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Christiansen, John K.; Gasparin, Marta

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John K. Christensen and Marta Gasparin

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DRAWING THINGS TOGETHER IN THE FUZZY FRONT END WITH BLACK-BOXES.

John K. Christiansen

and

Marta Gasparin*

Copenhagen Business School, Denmark johnc@cbs.dk

* University of Leicester, School of Business mg.om@cbs.dk

ABSTRACT

An explanatory study of four innovation processes demonstrates that it can be useful to understand the front as a process where social and technical elements are interweaved and knitted together. This analysis adds to the understanding of the processes that makes it possible to move innovation processes through the dynamic and ambiguous fuzzy front end to concept development and product development.

The study is based on ethnographic research and intensive use of historical archives, providing the data for the development of four cases that reveals the processes, networks and outcomes in these. Data are analyzed using relevant software and structured methods and analytical procedures involving multiple researchers and both internal and external validation of observations.

The study indicates that this interlocking is not a linear progressing managed process, nor is driven by a single individual or by a system, nor the outcome of the environments or of the strategic decisions planned by managers or gatekeepers, but that it is an emerging network where human and non-human actors are pulled together into a continually stronger network that is closed, i.e. black-boxed. Using the concept of black-boxing in studies of the fuzzy front end of product development is new. The analysis show that the concept of black-boxing is useful to analyze these processes, and a useful concept for understanding the challenges managers face.

The analysis presents the processes that leads to successful stable Blackboxing for four products that can move the FFE into concept development and successful detailed development by using method of the socio- and techno-gram to depict the processes.

The analysis contributes to prior research on the front end processes in several ways. It focuses on the micro-processes and how the human and non- human actors are draw into the network to make the alliances between the social and the technical, and illustrating the blurred boundaries between what is technical and what is social in the front end. Second, the analysis shows the blurred boundaries between what is in and what is outside the front end process and the company, what can be controlled directly what can't. Third, the processes are not a forward movement following guidelines, plans or proposals, but rather a movement back-and-forth and left-and-right, in whatever direction that can increase the creation of a strong network.

Keywords: fuzzy front end, black-boxing, concept development, innovation processes, management

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INTRODUCTION

Interestingly, the front end is an area of NPD that is frequently mentioned as the most critical phase of the innovation (Frishammar et al, 2012, Frishammar et al, 2013, Koen et al, 2001), but there are not many studies on how management of this phase is actually taking place on a micro level, that is: what are the actions that bring together a product or the proposal for a new product? The front end of new product development or the fuzzy front end (Frishammar et al, 2012) - is one of the most critical parts in the innovation process which managers have to deal with in order to develop new products (Kim and Wilemon, 2002; Reid and Brentani, 2004), which is considered crucial for companies to stay competitive (Khurana and Rosenthal, 1998). The front end is defined as the early phases of the new product development (Khurana and Rosenthal, 1998), the "pre-project activities" (Verganti, 1997) while Cooper considers nearly half of the phases to be the front end processes - that is ideation, scoping the project, defining the product, and building the business case, and as the most critical part of NPD (Cooper, 2008, p. 217). We here adopt the definition from Khurana and Rosenthal (1998, p. 59) that divide the front end into three phases: Pre-Phase Zero, Phase Zero and Phase one (ibid. p. 59). These phases includes: (1) preliminary opportunity identification, Idea generation, Market and Technology analysis and product and portfolio strategy alignment (2) Product concept and (3) Feasibility and project planning. They further state "we define the front end to include product strategy formulation and communication, opportunity identification and assessment, idea generation, product definition, project planning, and executive reviews" and that " the front end is "complete" when a business unit either commits to the funding and launch of a newproduct development project, or decides not to do this (the continue/no-go decision)." To this we add, that the front-end process in the analysis presented here, does include the innovation processes until the first prototype of a piece of furniture is ready for volume manufacturing and market launch, following the definition by Khurana and Rosenthal (1998, p. 59). Thus the front end definition applied here, does include various prototypes, production technique development, modifications and improvements carried out on the design and prototypes.

Prior analysis on the managerial issues related to the front end processes has focused on how to handle the uncertainty, to improve information processing or how to increase speed related to the front end processes. Although these approaches might have produced many valuable insights, we propose an alternative view, to demonstrate in an explanatory study how a micro-oriented approach focusing on the interweaving of social and technical elements in the process is emerging. So, rather than focusing on different activities related to discrete entities such as markets, customers, idea testing, strategy alignment and planning, the analysis of this paper focuses on explaining what are the actual micro-processes that produced four different pieces of furniture from a manufacturer. As the fuzzy front involves processes that lead to the amalgamation that feeds into the more linear development and refinement project phases (Khurana and Rosenthal, 1998, p. 59), we study things in the making: the transformation of one or several ideas into a conceptual model that can become a product that a company can finalize into a product on a market. ANT simultaneously makes possible to study both humans - as managers, designers, engineers, manufacturing and marketing experts - and *at the same time* the technologies that they are struggling with trying to use and connect into new products.

The remaining paper is structured accordingly. First, prior research on the front end is presented and its characteristics derived. Second, an alternative understanding and model is presented. Third, by approaching the front end from an ethnographic rather than from a managerial research position we use four cases in the explanatory research to illustrate how a micro-process approach can produce new insights into the managerial challenges in the front end. Fourth, a discussion and conclusions are delineated, before implications for research and management are addressed.

ANALYTICAL FOUNDATION: ACTOR NETWORK THEORY

The present research analyzes the micro-processes in the fuzzy front end and especially how the technical and the social are knitted together in the processes. This theoiry can illuminate how the technical and the social aspects are related and make possible to move an idea or a concept from being an idea through the fuzzy front end (FFE) to the next phase, where the product or service is developed. In order to analyze the micro-actions in the fuzzy front end and understand how an idea for a new product become a prototype, we use Actor-Network Theory (ANT) as an analytical framework, and we assessed it appropriate due to a number of reasons.

First, prior research on front end processes has pointed to several aspects of the FFE: the different types of activities that are needed to be undertaken, such as idea identification and selection, identification of customers and markets potentials and the sequence of these (Khurana and Rosenthal, 1998; Reid and Brentani, 2004); the handling of uncertainties of various kinds (Brentani and Reid, 2012); how different types of information technologies (Saff and Ernst, 2003) or organizational structures (Thomke and Fujimoto, 2000) can be used to facilitate the processes and might involve some type of strategy to increase the inflow of solutions and external knowledge in different forms (Christiansen, Gasparin and Varnes, 2013). However, the microprocesses that make the relationships between the technical and the social processes have not yet been explored, and ANT offers the possibility of analyzing such processes. ANT approaches "science and technology in the making" as opposed to "ready made science and technology" (Latour 1987), and thus focuses our attention on the processes. As the fuzzy front involves processes that lead to the amalgamation that feed into the more linear development and refinement project phases (Khurana and Rosenthal (1998, p. 59)), we are trying to study things in the making: the transformation of one or several ideas into a potential product or service that a company can finalize into a product on a market.

<u>Second</u>, being curious about the fuzzy front end micro-processes, we need a theory that simultaneously makes possible to study both humans - as managers, designers, engineers, manufacturing and marketing experts - and *at the same time* the technologies that they are struggling with and trying to use and connect into new products. Thus, we have decided to follow the ANT proclamation and "open the black box" of science and technology by "following the actors" (Latour, 1987). ANT explains these human and non-human actors as active "actants":

"An actor in ANT is a semiotic definition – an actant – that is something that acts or to which activity is granted by another...an actant

can literally be anything provided it is granted to be the source of

action" (Latour 1996, p. 373; see also Callon and Latour 1981, p. 286). The human and non-human actors are in ANT considered equally important and relevant, and therefore the resulting network among different actors are consciously labeled as 'sociotechnical network' or 'heterogeneous network' (Latour, 2005) to clarify the mixed nature of these networks. This is expressed and explained with a principle of 'generalized symmetry' (Callon, 1986a) that eliminates the duality between humans and non-humans. The fact that humans and non-humans have the same ontological dignity is based on a long series of empirical studies in labs, past and present innovation projects, research centers that show how texts, technologies and humans are equally important in the construction of the actor-networks (Callon & Latour 1981; Latour 1987; Law 1994). The social and the technical are equally important from the outset in this theory, although we cannot know their precise roles until we have studied them in the processes:

"Often in practice we bracket off non-human materials, assuming they have a status which differs from that of a human. So materials become resources or constraints; they are said to be passive; to be active only when they are mobilized by flesh and blood actors. But if the social is really materially heterogeneous then this asymmetry doesn't work very well. Yes, there are differences between conversations, texts, techniques and bodies. Of course. But why should we start out by assuming that some of these have no active role to play in social dynamics?" (Callon and Law 1997, p.168).

ANT proposes a "flat ontology", which rejects any a priori attribution of scale to social entities (Latour 1996). In this frame, constructs or measurements are replaced by one of identifying connections (Latour 2005).

<u>Third</u>, we want to be able to describe how the different actors - human and nonhumans - the social and the technical - get connected in the fuzzy front end. Actornetwork theory regards the construction of the network as the outcome of what they call "interessement" processes, as stated: actors interact and work for building a network knitted together with associations (Callon and Latour, 1981). The interessement represents a successful inscription of an actor to be part of the network, but the networks are only stable as long as the actors do not leave them, so networks are basically fragile (Latour, 1996). The nature of networks being fragile and precarious also leads to the observation of their performative nature. Relations need to be repeatedly 'performed' or the network will dissolve (Latour, 2005). Thus, in the FFE, we will investigate processes that are mobilizes to try to knit different actors together, as without these kind of processes - based on ANT - the FFE remains fuzzy - unclear unsuccessful and an idea or concept could not be transformed into a successful prototype. This leads to the last point.

<u>Fourth</u>, even if we want analyze the front end processes, we also assume that the front end processes at some point get settled and that different controversies on choices (Christiansen & Gasparin, 2016) related to areas such as design, material, manufacturing techniques and costs, are closed by some sort of decisions that make possible to move the innovation process from the fuzzy-front-end to next steps in the innovation process (Khurana and Rosenthal, 1998). ANT argues that closing the activities but forming a stable network can transform the multiple activities into a closed and stable "black box". Black box is a term used to explain how actors close debates, processes and controversies. A black box represents the stable and organized outcome of the FFE processes:

"[t]he assembly of disorderly and unreliable allies is thus slowly turned into something that closely resembles an organized whole. When such a cohesion is obtained we at last have a black box" (Latour, 1987, p. 130-131).

A Black box can represent the concept development or the prototype of a new furniture. Although it is not an easy task, the objective here is to open the black boxes of the prototypes of two chairs and two easy-chairs.

"The impossible task of opening the black boxes is made feasible by moving in time and space until one finds the controversial topic on which scientists and engineers are [or was] busy at work" (Latour, 1987, 4)

Black boxes represent a form of technical and social reduction, where the social (actors) engage in and with technology. Our interest and preoccupation lies in "opening" these black boxes for closer scrutiny, thus analyzing the particular processes that led to a certain black box (prototype).

"Is not simply a question of the number of allies but of their acting as a unified whole. (...) When many elements are made to act as one, this is what I will now call a black box (Latour, 1987, pg. 131).

One could say that the inventor - the entrepreneur - that started the innovation process and the front end is perpetually in search of allies (Akrich, et al., 2002a) and those allies consist in this perspective of social and technical allies, human and non-human actors (Latour, 1987).

Analytical framework

From the literature, it is proposed that the front end processes at some point get settled (Brentani and Reid, 2012) and that different controversies on choices related to areas such as design, material, manufacturing techniques and costs are closed by decisions and acts (Christiansen and Gasparin, 2016) that make it possible to move the innovation process from the fuzzy-front-end to next steps in the innovation process (Khurana and Rosenthal, 1998). ANT argues that closing the activities by forming a stable network creates a stable "black box". Black box is a term used to explain how actors close debates, processes and controversies in an cohesive way (Latour, 1987), and in the fuzzy front end a black box is a successful outcome, for example a project brief or a prototype. We decide to analyze the process of the production of the black box of four successful prototypes that became very successful designs to understand the process of the interweaving of the technical and social aspects.

Following the four elements presented above the analysis will uncover the processes between the human- and non human actors in the network construction that leads to the successful black-boxing of the fuzzy front end. Black-boxes represent more than what can be seen by observing the object, the prototype or first version of a chair, because they represents all the actors and their actions to build it. Black-boxes are constantly under treat to break down, as actors might be treacherous and might leave the network, making it fragile: materials might not work as intended, machines might not be able to produce the expected outcome, designers might get better offers from competitors, or the calculations for the production costs might be questioned (Latour, 1987).



Figure 1: Our framework to analyze the front end as an interessement process, Based on Latour, 1987.

When the interessement process are successful and creates a stable network - e.g. in the form of the first reliable and working prototype, it becomes a black-box (Latour, 1987). Derived from Latour (1987) the a process leading to a successful Blackboxing looks as the presented in figure 2 below.



Figure 2: A successful blackboxed front-end innovation process, which produces a new prototype of a product ready for detailed product development, manufacturing and market-launch.

The black-boxing process is driven by spokespersons that speak as representatives of, and for, the innovation (the chair) building a network of human and non-human actors, which become connected across organizational, social and technical areas (Akrich et al, 2002a). The spokesperson attempts to impose and stabilize the identity of the other actors with different devices used to implement these actions, cutting, weakening or creating the links between the actors in the network (Latour, 1996) and enroll them. Enrolment occurs when the actors accept the roles attributed to them and becomes locked into the actor-network (Latour, 1987). In this sense, the interessement process builds the network from entities to which it both receives and attaches characteristics and establishes temporarily stable links among them (Latour, 1987).

METHOD AND ANALYSIS

The Actor-Network-Theory is rich on empirical studies published in books and articles from the last 30 years on scientific and technical innovations and frequently associated with the three researchers Michel Callon, Bruno Latour and John Law, but there are others (Akrich and Latour 1992; Callon 1999; Callon and Law 1997; Hassard, Law and Lee 1999; Latour 1987; Latour 1996; Latour 1999; Latour 2005; Law 1992; Law 1997; Law 2007; Lee and Brown 1994; Neyland 2006).

ANT does not stipulate one rigorous method on how to use, collect and analyze data (Law, 2004), but its statement elaborated by Latour (1986) to "follow the actor" (inspired by Garfinkel, 1967) has become somewhat of a dogma, although Latour (1988) admits that there are essentially an endless number of potential human and nonhuman actors to follow. Thus, ANT leaves up to the researchers to evaluate when the information collected is sufficient to produce and enact a sufficient narrative. Besides, ANT is difficult to describe detached from its empirical studies and is best understood as something that is performed rather than something that is summarized (Law 1997; Law & Singleton 2000). The method used has been described "as another way to be of being faithful to the insights of ethnomethodology" (Latour, 1999, p.19), as a "final vocabulary" (Lee & Brown, 1994, 774)," a ruthless application of semiotics" (Law, 1999, p. 7).

Based on prior contacts with the company, the researchers got access to the empirical setting, and after some negotiations they agreed with the senior managers within the area of sales, marketing and product development, to conduct an historical empirical study of four chairs from the company. The researchers were offered access to the company museum, written material like the minutes from board meetings, scrapbooks and publications. The company museum holds a complete collection of its past and present prototypes and manufactured models. A steering committee, with two managers from the company, met the researchers every 4-6 months over a period of 2 years. One of the three researchers was the prime investigator, and devoted a total of more than 60 days in the company. During the weekly site visits, formal and in-formal ad-hoc interviews were conducted, as well as collection of additional material such a marketing material, minutes from company board meetings, letters, pictures, newspaper and magazine clippings and brochures and on-site observations. Additional background information was collected from recorded radio, television documentaries, and documents collected in the design museum in Copenhagen, Victoria and Albert Museum in London, and Catherine College in Oxford.

The printed material was ordered into a database, which subsequently consisted of 65 images from public museums, 563 records related to the four analyzed chairs and their design, 1.219 images from the collection in the company museum and 246 records concerning different internal documents, including reports, letters, minutes, financial documents, financial statements, press-releases and clips from news-papers and magazines and presentations. Records were translated from Danish, Norwegian, French, Spanish and Italian into English. For each record, details on the source, content and other signifiers were noted in the database.

Three rounds of scheduled interviews were conducted. To guide the interviews a list of questions was prepared and reviewed by all three researchers, functioning as a checklist (Kvale and Brinkmann, 2008). The 22 scheduled interviews lasted between 1 hour and 2,5 hours - with an average of one hour and half. The scheduled interviews were transcribed, coded and analysed using Dedoose. Five of the interviewees were interviewed twice. Each interview was transcribed in full, place and time was recorded

as well as first thoughts and reflections

Date	Position	Function	Date	Position	Function
June 2011	Design manger	Architect	Nov 2011	FH designer	Cabinetmaker
June 2011	FH designer	Cabinetmaker	Nov 2011	Librarian at	Historian
June 2011	Consultant at the DK Design Centre	Historian	Sep 2012	HR manager	Business
June 2011	Large design shop		Oct 2012	CFO	Finance
June 2011	Brand Manager	Marketing	Oct 2012	Former design manager	Architect
June 2011	Head of Design	Architect	Oct 2012	Marketing manager	Marketing
June 2011	Graphic Design	Design	Oct 2012	Design manager	Architect
June 2011	Brand Operations	Business	Feb 2013	Librarian at St. Catherine Coll.	Archeologist
July 2011	Kasper	Designer	March 2013	Design manager	Architect
July 2011	Mgr. auction house in Milano	Historian of Art	March 2013	Marketing manager	Business
Oct. 2011	Personal Assistant to the CEO	Engineering	March 2013	CFO	Finance

Table 1: The 22 scheduled interviews.

Besides the scheduled ones, more than twenty-five informal interviews were made with employees encountered during lunchtime, visits to different departments and on the parking lot. These interviews were not recorded, but they were noticed, summarized and quoted in the research diary together with observer reflections and additional observations.

The three rounds of planned interviews, the informal interviews, observations and the collection of written materials, documents, minutes and company brochures became more focused during the last year of the research, but at the same time also more farreaching, when adhering to an ethnographic approach trying to uncover the sociotechnical actors, interessement processes and the human and non-human actors enrolment into socio-technical networks. The ethnographic study became a historical one, following the Latourian inclination to follow the actors and keeping a deliberate openness to multiplicity (Mol, 2002), i.e. being able collect data and uncover actions as different practices rather than jumping to one or another classification (or what ANT would call a black-boxing) of what has been observed. Rather than being sequential, trying to establish certain observations as facts, an ethnographically inspired ANT study therefore makes the researcher to move-back and forth between observations and preliminary analysis (Garfinkel, 1967) to uncover actors (human and non-humans) in a process of constantly investigating their relationships, collecting suggested interpretations, controversies, sources of mobilization and creations of networks and black boxes. Thus, the data collection in this approach becomes constantly informed by the (preliminary) analysis, challenged and searching for deeper knowledge.

So, any accounts of observed practices are not considered "final" or closed for further investigation. They are considered preliminary, and they spur the next investigation, as there is always the possibility of further questioning (Garfinkel, 1967). Thus, data collection and analysis become intertwined in this ethnographic approach, and the construction of potential mappings of the socio-technical networks and their black boxing are an ongoing process during the study, as demonstrated in prior ANT research e.g. in the study of scientists plotting the rainforest in Amazonas (Latour, 1999).

The coding of data in a constructivist theory as ANT thus involves identification of actors, the practices, and the relations between actors, the interessement processes and attempts to close eventual blackboxes etc. According to Saldana (2011, p. 3) a code in qualitative inquiry is:

" [...] most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data. The data can insist of interview transcripts, participant observation field notes, journals, document, literature, artefacts, photographs, video, website, e-mail correspondence and so on. "

The first cycle of coding used several approaches: attribute coding, descriptive coding value coding and simultaneous coding (Saldana, 2011). Attribute coding identifies the attributes of the population: the actors and the different features of the chairs that were associated and disassociated in the observed processes. Descriptive coding represents an essence or a significant observation and "[...] summaries in a word or short phrase - most often as a noun - the basic topic of a passage of qualitative data (.

...). It is important that these codes are identifications of the topic, not abbreviation of the content. The topic is what is talked or written about". (Saldana, 2011, p. 70). Value coding, as described in Saldana (2011), is a qualitative description by the researcher, of the expressed values and attitudes of the actors, based on analysis of interviews, field notes and documents. Simultaneous coding is the application of two or more different codes to a single qualitative datum (Saldana, 2011).

The first analysis produced a number of narratives for each chair, significant episodes, identification of actors, spokespersons, enrolment processes, mobilizations, interessement process, translations, black boxes, framing devices, valuing and technologies of managing. This intermediate outcome revealed several possible avenues for further investigation.

The scope of the second cycle coding in the analysis was to develop a conceptual and theoretic organization of the outcome from the first cycle of coding (Saldana, 2011), but also assembling and synthesizing observations informed by additional readings of the data and collection of further data. This was supported by field observations in the company and access to different sources.

The second round of analysis helped developing the theoretical framework to be used in the third round of the analysis. The analysis focused on fewer selected theoretical elements, as actors, interessement, funnel of interest, networks, spokespersons, features associated and dis-associated, black boxes and episodes. The episodes helped constructing the historical process-narrative for each product. The present analysis focuses only on the fuzzy-front end of these narratives. A re-coding of the interviews and the material in the database using Dedoose supported the final analysis and the production of the four narratives.

This approach was suitable for performing a study based on three methodological principles: agnosticism, generalized symmetry and free association. Agnosticism implies abandoning any pre-conceived assumptions of causal relationships, nature of the networks or the accuracy of the actor's explanations. Thus, this framework demands that all interpretations have to be considered of equal importance (Ritzer, 2005). Generalized symmetry implies not changing registers when researchers move from the technical to the social aspects (Callon, 1986a). In other words, observers should use the same explanatory frame or vocabulary to examine human and non-human actors (Ritzer, 2005). Lastly, free association requires that the observer abandon the division

between Society (the social) and Nature (the technical) in the analysis. As Latour states: 'Society and technology are not two ontologically distinct entities but more like phases of the same essential action' (Latour, 1991, p.129).

The study observes criteria of validity, reliability and generalization. Reliability was achieved by filing all collected data, both primary and secondary, in a database accessible for all researchers in the study. Internal validity, as concerned with the soundness and rigor of the study (Daymon & Holloway, 2012) was achieved by multiple presentations and discussions of the analytical framework. Furthermore validity was achieved by using the 'Member checking' method, which requires the researchers to present the analysis and the results to the participants in the study and listen carefully to their feedback (Daymon & Holloway, 2012). Generalizability (also known as external validity) checks whether a study's findings are generalizable beyond the immediate study. Yin asserts that general applicability will result from 'the rigor with which the study is constructed' (Yin, 2013, p. 45). Affirming generalizability is more difficult for qualitative research than it is for quantitative one, since 'qualitative researchers often make statements which are context specific' (Daymon & Holloway, 2011, p. 80). Furthermore, each situation and network is heterogeneous, therefore the generalization of observations is less relevant for ANT scholars. However, from the present study, we might make generalizations regarding the observed interplay between humans and non-humans in the fuzzy front end, the micro-processes that are happening in this phase. This implies that we do not aim at generalizing the individual activities, but we can illustrate how human and non-human actors are mobilized, become related in the construction of the network and the black-boxing of the fuzzy front end is occurring, which are all new to research on the FFE.

ANALYSIS

The cases chosen are four furniture products developed and manufactured by a Danish Design Company, Fritz Hansen. "Series 7" was launched in the marketplace in 1955, "Egg" in 1958, "Ice" in 2002 and "RO" in 2013. The narrative presented here are all based on interviews and historical documents.

To focus the present presentation within the limitations of a conference paper we have chosen to bring two network drawings for each black-boxing process: A network drawing showing the complete network for each product and the analysis of the successful black-boxing process that lead the process from the fuzzy-front end to a conceptual model, that could go into detailed product development.

All the four selected products where considered radical at the time for their introduction to the market, both for the company, the industry and the (international) customers, and they all become highly evaluated by observers and critics and became successful in the market and as generators of income for the company.

The Series 7 chair

The Serie7 is a plywood chair manufactured by Fritz Hansen and introduced in the marketplace in 1955. The Serie7 is the result of translations of the former Ant chair, which was launched in the market in 1952, to enrol and silence the customers that were making the networks of the chair unstable by criticizing the three legs in the first version and a lack of an armrest.



Figure 3: The network needed to produce the Series 7 chair.



Figure 4: The Blackboxing in the fuzzy front end for the Series 7 chair.

The Egg chair

The Egg is a lounge chair or easy chair introduced in the market in 1958 at the Formes Scandinaves exhibition at Musee des Arts Decoratifs in Paris.





Figure 5: The network needed to produce the Egg chair.



Figure 6: The Blackboxing in the fuzzy front end for the Egg chair

The Ice chair

The Ice chair marks a milestone in the history of the company Fritz Hansen: it's the first chair marketed from Fritz Hansen that is equally suited for both indoor and outdoor use. The chair with its rib-like back incorporates the virtues of classic chairs of the past while the choice of materials points to the future. The base is natural anodized aluminium and the seat and backrest are made of ASA-plastic, a both sturdy and sustainable choice. The result is a lightweight, highly comfortable and hardwearing chair. The Ice chair had an unusual long fuzzy front-end.



Figure 7: The network needed to produce the Ice chair



Figure 8: The Blackboxing in the fuzzy front end for the Ice chair

The RO

The RO chair is a so-called easy chair, meant to be a comfortable and relaxing chair that was brought to market in 2013. The RO is the first easy chair in the company portfolio after the Egg, and the ambition of the company was to introduce a newly designed easy chair with a lower price tag than the much older Egg. The development of the RO was divided into two main phases: First the (fuzzy) front-end with the idea generation and concept development to a prototype and then the development (manufacturing and launch). The whole process took about 2 years and of these the front-end processes took about 8 months.



you need this..... and this.....

[network analysis in progress.....] Figure 9: The network needed to produce the Ice chair



Figure 9: The Blackboxing in the fuzzy front end for the RO easy chair.

DISCUSSION

In this article, for the first time in the front end literature the role of human and nonhuman actors has been analyzed with the use of the concept of black-boxing. In previous research, these elements were separated and the emphasis has been on the role of the gatekeepers, on the environment or organizational issues (Khurana and Rosenthal, 1998 Veyzer, 1998, Poskela and Martinsuo, 2009, Martinsuo and Poskela, 2011) rather than on the complexity of this system, constituted by a web of human and non-human actors that are co-constructing the system. The previous perspectives also described the front end process as a progressing linear process (Khurana and Rosenthal, 1998), successful as long as the company was following the process and meeting the criteria to enhance the performance.

Prototype case	The Series 7	The Egg	The Ice	The Ro chair
1 otogre cuse	1110 201105 /	1.10 2.88	chair	
Human actors	CEO Production mgr. Novo mgr. Architect Design studio employees Innovative employees in manufacturing Blacksmiths' Complaining customers Reluctant designer	CEO Production mgr. Architect Management Design studio Sculptor Shipbuilder Production employees	CEO Design manager and design team External designer Other designers Top mgt. Design team	CEO/CFO/Marketing mgr. Design Manager External 'designer' Manufacturing employees Upholstering
Non-human actors	Design team Cost concerns Eames chairs using plywood Industrial production Organic design Big order Hot-steam bending Plywood manufacturing Sketches Design studio Experiments Prototypes Ant chair Dan Chair Adding a leg and armrest	Industrial production Eames & Saarinen chairs New chair for hotel Sketches Prototypes Experiments with sculptor License Styropor (Polystyrene) Aluminium feet Upholstering technique	Fashion scouts reports Marketing department reports Design brief Revised brief A radically new chair Design competition Out- in-door chair Old cafe chair Aluminium Plastic A precise chair Design sketch First prototype Last minute modification	Design brief for affordable easy chair Anthropological consumer research Sketches 3 levels of design Modified design brief First design draft 7 prototypes + Back seat design Back with increased comfort
Spokesperson	CEO	CEO	CEO	CEO/Marketing mgr.
Approaches used by spokesperson(s)	Persuasion by CEO of designer	Inspiration to architect and license work	Customer knowledge and design competition	Careful selected one designer. Management insisted on using the design brief
Planned or emerging?	Based on customer complaints	Exploit new material and inspiration	Plan: A new in- outdoor chair	Plan: A new chair

Table 2: Summar	y of the four cases.
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The design/innovation manager becomes an igniter that motivates the process, a spokesperson who provides some visions on what is needed, but need to get allies into the network, needs to mobilize materials, and architects, designers, other managers, manufacturing employees, blacksmiths, shipbuilders, fashion scouts and handle customers and transform their complaints into the fuzzy-front-end process. Thus they acts as what Latour (1979) has called a spokesperson, one that speaks on behalf of others, here the idea of the need for a new piece of furniture.

In all four cases the non-humans play an important role for the closing of the black box: Different materials need to be identified, handled and managed to become allies (Plywood, Styropor, licenses, plastic, aluminium, upholstering techniques) but also prototypes, design briefs, a hotel, a canteen, an aluminium feet, industrial production, cost-concerns, bending techniques, the desire to do a radical innovation, references to previous products and concerns about the portfolio of present products.

Also, in all four cases, and that might special for this industry and this size of company, a CEO played an important role in the fuzzy front-end processes as the spokesperson. So did also employees from marketing, sales, production and different design people, but also blacksmiths, a shipbuilder, a design team and complaining customers.

The interest of all these human and non-human actors has been translated into the network. Each association of new allies provides a contribution to the "development process", as they become allies, but also add or modifies the network, so the final prototype is the sum or the outcome of these processes and the struggles that produced the black box and holds it together. Everything happens and moves across the two systems - or the two sides of the socio-technogram: If there are requirements or constraints in the socio-gram then negotiations will influence the technogram also. The figures in the analysis show those associations that have become strong and stable: Those that made the final prototype look as it did, when is so strong that it could move into product development.

Thus, from the present analysis of four processes, the front end innovation processes can be seen as a mishmash of decisions that cannot wait (Akrich et al, 2002), in an environment of complex changing markets and customer tastes, in which actions cannot be planned or predicted (hence the term nonlinear) (Christiansen and Varnes, 2007). The construction of the prototype meets many different trials (tests) and accusations in the process that needs to be handled. The vision or desire to develop a new piece of furniture and the construction of a prototype for this is constantly in search of allies in the fuzzy-front end during which the goals are presented and then thrown into the turmoil of many ongoing processes. Several translations of ideas, concepts and reinterpretations are presented during each of the four cases, and those are influenced by and related to modifications, changes and replacements done in the technogram.

The final, stable – but always fragile – idea that was finally transformed into a prototype to be developed into a new product is an outcome of alliances and relations between many. Thus, the final prototype is a bricolage, where the traditional role of the managers as gatekeepers is challenged and managers become spokespersons in search of allies, and where each new actor both associate but also transform the design. These chairs were also radically innovative

Radical (or discontinuous) innovation refers to an innovation that involves dramatic leaps in terms of customer familiarity and use (Veyzer, 1998). The discontinuity involves also the development of new technologies, which are offering significantly enhanced benefits. The process of discontinuous innovations is frequently unarticulated and lack of protocols and procedures to follow., which is actually aligned with the findings of these cases.

CONCLUSIONS, AND DIRECTION FOR FUTURE RESEARCH

"A chair is only finished when someone sits in it." Hans J. Wegner Danish architect, 1914-2007

In this article, we have investigated the processes in the FFE that are mobilized to knit different actors together, as without these kind of processes - based on ANT - the FFE remains fuzzy - unclear - unsuccessful and an idea or concept could not be transformed into a successful prototype. Without the Blackboxing and it relations between the social and the technical, based on negotiations, associations and interactions the fuzzy front end could not be concluded with a prototype ready for someone - after further processes - to finally sit in.

The analysis enabled a map of how the front end processes, that produces a prototype that can lead to further product development, is a complex weaving of an increasingly stronger network between human and non-human actors. The analysis also highlight the many associations that are needed to successful enrol materials, production technologies, designers, craftsman, managers and so on. The analysis illustrate how, in a front end innovation context, the network of human and non-human actors working together are complex, and how they are guided and framed - but not managed - by a spokesperson, a person (a manager, a designer, a manufacturer) who is working for an idea, supporting some core values and skilful in understanding the prototype as the outcome of a network that is constructed in the process, and need to be adaptable to be attractive for others he want to join the network.

Limitations

Presently the network analysis need another sanity check and both internal and external validation needs to be done once again, due to the complex nature of these cases and that the analysis rely on many different sources from inside and outside the company.

The analysis can be driven further, either by looking at the people who are convinced, or by looking at the new associations made to convince them, as Latour (1987, p. 131 states) "We may now generalize a bit from what we have learned. If you take any black box and make a freeze-frame of it, you may consider the system of alliances it knits together in two different ways: first, by looking at who it is designed to enroll; second, by considering what it is tied to so as to make the enrolment inescapable. We may on the one hand draw its sociogram, and on the other its technogram. Every piece of information you obtain on one system is also information on the other. "

The identification of the different human and non-human actors that are considered critical for the Blackboxing had proven to be a require multiple rounds of analysis and careful inspection of networks and sources. This process has revealed a weakness in the ANT theory, mentioned by others before, as 'flat' networks does not provide any aid in identifying influential actors from less influential ones, as they in principle all are important for constituting the network.

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