Design Research through the Lens of Sociology of Technology

Hilde Østerås Berntsen[1] & Rikke Seim[2]

[1] Department of product design, The Norwegian University of Science and Technology

[2] Department of Manufacturing Engineering and Management, Technical University of Denmark

Abstract

The use of an approach to design research inspired by Sociology of Technology offers a nuanced understanding of design processes. The purpose of this paper is to explore how terminology derived from the socio-technical theory of Actor Network (ANT) can be used to understand the complexity of design processes by viewing these processes as building and alignment of networks. The applicability of ANT in design research is demonstrated in an analysis of an action research based case study. In this case study a socio-technical approach called “workspace design” is employed in a process of re-design of existing workspace and work practice in an industrial company. The case study (i) illustrates a socio-technical approach to design research and (ii) shows how ANT terminology can be applied in an analysis of the course of events in a design process with numerous actors involved.

Keywords: Sociology of Technology, Actor Network Theory (ANT), Workspace Design, Design Research

1. Introduction

Design is influenced by, and based on, theories and perspectives from many different disciplines such as physiology, cognitive psychology, engineering, economy, management, and fine arts. In the latest years, perspectives and theories from sociology, philosophy, social sciences, social anthropology, and history, have also been applied in design research. These theories have mainly been used to understand the symbolic meaning of the product, or the user's interaction with the product.

However, design is more than products and their interaction with users. By understanding the complex field of negotiations and interpretation processes in design, it is possible to gain insight into the nature of design processes and thereby facilitate an improved design process. Theory and terminology from the research field *Science, Technology and Society* (STS) can contribute to the understanding of these complex processes. In STS-theories, facts, concrete artefacts, organizations or institutions are not taken for granted, but as phenomena that are continuously interpreted regarding their meaning in society (Callon 1987:83-101).

There are several schools within the field of STS. However, the analysis in this paper is based upon the terminology of Actor Network Theory (ANT). ANT can be used retrospectively to understand how an artefact has been constructed by a heterogeneous network consisting of different types of stakeholders. The specific novelty in ANT is the understanding that the human and non-human actors interact in a network, and that new actors that usually are not included in the network can be introduced (Monteiro 2000:75).

This paper explores how ANT can be used as an instrument for analyzing workspace design. First, we present some main concepts and arguments in ANT; second, we describe a case that portrays the course of events through a design process using ANT terminology.

The case study is conducted during 2006 as part of the action research program "Workspace Design: Intervention in technological and organizational changes in three sectors" based at the Department of Manufacturing Engineering and Management (IPL) at the Technical University of Denmark (DTU).

The following section presents a few concepts and ideas within ANT that we regard as particular relevant for design research; such as *actor*, *actor-network*, *black box*, *translation* and *the translation model*, *alignment* and *obligatory point of passage*.

1.1 The terminology of Actor Network Theory

ANT was developed by the French researchers Michel Callon, Bruno Latour and John Law in the eighties. The ANT approach is termed post structural, but do not (like other structural theories) distinguish between human and non-human actors. Actor networks consist of human as well as non-human actors with aligned interests, which interact in an interwoven

network. Each actor (a person, an object, an organisation etc) is defined through its interaction with other actors (Latour 1987, Callon 1986, Law (1987), Law & Hassard 1999, Bijker, Hughes and Pinch 1987).

ANT is built on the assumption that technology and science have an impact on society. Further, all objects, humans, texts, graphical symbols, and technological artefacts are related to each other, and to the surrounding environment. The purpose of ANT is to describe what enables humans to act, with all the remedies, alliances, mechanisms, and power that are used and exerted (Latour 1992, Callon 1986). ANT rejects the technological determinism of earlier theories, instead technological design processes are regarded as social processes of network building (Howcroft, Mitev & Wilson 2005).

These perspectives represent a shift in focus, from the study of cause and effect relations, to the study of technology and science as tightly interwoven relations between humans and artefacts. These relations will not necessarily be clear or explicit; they are rather deeply rooted in the network logic, and invisible. This status quo is termed black box in ANT. The concept black boxing is used to describe what is tacitly taken for granted, and no longer discussed or negotiated by the actors in the network. The opening and study of such black boxes (e.g. by deep study of cases or discourse analysis) makes it possible to reveal new aspects regarding the relations in the network.

1.2 The translation model

Translation is a central concept in ANT, and refers to the process persuasion of actors and thereby creating an aligned network (Howcroft, Mitev & Wilson 2005). In Callon's famous article about the scallops and the fishermen of Saint Brieuc Bay (Callon 1986) the translation process is divided into four stages, *problematization*, *interessment*, *enrolment* and *mobilization/ inscription*.

In the stage of *problematization*, an actor analyses the situation, defines the problem and proposes a solution. The actors will attempt to establish themselves as an obligatory passage point (OPP), and become essential for the network (Callon 1986). OPP refers to the point that channels all interests into one direction. The OPP creates a *black box*, and translation processes run automatically without being renegotiated case by case.

In the second stage, *interessment*, other actors become interested in the solution proposed. They change their affiliation to a certain group in favour of the new actor. In the stage of *enrolment*, the solution is accepted of the network as a new concept (see also "new mixing plant", p.13). A new network of interests is now generated. In the fourth stage, *mobilization*, the new network starts to operate target oriented to implement the solution proposed (Callon 1986).

According to actor-network theory, the implementation potential will be in the hands of those, who are able to translate problems and needs to support their own enterprise (Latour

1998:48). ANT and the translation model enables the study of different types and layers of decisions making that are influenced by different interests or decisions; e.g. local and national authorities, manufacturers, developers, company owners, suppliers, etc.

2. The Workspace Design – a socio-technical concept

The socio-technical design concept 'Workspace Design' has been developed as part of the earlier mentioned research program "Workspace Design: Intervention in technological and organizational changes in three sectors". The broader notion of workspace design is inspired by the SOFT model by Horgen et al. (1999). The workplace with work practices is embedded in the workspace with four dimensions; spatial, organizational, financial, and technological (SOFT). These dimensions are interdependent and in a dynamic relationship with one another. Therefore a change in one dimension demands change in others. Staging the workspace design process is aimed at creating a dynamic coherence between work and these four dimensions of the workspace. The basic idea in the concept is that actors are needed, who are capable of working across the four corners, facilitating and negotiating the process of workplace-making with the different groups. These actors are staging the workspace design process, they are workspace designers. This is a job of creating shared visions among participants with different perspectives and competencies, overcoming resistance and political interests, setting up a collaborative design process, and facilitating meetings between actors from different corners in the SOFT model.

2.1 Workspace design in an industrial company

The case company is an industrial manufacturer that produces coated plastic tubes used in renovation of pipes and sewers, the so-called 'no-dig-method'. The case study focuses on implementation of new technology in the manufacturing of the coating material. The production is very labour intensive causing numeral ergonomic problems such as heavy lifting and chemical fumes. Furthermore, the spatial layout of the mixing plant has been changed on numerous occasions resulting in an opaque layout and inefficient work conditions. The management wanted to eliminate these disadvantages in the existing production by implementing new technology.

2.2 The beginning of the project – building the network

The management decided that a whole new mixing plant including a new type of technology was needed. They wanted to reform the working conditions as a whole, thereby solving all the problems in the existing plant. A project team was appointed consisting of the production manager, a contractor specialized in production systems and a consulting design engineer. After a while the team came in contact with a machine supplier that was able to deliver the required technology. The team involved a knowledgeable employee from the mixing plant in the dialogue with the machine supplier. This was done because the management was aware of the complexity of the production, and recognized that the employees knew more about the production than the production manager.

At this point the network was quite small – centred around the three permanent members of the project team (illustrated by the grey circle in figure 1.). The two engineers handled all communication with the machine supplier, and the production manager communicated with the representative of the employees. The other employees – as well as the rest of the company - were informed about the project mainly through informal channels. The production manager's status as project manager, and his role as connection link between the company and engineers, made him a central actor (OPP).

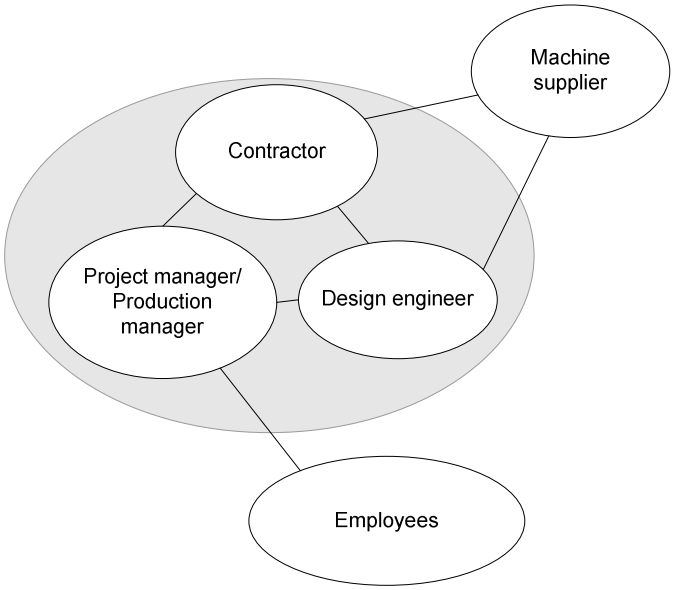

Figure 1: The network before the intervention. The grey circle represents the power centre of the network – the project team

Subsequent interviews with the actors revealed that the network as poorly aligned; for instance the engineers had an insufficient insight in the work practice and the employees felt disconnected from the process and feared that the complexity of the production had not been sufficiently considered in the choice of technology. The translation processes in the network had not been successful; the actors had not succeeded in persuading each other to a common goal.

2.3 The intervention – rebuilding the network

At this point the Workspace design team (hereafter referred to as the WSD-team) contacted the company, and it was agreed that the WSD-team should facilitate the design of the new mixing plant. The WSD-team principles regarding user participation and involvement of ergonomists in the design process appealed to the management and were in line with the overall object of the project; improving ergonomics in the workplace. Also the management view of employees as having a high level of practical knowledge complied with the participatory design methods in the workspace design concept.

The intervention - that was planed in cooperation with the management, the designers and the WSD-team - consisted of three different elements: Preparation, layout sessions, and use scenarios. The different methods used in these phases will not be described in this article; instead the focus is put on the process, more specific the rebuilding and alignment of the network.

The central part of the WSD-team's re-building and translation of the network was the introduction of new active actors to the network – in particular the employees. The purpose of this intervention was to build a more strongly aligned network, where the employees were given a key position that would allow them to influence the design process and thereby the design solution by translating other actors (interessment phase). The wish for enrolment - and empowerment – of the employees formed the basis for the selection of methods. Thus all communication tools were visual (pictures, simple drawings, scale models etc.). Technical drawing such as Auto CAD drawings, which is more commonly used in design processes, might be more approachable for some actors such as engineers, architects etc. - but is not intuitively understandable for other actors. Visual tools on the other hand have an equalizing quality, all human actors in the network, without regard for their formal training and background, are able to communicate using these simple tools.

Figure 2: Example for the use of visual communication tools at workshop. Here the communication tool is a simplified plan drawing and coloured cardboard pieces, representing machine parts, artefacts, work procedures etc.

As mentioned before, the production manager already played an important role as obligatory passage point in the existing network; the WSD-team used this knowledge to secure the durability of the new network by forming an alliance with the production manager. The production manager understood the intentions of the WSD-team and made his commitment to the project and the principals of participation clear to both designers and employees by

requesting that both engineers as well as all employees participated in the activities. The production manager also introduced other actors in the network that he saw as relevant to involve in the decision making. In this way two members of the safety organization – the quality and safety coordinator and a safety representative – were involved in the project.

The network after the WSD-intervention is shown in figure 3. It is clear that the re-build network is an extended version of the old network and most actors are actively involved in the design process illustrated by the grey circle. The machine supplier is not considered an active part of the process because at this point the design task mostly revolved around the layout of the new plant; the machine in question was more or less a standard machine.

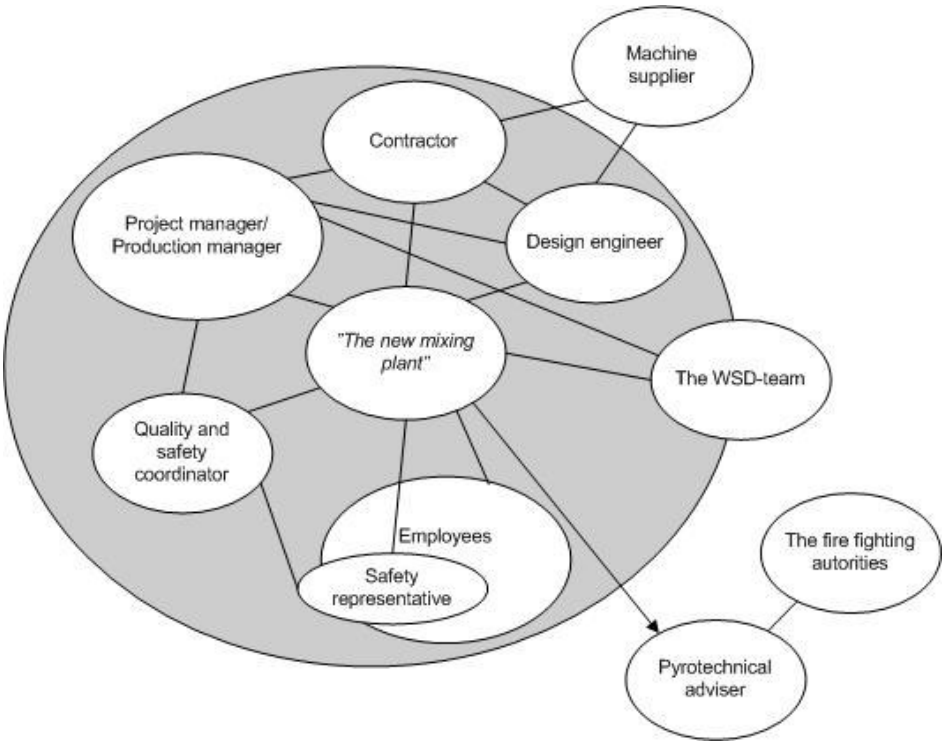

Figure 3: The network after the intervention. The grey circle indicates the active actors in the network

The active actors – indicated by the grey circle – all participated in the WSD-activities; layout sessions, use scenarios etc. During the first workshop it became apparent that there were differences in the way the different actors talked about – and defined – the design object. The two engineers focused on the machine itself and the piping but they black boxed to some extend the future work. The employees on the other hand were more concerned about how the layout of the new plant would influence their future work procedures. However, during the co-design process a shared notion of "the new mixing plant" consisting of machine parts, piping, layout as well as the future work practice started to form between the participants. This shared notion manifested it self as a nonhuman actor in the network represented by the visual tools (a simplified plan drawing in the layout sessions and a scale model in the use scenarios). This new actor became central in the new stronger aligned network, because it made the employees capable of communicating their point of view and

their design ideas. Figure 4 illustrates the design engineer's initial layout solution developed before the WSD-teams intervention. This layout was optimized regarding the piping, and no structural changes of the plant were included.

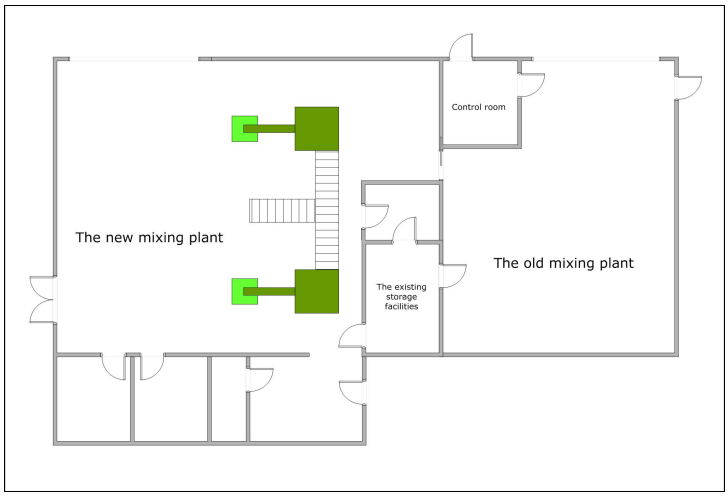

Figure 4: Initial layout proposal

When the employees were introduced to the spatial layout proposal they quickly pointed out some disadvantages embedded in the layout. For instance, the engineers had planed to use the existing storage facilities; however the employees remembered that these facilities did not live up to the requirements of the fire fighting authorities. As a direct result of this, the company contacted a pyrotechnical adviser and the fire fighting authorities. This introduction of new actors to the network is illustrated in figure 3. The employees also pointed out, that they had to be able to look from the control room out into the mixing plant, the engineers had overlooked this fact; they believed that the new machine would be able to run without breakdowns as long as the raw materials lived up to the requirements. However, the employees knew, that the quality of raw materials varies causing breakdowns, and that the new technology will be even more vulnerable for such variations in the raw materials.

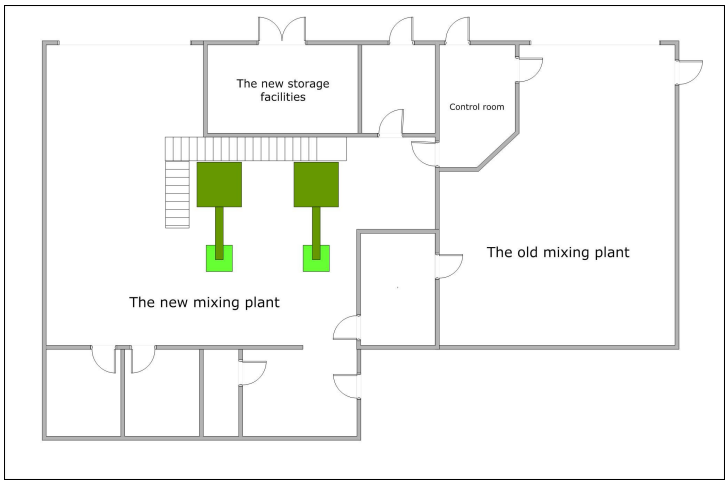

Figure 5: The layout solution designed during the WSD-workshops

The co-design process that took place during the layout sessions and the use scenarios resulted in a layout solution (see figure 5) that took many of the employees considerations into account.

The WSD-team's role in the project is illustrated in figure 3. Here the WSD-team is shown as standing in the periphery of the grey circle. This indicates that the WSD-team was not a part of the design process it self; the function of the WSD-team was merely to facilitate a participatory design process with many different actors. It would be too extensive for this article to discuss the activities of the WSD-team methodologically but the role of the researcher in a design process is certainly an aspect one has to consider when using the ANT methodology in these kinds of settings. In general, however, the approach of ANT to consider the social and technological evolution as symmetrical and to integrate what is human and non-human into the same conceptual framework seems very useful for design, which is constantly forced to regard social, physical and symbolic aspects likewise.

3. Conclusion

In this paper we have tried to demonstrate the applicability of socio-technical approaches in design research, and more specifically how the terminology of actor-network-theory (ANT) can be used to describe the complex processes of negotiation and interpretation that are involved in design process and thereby add new perspectives to design research. The case study described in this paper illustrates how design of a workspace can be viewed as building and aligning networks, where both human and non-human actors are able to influence each other (translation) and thereby work together in a co-design process.

References

Bijker, T., Hughes, T. and Pinch, T. (ed.) (1987), “The social construction of technological systems”, MIT Press.

Callon, M. (1986), “Some elements of a sociology of translation: domestication of the scallops and the fishermen of Saint Brieuc Bay”, in *Power, action, and belief: Anew sociology of knowledge?*, Law, J (red.) (1986), Routledge, London, pp 196-233.

Callon (1987), “Society in the Making: The Study of Technology as a Tool for Sociological Analysis” in *The Social Construction of Technological Systems*, Bijker, Hughes & Pinch (red.) (1987), Cambridge MA, The MIT Press.

Horgen T. H., Joroff, M.L., Porter, W.L., & Shön, D.A. (1999), “Excellence by Design: Transforming Workplace and Work Practice”. John Wiley & Sons, New York.

Howcroft, D., Mitev, N., & Wilson, M. (2005), “What We May Learn from the Social Shaping of Technology Approach” in *Social Theory and Philosophy of Information Systems*, L. Wilcocks & Mingers, John Wiley, London, pp. 329-371.

Latour, B. (1987), “Science in action”, Open University Press, Milton Keynes.

Latour, B. (1992), “Where Are the Missing masses? The Sociology of a few mundane Artifacts” in *Shaping technology/building society: studies in sociotechnical change*, W. E. Bijker & J. Law, eds., MIT Press, Cambridge MA.

Latour, B (1998), “Artefaktens återkomst. Ett möte mellan organisationsteori och tingens sociologi”, in *Studier i företagsekonomi 5*, Nerenius & Santérus Förlag, Göteborg.

Law, John, (1987), “Technology and heterogeneous engineering: The case of the Portugese expansion”, in *The Social Construction of Technological Systems*, Bijker, Hughes & Pinch (red.) (1987), Cambridge MA, the MIT Press.

Law, J. & Hassard, J. (1999), “Actor Network Theory and after”, the Sociological Review Monographs, Blackwell Publishers / The Sociological Review.

Monteiro, E, (2000), “Actor-network theory”, in *From control to drift. The dynamics of corportate information infrastructure*, Ciborra, C. (ed.), Oxford Univ. Press, 2000, pp. 71 - 83.

Pinch, T. J. & Bijker, W. E. (1987), "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, W. E. Bijker & et al, eds., MIT Press, Cambridge, pp. 17-50.