Faculty of Design

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The Roots of System-Oriented Design

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The roots of SOD

SOD draws on different sources. It is based on an experimental designerly practice[1] for complexity that did not originally have strong ties to systems theories. The main component of this practice was the innovative use of visualization for dealing with complexity. Visualization is found in different variations in all design fields. To limit the discussion, however, we need to exclude many aspects of design visualization to get to the core of the issue: designing for complexity. The many different strategies for visualization in design are found in two groups that are less central to the discussion in this book: 1) visualisations of design visions, and 2) solutions and information visualisation. Though both are important for communicating the results of a SOD process, we are more interested in looking at visualisations that are closely-related to the *generative learning and design process*. This means visualisation as high-level processual tools, methods, and conceptual frameworks. Another framing of the subject is made by mainly excluding the figurative design sketches commonly found in any generative design process. This mode of generative sketching will only be discussed as secondary issues. Though we recognize their importance and encourage the use of these types of sketches even early in the process, they are not the focus of this discussion. We need to keep in mind though that figurative sketches might be part of larger process, such as part of a Gigamap together with other representations such as texts, tables, symbols, and labels.

Though we insist on mixing various types of visualizations, the focus of this discussion emerges from the use of diagrams in design process visualisation and their potential to connect designing and thinking into an organic whole. These diagrammatic and generative visualisations are integrated media for both analytical and generative activities. They provide

[1] The experimental design practice was conducted within the framework of the OCEAN Design Research Association (www.ocean-designresearch.net).

a smooth transition from analysis to synthesis, and are artefacts that can be used to both analyse and conceptualise design.

An important source of reference is the discussion on the use of generative diagrams in architecture that emerged in the mid-1990's to around 2005. Important contributors to this development were, among others, Peter Eisenmann (1999b), Ben van Berkel (Berkel & Bos, 1999; Berkel, Bos, & Henninger, 1998) Greg Lynn (1999), and the many projects and publications by the OCEAN Design Research Association from 1994 onwards ("OCEAN Design Research Association," 1995). This was a crucial innovation, and diagramming became a generative and creative working mode. This is a central influence on how we conceive diagramming in SOD, preparing the ground for Gigamapping.

The other main source of inspiration for the development of SOD is the rich and diverse landscape of systems theories and approaches. Some of the most important approaches and concepts for designers from the field of systems theories are the above-mentioned contributions by the designer Horst Rittel, and the architect Christopher Alexander (Alexander, 1964; Protzen & Harris, 2010; Rittel & Webber, 1973).

We will revisit both these sources later.

The generative diagram

In the following chapter, I will briefly present the use of generative diagrams, the related experimental research in design from the mid-1990's on, and how this was developed into the theories and practices of design computing and digital diagramming. We will end with a discussion where the lines are drawn towards a more general design methodology that focuses on open-ended design for very complex social systems.

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Discourse on the diagram's role in architecture has contributed, for a short period, to a change in the ways we can address complexity in design (Berkel et al., 1998; Massumi, 1998; Allen, 1999b; Berkel & Bos, 1999; Bettum & Michael, 2000; DeLanda, 1999;

Eisenman, 1999a; Hensel, Menges, & Weinstock, 2004; Lynn, 1999; Sevaldson, 2000a). The most radical innovation from this discussion is the *generative diagram*, which indicates a designerly way of dealing with complexity. It was based on the concept of "soft programming" within the architectural and urban space where the usage of spaces was by planned, so that it was open-ended, emergent, highly user-driven, and opportunistic. This opportunism is defined by a close relation and real-time negotiation between the users' needs and the offerings from the environment. This is obvious in the way humans interact with untouched nature, such as in finding a rock to rest on, a ground to raise a tent, or a smooth landscape to travel on. On a hike, for example, we tend take a short break when we are tired. If we stumble across a site that is especially inviting, perhaps one with a view and a stone to sit on, we might make an unintentional stop. If we are tired but there is no suitable place to rest, we might push on until somewhere acceptable is found. As can be seen, we interpret the functions of our surrounding environment according to our needs. This is soft and ad hoc programming. The stones are not there for the specific function of being a place to sit on, but we see the opportunity and interpret its potential function. This type of opportunistic interpretation of our surroundings is continuously at work. It means functionality is not only a question of offering, but also a question of projection. This is rarely acknowledged by designers.[2] Openness to a similar opportunistic interaction with designed spaces is already baked into our designs.

The new soft strategies are more suggestive on how spaces can be used and interpreted freely. Though much of this was experimental design, some of the principles and formal solutions drippled down to build architecture. For example, Snøhetta used this theme in exterior landscaping such as on the roof of the Oslo Opera, as well as in interior design like the case of the the Ryerson Student Learning Centre (*Figure 1*)

[2] Recent theory in service design suggests that a service is produced in the moment of interaction and in a co-design process (Sangiorgi?)REFERANSE MÅ FIKSES

Figure 1: A landscape-like interior softly programmed for multiple uses and interpretations. The Ryerson Student Learning Center *by* Snøhetta and Zeidler Partnership Architects, 2015 (Image rights*:* get image from Snøhetta).

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(Snøhetta prosjekt http://www.theglobeandmail.com/life/home-and-garden/architecture/building-the-future-the-eclectic-norweigan-firm-thats-defining-architecture/article25876778/)

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This is one of the main reasons why hard systems models do not work in the context of human activity systems. Elements do not have a clearly-defined function, but their function is a case of interpretation.

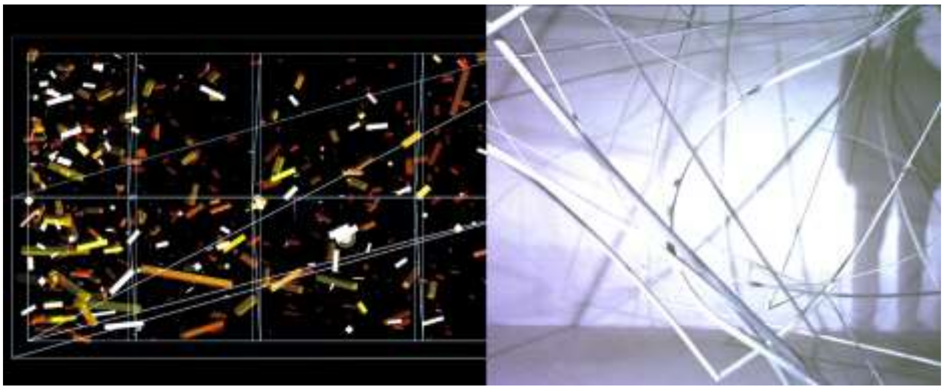

Figure 2: A computer-generated particle animation was used as a generative dynamic diagram that functioned as a spatial organiser for a tubular spatial installation. The particles only informed the main distribution of the tubular structures. So in a way, it replaced or sabotaged the Cartesian grid as a spatial organising principle. The installation was designed so that visitors could use the space opportunistically, without predefining or programming particular places or functions. Chamberworks (OCEAN Design Research Association, 1998).

This type of design requires a new methodology. It is very hard for a designer to be free from imagining specific uses for their design. Archetypes, preconceptions, and expectations come in the way of soft programming. Peter Eisenman recognized this problem when he called the diagram an agent to sabotage the architect's intentions (Eisenman, 1999b).

This need for working with de-programmed structural features and field distribution was developed further by the collaborative work of the OCEAN Design Research Association in the mid-nineties and early 2000 [3]. From the very beginning, OCEAN focused on the concept of the "open design" (Eco, 1989).

Computer graphics and animation was introduced in a new way to architecture by Greg Lynn (Lynn, 1999), and the computer was well-suited for generative diagramming. OCEAN's work was highly experimental, research-driven, and based on creative design computing (Sevaldson, 2005). The group's emphasis was on research and only small, temporal projects were realized. Despite this or maybe because of this, these projects represent the most

[3] The experimental design network OCEAN was founded in London ("OCEAN Design Research Association," 1995) It was known in periods as OCEAN-net and OCEAN-NORTH. Its last and current name is OCEAN Design Research Association, and it is a registered non-profit association. The author became a member of OCEAN in 1997 (www.ocean-designresearch.net).

clearly-defined strategies for using generative diagrams to create soft-programmed architectural and urban spaces.

A case for these early experiments is the installation, "Chamberworks" by OCEAN. The strategy of generative diagramming implied the use of a loose spatial scaffold, and a framework to be filled with diagrammatic elements that are open for interpretation. The framework needed to be unspecific, but highly detailed and rich to provide enough incitements for self-programmed interaction. A soft framework is one that influences design decisions and imposes design program in an open-ended manner, leaving large parts of decision-making to future users.[4] These discussions were tightly connected to ideas of continuity represented by the iconic continuous surfaces of 1990's architecture.[5]

[4] For a deeper recap of this discussion, see (Sevaldson, 2005) and on complexity at 297.
[5] For more discussions on this, see (Sevaldson, 2005)at 65).

Figure 3: An example of the continuous surface is the roof of the Oslo Opera House by Snøhetta. The design was from 2000 and the Opera House was finalized in 2008 (Photo: Hans Rosbach 2007, Gnu free documentation license).

Though systems approaches were rarely mentioned in these discussions, the relation between this way of thinking and Systems Thinking is obvious when looking at how this approach emphasises open designs, future use, future systemic developments, issues of self-organization, and the phenomena of emergence. In principal, this generative approach brings an aspect of advanced design thinking to Systems Thinking. It involves strategies of dealing with the speculative and unforeseen in a systemic way. The concept of the “open design” is central. Open design strategies do not prescribe or program human use in a clear manner. Instead, one serves the user with opportunities for use. Such an approach involves the user in the interpretation of the artefact.

Figure 4: The sculptural furniture piece “*E*xtra Terrain” is an example of how the continuous surface was developed into open designs. The object breaks the schema by ambulating between an art sculpture and a furniture piece *without* providing any recognisable furniture feature *such as* clearly-defined seating surfaces. *It is up to the user to interpret how the surface should be used. In a sense, t*he user programs the piece in the moment of use (Kivi Sotamaa and Markus Holmsten. 2000).

A discussion of “unfinishedness” emerged. Open designs are obviously opportunities for change and further developments. Users could, and should, change the use of the objects according to their desires. But further on, they might even change the design itself. This has become one of the main drivers in the software development business. User feedback, together with error detection uncovered by unexpected user activities, has enabled the continuous improvement towards new software versions. The involvement of users in design and re-design processes has led to discussions around such “versioning” as a concept for open design not just in software, but also for architectural and urban spaces (Pasquarelli, 2002). Bringing these discussions together is highly beneficial, not only for design, but also to other fields.

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Though the projects and suggestions by OCEAN were often quite abstract, experimental, and conceptual, they were always people-related. One main theme in the work of OCEAN was the “folded surface”, which was a theme for many avant-garde architects at the time (Eisenman, 1993; Lynn, 1993, 1998). The notion of “folding” in architecture came as a reaction to deconstruction and the collage of post-modernism, which was criticized for its tendency towards disintegration and the breaking of relations. The folded surface was a means to look at the (urban) fabric as a continuum, where everything was connected by sharing the same datum. However, this datum, the folded surface, was differentiated and articulated so as to produce diversity. These ideas were inspired by new digital tools as much as by contemporary French philosophers like Deleause and Guattari. In particular, the NURBS surface,[6] an ideal mathematic model that represents the continuous surface and its diversity, was particularly central. In addition, digital animation tools also made it possible to work with time, dynamics, and movements in a more direct way.

Lynn introduced the idea of flexibility as a built-in feature of rigid shapes, and that rigid shapes can be more or less flexible in operation (Lynn, 1999). A classic example that he uses to demonstrate this is the hull of a sailing boat. A hull that has been adapted for all-round conditions is a flexible adaptation – a result of negotiation and compromise between many ideals. Whereas a hull made for specialised conditions (e.g. ocean waves or flat water) have less flexibility built into it. Lynn’s example points to the important issue that flexibility is the product of interactions between objects, environments, and actors. This is where the hidden systemic dimension of those discussions emerges.

OCEAN’s practice further developed this discourse on the relationship between geometry and flexibility. The modernist answer to the question of flexibility was the “Plan Libre” or “open plan”, as suggested by Le Corbusier. Under this notion, the ideal was an open flat space, uninterrupted by building elements, which allowed for all kinds of flexible

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[6] NURBS: Non-Uniform Rational B-Spline is a common mathematical model today for representing free-form surfaces in 3D-design software.

subdivisions. Practically, however, it was populated by regularly-spaced columns that severely limited and restrained flexibility by reinforcing a rectangular grid. This limitation, along with the void of the flat space, restricted the imagined and practical use-potential of the space, as opposed to opening it up for free use. We were searching for another type of flexibility, arguing that the empty Cartesian space, with its rectangular grid, is all but neutral and that it frames and influences the design. However, the grid that is normally regarded as a neutral spatial organising device is far from innocent. It influences and lays preconditions for our designs; it is a strait jacket in disguise. By tweaking and deforming the design space, we were influenced to arrive at different results from the untouched Cartesian space grid. An investigation into whether articulation of the flat plane through deforming would lead to other results or other unarticuled possibilities for inhabitation eventually led to identifying potential for flexibility beyond the planar surface (*Figure 5*)

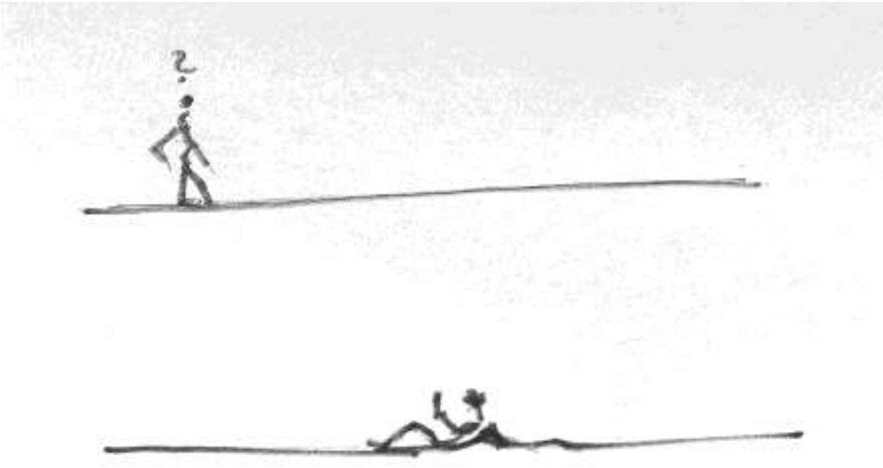

Figure 5: The modernist notion of flexibility, the "*Plan Libre*" was based on the idea that a generic Cartesian planar geometry is the most flexible, since it can be inhabited by anything. In OCEAN, we suggested another type of flexibility initiating a generic un-programmed articulation. The idea was that a diversified geometry would provide more flexibility for inhabitation, or at least a wider potential for different types of use. Flexibility is not a feature of an artefact, but it emerges in the interaction between people, objects, and environments. (Sketch by author, 2002).

The interesting contribution of these discussions to systemic design is the concept of the generative diagram, which turns the design process upside down. In this process, we first search for interesting configurations, structures, and patterns by generating visual structures. These can be produced by hand, but they are more typically generated by using computers and a long-range of software, both 2D and 3D. By using generative computing like animation, we are able to produce large amounts of variations. From these variations, we can then select the ones that are most interesting for further use. Overall, this process takes away some of the control aspect in design. In my work, this speculative / generative diagrams are further developed towards more particularly-informed diagrammatic visualisation. I will quickly recap this development by illustrating it with three projects. They span from the urban and architectural scale, to the kitchen as a space for activities, and even to the scale of object, which in this case is a set of cooking tools.

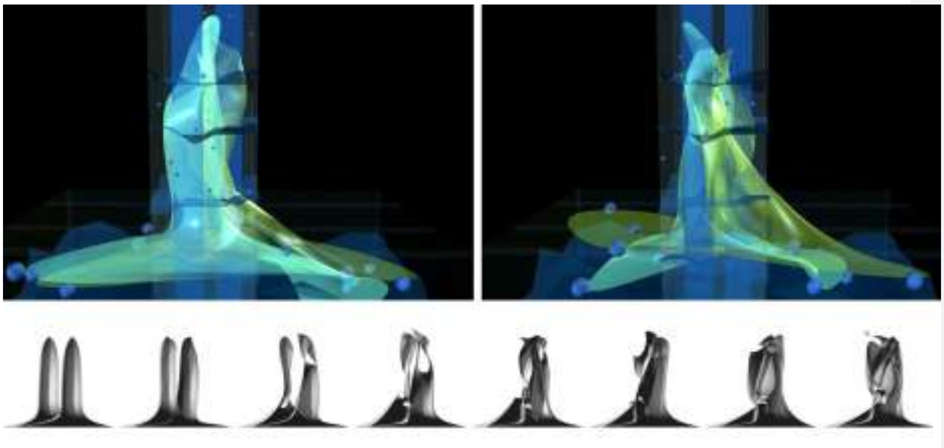

Figure 6: Dynamic generative diagrams *showing* OCEAN's suggestion for a new World Trade Center.

The first project, a suggestion by OCEAN for the new Work Trade Centre, is representative of the generative dynamic diagram (Protetch, 2002). Titled "World Centre for Human Concerns", the design project was a response to an invitation by the Max Protetch Gallery in New York as part of an initiative that commemorated the dreadful events of 9/11. It is an example of generative diagramming. The project's generative diagrams were created with the use of animation software that, through a special setup, deformed original surfaces. The resulting surfaces were considered something in-between spatial organisers, articulated design spaces, and inspiration for the organisation of spaces and spatial form. They were generative dynamic diagrams that could be used to design for complex, unforeseen futures. Initially without any function or program, the functions of the surfaces were negotiated at a later stage. This was both a process of opportunistic inspiration from the geometries, and a matter of tweaking and altering the geometries.

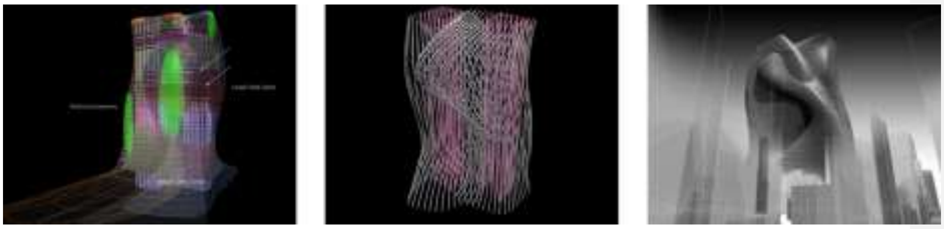

Figure 7: The resulting design is a configuration of the structure and "landscape" for a vertical city with a multitude of programs and ecosystems, vertical forests, and different time zones (left). An intricate basket structure provides structural strength and a communication network (middle). Final design (right).

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The construction of generative diagrams that break from the purely descriptive mode of diagramming is a radical contribution to design. When brought together with systemic design, this results in diagramming techniques that are specialised for open-ended, flexible, and changeable designs.

These concepts led to the development of a series of masters-level design studios called "Designing Time". With an aim to investigate time as a design material, this work preceded and strongly influenced SOD (Sevaldson, 2004). The studios had a number of important intentions:

- To closely observe reallife phenomena over time;
- To use time-based analyses to understand real-world phenomena, entities, and relations;
- To re-understand design interventions as processes unfolding over time rather than merely as objects;
- To investigate complexity;
- To use diagramming and a range of visual tools (e.g. video editing and filtering, animation etc.) to reinterpret observations and generate new interventions; and
- To design sequences of actions and experiences.

Observations over time made the students rediscover familiar, repetitive processes and look at them with new eyes. The relations between objects and the complexity of seemingly simple activities were also revealed. Time-based approaches inherently lead to systems perspectives because they unravel relations. Observations turned out to be an important technique for breaking schemata – to look beyond the clichés and preconceptions that we have about objects, as well as processes. Even seemingly simple, everyday activities like cooking dinner were given new understanding through careful self-observation. This brought to light the high-level of complexity that was embedded in everyday activities (**Error! Reference source not found.**). These techniques and tools inspired the Gigamapping process, where breaking preconceptions is a central aspect.

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