore and discover new, meaningful and valuable forms. Design research (3) 'for' architectural designing might for instance study the simulated morphogenetic development of styles (for example from often simple forms in the beginning, over increasingly more complex forms towards a culmination in the middle and back to a decreasing order of complexity of forms in the end. By informing the designer about such a principle of development the designer might identify his own position and react accordingly. The history of specific forms is frequently used as a justification to take formal decisions.

4.2 'A' & 'B' simulations

Simulations are also adequate for empirical and hermeneutical research. The hermeneutical researcher might ask global questions and get holistic answers with ethical and moral connotations. He might introduce his own experiences, insights, inspiration, attitudes and desires, his own principles, meanings and interpretations, his tacit knowledge and intuitions. The empirical researcher on the other hand might ask more specific questions and get both analytical and generalisable answers out of his simulated experiments. He is allowed to observe and explore non-committedly and to isolate ethical and moral influences only to the selection of the problem. He might restrict his efforts to the truth of his explicitly stated hypotheses and theories and he might strive for consistency, rationality and explicit knowledge, without emotional commitment.

5 'A' & 'B' ROLES

5.1 Role of 'A' artists and hermeneutists

Within these developments, the role of the practically and artistically oriented architect (or the hermeneutically and theoretically inclined critic) will be twofold. Firstly, towards the user (and everybody else concerned) this type of architect or critic (with their rich and powerful minds charged with associations and metaphors) might act as the imaginative and experienced adviser end/or partner of the users. They may serve as authoritative interpreters and selectionists with the expertise and intuition to steer the morphogenetic breeding process in the most promising directions. Secondly, towards the software-maker or academic researcher-developer, acting as avant-garde architects or critics, showing and stating the needs for new universes of forms to be opened up by new generations of morphogenetic software.

5.2 Role of 'B' technicians and empiricists

For the empirically oriented academic architects, there is either a scientific research or a technological development point of departure open to explore and develop. The scientific empirical approach in cognitive research is aimed at the abilities of designers to create and evaluate. In order to explain, predict and simulate those capabilities, working models are needed as operational transformations of hypotheses or theories. Those models are inevitably influenced by the general scientific issues of their time. Therefore mechanical models are now increasingly replaced by computational models of creative perceiving, behaving, thinking and designing. In this respect, especially genetic algorithms and neural networks are already identified as suitable models to compare, explain, predict, test and simulate particular mental processes of problem finding and problem solving. In comparing the performances of those modelling techniques with humans, we get a more fundamental understanding of the mechanisms involved and of the power and weaknesses of both human and machine systems.

6 BOTTOM-UP ADVANTAGES

6.1 From top-down to bottom-up conceptualisations

Until now, 'A' artist-designers and hermeneutical scientists or reviewers have heavily relied on hierarchical ways of visual, analogical and metaphorical thinking and doing: the artist-designer in creating original forms from general to specific, from global to local and from overview to detail and in the same vein, the hermeneutical scientists and critics in re-creating and re-interpreting those same forms. This is called a top-down approach of conceptualisation. With morphogenetic designing it is possible to conceptualise from the bottom-up on two levels. First during the conception of the software, defining the solution space of all forms possible to generate. Secondly in using the software: while breeding or steering to particular forms within the immensely vast, built-in combinatorial solution space. Not only does this make an individual conceptualisation process possible, but also a co-operative process of designing by analysis, selection and breeding.

6.2 From top-down to bottom-up innovations

Contrary to the top-down design approach as practised by architectural designers as a necessity to cope with complexity, morphogenetic designing allows a bottom-up procedure. By working from the parts to the whole, the accompanying emergent properties are generated automatically at the same time. Instead of defining the concept at the very beginning onces and for all, the design concept will than gradually emerge out of the automatic application of the rules of the program or brief and those of the environmental context or situation. But in both cases, the fundamental process of selection of the design concept might still be based on the same elaboration of memories as visual images, associations or metaphors. They only differ in the suddenness of appearance of the concept and thus also in the degree of communication and co-operation possible during the process of conception. The bottom-up approach makes the discovery, elaboration and study of innovation possible long after the sudden moment of inception. Everybody using morphogenetic software might be surprised by the wholes that will emerge time and again, out of all the valuable combinations possible. For instance, in our floor plan generator of the accompanying paper of Snijder and Daru (1996) one simple local rule demanding an unbroken chain of connections between floor parts, each one joined to one room, will create or let emerge automatically within the interactive breeding process successive generations of circulation systems, without someone specifying the structures in advance. With a top down approach on the other hand, the parts are defined and fixed by the whole in advance, making it hard to develop advanced innovations after the very moment of inception, otherwise than starting afresh or making some limited variants. Onces you have defined your circulation system, you are stuck with it.

7 CAPTURING EMERGENCE & SELF-ORGANISATION

7.1 From analysis to synthesis

Until the emergence of chaos and complexity theories, empirical science has isolated, modelled, explained and predicted phenomena with equations. But to solve those equations, mutual interactions between the variables are not allowed or at least should be kept to the minimum to get reliable results. This typically represents the analytical approach. However, to capture phenomena like emergence and self-organisation in intrinsically complex adaptive ecosystems, the variables of the model should interact freely and substantially. In those circumstances, equations are not sufficient enough to explain the behaviour of the phenomena involved. But nowadays at least its emergent properties might be studied and partially explained and understood with visualised morphogenetic computer simulations. This implies a paradigmatic shift from an analytical to a synthetical vision of how at least important parts or phenomena of the world might work.

7.2 Convergence of science and design

Both artistical and technological designers have always been aware of the irreducibility of the whole into its parts. It is in the interactions of the parts that they perceive a whole in a piece of art or technology. In the same vein, hermeneutical scientists and critics have observed, studied and evaluated the structure of interactions in products of art and design. But as stated above, now even empirical scientists are becoming increasingly aware of the importance of those same phenomena and the possibilities to study them synthetically by visualised morphogenetic simulations. And it is in computers, that those simulations thrive as synthesisers. With the same morphogenetic simulation software both the two types of scientists and designers are enabled to do their specific tasks and in doing so they might also simultaneously contribute to each others work as well. Technological designers as software writers and artistical designers as users of the same morphogenetic simulation software for instance, could help each other in specifying and testing the developed software from both a producers and a users point of view. Morphogenetic simulations, working as intuitive synthesisers will enable and amplify the creative capabilities of both, the user-designers in breeding their own valuable forms and the scientists in inferring holistic explanations out of the unobstructively registered processes and generated results in order to discover the underlying principles of form generation, self-organisation and emergence. Based on similar experiences with the same simulated operations, the modes of thinking and doing of the involved participants will increasingly converge. This will create a common denominator for understanding and co-operation. The individual experiences of the designers and the holistic explanations of the scientists will in the end give all groups a better grasp on all the mechanisms of the morphogenetic processes involved.

8 CONCLUSIONS

8.1 Resolving the 'A' & 'B' contradictions

With the arrival of morphogenetic design and research software, the old, obstinate controversies between the intermingle of empirical and hermeneutical research and artistical and technological designing might be resolved in principle. In reality however, we might expect both, a slow decline of the old ideas within a generation of scientists and designers and in in the same time a growing acceptance of the new ideas. Both 'A' and 'B' scientists and designers could start their work, based on the same morphogenetic simulation software. The scientists need the behaviour of the designers for their research and the designers might be willing to apply the findings of the scientists in order to make their designs unexpected and innovative, useful and enjoyable, valuable and meaningful. In the end, all four disciplines might work close together with regard to each others roles and competencies, their deviating abilities and interests, their prejudices and attitudes. Morphogenetic design and research might introduce or even force new ways of co-operating and understanding. Not only because the tasks and roles involved are redefined in a more synthetic way, but also because this will in the long run establish a common conceptual core of knowledge, experience and understanding for the cultures of science and design and of the empirical and hermeneutical approaches involved.

8.2 Resolving personality-related contradictions

But with the analysis-synthesis contradictions removed, there are still other, personality-related controversies left to consider. In order to stimulate co-operative behaviour one should particularly take into account the styles of design thinking, feeling, learning and doing in order to fulfil the potentialities hidden behind the development activities of morphogenetic designing.

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