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UNDER THE GUISE OF OPENNESS: EXPLORING DIGITAL INNOVATION IN USER INTERFACE DESIGN

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UNDER THE PRESSURE OF OPENNESS: EXPLORING DIGITAL INNOVATION IN USER INTERFACE DESIGN

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In this study we are concerned with the ways digital components increasingly challenge preexisting work practices in traditional product development. By drawing on an in depth case study of an automakers attempt to respond to digital innovation, we explore digital innovation in a hardware regime. More specifically, we studied challenges connected to the specification process, and the difficulties of working with digital innovation in user interface design. Based upon our analyses of AutoInc, a world leading car manufacturer, we draw three overarching conclusions. First, specifying requirements for a digital material is in some ways a paradox. That is, the nature of digital innovation enforces agility both in terms of specification and use; it is, so to say, a volatile material. Second, we found that with two innovation regimes in one firm, different characteristic in forms of architecture, design and organizational structures need to coexist. This typically brings tensions between the urge for managerial control and the principles of openness. Last, this study indicates that fine-grained level of specifications may also force a shift in the locus of innovation. Thus, autonomy in the design process may be unintentionally narrowed.

Keywords: Openness, Digital Innovation, Interface Design, Automotive industry.

1. Introduction

During the winter of 2009, the management group of AutoInc, a world-leading car manufacturing firm, communicated that digital design and human machine interaction (HMI[1]) design was to be considered as one of the leading cornerstones in developing AutoInc's future car models. The focus on digital design was a consequence of the growing presence of digital displays in the driver area and the possibilities for increasing customization, differentiation and improving the driving experience with an exciting and appealing HMI.

By that time, the financial turmoil had made it clear that the automotive industry needed to break with its current innovation path and that digital technology would play a major role in redefining the industry (Thrun and Levandowski 2009). For AutoInc, the focus on digital technology was a historical decision that had grown from the movements of the market. Accordingly, AutoInc had the ambition to be a part of a growing development in user interface design and, in particular, boost innovation with the use of digital functionality (Leonardi 2010) and enable for open innovation (Chesbrough et al. 2006; Chesbrough 2003b; West and Gallagher 2006). As described by a manager: *"…we want to be an 'enjoyable' brand, a concept that should be reflected in all attributes and functions. When it comes to user interface design this requires openness, we need to put away all the pointers such as 'you are not wearing your belt' or 'you are about to drive off the road', and focus on becoming more pleasant and emotionally enjoyable."*
To that end, the importance of what and how information was presented in the driver environment had always been a matter of cognitive load, human factors, safety and usability (Green 2003; Wierville 1993). With the articulation of the focus on digital user interface development however, AutoInc was in a process of changing old work structures as to open up for external innovation and exploration.

The automotive manufacturing industry has a strong hardware legacy, where development processes and organizational structures are typically adjusted and reflected in the physical product, i.e. the car (Andreasson et al. 2010). However, in the last 30 years, digital data has increased in cars, in fact already in 2002 over 80% of innovations in cars originated from software (Leen and Hefferman 2002). More so, software represents more than a third of the development cost for a car (Weber and Weisbrod 2003). Today, as new functionality requirements are increasingly connected to software, the automotive industry is facing several challenges in terms of changing innovation processes. Such challenges involve definition of key competencies, processes, methods, and tools (Broy 2006; Pretschner et al. 2007). As an example, institutionalized supplier relations are put under pressure with the increase of digital data (Mathiassen et al. 2007; Weber and Weisbrod 2003). A car is a complex product, consisting of more than 15000 components. While suppliers produce the majority of these components, an increasingly pressing issue is how to include and combine digital elements in hardware components produced outside the boundaries of the firm.

Against this backdrop, this article aim to elaborate on how digital innovation affects design practices of user interfaces for digital displays. The research question is formulated as follows: *How does digital innovation effect design practices in a manufacturing firm (with open innovation ambitions)?*

Drawing on the open innovation literature and HMI design, we are particularly interested in understanding changes in the specification process and the consequences of turning a previously tangible function (such as physical buttons and switches) into an increasingly digital material.

[1] HMI is an abbreviation for Human Machine Interaction used in the automotive industry. It embraces the concepts of User Interface design and User Interaction design

The remainder of the paper is structured as follows. In the following section we present a brief review of current research regarding digital innovation. This is followed with a presentation of our theoretical lens based on open innovation literature. In the third section we define our methodological approach and then continue with presenting the AutoInc case. In section five we discuss the case in regards to the openness construct. We end the paper with conclusions and implications for research and practice.

2. Digital Innovation

The digitization of products has changed whole industries. Consider for example, the radical changes in the camera/photograph industry (Tripsas 2009), the newspaper industry (Ihlström and Henfridsson 2005) and the mobile manufacturing industry (Selander et al. 2010). It appears as if what previously used to be self-contained objects with well-defined functionality and meaning are now increasingly open-ended, agile and dynamic (Remneland-Wikhamn 2011). In particular, with the increase of digital components, content, value and usage can change and converge from one minute to the other (Yoo 2010). In a car context, this could be exemplified by the infotainment[2] systems that traditionally included separate systems, such as navigation, radio, CD player. Today those systems are integrated and converged in a single black box and a digital display in the center stack.

Digital innovation can be defined as the recombination of physical and digital components into new products (Yoo et al. 2010). This recombination process typically entails external exploration and encompasses the search of generating novel knowledge and exploring new opportunities (Vera and Crossan 2004; Yoo 2010). This includes the integration of diverse forms of knowledge, and the search for competence and information across internal and external stakeholders (Boland et al. 2007). More so, the possibility to reproduce digital content, at low cost and at a very rapid pace, force product developing organizations to change their logic in regards to control. Such control mechanisms need to be adjusted so that they follow the distributed development and production of digital innovation (Yoo et al. 2008). It has been suggested that the mode of control have to move from being centralized and hierarchical to become socialized "whereby organization members develop common expectations and shared values that promote likeminded decision-making" (Nobel and Birkinshaw 1998, p. 483). Hence, dynamic capabilities are increasingly relevant (Teece et al. 1997), as strategic processes within organizations are required to adjust and adopt to utilize possible digital options (Sambamurthy et al. 2003).

Digital options as a complement to already existing options require adjustments and alignments between two separate innovation paradigms, the digital and the physical. It has been suggested that when two innovation regimes need to coexist one has to consider different characteristics in forms of architecture, design and organizational structures (Svahn and Henfridsson 2012). For example, structures required for developing and producing a metal chassis for a car, look different from the structures required to develop and produce the HMI software. The development of a metal chassis usually follows a strict sequential order while the HMI software development process is non-linear. Moreover, it has been suggested that to succeed today, organizations need to enable and manage a state of constant creative conflict between internal and external design (Tushman et al. 2011). In particular, recent innovation research stresses the importance of external acquisition of new knowledge for exploration (Raisch et al. 2009) and *open innovation* processes (Cooke 2005).

By knowing and recognizing the potential of digital and open innovation, many car manufacturers today are increasingly providing in-car data to external developers (Ili et al. 2010). In view of the competition over automobile information services, openness is considered as a way of pushing service

[2]Infotainment is a neologism for Information and Entertainment and has in the last couple of decades received an increased amount of attention due to the growth of digitized services and functions in cars, such as navigation, tire pressure information and lately, the possibility to watch movies in the rear seat

innovation closer to those who experience the needs and to develop new innovation networks with the potential to break with the past (Chesbrough et al. 2006; Van de Ven 2005). Illustrative initiatives, in regards to opening up for external resources and suppliers outside of the car manufacturer industry, have been executed in, for example, GENIVI[3] (Macario et al. 2009).

3. Open Innovation in Product Development

The open innovation concept rest upon the assumption that an organization may benefit more when letting an organizations innovative activities and intellectual property be available for external organizations and stakeholders to use than if keeping it internal and have centralized controlling mechanism (Chesbrough 2003b). However, fully implementing and embracing the open innovation idea has shown to be hard, specifically in the beginning of projects when the product is untried and little, or no, information about profit possibilities exist (Chesbrough 2006). In particular, open innovation initiatives typically involve early stage ambiguity in project outcome and payoff.

Research suggests that the multi-layered and modular architecture of digital data, that enables open innovation in the first place, not only drives but even forces firms to form new relationships as to create value they cannot create on their own (Yoo et al. 2010). Thus, an open innovation agenda includes the simultaneous work by users and external developers to innovate and add value to different products (Von Hippel 2005). By providing software development toolkits (SDK) for anyone to use (von Hippel and Katz 2002) and distribution of internal data (Tapscott and Williams 2007), organizations hope to grasp innovative competence that rests outside the boundaries of the firm. For a car manufacturer such data would typically be in-car sensor data on different functionality such as speed, fuel levels, but also information about what music is being played or in what direction the car is heading. However, to enable an open innovation process one needs to reconsider the organizations attitude and stand towards, for example, control. Shifting from “we should control our intellectual property (IP) so that our competitors don’t profit from our ideas” to “We should profit from others’ use of our IP, and we should buy others’ IP whenever it advances our own business model” is necessary (Chesbrough 2003a, p xxvi).

The automotive industry is spending remarkable amounts on research and development (R&D) in their efforts to enable a more open approach to innovation, as with the GENIVI project. Simultaneously the industry is under pressure to dramatically reduce costs due to shorter product life cycles and price erosion (Ili et al. 2010). Recent research have suggested that the design and specification process is key in understanding the outcome (Chakraborty et al. 2010) and the development (Mathiassen et al. 2007) of new innovative design and open innovation. While typically seen as a way of creating possibilities for designing new products and applications, the specification process has also been a traditional way to control the innovation design process (Baldwin and Clark 2000). In traditional product development organizations, such as the automotive industry, much emphasis has been put on deciding early on specification for the product in order to control the functionality and secure quality (Baldwin and Clark 2000). The increase of digital data and dynamic design however, is increasingly forcing this process to change. In particular, digital data brings agile ways to work, that is, requirements and specifications may change very late in the development process (Lenfle and Midler 2009). More so, digital characteristics such as reproducibility and programmability make digital components essentially different from solely physical artifacts (Yoo et al. 2010). By drawing on a single case study of the HMI group at AutoInc, a multinational car manufacturing firm, we seek to further understand the contradictions and consequences of open innovation and digitization on product development organizations.

[3] GENIVI® is a non-profit industry alliance committed to driving the broad adoption of an In-Vehicle Infotainment (IVI) open-source development platform (http://www.genivi.org/ Accessed: March 27 2012)

4. Methodological Approach

We conducted a 6-month interpretive case study (Gerring 2007; Klein and Myers 1999) at one of the world's largest automakers, AutoInc. With this approach we aimed to explore the empirical setting and improve the understanding of the complexities that emerge when digital content escalate in the innovation process.

During the last two years the development of user interfaces had received full attention at AutoInc. In fact, developing new innovative user interfaces solutions had become a core strategy at AutoInc and received a significant amount of resources. There were several reasons behind this increased focus on user interfaces. First, the instrument cluster was becoming increasingly digital emphasizing the importance of usability and cognitive load issues due to traffic circumstances. Second, user interfaces had become central in pushing digital innovations directly aimed at the user. Third, with the increase of digital data user interface development had become an important mean to communicate the brand towards customers. Last, recognizing that the in-car infotainment now competes with the consumer electronics industry required a radically new approach, where open innovation was considered as one important strategy.

4.2 Data Collection

We used two main sources of data to trace AutoInc's efforts to push open innovation in user interface development: (1) In-depth semi-structured interviews with employees involved in the user interface development process and, (2) workshops with employees and consultants at AutoInc as to understand the overall strategy of user interface development and digital innovation. A third data source included 21 different specifications (requirement documents) released internally at AutoInc during the years 2000-2011. Although this data did not become an important element for the published result in this study it provided important insights to us on the changing development and magnitude of specifications over time.

Respondent	***Amount***
User Interface Manager	*1*
Interaction Design Engineer	*3*
User Interface Design Responsible	*6*
Total	*10*

Table 1 Interviews

The interviews, ten in total (see Table 1), were conducted during the months of May and June 2010. The respondents included a wide range of personal involved in the user interface development process, for example; User Interface Managers, Interaction Design Engineer, and Responsible for User Interface. The User Interface manger was responsible for all research projects before they transferred into development and production. Interaction Design Engineers included those working with implementing and specifying HMI requirements in different development projects. Those responsible for the user interface design, included product planners and managers working with overall design strategies coupled to the brand in general.

The interviews were semi structured and lasted on average one hour. All interviews were digitally recorded and transcribed. Key questions concerned issues related to the changing character of HMI design, requirement engineering, and difficulties/contradictions in working with an increasingly digital material.

Additionally, we conducted two workshops together with higher levels of management within the organization. The two different workshops discussed possibilities, consequences and challenges with open innovation and the increase of digital technology. The workshops also discussed how consumer electronics affect their customers and force AutoInc to take a new perspective on their product. The workshops took place in May 2010 and in November 2010 and lasted on average two hours. Seven managers from different areas within the automotive organization were represented at the first workshop while 12 managers were represented at the second workshop.

4.3 Data Analysis

Through iterative reading of the empirical data, the initial analysis phase started with thematic analysis (Fereday and Muir-Cochrane 2006) facilitated by open coding (Charmaz 2006). The open coding process involved naming and taking segments of data apart, a process that generated 181 descriptive codes. The second phase of the data analysis included clustering the data into coding families (Charmaz 2006). The descriptive concepts (initial codes), were clustered into six themes: User interface-development, Specifications, Tensions, Openness, Design and Tools. These themes guided us in finding an appropriate theoretical framework from which to analyze our data (Fereday and Muir-Cochrane 2006). More so, as to increase the overview of our data, we conducted network data displays following the recommendations of Miles and Huberman (1994). The network data display provided an overview of key events and links between them along with a better understanding of the case. The third phase of the data analysis included writing a thick descriptive case story (Geertz 1973; Langley 1999) as to isolate the core focus of the study. It allowed us to present the empirical data in a condensed but vivid and detailed form, including both practice and context data. We identified, in particular, three main challenges in the data material. These three challenges were related to (1) software development, (2) changing tools, and last (3) renegotiating supplier relations. The thick description was presented to AutoInc to validate our understanding of the data material.

5. The AutoInc Case

The user interface group had grown dramatically within AutoInc. Not more than ten years ago, the user interface function was more or less dependent on two key persons specialized in ergonomics. In 2009, however, AutoInc communicated that user interfaces was to be a major strategic focal point. For the user interface group, this meant that AutoInc would put a lot of emphasis and resources on user interface development. The group was even expected to grow during the hard financial times of 2009-2010. The ambition of becoming leaders in HMI development and design could to some degree be considered as a historical decision. With long traditions of product manufacturing AutoInc had previously focused on hardware related issues, such as door handles and safety issues. The new strategic position of HMI development was recognized throughout the organization, a manager commented: *"By now it [user interface design] is as important as our other trademarks... this creates ripple effects, and we need to change our work processes. Put simply, we do not have any (physical) products, we don't work with hardware."*

Inspired by the movement of the market, AutoInc had realized that they needed to open up to external collaborations and change their old institutionalized work processes – this, in turn, created several co-evolving challenges. The user interface employees both wanted these changes but also felt the pressure of leveraging new innovative user interface design. Increasingly, this required new approaches to software development processes, new tools, and renegotiated supplier relations.

5.1 Software Development at AutoInc

The scope of HMI development includes the entire infotainment area. This area had gone through radical changes with the increase of digital products. In particular, services such as navigation, radio, telephone, music etc. is increasingly covered in the very same hardware. The convergence of different systems requires complex user interface solutions, and AutoInc struggled with finding user interface consistency between the different solutions to enable easy interaction. Accordingly, the very streamlined hardware legacy within AutoInc, needed to be adjusted to fit development of user interface software, an Interaction Design Engineer explained: *"Software and hardware follow different* *business paths. Today we are dominated by engineers, and controlled by hard values. We need to embrace the new and make it sound reasonable to us."*

To clarify the new focus of HMI development, AutoInc made a strategic decision to divide user interface design in three new sub-domains; the keywords being that user interfaces was to appeal to enjoyable and emotional aspects of the driver experience. This was not an easy task as commented by an interface design responsible: *"'Hard' functions are much easier to communicate and for the receiver to understand, so they typically get much more impact and penetration. That is much easier than presenting soft values and changing the development process."*

In particular, the HMI group experienced how managers from all over the organization wanted to have a say about the user interface design process and more so, the end result. With little or no knowledge in regards to software, and user interface software in particular, the managers slowed down the development process significantly as requirements and specifications were continuously renegotiated. A manager responsible for product planning of user interfaces explained the problem: *"Fuel consumption, performance and things like that, crash worthiness and other stuff can be measured, but HMI is very emotional and that is what makes it fun. But this also means that managers up in the hierarchy want to be involved and have opinions, it slows down the process".*

It was not only the increase of digital functionality and software that was hard to understand and grasp. Rather, it appeared as if the understanding and agency in the software design process was limited, partly at least, by the lack of accurate tools to specify and design software requirements. A design engineer commented: *"This is one of our absolute weaknesses, why we are stubborn enough to hold on to the old requirement processes and tools. […] It doesn't fit with the new technology"*

Thus changing tools to specify requirements became a central question in the pursuit to fulfill the goals of creating enjoyable and emotionally attractive HMI designs.

5.2 Changing Development Tools

The traditional tools available in the requirement and specification process included Word, Excel, Visio, Power point and "One Pager". With the graphical focus on user interfaces, however, it seemed increasingly hard to visualize, in Word or Power point, emotional attractiveness and enjoyable experiences. In order to increase the possibilities of working in a more digital matter some of the user interface engineers started increasingly to communicate through Flash. An interaction design engineer commented: *"We are increasingly working with images and what we want the customer to feel and experience when they enter the car…Flash helps us to illustrate our ambitions and ideas"*

To further help the HMI group in advancing the HMI solutions, AutoInc invested in a new user interface simulator as to help visualizing new concept and ideas. With the simulator one could test and evaluate new concepts and suggestions in an agile manner. Despite this, it was soon to be noticed, that the specification process took significantly longer time than before – this was particularly due to three main reasons: first, with the new tools at hand, the user interface designers started to create specifications on an even lower level than before. In particular, they were able to decide upon the design themselves earlier in the process – thus limiting the creative impact of the external suppliers. To put it crudely, while aspiring for external innovation they found themselves increasingly exploiting their own internal creativity and knowledge. One of the managers commented: *"AutoInc has a very traditional development legacy where everything is dependent on drafts and so on. It has proven very hard to change the requirement and specification process for user interface design and even making it useful"*

Secondly, working graphically and with concepts such as "enjoyable" as a core value, the specification process became much more dependent on the judgment of individuals. Thus, nobody really knew what to specify for, and employees from all over the organization wanted to have a say about the HMI design. Last, while the new tools enabled for flexible and agile software changes, the new way to specify brought an increase amount of work. It appeared as if, with the "graphical way to work" the user interface designers were doing more or less the whole work and design themselves. An interaction design engineer described: *"I guess it's about control... if it's not then I don't know why we have the situation that we have today. Sometimes it feels as if we are making specifications on such detailed level that we might as well have done the whole thing ourselves"*

The detailed level of specifications not only significantly prolonged the development process but also inhibited the autonomy in the design process for the suppliers, and other external stakeholders. Thus the new structure of the user interface group, in combination with the simulator, and the increasing use of Flash became the primary way to control supplier input and output.

5.3 Renegotiating Supplier Relations

The suppliers have had, traditionally at least, a very strong position in the development processes at AutoInc. As most large scale organizations these relationships had been developed over several years and followed a strong institutionalized pattern. More so, the work processes of the suppliers were to a large degree mirrored in the AutoInc organization. With the new tools at hand, however, the collaboration process had changed. *"This new process [requirement specification] creates a lot of administration for AutoInc. Management have communicated that 'we need to control this, own this, and we need to make specifications on the lowest levels' they don't realize that the suppliers use our specifications as an instrument of control. That is, they only do what they have to do, instead of doing what they know would be the best solution."*

This was troublesome for the user interface designers who increasingly aspired to work with partners outside the traditional car industry. Such shift of powers, from traditional suppliers to external developers was not made possible. The inability to break free from traditional suppliers was the most important underlying reason, as user interface designers increasingly took charge of the design process. This was accomplished by internally develop graphical illustrations for supplier directions and guidance. Thus, the specification process was becoming less dependent on cooperation and collaborative design and more dominated by the user interface design group. Relating this to the initial ambitions to reach increased openness, the user interface design process seemed to be more controlled than ever before by the internal AutoInc designers. It appeared, by then, that the very concept of openness had shift meaning. While initially communicating openness in terms of involving external innovators, openness was increasingly discussed in terms of designing for flexibility. A manager described: *"We need to prepare us so that we can realize concepts and increase the flexibility in the user interface development process. We want to control the user interface process in a totally different way than before."*

The detailed level of specifications brought fundamental shifts in the power balance between suppliers and user interface designers specifying requirements. As indicated, historically, the suppliers had quite a say in the development process. Now the user interface designers more or less controlled the whole process.

6. Discussion

We set out to improve our understanding of how digital innovation effect design practices in a manufacturing firm. With this focus in mind, we conducted a case study of AutoInc's efforts to change its user interface design processes and become more 'open'. In what follows, we discuss the AutoInc case in relation to digital innovation and the openness agenda: First, the challenge of combining and working in two innovation paradigms and second, the challenge of balancing between counteracting strategies of openness and control.

6.1 Combining Two Innovation Paradigms

Initially, the AutoInc case illustrates the difficulties in combining two innovation paradigms. At AutoInc, the traditional way to specify requirements was based on a hardware tradition. This became particularly evident as the focus of user interface design turned from traditional ergonomics to more soft values such as emotional attractiveness and enjoyment. These new "soft" core values were to be implemented with digital means, however the user interface designers struggled with understanding how to specify such soft requirements. As suggested by Yoo (2010) and Andreasson et al. (2010) it appeared as if the increase of digital data required new capabilities and new work practices.

The traditional requirement engineering process was built on old institutionalized processes between traditional stakeholders. These collaborative relationships were, as suggested by Chakraborty et al. (2010) characterized by alliances and incremental knowledge sharing. Thus, the new emphasis on digitization and design created "communication gaps" (Mathiassen et al. 2007) and difficulties in reaching "collaborative sense making" (Chakraborty et al. 2010). These gaps existed both internally between the traditional interface designers and externally between the OEM (Original Equipment Manufacturer; i.e. other automakers) and the traditional suppliers. Much of the reasons behind these communication gaps rested in the separate design processes between the digital and the physical. Digital artifacts by necessity follow a non-linear design process, while physical components typically follow a strict sequential order (Svahn and Henfridsson 2012), this created a tension between design and task (Andreasson et al. 2010). More so, as the user interface design group received increased focus, several managers *within* the company wanted to be involved in the process. This typically slowed down the development and specification process.

6.2 Balancing between Openness and Control

Previous research highlights the possibilities and potentials in innovating with digital content and open innovation (Chesbrough 2003a; Tapscott and Williams 2007; von Hippel and Katz 2002). Yet, little research has been conducted on the challenges that established firms are facing when opening up their innovation processes (Chesbrough et al. 2006). AutoInc had ambitions to involve external stakeholders to enable open innovation but ended up controlling the process even more than before. In particular, the user interface group was increasingly expected to combine their knowledge with the development of digital design. While not knowing how to do this, the user interface design group started to work with new tools such as Flash in combination with the traditional specification tools. As a consequence, they continued to follow the traditional product innovation paths, focusing on early capture of requirements while exploiting internal industry and design competence (Andriopoulos and Lewis 2009; Jansen et al. 2009).

We found, as suggested by Floyd and Lane (2000), that the internal focus on control in developing specifications, contradicted the experimental and explorative promises that digital innovation may enable. It seemed as even though the aim of AutoInc was to become increasingly open in the design and specification process – the new tools and supplier relations forced them in another direction. Unsurprisingly then, the user interface designers unintentionally limited the opportunities for other external stakeholders to be involved in any phase of the innovation cycle. The outspoken strategy was to enable new relations with new stakeholders for a more exciting and modern user interfaces to customers. However the fine-grained level of specifications shifted the locus of innovation towards internal design. So, while the new tools enabled the user interface designers to better envision their design, it narrowed the supplier's involvement in the design process. Rather than reaching out and explore new knowledge, AutoInc developed a short-time, control focus – thus, as suggested by Floyd and Lane (2000) contradicting the aim to reach decentralized innovation. More so, trying to specify soft requirements, even if new tools were implemented, took essentially longer time than before since no one really knew how and what to specify for. Additionally, the organizational knowledge about digital options (Sambamurthy et al. 2003) appeared limited. Even though ambitions existed to involve other external stakeholders and elaborate on their knowledge, the path they were following reflected a mindset of ”internal exploitation” (Chesbrough et al. 2006) rather than external exploration.

Last, while AutoInc used the fine-grained specifications to control internally what was going to be included in their products and services the specifications were also used by the supplier as a way to control and guarantee the responsibilities between AutoInc and the supplier. As a consequence, the suppliers simply did what they were told, rather than what possibly would be the best solution.

7. Conclusions and Implications

Based upon our analyses of AutoInc, we draw three overarching conclusions. First, specifying requirements for a volatile invention such as user interfaces is in some ways a paradox. “Soft” values like “attractiveness” and “enjoyment” that are supposed to be implemented by means of a volatile material in a physical artifact is challenging. Second, we confirm that with two innovation regimes in one firm, different characteristic in forms of architecture, design and organizational structures need to coexist (Svahn and Henfridsson 2012). This, in turn, typically brings a discussion of control and governance. We found that while aiming to become more open in terms of innovating outside the boundaries of the organization, the user interface group moved in an opposite direction, specifying requirements on such a detailed level that the finally controlled the whole design process themselves. Last, this study indicates that fine grained specifications may shift the locus of innovation. Thus, the autonomy in the design process may be unintentionally narrowed.

This paper underscores the difficulties in moving from a traditional product development paradigm towards open and digital innovation. Open innovation theories; do not fully succeed in explaining the often somewhat contradictory consequences of open innovation. Our study suggests that a general framework is needed that incorporates such inconsistencies and contradictions.

8. Limitations and Future Research

This study had several limitations that point to future research directions. First, the conceptualization of the volatile nature of digital innovation is at an early stage of development and the discussion of materiality and more specifically, the “digital materiality” has only recently received larger attention (Barad 2003; Leonardi 2010; Leonardi and Barley 2008). More research can reveal deeper insight to digital innovation in general and digital matters specifically. Further, the current version of this paper does not discuss the limits or deeper meaning of user interface design per se. That is, in future research we need to ask ourselves, not only what user interface is but rather *when* it is. Last, we recognize that this study is partly limited by its sole focus on the automotive industry and the fact that we studied only one organization. We believe that the AutoInc case, however, generates insights important for the continued investigation of digital innovation in manufacturing firms (Henfridsson et al. 2009; Yoo 2010; Yoo et al. 2010).

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