WHEN MEANING DRIVES INNOVATION - A STUDY OF INNOVATION DYNAMICS IN THE ROBOTIC INDUSTRY

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ABSTRACT

No one nowadays dare to question the value of innovation. Indeed, several studies, from macroeconomics, to innovation economics, from strategy to innovation management, have investigated and discussed how innovation drives competitive advantage and the wealth of nations. However, in most studies, "innovation" is usually a shortcut for "technological innovation", i.e. improvement driven by technological change. There are instead multiple drivers of change, within which technology is only one (and not necessarily what builds most value) both in business and society. In this article we focus on another driver of innovation, namely the search for "meaning". Innovation of meaning is defined as a change in the "purpose" for people to buy and use products. It's not necessarily associated to an improvement in performance, but, rather, by a change of performance and the creation of a new reason for people to use things. Meanings are concerned with the "why" of use, not the "how". It is about making sense of an experience of use.

Innovation of meaning seems to be a significant driver of differentiation, as shown in Verganti, 2009, Hekkert et al., 2011, Verganti and Öberg, 2012 and in some extent also in studies on technologies (Christensen, 1997) and market innovation (Kim and Mauborgne, 2005, Moon, 2010). However, we lack a deep understanding of if and how innovation of meaning creates value, and how it shapes competition in industries. The purpose of this article, therefore, is to contribute to create a better understanding of the value of innovation of meaning. Is innovation of meaning relevant for business and competition? If so, "how" (i.e. through which assets and economics is a new product meaning contributing to create value for businesses), and "when" (i.e. in which context is innovation of meaning a more or less fruitful strategy?). These questions are not marginal and cannot rely on traditional theories on the value of innovation. If indeed technological innovation creates an improvement in performance and therefore has a direct impact on value, innovation of meaning cannot be put on a scale (i.e. it is impossible to quantitatively claim that a meaning is "better" than another meaning). Therefore assessing the value of a change in meaning implies to redefine our assumptions about the value of innovation and challenges the related theoretical frameworks.

In order to grasp the profound dynamics of innovation and its impacts on competition, our analysis focuses on a specific industry: industrial robotics. By analyzing major changes in meanings in this industry, and in particular innovations associated with safe robotics (a breakthrough in meaning for industrial robots, whose traditional meaning was of being dangerous and to be kept far from people), we show that innovation of meaning can indeed create significant value, even in an business-to-business environment that is typically considered to be driven by performance rather than by purpose. We also show that innovation of meaning may create value through

several factors. Not only sales volumes, but also, and above all, through profit margins, brand, and positioning. Even if a change in meaning does not necessarily substitute an incumbent dominant solution. This implies that, differently than technological change, that is predestined to saturation cycles, there is always a potential for creating value (or destroying value) by a change in meaning. In fact, it leaves major questions open about how to assess and capture this potential. We therefore conclude by discussing the major theoretical questions about when and how investments in innovation of meaning are more likely to create value and possible research directions, namely: what are the circumstances that make people willing to re-interpret the meaning of a product? And, conversely, what are the circumstances that make people prefer to stay within the existing meaning of a product? And most of all, how can businesses recognize these two different situations?

INTRODUCTION

"Here's to the crazy ones. The misfits. The rebels. The troublemakers. The round pegs in the square holes. The ones who see things differently. They're not fond of rules. And they have no respect for the status quo. You can quote them, disagree with them, glorify or vilify them. About the only thing you can't do is ignore them. Because they change things. They push the human race forward. And while some may see them as the crazy ones, we see genius. Because the people who are crazy enough to think they can change the world, are the ones who do."

Apple's Commercial, 1997.

A well known commercial launched by Apple Computer in 1997 shows seventeen radical innovators of the 20th century. Among them we can recognize Albert Einstein, Richard Branson, John Lennon, Mahatma Gandhi, Pablo Picasso, Thomas Edison, Ted Turner, Frank Lloyd Wright. The voice on the commercial clearly explains what they share: they have practiced a life of thinking differently. "Different" in their case does not imply "better": not by one order of magnitude and not even by ten orders of magnitude. Different instead implies that they changed the frame of reference in which things were judged and assessed. They changed the meaning of things, the "definitions" of what things are: the "why" before the "how". Picasso's paintings were not "better" paintings, i.e. more precise descriptions of nature or humans. They were different interpretations of what art is. So different that his creations (as well as the creations of all other personalities of the commercial), where considered to be strange, crazy, even wrong by incumbents in their fields.

This type of innovation, based on the change of meanings, occurs also in businesses and markets, even if it is often disregarded in innovation studies. And Apple, the promoter of such commercial, has been indeed thriving thanks to its capability of innovating the meaning of products. They have changed the meaning of digital music from portability to accessibility, and the meaning of smart phone from business tools for being connected to personal entertainment devices.

Innovation of product meanings does not spring merely from technology nor from transferring solutions to new markets. Instead, it is driven by the search for *meaning*, which is the *"purpose for users to buy and use products"*. Meanings are concerned with the "why" of use, not the "how". It is about making sense of an experience of use, and therefore connected to artifacts as products or services and the system surrounding them.

Scholars in different fields have discussed that people buy meanings (Levy, 1959, Csikszentmihalyi and Rochberg-Halton, 1981), and that product meanings can be innovated (Heskett, 2002, Norman, 2004). Indeed, early studies show that innovation

of product meanings occur in every industry and markets (Verganti, 2009, Hekkert et al., 2011, Verganti and Öberg, 2012, Jahnke, 2012, Norman and Verganti, 2012): beyond the examples of Apples previously mentioned. Yet, although there is early evidence that innovation of meaning may be a source of competitive advantage, we lack a deep understanding of if and how innovation of meaning creates value, and how it shapes industries. The purpose of this article is to contribute to create a better understanding of the value of innovation of meaning. Is meaning a relevant driver of innovation compared to technological innovation or market change? When does it constitute the best option for a company? More specifically, our research questions related to the value of innovation of meanings are:

- "How" does innovation of meaning occur? I.e. Through which assets and economics is a new product meaning contributing to create value for businesses?
- "When" does innovation of meanings occur? I.e. In which context is innovation of meaning a more or less fruitful strategy?

These questions are not marginal and cannot rely on traditional theories on the value of innovation. If indeed technological innovation creates an improvement in performance and therefore has a direct impact on value, innovation of meaning cannot be put on a scale (i.e. it is impossible to quantitatively claim that a meaning is "better" than another meaning). Therefore assessing the value of a change in meaning implies to redefine our assumptions about the value of innovation and challenges the related theoretical frameworks.

To address those questions, the article starts by providing a definition of what innovation of meaning is and what its peculiar nature is. Then we overview existing theories on the value of innovation and show why these theories does not perfectly allow to capture the value of innovation of meaning. This leads to the need of providing a new lens to understand the relevance of innovation of meanings and therefore to our empirical investigation, which we focused on the industry of industrial robotics; purposefully chosen by the need to explore meaning in an extreme unfavorable case: a business-to-business market, where meanings would be assumed to be less relevant than technology as a driver of innovation. We discuss the impact on this industry of two breakthroughs in meanings: the Robocoaster, a new riding experience in amusement parks where robots are used for entertainment and in close contacts with humans, and the Da Vinci system, an application of robots in surgery, where again robots are interpreted as a mean to save human life instead of being harmful. Both innovations were considered to be "crazy" by incumbents, and both ended up being successful. We discuss the impact of these innovations in the industry, and the value for their innovating companies. Finally we discuss implications for a theory of the value of innovation of meanings and directions for future research.

INNOVATION OF MEANING: DEFINITION AND NATURE

"Meaning" is a delicate and broad concept. The definition of meaning could clearly give a plethora of answers relating to as vast fields as philosophy, psychology, theology, anthropology, and semiology. And indeed the dictionaries give a multitude of definitions. Being aware of this complexity (a discussion of which is provided in Öberg and Verganti, 2012) our acceptation of the term is focused and specific. We refer to the meaning of a *product or service* and the *meaningful experience* that a person has when interacting with it. We align with the thoughts of modern philosophy where it is up to the *individual* to decide what meaning is. Therefore, a meaning is not always explicit and obvious. It spurs from the experience and practice of an individual

but it is also connected to society, technology and culture. And because of this, an individual alone cannot construct a meaning; rather, it is a co-development between an individual and other actors in a context. It is a value created in - and over - time and therefore not constant. A meaning, in this sense, is something that is partly a personal interpretation but also socially constructed (Berger and Luckmann, 1967).

As previously stated, scholars in design (Krippendorff, 1989, Margolin and Buchanan, 1996, Heskett, 2002, Karjalainen, 2003), cultural anthropology (Holt and Cameron, 2010), sociology (Baudrillard, 1986), psychology (Csikszentmihalyi and Rochberg-Halton, 1981) and marketing (Levitt, 1959, Peterson et al., 1986, Hirschman, 1986, Fournier, 1991, Sheth et al., 1991, Zaltman, 2003) underline how people give meaning to things and products. Every product or service has a meaning and can be innovated. Consider for example the industry of industrial robots. A common view of a robot is a machine that moves fast and precise in a repetitive manner. It normally carries heavy loads, assembles components or move goods around from one point to another, but it is also capable of painting for example cars, cut out pieces from different materials or rub and polish surfaces. Innovation in the industry has mainly been driven by technologies enabling rapid and more precise movements. At moments, also by entering new domains with these multi task products. However, another dimension has also driven major changes in competition: the change of the meaning of what the purpose of an industrial robot is. For example, whereas early applications of robots were meant to *substitute* human labor in heavy duties (i.e. to provide strength and energy to production), more recent applications, based on sophisticated software applications, are meant to *enhance* the capabilities of workers, without substituting them, but rather, by providing more intelligent ways of designing and managing plants (to provide brain and intelligence to production). Innovation of meaning however has a peculiar nature that differs from technological or market innovation (see Figure 1), namely:

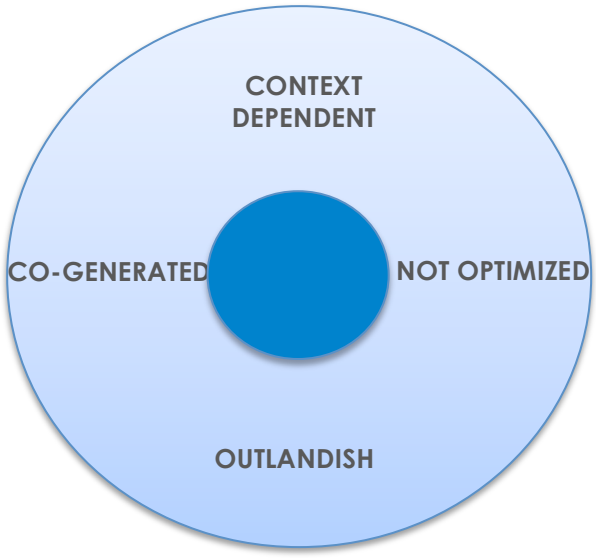

Figure 1 The Nature of Innovation of Meaning

- *Being context dependent*. Technological innovation implies to search for solutions that can (almost exclusively) be technically described. Innovation, in this sense, is dominantly directed to finding a solution with a better performance. Innovation of

meaning, instead, implies to step back from a close focus on the problem at hand, and consider the overall user experience - beyond the specific interaction with a product. By reinterpreting the relationship between the product and the surrounding context, an innovation of meaning redefines the purpose of this product. The novel interpretations come when a company has the capability to see both the parts (the individual events, one of which is the product at hand) and the whole (the overall user experience, which is the envisioned course of action). Innovations of meaning are therefore context dependent. It is not about designing a product, but about designing a scenario and experience that occurs in a specific context.

- *Being not optimized.* Another major characteristic of innovations of meanings is that they cannot be optimized. Meanings cannot be put on a scale. They belong to an ever-shifting sphere of knowledge, opinions, news and proposals. Their nature do not fit with the dominant theories that see innovation as problem solving and as a process of progressive reduction of uncertainty and that assume that there is an optimal solution out there, that just need to be founded.
- *Being outlandish*. Developing a radical change in meaning implies to overcome dominant assumptions about what a product is meant for. It implies to question the existing socio-cultural paradigm. Proposers of breakthroughs in meaning often appear as strange, bizarre, crazy, because they moves on different dimensions and purposes.
- *Being co-generated*. A radical change in the meaning of things hardly emerges as an answer to a clear market need. In contrast to most theories of innovation that advocate a closer look to users in order to realize innovation, a radical change in meaning implies to step back from current needs and propose a new vision that is still not existing in the market (Verganti, 2009).

THE RELEVANCE OF INNOVATION AND ITS IMPLICATIONS FOR MEANING

Early studies on innovation have dedicated much effort on investigating the value of innovation. However, in these studies, "innovation" is usually a shortcut for "technological innovation", i.e. improvement driven by technological change. Studies in economics have focused mainly on the impact of innovation on the growth and wealth of economies (Kendrick, 1961, Rogers, 1962, Mansfield, 1968, Lederman and National Science Foundation (U.S). Office of Economic and Manpower Studies., 1971, Terleckyj, 1974). Innovation in this stream of studies is mainly driven by technology and its impact is on growth through improvements of productivity functions. Studies on strategy and management of innovation have also mainly focused on the value provided by technologies and its differentiating power (Abernathy and Utterback, 1978, Porter, 1985, Utterback, 1994, Tuschman and Anderson, 1986, Andersson and Tuschman, 1991, Christensen, 1997).

All these studies assume that innovation creates an improvement in performance, and this improvement in performance is associated with an increase in value (or, in other words, in the utility function of users). Whilst this assumption may apply to technological innovation, a change in meaning is not necessarily associated to an improvement in performance. Rather, as discussed above, it stems for a change of purpose that is a redefinition of the performance dimensions. These theories therefore hardly help to explain the value of innovation of meanings. Also those studies that move beyond technologies to investigate the value of innovation (Abell, 1980, Kim and Mauborgne, 2005, Moon, 2010) explore more changes in markets than in meanings.

Studies that more closely connect with investigating the value of innovation of meanings are those related to the analysis of the value of design. Indeed, some scholars consider design as an activity of "making sense of things" (Krippendorff, 1989), and therefore design as the innovation process concerned with the redefinition of meanings. Unfortunately however, notwithstanding a growing stream of literature on assessing the value of design, analysis of the strategic relevance of design and its impact on industry dynamics are still mainly anecdotal (Roy, 1994, Trueman and Jobber, 1998, Wallace, 2001, Rich, 2004, Bedford et al. 2006). Those studies that move close to quantitative analyses, instead shift into classical analysis of performance improvements (Swan et al., 2005, Chiva and Alegre, 2009), or look more at the aesthetic dimension of design, i.e. form and style (Gemser and Leenders, 2001, Creusen and Schoormans, 2004, Hertenstein et al., 2005, Rindova and Petkova, 2007, Talke et al., 2009), which is only one of the possible many instantiations of innovation of meanings (for a comprehensive review on issues related to research in design see Ravasi and Stigliani, 2012, for a specific review and research agenda on measuring the value of design see Candi and Gemser, 2010).

Therefore, as existing theories on the value of innovation do not fit with the peculiar nature of innovation of meanings, and as studies on design only provide a possible direction to come closer to this nature, still we miss a framework that can help us to understand how and when innovation of meaning is relevant for competition, and, most of all, that analyzes its impact on value beyond anecdotic evidence.

METHODOLOGY

We have carried through a qualitative, retrospective case study, consisting of three different but parallel investigations. First, companies within the robotic industry were visited, discussions took place and workshops were held to identify suitable cases for exploring the phenomena of innovation of meaning (see Wikström et al, 2011 for a thorough explanation of the methods used). The output was then discussed within our research group where field notes from two and up to five researchers (with different backgrounds and experience) were compared. In parallel, we also discussed the findings with the companies to be able to select two of the major radical innovations in the industry for further research.

Second, these cases were studied in depth through semi-structured interviews, secondary data and follow up discussions. The interviewees represented different parts of the organizations, like pre development, product management, software engineering as well as corporate research innovation management and sales. We collected data on the innovative strategies of these firms, both on a general level but also concerning the specific case. The material has then been subject to a *pair analysis*, where the behaviors of two different firms (confronted with the same opportunities/challenges and within the same industry) have been compared.

Finally, the innovation of meaning in the industry as such has been examined in two contexts, the traditional market of robots for manufacturing and, the applications of industrial robots *outside* of manufacturing context. Every context has been investigated on two dimensions: the innovation of meaning on one hand (connected to meaning change but also technology and social changes) and the competitive performance on the other (relating to success factors as sales, margins, competitive advantages and market share). This part of the study has also been enriched by the study of robotics and meaning by two master theses in innovation management.

The findings have resulted in a map showing the development of technology within the robotic industry and relating to innovations of meaning, from the 70s up to todays

date. In order to check our interpretations of innovation of meanings and the industry dynamics, the map has been discussed and iteratively refined with experts of robotics and automation within academia, industry and associations working with more radical robotic initiatives.

WHAT IS INNOVATION OF MEANING?

The Robocoaster

We will now take a closer look at two cases within robotics. Our first case starts off at KUKA Robotics in Germany and a robot called the Robocoaster. The story starts from the perspective of an employee that, after 30 years within the same industry, wanted to do something else. He found himself in a very stressful career path and he made a conscious decision to change his life and approach to business. In this moment, he merged his professional knowledge with a personal passion. Since childhood he had always been a theme park enthusiast. He had always enjoyed looking at the structures of rollercoasters and other attractions. And, he had come to understand that the new trends of amusement rides pointed towards *interaction* instead of *surrender* oneself to the power of "g"s (gravity acceleration). In parallel, he had also found that the existing technology for attractions like rollercoasters seemed old. Taken together, the interest for amusement rides and the knowledge of robotics formed an idea about an interactive passenger-carrying robot that could move humans around in a fun and unpredictable way. With this idea in mind, he carefully studied both the market for robots and the amusement park industry. But, nowhere was this type of solution to be found. Robots were simply not used on the field of amusement parks. Filled with his ambition to create a new roller coaster, a *robo*-coaster, he left KUKA in the late 90's and started his own business. The "RoboCoaster" was a dream coming true, but it was not a one-man work. It came to be a close development project with his former employer, KUKA.

The meaning change

The Robocoaster is, from a technologically point of view, nothing incredibly new. It is an adaptation of a standard robot, the KR 500 by KUKA, integrated with a software application and a two persons-seat in the end or the robotic arm. Normally, this robot is used in car manufacturing sites, but in this case, instead, the passengers can program their ride themselves before entering. Every ride becomes unique, be it easy and gentle or scary and fast, depending on personal taste, courage (and insanity!) Connected to the robot is a whole range of add-ons, like a cover for the seat, laser guns, screens, sound, LED-technologies etc (for a more detailed description see Öberg and Verganti, 2011).

From the traditional role of robots as "substituting humans in heavy labor" (as lifting and moving objects in for example car assembly) the Robocoaster instead, uses its power to lift humans around in amusement parks. From the old meaning of an efficient, reliable and predictable robot, the meaning has shifted to a fun, not at all predictable and interacting robot. It does not follow the dominant assumptions of what a robot should be meant for, but instead, it offers something different. It proposes interaction with humans instead of substituting them and it plays on emotions rather than being highly efficient.

The value

The Robocoaster is a company that has been around for ten years, with increasing sales and significant margins. But, to competitors, this product did not follow the

dominant argumentation of "high speed" or "performance". As a consequence, not a single company in the business recognized the value of this type of product, and Robocoaster is therefore still without competition since the launch in 2003. Nevertheless, the concept of delivering "emotions" has proved valuable in several ways:

Growing sales: First, the product shows growing sales since the launch in 2002/2003 when the first ten Robocoasters were delivered to Legoland Billund, Denmark. In total over two hundred systems will be sold by the end of Q2, 2012.

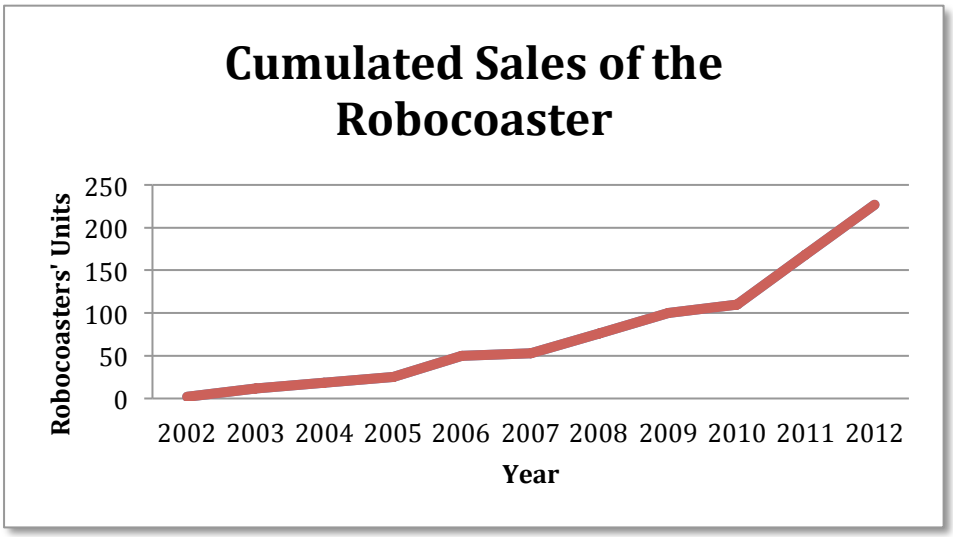

Figure 2 Cumulated sales of the Robocoaster

Rendering high (-er) value: Second, although sales are rapidly growing, the potential size of the markets is still small compared to traditional robots. KUKA, for example, sales about 10 000 -12 000 robots a year, while the Robocoaster sells merely about 50 systems yearly. But, the margin of a general manufacturing robot is very low. Sometimes, it can even be negative, as robotic companies sell robots with a loss to penetrate the market. The Robocoaster instead, derives a significant margin, due to the embedded safety systems and know-how. One Robocoaster represents approximately ten times the margin of one general manufacturing robot and therefore generates a much higher value. Also, the growth margin (as in the additional sales of end-of-arm devices like grippers, press tools or paint or welding guns) is close to zero (about 2-3%) for a "normal" robot while the potential to sell additional system elements are significant for a Robocoaster (there are many applications and add-ons possible, like media systems, complex transporters, customized safety elements and software systems).

Mastering additional sales: Also, differently than many robotic manufacturers, the company is fully in charge of a range of applications to their product. They manage to deliver adjusted solutions that are well integrated to the external systems of the clients. In the majority of cases of traditional robotics, these services are provided by so called "system integrators", companies external to the manufacturer. But, in the Robocoaster case, the delivery of key embedded technologies and customized solutions are all under control of the mother company and therefore generate additional sales.

Rendering value to new fields: In addition, forecasts in the amusement park business indicate that investments connected to the Robocoaster (like 3D solutions

and software/hard ware combined systems) will increase significantly, from 8 to 15 %, over the coming years (TEA/AECOM 2011), while the investments in real big constructions (like rollercoasters) will decrease. The appetite of amusement park visitors seems towards so-called "Media Based Solutions" (and water based rides!) rather than the classic rollercoasters, where there is a downward looking trend.

Considering the above parameters, the Robocoaster cannot be considered as a trivial and not valuable product. It has a proofed value both from the perspective of the robotic industry (as in sales, margin and additional sales) but also, it contributes to the development of attractions (and sales) in the industry of amusement parks.

Social change and technology

The birth of the Robocoaster was, not an instant idea, nor a result of intense brainstorming. It was not an answer to an explicit need or to a stated problem. Instead, it emerged through several streams of investigation. First, being a roller-coaster fan, the KUKA employee followed the trends of amusement parks and he could see that the need of interactive attractions grew stronger. Simultaneously, he found the technology around for attractions old fashioned. In addition, the "bigger, faster, higher" mentality (that had been dominant among amusement parks in search for new attractions) seemed to be falling, in favor for more human centered attractions. Investments in attractions competing on the amount of "Gs" (like "big, scary rollercoasters that only the "Die-hard" would dare") were declining and no longer on the peak. Taken together, this employee was open to, and embraced, several social dimensions external to his main industry, the robotics. Technology wise, there was nothing visibly new around, though. Instead, there was apparently, something hidden in the existing technology, namely, the capability to create joys and thrills rather than efficiency.

What happened, is that while technology *within* the industry remained the same, social and cultural changes emerged, as they always do. In this case, they were connected to amusement rides and to advancements of technologies in other fields, like media/software and screens. The former KUKA employee managed to capture theses changes, and interpret them within his field of expertise. Moreover, he managed to make his former colleagues aware of and interpret these social changes as well – to the extent that they were convinced to invest in the development of the coming Robocoaster project. But, how come KUKA managed to recognize the value of swirling humans around in a heavy-duty robot? While competitors did not?

The dynamics of the industry

At KUKA in Augsburg, Germany a lot of things happened at this time. Instead of the dominant perception in the industry of "people and robots should be safely kept apart" a new more human oriented strategy was under development. Instead of separating humans and robots, the new approach at KUKAs headquarters was "the more integrated the interaction, the better it is". Through the development of embedded software systems, KUKA, was trying to create *safe* robotics, still with optimal efficiency. In addition, KUKA had a very progressive management board, an influx of young people with knowledge about robotics - but not from within the industry itself. This management was very "German" (quote from the founder of the Robocoaster, being British-Italian!), they were "meticulous about detail and obsessive about safety". Aware of this, the employee presented a very comprehensive and rich proposal to the management board. The business case of the Robocoaster included all possible dimensions. It was strategically, technically and commercially "correct". It

showed a viable strategy with upcoming costs, market penetration, risks and certification issues all well presented. And of course, no one had ever heard about a seat connected to the robot! The proposed "Robocoaster" was considered a joke.

(Actually, one of the major competitors consciously said no to develop a similar robot, arguing that it was considered too dangerous. Potentially, if something went wrong, a robot like this could kill people. This competitor chose to avoid the risk to be associated with severe accidents. They made a clear decision not to invest in this direction….) But, as KUKA was already "half-across" the bridge with their works on safe robotics connected to humans and software, and as the business case was so rich in its coverage, the management board was convinced that the Robocoaster would be accepted on the market. And so, the development of the Robocoaster could begin.

With a mindset that was already "open" to connections between human and robots (a "no-no" to many competitors) KUKA did not only manage to embrace the potential in the Robocoaster case, they also used this ability in coming projects. Today, the most important value of the Robocoaster, is not the robot itself, but he impact it has created on the strategy of KUKA as a new thinking and "to other industries" open company. Starting from serving the amusement park business ten years ago, KUKA is now working intensively in for example the medical domain. We will now take a look at one of these cases, the Da Vinci, a robot connected to surgery of the human body.

The DaVinci system

As earlier mentioned, in the early 2000s, KUKA increased their focus on the human-machine dimensions, not by improving technology of movements (a very expensive exercise) but by developing software technologies. The vision was to make robots "safe", not only interesting for the existing customers but also appealing for home-applications and to hospitals. This human-close vision gave to the robots a new language. If the former robots delivered on accuracy and stiffness by their heavy constructions, the new and smaller ones came to express a lighter, softer and less accurate perception. They came to be used for completely different production systems, for example, the delicate mounting of the gears on the new generation of Mercedes.

Together with the very demanding safety certifications of the Robocoaster, the new human-close strategy led KUKA towards new applications. One came to be the Da Vinci system, developed in cooperation with the company Intuitive Surgical. This system is used for endoscopic surgery of the human body and it consists a combination of a robot, several cameras, a remote connection and, of course, a surgeon. By leveraging a high-speed connection, the knowledge and expertise of a surgeon could, from now on, be mobilized through the "hands" of a robot. The doctor, actually, did not have to be physically present but could operate remotely. In the vast majority of cases, this meant that the surgeon is still in the same building (but operations have been taken place as far as 620 kilometers form the patient).

Indeed, this remote surgery procedure might appear a bit scary at a first glance. But, there are several advantages. First, the expertise of the surgeon can assist more surgeries as she or he can work on a distance, without being forced to travel to the patient (or the other way around). Second, the career of the surgeon is extended since the robotic systems helps to prevent shaky movements of the hands of the surgeon, a problem that arrives with increasing age of the surgeons. Third, on the "orders" of the surgeon (by voice control), the robotic systems performs with the same precision time and time again, something that leads to increased patient safety. In other words, the risk of mistakes due to the "human factor" decreases.

The meaning change

When KUKA started to deliver the new, more sensitive robots (mainly for the automotive industry), their robots, gained a new, additional position: from *accuracy* (within traditional application fields as welding), to *possibility* (handling different systems connected to client) to *sensitivity* (precise and detailed assembly). A new emerging meaning of sensitive, almost intuitive, robots was under development. This meaning grew even more profound when the sensory skills of the robot evolved through the context of surgery. The meaning changed from sensing "hardware" (as in the gearbox of a car) to sensing the flesh and tissue of a human body. Suddenly, the meaning of a robot changed radically, from the extreme notion of replacing humans to the more humble approach of interacting with them, even saving a human life. Again, by understanding the context and connecting to new and/or different technologies, KUKA managed to innovate the meaning of their technology, in this case by leveraging the idea of remote surgery.

The value

The Da Vinci system could be considered a very dangerous and unpleasant idea. Only the idea of surgery, as such, normally creates stress to a patient. Knowing that the surgeon will not operate herself, maybe not even being in the room, understandably, raises the level of stress even more! Also from a surgeon's perspective, the change in the meaning is significant. From being totally in charge of the operation, the robot now perform the movements (while the surgeon still control the process). In this way, the system implies that a robot, actually, can be better than a human during surgery. Despite placing surgeons in a new position, the Da Vinci system is up and running since it was approved by FDA (The Food and Drug Administration) in 2000. It is used for cardiothoracic surgery, gynecology, urology, pediatric and general surgery by hundreds of surgeons all over the world. Also, it serves the purpose of training coming surgeons. One domain that has gained important advantages of the system is the prostatectomy where the surgery wait time is significant. Within this field the number of surgeries have increased from less than 10 000 in 2003 to more than 70 000 in 2008, with the help of the robot adjusted system.

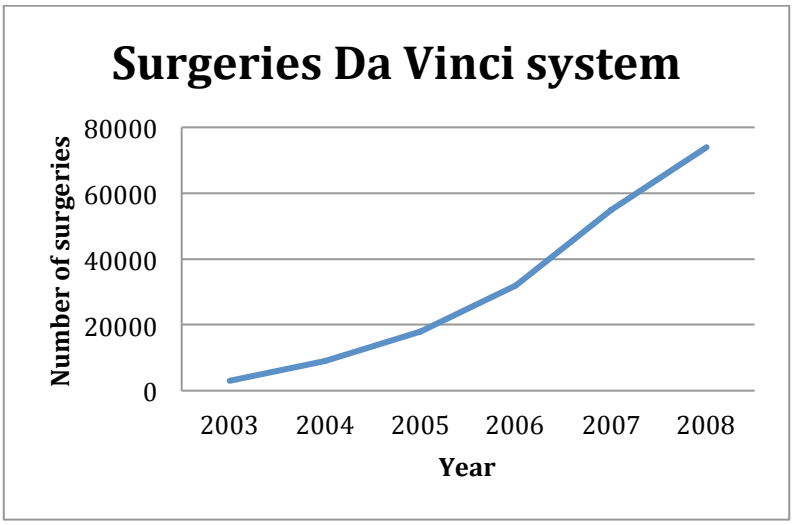

Figure 3 Surgeries performed with the Da Vinci system

Additionally, the Da Vinci system has gained a large share of prostatectomy surgeries when compared to other systems. From a non-existent position in the early 2000s, the system has been dominating from 2004 and on. From a business perspective, the idea of bringing robot technology in contact with and even, within, the human body seems to have resulted in several advantages.

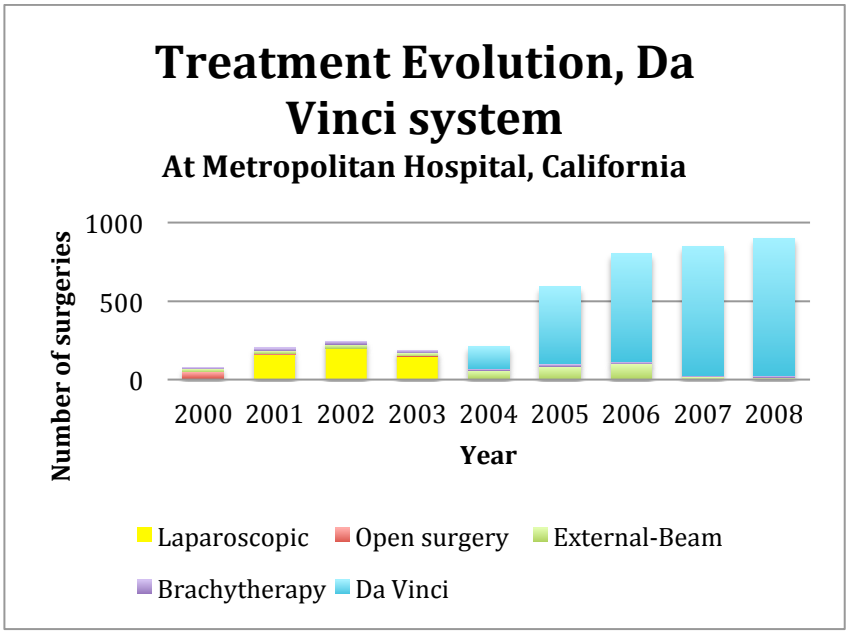

Figure 4 Different types of surgeries within Prostatectomy

Social change and technology

The move of KUKA towards medical systems did not happen by chance. Instead it fitted well into the evolvement of technologies for surgery equipment. But, when the company entered the field as a new player – they did not do it alone. They did it in cooperation with another established company, Intuitive Surgical, with the right know-how. Still, to be able to contribute to the work of surgeons, KUKA itself, had to understand the basic conditions and reasoning behind surgery. They had to consider both technological changes but, never the less, also social changes connected to modern surgery.

One basic understanding was the focus on improving the cameras used for *endoscopy*. The great advantage with this procedure is that the surgeon can operate with long, thin instruments and a small camera - without making major cuts and therefore putting less stress on the patient. The disadvantage of this technique, though, is that a surgeon needs an assistant to control the camera that exposes the picture on an external screen. As a result, the surgeon looses control over the camera and also on her or his hands when examining the screen. Understanding these basic conditions, KUKA could start comparing their robot technology with the existing surgery equipment systems. Taken these technological conditions into account, they also took time to investigate the *social* dimensions of surgery. These included the fact that more and more people were in need of surgery, that surgeons were under constant time-pressure and that the career of theses valuable surgeons was shortened due to shaking hands with growing age. In addition, KUKA also had to grasp the attitude towards non-manual systems in contact with humans. For example, would a robot-based system really be accepted within surgery?

KUKA realized that there were already solutions to control and steer the camera with high precision and endurance by letting the surgeon using pedals or voice control. There was also equipment to control the incisions. But there was still room for improvements. The certified movements of a robot could, indeed, improve surgery by leveraging even higher precision and a more intuitive feeling than the existing systems. In addition, the technology also allowed a remote control of the robot that opened up for new ways of performing surgery on a distance. With these possibilities at hand, KUKA managed to deliver a robot that has become very valuable within surgery. They did it despite internal doubts and struggles by carefully relating to and leveraging both technological and social changes.

DISCUSSION

The study of the value of the Robocoaster as well as the Da Vinci system gives insight about the dynamics of innovation *within* the industrial robotic industry. But, it also allows the perspective of the *new* markets. As a result, it has helped us to shed light on the value of innovation of meaning.

Innovation of meanings creates value

First, both the cases of the Robocoaster and of the Da Vinci system show that innovation of meaning can have a significant impact on the competitive dynamics of industries and may create significant value for businesses. Both firms have economically profited from the innovation, with an impact on industry and on assets that have taken different forms. In the case of the Robocoaster, the change in meaning has generated a totally new business. The value is not only in terms of sales (still small relatively to established markets, although with a steep and steady growth), but also and especially in terms of margins (that are one order of magnitude higher than in robots for manufacturing). The benefits are also in terms of competitive assets, as this innovation enables KUKA to appear as a forerunner in applications of safe robotics outside traditional markets. This brand identity allows KUKA to attract clients who are looking for an industrial partner that is open to pioneering applications of robotics outside of known lands (indeed KUKA robots are increasingly adopted in various fields, such as trash sorting for recycling purposes or micro soft assembly). Innovation of meanings therefore has a significant impact on the capability of firms to continuously open for new opportunities, being an innovation that inherently moves outside existing trajectories. The advantages of innovation of meaning are even more evident in the case of the Da Vinci system, where the new application is dominating the industry, as it is almost totally substituting the old procedures in certain fields of surgery. What is interesting is that innovation of meaning can redefine the dynamics of competition even in business-to-business industries such as industrial robots, where clients are not end consumers, but institutions. Of course, we do not mean that any attempt to innovate the meaning of things generate value. There are also failures in understanding meanings, and not all new proposals of meanings turn into a success (for example, early attempts to redefine the use of robots in many fields, such as in households applications, have failed until now).

There is always a potential for (at least one) innovation of meaning

Whereas a positive answer to our first question (Does innovation of meaning creates value and how?) emerges clearly from the analysis of the cases, our second question (When does innovation of meanings create value?) requires a deeper reflection.

Why did these two innovations occurred? Is there any contextual factor that explain their success, and without which those innovations would have never happened?
The answer is not immediate. By looking at those two applications, and by complementing this with a broader view at the evolution of industrial robotics in the last 30 years, we can observe that (1) there have been several changes in meanings in the industry. These changes are limited in number (innovation of meaning does not happen frequently), but punctuate the entire history of the industry; (2) there was no clear contextual factor that is related to those changes, not a clear market demand: most of these innovations do not come from an explicit market need, but they are the result of a vision put forward by a company (there was no explicit request for a Robocoaster, and the meaning that robots can be better than a surgeon was an outlandish statement in healthcare).

These two considerations seem to point into one direction: it seems that there is always a potential for an innovation of meaning, without a specific condition explaining what are the circumstances that prevent it or make it more or less fruitful. This statement, differs from what we can find in innovation studies (especially those related to technological innovation). Indeed, there is a profound difference in the dynamics through which investments in technologies and investments in meanings may create value. We can illustrate this difference by using a metaphor of "climbing hills" and "searching for islands" to represent the process of search for solutions (see Figure 5, adapted from Norman and Verganti, 2012).

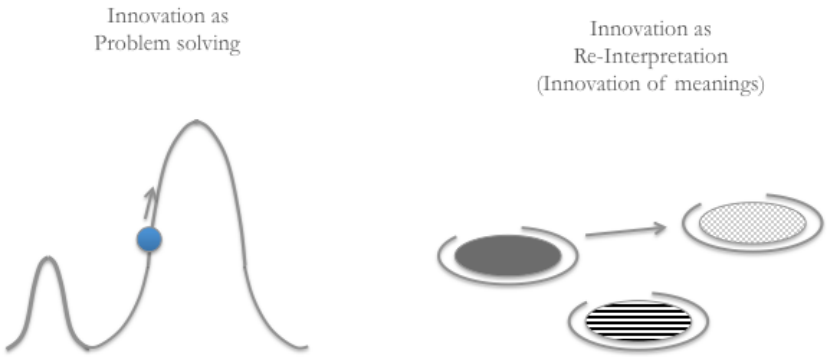

Figure 5 The value of innovation as problem solving versus innovation as re-interpretation (Innovation of meanings)

- Technological innovation may be described as a process of problem solving based on optimization: it aims at improving performance by finding a better solution to a defined problem. In other words, it can be described as in the left diagram of the figure: as a process of climbing up a hill where the height of the hill represents a better performance. In this process the solver knows when a solution is better: it happens when the solution allows to move further up in the hill. In this process of "moving upwards" technological innovation is associated to a process of saturation: at a given point it reaches the top of the hill. This is due to two combined phenomenon. 1) the saturated (s-shaped) relationship between investments in technological research and increase in performance: at a given point optimization reaches a limit (a local maximum). To get to a better solution one should jump towards a higher mountain and 2) the progressive transformation of the relationship between performance and value, as explained in the Kano model (Kano et al., 1984): when a new performance is proposed and improved, it usually acts as a major delightful differentiator: small

improvements in performance turns into relevant increases in value. Later however, the relationship becomes linear, and eventually flat: the feature becomes a "must-have" and improvements in performance (even the most radical jumps) are not associated anymore with increase in value. Along this process of optimization the challenge in technological innovation is to find the solutions that allows to move further up until the maximum, but the existence of this better solution is always uncertain. It is not clear if one has reached the top of the hill or there is another higher hill further away. Innovation of meaning instead works differently. Since meanings cannot be put into a scale, their innovation does not move uphill in a process of optimization, but rather it changes the purpose (e.g. the structure of value). In other words it can be seen as a move to a different island or a different planet. Furthermore, meanings are not subjected to saturation, since they are not connected to filling the gaps between needs (the higher hills to be reached) and existing solutions, but about creating new dimensions and new purposes. Even if a person is satisfied with what she has, a new meaning may always emerge and be proposed. This implies that there is always the potential for a new meaning: new meanings can always be envisioned without incurring into a process of saturation. In our analogy, there is always room for new planets and new islands, even if one feels comfortable with the place where one currently is.

- Technological innovation tends to lead to one dominant solution. Indeed many studies have shown how technologies tend to coagulate competition around dominant designs (Utterback 1994), where the winner takes (almost) all. This is implicit in the process of optimization that pushes towards the best solution for a given performance. In our analogy with hills, once a higher hill is found - then every rational decision maker moves towards that optimal solution. As meanings instead cannot be put into a scale, and purposes differ in culture and society, several successful meanings can coexist without necessarily one becoming dominant (this for example has been demonstrated in fashion – Cappetta et al 2006 - and in furniture Dell'Era and Verganti 2011). This implies that indeed, there is even the potential for more than one possible winning innovation of meaning. In our analogy, there are several islands, each one with its own inhabitants.

The challenge of innovation of meaning is value recognition

As said above therefore, there is always a potential for one (or more) innovations of meanings. This does not implicate, however, that any investment in innovation of meaning lead to an increase in value, even if the solution found is theoretically a "better" solution. The reason for this is that even if there is always a chance to change the meaning of things for "the better" (in terms of potential return on profitability and competitive position), it is hard to understand the value of a proposed new meaning. Being a change in meaning (a change towards a new attribute in the Kano's model), it is difficult to predict what the relationship between that attribute and its value will be, unless a firm reframes its interpretation of what could be meaningful to people. Therefore, in technological innovation uncertainty concerns the *existence* of a solution - not its value (we do not know if the solution to move further up exists). With innovation of meanings, instead, uncertainty does *not* concern the existence of better solutions (there are always new possible meanings, as there always are new islands and new planets) - but the *recognition of the value*.

Of course, there are criteria to investigate whether a proposal for a new meaning could be a success in the market or not. In particular, in the field of design, and especially of human centered design, a useful concept is that of *affordance* (Gibson

1977 and 1979). *Affordance* refers to the relationships between the world and an actor: whether a person can "afford" an object. Affordances of new objects should therefore be in line with the socio-cultural environment in order to be accepted by people. Note that we do not talk about users and products here. A new product could be in contrast with existing affordances of products that are already on the market. For example, the Alessi's lemon squeezer, designed by Philippe Starck, is hard to use, and frankly, it does not squeeze lemons properly. But, in any case the product should be in line with the affordances in the *life* of *people*. In this case, the lemon squeezer is in line with people's search for affective objects. Investigating affordances in peoples' life of course requires more complicated and sophisticated analyses than understanding user needs in a given market.

The value of innovation of meaning is not an exogenous variable

The fourth big difference between innovation of meaning and technological innovation concerns the possibility to influence the value function. In other words, in technological innovation, value and in particular the relationship between performance and value, is considered to be an exogenous variable: it's out there in the market and it needs to be understood. In innovation of meanings the value function instead is an endogenous variable: the value of an innovation of meaning is co-generated between people and firms that propose the innovation (see our description of the nature of innovation of meanings). Its value therefore depends also on how a firm design the product, how it presents it, how it seduces people through its proposal. Which means that a very committed innovator with a strong vision can, in innovation of meanings, be more successful than a non-committed innovator whose meaning is potentially better. The story of the Robocoaster shows how the new meaning of robots in entertainment was not an answer to an explicit market demand, but a vision of an entrepreneur whose commitment and passion eventually transformed the meaning people give to robots. Coming back to our metaphor of the island: the island is not out there to be discovered, but is created by the company that makes the proposal. You can create affordances and you can even have an impact on the socio-cultural environment through innovation of meaning. Therefore, searching for innovation of meaning does not imply to look for a new island with traditional binoculars, but to *envision* a new island that is not there yet, through binoculars with an augmented reality funciton: the background is real, but the island is built on top of it. The power of the innovator and its vision is therefore enormous with innovation of meanings.

CONCLUSIONS

In this article we have explored the value of innovation of meaning, i.e. the change on the reason why people buy and use products. By focusing on the dynamics of innovation in industrial robotics, and in particular on the transition to safe robotics epitomized by the Robocoaster (a new ride in amusement parks based on robots) and the Da Vinci system (a robot supporting remote surgery), we show that innovation of meaning **can have a significant impact** on an industry and generate significant profit for the innovator. Nevertheless, understanding the circumstances that make innovation of meaning valuable is an intricate matter. Different than technology-based theories of innovation, it appears that **there is always a possibility to create one and even more profitable innovation of meanings**. Meanings are not subjected to saturation and to limits in searching for solutions. The problem however is that even if there is always a potential for a new meaning, it is hard to discern between promising and unpromising meanings. Investments into innovation of meanings therefore are

subjected to high risk and uncertainty as it is for technological innovation, but for a different reason: not because of the risk of not finding a solution, but because of the risk of not **understanding what is the right direction**. Discussing the value of innovation of meaning is even more challenging if we consider that this value is **not an exogenous property of the market, but is co-generated by people and the company** that create the innovation. The value of innovation of meaning, in other words, does not depend only on characteristics of the market or of the innovation itself, but on the vision of who is proposing the innovation, her commitment and strategy to propose the new meaning. This opens up the need for further research on the relationship between affordances in the life of people (what people can really afford, accept, and when people is willing to change for new meanings), how companies can complement them, and the socio-cultural environment in which meaning is given. One major question for example is: how often can people afford to radically change the meaning they give to products? What is the relationship between frequency of change in meaning and probability of success? When do people want to stay where they are, even if they recognize an offer that is apparently more meaningful? These are questions that hopefully will inspire new research.

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