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OPEN ARCHITECTURAL DESIGN

An approach to managing complexity and uncertainty in an open design process

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Abstract. By open exchange of ideas and artifacts and non apriori hierarchical processes, Open Strategies enable a better usage of distributed resources, and the release of more creative potential. Applying these Open Strategies to the architectural design process, is goal of our project. The technical basis for our research is FREAC, a software framework developed in-house which provides a collaboration space for co-operation between different users and tools. This framework is designed not just for exchanging the outcome of the design process but also for opening up the design process itself and making it more transparent. Such highly open and distributed design processes, however, also present new problems and uncertainties which need to be taken into account in order to reach successful design outcomes. As a result proposals for the management of such processes need to be developed that facilitate collaborative work but do not unnecessarily constrain the inherent complexity of the design process. The actor-network theory, and other different management concepts, provides a theoretical underpinning for our approach. The project is a collaboration between the fields of computer science in architecture and media management.

Keywords. Collaboration; open design process; actor-network theory; software framework.

1. Introduction

Contemporary architectural design and planning brings new challenges to the design process: internationalisation, digitisation, increased differentiation between disciplines as well as spatially and temporally distributed working methods. Effective coordination between different participants plays an important role in fulfilling the complex requirements of today's building constructions and to achieve high-quality results. Although the architectural design and planning process is now almost completely digital, computer-aided spatially distributed collaboration and the associated use of distributed expertise in the key phases of design have still be implemented successfully. While current developments in building information modelling are centred around the integrative aspects of a common model, they focus primarily on effective data exchange and maintain a strict division of roles. Although the exchange of data is being conducted at a faster rate than ever before, the working process is still dominated by a linear and sequential pattern. Mistakes made in such "a priori" hierarchically organised processes are hard to correct. In addition, rigid structures hinder the emergence of creative processes and innovation.

The potential of digital technology lies not only in the acceleration of already established working methods, but also enables them to be restructured entirely. A good example of how structures are changing across many fields is the emergence of open development methods, e.g. open source initiatives in computer science (Raymond, 2001) or collective intelligence or swarm intelligence in economics (Levy, 1997). These make it possible to access and exploit decentralised skills more effectively. "Open" thereby designates the free exchange of information, licenses, ideas, data and artefacts. How this exchange is designed varies from case to case. Initial approaches to applying such open strategies to the process of designing are evident, for example, in "Wikitecture" (Chase et al., 2008), the urban planning project "divercity" (Köngs et al., 2000) as well as in product design (www.theoscarproject.org). All these projects, however, lack suitable management strategy approaches for successfully facilitating a genuinely open process. Typical problems include issues of quality assurance and motivation, the enabling of coherent action, the mapping and storage of information and knowledge, and effective communication between designers.

Our goal is the development of techniques and methods to enable spatially distributed design processes based on such open strategies in the field

of architecture. A key challenge of the project is to avoid hindering the creative process of designing in digital environments, in other words to create "enabling spaces". At the same time, it addresses approaches to coordinating processes occurring within these "spaces" without constraining their inherent complexity. In the following we introduce a theoretical and technical foundation that provides insights into how and with what mechanisms such open design processes can be controlled.

2. FREAC as a framework for collaborative architectural design in digital networks

The practice of designing typically deals with non-operational problems. For the most part, actions in this process take place simultaneously at different levels of abstraction and scale. Architectural design is therefore not innately suited to a sequential chain of fixed stages but is instead characterised by simultaneity, plurality and the mutual production of interconnected information. Everyone involved informs the result by contributing ideas and skills (fig.1). To exploit such networked expertise as accessibly as possible, a space needs to be created on a technical level that facilitates the act of contributing. For several years we have been developing tools based on our in-house experimental programming platform FREAC (Framework for Enhancing Research in Architectural Design and Communication). This platform provides a flexible data structure for the integration and linking of digital tools. It allows an open exchange and transfer between different actors and provides a flexible technical framework for different research projects. The main aspects of this framework are as follows:

2.1. SEAMLESS COUPLING OF HETEROGENEOUS TOOLS

Almost all collaborative design projects face the problem of having to develop interfaces between different tools. As a result, many projects are limited to an asynchronous exchange of data over the net in the form of web platforms, etc. These "interruptions" reinforce a phase-oriented working method and thus interfere with the flow of the creative design process. To facilitate networking as an open process, it is vital that the barriers between tools are kept as low as possible. Rather than using one complicated universal program, it should be possible to create and use many small, easy-to-use tools that can be seamlessly interconnected and combined as required. The FREAC platform uses a TCP client–server principle to effect communication between these tools. When changes are made to the digital model all clients linked with the server are automatically informed and can synchronise their local models. The resulting

seamless coupling of different tools means that every tool can immediately "see" how other tools have affected the model and can build directly on the changes made. It also allows different tools, methods and technologies to be brought into direct relationship with one another, for example to seamlessly integrate freehand sketching (Schneider and Petzold, 2009). The resulting content is therefore always linked to each other in one or the other semantic form, creating networks of design tools and artefacts (see fig. 2).

2.2. CONNECTING USERS (SEAMLESSLY)

Communication within spatially distributed design processes is always mediated – by the digital tools as well as the content and artefacts created with them. These are stored on a server which all parties are able to access in real time using different tools. The seamless technical interlinking of digital tools and their users enables them to circulate freely and without barriers in the network. Modifications can occur both asynchronously and synchronously at any time creating a smooth transition between individual and group editing and facilitating the dynamic formation of networks (flexible group sizes) of human actors.

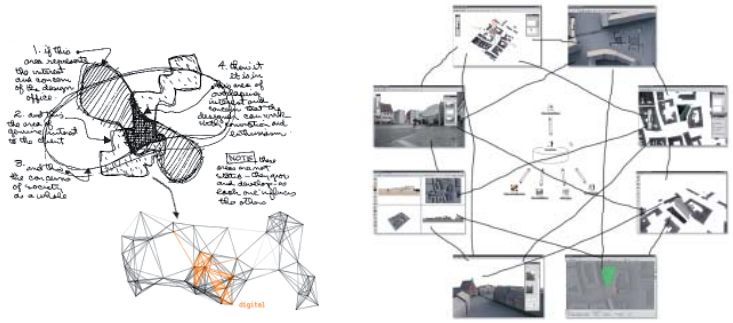

Figure 1 (left): Designing a network: digital tools as part of the design networks [sketch collage of Charles Eames (1969) and its own graphic]. Figure 2 (right): Via FREAC all (connected) tools are interlinked and form a complex network of heterogeneous data / content (video online at: http://vimeo.com/8591465).

2.3. STORING PROCESSES (AUTOMATIC)

The FREAC server can handle all kinds of data. Each item of data receives a reference detailing when it was created, with which client and by which user. Each reference can be called up, combined with others and interpreted selectively. To avoid unnecessary data load, the model only changes within the transactions, i.e. only the changes are saved, not the whole model. The aim is the emergence of an ordered structure that obviates the need to structure the data manually.

The technical framework is a basis for the creation and use of (design) tools and creates an open communication space for collaborative design projects. In the following, the theoretical foundation (from a management perspective) for capturing, analysing and evaluating designing in open networks is discussed.

3. The actor-network theory as a framework theory for an open architectural design model

The creation of technical networks is simultaneously the creation of social and organisational contexts and spaces of action. To coordinate complex processes in such technical and social networks (different tools, content, users), it is crucial to make visible the processes taking place. The actor-network theory (ANT) is used to describe these multiple interactions between the actors in their necessary complexity. Decisive here is the acceptance of complexity, as a complex open design network is able to respond more innovatively and flexibly to changes and gives rise to creative synergies. The actors play a key role in the ANT. They represent entities that freely interact within a network and behave in different ways. Their "capabilities lie in how they are able to affect other actors, how they change, transform or produce them" (Belliger and Krieger, 2006). A special aspect of the actors lies in the assumption that there is a coexistence or symmetry of human and non-human actors, who mutually ascribe one another action (Belliger and Krieger, 2006). As such, in the process of a specific "open architectural design-project" (e.g., an open competition), there are heterogeneous human and non-human actors that act differently within the network and influence one another mutually.

Besides the architect, expert planners and developers, one can also regard design tools, environmental conditions, laws, norms and institutions as contributing actors in the design process. While their differences are not denied, the construction of networks helps to uncover their differences and their available capacities and influence. Overall, the resulting design can no longer be seen as the work of a single actor, but as the product of input from all the actors contributing to the network, regardless of their importance or size. Although the network gradually stabilises over time, it can be understood as an open network: it is open to ongoing change produced by the participating actors, as well as any new actors that enter the process, and as such is in a state of permanent flux.

The relationships between these actors influence the entire design process and a permanent navigation, mediation and translation takes place between these heterogeneous components in the network (fig. 2). At a technical (digital) level it is therefore important that the different demands, ideas, restrictions, rules, designers and tools can be integrated in a suitable manner to guarantee

effective translation processes and foster the emergence of networks. A specific architectural design project which runs on FREAC as a digital platform can be seen as an actor-network. Thereby different people can contribute by making models, sketches, but also by sharing knowledge about architectural references or experiences with specific situations. But also tools (which are developed in different research projects based on FREAC) contribute by calculating or simulating different aspects, or by searching relevant content from internet databases (such as Panoramio, GoogleMaps, nextroom.at, etc.). Such tools in turn can influence decisions of human actors and trigger communication processes.

4. Accepting and managing uncertainty and complexity in an open design process

Open development methods, such as those suggested here for the creative design process make it possible to effectively use and process decentralised skills and competencies. At the same time, however, it is more difficult and challenging to keep it under control. Together with the emerging complexity, different sources of uncertainties appear. They evoke questions for effective coordination. Bruno Latour addresses in conjunction with the actor-network theory five sources of uncertainty in order to highlight the discrepancies between the sociology of the social and the sociology of associations (Latour, 2007). Below, four of these sources are used to address the most important uncertainties, which have to be considered in an open design process in more detail. The first uncertainty insists in “the nature of groups.” He describes the fact that in a network there is an ongoing relocation of actors who leave their traces, which can be analyzed (Latour, 2007). According to that a network is not preexisting, but always has to be assembled anew as an association. At this point, the design process manifests itself as an open network in which many actors and with it many ideas and skills can flow in. It is a fluid and permanent evolving network, which has no stable structure. The second source of uncertainty is concerned with the nature of actions and includes that human activity is not transparent, but a conglomeration of many surprising sources which have to be revealed to finally make statements about who is acting (Latour, 2007). Accordingly, one never knows who is actually acting. If individual actions in the design process are difficult to identify, it is also difficult to coordinate and motivate these actors. The third source of uncertainty – the nature of objects – describes that different threads of action mix together arbitrarily, therefore they often not purely consist of human-to-human or object-to-object relations (Latour, 2007). Without objects / artefacts architectural design processes would be unthinkable. Digital tools have an impact on the perception

and the actions of the designers and the entire design process, so that they should be taken into account for the purpose of an effective management. The fourth source of uncertainty – the nature of the facts – Latour stresses that an object of study should always be understood as a controversial and not as an indisputable fact. In architectural design processes, we are always dealing with unfinished, incomplete and vague constructions of reality. Thus there is a permanent need for interpretation, which in turn depends on the experience and knowledge of the actors involved.

The identified uncertainties, which occur in the proposed open design process, raise up questions about the coordination or management of the heterogeneous elements of a network. Unlike in traditional approaches including principal-agent theory or the hierarchical management process of planning, organisation and control, it is not enough to search moments of indeterminacy in only one other subject or in a linear and hierarchial process (Schreyögg, 2003). So how can one coordinate processes that take place in constantly evolving networks in which it is hard to draw conclusions about who is actually acting, where the influence of non-actors must be considered and artifacts are negotiated, which are interpreted individually by all the actors?

5. Coordinating open design networks

In our project FREAC, as the digital platform provides the space for an open design process. Based on the identified uncertainties in the following possible solutions are outlined how these can be coordinated in a virtual design environment.

5.1. GROUP DYNAMICS

In open design network is characterised by instability and constant change. The coherency of actions and the consistency of the results therefore appear vague because, unlike previous approaches, they do not take place within a fixed structure. The ongoing changes to networks with no predetermined structure are triggered by the free, creative and networked actions of different actors. Human and non-human actors contribute to each other, initiating translation and network-formation processes, changing them, expanding or limiting them. FREAC allows recording these different stages of development in a process-oriented way. With the collected information, including the intermediate steps and links that were necessary for their creation, navigation techniques can be developed that make permanent changes understandable and thus “coordinateable”. Actors can not and must not understand all the complex processes of change and integrate them into their local activities.

They select only the relevant change processes and accordingly adapt them for their actions. Their changes are automatically stored and in turn available for other actors and their adjustment processes.

5.2. TRANSCRIPTION OF ACTIONS

The scope for actors in an open design network is much larger than in a linear design process. However, assigning actions to actors is more difficult and may lead to motivation as well as quality problems. A decreased level of direct external regulation must therefore be compensated for by increased self-control. In addition to a policy of seeing and being seen, the digital tools in FREAC can be used for storing and reading evaluations and feedback. Beyond that, monitoring occurs not only directly but also, and more importantly, indirectly through networked action. As anyone is able to partner with another actor, actors need to react flexibly to one another, continually adjusting their actions and their designs to each other. Monitoring, control and by implication also feedback is therefore already an aspect of the open design process itself. Each actor stands in the centre of observation and is himself an observer of all the others involved. Observation is not limited solely to other human actors, but can also be undertaken by digital evaluation and simulation tools. Feedback from other actors allows the actor to adapt flexibly to the expectations of their environment. As in an open and complex network one is not able to immediately identify who does what at a particular moment in time, open design networks can potentially be seen as a permanent space and stimulus for self-reflection (Bröckling, 2007). Through the seamless linkage of actors and the permanent and automatic saving of changes in the design process, a technical basis is created for such self-reflection and self-optimisation processes. The seamless coupling of actors establishes a 360-degree field of vision, which makes it possible for actors to continuously monitor, evaluate and compare. By recording changes in the design process, it is possible to trace actions to a specific tool, user, point in time and their relations.

5.3. THE ROLE OF THE OBJECTS

Digital tools and other non-human actors such as norms and laws have a significant impact on the overall process, as well as on human action and human perception. Here we need to consider the affect of individual tools and the impact of their limited functionality and action-space in the design process. The use of a tool of any kind sets up a temporary ‘world,’ which is limited or defined by the scope of the respective tool (its functionality) and its compatibility with other ‘worlds’ (which in turn are the product of other tools). For

example, while using a volumetric modelling tool, one can design volumetric models and is therefore restricted to this view. Since the process of designing occurs in parallel at many levels of abstraction and scale, one needs to be able to switch between tools and the functionality they provide according to the respective situation. In the case of digital tools, a crucial aspect is therefore the ease with which one can switch – the smoothness of transition – from one tool to the next. In FREAC heterogeneous tools (sketches, models, drawings, simulations) coexist within the same design space and one is not so tightly focused on one tool (and its scope), but can move freely between different 'worlds'. The tools do, however, leave recognisable traces which can therefore be tracked and analysed.

5.4. OPEN PROCESSES AS A PERMANENT CONSTRUCTION

When designing, constructs are constantly being negotiated and exchanged which need interpretation. In digital design processes greater importance is therefore accorded to the transparency and stability of knowledge and information resources than in linear hierarchical design processes. Human actors must accordingly possess the competence to interpret the structures and develop this ability constantly. In addition, they must be able to work and learn independently without direct instruction. Non-human actors, such as digital artefacts should serve as so-called "boundary-objects", which can constitute and maintain a connection between the different worlds of knowledge (Rossler, 2008). For this, they need to convey a sufficient degree of common shared meanings. Such objects need to be plastic enough to be adaptable to the local needs of different groups while remaining robust enough to retain a common identity across different situations. In this respect, we are concerned with the descriptive mapping, storage, transfer and use of knowledge and information. However, it is difficult to coordinate a network of completely heterogeneous components, since the interpretation of the different content itself is problematic. This is due not least to the fact that their construction and interpretation depends on the specific knowledge of the respective individuals and is as a consequence highly subjective. Likewise, in many cases different tools are not directly comparable, and even artefacts created with the same tools can transport entirely different meanings, intentions, etc. Of course, ambiguity of meaning on the one hand and the specificity of the individual actors on the other can represent a creative potential that does not necessarily need conclusive clarification. In the technical implementation, it is therefore necessary to establish connections – boundary objects – between different virtual artefacts. These different pieces of information or artefacts must have some kind of semantic relationship to one another (e.g., a sketch belongs to a model from

a particular viewpoint, authored by XYZ). Using this information, navigation structures can be derived which enable one to represent contextual links. Thus it becomes possible to browse between different states of artefacts, to derive and record intentions and so on.

6. Conclusion / outlook

The paper introduces Open Architectural Design as an experimental approach to collaborative design, and reflects it from a media-managment perspective. At the outset we discussed the concept of "open" as denoting the free exchange of ideas and artefacts, much in the same way that open source projects make their source data freely accessible. Using the technical framework FREAC presented in this paper, we extend this definition to open up the design process itself. In this way, it is possible to facilitate the networking of actions by many different actors. However, even complex systems require efficient coordination mechanisms to keep the network under control, without – and this is the biggest challenge – limiting its degree of openness. The extent to which creative processes can actually be opened up, and whether this has added value for the quality of the results needs to be explored further. This paper has discussed a theoretical framework to assist in the conception of digital tools. In future work we will create communication and coordination prototypes using FREAC, in order to extend "action spaces" and manage them sensibly. Additional problems and issues relating to the management of these action-spaces can then be evaluated empirically.

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