The Finnish metal industry on the verge of the Industrial Internet as a setting for service design

Researching the digital and design maturity of the industry

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Master's thesis

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Tiivistelmä

Tämä tutkielma käsittelee muotoilun roolia suomalaisessa kone- ja metalliteollisuudessa, ja digitalisaation sekä teollisen internetin vaikutusta näiden toimialoihin. Metalliteollisuuden toimialat tuottavat kasvavia määriä palveluita, joissa digitalisaatiolla ja teollisella internetillä on osansa. Palvelumuotoilua voidaan hyödyntää liiketoiminnan laajentuessa fyysisistä tuotteista aina aineettomiin kokonaisuuksiin saakka.

Tämä tutkielma pyrkii löytämään ymmärryksen sille, kuinka digitaalisesti kehittynyt teollisuus on erityisesti teollisen internetin osalta, kuinka tietoisia yritykset ovat muotoilusta ja muotoilun metodeista, sekä kuinka yritykset näkevät tulevaisuuden digitalisaation ja muotoilun kautta. Lisäksi tutkielma pyrkii löytämään toimivia tapoja palvelumuotoilun hyödyntämiseen teollisuuden toimialojen yhteydessä.

Opinnäytteen aihetta lähestyttiin haastattelemalla muotoilun ja metalliteollisuuden ammattilaisia. Mukaan on valikoitunut myös teollisen internetin professorin haastattelu. Teollista internetiä on kuvailtu seuraavaksi teolliseksi vallankumoukseksi ja tutkimuksessa selvitetään, miten tämä näkyy käytännössä kahdeksassa suomalaisen metalliteollisuuden yrityksessä. Tämän mittakaavan muutokset vaikuttavat myös palveluntarjoajien, kuten muotoiluyritysten tarjoamaan. Tutkielma pyrkii myös paremmin ymmärtämään odotuksia ja mahdollisuuksia palvelumuotoiluun liittyen tässä kontekstissa.

Tämä tutkielma osallistuu keskusteluun siitä, kuinka palvelumuotoilua voidaan hyödyntää metalliteollisuudessa teollisen internetin vaatimukset huomioon ottaen. Tutkielmaan valittiin pieniä ja keskisuuria yrityksiä metalliteollisuudesta. Pk-yritykset voivat saada tästä tutkielmasta uusia ideoita tai vastauksia kysymyksiin, jotka liittyvät palvelumuotoiluun, palvelullistamiseen ja digitalisaatioon. Toivon, että teollisuus ja suunnittelijat löytävät tutkielmasta apua keskinäiseen vuoropuheluunsa.

Avainsanat IIoT, Palvelumuotoilu, Metalliteollisuus

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Abstract

This thesis examines the role of design within machinery and equipment manufacturing SMEs (small and medium-sized enterprises) of the Finnish metal industry. Design has traditionally been understood as a form giving activity, and often still remains so in companies of the metal industry. The industry is starting to produce an increasing amount of services partially driven by digitalisation and the Industrial Internet. Servitisation of the industry demands for new kinds of competences and service design approach could be used to support the transition from designing physical products to broader and in some cases immaterial entities. Service design approach however still remains unknown to many companies of the industry and an effort has to be made to spread the understanding of it.

This research aims to gain better understanding on how digitally advanced the industry is, how familiar it is with the design approach, and how it sees it's future in terms of digitalisation and design in practice. This study's approach to the topic was to interview professionals from the design field and the metal industry. Eight SMEs of the industry were selected to this study and this thesis reveals how digitalisation and design are visible in practice in these companies. The research also includes one interview with a professor of the Industrial Internet at Aalto University.

In addition to evaluating the maturity of the industry, the thesis seeks for successful ways of applying service design in the defined context of the study. The Industrial Internet has been described as the next Industrial Revolution and transformations at this scale affect the offerings of service providers such as design consultancies. This is also an attempt to better understand the expectations and opportunities for service design in response to the IIoT.

This thesis contributes to the discussion of applying service design expertise in the metal industry under the demands of the Industrial Internet and this thesis can provide the SMEs with new ideas or answers to questions related to service design, servitisation and digitalisation. I hope that companies of the metal industry and the design community could benefit from the findings of this thesis and to create dialogue between the two of them.

Keywords IIoT, Service Design, Metal industry

Thanks to

All the eight interviewees for our interesting conversations and for sharing your thoughts and experiences with me so generously! It was truly fascinating to hear how the companies have started to adapt to digitalisation and the IIoT.

LINK Design and Development for providing me with this interesting topic and Piritta, Jaakko, Matti, Mika and Anu for your contribution to this work.

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1. Introduction

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1.1 Servitisation and digitalisation – two major transformations taking place in the industry

Digitalisation is still in its early stages and the Industrial Internet (IIoT) is even more so. The effects of digitalisation on the economy have only started to be fully felt over the past twenty years. Despite the short period of time, digitalisation has had a huge effect on social and economic activities. Digitalisation is an essential part of all kinds of business activities and the everyday lives of citizens (TEM, 2015). The IIoT has been described as a new industrial revolution, from which Finland is looking for new growth opportunities and competitive edge. The Prime Minister's Office has identified it as one of its key themes (Juhanko et al., 2015).

Digitalisation links the industry and services together, and they should be examined and developed as a whole. The service activities within the industry are becoming increasingly central. For example the elevator and escalator manufacturer KONE bases its business model on a lifecycle model that includes maintenance of equipment, and modernization of their solutions. In 2014, the service business accounted for 45 per cent of KONE sales (Hakonen, 2015). This interest towards the service orientation can be explained by maturing produc markets and decreasing margins. Many services also offer a higher profit margin and a steadier income flow, and services provide an opportunity to build close and long-term partnerships with customers (TEM, 2015).

In the past, services have been considered to be of secondary importance to the overall economic development. Lately, more attention has been given to broader approaches that are based on interaction between the industry and services, not on a contradicting relationship between the two (TEM, 2015). It has been recognised that value is co-created with the user in exchange while using the goods and services (Vargo & Lush, 2004). The IIoT enables new ways of operating business activities as well as collaborating with enterprises, customers and end users. In terms of services, the use of the IIoT is often limited to the most traditional services: remote control has been used to enhance maintenance services supporting products. Many enterprises are still far from adopting a more comprehensive approach to change, building diverse customer-oriented business activities with the help of the IIoT (TEM, 2015).

TEM (2015) research suggests that the Finnish industry should concentrate on highly differentiated services. Vuorela et al. (2013) state that users of the 21st century require more than mere technical efficiency of the services that they use in their everyday work and that customer insight should be turned into a competitive advantage. TEM (2015) outlines that it

is usually impossible to compete against global entrants with cost or the breadth of offering. Digitalisation however, enables even small domestic players to respond to the challenge by developing highly targeted and differentiated services. In practice, that involves applying customer insight analytics to maximize the understanding of local customers. That way, companies will be able to target their marketing and sales activities better than before (TEM, 2015).

Image 1. *The expanding two directions of the product development process in the technologies industry (Hasu et al., 2004).*

A designers' know-how is utilized, for example for product differentiation. The image shows how requirements related to design have expanded in two directions. Chronologically the earlier phase of enlargement was associated with the company's own primary processes such as reducing production costs, shortening production and installation times and improving logistical efficiency. In addition to pure cost-effectiveness, companies have a growing need to stand out from the competition. The driving force behind a differentiation strategy lies in understanding and anticipating customers' processes and user activities. Development of new innovative services requires new types of information about users and their changing needs (Hasu et al., 2004).

1.2 SMEs of the Finnish metal industry as the target group of the study

The Finnish metal industry is an interesting group to study within the frame of service design for the IIoT. The industry has a strong foundation in Finland - as a whole the metal industry has a 41,4% share of industrial production in Finland (Statistics Finland, 2015) and a share of 48% in Finnish exports of goods in 2016. However, the companies within the industry are facing challenges in renewing themselves and in making new appealing products and services that could compete in the global market. International trade of the metal industry has decreased over the past few years globally. The current situation is not satisfying for countries or companies that depend on export of goods (The Finnish Metalworkers' Union, 2016).

The research group was narrowed down to small and medium-sized enterprises (SMEs) of the machinery and equipment manufacturers within the Finnish metal industry. Small and medium sized enterprises have different kinds of organisational structures and ways of operating compared to large ones. Vuorela et al. (2013) note that innovation is the most significant factor that can be used to compensate for any disadvantages experienced because of a size difference. SMEs in many areas are the primary growth driver of industry. Innovation has become nothing less than a survival strategy as the centre of economic activity in the developing world shifts inexorably from industrial manufacturing to knowledge creation and service delivery (Brown, 2009). The IIoT opens interesting opportunities for the industry and potentially serves as a tool for Finnish companies to compete in the Global Market.

SMEs should recognize the strategic importance of design and use it for research, development and innovation activities (TEM, Muotoile Suomi, 2013). There is still a lot of work in creating awareness of service design and the use of this approach in the industrial context. Finnish small and medium-sized companies still use design expertise very limitedly. However, every third industrial company utilizes design in Finland, which means that it leaves behind the other main sectors including business, service and construction sectors. Never the less, it is more common for older large and medium sized companies to invest in design than for young and small companies. Their investment rate also depended on how growth-oriented the companies were. Companies that were content in preserving their current status at the markets had less interest in investing in design (Lith, 2013).

1.3 Introducing the research partner: LINK Design and Development

LINK Design and Development Oy is an Otaniemi based design agency that provides integrated design services and strategies combined together with a business-oriented view. The company has throughout its existence worked with companies from the metal industry and has an active role in questioning old operating models and creating new products, services and business models which is now particularly important with the rise of the IIoT. After years of practical work LINK Design built a strong understanding of the questions that are present in the field. LINK Design has created a wide set of tools and methods to tackle with these questions.

The company was founded in 2009, and has approximately 40 employees with multifaceted backgrounds including professionals from business, service design, interaction design, industrial design, mechanical design, and engineering backgrounds. The company works in close collaboration with hardware and software companies and thus has a full capacity to realise functioning end products of high complexity.

User-centeredness is a core theme of the company and it is present from strategic planning to executing the projects in practice resulting in intuitive and highly usable solutions.

1.4 Research question and objectives of the thesis

The research question of this study is:

How mature are SMEs of the metal industry in terms of digitalisation, the IIoT and design?

The motive behind this thesis was to better understand the current status, future vision and the needs of SMEs of the machinery and equipment manufacturers in the Finnish metal industry regarding digitalisation, the IIoT and servitisation. The focus of this thesis is rather on how the IIoT is/ will be visible in their product and service offering rather than on digitalising internal processes of the companies. The research was carried out by studying literature related to the topic and by interviewing SMEs that operate in the Finnish metal industry as well as design professionals who have experience working in this context. The interviews provided material that enabled me to map out the digital and design maturity of the companies.

The sub question is:

In what ways can service design support the SMEs of Finnish metal industry in adapting the Industrial Internet to their product and service offerings?

I was interested in identifying places in which service design could support the companies to adapt to the IIoT. As an outcome of this thesis I aim to outline key issues and guidelines for those designers working in this context.

Technological solutions, legislation and funding are all essential topics related to the IIoT, but out of the scope of this research.

2. Theoretical background

This chapter introduces the central terminology and phenomenon related to the research topic and presents models for evaluating the digital and design maturity of an organisation. The chapter is divided into two sections. The first section is an overview on new connected technologies. It introduces how value is embedded to technologies and highlights the expanded business opportunities enabled by the IIoT. The second part of this chapter introduces design as an approach and how design has evolved towards more strategic levels. It discusses how design thinking and service design can be used to answer complex questions as the ones related to the IIoT.

2.1 Different levels of connected intelligence

One of the main objectives of this research is to evaluate the digital maturity of SMEs in the metal industry. In this chapter I will present a tool for evaluating digital maturity in general and different models for applying the IIoT. This chapter will present the essential terminology related to the topic, the meaning and differences between the Internet of Things (IoT), the Industrial Internet of Things (IIoT), the Internet of Everything (IoE), Machine-to-machine (M2M) and Industry 4.0. Following this I will go through the meaning of big data and data analytics, as they are essential elements to the above mentioned concepts. Finally I will discuss how values can be embedded to technologies and identify business opportunities that are made possible by the IIoT.

2.1.1 Measuring digital maturity

The IIoT can become a driving force of the industry as will be further explained in this chapter. The IIoT has been expected to have an effect that can be compared to the Industrial Revolution and to the Internet Revolution. Thus, it can be presumed to have an influence on the entire industry and companies need to find a way to position themselves. This thesis gathers information from the field and creates understanding on how the digital transformation is visible in the SMEs of the Finnish metal industry. When focusing on a company level, the digital maturity comes down to the interest and competence of an organisation. Transformation requires a shared vision from the management level and a high level of commitment throughout the organisation.

Westerman et al. (2012) introduced a model for evaluating the digital maturity of an organisation. The model has two dimensions to it: digital intensity and transformation management. Digital intensity refers to the amount of digital initiatives in customer engagement, internal operations and even business model innovation. Digital initiatives can be things such as a company website, social media, cloud service, e-commerce, the company online purchases, the use of digital channels in the distribution and marketing of services, the use of Big Data and the IoT (Alavuotunki et al. 2015). Transformation management intensity refers to the extent of coordination of digital transformation in the company. This includes leadership capabilities such as future visions, governance and engagement as well as good IT and business relationships within the company (Westerman et al., 2012).

The graph contains four different levels of digital maturity: beginners, fashionistas, conservatives and digirati. The beginners are limited to traditional software such as

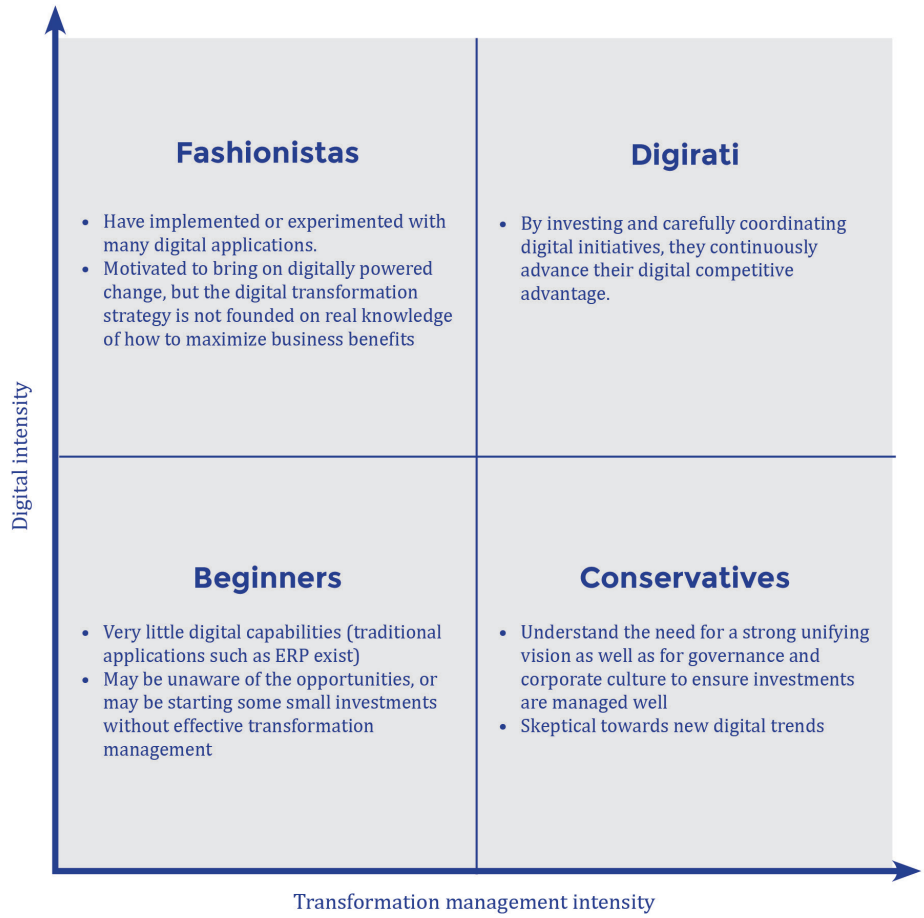


Image 2. *Four types of digital maturity, Westerman et al. (2012)*

enterprise resource planning software (ERP). They might have had some experimentation with more advanced technologies, but have no effective transformation management in place. Fashionistas are motivated to bring digitally powered change and are active in experimenting new technologies and have succeeded in implementing some. However, the fashionistas are struggling in building holistic governance and vision on how solutions should work in order to maximize business benefits. They might have several separate and overlapping systems that fail to create a coherent whole. Digital conservatives have an opposite view compared to the fashionistas. They understand the importance of vision, governance and corporate culture, but have a very careful and sceptical approach when it comes to new digital innovations. Digirati stands for organisations that have succeeded in digitalization by combining good vision and governance together with continuous investments into new technologies that are in line with their vision (Westerman et al., 2012).

2.1.2 Previous research on the digital maturity of the industry

Statistics Finland conducted a research that examined the level of digitalisation in Finnish companies in 2014. Statistics Finland (2014) defines digitalisation as the transformation of goods, services, production or distribution to a digital format. 22 per cent of industrial companies estimated the importance of digitisation in marketing either large or moderate. The number remained low at 20 per cent within machinery and equipment manufacturers of the metal industry. From all the industrial companies, 30 per cent considered digital products to be significant for their business and the number was the same within the machinery and equipment manufacturers of the metal industry.

Marketvisio and Technology Industries of Finland conducted a qualitative IIoT specific research with 33 companies (38 respondents) in 2014. The purpose of the research was to understand the view of the companies on the Industrial Internet (Korhonen and Valli, 2014). Forty per cent of the interviewees were from the equipment and machine manufacturing industry. The biggest challenges and questions were related to questions of the business model and the interviewees doubted that they could renew their business models with their current skillsets. There were seen to be challenges within different areas of an organisation: sales teams were facing difficulties in the argumentation of the benefits of the solutions and their customers did not know how to buy them. The production teams had difficulties in understanding the value of networks and the product development of an organisation might start developing IIoT based solutions by themselves without bridging it to other activities of the organisation. Overall, the transition requires a strong visionary that has the courage to take risks. The opportunities that the companies saw in the IIoT were mostly related to in enhancing productivity (28%) followed by improved risk management (14%) and reducing interruption in the production (12%). New services, new ecosystems and responding to customer needs only attracted 9% of the interviewees (Korhonen and Valli, 2014).

I was not able to find quantitative data about IIoT in Finland. Thus it is difficult to say how common the technology has become within the industry. The Finnish Industrial Internet Forum (FiiF, 2017) has almost 300 members listed on their website and that could give some idea of how widely the IIoT is applied. The members of FiiF are however not limited to industrial companies and the list includes a variety of organisation such as service providers and universities.

2.1.3 The next Industrial Revolution

The Industrial Internet, which we are now facing, has been described as the third industrial revolution. Just like the Industrial Revolution and the Internet Revolution, it will change the way we do business and interact with industrial machines (Evans & Annunziata, 2012).

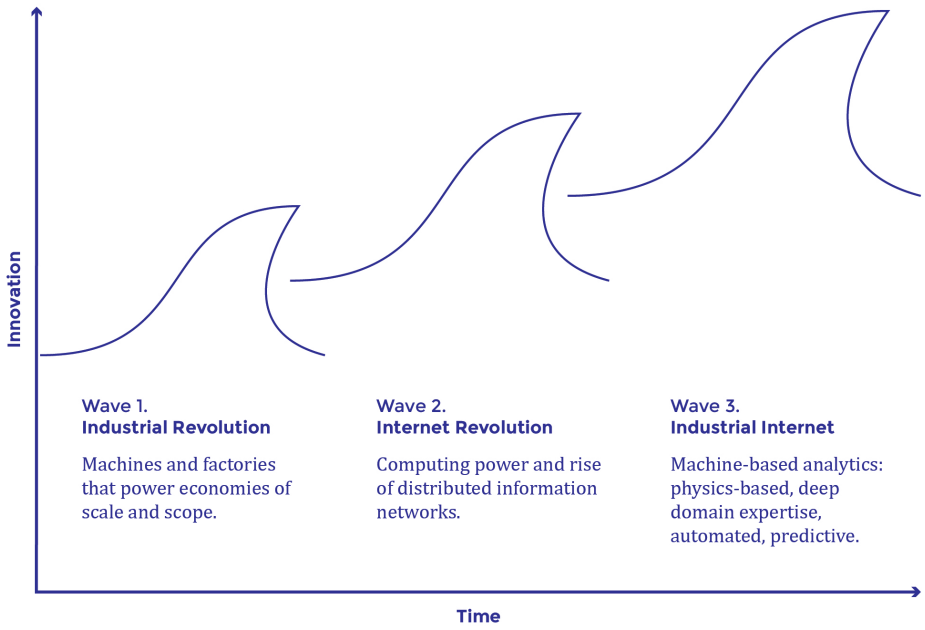


Image 3. *Rise of the Industrial Internet, Evans & Annunziata, 2012*

During the Industrial Revolution in 1750 to 1900 new innovations in technology were applied to manufacturing, energy production, transportation and agriculture. It started with the commercialization of the steam engine that was followed with the internal combustion engine, electricity and other machines. This resulted in a profound transformation in transportation to railways, steamboats and trucks. It gave new channels for communication by the means of telephones and telegraphs. Simultaneously it created significant economies of scale and reduced costs as machines and fleets got larger and production volumes increased (Evans & Annunziata, 2012).

The next remarkable technological leap called the Internet Revolution started in the 1950's along with the first computers and software. Starting from the 1970's closed networks gave way to open networks, today known as the World Wide Web. The Internet enabled speed and flexibility for commercial transactions and social interactions. It also provided a platform for

new businesses (Evans & Annunziata, 2012). Now in the third wave of the Industrial Internet the Internet is becoming an integral part of the product itself (Porter & Heppelman, 2014).

According to the Cisco Internet Business Solution Group (IBSG) somewhere between 2008 and 2009, there were more devices connected to the Internet than there were people. In 2010 the amount of connected devices rose to 12,5 billion, while the world's human population was 6.8 billion, meaning that there were 1.84 connected devices per person (Evans, 2011).

Estimates for the future vary and have changed over the years. In the white paper from 2011 Evans' estimation for 2020 was 50 billion connected devices. Afterwards he has lowered the estimation to 30 billion devices (IEEE Xplore, 2016). The business-to-business sector (b2b) is estimated to bring two times more of economic value than the consumer market (Manyika et al., 2015).

2.1.4 IoT ,IoE , IIoT, M2M, Industry 4.0

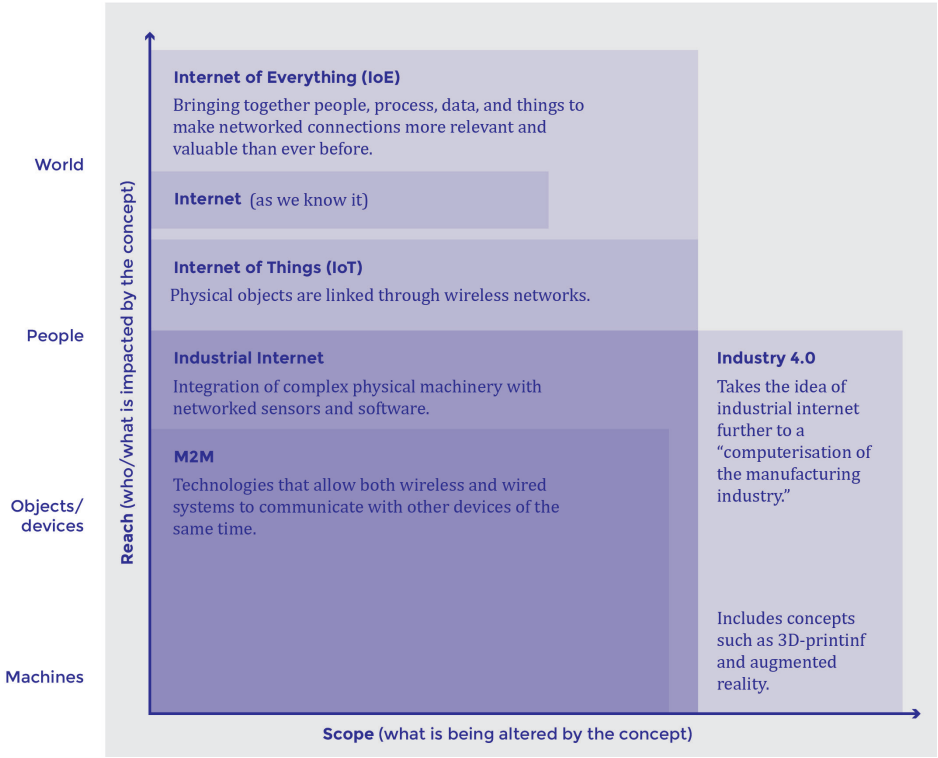


Image 4. *Concept disambiguation: IoT vs. IoE vs M2M vs others by Lueth in 2014*

The phenomenon can be described with many different terms that have slight differences to their meaning. The existing vocabulary is vast and often used interchangeably. Some of the most common terms are explained bellow.

The Internet of Things is the most common term to the general public. So what does the sentence *the Internet of Things* stand for? The International Organization for Standardization (ISO) achieves to sum up a relatively holistic definition in a short sentence:

"The Internet of Things is an infrastructure of interconnected objects, people, systems and information resources together with intelligent services to allow them to process information of the physical and the virtual world and react." ISO/IEC JTC 1, 2014)

Technically *Things* refer to smart products that in addition to containing mechanical and electronic parts are becoming increasingly complex by combining hardware, sensors, more data storage space, microprocessors, software and more complex and improved connectivity (Porter & Heppelman, 2014). *Things* are then connected to *the Internet* in order to send, receive or communicate information (McEwen & Cassimally, 2014). Each *Thing* has its own IP-address (Collin & Saarelainen, 2016). In addition to the *Things*, intelligent, connected products and services require completely new, multi-layered technology infrastructure (technology stack) construction. The infrastructure consists of software, application, networks, devices, cloud, information management platforms, as well as business models and processes related to them (Juhanko et al., 2015).

The Internet of everything connects data from the consumers, the society and the industry. It links people, processes, data, things and devices together and transforms the information to new possibilities, richer experiences and desirable business opportunities for individuals, businesses and nations. For the industry this means that they can reach out from their traditional scope of producing a component or a product to producing smart products, smart connected products or services, completely new product systems or even managing a system of systems (Juhanko et al., 2015).

This thesis concentrates on *the Industrial Internet of Things,* also known as the *Industrial Internet (IIoT)*. The focus is on industries as in contrast to the *Internet of Things* that is often associated with consumer products (Juhanko et al., 2015). The name can be misleading and create an understanding that the Industrial Internet is only used as a utility within the manufacturing industry. A great potential lies outside the factory in the premises of the user where individual machines and devices work in an environment that usually has

devices from other providers as well (Collin & Saarelainen, 2016). Other terms related to the industry include Machine-to-Machine communication (M2M). This approach is more limited in the way that it excludes the user (TEM, 2015). Industry 4.0 is a strategic program in Germany that aims for smart manufacturing of the future. The key characteristics include production of extensively individualised products, within highly flexible production environments; early-stage integration of customers and business partners within design and value-creation processes; and linking of production and high quality services, to yield hybrid products (The German Federal Ministry of Education and Research, 2014). It also includes new forms of human-machine interaction such as touch interfaces and augmented-reality systems; and improvements in transferring digital instructions to the physical world, such as advanced robotics and 3-D printing (Wee & Baur, 2015).

2.1.5 Big Data and data analytics

Data is obviously a core theme to the IIoT. Big data refers to the large volumes of digitalised data that has grown exponentially over the past few years. Data management and analytics solutions are designed for large and complex datasets that are difficult to process with traditional database management tools and data processing applications (Nikulainen, 2013). Data-analytics identifies exceptions in data and can potentially identify cause-effect relationships.

In the digital service society, information (data, information and knowledge) plays a key role, but it is ultimately only the raw material that enables services (TEM, 2015). A common starting point for exploiting data, irrespective of the subject matter and the industry, is that the data should provide added value for the business or to a whole ecosystem. Another important question related to data is the format in which it is communicated. Raw data should be processed, filtered and visualised in different ways for different users. The presentation techniques should be graphical and user friendly and accessible through different devices (Collin & Saarelainen, 2016).

2.1.6 Embedded values in new technologies

The agrarian society was followed by the industrial society. Industrial logic is also known as the goods-dominant logic and it is based on goods that are first designed, then manufactured and finally delivered to the customer. In this model the value of the product is created in the process of the industrial operator and the product is merely a transmitter of added value. The customer consumes the product and replaces it by buying a new, an even better product.

Therefore its value will eventually be lost. The goods-dominant logic is still commonly used but it has been questioned and we are currently in a transitional phase towards a post-industrial service society as explained before. This change is accompanied by the service-dominant logic (TEM, 2015).

Vargo and Lusch introduced the service-dominant logic model in the field of marketing in 2004 and it has been widely referred to ever since. In the service-dominant logic model, customer value is created from the interplay between a service and a customer rather than from the exchange of goods. It is a holistic approach in which value is created through continuous series of economic and social processes rather than being limited to goods that are only occasionally involved in exchange. Streaming processes enable the offering to be developed continuously based on the received feedback. Continuous feedback can be used to strengthen the value proposition. In digital services, the service cannot be exhausted. Instead, the service improves every time it is used, as a result of each interaction (TEM, 2015).

2.1.7 Different approaches to, and business opportunities enabled by the IIoT

The IIoT brings new business opportunities to the industry, but finding the right kind of business model can be challenging. According to Porter and Heppelman (2014) many companies with smart connected products will face the fundamental question, “What business am I in?” Companies must consider how value is created and captured, how relationships with traditional business partners and channels are redefined, and what role companies should play as industry boundaries are expanded. The IIoT enables companies to entirely rethink their business models and exit their current competitive environments. Chan and Maugborne (2005) introduce the ideology behind blue and red oceans in their book the Blue Ocean Strategy. Red Oceans depict existing extremely competitive markets where industry boundaries are already defined and accepted. The companies try to outperform their competitors and reach for a better share of the existing demand. Blue Oceans are unknown waters with space for new solutions and markets where the rules of the game are not set yet. Chan and Maugborne state that even tough some blue oceans are created well beyond existing industry boundaries, most are created from within red oceans by expanding existing industry boundaries. I will now go through a few different kinds of approaches to deploying the IIoT.

Intelligence, automation and data-based services

Porter and Heppelman (2014) identify four capabilities that are enabled by the IIoT. Companies need to choose from these capabilities based on how they want to deliver value to their customers and it defines their competitive positioning. These capabilities include *monitoring, control, optimisation and autonomy.*

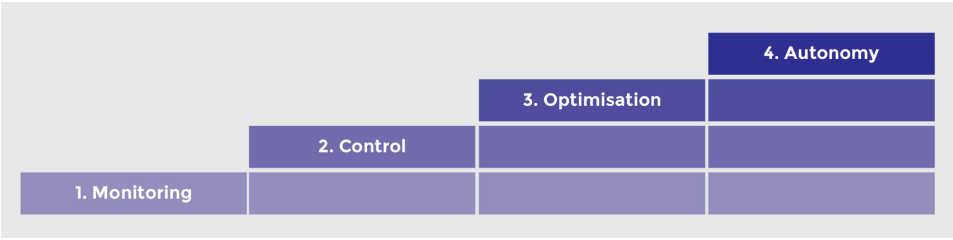


Image 5. *Capabilities of Smart, Connected Products by Porter and Heppelman, 2014*

The IIoT enables *monitoring* a product's condition, operation and external environment through sensors and external data sources. The system alerts users or others to changes in circumstances or performance. It is then possible to track history, understand operating characteristics and how the product is used. It can then be *controlled* through remote commands or algorithms. Monitoring of data flow allows companies to *optimize* product performance such as output, utilisation and efficiency. At the most advanced level a product can learn from its environment, self-diagnose, adapt to users preferences *autonomously*.

Collin & Saarelainen (2016) have identified four different levels of applying the IIoT. The levels have similarities with the characteristics that were identified by Porter and Heppelman before. In addition to those features they introduce the possibility of creating data based services and businesses.

Level 1. The first level comprehends *remote monitoring and optimisation through remote management and remote updates.* The first step towards utilising sensor data is taken when products with sensors are connected to the same network and data is imported into a centralized user interface. Through remote monitoring it becomes possible to provide real-time visibility on the status of the devices, operations, location, productivity, and history information. Remote control and programming can improve productivity as product features can be changed or problems can be solved through remote updates. It brings benefits to the business for example information on the use of the machine during the warranty period. In the event of a complaint, the company may check the situation through the data

gathered. Data can also be used to locate the problem and to pass this information to product development.

Level 2. The second level, *predictive service and analytics* can be more challenging to reach as it is a more demanding step to be able to analyse data. It brings the possibility to optimize processes, predict failures and perform proactive measures based on data analytics. Preventative maintenance increases the equipment utilisation rate by reducing unexpected breaks in production and by shortening planned service shutdowns.

Level 3. The third level, *new data-based service business* comprehends selling the product-as-a-service. The manufacturer can start selling the product so that price is based on variables e.g. hours of production, production volume or production downtime. Selling products might become easier as the customer avoids having to make large single investments. The manufacturer can also start to sell after-sales services such as analytics based remote optimisation. Remote updates can also be provided as an additional service. A possibility is also to offer entire service system operating services. Manufacturers can build applications and user interfaces for customers e.g. mobile applications can provide a better user experience that a customer would be willing to pay for. Data is commonly believed to become a commodity and selling anonymous masses could become a source for new business.

Level 4. The fourth level then comprises *intelligent factories and autonomous products.* All individual devices have sensors and are connected to the same network, analytical system and thus to each other. As a whole it creates an ecosystem that functions independently, efficiently and safely, and in a more environmentally friendly way.

Optimising processes

Instead of focusing solely on the interaction between a producer and a customer, an ecosystem approach has been highlighted. This can mean either that different operators examine their own business models as a part of a wider whole or that joint efforts are made to direct the development of the whole ecosystem in a jointly agreed manner (TEM, 2015).

Pernia and Lindström (2016) picture a holistic automated process for harbour terminals. Terminals should find new ways to serve their customers, the ocean carriers. Currently what automation can achieve in terms of efficiency and business continuity is limited due to the lack of seamless integration between equipment, systems and people. There is no joint decision-making on the vessel stowage and planning side between carrier and terminal. It lacks optimal use of data, visibility, control and proactivity in managing the operations.

In their vision value will no longer come from particular applications, but from holistic systems improving overall productivity, safety, and sustainability. Therefore altering only one part of the ecosystem will not be effective. Instead changes in terminals must be accompanied by changes in the whole ocean supply chain. They see that change is inevitable and that that if terminal operators do not wish to lead innovation, in any case they should be prepared for outside disruption to ocean shipping and terminal operations such as Amazon.

Image 6. *Kalmar Navis ecosystem by Pernia and Lindström, 2016*

Porter and Heppelman (2014) argue that the Internet of Things has the potential to not only reshape competition within an industry, but also expand the definition of an industry itself. The boundaries of an industry widen from the functionality of one product to the performance of a set of related products that together meet a broader underlying need. The manufacturer can offer a package of connected equipment that optimises overall results. An industry's boundaries can continue to expand to the level of systems of systems that consists of a set of systems as well as external information that can be coordinated and optimised (Porter & Heppelman, 2014). The challenge of the companies is to position themselves in the correct level. It would be desirable for the companies to take the step from being component and equipment suppliers to providing integrated systems and solutions as well as to operate and maintain them (Juhanko et al., 2015).

The idea of different system levels is depicted through an example of integrated farm equipment in image 7. Integrating equipment such as tractors, tillers, and planters – can enable better overall equipment performance and thus expand the industry from tractor manufacturing to farm equipment organisation. The final level can be used to optimise overall farm performance by connecting irrigation systems and soil and nutrient sources with information on weather and crop prices. Traditionally, the industry has operated in closed systems (intranets), but In order to use the IIoT to its full potential requires opening up of these systems (Internet) to external stakeholders, such as customers, innovators and other partners (Juhanko et al., 2015) and the system of systems model follow this principle.

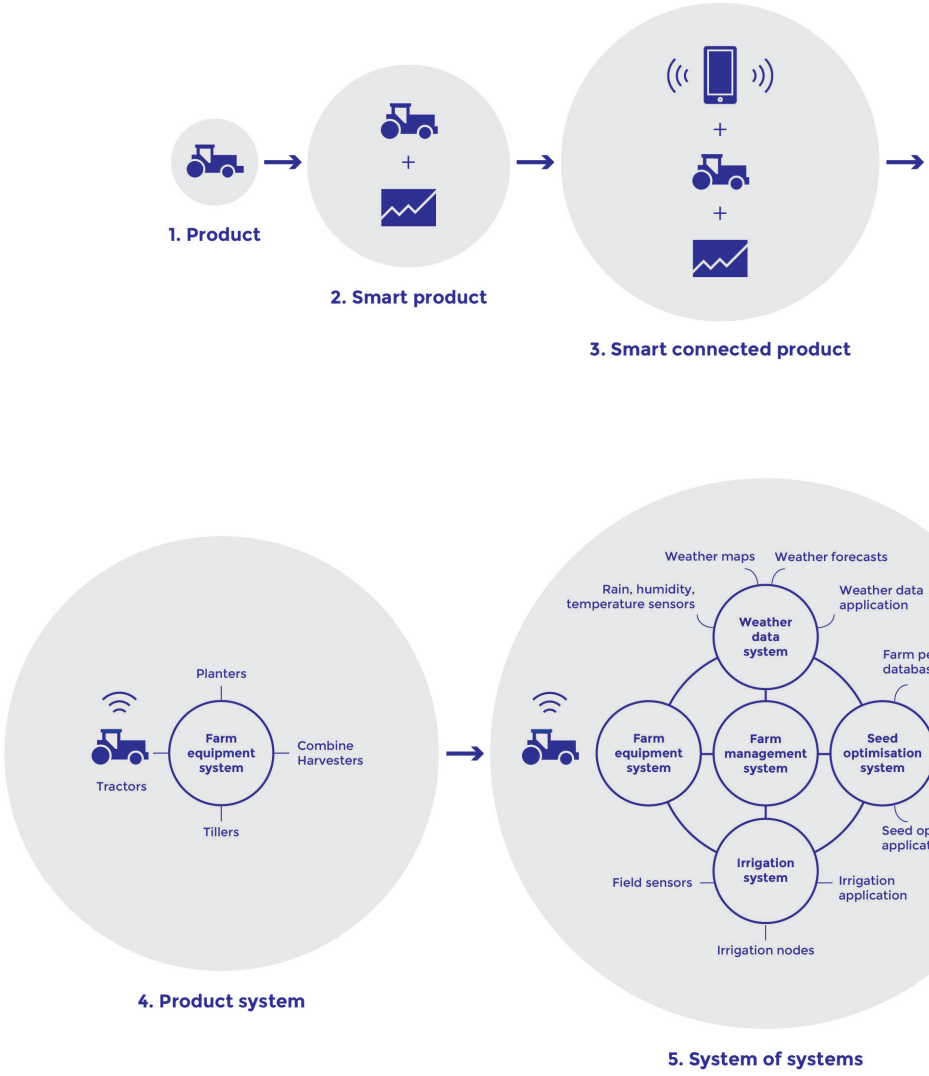


Image 7. *System of systems by Porter and Heppelman, 2014*

2.2 Service design approach for embracing the IIoT

The second section of this chapter focuses on the other main objective of this study - different ways of utilising design methods. Today design is used to solve questions of increased complexity and those levels of design might not have been fully recognised by the industry yet. This section begins by introducing a method by Junginger (2009) that can be used as a tool to discuss and understand how design expertise is used within an organisation. This chapter will provide an overview of the design profession, its history and current operating dimensions. It introduces the use of service design in an industrial context and as a tool for business development.

2.2.1 Measuring design maturity

The most recent dimensions to design are still finding their way to be widely adapted to use by companies of the metal industry. The purpose of this study was to understand how design has been used in the metal industry so far and how design methods could be applied to solving problems related to the IIoT in the most beneficial ways in the future. A model by Junginger (2009) that evaluates the role of design in an organisation was chosen for this study and is explained bellow.

Image 8. *The role of design in an organisation by Junginger, 2009*

The dark circles represent the organisation and the white circles represent design. The circles make four different compositions representing four different ways of applying design within an organisation. There can be in between models as well and shifts may occur

between the places in both directions. The purpose is not to represent values of good or bad; low or high. The aim of the graph is to expand the notion of designing and shift the emphasis away from the traditional realms of design activities towards those that have a deeper impact and greater involvement of the organisation. This model serves as a tool to generate and discuss arguments for the ways that design could be used within an organisation. Buchanan (2008) argued that in order for an organisation to successfully include design as a tool in their practices they must have a sufficient understanding of the discipline. Many organisations are interested in design, but there is a risk that it will not sustain their interest in design, if design as a discipline of thinking and making is misunderstood or poorly understood.

The four compositions that will be explained next are: design on the organisational periphery as an add-on, design as part of an organisational function, design at the core of the organisation, design as an integral part to the organisation. The most common setting for design is on an organisation's is periphery. Meaning that design activities are not central to the organisation and take place separately from organizational operational activities. It is a resource that can be called upon or dismissed and is usually highly controlled. In this setting the designed product changes, but often the organisational framework remains unchanged. The next level of design is when it's part of one or two organisational functions such as the marketing or engineering department. Design thinking and design methods are thus applied somewhere in the organisation. Yet, design activities typically remain limited to traditional products and services, though with a greater impact on their organisational strategy at a departmental level. In the third level design reaches the core, has access to organisation's leadership and links directly to an organisation's overall strategy. This means that vision and purpose, the structure, resources and procedures of an organisation can be questioned and inquired to. The design visually integrates products and services into a coherent whole, but it often fails to reach into the organisation itself. In the final level the organisation is no longer a given framework in which design has to find its place. Instead, the organisation is being questioned, formed and shaped by design inquiries. The role of design is to discover and invent solutions to all kinds of organisational problems (Junginger, 2009).

Junginger (2009) asks the question if external design expertise is always less influential and less likely to instil, generate and implement change within an organisation. She speculates that it might well be that there are cases in which design "on the fringe" enjoys more freedom to explore, envision and invent and that a company might consciously choose to position a project on the organisational fringe as part of a change strategy. If a designer, be it internal or external is involved with IIoT-projects, she or he will most likely be involved with strategic discussions, since the IIoT urges strategic change.

2.2.2 Previous research on the use of design in the industry

The use of design has usually been researched by country and the availability of comparative international data on intangible resources in general, such as design is very limited (OECD, 2011). The Innovation barometer by the European Commission (2015) compares the use of design within countries of the European Union. The research demonstrates that 43% of Finnish companies do not use design at all compared to the average European Union rate of 38%. 9% of Finnish companies considered design as a central element to the company's strategy in comparison to the average of 13% within the EU. All in all, the results of the Finnish companies were thus slightly bellow the European average.

Some research has been done about the use of design in Finnish companies in the 21st century. The most recent research was completed by Alavuotunki et al. and published by the Finnish Ministry of Economic Affairs and Employment in 2015. The target group of that study were companies from the industry, software service companies and other information-intensive business companies. The research was conveyed by an electronic survey, and case studies all together resulting in approximately 160 replies. Ornamo (The Finnish Association of Designers) published an industry report in 2013. The report demonstrated results from a survey that Ornamo conducted with approximately 30 large companies of the Finnish industry. In addition to this it presented results from a survey conducted by the Confederation of Finnish Industries (EK) report (2013) that included replies from approximately 700 SMEs (Lith, 2013). The Association for Finnish Work also conducted a similar research with the members of the association in 2013 (Eljala 2013). The research gained approximately 1400 replies.

The most recent study by Alavuotunki et al. (2015) demonstrates that design is usually used as a form-giving activity or as means to improve usability. Design was also often seen as an integrated part to an organisation's marketing activities. The results correlate with the studies conducted by Lith and Eljala. The research by Eljala (2013) asked the companies that do not use design to identify reasons behind it. The common answers were due to design not being suitable for their industry or that it was not seen as something compulsory in their field.

The study by Alavuotunki et al. (2015) shows that a quarter of the respondents saw design as an integral part of an organisations strategy and corporate culture. In those companies design can be or has become a competitive advantage alongside with efficiency. In those cases design was seen to enhance customer experience, improve the usability of the product, unify the visual image of the company and reinforce the brand. Other higher-level benefits

that were identified, were bringing a customers point of view to business development and identifying new customer needs and presenting a new way of thinking. Those companies that used design to improve the appearance of the products or usability, did not consider design to have a direct impact on the business. The impact of design on internal processes remained low in all cases. The research also demonstrated that design was least used in spatial design and in business model development.

In order for design to be successfully applied at a strategic level, commitment from the management level of an organisation is required. In addition to this it requires understanding of a customer's perspective, which is brought alongside to traditional product development that has usually been driven by technical features. The research shows that design is more often used at a strategic level in companies that tend invest in research, development and innovation activities more in general. There was also found to be a link between how digitally advanced the company is and how much it utilises design. Those companies that were digitally more advanced tended to use design more. There seemed not to be a connection with how international or growth oriented the company was in relation to using design (Alavuotunki et al. 2015). This finding is opposing to the results from the research by Lith 2013 that demonstrates that design is used approximately twice as much (20-25%) in growth oriented companies compared to those companies that are not as growth oriented (13%).

In the research conducted by Alavuotunki et al. (2015) the respondents considered that the use of design had increased in their organisation over the past three years. Those companies that had used design more comprehensively were more likely to invest in design in the future and predicted that design has a growing role in their organisation. In contrast, those companies that had not used design in a wide sense estimated that they would use it less in the future. The reasons that limited the use of design were connected to the lack of resources, unclear benefits and the lack of understanding design within a company and the challenge of having to adapt to a new way of thinking. A challenge that was particularly connected to the more strategic levels of design was the lack of communication between he designers and the company's business management.

2.2.3 The evolved and expanded role of design

The understanding of design has evolved and expanded from traditional product-centred design to intangible objects such as services and processes. Design methods are applied to questions of increasing complexity in varying contexts within the business sector, the public sector and on an even wider in the society (TEM, 2013). It is important to understand

how the design profession has developed in order to understand its current dimensions in operating at a strategic level. Valtonen (2007) researched the changes of the design practice in Finland in her dissertation. The changes are described by focusing on one decade at a time starting from the sixties up to the late 20th century.

In the very beginning the industrial design profession was first linked to that of an artist and the designs were rather objects of art rather than utilitarian products. In the fifties Finnish design gained great success in international competitions, such as Milan Triennials and designers were seen as creators and artists behind the objects e.g. Tapio Wirkkala.

In the sixties designers began to gradually transfer to the industrial realm and they became members of engineering and marketing teams. In the beginning, the role of a designer remained as that of a creative person who gave form to an industrially made product. This gradually changed to design becoming a more solid part of a product development process rather than being an add-on.

In the seventies designers wanted to contribute not only to the product development process, but also in defining what the product should actually be. It became important to understand the person who was going to use the product. Followed by this ergonomics and user understanding became widely popular.

The eighties brought along the conception of design management. Designers had an increasing role as interpreters and coordinators between end-users and different units within a company such as marketing and engineering. Yet, the design management discussion concentrated on a very practical level of issues. Designers gained larger responsibilities on a wider scale of product coordination such as unifying product portfolios rather than being limited to defining a single product.

Brand building and strategic design became widely popular in the nineties, when corporate brands became a hot topic. Design and design management expanded to the entire end-user experience of the corporation and its brand. This lead to designers being part of the strategic planning of everything from the very first concept to the last retail solution (Valtonen, 2007). In the beginning of the 21st century design was recognised as a tool for innovation. Globalisation and the "China effect" forced the industry to rethink their competitiveness and looking at things with a creative mind and finding new solutions was needed (Valtonen, 2007).

Starting from the late 20th century to more recently, disciplines such as interaction design,

service design, and transformation design have become more distinguished fields of design. The emergence of these fields grows on the changing role of design in an organisation and is strongly linked to the development of new information and communications technologies, and devices through which services can be delivered (Kimbell, 2009).

To sum up, each step in this brief history represents a move from design as giving shape to objects towards using design to give shape to decisions. There has been a shift towards strategic levels of design where design is used as a way to specify the intentions that we want to accomplish and steward efforts towards the realisation of those aims (Boyer et al., 2011).

2.2.4 What does service design mean in the industrial context?

Service design according to Mager (2009) introduces new processes and methods for service providers that aim to ensure service interfaces to be useful, usable and desirable from the client's point of view and efficient, and distinctive from the supplier's point of view. The focus is on people (being users, service, staff, communities or humanity in a wider sense) and on providing them with tools to efficiently engage with their environment. This idea is central to design in general and particularly while practising design for services (Meroni & Sangiorgi, 2011).

Designers can work in diverse ways at different levels from operational levels towards more strategic levels of design. There are different kinds of methods that help to achieve goals such as aiming to improve an existing service or initiating wider transformations (Meroni & Sangiorgi, 2011). Designers can work on parts and segments of services, redesigning interactions and experiences, or can foster wider service reconfigurations, suggesting new business models and value networks; moreover they can use services as vehicles for societal change, generating the conditions for a more sustainable society and an economy to come (Meroni & Sangiorgi, 2011).

Service design is about concretising abstract content into something that can be easily shared, understood, discussed and prototyped together (Miettinen, 2017) and is a common development language between stakeholders (Tuulaniemi, 2011). It is about doing, making and learning through practice in iterative cycles, and it encourages trying and failing early (Miettinen, 2017).

Whilst not needing to expertise with the specific problem's details or content, the design lead needs to be able to bring a diverse group of experts and stakeholders together in coordinatied effort (Hasu et al., 2004). As co-design increasingly becomes the norm,

designing is shifting to be the responsibility of a collective creativity rather than a single entity. Designers often in this case embody the role of the design lead in guiding a team through a design process (Howard and Melles, 2011).

Service design in an industrial context can be called *industrial service design*. In this context human-centred design and recognising opportunities is not enough. The service design process should result in cost savings and additional revenues as industrial service design aims for growth. Service design should also increase customer loyalty, lead to the discovery of new unique selling points, result in higher margins and speed up the innovation process (Miettinen, 2017).

Finding academic writings or project descriptions of a service designer's role in a multidisclipinary team in the context of the IoT or the IIoT still remains a challenge. However many design agencies and digital agencies market service design specifically targeted to solving questions related to digitalisation and the IoT. Futurice for example recently launched an IoT Service Design Kit. It is a co-creation tool for designers and developers for creating user-centric interactive scenarios (Futurice, 2017).

2.2.5 Service design contributing to business model development

Miettinen (2017) aligns that business models have changed and that it is particularly the case with services. Tuulaniemi (2011) describes the ways in which service design can contribute to business development of an organisation. According to him service design can help in recognising new business opportunities by identifying users needs and by responding to them in concrete ways. Designers contribute to the discussion of service features, price and supply channels. Services are multi-channel and delivered in person or through mobile and digital channels. They are coordinated and made understandable to the user (Miettinen, 2017). Brand value is formed through touch points and two-way interaction between the company and the customer. The process process can be analysed to find ways to improve it. Organisation structures can be developed in a way that they support staff at the customer interface better. Service design can also be used to develop internal processes within an organisation (Tuulaniemi, 2011).

Osterwalder and Pigneur presented the Business Model Canvas (BMC) in 2010 that has gained popularity ever since. According to them, a business model is like a blueprint for a strategy to be implemented through organisational structures, processes and systems. Designers expertise can be particularly valuable in extending boundaries of thought, in

generating new options, and ultimately, to create value to users (Osterwalder & Pigneur, 2010). According to them, there are four main areas of business including: customers, offer, infrastructure and financial viability that can be broken down to nine building blocks: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. In particular design can provide input to these building blocks through customer insights, ideation, visual thinking, prototyping, storytelling, and scenarios. Miettinen (2017) outlines similar benefits of design in business model development: design provides the design tools and methods to analyse and develop the service experience in a holistic and human-centred way. It also helps to concretise and visualise complex processes and ecosystems.

Alternatives for the BMC have been presented, such as the Platform Business Model Canvas created by Digital Ahead. According to them the BMC is too limited for platform-based businesses. In their view the BMC is designed for linear businesses, where a producer serves the need of a consumer A to B. They argue that in the new age of digital companies, there is no longer a linear relationship. Platforms like AirBnB, Uber, Facebook & Co are orchestrating the different demands between different producers and consumers and also include 3rd party partners that create a network. Therefore the PBMC is designed like a circle, connecting the different stakeholders around the platform (Digital Ahead, 2017).

2.2.6 Combining system thinking and design thinking

The IIoT brings service ecosystems and system levels closer to the product manufacturers than before. In order to make most of the technology, one must make an effort to understand the operating environment as a whole and identify the key points in which the IIoT solutions would be beneficial and provide added value. Systems thinking combined together with design thinking provides a holistic way to understand dependencies in complex systems and respectively synthesise and find opportunities for development.

Boyer et al. (2011) illustrate that if problems are considered in isolation then isolated dots—silos of knowledge will have plenty of gaps in between. While we have become better at defining and tackling issues within individual 'dots,' the gaps between them are where the challenges of the 21st century lie. Therefore horizontal efforts must be made to understand the bigger picture. Pourdehnad et al. (2011) explain that the essence of systems thinking is encapsulated in the concept of systemic wholeness, which is grasped by looking at the whole instead of the parts meaning that a system is always a sub-system of some larger system. A system involves an interconnected complex of functionally related components and failing to consider the systemic properties as derived from the interaction of the parts leads to sub-

optimisation of the performance of the whole.

With systems thinking, managers and designers learn how the parts of their organisation interact, not how they preform independently. In order to understand different parts of the system stakeholders must be involved. It often happens that different stakeholders are involved at different phases of the process and don't see how their individual experiences fit into the whole system. Here it remains for the designer to piece it all together (Pourdehnad et al. 2011) and to understand decisions affect different scales (Boyer et al., 2011). From another point of view, it is important to engage employees redefining the vision and mission. If the employees or other stakeholders feel like they can participate in the change, then they will feel more committed to it (Bello, 2017) and ideas generated will more likely be implemented and maintained (Pourdehnad et al. 2011).

Pourdehnad et al. (2011) explain that design thinking refers to a designers sensibility and methods to problem solving, no matter what the problem is. In systems community, design thinking has become the preferred approach to problem solving and planning for a variety of reasons: the belief in the synthetic mode of thought, the idea that the future is subject to creation (design being the creative process), the concept that you need to dissolve problems (and not solve them) through redesign of the system etc. Boyer et al. (2011) describe that designers have the ability to cope with the compound uncertainty of lacking a clear strategy but being 'on the hook' for very specific and concrete decisions. Designers have developed ways of working to clarify inputs and outputs, problem and solution, opportunity and ambition, in tandem.

A design process typically follows iterative four steps of exploration, creation, reflection and implementation. Literature and practice refer to various other frameworks made up of three to seven or even more steps, but fundamentally they all share the same mindset (Stickdorn, 2011). The wording also varies such as in the Double Diamond model be the Design Council (2007) presented here. The process begins with the discover phase (initial idea, user needs) and is followed by the define (interpretation, business objectives), develop (solution development, iteration rounds, prototyping and evaluation), and deliver (final testing and launch) phases. Rather than being a linear process to solving a problem, the design process is iterative in its nature that searches for new opportunities. This cyclical approach can be used to explore issues in a cursory way, enabling a more intelligent focus as specific bits of content prove to be interesting or useful and discard the solutions that lead to a dead end (Boyer et al., 2011).

To sum up, successful design demands for identifying and considering the essential parts of

the system. Decisions of design must be based on the amount of improvement to the system as a whole, not just individual parts or units. Even if redesigning a part of it, design can be enhanced if it improves the performance of the system as a whole (Pourdehnad et al. 2011).

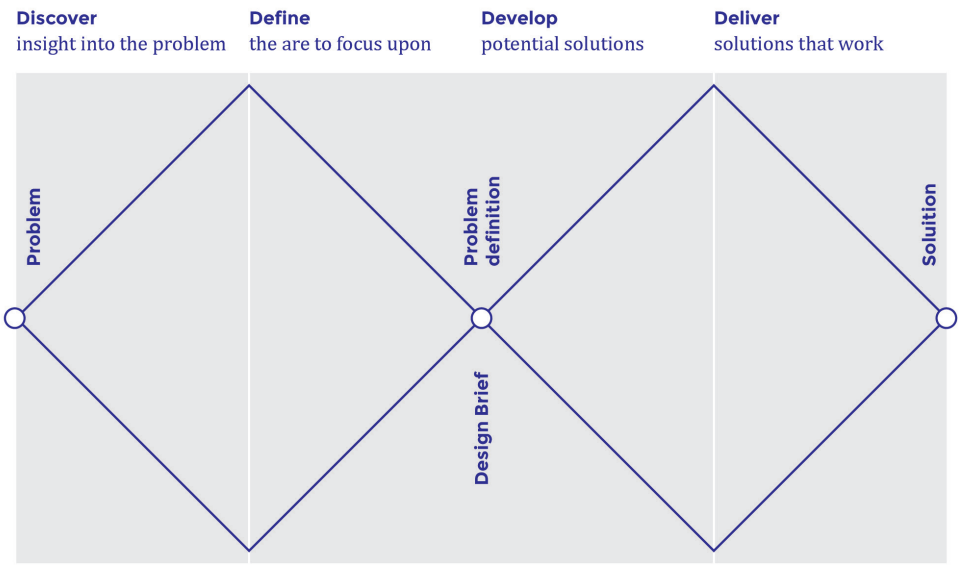


Image 9. *The Double Diamond model developed by the Design Council in 2005*

3. Research

3.1 Methods

In order to gather information about the current state of affairs of service design and the incorporation of the IIoT within the SMEs qualitative data was collected in three different ways. A focus group interview was arranged at LINK Design and Development in February in order to get a service providers' and designers' points of view. Themed interviews were held in the spring of 2017 with eight SMEs of the metal industry. In March I interviewed Martti Mäntylä, Professor of Information Technology at Aalto University in order to gain a better understanding of the IIoT and how it will evolve in the future. This chapter will explain how the research was carried out.

3.1.1 Focus group interview at LINK Design and Development

The focus group method was used to gather knowledge from employees of LINK Design and Development. The participants of the focus group have years of experience of working with companies from the metal industry regarding the IoT and service design it and thus possesses useful information regarding this thesis.

An invitation was sent to the participants and in the invitation I asked all the participants to think about one to three SMEs from the metal industry that I could interview. There were two reasons for why I asked them to do this. Firstly, I assumed that the participants would have good suggestions for whom I could interview. Secondly, it made the participants think about the questions of the focus group through these companies. This helped to get concrete examples and to prevent over generalised results. Simultaneously I gained useful information about the companies that I would interview. As Silverman (2010) states, setting up a focus group prior to interviews can help to clarify the issues that you wish to raise.

A focus group is a semi structured group discussion and a set of open-ended questions was prepared for the workshop. As Krueger and Casey (2015) outline: there is no pressure by the moderator to have the group reach consensus. Instead attention is placed on understanding the feelings, comments, and thought processes of participants as they discuss this issue.

The discussion of the workshop was broken into three main topics. The first task was to define the target group in more detail. Next we discussed the possibilities that the IIoT can potentially bring to the SMEs and the challenges in adapting the technology. Finally we discussed how service design could support in adapting the technology and challenges in utilizing service design in the context. The complete structure can be found in attachment 1.

The main focus was in the discussion, but I also printed out maturity graphs by Westerman et al. (2012) image 2 and Junginger (2009) image 8 previously explained in chapter 2. They were used to encourage conversation and to make it possible for the participants to visualize their thoughts.

Krueger and Casey (2015) advise selecting participants who have certain characteristics in common that relate to the topic of the focus group. The participants were all employees of LINK Design and have experience from working with the metal industry and were familiar with the topic. According to Krueger and Casey (2015) the group size should stay between five to ten people and the discussions should be relaxed where participants enjoy sharing their ideas. All together there were four participants to this focus group, because one of the participants was unable to attend and she was then interviewed separately. The focus group participants had versatile backgrounds and thus slightly different approaches to the topic. There were participants from the management level and experts from service design, business, IoT and digitalisation backgrounds. This resulted in a fruitful conversation in which the participants could build on each others thoughts.

Image 10. *Focus group interview at LINK Design and development*

3.1.2 Interviews with SMEs of the metal industry

Eight themed in-depth interviews were arranged with SMEs of the machinery and equipment manufacturing industry. According to Boyce and Neale (2006) In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation. The benefits of in-depth interviews and the reason behind choosing this technique was that they provide much more detailed information than what is available through other data collection methods, such as surveys. They also may provide a more relaxed atmosphere in which to collect information and thus people may feel more comfortable in having a conversation with you as opposed to filling out a survey.

The target group for this study was fined down to SMEs of the metal industry that have already taken some initiative towards digitalisation and the IIoT. Companies that have already had to deal with the challenges of adapting to the use of a new technology and service was seen to provide a more fruitful foundation for discussion in comparison to companies which were yet not very familiar with the topic. All of the companies operate in the business-to-business sector meaning that their customers are professional users rather than normal consumers.

According to Flick (2007) the focus of interview research is mostly on the individual experience of the participant, which is seen to be relevant for understanding the experience of people in a similar situation. Within the target companies, interviewees were selected based on their role in the company. The selected group included professionals such as managing directors, sales directors and research managers who have responsibilities in strategic development in their respective companies. Anonymity was promised to the interviewees and this is why the interviewees are named in this thesis as interviewee 1., interviewee 2, interviewee 3 etc. In addition to this, together with the interviewees, we decided on an abstract definition of the industry that they operate in. The interviewees and their operating fields are listed in detail in the next chapter.

The interviewees were approached by myself or by the focus group participants. When they were contacted, they were informed about the topic, guaranteed anonymity and told that the interviews would be audio recorded.

Each interview took approximately one and a half hours. The interviews were audio recorded and transcribed for analysing purposes. The interview was divided into three themes. In the beginning we discussed the background of this project and the interviewee introduced

himself and the company. We then spoke about digitalisation and the IIoT, the current status and future prospects related to them. We then continued the discussion on to design, how it is applied in their company today and in the future. I was also interested about their current understanding in relation to service design and if they found service design methodologies to be beneficial to them in the context of the IIoT. The list of questions can be found in attachment 2.

Image 11. *From an interview with one of the companies.*

Some printed material was also prepared to support the interviews. As Flick (1998) points out: the interviewee can be supported in recalling a specific situation by using materials (e.g. an excerpt of a text, a picture) which correspond to the questions. Cards were made in order to support some of the questions and to make it easier for the interviewee to answer those questions. The cards can be found in attachment 4 and 5. For example, question 3.5. asks the interviewee to identify the kinds of benefits the IIoT could bring to their company and similarly question 4.4. asks the following question: "Have you considered to use/used service design in relation to the IIoT development projects?" If the interviewee is not very familiar with the topic, the questions might be difficult to answer to and this was a way to create some discussion over it. In addition to this, in connection with the question 3.6., the interviewees were asked to comment different kinds of models that related to the IIoT and to identify how they can be applied to their company, where they are now and where they want to be in the

future. The models were explained earlier in this study and they were: capabilities of smart, connected products (image 5), Kalmar Navis ecosystem (image 6), system of systems (image 7). In addition to this they were asked to discuss how widely company processes have been digitalised with the help of the model in attachment 6. Similarly the interviewees were asked to comment the graph of design within an organisation by Junginger (image 8) in relation to question 4.6. "How do you see the role of design in your organisation in the future"

After interviews one and two the set of questions was modified. I had to find a way to gain more insight on how interviewees saw the future of the IIoT in their company. The modified structure was proven to be successful with interviewee three. After making the last modifications to the interview structure I returned to company one and two in order to fill in the missing material.

3.1.3 Expert interview

We met with Professor Martti Mäntylä for one hour in March in order to discuss the metal Industry, their current status and future prospects related to digitalisation and the IIoT. Martti Mäntylä is a Professor of Information Technology at Aalto University. His main focus area is the digitalisation of the industry in general and the IIoT. He also leads a multidisciplinary Digital Disruption of Industry research project (2015-2020) that studies the impacts of digitalisation to the Finnish society through the lens of the industry (Digital Disruption of Industry, 2017). He is also in charge of the Industrial Internet Campus at Aalto University, a platform for students, researchers and companies to innovate and co-create smart, connected products and services (Industrial Internet Campus, 2017). He is thus familiar with the academics and research related to this topic, but also in close contact with the industry.

I was particularly interested in hearing about how the future will be related to the IIoT. The interview also included questions about the challenges that the industry is facing and the possibilities that the IoT could bring to the industry. The structure of the interview can be found in attachment 3.

4. Analysis

The focus group interview, the interview with Professor Martti Mäntylä and the interviews with the target group were mapped out with the help of the affinity diagram tool in order to discover trends and patterns in perception of the field. The findings are divided into three sections: the current situation, the future and the challenges it brings. These three sections are then examined from two different perspectives, the first being understanding how the company perceives the IIoT and the second being design's role in the company and related to the IIoT.

4.1 Current situation

4.1.1 The Industrial Internet

All of the companies showed interest towards the IIoT and were convinced that the future will head towards that direction. They also saw it as a way to improve competitiveness in the global market and as a way to reinforce customer relationships. All of them had a basic foundation for digitalisation, but some showed more progress in adapting to the IIoT. According to the interviewees digitalisation, the IoT and the IIoT are widely discussed topics, but they have not taken concrete form in their fields. According to Mäntylä (2017) awareness has built up rapidly within the past one and a half years and that an increasing amount of companies have taken leaps toward digitalisation. This trend was also recognised within LINK Design.

Interview nro.	Interviewee	Industry	Research	Ongoing pilot	Commercial product	Design as styling	Usability / ergonomics	Service design	In-house designers
1	Director	Mobile work machines	●		●	●	●		
2	Head of Strategic Business Development	Logistics solutions	●	●			●	●	●
3	Sales Director	Mobile work machines	●			●	●		
4	Managing Director	Building structures	●			●	●		●
5	Managing Director	Rail transport components	●						
6	Chief Digital Officer	Intelligent Factory	●		●	●	●	●	●
7	Research Manager	Agriculture industry	●		●	●	●		
8	Managing Director	Cable support system manufacturig	●				●		

Image 12. *The current status of the companies regarding IIoT and design*

> *"It's difficult to give a percentage of how important it (the IIoT) will become for us, but it will have a growing importance."*
> *- Interview 3*

> *"In the past, if you went to talk about it (the IIoT), it was experienced as some kind of blabbering. But today you can talk to them and be able to lead things that are important to those companies."*
> *-Design consultant*

Almost each of the interviewees figured that their competitors have not started to develop their own IIoT solutions yet. Hereby several of the interviewees considered themselves as forerunners in comparison to their direct competitors. Companies number 1, 6, 7 already have commercial products and company number 2 is currently running pilots with their customers to test their system. Company number 8 decided to build a Bluetooth based solution as a WLAN based solution was identified to being too expensive. All the other companies are in the research phase.

The interest towards the IIoT in most cases had emerged from inside of the companies or from the surrounding society rather than from their customers. Several of the interviewees had large global companies as their customers. Never the less, those customers had not demanded for more intelligent products or services so far. Only company number 7 emphasized, that competition already exists in their field.

> *"Competitors are doing the same thing, so you actually have to move really quickly or you will stay behind. This is similar to, I think everybody knows Nokia and all business stuff that went wrong 10 years ago. In the end, it comes to services and their systems even in our field. If we don't put a lot of effort into development, there is a chance that our competitors will make equivalent services in a better way. They might manage to bring it to the public faster and get some of our clients to try out their products. There is the risk that we will lose business. From another point of view this brings tremendous opportunities. But as a risk, deciding to do nothing is not a good option, because surely somebody is thinking about these things."*
> *- Interviewee 7*

The common motivation towards the IIoT was to break out from their current status as product or component suppliers and/or to find a way for steadier income. The selected companies produce high quality products that cannot compete when it comes to pricing and some of the interviewees admitted that they are currently struggling to compete in the global market.

> *"The problem with the products is that anyone can see what it costs in China."*
> *- Interviewee 5*

> *"Our business at least for the past 3-4 years has been profitable and good, but the challenge is to find growth. There is no clear trend for growth and it is definitely so, that*

we are seeking for new growth opportunities."
- Interviewee 2

"I would like to say that it (IIoT) enables explosive business rather than steadier income."
- Interviewee 6

Only one interviewee (interviewee 1) brought up, that the demand for an IIoT based solution came from their customers. In the case of Interviewee 2, the demand for a better solution came from their customers and the IIoT provided a solution for it. In fact they had dealt with the same problem for decades, but previous technological solutions did not suffice in solving the problem.

"It has been something that the customers have worried about and something that has been brought up constantly. Customers themselves have tried solving it by themselves with the use of barcodes and RFIDs, but the solutions weren't feasible. I was convinced that there needed to be another way to solve the problem and then we began to look into it more. After a little progress, we showed it to our customers and there has been a lot of interest in it, so it has enforced it (the concept)."
- Interviewee 2

4.1.2 Design

The interviewees had experience from using design at different levels. Awareness of service design also varied within the companies. Some of them heard about it for the first times and some had experiences from using service design methods.

Company number 5 had no experience of utilising design. Their product is located in a very limited space where it is not visible and that is why they have decided not to invest in design. Companies number 1,3, 4, 7 and 8 have experience from industrial design and ergonomics or usability. Companies number 2 and 6 have applied design in a versatile manner including industrial design, user experience, user interface and service design. The Interviewees 3 and 6 have a design education background and company number 2 has an industrial designer within the organization. These companies emphasised the importance of understanding the user, user experience and usability more compared to other companies and considered these qualities as essential or even the most important aspects of design.

"In my opinion, the true offering of design is in the functionality and in creating the whole rather than on what the product looks like."
- Interviewee 4

"We have this observation-based method that we use. The method helps us to understand the customer's processes and its economic effects. We go to the customer's premises to observe, photograph and video record their activities. It reveals problem

areas, within the process, how long it takes (the process), and the safety risks. It helps us to identify the things that could be improved within the process. We have used it a few times when a customer has showed interest towards looking at things critically. There are a lot of customers who have asked for the same thing for 5 to 20 years and it works for them. They are fine with making small improvements, but the aim of this however, is to radically change the ways things work."
- Interviewee 2

"Service design should be involved throughout the process starting from discovering the need and so forth and finally concretised in the user interfaces of the system. Especially in industry, digitalisation and the IoT are still in their early stages and seem to be driven by engineers. It can easily happen that the user experience is better for machines than for people. So there is a lot to do there."
- Interviewee 2

Almost all of the interviewees had heard of service design before, but they were not quite familiar with all of its dimensions. Unsurprisingly service design and its potential were best understood and exploited in companies that had design competence within the company.

"There is much talk about service design, but it is still quite difficult to get a grasp of it."
- Interviewee 3

"It is difficult to see what is the difference between business conceptualisation and service design is."
- Interviewee 4

4.1.3 Two different approaches to getting started

Two sometimes overlapping ways of getting started could be identified. All of the companies had done or are currently doing excessive research. However a few of them had included user research more intensively than others. In a very few cases user-centeredness was truly set as a cornerstone for development or as a source for innovation. According to Mäntylä (2017) in general the IIoT should be approached and new businesses should be discovered starting from the point of view of the customer and through the added value that it provides to him/her.

"In my opinion, the first thing when talking about digitalisation is customer-centricity. What I've tried to bring to this organisation is different methods for obtaining customer and user understanding. The UX and the principles of user research methods in the sense, that we should listen and ask a little more."
- Interviewee 6

"Today, many companies think about the customer's need related to their product rather than finding out what the need of the customer is right now."
- Design consultant

The overall impression was that companies were eager to get a functioning intelligent product or prototype out as soon as possible and continue developing it based on the use of the product and the data that was collected. In some cases, user research was seen as a useful tool that could come in later in the process. The value of data was also recognised by LINK Design and it was considered important to find ways to combine qualitative understanding together with obtained data.

> *"Only after you have obtained data, can you partly say how it can be used (product/ service). It can be a reason to build them (prototypes), to see what the data is and what kind of value it could produce."*
> *- Design consultant*

> *"When we've gathered information from what comes out of the machine, then we can see and learn how to utilise it. When we start to interact with our clientele, we will get to talk about the market demand. This is still a very unfamiliar thing for them and our clientele has not shown demand for it so far. This is how we get to understand the needs and learn to understand the customer and so it could come in consideration later (service design). This might not be the optimal way of thinking, but a SME needs consider their resources and their affairs. One has to get started with something."*
> *- Interviewee 3*

The importance of prototyping, testing and creating a lean and agile culture were discussed in several interviews and it was seen to be an effective way of working.

> *"Obtaining an experimental corporate culture has been vital for our organisation to make progress. We do not have competence or resources to take theoretical analysis so far, that we could verify and determine on one solution. In my opinion the only way to make this work has been through experimentation. It has enabled us to see whether something works or not and then we continue forward. But the experimentation culture is by no means in the company DNA. The company's history is entirely based on industrial mass production and doing things right at once where mistakes are not allowed. This is a completely opposing mentality to go and test ideas and to see what happens."*
> *- Interviewee 2*

> *"Traditionally in the industry, it has been so that somebody comes up with an idea. In my opinion this goes in to the same category with lottery. It needs to be done through research and alternative concepts.Especially when looking for something new and something that insists profound change and is radical."*
> *- Interviewee 4*

> *"Our activities are organised in a lean way meaning that everything is done more or less in small projects. An owner is assigned to each project together with, intermediate goals, etc. We update all our day-to-day activities to the system (other than ERP based functions including production, finance, and staff operations). Every day, week and month, there are events. Some of the projects require decision-making at the management level. In that case, the status changes and moves up the system and leaves it for the management team to decide on."*
> *- Interviewee 8*

4.2 Future visions

4.2.1 The Industrial Internet

Future plans regarding the IIoT were one of the core themes of the interviews. This chapter will present the goals and future plans that the interviewees shared in regards to the IIoT. Even though the IIoT was not very visible in the interviewees' fields so far, the interviewees experienced that the competitors will catch up with them soon. They also brought up, that the current competitors are probably not going to be the same ones as those of the future. Competitors can come from completely different directions than before. Amazon was mentioned as a possible threat as it already has existing platforms and resources for excessive development.

Four different levels of applying the IIoT where discussed before (p.28-29) and the results of the interviews are divided under those levels. In the discussion with Professor Mäntylä, we focused on the first three levels and according to him examples of SMEs exists in Finland in all three levels.

Level 1: Remote monitoring, remote management, optimisation and remote updates

Level one is a logical first step to developing smart connected products and services. The companies estimated their first intelligent products to be out from the next 4 months up to two-three years from now. Company number 1 which already has a commercial product said that it took them 2 years to have a functioning product. Similarly company number 2 that has running pilots with customers started the research 2 years ago, but estimated that it will take them one more year to have a ready commercial product. Companies number 6 and 8 stand out from the crowd. Company 8 is part of a vast IIoT ecosystem that is managed at the Group level. Discussions of IIoT at the Group level have taken place form the beginning of 2010s. Sensors have been a core element to the devices of company 6 for years. Their system allows remote management and updates, whereas others can only monitor their products for now.

> *"Our products are full of sensors, so we get a lot of data out of them. It already exists, but then there is connectivity. We have remote access to all our machines; it has been possible for a long time. We are able to solve 85% of customer problems at a distance without having to send anyone there. This is still just the surface. The next step is to make use of the data in real-time so that you can make conclusions, decisions, and actions based on it and of course history analysis is enabled by Big data also."*
> *- Interviewee 6*

In practice, their products of the interview companies were imagined to gather data for the use of the company and provide information or reports to their customers. The objectives behind implementing self monitoring products were to better know their products: to understand its strengths, weaknesses and operating environments and finally to utilise this information in product development. It was also expected to enhance efficiency, bring savings and to deepen the companies' relationship with their customers.

According to Mäntylä, when the larger audience first noticed the IIoT, many of the companies started to experiment at this level. This category however only offers small savings to companies and to their customers. These savings are obtained through things such as energy savings. This issue was also recognised by Interviewee 1 and 2, who already have systems that are in use.

> *"We do not see that this will result in great revenues. We hope that with this IoT system we will be able to close more deals related to our product and provide us with indirect revenue."*
> *- Interviewee 1*

> *"Even though it isn't bringing us income yet, we want this so that we can deepen our relationship with our customers."*
> *- Interviewee 2*

Level 2: Predictive service and analytics

None of the companies had quite reached this stage so far. However, this was considered as a logical continuity for the first phase. Interviewees outlined that data needs to be collected for a few years in order for a service to be reliably predictive. This stage was seen to be timed approximately five years from now. Mäntylä (2017) estimated, that if this is carried out successfully, it can result in up to 40-50% increase of revenues, but some companies may gain a smaller percentage such as 10-20%.

The companies aimed for optimised maintenance activities that lead to a reduced amount of reclamations and thus to better customer satisfaction. Maintenance activities can partially be taken care of from a distance with the use of remote monitoring, diagnosis, control, updates, and programming. Optimised and remote maintenance activities were also considered to reduce maintenance costs.

> *"Remote diagnosis will surely come to question. In my opinion this (level) will start to get closer to a service business in a way that we can direct and provide more added value to our customers."*
> *Interviewee 3*

> *"We don't really have predictive diagnostics, maintenance or repair yet, but this is the direction that we are heading."*
> *- Interviewee 6*

Level 3: New data-based service business

The interviewees all seemed to have thoughts towards this direction, but the plans became more blurred at this level. Quite a few of the interviewees are only taking their very first steps now and had not been able to think this far in detail.

Mäntylä (2017) explained that the third level requires companies to step out of their usual operating environments as it might require developing completely new business models. Companies can for example sell performance as a service instead of selling products. The level of risk and the potential turnover are the greatest here compared to the previous two levels. The interviewees demonstrated a demand for successful examples of new business models. This was something that the designers of LINK Design had also identified in their conversations with the industry.

> *"Established service models are not on the market yet. Thus, there aren't any examples that they could relate to or be inspired by alternative ways of doing business. This is usually a sign of the organization's, the customer's and the market's maturity level in which more or less everyone produces the same product, resulting in a price competition. In order for it to change to a situation where the conversation revolves around other things than the price, major investments are required in product development, marketing and many more."*
> *- Design consultant*

> *"There are a lot more examples of machines that operate in the world of production. Our machines are used in service contexts and that brings in its own challenges."*
> *- Interviewee 3*

> *"In Finland there seems to be an understanding that if you put sensors, data is collected and that makes a remote access interface. Even though it could be the whole business and the pricing model that would make the service in a way. A little like a hotel where the customer does not own anything and does not have to worry about anything."*
> *- Design consultant*

Company number 4 and 6 presented clear initiative towards building completely new kinds of a business models. The product of company number 4 is strategically located in a place that could provide useful information for a bigger ecosystem such as owners of buildings and to city authorities for example.

> *"We're trying push off traditional thinking meaning that it wouldn't be left there, that it (product/service) would only be sold once. We're doing preliminary studies in which we are trying to think of all the lines that could be connected to the circle of who could be involved."*

- Interviewee 4

"There is a lot of data going through our systems and we want to use of it and make data-utilizing services. It's the reason why we have been reformed this way and why we have this digital unit. Now we have the opportunity and the freedom to focus on developing the software and data services as its own entirety without having to think about the physical products."
-Interviewee 6

"We are trying to develop different options for the customer. There could be 3-4 different packages that the customer could choose from depending on what kind of information or service he wants. At the fourth level you could have all the possible things that you can imagine of, and all that information would be available to you on your cell phone or laptop. Each of those packages would be priced differently."
- Interviewee 7

The ecosystem idea was considered interesting from the point of view of interviewee number 2, 6 and 7. Interviewee number 2 figured that their system would become more complete and serve the customer better, if their system could be connected to their customer's systems. However he was sceptical that it could happen since their customers deal with sensitive information. Therefore, even if they would combine their systems together, Company 2 could not see or use that data.

"Our product is a door-to-door system. If we could command other systems as well, then it would be more of an end-to-end process and that is where we are heading and we already have some cases."
- Interviewee 6

"We are aiming to provide our end-users holistic solutions at a Group level. We have a cloud service and all of our products are connected to it. We are collecting data, trying to analyse it, and then depending on what the services are, somehow try to bring added value to the customer. This is the intent, but it's not ready yet."
- Interviewee 7

Concrete evidence of how rapidly this field is evolving was experienced during this research. As explained earlier, I had to return to interviewees 1 and 2 to collect more data. During the first time I visited interviewee 1, he mentioned that they aren't actively searching for new service models. However, approximately one month later when I returned back for the second interview, the situation had changed. The interviewee had been approached with an initiative to create an ecosystem between the stakeholders that operate within the same value chain. This project will only start in autumn, but will most likely end up in creating a wider system for the entire ecosystem.

Company number 2 is considering the possibility of creating a business model based on usage or capacity. Company number 3 on the other hand presented and idea of selling

lifetime warranty of the product. The interviewee was not fully convinced of the idea yet, since he was worried that their customers would not respect the deal.

> *"There is a problem if a customer does not use the product according to the guided use. If the product is misused, there is no chance that it wouldn't break, but the person who is using it might not care since he knows that he will automatically get a new one. It can become a terrible financial burden for us."*
> *- Interviewee 5*

> *"If there is a company for whom services are not relevant to, then it (a service) is not seen as a source of income, but rather so that you have to deliver the spare parts to them, then it will be seen as an expense. If it is not seen as a potential for profit, then there is no money invested in it either."*
> *- Design consultant*

Selling data outside the company or for the use of the customers was not brought up.

> *"We are still not that far that some external partner could make business out of our Big Data. Open value networks are still under research."*
> *- Interviewee 3*

Level 4: intelligent factories and autonomous products

Intelligent factories and autonomous products felt distant to the interviewees for now. They often said that it is too early to say, but gave a careful prediction that this is probably where they will be heading in the long run. Company 7, who is in any case ahead in the process estimated this to be reality to them in 2030. Full automation in many cases requires high-level cooperation with other devices and service providers within their operational processes. This question was particularly challenging for companies that were not determined on their partners yet.

> *"The processes are autonomous to some extent, but it does not include self-coordination with other product and systems, that's where we are still heading. And autonomous personalisation, for example is further away. Far-reaching autonomy is actually quite sci-fi."*
> *- Interviewee 6*

> *"One thing that is related to this is that we have these self-directed vehicles where a tracktor is driven by the GPS. Connecting things with each other is a bit further away."*
> *- Interviewee 7*

> *"I am sceptical, I don't believe that we will see a fully automatic machine very soon. There are many changing factors. There are some areas however that can be made automatic to facilitate the use of the machine."*
> *- Interviewee 1*

4.2.2 Summary

All the interviewees were interested in ways of adapting IIoT to their product and service offerings. Some of the interviewees were satisfied with preserving their current role and selling the product with more intelligent features that would benefit them by obtaining savings that would mostly be created by remote and preventative maintenance services. A few of the interviewees were more interested in building holistic systems for users needs and/or data-based services.

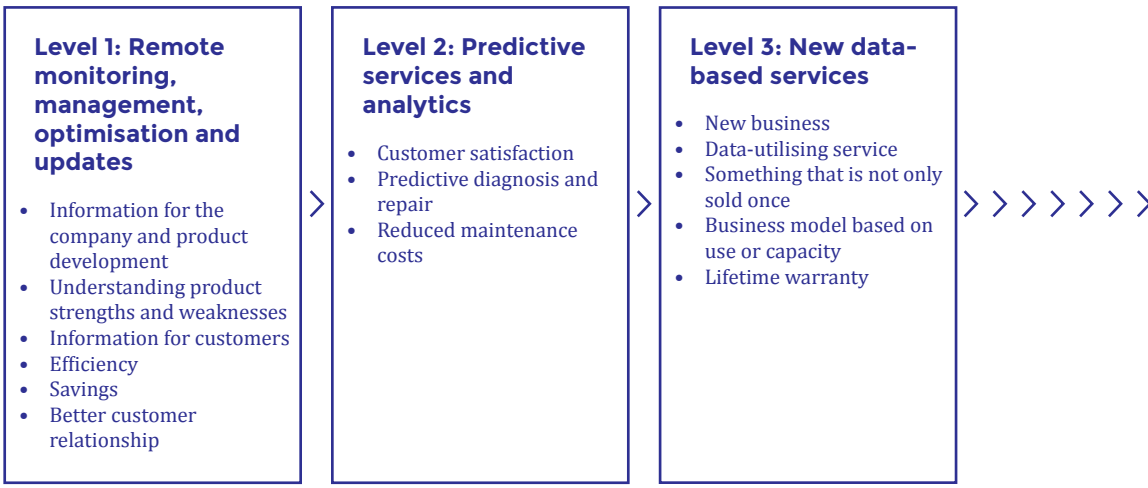
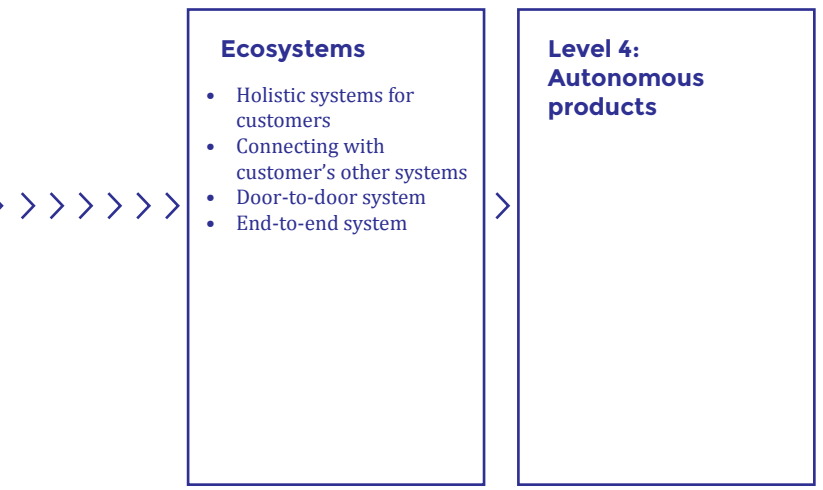


Image 13. *Benefits of and goals for IIoT that were brought up during the interviews*



Interviewee 7's product was already part of a larger ecosystem. There was a lot of interest in connecting with other systems, but most of the interviewees were waiting for someone else to create the platform that they could join in.

Company 6 already has automatic products. Full autonomy including self-coordination of operation with other products felt still distant to all of the interviewees.

4.2.3 Design

The interviews showed that service design had not been widely used so far. However in many of the cases the interviewees saw a possible entry for service design as a tool for tackling questions related to digitalisation. Here are the findings on how the interviewees saw that service design could be beneficial to them. The findings are categorised under the following subheadings: role of a service designer, understanding the bigger picture, understanding users, stakeholders and their needs, visualisations, prototypes, branding, business models and partners.

We discussed how the design background of the companies influences further design projects in the organisations. There were two opposing opinions at LINK Design.

> *"The industry is familiar with 'hard' development, but when it comes to the 'soft' side - human values and understanding users – it is something unfamiliar and they do not really know how to utilise it. They might not quite believe in it (service design), because they don't know enough about it and they are too afraid to go for something unfamiliar. If there are people inside the company who are familiar with the topic, then discussing it (service design) is a lot easier and they might be more prepared to jump into something they necessarily haven't done before."*
> *- Design consultant*

> *"It is always easier for a consultant, if the customer is familiar with the topic. Then it is much easier to get into that conversation."*
> *- Design consultant*

> *"I would argue that it's not easier to enter with service design even if they have experience from industrial design before, because it is it's own thing and you talk to different people about it, at least in the context of IoT services. Because then it is also related to servitisation and to how ready the organisation is for them becoming a service organization."*
> *- Design consultant*

Role of a service designer

Holistic and in depth understanding of the IIoT phenomenon were qualities that were expected from a service designer. Design agencies were also expected to work as matchmakers between the companies and possible partners in creating their IIoT solution.

According to interviewee 4 a skilful service designer's role can be compared to one of a movie director whose responsibility is to orchestrate the whole process. He also pointed out that a mastering this role requires a lot from the designer, and designers who posses these skills are still hard to find.

The idea of coaching was presented by interviewee 5: *"An idea of coaching came to my mind. There are companies that organise "raising the spirit" workshops. This idea, but with the difference that you should know our products well."*

Understanding the bigger picture

Building the bigger picture, understanding all the variables, and creating concepts based on them were qualities that were appreciated from a designer. Quoting interviewee number 4: "*In my opinion a good designer demonstrates a comprehensive understanding of things."*

> *"Before creating any concepts, we need to understand the functions and the interfaces. This is the same for anything that is designed. You need to understand the interfaces, functions, and stakeholders to be able to see different possibilities. It requires immense capability from somebody to be able to comprehend the bigger picture and to complete the puzzle."*
> *- Interviewee 4*

> *"If I try to think of where we have catching up to do, then I am convinced that we must certainly work with a broader concept."*
> *- Interviewee 5*

> *"Everything is fast, changes are quick and everything is more complex in a certain way. Service design could really make breakthrough here, in this complex world, to simplify things and find the right doors."*
> *- Interviewee 4*

Understanding users, stakeholders and their needs

For many of the companies being close to the customers was seen as an advantage in competing against big players. Therefore good customer experience was also seen as something valuable. User engagement in project development was still very limited and usually remained as a tool for product validation.

> *"Design, when it gets closer to the dimensions of service design and understanding user operations and goals for development - this is where the role of design is likely to increase in our company. In fact our company is striving for it, and for us it would be beneficial that it would head towards that direction in general. It enables creating added value to customers and therefore products at our cost level would sell better."*
> *- Interviewee 2*

> *"We are thinking of creating a retail web store which sells all kinds of products that are linked with our customers needs. We want to own the customer and to see everything that the customer buys. This way we could find out what else we should start offering."*
> *- Interviewee 2*

The designers and some of the interviewees underlined the importance of user engagement

as a solid foundation for new concept development. This research focused on B2B companies meaning that the end users were often not the ones who got to decide on the purchase of the product. In those cases user-centricity was not seen as important compared to other issues such as efficiency of the product. In some cases the end users could influence the decision and in these cases ergonomics and usability were paid more attention to.

> *"Motivation is something that I would like to emphasize; customers', stakeholders' and employees' motivation. If you find out what motivates each group in value creation, then you're on the money. It's a very abstract notion, but the conversation often leads to what or how? One should ask why would somebody use this? Why would somebody change the way that they are working? This is probably more connected to management level thinking and that they would understand the word why."*
> *- Design consultant*

> *"Customer and stakeholder understanding and the experience that the service provides them are directly linked with whether the service experience has monetary value or not. If the service experience is good, then we can start creating concepts and creating some kinds of revenue models and so forth."*
> *- Interviewee 4*

> *"Ergonomics are an important factor, especially Nordic customers come here to see our machine in use. The drivers have a really important role and they have a say in what feels better to the hand."*
> *- Interviewee 1*

> *"The design needs to be user-centred, that's obvious. Installation-related user-oriented design is currently being carried out so that we have 3-5 installers who get to comment on our products. This is not the end customer - but the end user who tests them. They get to decide on what they want to install there."*
> *- Interviewee 8*

User research at a deeper level was still relatively new to some of the companies. They also weren't quite sure of how to apply it in their context or in relation to the IIoT. They might also have had alternative more traditional ways of getting feedback for product development.

> *"I am familiar with user inspired design, but I'm just trying to bring it to this context. We have individual entrepreneurs as our customers. They are aging and they work six days per week. So I am not sure how much we could involve them or how much they would have a say in this."*
> *- Interviewee 3*

> *"Their products have more to do with the quality of life and facilitating the lives of people. We are in heavy metal industry and a different logic applies here. We are dealing with cost-logics and maintenance."*
> *- Interviewee 5*

Business models

Most of the interviewees including the companies, designers and professor Mäntylä considered business models to be the most challenging issue related to the IIoT. Service design was seen as a tool that could contribute to building it.

> *"The biggest challenge in IIoT is the business models. It is not possible to build a business model, if you don't have enough information on the customers or the value propositions."*
> *- Design consultant*

> *"What I've tried to bring to the organisation is the idea of servitisation, and the means of service design in the business model point of view."*
> *- Interviewee 6*

> *"In a way, sales and contract models and other things that are visible to the customers can slow down the process a lot. They might be able to realise the technological parts, but will they succeed in selling it and in what ways?"*
> *- Design consultant*

> *"With design I mean design from a wide perspective, so that it includes the understanding of a business idea, as well as how to buy it. It (service design) understands the extensive meaning of a customer."*
> *- Interviewee 5*

A partner in creating strategy and vision

Even though service design was recognised as a tool to understand the bigger picture it did not reach strategic levels of design to the full extent. In fact, service design often entered the project only after visions for the IIoT were created even though it could still impact and influence these visions afterwards.

> *"We created visions by ourselves first and advanced them later with the help of service designers. We had a strategic project with a design consultancy and there were some elements of it, but it was not in the core of it. Similarly we had thought of new earning models before entering the service design project."*
> *- Interviewee 2*

> *"Envisioning is a part of the strategic affairs of the company. Many parties are involved with it. There are consultants, product development partners defining the vision. Nobody actually owns it (the vision)."*
> *- Interviewee 4*

> *"The most important thing is to have a clear vision. Without a vision it (the project development) will just not develop into any direction. It's (a vision) a source of passion that shows where we are heading, with what resources in what kind of a time frame."*
> *- Interviewee 5*

Visualisation and prototypes

Visualisations in terms of visualising service ideas and prototypes were only brought up by some of the interviewees. One of the reasons may have been that prototyping services is still something relatively new.

> *"If it is possible to visualise and to make models of the idea in the beginning of the process to be able to test it, then that is certainly the best possible scenario."*
> *- Interviewee 4*

Visualising and designing user interfaces came up occasionally. Good usability was seen as valuable here.

> *"The project with the service design agency also included a few rounds of visual designs for the user interface."*
> *- Interviewee 2*

> *"In the future we will give more respect to the fact that a user can use an interface and document his/her workflow efficiently. Of course things should happen automatically if possible. Careful documentation is an essential part of the Industrial Internet."*
> *- Professor Mäntylä*

Branding and productising

Branding was mostly seen as a bi-product of service design and similarly productising was a natural continuity to the work done before. Companies brought up the need for help with concretising plans and making sure that details are in place.

> *"Productising could be done so that we would have something in addition to the one physical product. We should be able to enter in a value chain in which we provide the possibility for the customer to contribute to producing added value."*
> *- Interviewee 5*

> *"Productising is one big challenge. Our company has traditionally produced machines for others. They provide us with drawings and we do not need to care about productising it. Now that we have our own product, we have to think about productising it so that it is ready to enter the markets and to be used by our customers and it is difficult to get this organisation involved with it. It's not only about having a machine, it's about having all the maintenance instructions, promotion and technical materials."*
> *- Interviewee 1*

> *"Creating a strong brand is the ABC of everything. In my opinion this is connected to the value proposition in a way. I think that the product is only responsible for a small share of the satisfaction. One who looks at things only from the product point of view, will loose eventually. They might not notice that the customer is paying for his/her own comfort and experience."*
> *- Interviewee 5*

“You can copy the bolts of the nuts, but you cannot copy the brand.“
- Design consultant

4.2.4 Summary

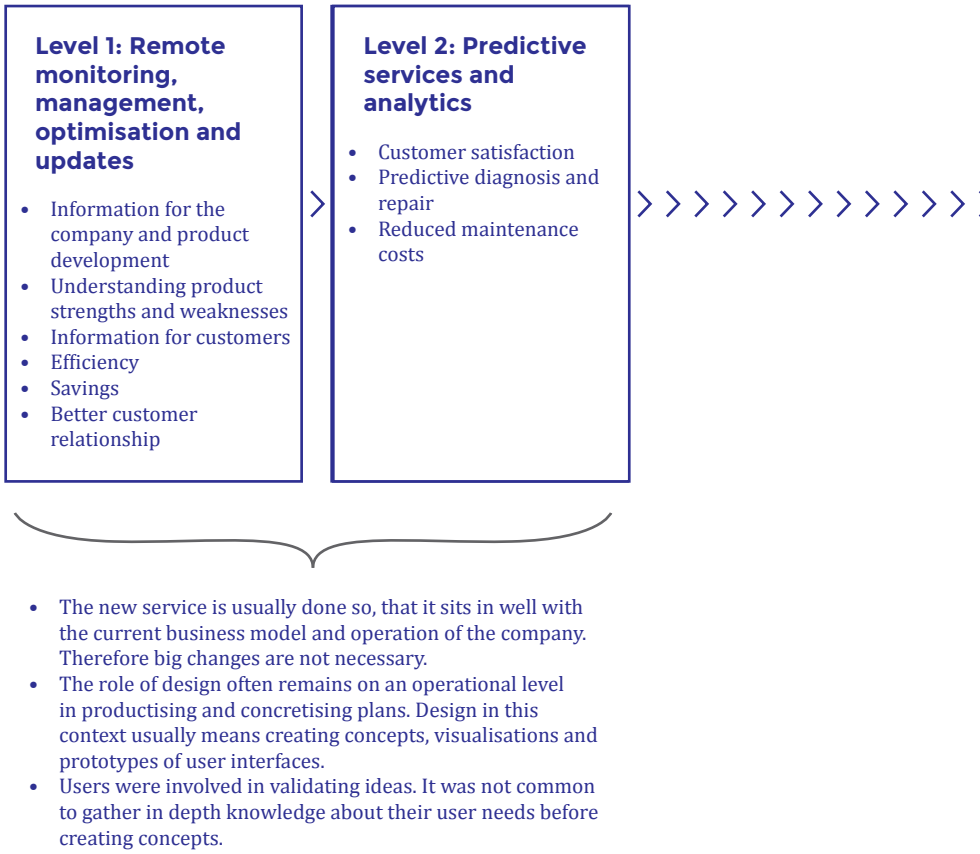
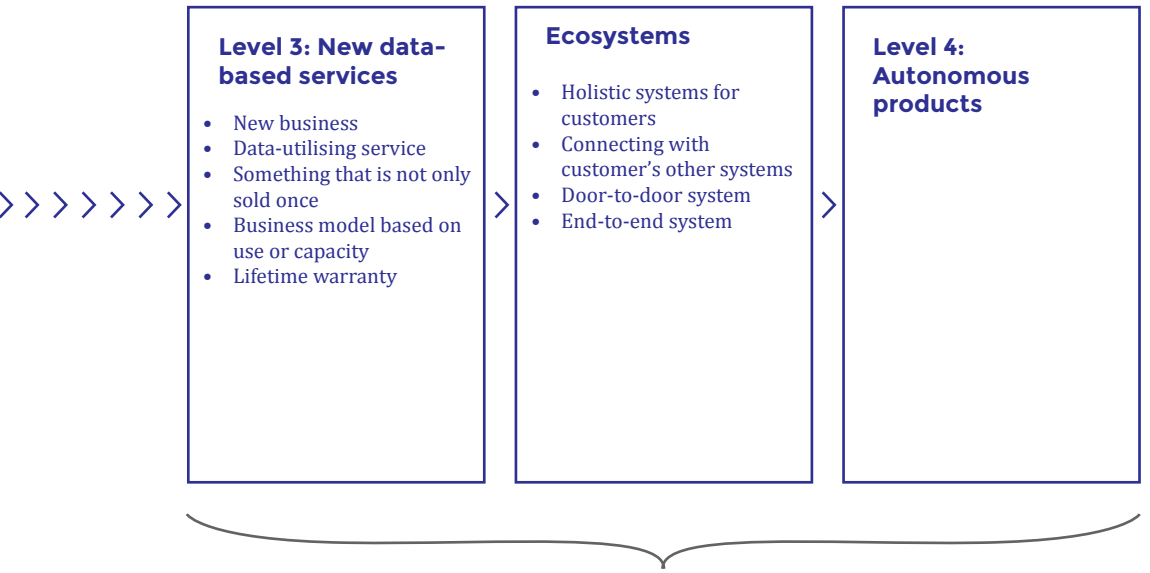


Image 14. *The role of design in IIoT projects drawn out based on the interviews*

There was a clear division between how the design profession was understood. The most common way of using design was in the shape of industrial design, ergonomics and usability. There were some companies that had not used any form of design, due to the fact that their products were located in hidden places. They however, showed interest towards utilising service design in the future. The interest towards service design and design thinking was thus not connected to the design history of the company, but rather it was a question of how informed they were about service design and design thinking in specific, and how purposeful they saw it in their context. The companies that had in-house designers often said that for them the greatest value of design comes from understanding the users and the context that the product or service is used in. Similarly those companies were most familiar with the more recent approaches to design.



- Questions at these levels become more difficult to answer and business models are likely to change. System and design thinking and service design were seen as useful tools here.
- The role of design was seen particularly useful in understanding the bigger picture and yet again in simplifying things, and finding the right doors.
- Design was seen as a way to create concepts, visualisations and prototypes of the service as well as the user interfaces.
- The role of a designer was to orchestrate the process and to coach it.
- Designers were also expected to have a holistic understanding of the IIoT phenomenon, and to provide contacts and work as a matchmaker between partners.

4.3 Problems and challenges

I will now go through the issues related to using service design and beginning to implement the IIoT that were brought up in the interviews. The issues usually revolved around the following themes: awareness of the organisation relating to digitalisation and the IIoT, a limited amount of resources, the role of the company in the value network, creating revenue and questions related to users and user interfaces. The problems related to utilising design are discussed at the end of this chapter. A graph was made for each of the problems and challenges listed above. In addition to the problems and challenges I added the opportunities that the interviewees saw in each category to each graph to better represent the relationship between the opportunities and challenges. As a third element, I added to the graphs the opportunities for service design that were identified earlier in the text. This was done in order to outline the understanding of service design today, thus contributing to the research question of how mature the companies are now in terms of design.

The product and service

The worries that the companies had relating to smart products and services had a lot to do with what the response will be from their customers' side and if the customers will adapt it to their common use. They were also concerned about timing, as they felt that the customers are not yet ready for these kinds of solutions. They also did not want to enter the market too late either. There were some observations related to realising the products and services in practice. Even though the common word is, that the price of technology has decreased, the prices were still considered to be too high in some contexts of use. Some interviewees were also concerned about the price of creating and maintaining software.

> *"The problem isn't that there wouldn't be sensors available. The problem is that they are too costly compared to our product. It is less expensive for us to provide the customers with a new product than to give them a device that informs them when it should be maintained or replaced with a new one."*
> *- Interviewee 5*

> *"Bringing such information for example to an application on your phone is a remarkably challenging, inclusive and an expensive project."*
> *- Interviewee 4*

It is important to keep in mind, that a product needs to be designed so that it works even without the cloud service.

"Small companies might face the challenge to gain trust from customers. The customers might be worried for what will happen if the company suddenly stops offering the service. Therefore they might want a solution that works by itself even without the cloud service."
- Design consultant

"One of our products is sold to seventy-three countries including many third world countries. Therefore we need to think about the technologies. We are using very basic and reliable technologies there."
- Interviewee 3

Only one interviewee briefly mentioned safety issues. It can be deduced that there are existing and efficient tools for securing the use of a solution and the data.

"How to take care of safety, I guess it is starting to be a challenge too."
- Interviewee 4

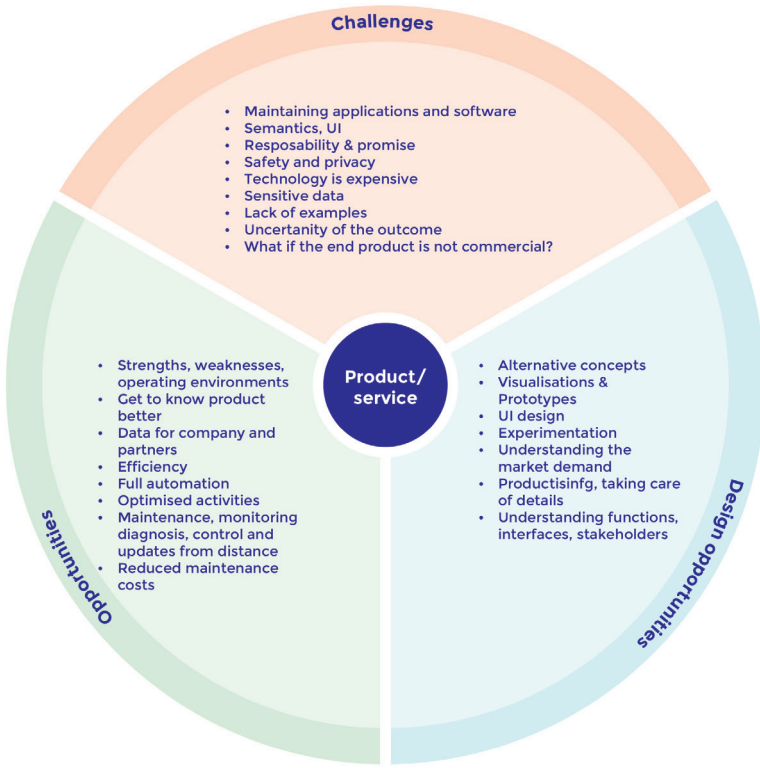


Image 15. *The graph illustrates the challenges and opportunities related to the smart product and/or service and how design expertise could be used in this context. The content of the graph is based on what the interviewees told during the interviews.*

Awareness

A key issue was building awareness of the IIoT within the companies. The interviewees said that it has been a rocky road in convincing the companies' management and board of directors.

> *"One big challenge is to what extent does the company's management and board see the importance of this and can take leadership over it. It might be that we are already one step further in this. Then finally it's about getting the employees involved with it."*
> *- Professor Mäntylä*

> *"Competence will probably come through partners, but from my experience there also needs to be people who take responsibility in the company."*
> *- Design consultant*

> *"These are huge challenges for our organisation culture, because our focus and know-how is in a completely different direction. It requires a strong visionary who believes that this is the direction that we have to take even though we are not sure of where it is all heading. In addition to this is requires the vision of the CEO and would need the support from the board of directors as well. Even though we have succeeded quite well, it hasn't been easy. If there wouldn't have been a person at the management level who was prepared to take the risk and let go, then nothing would have happened."*
> *- Interviewee 2*

> *"This company hasn't been very well informed about it (digitalisation and IIoT) and we haven't had a clear strategy that would point out the connections and give direction. These are often the challenges of an SME, because it is not possible for us to carry five projects and do research on top of that to see what works out. We have to keep a narrow focus and it needs to be framed well."*
> *- Interviewee 4*

Digital transformation does not only touch the upper levels of a company, but the organisation as a whole. This was recognised both by the designers and the interviewees.

> *"The change from being a product supplier to supplying services is a huge cultural change. It requires the whole organisation and its employees to learn it. It is a big thing, but it is sometimes left aside."*
> *- Design consultant*

> *"It's been a good thing that we have our own factory where we can experiment. It has been a way for our production workers and production management to see what is happening. It has helped them to realise how this (the IIoT) could help our customers and that it could help them as well even in the production. When we've told the factory manager that we would like to try out something, then he has always asked us what we need. If his attitude would have been such that the production will get disturbed because of us, then we wouldn't have been able to make progress."*
> *- Interviewee 2*

SMEs often need the help of service providers to fill in the missing competences.

"The competence, experience and awareness of employees have been big challenges related to digitalisation in our company. It is very rare for somebody to admit that his or her information is out-dated and that it would be useful to educate himself/herself. "
- Interviewee 5

"It is inevitable that in addition to resources the company's own resources, they need partners or hiring new skills that they might be nervous for."
- Design consultant

"In this information world, I would say that the better partners you have – the better decisions you are making. It can be a problem that everyone doesn't admit to that. It is seen so that using services isn't more efficient than doing things by ourselves."
- Interviewee 5

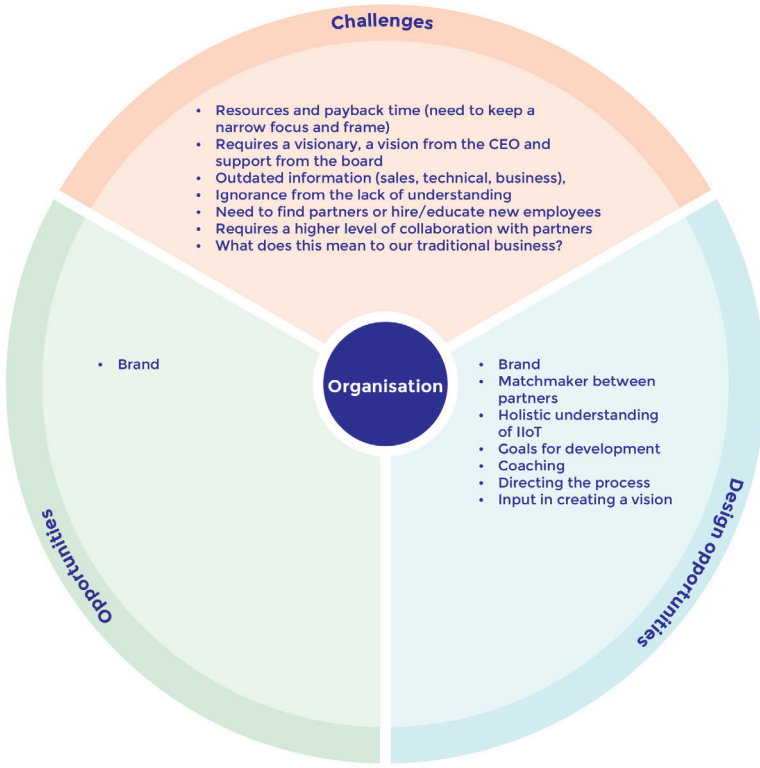


Image 16. *The graph illustrates the challenges and opportunities related to the organisation culture, and how design expertise could be used in this context. The content of the graph is based on what the interviewees told during the interviews.*

Role & platform

The interviewees were eager to find new business solutions, but in practice the interviews left the impression that the companies were most comfortable in sustaining their usual operating environments and remaining more or less in the current role as product or component suppliers. Some companies demonstrated more interest towards discovering new connections and who figuring out how they could benefit from their data.

> *"I imagine and hope for a world where these companies have built products based on customer values and then possibly brought about new services. At the same time, they should build competence in cooperating with other companies."*
> *- Professor Mäntylä*

Some of the interviewees had created their own platforms. This was usually the case if it was enabled by a system managed by the Group level or if the product operates in a closed environment where it is the main player. In these cases it was also typical that the platform was used by their own or their company Group's products only. They were however considering to open their platforms for others in the future.

Those companies whose products had a smaller role in a complex entity expected other parties to create platforms that they could join in with. These companies were preparing their products to be ready for when their customers or partners would show demand and interest in an integrated product. At that time the interfaces for the platform would be created.

> *"My guess is that these big players, in our case train manufacturers will create standards and determine the kinds of components that will be allowed in their trains and how they will be tracked. Our product shares the responsibility of one function at the same time with the other components. Thus, it makes more sense for the bigger companies to build these systems."*
> *- Interviewee 5*

> *"We are starting to get there, but the biggest problem of the IoT has been that there is no interface or infrastructure that everyone could connect to. I have done some preliminary research, but it seems that there is still no city network that we could connect to."*
> *- Interviewee 4*

> *"It is actually a challenge for an SME like us that doesn't have IoT-experts behind the door, to join the right group at the right time."*
> *- Interviewee 4*

> *"Our customer's job might include five to six different kinds of tasks and many kinds of tools within one day. Lets say that the customer uses ten or twenty machines a day and one or two of them is one of our products. Can we then offer a service system and install technology to the other machines through which they could connect to our system. This*

feels a bit strange at this stage, when we are not the big player there. However, our system should be open enough to enter other systems."
- Interviewee 1

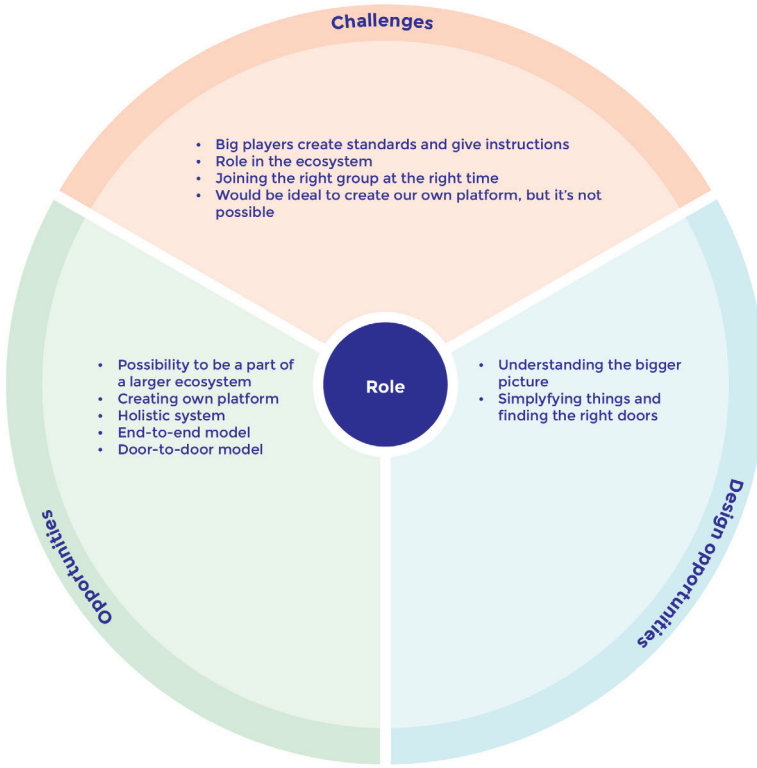


Image 17. *The graph illustrates the challenges and opportunities related to the role of the company the ecosystem and how design expertise could be used in this context. The content of the graph is based on what the interviewees told during the interviews.*

New business with the IIoT

The interviewees agreed on business and revenue models being one of the most challenging issues related to the IIoT. It was difficult for the companies to imagine how to earn with IIoT solutions. They were also concerned with how it would influence their current business.

"If something goes wrong, it goes wrong here (with the business model). For example if a company doesn't succeed in identifying their revenue streams and how they secure it. Or

even worse, if this part fails and we are in a market that is declining or our service is no longer needed."
- Interviewee 5

"We sell twenty to thirty products per year and therefore it's not possible for the service business to grow huge."
- Interviewee 1

"If we start to offer this new service to our customers, then we'll have to take responsibility for it as well. We give them a certain promise, and then we are confronted with the question that "Can we keep that promise?" And if we fail, then what does it mean to our traditional business? These are the kinds of fears related to the investments and resources that it takes."
- Interviewee 2

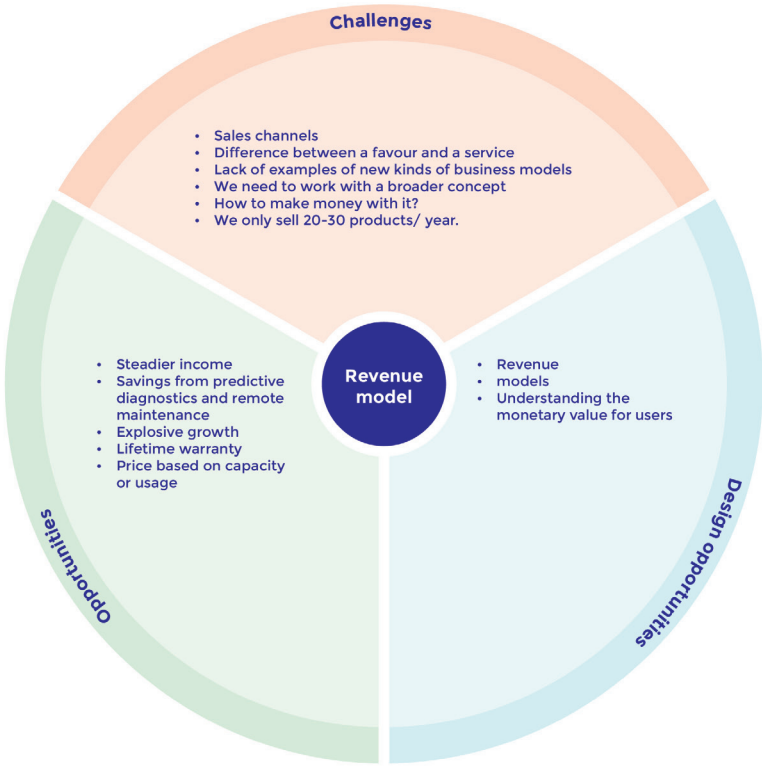


Image 18. *The graph illustrates the challenges and opportunities related to the revenue model and how design expertise could be used in this context. The content of the graph is based on what the interviewees told during the interviews.*

There was also the risk that customers would take the services for granted or that they would not be ready to pay for the service or take it in use. It was identified that being able to truly adapt the IIoT to the service and product offering would require new kinds of sales skills and channels.

> *"You need to be very careful with what is the difference between a favour and a service. If you keep doing favours, then it is really difficult for you to make any business out of it. When the customers get used to it, they will keep on expecting more. You have to be able to describe it and give a price to it even if there are some services that are free of charge. Then you will have a foundation that is perceived as a service that has a price."*
> *- Interviewee 3*

> *"I don't know any company that would have made money with the IoT. It has become a necessity and customers expect that they can follow the products digitally and it has become a selling argument that it is possible."*
> *- Interviewee 1*

> *"Who is it sold to? Who will buy it? By which model will it be sold, purchased, and delivered with? Our business models are partially renewed now that we're talking about selling software, selling data or data-based services. We have sold software in relation to our tangible product before. Now we're close to having our first deal in selling intangible stuff. It requires its own sales channels, tactics and strategy, and the business models and earnings models are all different. That is the big thing really, the way it is sold, the whole selling network. The sales skills from before do not work at all."*
> *- Interviewee 6*

Users and user interface

Understanding what the customer's need and how it fits in together with the customer's current working processes was important for services to be used in the desired way.

> *"Technically this would have been possible to realise a long time ago. However, the total cost of the investment and/or the workload that it would have required from our customers made it impossible. It would have required our customers to perform a lot of extra manual work and that is something that is easily left undone. Also, It would have required training the staff and making sure that it is used as it is intended to be used. It shouldn't require any extra work, it should work automatically."*
> *- Interviewee 2*

> *"It is worth putting money only on what one can handle with little effort."*
> *- Design consultant*

Also in relation to this topic, the interviewees made an effort to communicate the information in an understandable and an engaging way. However, it was not a given, that users would make use of the solutions to the full extent.

> *"The biggest challenge is to understand the source through which the information is brought to the user and the shape in which it is communicated to him or her. Semantics,*

user interfaces, application interfaces and managing them are a huge challenge. When they become very complex, then using them, maintaining them and committing to them is difficult."
- Interviewee 3

"Different kinds of data collection solutions have been around for a while, but finding a way of creating reports – creating an overview of what is happening was a challenge."
- Interviewee 1

"We've seen that too, that the customers have asked for more than what they've actually ended up using. They might not have internalised all the utilities yet or understood how to lower the fuel consumption (of the machine) based on this information."
- Interviewee 1

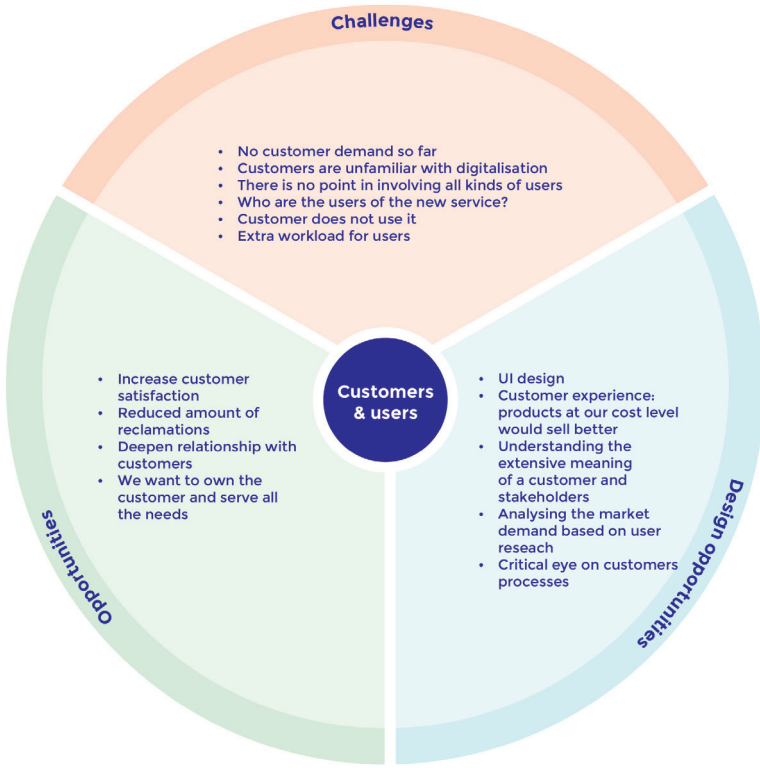


Image 19. *The graph illustrates the challenges and opportunities related to implementing the IIoT for users and customers of the product and/or service and how design expertise could be used in this context. The content of the graph is based on what the interviewees told during the interviews.*

Resources

The companies were commonly struggling with the lack of resources. Large investments, abstract outcomes and uncertainty of the payback time were things that made the companies uncertain of investing in IIoT solutions.

> *"We need to keep in mind that not all attempts for the IoT succeed. The common message is that if you jump on board, you will make a fortune. However, there is an equal chance that you will lose your money. You will invent something that isn't commercially viable, somebody else has invented a better thing or then a bigger player says that they don't admit to it, because they already have it even if it's of a weaker quality."*
> *- Interviewee 5*

> *"Most companies have a tight financial situation, so how are the resources used? Are they used for something that will immediately bring something small, but that will continue to dig you deeper in to the hole. Or is it something that will take you elsewhere, but there is no guarantee of the schedule and that there is a fair chance that it wont result in anything usable."*
> *- Interviewee 2*

There are many other activities within companies and it is a challenge to find the right balance for sharing the resources within a company. Nevertheless, Professor Mäntylä identified an increase of investments in ICT and IT.

> *"There is an existing trend that an increasing amount of investments are directed towards ICT, IT and the IIoT rather than systems, factory walls and floors etc."*
> *- Professor Mäntylä*

> *"Everyone needs to focus their resources on something. A bigger player might be able to concentrate on many things at a time."*
> *- Interviewee 5*

> *"Our product development resources have pretty much been tied to making our product meet the environmental legislations such as emission regulations. We have to think about investments according to our scale and resources. We know that upcoming legislation will set our next deadline meaning that our resources need to be focused there."*
> *- Interviewee 3*

> *"We are continuously balancing between the existing business and future projects and how resources should be used."*
> *- Interviewee 2*

Service design

The problems related to service design are identified below. Some problems were already mentioned earlier in this chapter. There it was identified, that communicating and understanding the meaning of design is difficult. Another major factor that limited the use of service design was the lack of resources.

> *"It might be difficult for them to imagine what the services would be as they are not familiar with it and it would take a tremendous time to find out what they actually would be."*
> *- Design consultant*

> *"What kinds of tangible things will we get out of it? Those are probably the most challenging things in service design and in what time frame."*
> *- Design consultant*

> *"In theory it would be possible for the role of design to increase up to the highest levels of design (see p.32). But at the moment our governance, board guidance and strategy don't support it yet."*
> *- Interviewee 2*

> *"I think that service design would break through better, when the role of service design within different processes is clarified."*
> *- Interviewee 4*

> *"The challenge for companies to start using service design might be to understand what kind of added value will it provide. For us it is most important that we will be able to produce iron and then we can think about what kinds of other functionalities would provide added value."*
> *- Interviewee 4*

> *"If you were to ask someone else, it would be a very different conversation. There are many cultural things. This is a project house and an engineering organization. You have to be able to pragmatically justify why it might be useful and should be done."*
> *- Interviewee 6*

4.4 Findings

The interviewees had recognised the potential in the IIoT, but this view was not commonly shared throughout their organisations. The lack of awareness and skills were often seen as a restraining factors. This means that they would have to find new partners with whom to collaborate with. The lack of resources was also a common problem among the SMEs. Nevertheless, all of the interviewees had reached the initial research phases of development and some had already realised commercial products or are currently piloting products.

Most of the questions and challenges that were brought up by the interviewees were connected to business models. The interviewees presented questions such as, how can we make money out of this? What products and services are the customers ready to pay for? What will the customers begin to use? Who should we partner with? More than half of the interviewees saw the potential of using service design to answer these questions and three of the interviewees had already utilised service design to solve questions related to the IIoT.

A common goal of the companies regarding the IIoT was to build an intelligent product and reach enhanced levels of efficiency and thus obtain savings. Some companies were willing to operate in a wider ecosystem or sell product-as-a-service. The companies are currently searching for their role, but it seemed as the opportunities brought by the IIoT were not used to their full capacity and the companies were most comfortable in remaining in their current role with the difference of providing products that are smarter in their qualities.

5. Conclusion

5.1 The research question revisited

The objective of this study was to build understanding on what is currently happening in the metal industry in terms of digitalisation, the IIoT and servitisation and to identify places for service design to support these transitions. The research was conducted by compleating a desk review, by interviewing design professionals and interviewing representatives of the metal industry who have responsibilities in strategic development in their respective companies. The research also included one interview with a professor of the Industrial Internet at Aalto University.

The research question posed was: How mature are SMEs of the metal industry in terms of digitalisation, the IIoT and design?

Digital maturity

The interviewees had already taken initial steps towards creating smart and connected devices. This made it possible to focus on evaluating the progress in relation to the IIoT rather than sticking to evaluating digitalisation in general. The interest towards building new kinds of products and services came from the will to create new and steadier revenue for the business. The companies also considered the IIoT to bring them closer to their customers and thus increase their competitiveness. A few companies were further in the process and were running pilots or had already functioning products that are now being improved. In addition to this, many of the companies had invested significant amounts in to improving their own production by the use of more intelligent and automated systems. All in all, several of the interviewees identified themselves as forerunners of the IIoT compared to their competitors. At the same time they admitted, that they have lacked a clear strategy and business models that could guide them through the transition phase and that it still remained a challenge to get the whole organisation involved in the transformation. Thus, referring to the model of Westerman et al. (2012) (p. 21) there were companies from all four categories, but mostly from the “beginners” or “fashionistas” categories meaning that the interest towards the technology had awaked, but they are lacking effective transformation management and strategy. Resources were also a slowing factor. Most of the companies were working with very limited resources and they often needed to be guided elsewhere such as to meeting given environmental regulations. A common challenge for the SMEs was also the lack of skills in this field and they would have to partner with service providers to fill in the missing competences or educate their employees.

Research about the use and expectations towards the Industrial Internet has been done by Korhonen and Valli in Finland (2014). This thesis shows similar trends to their research with slight differences. The companies that were interviewed for the purpose of this thesis presented more interest towards creating completely new services, joining in or creating connected ecosystems and meeting to customers' needs with the help of IIoT solutions compared to the 9% from the research conducted by Korhonen and Valli (2014). In any case, even in this research the impression was that companies were often satisfied with improving the efficiency and performance of their product rather than exploring new service opportunities and possibilities of ecosystems. The challenges that were identified by Korhonen and Valli (2014) remained the same and were mostly concerned with the companies' business models.

Design maturity

The use and understanding of design methodologies varied as well as the interest towards utilising them in the future and in relation to projects dealing with the IIoT. Industrial design, ergonomics and usability were familiar to all of the interviewees of the metal industry, but as soon as we got to the more strategic directions of design, the discussion sometimes became more laboured. The results of this thesis were in align with previous studies that demonstrated that design was mostly used as a tool to design the appearance or usability of a product (Alavuotunki et al., 2015; Lith, 2013; Eljala. 2013). Design was used most comprehensively in companies that have in-house designers, and in their points of view the most significant value of design lies in the user-centricity and in understanding the bigger picture and demand for a new solution. Other than that, there was no trend that would have demonstrated that those companies, which have used design before as a tool for form giving or usability, would use design at a more strategic level compared to those companies that do not have a design background. In fact, there were companies that were interested particularly in the more strategic levels of design even without having any previous background in utilising design expertise when it came to designing the solutions and services of the IIoT. Thus, the interest had more to do with how familiar the interviewee was to those directions of design. Overall, those companies that searched for opportunities of the IIoT in a wider sense considered design methods at a strategic level to be beneficial in the future in mapping out the bigger picture, simplifying things, aiding in descision making and in revealing the users needs. The interviewees considered the role of design to increase in their companies depending on the amount of resources they have in use. In general however, the current and the predicted use of design often remained at the first two levels of Junginger's (2009) graph (p. 32).

5.2 Practices for future collaboration

The subquestion for this thesis was set in the beginning of the study: In what ways can service design support the SMEs of Finnish metal industry in adapting the Internet of Things to their product and service offerings?

Even though the current changes in the industry touch all the companies on a general level, the situation and the needs of each company were different. I will now highlight some of the themes that were brought up repeatedly and identify ways for service design to operate to aid in the incorporation of the IIoT to their products and services.

As identified before, many of the companies were taking their very first steps towards producing smart and connected products and services. This is why many of the companies appreciated that a service designer could provide holistic understanding on the phenomenon and insights on the direction that the IIoT will develop towards in the future. The idea of "coaching" was brought up by an interviewee and together with organising sessions with the purpose to inspire the companies to take a more active role with the IIoT. One of the interviewees had also taken part in sprints that lasted for a few weeks and resulted in quick service concepts.

After mapping out the challenges and opportunities that came up from the interviews, two main areas in which service design methods could be particularly useful emerged. The first one was making sense of complex entities. A service designer should be able to identify the system leves and discuss the opportunities that lie within them. At the moment the companies tended to stay very close to their prexisting role, whereas creating data-based services, wider operating ecosystems had not been widely explored. A far reaching scenario would be to look at the bigger picture, build a roadmap between different phases and identify project goals even if the company would only have resources to implement the first phase. As was previously mentioned in the theoretical background, designing even just a part of the whole system can significantly improve the overall quality of the service as long at its suitability at a system level is ensured.

A second theme that arose while mapping out the answers had to do with the difficulties related to cultural change. The interviewees were facing major difficulties in getting the whole organisation on board. Service design methods can help with the transition with using co-design methods. The purpose of this method is to involve different stakeholders and employees from each level to contribute to the development, ideation and testing of service ideas. It is important to involve all stakegholders in order to create coherent solutions that

benefit all system levels. Also, when implementing the service solutions, designers should educate the employees in using them. This dimension to service design had not yet been recognised by most of the interviewees.

In addition to this, designers should continue to raise awareness of the more recently formed disciplines to design as the understanding of design is still often limited to a discipline of form giving and usability. User-centricity still seememed distant to many of the companies and the IIoT solutions were often designed with the principles of efficiency and productivity. Yet, many of the questions that the interviewees presented were related to the user and the use of the service. They often asked questions such as: "Who is it sold to?", "Will the customers take it in use?", "Will the customer be ready to pay for it?" As one of the interviewees said: "It can easily happen that the user experience is better for machines than for people." Thus, designers need to find better ways to argue and concretise the benefits of this approach.

5.3 Reflection

The IIoT has a growing importance that can already be seen in whole ecosystems, which involve a variety of professionals such as product manufacturers and service providers including design agencies. Service design is often mentioned as a development tool in the publications related to the IIoT and vice versa digitalisation and the IIoT are often mentioned in design publications that predict trends for the future. The connection is there. However, it still seems to be difficult to find concrete examples and academic writings on how service design has been used and the role of a designer in a multidisciplinary team when developing solutions for the IIoT. This thesis attempts to create understanding of the role of design now and in the future within the metal industry and in connection to the IIoT. This thesis also aims to create dialogue between the industry and the service design community and suggests better practices for future collaboration.

There are some practical limitations to this work. This research consisted of eight interviews meaning that the sampling size is too small in order to make generalisations on the machinery and equipment manufacturers of the metal industry. I also only interviewed one person from each company, meaning that I had to base the analysis on one point of view. What I heard a few times during the interviews was that if I would ask anyone else in the company, the answers would be completely different. It would have thus provided a more holistic understanding of the situation, if there would have been more time to do a more comprehensive research.

There were some other limitations when it came to the interviews. I realised that there was a risk for technobabbeling, and I had to find ways to avoid this from happening. I felt that it helped when introducing the interviewees to the study, I made it clear that I was particularly interested in their honest experiences rather than commonly accepted ideologies. Another issue that might have been present, but was not evident, was that if I got polished answers related to the questions of design as I presented myself as a student of service design. Finally, the interviews and analysis were conducted in Finnish. The material has thus been translated into English and there is a chance that the meanings and dynamics behind sentences have changed.

This research was structured so, that I wanted to let the interviewees bring up the problem areas and identify the opportunities within the IIoT by themselves. A natural continuum for this study would be to concentrate on individual problem areas that were identified in the analysis. What might be challenging though, would be to get information on a deeper level since the industry has traditionally been a relatively closed environment.

The IIoT is a contemporary issue and this thesis has been a great opportunity for me to be able to study it, and to meet with professionals from the field. This research has truly helped me to develop and grow as a designer, and I feel more prepared and confident to working with projects dealing with the IIoT in the future. I now better understand the realities and logics of the industry. At the same time I gained insight to company structures and ecosystems of the industry. I got an overview of the opportunities and challenges that the companies are dealing with at the face of the IIoT. This research also clarified the value of service design in this context and reasons for why service design methods have not been used. These findings will help me to better communicate service design and its benefits in an environment that is not familiar with it and traditionally have a technology or efficiency driven approach to project development.

As to how I am going to continue with the work that I have done so far - I would be interested in concretising the results in a way that they could be implemented into use in the form of tools, methods or a toolkit.

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7. Attachments

Attachment 1. Focus group structure

1. **Introduction**
2. **Defining the target group**
3. **Digitalisation and the IIoT**
    a. How digitally advanced are the companies?
    b. What are the biggest challenges that the companies are facing in adapting the IIoT?
    c. What are the biggest opportunities that the IIoT provides for the companies?
4. **Design and service design**
    a. How much do the companies use design? What is the role of design?
    b. What are the biggest challenges that the companies are facing in using service design?
    c. What are the biggest opportunities that service design provide in this context?
5. **Conclusion**

* The text has been translated from Finnish to English

Attachment 2. Interview questions for SMEs of the metal industry

1. **Beginning (5min)**
   - 1.1. Background of the thesis
   - 1.2. Intention, structure and length of the interview
   - 1.3. Permission to record

2. **Background (10 min)**
   - 2.1. Could you shortly tell me about your company?
   - 2.2. Could you shortly tell me which areas are you responsible for in your company? What kinds of tasks are included in your work?

3. **Digitalisation and the IIoT (20 - 30 min)**
   - 3.1. Are you familiar with the concept of the Internet of Things or the Industrial Internet?
   - 3.2. Is digitalisation or the IIoT part of the company's strategy?
   - 3.3. What kinds digital or IIoT initiatives have you had so far/ are on going at the moment?
   - 3.4. What kinds of challenges do you see/ have experienced in embracing the IIoT?
   - 3.5. What do you consider that you might need help from partners for in the transformation?
   - 3.6. What kinds of opportunities could the IIoT bring to your company? (Use cards, see attachment 4)
   - 3.7. What is the role of the IIoT in the company now and it the future? (Use printed out material, see images 5,6,7 and attachment 6)
   - 3.8. How visible is the IIoT in your operating field today and in the future?

4. **Design (20 – 30 min)**
   - 4.1. What is the role of design in your company?
   - 4.2. Have designers been involved in IIoT projects? How?
   - 4.3. Are you familiar with the concept of service design?
   - 4.4. Have you considered to / used service design in relation to the IIoT development projects? (Use cards see, attachment 5)
   - 4.5. How do you see the role of design in your organisation in the future? (Use printed out material, see image 8)

5. **Conclusion and thanks**
   - 5.1. Did I forget to ask you something / is there something you would like to add?

Attachment 3. Questions for the interview with professor Martti Mäntylä

1. What is the current status of IIoT in the Finnish metal industry?
2. What are the companies' biggest challenges in relation to the IIoT?
3. What kinds of opportunities does IIoT bring to the companies?
4. How the IIoT develop in the future, what kinds of forms will it take in 10 years?
5. What does IIoT mean for people such as employees or users of the IIoT solutions?
6. Could you name some successful IIoT products or services?

Attachment 4. IIoT cards

Tiedon tuottaminen muille Producing data for others	**Uudet tuote- ja palvelualueet** New product and service areas
Uutta liiketoimintaa New business	**Tasaisempaa liikevaihtoa** Steadier revenue
Kustomoitavia tuotteita / palveluja Customised products or services	**Unique Sales Proposition** Unique Sales Proposition
Tiedon tuottaminen asiakkaalle Producing data to customers	**Uusia yhteistyöverkostoja** New networks of collaboration

Kilpailukyvyn parantuminen

Improving competitiveness

Tiedon tuottaminen yrityksen omaan käyttöön

Producing data for the internal use of the company

Asiakaskokemuksen parantaminen

Improving the customer experience

Attachment 5. Service design cards

Asiakasymmärrys Customer understanding	**Kehittämisen toimintamalli** A model for development
Visiointi Future visions	**Suunnan määrittäminen** Setting direction
Prototyypit Prototypes	**Pilotit** Pilots
Brändin vahvistus Brand enforcement	**Visioiden kiteytys ja havainnollistaminen** Crystallising and visualising visions

Lean / agile kehittäminen Lean and agile development	**Sidosryhmätutkimus** Stakeholder research
Konseptointi Concepts	**Testaus asiakkailla** User testing
Ideointi Ideation	**Henkilöstön koulutus** Staff training
Tuote - prosessi - systeemi Product - process - system	**Osallistamisen menetelmät** Collaborative methods

Markkinatarpeen määritys Identifying the market demand	**Arvolupausten määrittely** Value propositions
Prosessien tarkastelu Process review	**Käyttäjälähtöinen suunnittelu** User-centred design
Uudet palvelumallit New service models	**Uudet ansaintamallit** New revenue models
Palvelu- tai käyttökokemuksen kehittäminen Improving the service or user experience	**Tuotteistaminen** Productising


Mittaaminen ja arviointi
Measurement and evaluation

Attachment 6. How have the company processes been digitalised?