Master Thesis

Valorising the potentiality of new (and existing) technologies by identifying new applications

Politecnico di Milano - Faculty of Industrial Engineering

A dissertation submitted for the degree of Master in Management Engineering

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Executive Summary

This thesis aims at providing a methodology that can support companies in defining innovative applications, seizing the full potential of technologies. Starting from considerations regarding the branch of research in which we are involved, proceeding with the observation of significant real cases, we built up a current framework about the innovative approaches companies base on. The gathered data set the problem faced during the thesis: the missing valorisation of existing and new technologies and the restricted application horizons identified by companies.

In order to define a precise research direction we identified the objectives of the analysis: the definition of strategy that valorises existing and new technologies, together with a process to implement the strategy, which companies need in order to identify new applications. To achieve the outlined goals we used a multi method research, matching different approaches over the whole research path. Particularly in the initial phase we deeply analysed the literature about innovation, identifying the existing innovative models. Downstream we adopted both case study and action research methodologies. We selected four leading companies investigating the approaches and the related advantages in valorising technologies. Simultaneously we took part to the European project Light.Touch.Matters - Design driven development of touch sensitive luminous flexible plastics for applications in care & well-being - with the aim of concretely testing and refining the initial process proposed. Concluding, our thesis offers two main contributions that address companies towards the definition of new application fields. We defined an innovative approach, based on three dimensions, meanings, technologies and markets that support companies in guide companies towards the exploitation of the full potential of technologies. The strategy proposed bases on the concept that radical innovation stems from a combination of potential meanings enabled by technologies, which supports companies in facing new markets. In order to implement the strategy we provided a structured process based on the continuous interaction and discussion among partners. It leads to the definition of innovative application fields through the identification of new meanings and experiences within a selected context.

CHAPTER 1

Introduction

“Learning and innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow.”

William Pollard

The status quo can no longer sustain a business - it is not enough in this economy. New dimensions of innovation are necessary to modify or generate new processes and business models. Innovation is needed to adapt to an ever changing commercial, social and technological environment. It represents one of the main factors that allows firms to achieve success: depending on the radical content, innovation leads companies to middle or long term results. Hence innovation represents a key element on which an effective strategy must be based. Particularly the thesis is about managing innovation process in order to find out new applications with deeper radical contents, enabling companies to seize the potentialities embedded in new technologies. The overall objective is to support companies to innovate their products using new design-driven methodologies. This work critically presents traditional and modern innovation theories and strategies, pointing out the main elements that can affect the success of an innovation process. We studied the links between technology and design, exploring the connections among user needs, product functions and meanings. Over the work we presented cases of successful innovative companies, focusing on the most significant projects. On the other hand we reported the results originating from a European project about the development of touch sensitive luminous flexible plastics for applications in care & well-being, developing a scientific body of knowledge on design-driven materials research. Synthesizing the thesis aims at investigating the factors that support a company in the research of successful novel applications attractive for the market, identifying a structured methodology.

1.1 Problem setting

The thesis proposed here is part of an extensive research project, whose objective is the analysis of the *innovation methodologies* that lead to the identification of successful applications enabled by new and existing technologies. Over the time many authors dealt with the relevance of innovation in companies' strategy: different contributions focused on approaches towards innovation.

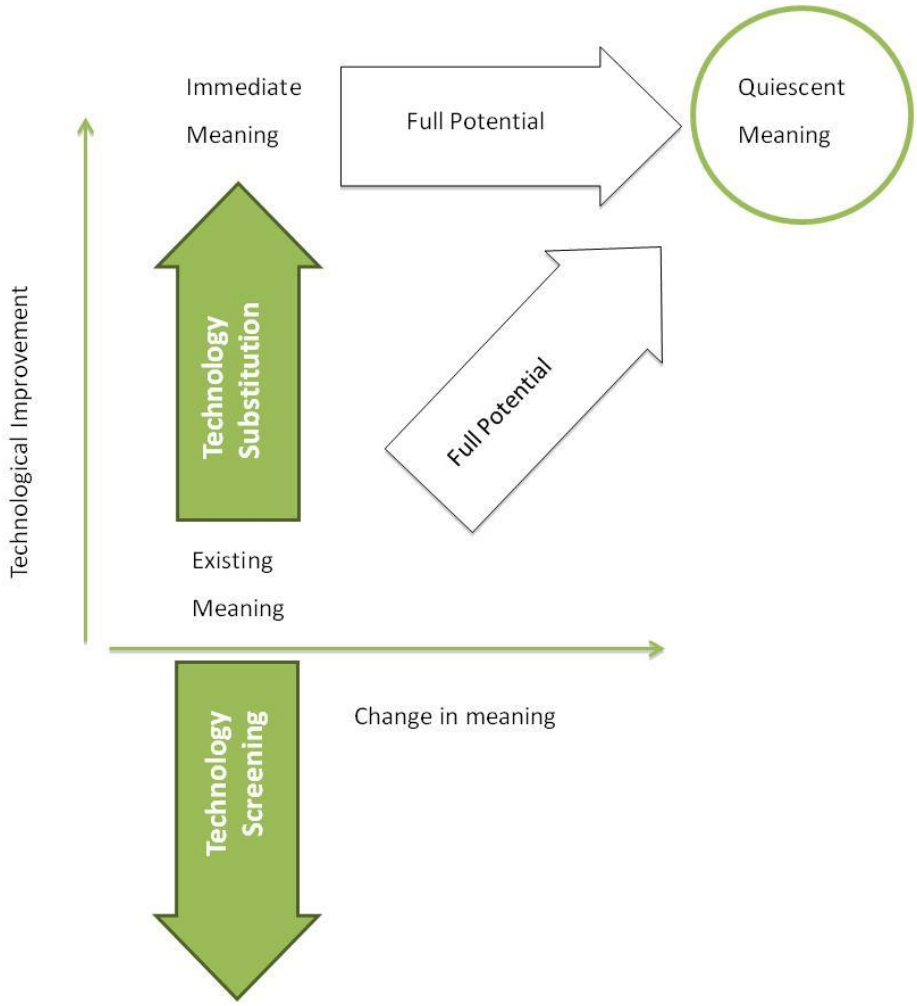

Figure 1.1 – The Role of the Meaning in Managing Break-Through Technologies

Particularly, the most recent streams (Verganti 2006, 2008, 2009) celebrate the role of the *meaning* in the process of identification of full potential of technology. Each technology embeds many potential meanings: some are immediate and promoted by those who have initially guided technological development, others are quiescent, but sooner or later they become manifest. Short sighted

companies often focus on the search of new markets for a technology without taking in consideration its meanings. In this way when companies look for potential applications they just focus on *technological substitutions*: companies add more effective and powerful functionalities or improve performance, leaving the existing meaning untouched. The myopic part of the industry embraces the new technology for utilitarian reasons— until a firm finds out the disruptive quiet meaning and realizes its full potential (horizontal arrow in the figure 1.1).

In order to clarify the concept we are dealing with, we present a famous case of radical innovation both in technology and meaning: Nintendo Wii is commonly considered to be the best example: it changed the way people use to play virtual games, through a new and dynamic system of playing (Griffiths, 2007).

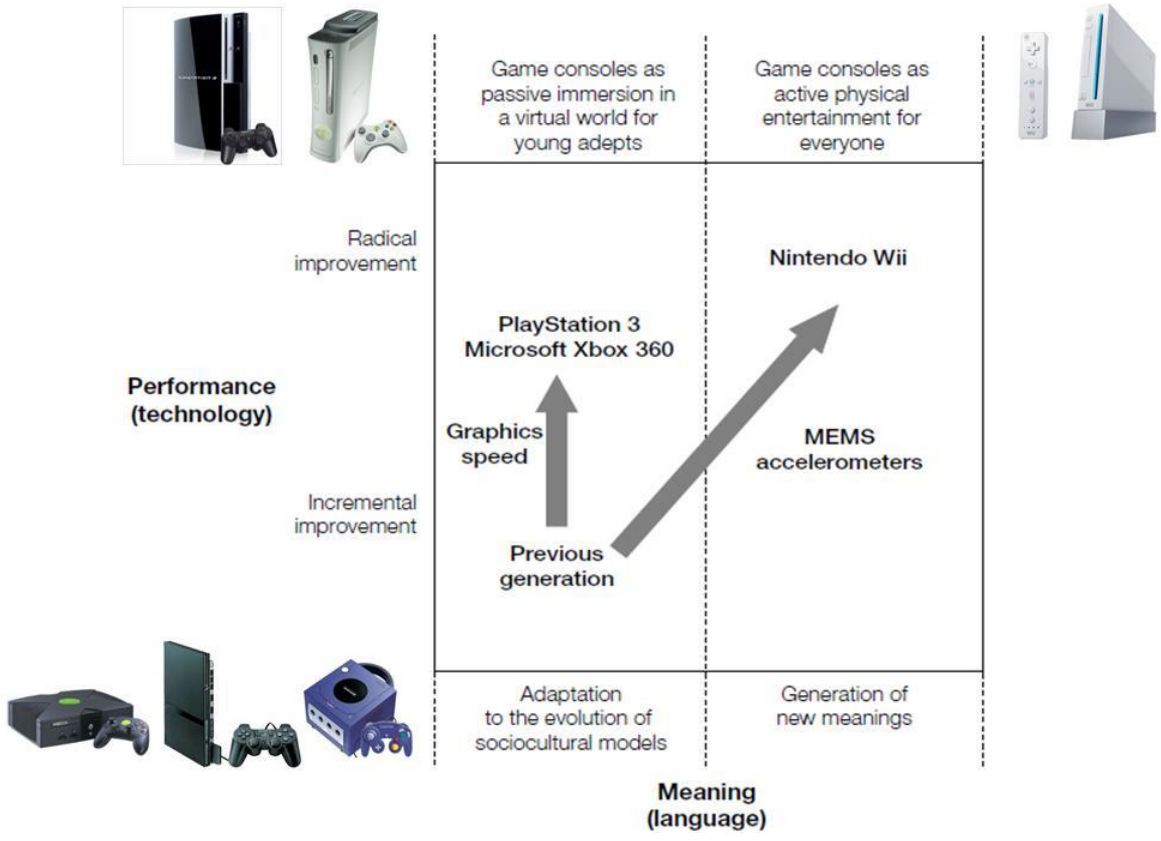

Figure 1.2 - Comparison of the Innovation Strategies of Nintendo, Sony and Microsoft in the Game Console Industry

At the base of the incredible success of the product is a breakthrough technology: *MEMS accelerometers by STM.* These small semiconductor components, sensing movement and inclinations, allow the device to sense how people are holding the controller and how fast they are moving it. The Wii does not merely add a new *functionality* (being sensitive to movements of the controller) to a traditional console game, but creates a radically different *meaning* that is conveyed by all aspects of the product (Hall, 2007). Nintendo brought a new technology into the industry (micro electromechanical systems, or MEMS) to transform a console game into a physically active experience for everyone. Nintendo distinguished from Sony that moved vertically, investing in technological development and leaving the meaning of the product untouched. Furthermore Sony was the first company STM got through to: despite of the possibility to embed the technology in the final product, Sony decided to screen the MEMS off, losing the opportunity to seize the full potential of the micro electromechanical systems (Sanchanta, 2007). Downstream we wondered about the reason research that guided STM in the development of accelerometers. Which were the inputs that drove the company through the discovery of MEMS and how STM identify the console game environment as a potential application field? Furthermore, why Sony didn't recognize the enormous hidden potential offered by the technology? Widening the scope to the totality of business sectors, the questions above are the main input for the research on which the thesis is based. Particularly, we are investigating on the potential application fields companies should evaluate according to the technologies owned. The different debated elements set the thesis basic problem: the missing valorisation of existing and new technologies and the restricted application horizons identified by companies.

1.2 Research objectives

Starting from the problem defined above, this section focuses on the main objectives of the research work. First of all we need to take into account that "*technologies offer opportunities*," as the semiologist Giampaolo Proni (2007) says, "*which are of course not infinite, but are greater in number than those imagined by early developers*". Technologies unveil numerous possibilities, especially in the initial stages of the development.

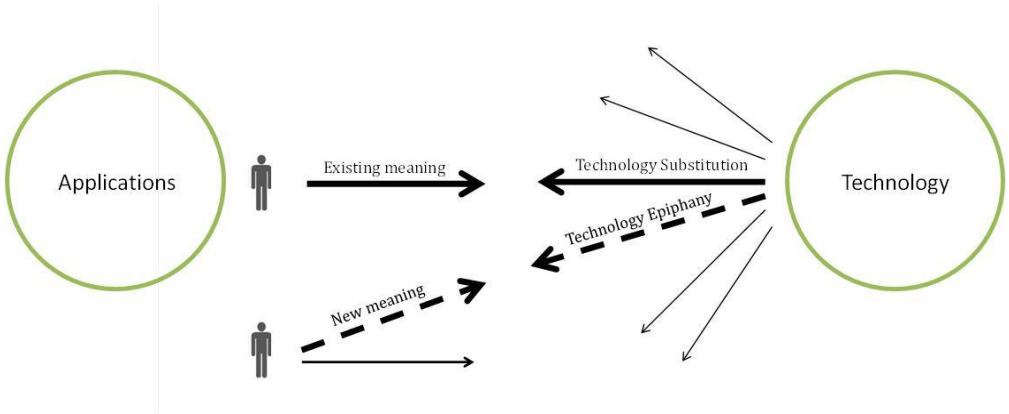

Figure 1.3 – The Interplay between Applications and Technology

A multitude of these opportunities represents functional improvements and *technology substitutions*, deriving from the companies' R&D activities, or pulled by market, as a direct consequence of explicit needs expressed by consumers. In this way the existing meaning of a technology is embraced and a radical Design Driven Innovation has not to be expected. The real challenge we are dealing with is to achieve the most potential applications discovering and *envisioning new meanings.* It involves a process of research and analysis in unusual fields, with unusual customers, towards unusual and powerful meanings. Developers of Wii, for example, would have screened off several interesting applications if they had only focused on markets and not on meanings, not fitting the dominant meanings in the market. No one would have thought of using MEMS accelerometers in game consoles if the meaning had been that of virtual entertainment, implying only movement of thumbs. But once a company questioned the dominant meaning and explored new possibilities in culture and society, fresh applications became visible. In other words, until the research focuses on applications to satisfy existing customers' needs, the solution will be oriented towards existing meaning. Instead, if the

analysis is open to new opportunities, even far from the actual market, but potentially disruptive, then they could intercept new meanings from new customers (that belong to completely different fields). Obviously, the entire process, as well as the strategy behind, is far from being simple and intuitive and it includes several challenges. Particularly this dissertation wants to focus on the definition of a *strategy* to valorise existing and new technologies, together with a *process* to implement that strategy, which companies need in order to identify new applications. The development of strategy is needed to discover and make clear which are the most promising application fields that are expected to have a bright future. In a broad basket of opportunities, the joint work by technology researchers and designers has to get a precise way towards the most interesting ones. On the other hand a concrete process related to the implementation of the innovation strategy is also necessary. In this process information and confrontation are exchanged between the design and the technology side, in order to raise awareness about technology features and potentialities, facilitating the research of application fields. The challenging task is to guide these streams of knowledge, introducing moments of verification and iterations aimed at making the two worlds converge. The structured process and the related tools allow the achievement of an active participation of all the actors to the phase of generating scenarios, discovering promising experiences, designing products and concepts.

1.3 Thesis Outline

To achieve concrete and grounded results we used a multi method research, matching different approaches over the whole process. A brief overview of the different steps of the thesis is depicted in figure 1.4.

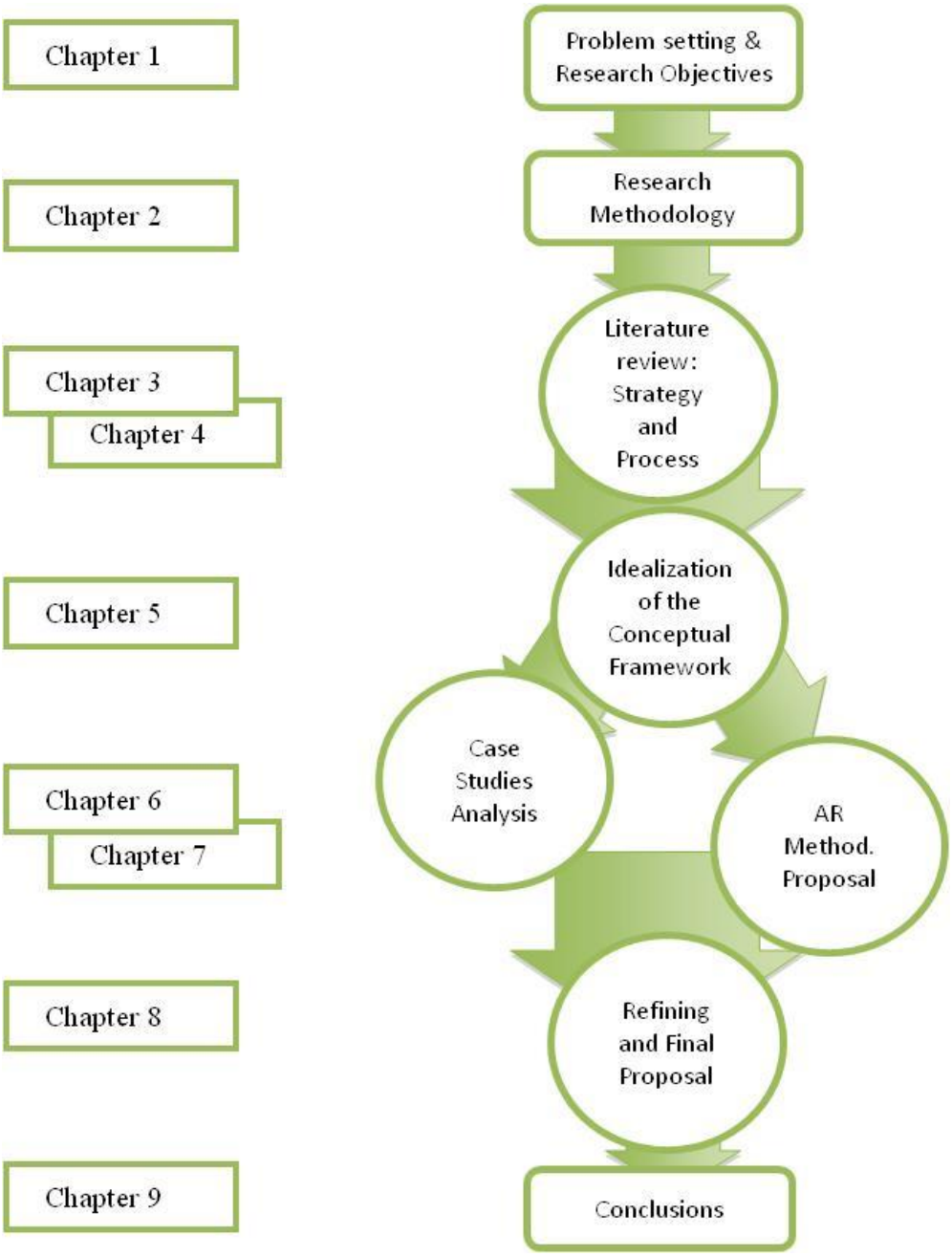

Figure 1.4 – The Thesis Outline

The graph above represents the thesis outline, showing the path through the all phases step by step, which brought from the problem setting to our final proposal. The research process started from the survey of the literature, in order to create a baseline to build up concrete reflections, in consequence of what other authors discussed over the last decades. The next step involved the idealization of a conceptual framework, which was developed and constructed through a process of qualitative

analysis. We started from the basic conclusions developed from the literature review, generating a framework to investigate/get insights from the reality in case studies and action research.

In the second part of our work the research based both on case study and action research. On the one hand, case study research enabled to capture the peculiarities of single cases. We selected leading companies in the innovation field in order to explore the innovation approaches used to valorise new and existing technologies. Action research, on the other hand, offered the opportunity to refine and assess the draft of the methodology initially developed. During the workshops, which coincided with key project milestones, we tested the proposed methodology, gathering a large number of criticalities and insights from the partners of the project. These elements played a fundamental role in the phase of refining, generating our final empirical results. In the last section we presented the result of this articulated process, describing the final proposal in terms of strategy and related methodology: the approach defined on the base of the case study research, the process refined through the action research. The graph above represents the thesis outline, showing the path through the all phases step by step, which brought from the problem setting to our final proposal. The research process started from the survey of the literature, in order to create a baseline to build up concrete reflections, in consequence of what other authors discussed over the last decades. The next step involved the idealization of a conceptual framework, which was developed and constructed through a process of qualitative analysis. We started from the basic conclusions developed from the literature review, generating a framework to investigate/get insights from the reality in case studies and action research.

CHAPTER 2

Research Methodology

After the definition of the problem and objectives at the base of the thesis, this chapter aims at introducing the methodology we followed during the research work. It retraces the steps we went through, explaining the scheme we based on during the literature review. The following section points out the path towards the definition of the conceptual framework and presents the multi method research we used. The two models we referred to in conducting case studies research and action research are presented, revealing the different steps that led us to the achievement of the objectives described in the introductive chapter. A clear and structured methodology is a necessary element in order to build up a solid research work and define concrete and grounded responses.

2.1 Surveying the Literature

The first chapter of literature review analyses the most significant literature sources that gave input and contributed to the creation of our conceptual framework. Going through the review, we decided to adopt the methodology developed by Machi and McEvoy (2009) as a conceptual scheme to search, develop and critique the information in the literature analysis.

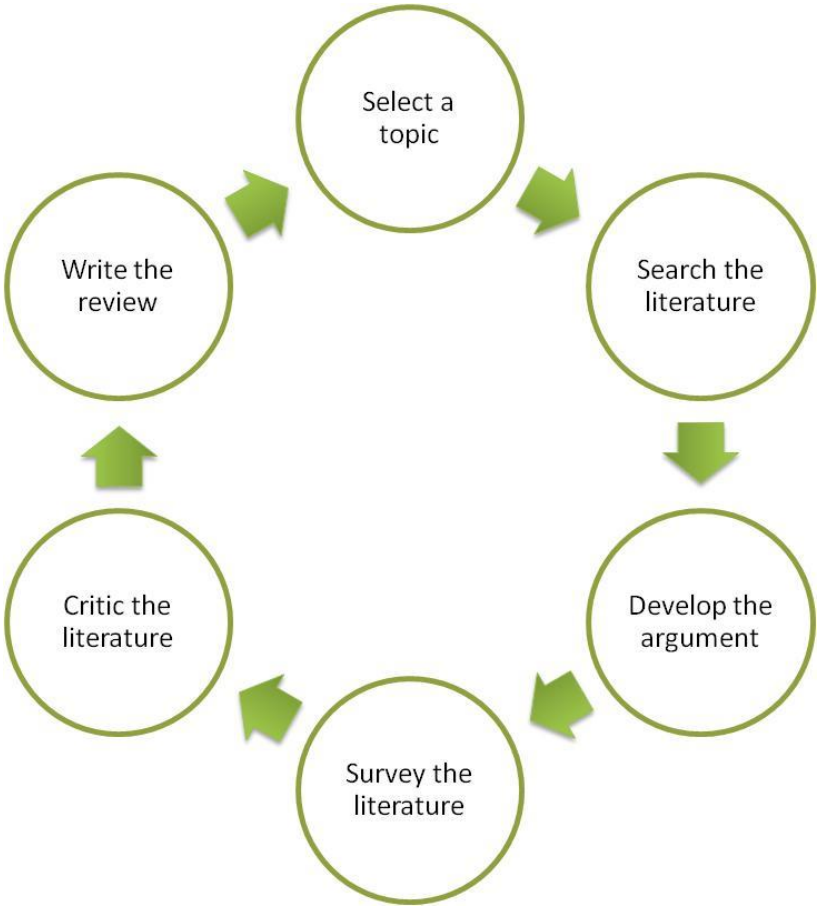

Figure 2.1 – Phases of Machi and McEvoy's Model of Literature Review

The first two steps of the figure 2.1 were basically a thesis set up, focusing our topic and identifying the most significant sources. The third step was a step of planning: we decided to split the innovation in two main features, distinguishing between the two main fields of analysis: *Strategy* and *Process*. The fourth and the fifth steps of the figure 2.1 were developed together, through two types of arguments:

- *Argument of discovery*: developing findings that represent the traditional state of knowledge about the research interest;
- *Argument of advocacy:* analysing and critiquing that knowledge through modern approaches and answers to the research question.

Six inter-connected streams of literature had contributed to the final embodiment of the research. The three main streams of *Technology Strategy, Business Strategy* and *Design Strategy* make up the first macro area about the innovation strategy. Then, following the same structure, *Technology Process, Business Process* and *Design Process* are the pillars of the second section about the innovation process. Here we described the importance of the adoption of structured processes and tools in order to implement the strategies previously discussed. *Design Briefing, Scenario Building* and *Cultural Probes* are presented in the design section, as effective techniques to inspire ideas and search for new application fields in the design process. Connections between streams and sub-areas are included, as shown in figure 3.1 in chapter 3, in the structure of the literature review. The last step of the model is the result of this process of surveying and discovering, materialized in the following paragraph of literature review.

2.2 Building the Conceptual Framework

A conceptual framework is not merely a collection of concepts but, rather, a construct in which each concept plays an integral role. Miles and Huberman (1994) state that a conceptual framework "lays out the key factors, constructs, or variables, and presumes relationships among them". According to this idea, our conceptual framework is not on variable or factors but on concepts alone, not a causal/analytical setting but, rather, an interpretative approach to social reality. In order to build our framework, we followed a methodology composed of these 7 main phases:

Methodological Phases
1. Mapping the selected data sources
2. Extensive reading and categorizing of the selected data
3. Identifying and naming concepts
4. Integrating concepts
5. Synthesis, resynthesis, and making it all make sense
6. Validating the conceptual framework

Figure 2.2 - Methodological Phases by Miles and Huberman's Model

Phase 1: Mapping the selected data sources

The first task was to map the spectrum of multidisciplinary literature regarding the phenomenon in question. It began with an extensive review of the multidisciplinary texts, that we basically summarized in the opening paragraph of the conceptual framework chapter "the ideal path to the conceptual framework" Data collection should be a comprehensive and complete "fishing trip" or "scoping" (Morse & Richards, 2002), and should facilitate holistic mapping and complete data collection to ensure validity (Morse & Mitcham, 2002).

Phase 2: Extensive reading and categorizing of the selected data

The aim in this phase was to read the selected data and categorize it both by discipline and by a scale of importance and representative power within each discipline. This process maximizes the effectiveness of our inquiry and ensures effective representation of each discipline.

Phase 3: Identifying and naming concepts

The aim in this phase was to read and reread the selected data and "discover" concepts (Glaser & Strauss. 1967; Strauss & Corbin. 1990). Its result is a list of numerous competing and sometimes contradictory concepts. Generally, this method allows concepts to emerge from the literature. Indeed, Morse, Hupcey, et al. (2002) have suggested that "qualitative inquiry that commences with the concept, rather than the phenomenon itself, is subject to violating the tenet of induction, thus is exposed to particular threats of invalidity".

Phase 4: Integrating concepts

The aim in this phase was to integrate and group together concepts that to one new concept. This phase reduced the number of concepts drastically and allowed us to come up with a unique model that we present in the 5th chapter.

Phase 5: Synthesis, resynthesis, and making it all make sense

The aim in this phase was to synthesize concepts into a theoretical framework. The researcher was open, tolerant, and flexible with the theorization process and the emerging new theory. As Miles and Huberman (1994) have suggested, researchers who use qualitative methods "need to know how they are constructing 'theory' as analysis proceeds, because that construction will . . . inevitably influence and constrain data collection, data reduction, and the drawing and verification of conclusions".

Phase 6: Validating the conceptual framework

The aim in this phase was to validate the conceptual framework. The question was whether the proposed framework and its concepts make sense not only to us but also in the application in the real world. Validating a theoretical framework is a process that starts with the researcher, who then seeks

validation among "outsiders." Basically this final step is out of the bounds of the chapter dedicated to the conceptual framework itself; on the contrary it is spread over the following chapters of case studies and action research.

2.3 From concepts to results

The analysis of the literature created a baseline to build up concrete reflections, in consequence of what other authors discussed over the last decades. The framework developed on that baseline was built with the intention of adding value to the innovation models extracted from literature.

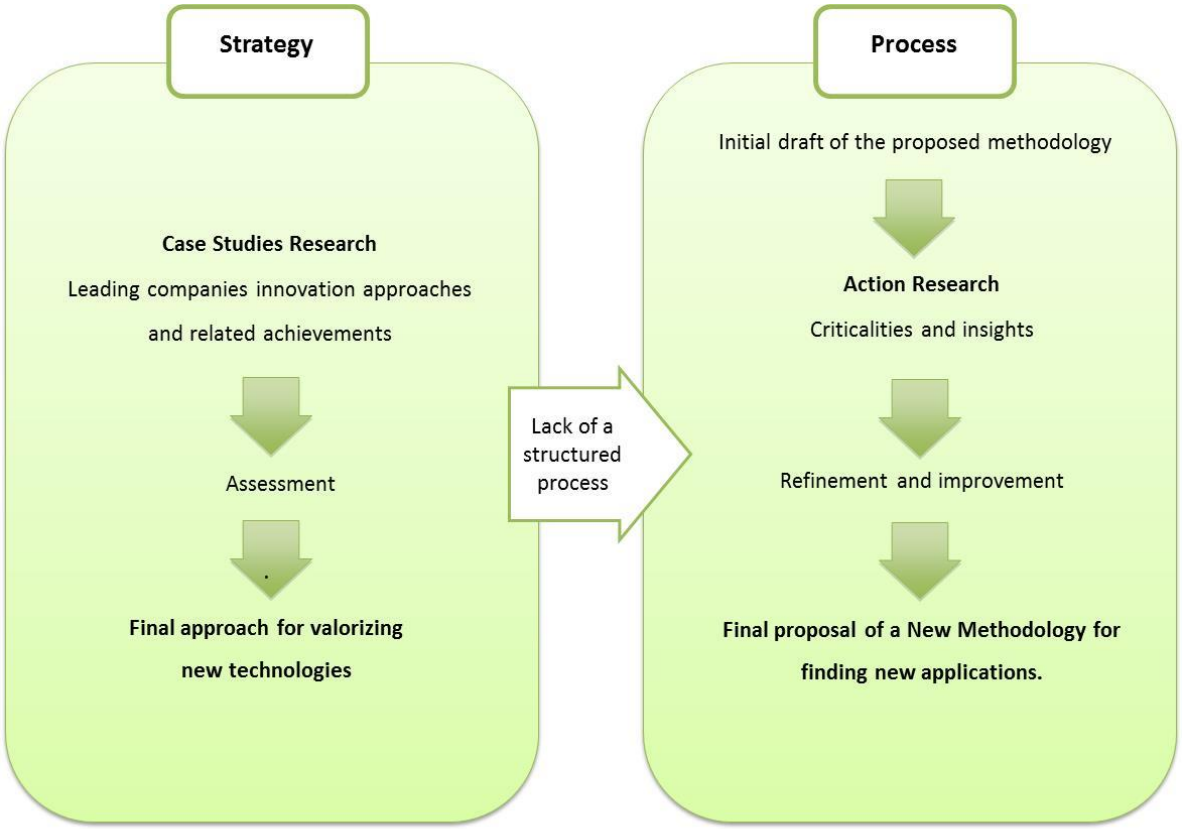

Figure 2.3 – The Scheme

According to the overall methodology of the proposal phase (showed in figure 2.3), the strategy framework was thought to be applied to case studies in order to map in a "*value-added way*" the different approaches companies use in valorising technologies. The framework has represented an hand lens aimed at investigating how leading companies in the innovation field succeed in exploiting the full potential of technology. In this way we were able to identify different approaches companies adopt, positioning each one in the diagram. The analysis includes a focus on specific projects in our opinion representing the best examples of technology valorisation. Particularly we conducted a deep analysis on innovation strategy related to each project, qualitatively and quantitatively evaluating benefits and results. From this analysis we defined the strategy a company should follow in order to maximize the valorisation of the technologies owned, identifying new applications.

In addition to the considerations related to the strategy we got a second output from the case studies (the harrow that links process and strategy in figure 2.3): a lack of well-defined and structured processes aimed at exploiting the full potential of technology. Hence, the proposal of a method and guidelines aimed at conveying companies towards intentional innovative results, supporting organizations in valorising technologies. Specifically we developed a process including intermediate steps and techniques aimed at facilitating the dialogue between the Design and the Technology side in order to define a unique direction towards the identification of new applications. The final process is the result of an initial draft refined with the lessons learned coming from the action research. We modified the first model, used in a real project, adding insights originating from criticalities by the partners, providing a well-grounded final version. As part of the project funded by the European Union "*Light.Touch.Matters* - Design driven development of touch sensitive luminous flexible plastics for applications in care & well-being"- we could reflect on the interpretations made by the participants. Particularly, action research gave us the opportunity to refine and assess the methodology initially developed: during the workshops, coinciding with key project milestones, we tested the proposed R&D design-driven methodology, gathering an appreciable number of criticalities and insights from partners, which played a fundamental role in the phase of refining. The last step represented the definition of the final proposal in terms of process aimed at fully valorising technology and seizing the all potentialities, grounded on insights and contributions from Action Research.

2.4 Researching through Case studies

Case studies research represented the initial part of the immersion of our research process in the reality. As mentioned before we chose a set of leading companies in the innovation field, in particular we selected them according to their capacity to valorise the potentialities of technologies. In conducting our studies on real examples, we dealt with significant projects in order to confine our research question and focus the analysis. Particularly, we chose those projects we believe represent the best examples of successful valorisation of specific technologies.

After a spread research in the field, we selected: *Tetra Pak, Pirelli, Italcementi, Pelma* and *Material Connexion Italia*. The purpose of this analysis was to gather insights about strategy used in recent projects that led companies to radical applications in terms of innovation. Next step was to map the approaches companies used during the selected projects in order to build up a complete framework of the innovation strategies leading companies base on. We conducted a series of interviews with managers involved in these projects, closely observing the context and the work environment. After a general overview about the innovation management in the company, we asked for details focusing on the strategy. We ended our analysis inspecting the advantages linked to the strategies followed during the projects, pointing out the added value due to the achievement of innovative solutions.

Before examining each case study we drew a broad landscape referring to the relevance end effectiveness of *case study approach*, pointing out the main advantages and characteristics. Case research has consistently been one of the most powerful research methods, particularly in the development of new theory (Lewis, 1988). The framework we decided to adopt is that one provided by Eisenhardt (1989), who defines the process of building theory from case study research (figure 2.4). He argues that a priori specification of constructs is valuable because “It permits researchers to measure constructs more accurately. If these constructs prove important, then researchers have a firmer empirical grounding for the emergent theory”.

Phase	Activity
Getting Started	Definition of research question and a priori constructs
Selecting Cases	Specified population and theoretical, not random, sampling
Crafting Instruments and Protocols	Multiple data collection methods
Entering the field	Overlap data collection and analysis and flexible data collection methods
Analysing data	Within-case and cross-case analysis
Shaping hypothesis	Iterative tabulation of evidence for each construct and search evidence for "why" behind relationships
Reaching Closure	Theoretical saturation when possible

Figure2.4 – Phases of Eisenhardt's Model of Case Study Research

Phase 1: Getting Started

An initial definition of the research question, in at least broad terms, is important in building theory from case studies. Mintzberg (1979) noted: "No matter how small our sample or what our interest, we have always tried to go into organizations with a well-defined focus — to collect specific kinds of data systematically". Confining our research scope, setting a clear problem has been representing the initial part of the thesis: a precise direction is fundamental to focus the efforts.

Phase 2: Selecting Cases

Selection of cases is an important aspect of building theory from case studies. The concept of population is crucial: it defines the set of entities from which the research sample is to be drawn. Also, selection of an appropriate population controls extraneous variation and helps to define the limits of generalizing the findings. The cases may be chosen to replicate previous cases or extend emergent theory, or they may be chosen to fill theoretical categories and provide examples of polar types. As anticipated before we selected the most interesting companies in terms of innovative

magnitude. In order to comprehend the current situation about innovation management we identified a set of companies that represent the best examples in fully valorising new and existing technologies.

Phase 3: Crafting Instruments and Protocols

Theory-building researchers typically combine multiple data collection methods. Of special note is the combining of qualitative with quantitative evidence. The combination of data types can be higher synergistic. Quantitative evidence can indicate relationships which may not be salient to the researchers. It also can keep researchers from being carried away by vivid, but false, impressions in qualitative data, and it can bolster findings when it corroborates those findings from qualitative evidence. The qualitative data are useful for understanding the rational or theory underlying relationships revealed in the quantitative data or may suggest directly theory which can then be strengthened by quantitative support (Jack, 1979). Also of special note is the use of multiple investigators. Multiple investigators have two key advantages. First, they enhance the creative potential of the study. Team members often have complementary insights which add to the richness of the data, and their different perspectives increase the likelihood of capitalizing on any novel insights which may be in the data. Second, the convergence of observations from multiple investigators enhances confidence in the findings. Specifically we used a multi method data collection method. We conducted an initial analysis through the study of papers and documents related to the specific company, selecting projects whose outputs represented radically innovative applications for the industry. Subsequently we interviewed managers involved in the chosen projects, gathering precious data and information. We used both secondary and primary resources, screening the web for interesting contributions and personally interviewing corporate staff.

Phase 4: Entering the Field

A striking feature of research to build theory from case studies is the frequent overlap of data analysis with data collection. Field notes, a running commentary to oneself and/or team, are an important means of accomplishing this overlap. As described by Van Maanen (1988), field notes are an on-going stream-of-consciousness commentary about what is happening in the research, involving both

observation and analysis — preferably separated from one another. One key to useful filed notes is to write down whatever impressions occur, that is, to react rather than to sift out what may seem important, because it is often difficult to know what will and will not be useful in the future. A second key to successful field notes is to push thinking in these notes by asking questions such as “what am I learning?” and “How does this case differ from the last?”.

Phase 5a: Analysing Within-Case Data

The importance of within-case analysis is driven by one of the realities of case study research, a staggering volume of data. Within-case analysis can help investigators cope with this deluge of data. The analysis typically involves detailed case study write-ups for each site. These write-ups are often simply pure descriptions, but they are central to the generation of insight (Gersick, 1988) because they help researchers to cope early in the analysis process with the often enormous volume of data. The overall idea is to become intimately familiar with each case as a stand-alone entity. This process allows the unique patterns of each case to emerge before investigators push to generalize patterns across cases. In addition, it gives investigators a rich familiarity with each case which, in turn, accelerates cross-case comparison.

For each case we conducted a deep analysis, presenting a company overview and a broad description of services and products offered. Subsequently we studied the innovation management process, trying to extracts a model valuable for our research in terms of strategy. For every company we organized and processed the data gathered in the previous steps, defining the specific structure related to the single case-study.

Phase 5b: Searching for Cross-Case Patterns

Coupled with within-case analysis is cross-case search for patterns. The tactics here are driven by the reality that people are notoriously poor processors of information. They leap to conclusions based on limited data, overly influenced by the vividness or by more elite respondents. They ignore basic statistical properties, or they sometimes inadvertently drop disconfirming evidence. The danger is that investigators reach premature and even false conclusions as a result of these information-

processing biases. Thus, the key to good cross-case comparison is counteracting these tendencies by looking at the data in many divergent ways. One tactic is to select categories or dimensions, and then to look for within-group similarities coupled with intergroup differences. Dimensions can be suggested by the research problem or by existing literature, or the researcher can simply choose some dimensions. A second tactic is to select pairs of cases and then to list the similarities and differences between each pair. This tactic forces researchers to look for the subtle similarities and differences between cases. The result of these forced comparisons can be new categories and concepts which the investigators did not anticipate. A third strategy is to divide the data by data source. For example, one researcher combs observational data, while another reviews interviews and still another works with questionnaire evidence. This tactic exploits the unique insights possible from different types of data collection. When a pattern from one data source is corroborated by the evidence from another, the finding is stronger and better grounded. When evidence conflicts, the researcher can sometimes reconcile the evidence through deeper probing of the meaning of the differences. In the final part of our case studies research we analysed data across all of the cases in order to identify similarities and differences among the approaches adopted by selected companies in valorising new and existing technologies

A variation of this tactic is to split the data into groups of cases, focusing on one group of cases initially, while later focusing on the remaining cases. Overall, the idea behind these cross-case searching tactics is to force investigators to go beyond initial impressions, especially through the use of structured and diverse lenses on the data. These tactics improve the likelihood of accurate and reliable theory, that is, a theory with a close fit with the data. Also, cross- case searching tactics enhance the probability that the investigators will capture the novel findings which may exist in the data. Specifically we compared answers to specific questions, analysing gaps and differences among the companies. For each question of the interview we mapped the answers of each manager in order to point out divergences and discordances.

Phase 6: Shaping Hypotheses

From within-site analysis plus various cross-site tactics and overall impressions, tentative themes, concepts, and possibly even relationships between variables begin to emerge. The next step is to

compare systematically the emergent frame with the evidence from each case in order to assess how well it fits with case data. The central idea is that researchers constantly compare theory and data — iterating toward a theory which closely fits the data. One step in shaping hypothesis is the sharpening of constructs. This is a two-part process involving: refining the definition of the construct and building evidence which measures the construct in each case. Overall, shaping-hypotheses in theory-building research involves measuring constructs and verifying relationships. The research team must judge the strength and consistency of relationships within and across cases and also fully display the evidence and procedures when the findings are published, so that readers may apply their own standards. We constantly compared the emergent frame with the literature. We tried to find out parallelisms rather than divergences with the theory, enforcing or reducing the relevance of findings.

Phase 7: Reaching Closure

Two issues are important in reaching closure, when to stop adding cases, and when to stop iterating between theory and data. In the first, ideally, researchers should stop adding cases when theoretical saturation is reached. This idea is quite similar to ending the revision of a manuscript when the incremental improvement in its quality is minimal. In practice, theoretical saturation often combines with pragmatic considerations, such as time and money to dictate when case collection ends. In the second closure issue, when to stop iterating between theory and data, again, saturation is the key idea. That is, the iteration process stops when the incremental improvement to theory is minimal. The final product of building theory from case studies may be concepts, a conceptual framework, or propositions. After the analysis of 5 case studies we gathered the right amount of data in order to proceed with the development of our model. Each case represented a level of organization of the innovation process, distinguishing structured and destructed paths.

2.5 Doing Action Research

As Mälardalen University's researchers (partners of Politecnico of Milan) we took part to the *Light.Touch.Matters*. *project*, a EU project that brings together product designers and material scientists, in order to develop a new generation of applications that combine touch sensitivity with luminosity, based on polymeric Piezo materials and flexible OLEDs. We tested the first draft of R&D methodology, coined after a broad research in literature, in the active environment of the Light Touch Matters, gathering different criticalities from the partners, discovering margins for improvements. Downstream, thanks to the numerous comments and insights, we refined and sharpened the first process proposed, providing a grounded and solid output. In this section we would like to present the literature behind the action research, unveiling the several strength points and advantages linked to this research approach.

Kurt Lewin, ex professor at MIT, first coined the term "action research" in 1944. In his paper "Action Research and Minority Problems" he described action research as "a comparative research on the conditions and effects of various forms of social action and research leading to social action" that uses "a spiral of steps, each of which is composed of a circle of planning, action and fact-finding about the result of the action". Action research is a generic term, which covers many forms of action-oriented research, and indicates diversity in theory and practice among action researchers, so providing a wide choice for potential action researchers as to what might be appropriate for their research question (Reason and Bradbury, 2001). The desired outcomes of the Action Research approach are not just solutions to the immediate problems but important learning from outcomes both intended and unintended, and a contribution to scientific knowledge and theory. Below we reported the main characteristics of our approach:

Research in action, rather than research about action. The action research focuses on research in action, rather than research about action. The central idea is that action research uses a scientific approach to study the resolution of important social or organisational issues together with those who experience these issues directly.

Action Research is participative. Members of the system which is being studied participate actively in the cyclical process outlined above. Such participation contrasts with traditional research where members of the system are objects of the study. Particularly in Light Touch Matters project, thanks to partner's criticisms, we developed a more solid final process including participant's suggestions.

Action Research is research concurrent with action. The goal is to make that action more effective while simultaneously building up a body of scientific knowledge. The aim of our participation to the project was that of developing an R&D process, basing the research on active situations and real scenarios.

Action Research is both a sequence of events and an approach to problem solving. As a sequence of events, it comprises iterative cycles of gathering data, feeding them back to those concerned, analysing the data, planning action, taking action and evaluating, leading to further data gathering and so on. As an approach to problem solving, it is an application of the scientific method of fact finding and experimentation to practical problems requiring action solutions and involving the collaboration and co-operation of the action researchers and members of the organisational system.

Action Research aims at developing holistic understanding during a project and recognising complexity. As organisations are dynamic socio-technical systems, action researchers need to have a broad view of how the system works and be able to move between formal structural and technical and informal people subsystems (Nadler and Tushman, 1984).

Action research requires a breadth of pre-understanding of the corporate environment, the conditions of business, the structure and dynamics of operating systems and the theoretical underpinnings of such systems. Pre-understanding refers to the knowledge the action researcher brings to the research project.

AR should be conducted in real time, though retrospective action research is also acceptable. While action research is a "live" case study being written as it unfolds, it can also take the form of a traditional case study written in retrospect, when the written case is used as an intervention into the organisation in the present (Kleiner and Roth, 1997).

In the thesis we referred to Coughlan and Coghlan's model (2002), depicted in figure 2.5. They proposed an action research cycle that comprises three types of step:

- *a pre-step* — to understand context and purpose;
- *six main steps* — to gather, feedback and analyse data, and to plan, implement and evaluate action;
- *a meta step* to monitor.

Figure 2.5 – Phases of Coughlan and Coghlan's Action Research Cycle

Pre-step: understanding context and purpose. The pre-step is driven by two questions concerning the rationale for action and for research. The action research cycle unfolds in real time and begins with the key members of the organisation developing an understanding of the context of the action project. The main questions are "Why is this project necessary/desirable?" and "What are the economic, political, social and technical forces driving the need for action?" The analysis of these forces identifies their source, their potency and the nature of the demands they are making on the system. The complementary pre-step is to ask what the rationale for the research is. This involves

asking why this action project is worth studying, how action research is an appropriate methodology to adopt and what contribution it is expected to make to knowledge. Particularly, the initial purpose of our participation to the project was that of gathering precious suggestions and information about the application of a new R&D design-driven methodology. Through the Light Touch Matters we supposed to test the proposed process, finding out the weakness and the strength points in order to refine the final output of the research, providing a more grounded contribution.

Main steps. The six main steps relate first to the data and then to the action. These steps are detailed as follows.

- *Data gathering.* Data are gathered in differing ways depending on the context. In AR, directly observable behaviour is an important source of data for the action researcher. Observations of the dynamics of groups at work provide the basis for inquiry into the underlying assumptions and their effects on the work and life of these groups (Schein, 1999). During the Light Touch Matters project we collected numerous criticisms not only through direct interventions but also simply observing the partners' reactions to a certain session or activity.
- *Data feedback.* The action researcher takes the gathered data and feeds it to the client system with a view to making it available for analysis. Sometimes the action researcher has gathered the data and does the reporting; at other times, the organisation itself has gathered the data and the action researcher facilitates or participates in the feedback meetings. Thorough constant releases, one after each workshop, we let project partners share in data gathered and middle results achieved. Through the papers we recapped the output in terms of information related to the previous sessions, making participant aware about the state of the art.
- *Data analysis.* The critical aspect of data analysis in action research is that it is collaborative — both the researcher and members of the client system do it together. This collaborative

approach is based on the assumption that clients know their organisation best, know what will work and, ultimately, will be the ones to implement and follow through on whatever actions will be taken. That's the reason why we requested the methodologies usually implemented by design agencies in terms of scenario building techniques and design-driven processes. Obviously the most interesting contributions represented a valuable resource in drawing the final R&D methodology.

- *Action planning*. Following from the analysis further action is planned. In the same vein and for the same reasons as the data-gathering step, action planning is a joint activity. The action research steering group and the senior management set who does what and an appropriate time schedule. We accurately define the methodology steps, identifying sessions and activities. We planned each phase in the process, designing the correct sequence in order to guide designers and technology researchers thorough a structured path.
- *Implementation*. The client implements the planned action. This involves making the desired changes and following through in the plans in collaboration with relevant key members of the organisation. During the project we introduced additional opportunities for discussion, despite unplanned, offering extra-time for open debates.
- *Evaluation.* Evaluation involves reflecting on the outcomes of the action, both intended and unintended, a review of the process in order that the next cycle of planning and action may benefit from the experience of the cycle completed. Evaluation is the key to learning. Reflections on *Light Touch Matters* project represent the main input in realizing a more effective R&D methodology, evaluating the reactions and the outputs.

Monitoring. Each action research cycle leads to another cycle, and so continuous planning, implementation and evaluation take place over time. Hence, a constant control of the process offers the opportunity for continuous learning.

Action research projects are situation specific and do not aim to create universal knowledge. At the same time action research must have some implications beyond those required for action or knowledge within the project. It is important, therefore, to extrapolate to other situations and to identify how the action research project could inform like organisations, similar issues and so on. Eden and Huxham (1996) present several important useful guides to how action research contributes to theory:

- *Action research generates emergent theory*, in which the theory develops from a synthesis of that which emerges from the data and that which emerges from the use in practice of the body of theory which informed the intervention and research intention.
- *Theory building*, as a result of action research, will be *incremental*, moving from the particular to the general in small steps.
- Action research demands an *explicit concern with theory* that is formed from the conceptualisation of the particular experience in ways that are intended to be meaningful to others.
- It is not enough to draw on the generality of action research through the design of tools, techniques and models, as the basis for their design must be explicit and shown to be related to the theory.

Concluding action research is a form of science which differs from experimental physics but is genuinely scientific in its emphasis on careful observation and study of the effects of human behaviour on human systems as they manage change (Coughlan and Coghlan, 2002).

CHAPTER 3

Literature Review - Innovation Strategy

From here onwards the concrete research work starts and the first point is the literature review. This chapter particularly aims to investigate the first half of the literature, since we divided it into two main streams: Strategy and Process. Then, those streams are both decomposed into three pillars: technology, business and design, which represent the different points of view of the analysis. From the strategy side, that is the focus of this chapter, the analysis went through the main approaches that different authors over different times described as effective means to manage applications for technologies.

3.1 Structure of the Literature Review

The structure we created, as explained above, is divided in two main streams: *innovation strategy* and *innovation process (and tools*). The figure 3.1 graphically represents the architecture of the literature review.

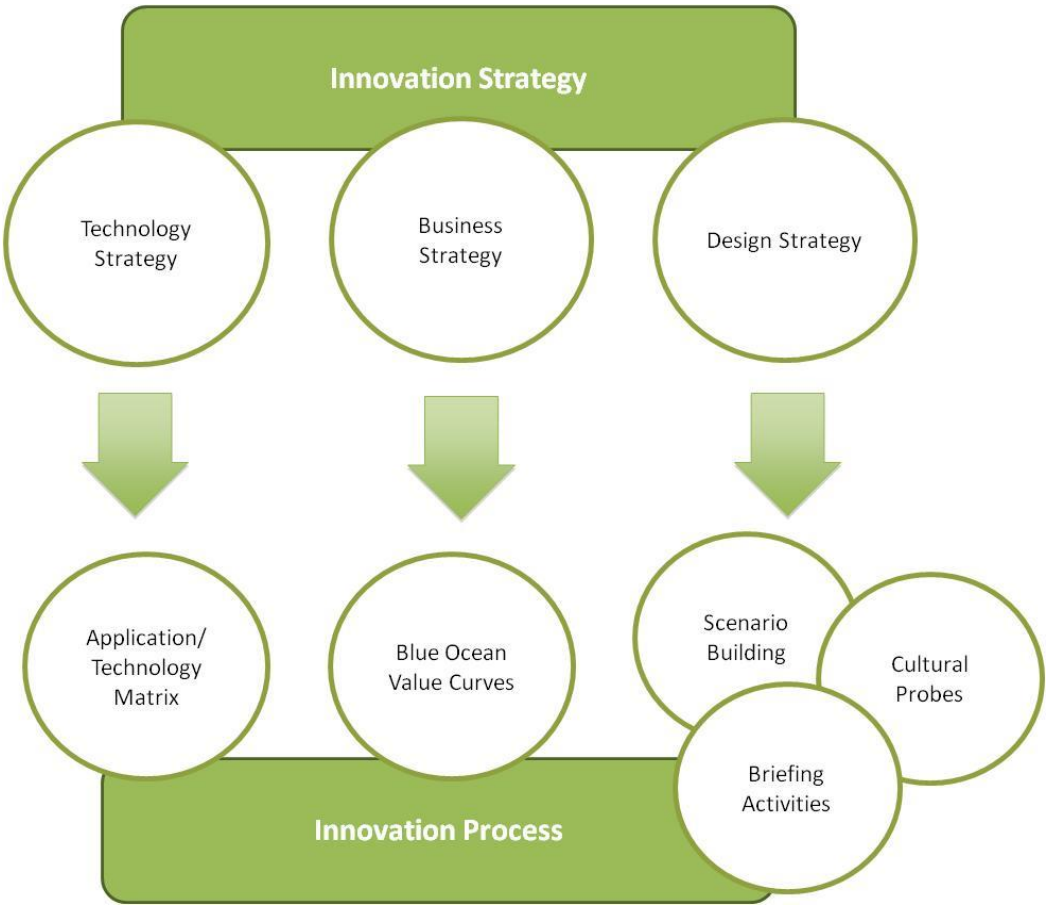

Figure 3.1 – The Structure of The Literature Review

We started from the analysis of the *innovation strategy,* as a first step towards the investigation of the strategic approach to innovation. This section is made up of three different pillars: t*echnology strategy, business strategy* and *design strategy*. The research focused on the relevant impact of innovation in guaranteeing companies success, particularly aiming to clarify the role of strategy from these three different points of view. The chapter *Technology Strategy* deals with the key factors of

technology management process. Technology is often the enabler of innovation and represents a source of sustainable competitive advantage. We studied in deep the major characteristics of technology strategy presenting mainly the Porter's model. In addition we focused on the role of technological innovation, analysing the central elements and the fundamental models. The second stream reveals the key factors of a strategy that seeks new markets, rather than new technologies or a new design perspective So, starting from the shift of the role of competition and the opening of new markets, we conducted a deep analysis on the *Blue Ocean* approach presenting the key elements and the fundamental characteristics of this new business strategy. Concluding the first macro area, we studied the evolution from traditional innovation models to the *design-driven innovation* approach, analysing the design perspective. We introduced here the concept of *Technology Epiphany*, which is a carrier point in our project of research.

After a critique analysis of the different approaches to strategy, the literature review goes more deeply in the analysis of the *innovation processes* that supports each of the three strategic sub-areas, studying how the processes evolve and how companies manage it. This is the base to build a structured path to investigate the common innovation processes adopted by companies to develop the three streams of innovation strategy named above. The chapter about the *Technology Process* first describes the technology/application matrix, and then focuses on the relationship between technology and innovation, explaining how innovative solutions usually come from novel technologies. The different approaches to technology innovation processes are showed in the end.

The *Business Process* chapter explains the analytical frameworks that characterize the process related to the Blue Ocean strategy. The concept of the *new value curves,* introduced in the business strategy section, is examined in depth in this part in order to explain how to read and interpret them. In the last section of *design process* the central role of design is evidenced, as enabler of new applications. Then, *scenario building* is considered to be the most appropriate technique to combine a description of some set of real ongoing activities with an imaginary futuristic view of how technologies might support these activities. Finally, *cultural probes* are presented, as a specific tool to gather information to guide design activities in the innovation process, through greater knowledge of the *user experience*.

3.2 Innovation Strategy: definition and key elements

Innovation is a powerful explanatory factor behind differences in performance between firms, regions and countries. Firms that succeed in innovation prosper, at the expense of their less able competitors (J. Fagerberg, 2003). Leonard and Swamp define innovation as "the embodiment, combination, and/or synthesis of knowledge in novel, relevant, valued new products, processes, or services" (Leonard & Swamp, 1999).

Roberts (1988) defines innovation as the combination of two different elements:

1. The generation of an idea or *invention*
2. The conversion of that invention into a business or other useful application.

The formula that well explains this concept is:

Innovation= Invention + Exploitation

The invention is about creating new ideas and getting them to work, the exploitation process includes all stages of commercial development, application and value transfer (Roberts, 1988).

Nowadays it is evident that in a changing and fast demanding environment organizations cannot disregard from the crucial role played by innovation, in order to create customer value, building a strategy that makes it possible. For organization leaders the challenge is to develop the ability to create value-added innovative products and/or services on a continuous basis, utilizing compelling innovation strategy to make decisions and deliver innovative contents to customers (Kathryn J. Deiss, 2004).

As described by Dodgson, Gann and Salter in The Management of Technological Innovation, "An innovation strategy helps firms decide in a, cumulative and sustainable manner, about the type of innovation that best match corporate objectives. It guides decisions on how resources are to be used to meet a firm's objectives for innovation and thereby deliver value and build competitive advantage." Then, the role of the innovation strategy is that of an aligning mechanism (plan) which can assist an organization in the execution of its overall strategy, and in achieving their ultimate goals.

3.3 Technology Strategy

3.3.1 The Management of Technologies

Firms outperforming competitors often derive their success from innovation and in many cases is technology based. Creating new products, processes and services is recognised as a major source of competitive advantage and *technology* is often the enabler of such innovations.

Abetti (1989) defines *technology* as "a body of knowledge, tools and techniques, derived from both science and practical experience, which is used in the development, design, production and application of products, processes, systems and services". This definition provides evidence of some key concepts related to technology and its role in competition:

- Technology is not only embodied into products but also into process or methods used to generate new products or services;
- Technology is knowing how to apply scientific and engineering knowledge to achieve practical results, products, processes and services, or knowing how to achieve practical results on the basis of the experience;
- From a business perspective, technology is not good per se but when intrinsically related to innovative objectives.

Innovative potential embodied in each technology as a source of competitive advantage is widely accepted by practitioners, governments and academics; hence the awareness of the strategic importance of technology. Most works in literature dealt with technology as strategic variable, treating the relationship between technology and strategy. Next chapters review the different approaches to technology strategy, distinguishing among the positioning and the resource based one, discussing about contributions on both streams.

3.3.2 The Positioning Approach Strategy: Porter's Framework

In the early 80s Porter focused on the firm's technology strategy, studying both the link with the company strategy and the key dimensions of technological decisions. Porter (1985) identifies the factors of a firm's technology strategy, suggesting that technology strategies basically consist of three decisions:

- *the selection of the technologies* to develop;
- whether to be *leader or follower*;
- whether to *sell the technology or not*.

Selection of technologies. The selection of the technologies to develop considered on two principles:

- the coherence of the technological choices with the firm's basic strategy. The technologies selected must support the firm in order to create the competitive advantage;
- the test of whether the technological change is desirable for the firm. The technological change is desirable when the advantage generated is sustainable for the firm and when the changes in the industry structure are favourable. Porter emphasises that it is necessary to look at the changes in the industry structure: a technological change may generate advantage for the firm and at the same time reduce the profitability of the whole industry. This process provokes a profitability decrease of the innovating firm too in the long term.

Leadership vs. followership. Being first mover has relevant advantages but also disadvantages. Both are identified and briefly commented in the box below.

First mover advantages	First mover disadvantages
Reputation: a relevant consequence of being a leader is the creation of an image as a pioneer in a certain business.	*Pioneering costs*: first movers have to bear costs related to the customer training and the development of the required resources.
Positioning: first mover can position itself within the business, forcing competitors to less favourable positions.	*Uncertainty of demand*: pioneers have to face with a significant variety and uncertainty of demand.
Switching costs: high switching costs for customers bring advantages to the first mover.	*Specific investments:* first movers have to sustain specific investments related to the new product/process.
Selection of the distribution channel: first movers can choose the most adequate distribution channel.	*Imitation at low cost:* imitators can adopt the technology at low cost, corroding pioneers' income.
Learning curve: first movers start learning curve in advance taking vantage of this.	*Technological discontinuities:* if there are relevant technological discontinuities, pioneers are more exposed to followers' attacks.
Access to input resources: first movers take advantage accessing to scarce resources.	*Changes in customers' needs:* if customer needs change, first movers can be associated with the old technology.
Standard definition: first movers can define the industry standard.	
Institutional barriers: first movers can raise institutional barriers against imitators.	
Initial profits: in the initial phase first movers can fix an high price because of the lack of competition.	

Figure 3.2 - Advantages and Disadvantages of the First Mover

This choice is based on two elements:

- the sustainability of the technological leadership;
- the advantages and disadvantages of being first mover.

The sustainability of the technological leadership depends on several factors:

- the source of the technological change. If the source of technology is within the industry, the technological leadership can be easier sustained, whereas, when technological source is external, other firms can access such source and the leadership is not sustainable (V. Chiesa, 2001);
- advantages related to the activity of technology development. If the activity of technology development enables the firm to get advantages such as scale economies in R&D, or higher R&D productivity, the firm's leadership is sustainable over the long term;
- the relative technological competencies. If technological competencies are unique comparing to competitors, the leadership can be easier sustained;
- the rate of diffusion of the leader technology. The process of learning by competitors can occur in different ways such as reverse engineering, information transfer through suppliers or personnel. The owner can protect the technology through a variety of resources: patenting, internal production equipment, vertical integration.

Licensing a technology (whether to sell or not). The decision to licence a technology is strictly linked to the introduction of a new technology onto the market rather than its development. Licencing a technology is convenient when it allows to:

- exploit the technology that otherwise would remain unexploited;
- access markets otherwise not available;
- introduce more rapidly a new standard;
- create competitors who stimulate the market demand, share pioneering costs and raising entry barriers;
- have higher profits than those granted by the exploitation on the market.

Porter (1985) also suggests the structure of the technology strategy formulation, defining different steps:

- identification of the specific technologies and sub-technologies of the firm's value chain;

- identification of the relevant technologies available in other industrial sectors;
- definition of the probable patterns of technological change;
- identification of the technologies critical for the firm's competitive advantage and favourable for the industry structure;
- evaluation of the firm's capabilities and the required investments for technology development;
- selection of a technology strategy able to reinforce the firm's competitive position. A possible decision could be that of acquire technologies from the outside.

3.3.3 The Resource Based Approach to Strategy

Unlike the positioning approach to strategy, which focuses on market structure and positioning within an industry, the starting point of resource based approaches to strategy is the firm's competencies and resources. The background concept is that a firm's competence is the actual source of sustainable and long term competitive advantage (Chiesa, 2001). Several contributions adopted this approach in the past: we are going to present Prahalad and Hamel (1989, 1990, 1993) and Itami and Nugami's models (1992).

Prahaland and Hamel view strategy as composed of the following fundamental elements:

- identifying the evolutionary patterns of the concerned industries;
- define the strategic architecture;
- recognise that competition is played at different levels and that differentials should be achieved at each level.
- fix stretched objectives and leverage competencies (stretch and leverage);
- design an appropriate organisation.

The turbulence and rapid change of markets, industry boundaries, customer needs, and products have brought to consider that these are not the appropriate reference points for strategy formulation. Successful firms are often those able to reshape competition and create new industries or to redefine the boundaries of existing industries, targeting latent needs or forcing changes in the purchasing attitude of customers. This means that positioning in existing industries may be not the appropriate perspective to assume in strategy formulation. This starts with the exercise of foreseeing future markets and needs in a long term perspective (5-15 years). Hamel and Prahalad emphasise that the industry foresight is a key issue and provide the required basis and the right direction to competence building and competition. Competence building requires a clear definition of how the context will be shaped and where the firm wants to be in the long term. On the basis of its long-term view of competition, a firm has to define its strategic intent in order to address the efforts. Once identified the intent, the most critical aspect is to define the action to take and the trajectory to follow. This is called strategic architecture which establishes the competencies to accumulate to compete and how to acquire them. Products are viewed as the set of functions to be performed to match customer needs and provide value to customers (Abell, 1980). Product functions are more stable than technologies and products themselves. Therefore, product functions are the basis for an organisation to develop a long-term strategy, and guide the company towards specific actions aimed to accumulate resources in a defined direction. The focus of long-term competition shifts from finding profitable product/market combinations to the inherent capability of a company to shape competition. The traditional competitive frame views strategy as selecting contexts appropriate to a firm's strengths and positioning favourably. The attention is paid to end products and their markets. In the competence-based competition competitive arenas are seen as factors which may be influenced and controlled by the firm. Roots of competitive advantage reside into a firm's existing resources and assets (competencies), and sustaining competitive advantage over time means to continuously create and develop new asset-based asymmetries beside the exploitation of the existing ones. End products become just the leaves of the tree of which the roots are the firm's intangible assets. These distinctive core competencies are the basis of long term competition, whilst end products are just the current (transient) embodiments of a firm's competitive advantage. The tangible link between core competencies and end products is the core product that is the physical embodiment of one or more core competencies; in other words, the core component that generates

the value of the end products. Core competencies have been defined in a variety of ways. They are viewed as a set of irreversible assets along which the firm is uniquely advantaged (Collis, 1991). Prahalad and Hamel (1990) have defined the core competencies as the collective learning in the organisation, especially how to co-ordinate diverse production skills and integrate multiple streams of technologies, stressing the role of technology. Core competencies represent the result of a cumulative resource development process and are based on skills and knowledge embedded in the organisation. Such skills are built incrementally via a series of learning cycles within a long term process of accumulating capabilities (Grindley, 1991). Knowledge and skills which are hard to imitate are source of lasting advantage. Prahalad and Hamel clearly state the key characteristics of competencies to be core:

- provide value for the customers;
- lead to a variety of applications;
- are hard to imitate.

On the other hand, Itami and Numagami's review deals with the dynamic interactions between technology and strategy. The types of interactions between the two elements are three:

- between current strategy and current technology;
- between current strategy and future technology;
- between future strategy and current technology.

The first case focuses on the contemporaneous match between the strategy the firm wants to take and the technology it possesses. The underlying assumptions are that technology can act on strategy in three ways:

- a weapon to differentiate the firm from its competitors;
- a constraint to which firms must adapt;
- a threat firms have to guard against and cope with.

The second perspective is that current strategic decisions have implications for future technology accumulation. Strategy is designed to facilitate the development and accumulation of new knowledge in technological fields to be exploited in future competition. The third perspective is concerned with the effects of current technology on future strategy of the firm. Technology that the firm possesses now and/or the firm's current commitment to technological development affect human cognitive processes for strategy formation within the firm. Technology drives cognition of a particular strategy

as it channels and activates idea generation processes and helps integrate fragmentary ideas. It is technology which drives the strategy formation process. The above contributions draw the conceptual approaches to technology strategy and define the relationship between technology and strategy. Next chapter describes the different technologies strategies particularly suitable for dynamic competitive contexts.

3.3.4 Different approaches to Technology Strategy

Five major categories of technology strategies can be identified (Chiesa, 2001):

- *competence deepening,*
- *competence fertilising,*
- *competence refreshing,*
- *competence complementing,*
- *competence destroying*.

These different types of technology strategy can be positioned on the *technology-applications matrix*, defining which are the most appropriate for each intersection. Basically it depicts the different scenarios in terms of technologies and applications, representing the basis of strategy formulation. The matrix is the result of an *external and internal context analysis* allowing organizations to realize the evaluation of technologies owned and the ones to be introduced. Specifically the externally driven analysis guides towards the identification of the future scenarios, defining both the potential applications to fulfil new customer needs and the related technologies. On the other hand the internally driven analysis reviews the set of the technological skills available within the firm and leads to the identification of the applications which could be generated exploiting such skills.

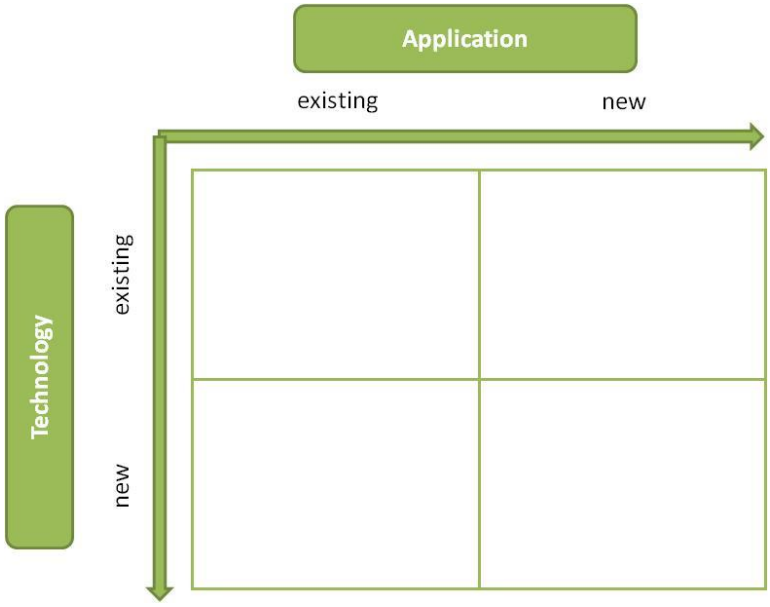

Figure 3.3 – The Technology-Application Matrix

The sense of the matrix will be explained in the "process and tools section", describing the techniques that allow to build the grid.

Competence deepening. Such strategy means investing on the technology/applications which are fundamental to the firm's current strategy. Concentrating investments on them would mean to found a firm's technology strategy on the deepening of the current base of knowledge and reinforce a firm's current technology base. This strategy is feasible if the existing skills are likely to remain highly appropriable, and are already widely applied. The critical element is how long they will remain appropriable. Undertaking such strategy means to strongly rely on the current critical technologies and on maintaining the knowledge gap with respect to competitors. A risk associated with such strategy is to keep the technical knowledge base too limited.

Competence fertilising. Competence fertilising actions concern technologies already available within the firm which show strong potential to create new applications. The development of these new applications could provide cross fertilisation effects with the existing applications, as they use the same technological base. Problems may rise on the commercialisation side, depending on the degree of familiarity of the firm with the markets of the new applications. In technological terms, investing on these technologies would mean to strongly reinforce the current competence base through providing a wider range of opportunities associated with it. Again this strategy is feasible if the current

technological base is likely to remain appropriable in the future. It is advisable when the range of application of the current technology base needs to be broadened.

Competence complementing. Investing on competence complementing technology/application combinations means to acquire new technologies to be integrated with the current set of technologies in order to open new market opportunities. This strategy underlies a key process to progressively shift the technological base from the current to a new one. As a matter of fact, it relies upon the integration of available technologies with new technologies to generate new applications or new modes of doing existing applications. The combination of new and existing technologies reduces the technological risk related to the applications. The use of the combination of such technologies for the development of existing applications reduces the associated commercial risk, as the firm is familiar with the related markets. Therefore, if correctly conceived and applied, this strategy helps change the firm's technological knowledge base gradually. Some acquired technologies become part of the future critical technology base and could be used in the future together with further new technologies to generate new applications and so on. In other words, investing on them means to make the first step to move to a new competence base.

They can be conceived competence complementing actions which may have lower strategic impact. They can concern new technologies which are not expected to become part of the future critical technological base. They simply allow to open new application opportunities at the moment, leaving that the firm's advantage is still based on the current technology base. In other words, it may occur that the new technologies are simply acquired to generate new applications but are not part of the future technology base.

Competence refreshing. Such investments are aimed to acquire new technologies which have the potential to generate a cluster of new applications in the future. Their potential to create a new technology base depends on the degree of appropriability associated with them. Undertaking competence refreshing may be highly risky as they involve the change of the technology base and concern new applications.

Competence destroying. The strategy conceived may also point out that certain technologies may erode the set of knowledge required for certain existing applications to be performed in the future. In other words the set of technologies required to operate certain businesses shifts and these new technologies are likely to prevail in the long term. If the firm recognises that there are no

opportunities to shift its knowledge base to stay in the same application range, it needs to refresh its current technological base. The earlier the firm recognises that a competence destroying set of technologies is emerging, the earlier can attempt to refresh its competence. This process can be speeded up through alliances and joint ventures that reduce the cost of refreshing competence. On the other hand, a firm can undertake competence destroying strategies aimed to build a new technology base and remain in the same application range. Conceptually competence refreshing and competence destroying actions do not differ. They both attempt to create a new technology base. The result is different, as competence destroying strategies lead to replace the existing base to realise the same set of applications, whereas competence refreshing strategies lead to create a new technology base but for new applications and therefore they do not lead to replace the existing one.

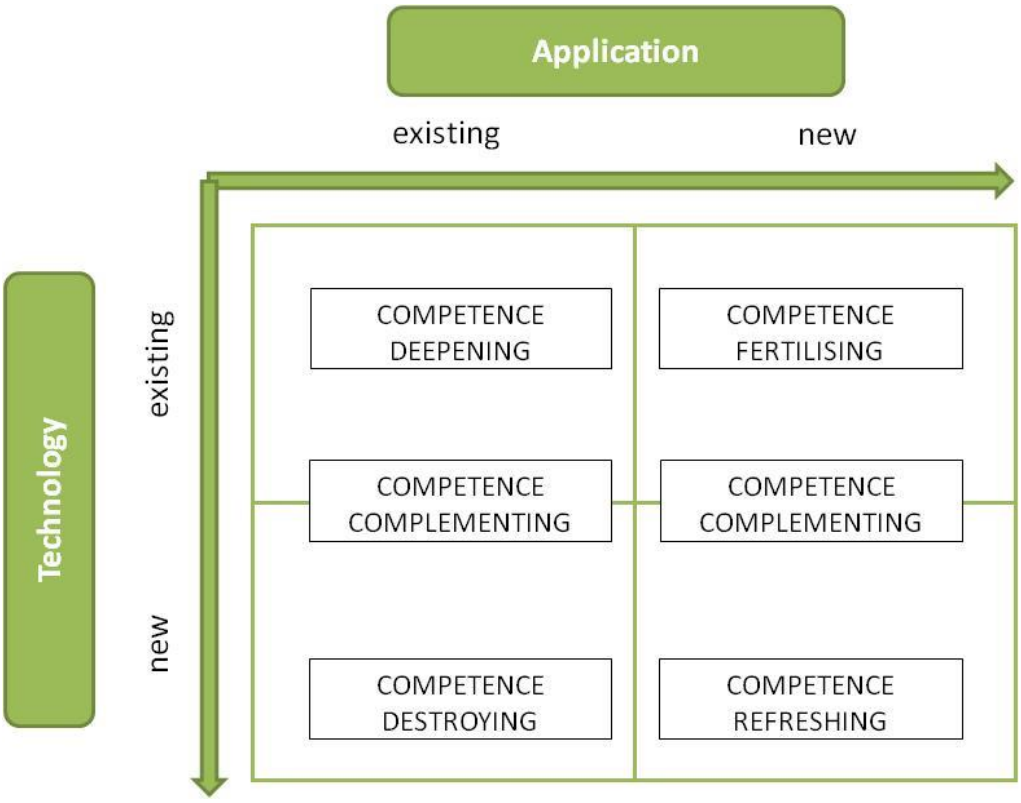

Figure 3.4 – The Major Categories of Technology Strategies

3.4 Business Strategy

3.4.1 Limits of a competitive approach

For the last twenty-five years competition has occupied the centre of strategic thinking. Indeed, one hardly speaks of strategy without drawing on the vocabulary of competition (W.C. Kim and R. Mauborgne, 1997). Such focus on the competition traces back to corporate strategy's root in military strategy. The very language of corporate strategy is deeply imbued with military references—chief executive "officers" in "headquarters". Described this way, strategy is about confronting an opponent and fighting over a given piece of land that is both limited and constant (Carl von Clausewitz, 1993).

Industrial organization economics gave formal expression to the prominent importance of competition to firm's success. IO economics suggests a casual flow from market structure to conduct and performance (J.S. Bain, 1956). Here, market structure, given by supply and demand conditions, shapes sellers' and buyers' conduct, which, in turn, determines end performance (F.M. Scherer, 1970). The academics call this the structuralist view, or environmental determinism. Taking market structure as given, much as military strategy takes land as given, such a view drives companies to try to carve out a defensible position against the competition in the existing market space. To sustain themselves in the marketplace, practitioners of strategy focus on building advantages over the competition, usually by assessing what competitors do and striving to do it better. Here, grabbing a bigger share of the market is also seen as a zero-sum game in which company's gain is achieved at another company's loss. Hence, competition, the supply side of the equation, remains the defining variable of strategy with the focus on diving up existing industry space (W.C. Kim and R. Mauborgne, 2005). Not surprisingly the result has been a fairly good understanding of how to compete skilfully in established markets, from analysing the underlying economic structure of an existing industry to choosing a strategic position of low cost or differentiation or focus (M.E. Porter, 1996). The arsenal of analytic tools and frameworks ranging from the five force framework to the value chain successfully anchored competition at the core of strategy. But should it be? The last study carried out by Kim and

R. Mauborgne suggests no. Strategies driven by competition usually have three latent effects (W.C. Kim and R. Mauborgne, 1997):

- *Imitative, not innovative*, approaches to the market.
- *Companies act reactively*. All the resources are absorbed in responding to daily competitive moves, rather than creating growth opportunities.
- A company's understanding of emerging mass markets and changing customer demands becoming *hazy*.

Conventional strategic logic drives a company to offer better solutions than rivals to existing problems defined by an industry. To achieve sustained profitable growth, companies must break out of the competitive and imitative trap; rather than striving to match or outperform the competition, organizations must cultivate innovation. Kim and Mauborgne's theory treats these concepts, suggesting companies abandoning red oceans and creating Blue Oceans in order to seize new profit and growth opportunities.

3.4.2 The Blue Ocean Strategy

W. Chan Kim and Renée Mauborgne believe Blue Ocean Strategy is the best organizational strategy to generate growth and profits. Blue Ocean Strategy suggests that an organization should create new demand in an uncontested market space, or a "Blue Ocean", rather than compete head-to-head with other suppliers in an existing industry. Let's analyse the Blue Ocean concept. Imagine a market composed of two different kinds of oceans: *red oceans and Blue Oceans*. Red oceans represent all the industries in existence today. This is the known market space. Blue Oceans denote all the industries not in existence today. This is the unknown market space. In the red oceans, industry boundaries are defined and accepted, and the competitive rules of the game are known (H.C. White, 1981). Here companies try to outperform their rivals to grab a greater share of existing demand. The dominant focus of strategy work over the past twenty-five years has been on competition-based red ocean

strategies (P. Auerbach, 1988). As the market space of red oceans gets crowded, prospects for profits and growth are reduced. Products become commodities and cutthroat competition turns the red ocean bloody.

Blue Oceans, in contrast, are defined by untapped market space, demand creation, and the opportunity for highly profitable growth. In Blue Oceans, competition is irrelevant because the rules of the game are waiting to be set (W.C. Kim and R. Mauborgne, 2005). Blue Oceans represent a vast, deep and not yet explored market space with wide potentialities. Red oceans will always matter, but the accelerated technological advances and the globalization push companies to go beyond competing in established industries. Red oceans become increasingly bloody because of commoditization of products and services, increasing price wars, and shrinking profit margins: management will need to be more concerned with Blue Oceans than the current cohort of managers is accustomed to.

In sharp contrast to companies playing by traditional rules, the creators of Blue Oceans never used the competition as their benchmark. Instead they made it irrelevant by creating a leap in value for both buyers and the company itself. While competition-based red ocean strategy assumes that an industry's structural conditions are given and that firms are forced to compete within them, Blue Ocean strategy is based on the view that market boundaries and industry structure are not given and can be reconstructed by the actions and beliefs of industry players. This is what is generally called the Reconstructionist view. In the red oceans, strategy is essentially a choice between differentiation and low cost. In the Reconstructionist world, however, the strategic aim is to create new rules of the game by breaking the existing value/cost trade-off and thereby creating a Blue Ocean. In the Reconstructionist view extra demand is out of the market, largely untapped.

The creation of Blue Oceans is about driving costs down while simultaneously driving value up for buyers. This is how a leap in value for both the company and its buyers is achieved. Because buyer value comes from the utility and price and because the value of the company is generated from price and its cost structure, Blue Ocean strategy is achieved only when the entire system of the company's utility, price, and cost activities is properly aligned (W.C. Kim and R. Mauborgne, 2005). The figure 3.5 [Red Ocean Versus Blue Ocean Strategy] depicts the main differences between the two distinct strategies.

Red Ocean Strategy	Blue Ocean Strategy
Compete in existing market space	*Create uncontested market space*
Beat the competition	*Make the competition irrelevant*
Exploit existing demand	*Create and capture new demand*
Make the value-cost trade-off	*Break the value-cost trade-off*
Differentiation or low cost	*Differentiation and low cost*

Figure 3.5 – Red Ocean Strategy versus Blue Ocean Strategy

3.4.3 Value Innovation: The Cornerstone of Blue Ocean Strategy

In Kim and Mauborgne's opinion what consistently separated winners from losers in creating Blue Oceans was their approach to strategy. The creators of Blue Oceans followed a logic that the authors call value innovation. Value innovation is a new way of thinking about and executing strategy that results in the creation of a Blue Ocean and a break from the competition. Importantly, value innovation defies one of the most commonly accepted dogmas of competition-based strategy: the value-cost trade-off. It is conventionally believed that companies can either create greater value to customers at a higher cost or create reasonable value at a lower cost. Here strategy is seen as making a choice between differentiation and low cost. In contrast, those that seek to create Blue Oceans pursue differentiation and low cost simultaneously.

As shown in figure 3.6 below, the creation of Blue Oceans is about driving costs down while simultaneously driving value up for buyers. This is how a leap in value for both the company and its buyers is achieved. Because buyer value comes from the utility and price that the company offers to buyers and because the value to the company is generated from price and its cost structure, value innovation is achieved only when the whole system of the company's utility, price, and cost activities is properly aligned. It is this whole-system approach that makes the creation of Blue Oceans a sustainable strategy. Blue Ocean strategy integrates the range of a firm's functional and operational activities. In contrast, innovations such as production innovations can be achieved at the subsystem level without impacting the company's overall strategy. An innovation in the production process, for example, may lower a company's cost structure to reinforce its existing cost leadership strategy without changing the utility proposition of its offering. Although innovations of this sort may help to secure and even lift a company's position in the existing market space, such a subsystem approach will rarely create a Blue Ocean of new market space. *Value innovation* is about strategy that embraces the entire system of a company's activities: it requires companies to orient the whole system toward achieving a leap in value for both buyers and themselves.

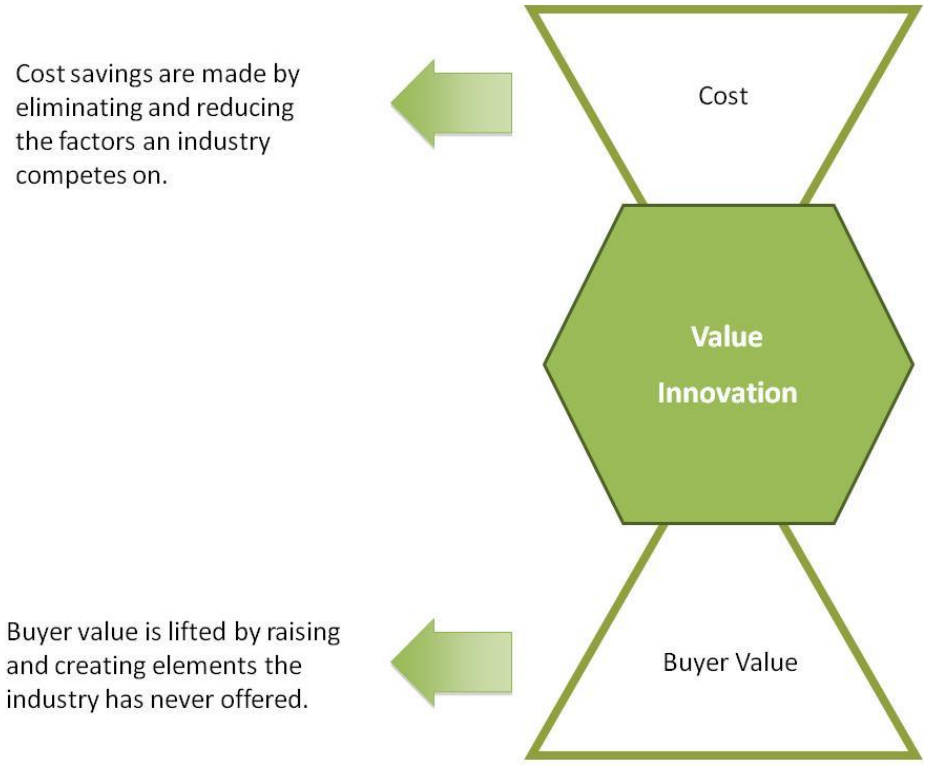

Figure 3.6 – Value Innovation: The Cornerstone of Blue Ocean Strategy

3.4.4 Formulating the Blue Ocean Strategy

Accelerated technological advances have substantially improved industrial productivity and have allowed suppliers to produce an unprecedented array of products and services. The result is that in increasing numbers of industries, supply exceeds demand. The trend toward globalization compounds the situation. While supply is on the rise as global competition intensifies, there is no clear evidence of an increase in demand worldwide, and statistics even point to declining populations in many developed markets. The result has been accelerated commoditization of products and services, increasing price wars, and shrinking profit margins. In overcrowded industries, differentiating brands becomes harder in both economic upturns and downturns. As red oceans become increasingly bloody, management struggle to find out untapped markets.

Literature presents some principle in formulating a compelling Blue Ocean strategy; particularly the first one is to reconstruct market boundaries in order to break from the competition and create Blue Oceans. The challenge is to successfully identify commercially Blue Ocean opportunities. Abandoning conventional competitive theories, companies wreck market boundaries and stray towards Blue Oceans. Fundamental assumptions companies tend to accept are listed below:

- Define their industry similarly and focus on being the best within it
- Look at their industries through the lens of generally accepted strategic groups (such as luxury automobiles, economy cars, and family vehicles), and strive to stand out in the strategic group they play in
- Focus on the same buyer group, be it the purchaser (as in the office equipment industry), the user (as in the clothing industry), or the influencer (as in the pharmaceutical industry)
- Define the scope of the products and services offered by their industry similarly
- Accept their industry's functional or emotional orientation.

To break out of red oceans, companies must break out of the accepted boundaries that define how they compete. Instead of looking within these boundaries, managers need to look systematically across them to create Blue Oceans. They need to look across alternative industries, across strategic groups, across buyer groups, across complementary product and service offerings, across the

functional-emotional orientation of an industry, and even across time. This gives companies keen insight into how to reconstruct market realities to open up Blue Oceans.

Furthermore most companies' strategic planning process keeps them wedded to red oceans. The process tends to drive companies to compete within existing market space. A typical strategic plan starts with a lengthy description of current industry conditions and the competitive situation. It continues with discussion of how to increase market share, capture new segments, or cut costs, followed by an outline of numerous goals and initiatives. The process usually culminates in the preparation of a large document full of data provided by people from various parts of the organization who often have conflicting agendas and poor communication. In this process, managers spend the majority of strategic thinking time filling in boxes and running numbers instead of thinking outside the box and developing a clear picture of how to break from the competition. These considerations bring to the second principle of Blue Ocean strategy: focus on the big picture, not the numbers. This principle is fundamental to mitigating the planning risk of investing lots of effort and lots of time but delivering only tactical red ocean move. Authors developed an alternative approach to the existing strategic planning process that is based not on preparing a document but on drawing a strategy canvas. This approach leads companies to creativity, opening organizations' eyes to Blue Oceans. By building a company's strategic planning process around a strategy canvas, a company and its managers focus their main attention on the big picture rather than becoming immersed in numbers and jargon and getting caught up in operational details. Drawing a strategy canvas does three things. First, it shows the strategic profile of an industry by depicting very clearly the factors (and the possible future factors) that affect competition among industry players. Second, it shows the strategic profile of current and potential competitors, identifying which factors they invest in strategically. Finally, it shows the company's strategic profile depicting how it invests in the factors of competition and how it might invest in them in the future. The strategic profile with high Blue Ocean potential has three complementary qualities: focus, divergence, and a compelling tagline. If a company's strategic profile does not clearly reveal those qualities, its strategy will likely be muddled, undifferentiated, and hard to communicate. The authors have developed a structured process for drawing and discussing a strategy canvas that pushes a company's strategy toward a Blue Ocean. The process has four major steps that are reported in the figure 3.7.

Visual Awakening	Visual Exploration	Visual Strategy Fair	Visual Communication
• Compare your business with your competitors' by drawing your "as is" strategy canvas • See where your strategy needs to change	• Go into the field to explore the paths to creating Blue Oceans • Observe the distinctive advantages of alternative products and services • See which factors you should eliminate, create or change	• Draw you "to be" strategy canvas based on insights from field observations • Get feedback on alternative strategy canvases from customers, competitors' customers and noncustomers • Use feedback to build the best "to be" strategy	• Distribute your before-and-after strategic profiles on one page for easy comparison • Support only those projects and operational moves that allow your company to close the gaps to actualize the new strategy

Figure 3.7 – The Phases towards A Compelling Strategy Canvas

The third principle of Blue Ocean strategy supports companies in maximizing the size of Blue Oceans. Reach beyond existing demand. This is a key component of achieving value innovation. By aggregating the greatest demand for a new offering, this approach attenuates the scale risk associated with creating a new market. To achieve this, companies should challenge two conventional strategy practices. One is the focus on existing customers. The other is the drive for finer segmentation to accommodate buyer differences.

Typically companies strive to retain and expand existing customers. This often leads to finer segmentation and greater tailoring of offerings to better meet customer preferences. The more intense the competition is, the greater, on average, is the resulting customization of offerings. As companies compete to embrace customer preferences through finer segmentation, they often risk creating too-small target markets. To maximize the size of Blue Oceans, companies need to take a reverse course. Instead of concentrating on customers, they need to look to noncustomers. And instead of focusing on customer differences, they need to build on powerful commonalities in what buyers' value. That allows companies to reach beyond existing demand to unlock a new mass of customers that did not exist before. Specifically, Kim and Mauborgne distinguish among *three tiers of noncustomers* that can be transformed into customers. They differ in their relative distance from the

market. As depicted in the figure 3.8, the first tier of noncustomers is closest to the market. They sit on the edge of the market. They are buyers who minimally purchase an industry's offering out of necessity but are mentally noncustomers of the industry. They are waiting to jump ship and leave the industry as soon as the opportunity presents itself. However, if offered a leap in value, not only would they stay, but also their frequency of purchases would multiply, unlocking enormous latent demand. The second tier of noncustomers is people who refuse to use the analyzed industry's offerings. These are buyers who have seen the industry's offerings as an option to fulfill their needs but have voted against them. They are noncustomers who have never thought of a specific company's offerings as an option. By focusing on key commonalities across these noncustomers and existing customers, companies can understand how to pull them into their new market.

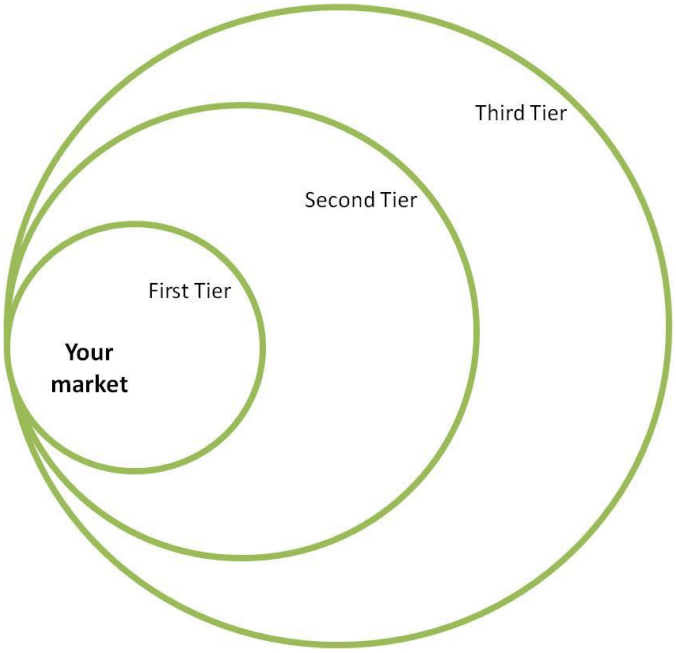

Figure 3.8 – Non-Customers Tiers

First Tier: "Soon-to be" noncustomers who are on the edge of your market, waiting to jump ship.

Second tier: "Refusing" noncustomers who consciously choose against your market.

Third Tier: "Unexplored" noncustomers who are in markets distant from yours.

The last challenge in defining a compelling Blue Ocean strategy is to build a robust business model. This brings to the fourth principle: get the strategic sequence right. With an understanding of the right

strategic sequence and of how to assess Blue Ocean ideas along the key criteria in that sequence, it is possible to dramatically reduce business model risk.

As shown in the figure 3.9, companies need to build their Blue Ocean strategy in the sequence of buyer utility, price, cost, and adoption.

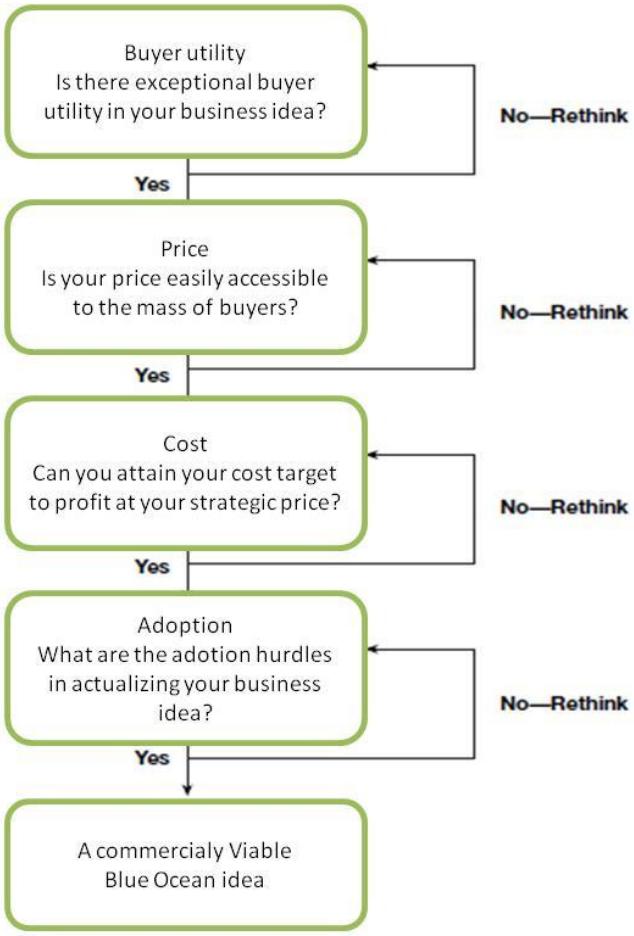

Figure 3.9 – How To Build a Blue Ocean Strategy

The starting point is *buyer utility*. Companies should ask themselves about their offering's exceptional utility and specifically whether there is a compelling reason for the mass of people to buy it. Absent this, there is no Blue Ocean potential to begin with. Here authors suggest two options. Park the idea, or rethink it until companies reach an affirmative answer. The second step is about *setting the right strategic price*. A company does not want to rely solely on price to create demand. Companies should propose an offering priced to attract the mass of target buyers in order to create irresistible market buzz. These first two steps address the revenue side of a company's business model. They ensure that companies create a leap in net buyer value, where net buyer value equals the utility buyers receive

minus the price they pay for it. The third element of this analysis is *cost*. It is fundamental that companies produce offerings at the target cost, profiting at the strategic price, avoiding letting costs drive prices. When the target cost cannot be met, organizations must either forgo the idea because the Blue Ocean won't be profitable, or they must innovate business models to hit the target cost. The cost side of a company's business model ensures that it creates a leap in value for itself in the form of profit—that is, the price of the offering minus the cost of production. It is the combination of exceptional utility, strategic pricing, and target costing that allows companies to achieve value innovation—a leap in value for both buyers and companies.

The last step is to address *adoption hurdles*. The formulation of Blue Ocean strategy is complete only when organizations can address adoption hurdles in the beginning to ensure the successful actualization of their idea. Adoption hurdles include, for example, potential resistance to the idea by retailers or partners. Because Blue Ocean strategies represent a significant departure from red oceans, it is key to address adoption hurdles up front. The key challenge is to engage in an open discussion about why the adoption of the new idea is necessary with three groups of stakeholders—employees, partners, and the general public—. It's necessary to explain its merits, set clear expectations for its ramifications, and describe how the company will address them. Companies that take the trouble to have such a dialogue with stakeholders will find that it amply repays the time and effort involved.

3.5 Design Strategy

When we go deep inside the features of the Innovation Process, we also have to consider that, at an early stage, organisations must strive to identify and prioritise potentially lucrative ideas linked to particular technologies (Whelan, 1988). It is all about Design and all about how potential ideas and technologies are interpreted and how these technologies can generate new opportunities.

"The etymology of design goes back to the Latin de + signare and means making something, distinguishing it by a sign, giving it significance, designating its relation to other things, owners, users or gods. Based on this original meaning, one could say: design is making sense [of things]." (Klaus Krippendorff, 1989)

The literature about the role of design in a company is such a spread and articulated one and we already discussed some good point in the previous chapter about the Innovation Strategy. What we really want to focus on in this chapter, instead, is the central role that design must play at the early stages of the innovation process, as interpreter of company's needs and enabler of new applications. Designers are involved in the whole innovation process, but their role is vital in the first part of *"making sense of things",* as Krippendorff stated above.

3.5.1 From traditional models to Design-Driven Innovation

The new product development process, together with the innovative nature it embeds, is typically considered to be one of the generation and interpretation of knowledge and it was and has been point of discussion in many literary works. In this wide field the literature originally identified two principal knowledge sources: knowledge about the availability of new technologies and knowledge about explicit customer needs. Since from the first years of research, in the early 80', Dosi revealed

two different approaches to innovation in terms of strategy: market-pull and technology-push (Dosi, 1982).

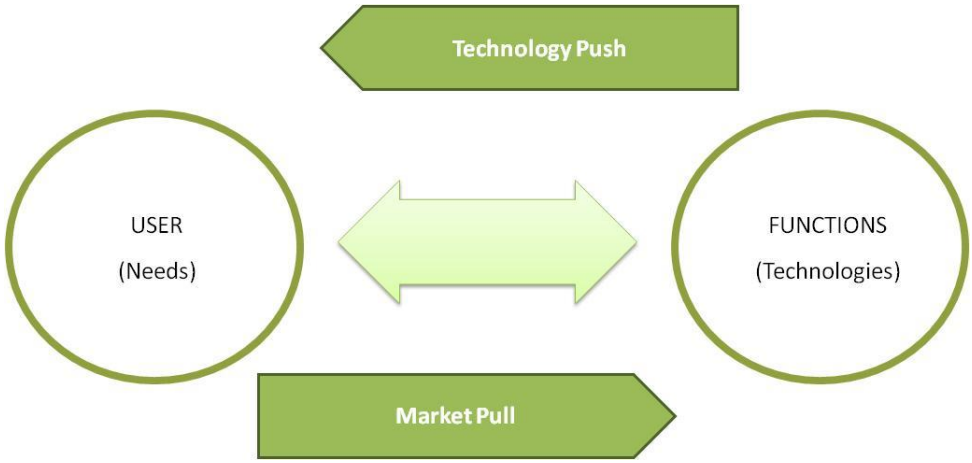

Figure 3.10 – Traditional approaches to innovation

The Market Pull approach bases on the idea that the knowledge necessary to innovate is embedded in the market: new products are the direct consequence of explicit needs expressed by the consumers (the arrow from left to right in the figure 3.10). The hypothesis at the base of this approach is that consumer needs are elements that can be identified and translated into physical products. In order to innovate effectively, companies need to know thoroughly and interpret correctly consumer needs (Stein and Iansiti, 1995). Market drivers become relevant for incremental innovation, where incremental adaptations of product meanings stems from the natural evolution of explicit cultural models adopted by customers. However market factors lose importance in radical innovation, where innovations originate from new cultural scenarios.

The technology-push approach rather than being driven by the market is based on the company's R&D activities that, through the identification and development of new technologies, allow to create new products (Abernathy and Clark, 1985; Henderson and Clark. 1990). Companies need to generate new pieces of knowledge (technologies) as result of internal research, and valorise them by creating products (the arrow from right to left in the figure 3.10).

In addition to that, in more recent years or research, Verganti (2006, 2008, 2009) has developed and described a *design-driven approach* that is complementary to market-pull and Technology Push In the design-driven approach, innovation stems from a third knowledge source, one that adds knowledge about user needs and technological opportunities: "the knowledge about the signs that can be used

to deliver a message to the user and about the socio-cultural context in which the user will give meaning to those signs". So the ability to understand, anticipate and influence the emergence of new product meanings becomes the driver of innovation.

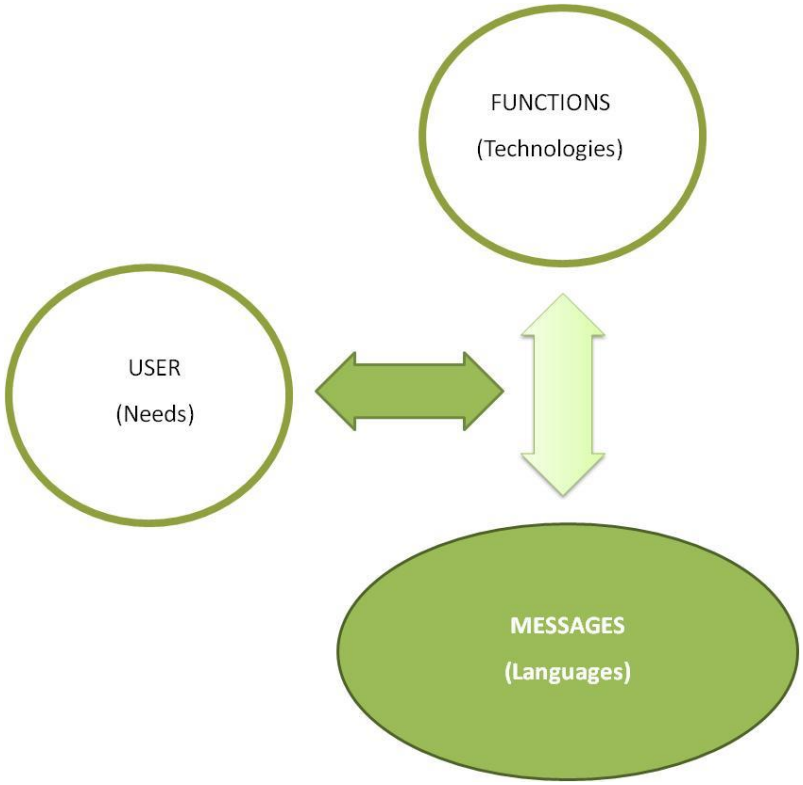

Figure 3.11 - The role of messages and languages (adapted from Verganti, 2008)

Companies like Nintendo or Apple, for example, hardly start from users' needs and requirements to activate the innovation process: they follow a different strategy that aims at radically change the emotional and symbolic content of products, i.e. their meanings and languages, through a deep understanding of broader changes in society, culture and technology. Rather than being pulled by user requirements, Design Driven Innovation is pushed by a firm's vision about possible new product meanings and languages that could diffuse in society (Verganti, 2009). What also expresses is the fact that this new messages and languages cannot be considered separately from the product functions, at the point that sometimes they are so entangled that distinguishing performance from meaning, and technology from language, is almost impossible. Indeed, there is a profound difference between changing a product's function but leaving its meaning untouched, and changing a function in order to radically innovate what a product means. In the latter case, the ultimate purpose of innovation is to

innovate meaning and the impact on business value is much more significant as the design-driven approach states. All the dynamics described are illustrated in the figure 3.11, in order to clarify the concepts.

3.5.2 The concept of Technology Epiphany

We can consider the impact of each approach both on the *dimension of performances and meanings*: changes on this two axes can assume an incremental or a radical nature (see 3.12): as stated in the previous paragraph, as long as innovation comes from the market, incremental improvements can be reached, searching for technologies that can better satisfy existing needs, or update product languages to respond to existing trends; but when innovation is driven by technology, the new product development process brings new functions into products, allowing a radical improvement on the functional dimension; at the same way, when design and product meanings are the main drivers of innovation, new meanings and messages can be embedded by products.

But what does take place when a powerful change is the combination of radical improvements both on the functional and semantic dimensions?

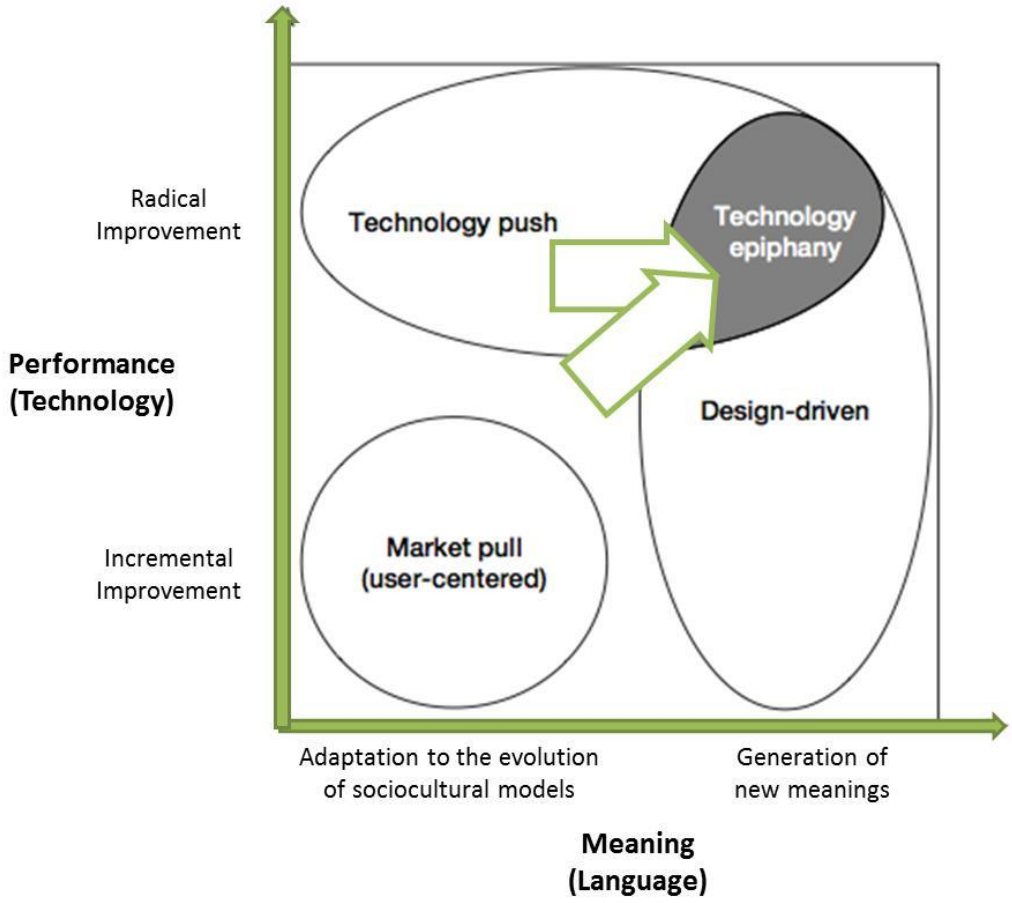

Figura 3.12 - The interplay between Technology-push and Design-driven innovation (Verganti, 2009)

The answer is *the interplay between technology-push and design-driven innovation*. Technologies become an enabler of new product meanings, mixing research activities related to new technologies and studies about emerging lifestyles and societal values in order to introduce radical design-driven innovations. The identification of innovative meanings is combined with research on new materials, surface treatments, manufacturing processes, etc., that can be embedded into new products. In this sense technological research and design research work together, exploring new languages embedded in artefacts and, consequently, playing with new technologies and new materials. They *coevolve* through both those small (incremental) and large (radical) innovation cycles we described (Latour, 1987). The concept behind it, studied by Verganti (2009), is that each technology is considered to embed a set of disruptive new meanings that are waiting to be uncovered. If a company reveals those

quiescent meanings it will seize the full value of technology, celebrating what Verganti (2009) calls a *Technology Epiphany*.

Unfortunately short sighted companies often focus on the search of new markets for a technology without taking in consideration its meanings. In this way when companies look for potential applications they just focus on *technological substitutions*: companies add more effective and powerful functionality or improve performance, leaving the existing meaning untouched. The myopic part of the industry embraces the new technology for utilitarian reasons— until a firm invests on design driven-innovation, finds out the disruptive quiet meaning and realizes its full potential. Especially in technology-intensive companies, design has got a minor role: in this companies design is eventually useful for creating a user friendly interface, thus making technology more accessible, and for wrapping the technology core in a nice box, but nothing more. In literature we can find some theories of management of innovation and technological breakthroughs that don't share this view of design: they usually describe industries as evolving through several stages (Utterback, 1994). In the early stage one or more radically new technologies break into an industry: this stage allows leapfrog changes of functions and performance. In this stage competitors struggle to find the most effective product architecture, solving technological problems. When the technology has run its course, innovation becomes incremental, the product becomes a commodity and everyone waits for another technological breakthrough. Hence design plays a role during incremental innovation, as a *differentiator*: only after the technology has provided everything it can, design could intervene in the innovation process making products different from the competitors' ones, leveraging on fast creativity, user interface, and style. In its radical version as *design-driven innovation*, design plays a major role at an inception of the technology, especially when a breakthrough technology arises. When a breakthrough technology emerges, it embeds many potential meanings. Some are immediate and promoted by those who have initially guided technological development. Other meanings are quiescent, but sooner or later they become. The same phenomena was also recognized by Tempelman *et al* (2012) when they spoke of the need for "technology transformation" i.e. the process of change that a technology undergoes when it gets 'productized' during product design.

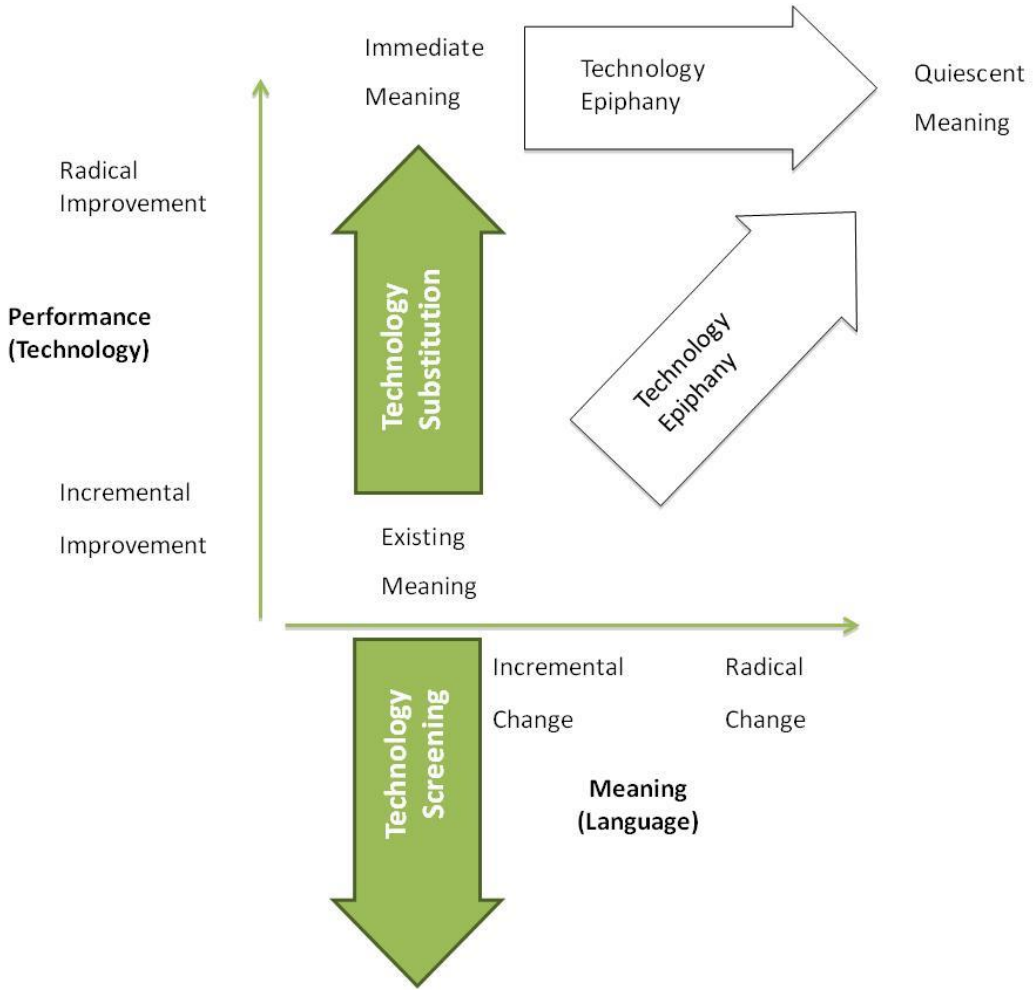

Figure 3.12 – Comparison of Strategies to Manage Break-Through Technologies: Purely Technologies or Interwoven With Design-Driven Innovation

Short sighted companies that see innovation strategy only in terms of technology will not search for the quiescent meaning. This approach leads to two myopic behaviours. On the one hand if the most immediate meaning of a new technology cannot support the existing meaning in the market, companies screen it off (the down arrow in the figure 3.12), considering it irrelevant to competition. Instead, if the most immediate meaning of the new technology does fit the existing meaning, a company will invest by substituting the new technology for current technologies (the upward arrow in the figure 3.12). However someone will eventually have a Technology Epiphany. A Technology Epiphany may occur when a company has understood that radical new meaning can emerge in the market and therefore is open to new technologies — usually those that competitors have screened of. Or a technological epiphany may occur when a company searches for the more-powerful meanings

that a new technology embeds, as indicated by the horizontal arrow in figure 3.12. There are several basic implications of this analysis: first of all, the full potential of technological breakthrough is achieved only when someone uncovers the more-powerful quiescent meaning of a new technology. In addition, a Technology Epiphany is usually much more disruptive to competition than the technological breakthroughs itself. Least but not last, given that technology-push and design-driven are closely linked, design is often critical, even for high-tech firms and their R&D: investigations into radical new technological should go hand in hand with the investigations into radical new meanings. Companies must be able to catch and understand emerging trends in society and this "listening" activity has to be integrated with research on technologies that allow products to embed new languages and coherent meanings in an appropriate way. This articulated process has two main actors: *designers* on one side and *material researchers* on the other. Design satisfies the need to be sensitive to socio-cultural messages and research offers the ability to transfer different inputs and stimuli into real projects, in order to exploit accumulated knowledge about socio-cultural phenomena and transform it into new products. In fact, a second role of designers in this process is to 'translate' the quiescent user needs towards unexplored technological functionalities/affordances, and back. By virtue of their education and experiences, designers tend to be better-suited for this bridging role than the other stakeholders in the innovation process.

CHAPTER 4

Literature Review - Innovation Process

After we explained the well-established strategies adopted by companies to generate and organize innovation when moving toward new applications, we scanned the literature sources in order to identify the right processes that result from the statement and development of the strategy itself. In particular, the object of the research in this section became the identification of specific methods that constitute the new product development process, from different points of view. The analysis proceeded with the leading scheme of the previous chapter. So, after we analysed technology, business and design strategy, we went through the investigation of the related processes maintaining the same structure.

4.1 Technology Process

4.1.1 The Context Foresight: the base of Technology Strategy

In dynamic contexts, decisions are taken on the basis of information gathered on the future shape of competition and industries, the forecast technological progress and the evolution of the external and internal context of the firm. The process of context foresight provides the base for future scenarios and represents the starting point of strategy formulation through the creation of the *technology-application matrix*. As anticipated in the part of literature concerning technology strategy, the matrix shows different scenarios in terms of applications and related technologies a company intends to focus on. It combines technology and applications from a double perspective:

- it links technological skills available within the firm to applications which could be generated exploiting such skills;
- it associates potential applications that could fulfil future customer needs to required technology.

The matrix offers a framework supporting companies in defining strategy according to the selected scenarios. The matrix is built on both external and internal context analysis: it represents the result of a context foresight that evaluates both future market shape and current company's technological condition. It allows to map company's future intentions and to link the correct strategies to achieve them. A focus on the process that brings to the development of the matrix is presented below, through the externally driven context analysis and then the internally driven one.

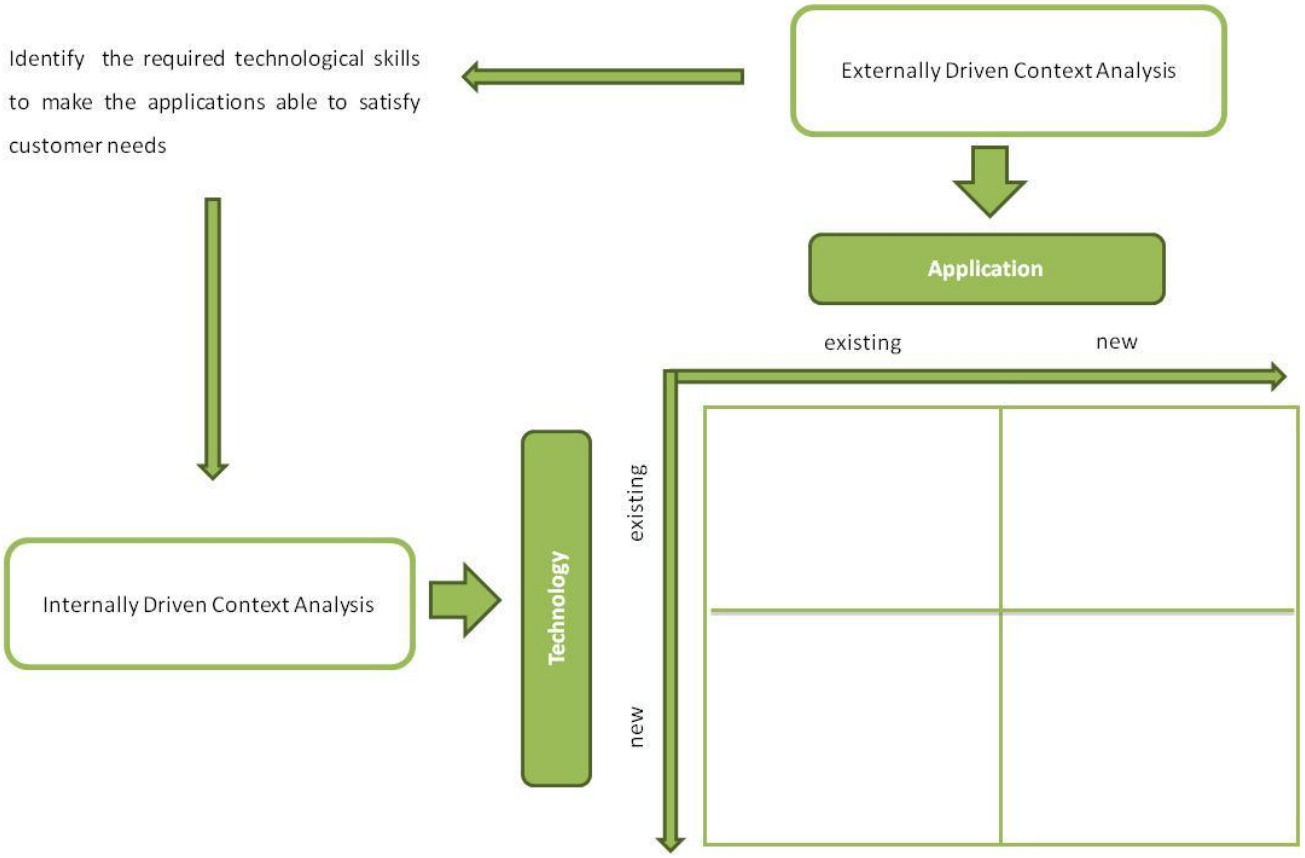

Figure 4.1 – The Context Foresight

Externally Driven Context Analysis

This analysis conceives market evolution and industry foresight as the drivers of the process of accumulation of the appropriate technological resources. It includes two steps:

- *the identification of the market shape and customer needs* in the future and the related applications;
- *the identification of the technologies* required to make applications.

The first step is the identification of how markets will be shaped in the future and customer needs will evolve. The central factors are the value for the customer and the understanding of its evolution. The value for the customer is related with product functionality and critical performance. The external analysis should therefore help understand the evolution of the dominant product paradigm able to satisfy customer benefits in the future. Benefits could concern not only the satisfaction of existing needs but also the explicitation of latent or not articulated needs. Consumption patterns and consumer behaviours become a key input to the external analysis, helping identify the key future

applications, fulfilling consumer needs. Of course, they can be both already existing applications and new applications. Successively, there is the identification of the skills required to make the applications. This means to identify both technology needed to respond to future or not articulated customer needs and technology needed to meet current customers' needs which will evolve. Tools and techniques dedicated to the external analysis are briefly descripted below.

Market forecasting. Market forecasting techniques help estimate the market potential of new applications and products. The most common techniques concern: market characteristics determination, estimation of the market potential, market share analysis, sales analysis, industry development studies, competitors' products analysis, short term forecasting, acceptance and potential of new products, long term forecasting, price fixing studies.

Technology forecasting. Technology forecasting has been defined as the description or prediction of a foreseeable technological innovation, specific scientific refinement or likely scientific discovery, which promises to serve some useful function with some indication of the most probable time of occurrence. The main element to foresee is the timing of the progress. This is the main objective of forecasting techniques. Technology forecasting techniques are divided into three main categories: qualitative methods, quantitative and time forecasting methods, probability forecasting methods. Qualitative methods include creativity spurring methods (brainstorming), time independent contextual mapping, analogies, morphological analysis, gap analysis, environmental surveillance and monitoring, scenarios. Quantitative and time forecasting methods include attribute and parameter identification, time series (growth and logistic curves), envelop curves, precursor events and curves, substitution curves, relevance trees. Probability forecasting methods include Delphi techniques, cross-impact analysis, gaming methods.

Reverse engineering. It is the disassembly and systematic analysis of the components of the competitors' product conducted with the end of learning how competitors design and produce their products.

Monitoring lead users and key customers. Customers and users play a key role for innovation in a variety of industries. Firms need to establish close and permanent relationships with their key customers and lead users which are often a major source of knowledge and ideas for technological innovation.

Technology scouting. Small units can be established simply to monitor the technological progress in a certain geographical area or at a certain technological centre. These units "listen" to what happens outside and monitor technology evolution.

Monitoring competitors. Another activity is that of monitoring competitors which has obvious difficulties. Large firms have often journals, publications, announcements, publicity, advertising and all sources where information about competitors can be captured.

Monitoring suppliers. Suppliers represent a significant source of information about technology and themselves can be source of innovation. They can also provide information about competitors. Therefore, firms need to establish close relationships with suppliers.

Monitoring external technological resources. Especially when a certain technological area is not covered internally, a systematic monitoring of the resources available and accessible externally has to be done.

Networking. A major source of information in technology is networking. Establishing and maintaining a network of relationship help capture information about technological progress.

Internally Driven Context Analysis

This analysis is based on the view of technology as cognitive driver of strategy. It is articulated into two steps:

- the identification of the set of the *technological skills available within the firm*;
- the identification of the *applications* which could be generated exploiting such skills.

Therefore, in this process, the starting point is the set of technological skills available within the firm. A first step of the process is the mapping of the firm's technological skills. Then, efforts should be done to identify the applications (existing and new) which can be generated exploiting the technological skills available. Here we describe techniques and tools supporting the internal context analysis.

Technological capability audit. The evaluation of the internal technological capabilities is usually conducted through a comparison with major competitors on several dimensions. Traditionally these dimensions were aimed to define the appropriateness of the R&D resources relatively to competitors:

- the level of R&D expenditure;
- the quality of human resources employed in technology development activities;

- the breadth and depth of the technological knowledge available;
- the level of the equipment used in the R&D activity.

Benchmarking. It consists of comparisons among competitors on specific dimensions in order to identify best practices in use. Therefore, great attention is paid to the process of technological innovation and practices in use to manage such process. The rationale behind this is that not only the amount and quality of resources are important for innovation but also how they are used and how the underlying processes are shaped. In their innovative capability audit framework, Burgelman et al. (1988) underline that both technological and functional capabilities should be audited and both formulation and implementation of innovation strategies addressed together with supportive organisational mechanisms.

In their framework, they include five main dimensions:

- resource availability and allocution
- understanding competitors' innovative strategies and industry evolution;
- understanding the technological environment;
- structural and cultural context;
- strategic management capacity to deal with entrepreneurial behaviour.

Adler et al. (1992) have argued that technical functions need a way to benchmark not only their products but also their strategic management process. They provide a framework to assess the overall functional strategies of technical units.

They set out three main elements of strategic management:

- direction setting (mission, objectives, strategic plan);
- policies;
- adjustment mechanisms (assessment of strengths and weaknesses, opportunities and threats).

Within the policies they analyse the role of:

- processes (personnel management, technical project management, quality assurance management);
- resources (intellectual properly, funding, facilities and equipment);
- linkages (structure, inter-functional linkages, external linkages, regulatory compliance).

At London Business School a research group developed a comprehensive benchmarking framework to audit a firm's technological capabilities (Chiesa et al., 1996). The model views innovation as a process

which includes four core processes (new product concept generation, technology acquisition, product development, production process innovation) and three support processes (leadership, resourcing, systems and tools). Each core and support process is then articulated into sub-processes on which a benchmarking exercise can be conducted. The framework can also be used to self-assess the firm's capabilities in technology management and is built to carry out a performance audit too.

Knowledge management system (learning processes). Each learning process can contribute to the inner and outer context foresight. Learning can take place in a variety of forms: by doing, by using, by failing, by studying (Pavitt, 1991).

Within this chapter we touched the concepts of new technologies and new applications, underlining the importance of innovation. Next pages will analyse the idea of technological innovation, presenting some key features and models.

4.1.2 Technological Innovation

Freeman described it as the process which includes the technical, design, manufacturing, management and commercial activities involved in the marketing of a new (or improved) product or the first use of a new (or improved) manufacturing process or equipment (Freeman, 1976). *Technology and innovation* are strictly entangled: innovative solutions are based on novel technologies. The speed of technological change increases; as a consequence, innovative activities within firms assume peculiar characteristics:

Cumulativeness. What a firm will be able to do in the future strongly depends on what it has done in the past. Pavitt (1991) states "actual and desirable performance characteristics of products and production processes are usually multidimensional and complex and cannot easily be reproduced from scratch" . He also states that tacit knowledge, the one obtained through experience and embedded into people and technical system or producers, is of central importance.

Specialisation. Firms tend to focus on narrow range of activities: they need to concentrate their efforts on few technological aspects and disciplines.

Geographical Division of Technological Labour. Given the cumulative nature and increasing specialisation of innovative activities, a division of labour in the process of creation of technological knowledge takes place. This provokes the birth of a number of different units of advanced knowledge in geographically limited areas.

Uncertainty. The rate of technological change is high; the uncertainty related to the innovative activities grows. There are a lot of unknown elements that increase the uncertainty of innovative activities.

Technology Integration. Technological innovation is not only the result of breakthroughs in one specific field: it can be achieved putting together two or more pieces of knowledge from different fields and integrating them in a new way. As Iansiti (1997) stated in his book technology integration is based on the concept that technologies act in conjunction with one another: they only add value as integrated systems. Technology integration represents the process of choosing among technological possibilities, to solve a product problem. These intrinsic characteristics of the technological progress make the process of technological innovation change and call for new ways to conceive and shape it within firms (Chiesa, 2001).

4.2.3 Models of Technological Innovation Process

The increasing complexity of the technological change stimulated thinking about modelling the process of technological innovation. In the previous chapter of the literature review we have already focused on the *two traditional ways* to view the innovation process: the Technology Push approach and the Market Pull. Again the Market Pull approach views the innovation as simple, linear and sequential; the emphasis is on marketing. The market is the source of ideas to direct R&D which plays

a reactive role. On the other hand the Technology Push approach emphasizes the role of R&D function and the market is seen as a receptacle of the results of the R&D activity.

The next generation of technological innovation process is given by Rothwell and Zegveld (1985) and Roberts (1988): the *interactive or coupling model*. It is based on the concept that technological innovation comes from the coupling of market needs with technological opportunities. In synthesis they suggest that innovation is the result of the matching and combination of pure Technology Push and Market Pull forces. R&D and marketing play a balanced role: the integration between the two represents the basis for combining technology opportunities and market satisfaction. Later Rothwell (1992) identified a further generation of innovation process: *innovation as a parallel process involving simultaneously R&D and other functions*. In this case, innovation is the result of the integration of knowledge from different teams. Emphasis is placed on the involvement with both upstream suppliers and lead users downstream; horizontal collaborations play a fundamental role too during the innovation process.

Finally, the last generation is identified which is the fully *integrated parallel development*. Linkages with suppliers and customers are very strong along with the whole innovation process. Horizontal linkages take place in a variety of forms. Emphasis is placed on organizational flexibility and speed of development. The latter two generations show the *cross-functional and multi-firm* nature of the technological innovation process, strongly emphasising the role of organisation and management in making the process of innovation effective.

The literature has suggested that the process of technological innovation within firms is viewed as a business process. Rothwell (1992) states that “it is generally acknowledged that today’s rates of technological change are high. What is less recognised is that the process by which technology is commercialised - the innovation process - is changing”. This aspect fosters a deeper comprehension of such process, analysing different contributes. Tidd et al. (1997) identify the generic activities the innovation process involves: scanning the environment (internal and external), defining the responses to give to the signals identified, obtaining the resources to enable the response, implementing the innovation project to respond effectively. On the basis of a review of many literature contributions, Chiesa et al. (1996) view innovation as a set of processes:

- *new product concept generation*, the process which brings together technology and market needs to develop new product concepts;

- *technology acquisition*, the development and management of technology per se, i.e. the process of acquiring the technology necessary for product and process innovation through internal R&D and/or other means;
- *product development*, the process of bringing a new product concept through development and manufacturing to the market;
- *production process innovation*, the process of innovating and developing new production processes.

Each of these in turn can be seen as a set of sub-process.

Product innovation	Generating new product concepts
	Product Innovation Planning
	Innovativeness and creativity
	Exploiting innovation
Product development	Product development process
	Transfer to manufacturing and distribution
	Teamwork and Organisation
	Industrial Design
Process innovation	Formulating a manufacturing strategy
	Implementation of a new process
	Continuous improvement
Technology acquisition	Formulating a technology strategy
	Selection, generation and sourcing of technology
	Management of intellectual property

Figure 4.2 – Chiesa's Model of Technological Innovation

4.2 Business Process

4.2.1 The Blue Ocean analytical Framework

The literature offers numerous analytical tools and frameworks in support of formulation and execution of Blue Ocean strategy. First of all we are going to present the strategy canvas, both a diagnostic and an action framework for building a compelling Blue Ocean strategy.

The Strategy Canvas

This tool serves two purposes. First, it captures the current state of play in the known market space. This allows to understand where the competition is currently investing, the factors the industry currently competes on in products, service, and delivery, and what customers receive from the existing competitive offerings on the market. It's possible to captures all the information in a graphic form: the horizontal axis captures the range of factors the industry competes on and invests in. The vertical axis shows the offering level that buyers receive across all factors. Plotting the current offering across all the factors you can understand company's strategic profile, or value curve, the basic component of the strategy canvas. It represents the company's relative performance across its industry's factor of competition. In order to clarify the concepts above we are going to present the example of the U.S. wine industry in the late 1990s, drawing the related strategy canvas. There are seven factors the industry competes on (see figure 4.3):

- Price per bottle of wine
- Use of enological terminology and distinctions in wine communication
- Above-the-line marketing to raise consumer awareness in a crowded market
- Aging quality of wine
- The prestige of a wine's vineyard and its legacy

- The complexity and sophistication of a wine's taste
- A diverse range of wines to cover all varieties of grapes and consumer preferences.

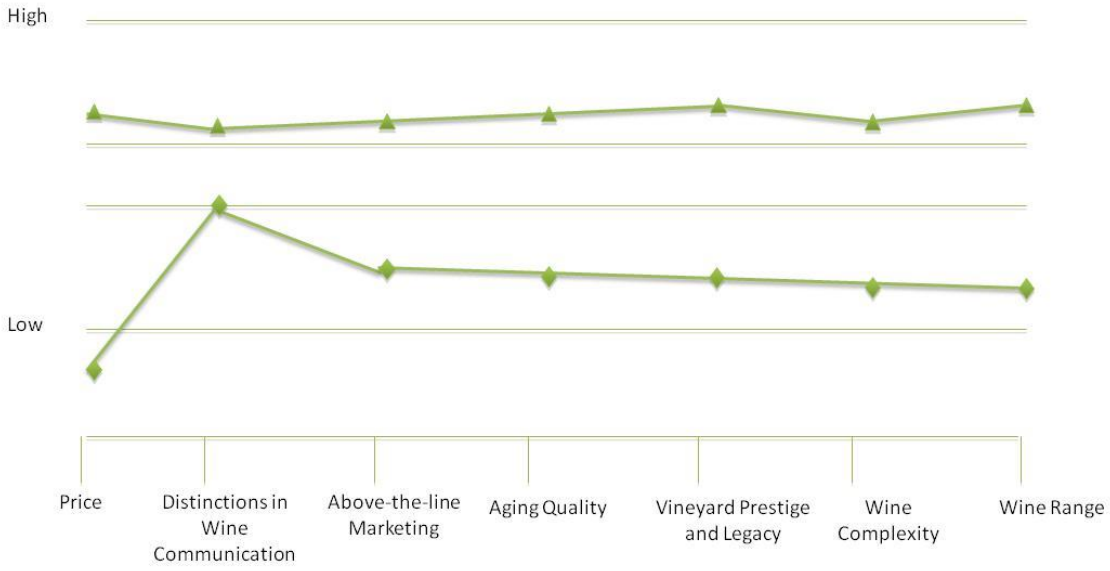

Figure 4.3 – Competitive Factors in U.S. Wine Industry

Researchers found that customers can scarcely imagine how to create uncontested market space. Their insight also tends toward the familiar "offer me more for less." And what customers typically want "more" of are those product and service features that the industry currently offers. To shift the strategy canvas of an industry, a company must reorient its strategic focus from competitors to alternatives and from customers to non-customers of the industry. Doing so companies gain insight into how to redefine the problem the industry focuses on and thereby how to reconstruct buyer value elements that reside across existing industry boundaries. Conventional strategic logic, by contrast, drives to offer better solutions than rivals to existing problems defined by the industry. In parallel to strategy canvas there is a second basic analytic supporting the discovery of Blue Ocean: the four actions framework.

The Four Actions Framework

To reconstruct buyer value elements in crafting a new value curve, Kim and Maurbogne (2005) developed the four actions framework. As shown in figure 4.4, to break the trade-off between

differentiation and low cost and to create a new value curve, there are four key questions to challenge an industry's strategic logic and business model:

- Which of the factors that the industry takes for granted should be eliminated?
- Which factors should be reduced well below the industry's standard?
- Which factors should be raised well above the industry's standard?
- Which factors should be created that the industry has never offered?

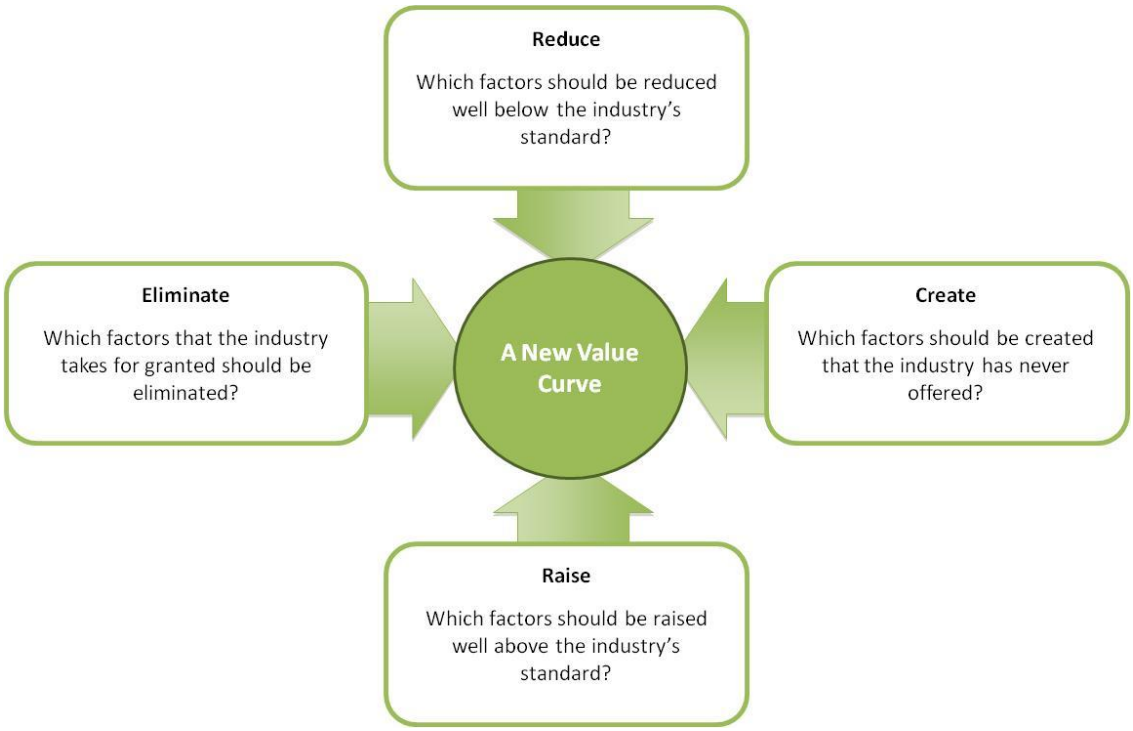

Figure 4.4 – The Four Actions Framework

The first question forces to consider eliminating factors that the companies in the industry have long competed on. Often those factors are taken for granted even though they no longer have value or may even detract from value. Sometimes there is a fundamental change in what is buyers' value, but companies that are focused on benchmarking one another do not act on, or even perceive, the change. The second question forces you to determine whether products or services have been overdesigned in the race to match and beat the competition. Here, companies over serve customers, increasing their cost structure for no gain. The third question pushes you to uncover and eliminate the compromises the industry forces customers to make. The fourth question helps to discover entirely new sources of value for buyers and to create new demand and shift the strategic pricing of the

industry. It is by pursuing the first two questions (of eliminating and reducing) that companies gain insight into how to drop cost structure. The two actions of eliminating and creating push companies to go beyond value maximization exercises with existing factors of competition: the two actions prompt companies to change the factors themselves, hence making the existing rules of competition irrelevant. The second two factors, by contrast, provide insight into how to lift buyer value and create new demand. Collectively, the all factors allow companies to systematically explore how they can reconstruct buyer value elements across alternative industries to offer buyers an entirely new experience, while simultaneously keeping cost structure low.

The Eliminate-Reduce-Raise-Create Grid

There is a third tool to create a compelling Blue Ocean. The grid pushes the companies not only to ask all four questions in the four actions framework but also to act on all four to create a new value curve. By driving companies to fill in the grid with the actions of eliminating and reducing as well as raising and creating, the grid gives companies several benefits:

- It pushes them to simultaneously pursue differentiation and low costs to break the value-cost trade-off.
- It immediately flags companies that are focused only on raising and creating and thereby lifting their cost structure and often over engineering products and services.
- It is easily understood by managers at any level, creating a high level of engagement in its application.
- Because completing the grid is a challenging task, it drives companies to robustly scrutinize every factor the industry competes on, making them discover the range of implicit assumptions they make unconsciously in competing.

4.2.2 Three characteristics of a good Strategy

An effective Blue Ocean strategy has three complementary qualities: *focus, divergence, and a compelling tagline* (Kim and Maurbogne, 2005). Without these qualities, a company's strategy will likely be muddled, undifferentiated, and hard to communicate with a high cost structure. The four actions of creating a new value curve should be well guided toward building a company's strategic profile with these characteristics. These three characteristics serve as an initial test of the commercial viability of Blue Ocean ideas.

Focus. Every great strategy has focus, and a company's strategic profile, or value curve, should clearly show it.

Divergence. When a company's strategy is formed reactively as it tries to keep up with the competition, it loses its uniqueness. The value curves of Blue Ocean strategists always stand apart. By applying the four actions of eliminating, reducing, raising, and creating, companies differentiate their profiles from the industry's average profile.

Compelling tagline. A good strategy has a clear-cut and compelling tagline. A good tagline must not only deliver a clear message but also advertise an offering truthfully, or else customers will lose trust and interest. In fact, a good way to test the effectiveness and strength of a strategy is to look at whether it contains a strong and authentic tagline.

These three criteria guide companies in carrying out the process of reconstruction to arrive at a *breakthrough in value* both for buyers and for themselves.

4.2.3 Reading the Value Curves

Reading the *value curve* enables companies to see the future in the present. Embedded in the value curves of an industry is a wealth of strategic knowledge on the current status and future of a business. Below the main points it is possible to retrieve analysing a value curve.

- *A Blue Ocean Strategy*. The first question the value curves answer is whether a business deserves to be a winner. When the curve meets the three criteria that define a good Blue Ocean strategy the company is on the right track. On the other hand, when a company's value curve lacks focus, its cost structure will tend to be high and its business model complex in implementation and execution. When it lacks divergence, a company's strategy is a me-too, with no reason to stand apart in the marketplace. When it lacks a compelling tagline that speaks to buyers, it is likely to be internally driven or a classic example of innovation for innovation's sake with no great commercial potential and no natural take-off capability.
- *A Company Caught in the Red Ocean*. When a company's value curve converges with its competitors, it signals that a company is likely caught within the red ocean of bloody competition.
- *Over-Delivery without Payback*. When a company's value curve on the strategy canvas is shown to deliver high levels across all factors, the question is, does the company's market share and profitability reflect these investments? If not, the strategy canvas signals that the company may be oversupplying its customers, offering too much of those elements that add incremental value to buyers. To value-innovate, the company must decide which factors to eliminate and reduce.
- *An Incoherent Strategy*. When the curve zigzags, it signals the company doesn't have a coherent strategy. Its strategy is likely based on independent sub-strategies.
- *Strategic Contradictions*. These are areas where a company is offering a high level on one competing factor while ignoring others that support that factor.
- *An Internally Drive Company*. In drawing the strategy canvas, how does a company label the industry's competing factors? Analysing the language of the strategy canvas helps a company understand how far it is from creating industry demand: is it using an operational jargon or the competing factors are stated in terms buyers can understand and value?

4.3 Design Process

The literature about the role of design in a company is such a spread and articulated one and we already discussed some good point in the previous chapter about the Innovation Strategy. What we really want to focus on in this chapter, instead, is the central role that design must play as enabler of new applications. Designers are involved in the whole innovation process, but their crucial role is "making sense of things", as Krippendorff stated (Krippendorff, 1989). According to these idea, extensive literature consider Scenario building and Cultural probes to be the most established and effective methods to make the design interpreter and explorer of ideas associated to products and businesses.

4.3.1 The art of Scenario Building

4.3.1.1 The concept of Scenario: an open future

Going through the concept of scenario, we found that the use of scenarios with an organizational connotation took place for the first time during the 50s, when the American Department of Defence started using the task of creating scenarios to devise defensive strategies in order to understand and anticipate potential enemy actions. The main contributions to this method derived from the futurist Kahn (1967), who defined it as "an hypothetical sequence of events constructed for the purpose of focusing attention on random processes and decision points." The transfer of the word "scenario" to the business environment originates from Kahn's studies in collaboration with Wiener (1967), who, similarly, described scenarios as "sequences of events through which the possible future developments are made visible". During the 60s, scenarios acquired greater importance, becoming a

precise methodology for researching in the future, but it is from the early 80s, as Linneman and Klein analysis evidenced (1981), that scenario planning started being used by a growing number of companies worldwide, particularly in unstable environments that require a long-term oriented plan. Nowadays, the term scenario is used to refer to the description of natural contexts, constructed or imagined for the product-user interaction (Nardi, 1992); similarly Suri and Marsh (2000) described scenario as "a set of users, a context and a set of tasks that users perform themselves; it combines a carefully researched description of some set of real ongoing activities with an imaginary futuristic view of how technology might support these activities in the best way."

According to what all these authors stated, we can basically say that scenario building consists in the development of a series of romanticised descriptions, i.e. of stories as texts, storyboards, videos, etc. that involve specific characters, events, products and environments, allowing you to explore the ideas of product or business in a realistic future. Scenarios are also a "useful tool especially when the number of variables to be considered is very high and the conditions to predict the future are complicated by human influence and the inability to accurately predict the course of future action" (Hare, 1985). In particular, during his studies on scenario planning, Van der Heijden (1997) identified six benefits that make the creation of the scenarios a key tool to stimulate the generation of ideas:

1. *Representation of the user experience*, that is a complex phenomenon when interacting with the product (Macdonald, 1998) and depends on the attributes of the product itself, the reactions that it evokes from its context and physical, social and cultural meaning, as well as aspects closely linked to the user (mood, goals, perceptions, expectations, etc.).
2. *Evaluation of the first ideas of design*;
3. *Communication of human factors* in order to understand and assimilate them easily;
4. *User identification,* generating imaginary individuals, with names, abilities and lifestyles, which are more easily relatable to the abstract descriptions of human characteristics;
5. *Focus for the interdisciplinary team,* since the development of a product involve a team of professionals from various disciplines and backgrounds;

Consideration of systems and environment, as it supports the exploration and representation of how the product will be integrated in different social and physical contexts.

4.3.1.2 Scenarios: tools and methods

Traditional method

The traditional method for creating effective scenarios includes the development of six steps (Coates, 2000):

1. *Identification and definition of the set of factors* to consider;
2. *Definition of the important variables* for the future: this is a critical task in which a person uses the knowledge available or that of the team in identifying these variables and organizing them in reporting relationships;
3. *Identification of the multi-dimensional theme of the scenario*, i.e. the critical factors illustrating possible future significant (4/6 issues for every objective);
4. *Scenario writing*, since, in general, scenarios are stories to be told;
5. *Final meeting to read, review and evaluate the scenario*, a process that can be repeated several times, until you get a satisfactory analysis of each scenario.

Beside this traditional base, the literature explores several changes to support the creation of scenarios. We collected below the most significant for our purposes: the "5-phases" method, the "three activity groups" method and the "Field Anomaly Relaxation" method.

"5 phases" method

In an article about technological forecasting Schlake identifies 5 key phases in a new interpretation of scenario building method (Schalke at al., 1998):

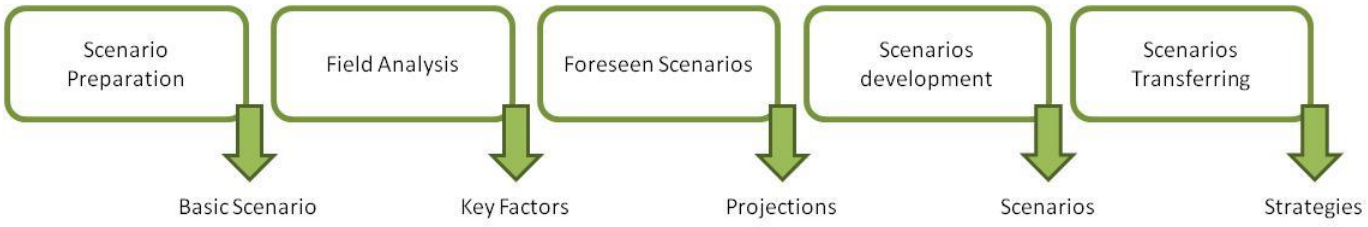

Figure 4.5 - Phases for Scenario Management

Phase 1: scenario preparation.

The primary objective of this phase is to support decisions in relation to a particular meaning or a particular technology (which approach can be achieved?). In exploring new needs and meanings

companies have got to consider a complex network of influences, called system thinking, and in this regard, should consider that new technologies, globalization, consumer expectations, the number of relevant factors, etc. continuously grow (tendency to variety), and that the dynamics of the change process in industrial and global environments are growing (tendency to dynamic). The meeting between variety and dynamics is defined as complexity: increasing in complexity, leads to the effectiveness of traditional management approaches to reduce and interdependencies between influencing factors such as divisions, market segmentation and external trends play a fundamental role.

Phase 2: field of scenarios analysis.

Beside definition of the field of decisions, the field of the scenarios have to be defined too, composed of a large number of influencing factors that include both internal and environmental factors resulting from three areas: industry, industrial environment (suppliers, customers, potential competitors, products) and global environment. This process leads to the definition of a certain number of factors (60 to 150) and can be supported by specific methods, such as brainstorming. In the end, only those key factors that impact most on the identification field of the scenarios have to be selected, to avoid the risk of creating too complex scenarios and confusing to manage (see figure 4.6).

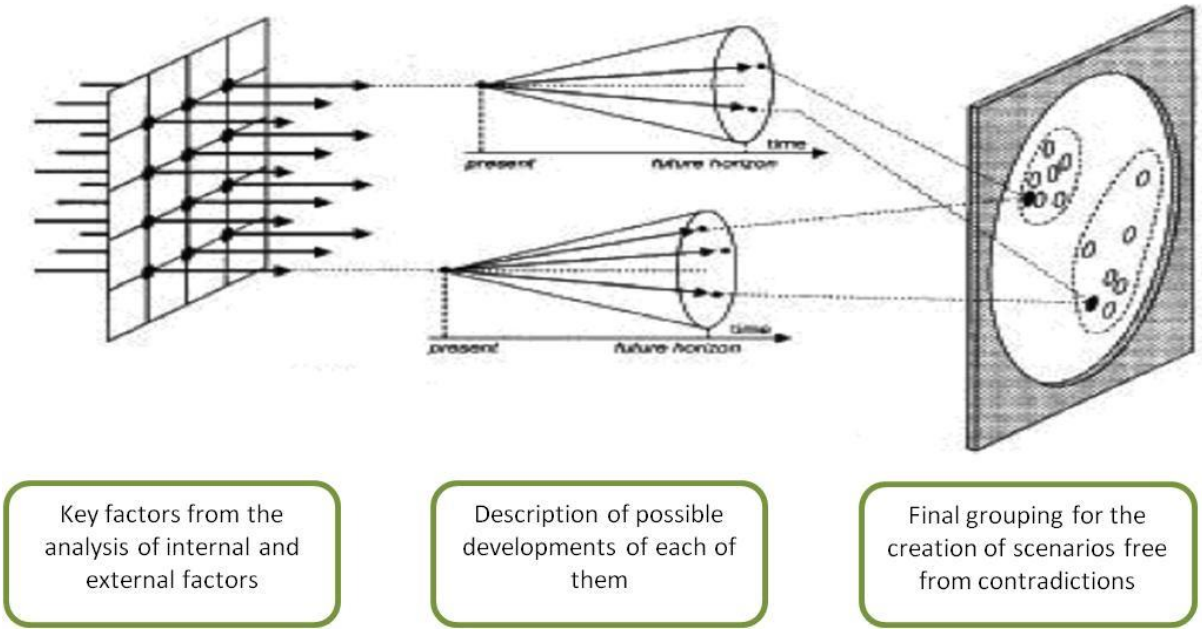

Figure 4.6 – Field of Scenario Analysis

Phase 3: expected scenarios.

In this phase, the reference time horizon is defined and all the possible developments of each key variable (projections) are analysed: the goal is not only to find the closest projection to reality, but to find an image that allows scenarios to fully describe the window of opportunity.

Phase 4: scenarios development.

Scenarios base on combinations of projections (bundles of projections): each couple of combinations is evaluated basing on their compatibility and the output of the consistency analysis is a reduction in the number of possible combinations. The pre-scenarios are intended to assign different bundles of projections for the determination of the scenario itself. Then, the analysis of clusters is used, a phase in which all the bundles are enclosed within a group characterized by projections that are similar in certain aspects; with this procedure, the number of possible scenarios to be tested is reduced but, as a limit, a considerable loss of information occurs, because several projections are incorporated into the same single group. The clustering phase leads then to the definition of some pre-scenarios that represent the best combination of projections with the lowest number of clusters and with the lowest amount of information lost.

Phase 5: scenarios transfer.

The last part consists in an analysis of the effects that have a direct impact on the business: the consequences of the identified scenarios and opportunities/ weaknesses identified are deeply analysed and evaluated.

"Three-activity groups" method

The "three-activity groups" method is based on concepts common to all the processes of long-term prediction divided in 3 groups of activities (Mercer, 1995):

Environmental analysis. For the correct identification of possible scenarios, it is necessary to analyse the external environment with a team of 5/7 members.

Scenario planning. This is the central activity that requires the development of six sequential sub-steps. The first step (choosing drivers for change) consists in examining the results of the environmental analysis to determine which are the factors (drivers) that, in the future, will determine the nature of the environment in which the organization is going to operate. The second step (combination of drivers in a feasible structure) involves the combination of drivers in order to identify an output represented by 7-9 logical groupings of driver. The third phase, production of 7-9 mini-

scenarios, identifies the approximate connection between the groups created in the previous step. After this phase, the number of mini-scenario is reduced to 2-3 expanded scenarios (step 4, reduction to 2-3 scenarios), through an open debate. As a result, the scenarios are transcribed in a more appropriate form to be used in the definition of new technologies and features for the new elaborated meanings (step 5, writing scenarios).

Corporate strategy. Scenarios identify some long-term forces and the consequent events the organization should move towards: in this key phase the internal resources of the organization intersect the unlimited external potential.

"Field Anomaly Relaxation (FAR)" Method

The focus of Scenario Planning is to understand the dynamic forces the drive change, through a set of scenario scripts that provide the narratives about how the future may evolve. Scenarios, then, should consider the high degree of uncertainty. The use of historical analogies is a critical approach to manage that. Contrary to all other methods, the FAR method involves this methodology because it evaluates the historical precedence, offering the opportunity to revisit the designed scenario in relation to historical events (Glenn J.C., 2001). Basically, this systematic technique describes future potentials and differs from other conventional predictive techniques because it allows to track future multiples and their likely evolution. The strength of this technique is that the output of analysis does not only consist in scenarios, but also in migration paths: FAR is based on the identification of the main drivers of change, which are synthesized in appropriate combinations, in order to produce a network of possible future scenarios connected to each other.

4.3.2 Cultural Probes

Several phases of the scenario building methods listed above involve a need of creativity and inspiration that is exactly what design is supposed to bring in the process of innovation. Io order to do

that the whole process needs to make use of tools that are able to stimulate the imagination, reduce inconsistencies and create a common language and structure collective thought.

The *cultural probes* approach*,* in particular, is a method of experimental research aimed at gathering information to guide design activities, through greater knowledge of *user experience*. The term "cultural probes" was coined by Dunne and Gaver (1999) which define the approach as "Design intervention that makes materials of inspiration explicit, while avoiding the social rules known by researchers."

This method is extremely important as a means of inspiration of interactive design, using technological surveys, household surveys, etc., that are utilized as an integral part of the design process. At operational level, cultural probes are packets containing an assortment of tools, (cameras, maps, postcards, questionnaires, diaries, etc.), designed to elicit inspiration in people; an opened discussion about new ideas, often unexpected, is driven by these means, without dominating the user groups. Cards, for example, (containing both images and questions) are an effective way to pose several questions to members of a group, as they are a method of communication and informal and friendly stimulation, which uses evocative expressions and images. In general, cultural probes are not designed for being analysed or synthesized. Instead, they represent the essential and relevant reflections for the development of design proposals: data collected are instruments to leave the old stereotypes about people needs, opening up new possibilities of interpretation.

Dunne himself says that thanks to this method "new knowledge emerges, and that knowledge creates a different kind of environment for needs and desires and also different expectations." Cultural probes are designed to cause, reveal and capture the motivational forces that give shape to an individual and to his usual environment: they represent a kit of provocative materials, created to explicit inspiring answers and learning information, for example, about people life style. Instead of designing solutions that meet users' needs, new forms of culture, new meanings and new values are discovered. As a point of strength, the method provides advice and help to overcome cultural and ethnographic boundaries and bridge the gap between what one says and what he really means, through interpretation. In this regard there is highly critical issue: results can often be incorrect and do not correspond to reality as excessively subjected to very subjective interpretations

4.3.2.1 The User Experience

In order to study the characteristics and methods related to c*ultural probes* it is essential to start from the concept of user experience. It consists of a variety of aspects and in the following we go through relevant issues related to this phenomenon. Sanders (2001) states that the moment when experience takes place is always woven into past memories, but also tightly coupled to the dreams of our imagination. She points out that these aspects, which can be difficult to articulate verbally, can be expressed through visual communication with tools such as collages. Kankainen (2002) has pointed out two principally different levels of user need: the motivation level and the action level. This remark is particularly relevant in new product concept development, when it is crucial to understand what the user would possibly do with a new system and what would be the driving motivation. In other words you have to first be able to recognize the issues that are relevant to the intended user and that affect on identifying the appropriate attributes and qualities for the product concept. After that it is possible to get deeper into the functional and interactional level of the concept development. Nieminen-Sundell (2003) has conducted several years ongoing studies of how new technology penetrates and finds its place in the household. The products seem to fight their place in the home environment similar to flora and fauna in the nature. This phenomenon is relevant when defining new product categories, which are replacing old technology or overlapping with current products in features and benefit they provide.

However, since the objectives of our research project are rather practical, we feel that the available models or frameworks, such as in the research areas presented above, are not alone useful enough. They enlighten the issue in a general level or focus only on some aspects of the user experience. We decided to use a framework of qualities of user experience, presented by the University of Art and Design Helsinki (2003), combining the most of the relevant aspects that have an impact on the human-product relationship in product concept design.

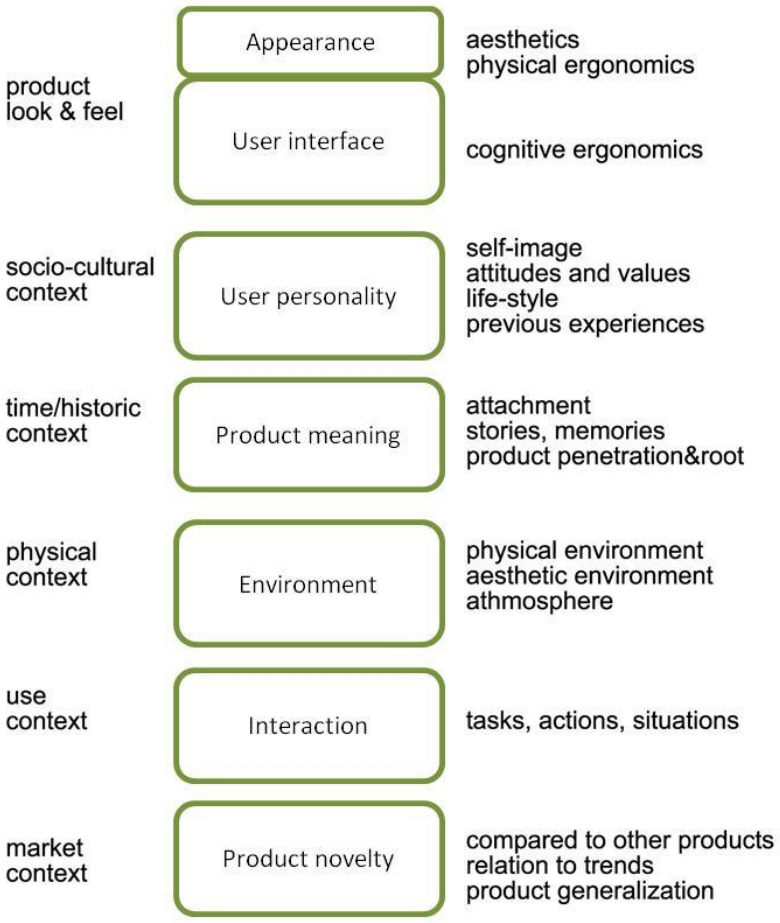

Figure 4.7 – Qualities of User Experience

In this model, the qualities are divided into two groups; directly product related qualities (appearance, user interface) and different contextual qualities, which have an effect on the human-product relationship. The model can be used for several purposes. First of all, it is useful in understanding and articulating the different aspects of the phenomenon as a whole. Secondly, it can be used as a tool to make sense of what type of user data exists and to compare what type of data different techniques can reveal.

4.3.2.2 Observing and Probing

Going deeply in the concrete application of Cultural Probes, there are two methods in particular, that derive from the *user-centred innovation,* which can be applied to the concept design through cultural

probes: o*bserving* e *probing*. In order to highlight the characteristics of these two approaches, we show here two real examples, conducted by the same University of Helsinki, to refine the model presented above about the concept of user experience: the first one, in a hospital laboratory, the method of *observing* is adopted; in the second one, instead, set in hospitals and transportation of patients, is based on the method of *probing*. In these cases, the user data are first examined and then interpreted by a team of multi-disciplinary design, with the aim of supporting the generation phase of the concept focused on the user.

Case 1: contextual design in laboratory equipment concept development. Five sessions of observation are organized in the laboratories of a hospital, conducted by a team responsible for creating the concept; from interviews, carried out in groups of two to five people, information related to working models are obtained. The resulting information is accurate and valid, but many aspects of user-experience are difficult to achieve through simple observation: these interviews are focused both on general aspects (comfort, personal opinions on the job, satisfaction instruction, and organizational pressures policies, etc.). and on less immediate aspects (for example, quality of laboratories) that can be only understood through deeper conversations with the staff.

*Case 2: probes in hospitals***.** The survey approach was the most appropriate one, in a project where the focus of the design is to get inspirations, visual data and empirical evidence for the creation of new concepts. The basic idea is to obtain sensitive environments, i.e. to be able to analyse situations and places where designers do not have access or have it only temporarily, in order to do this, a package of survey that includes diaries, card rooms and statements is adopted, containing also open questions and tasks in order to document the routine activities, thoughts expressed, expectations and general needs. These packages are delivered to six nurses with the aim of using them for five working days; after that, the multi-disciplinary team of design supports the interviews with the nurses discussing the survey material and making a collage of pictures depicting an ideal experience. The interviews then increase the documentation, giving the opportunity to discuss some aspects, some of those very critical, and to document the interpretations of the different investigations through the use of photographs to show the present context, this material can suggest some possible future design lines.

4.3.2.4 Cultural probes related to the user experience

These two experiments explained that the observing method is useful to draw a series of contextual data (workflow, sequences of actions, physical environment, ergonometric rules and usability, interactions between person and product), while it is ineffective in the study of rules related to personal aspects or to the market environment. Instead, the probing method is able to cover broad aspects related to the user experience detecting information that is not observable in other ways.

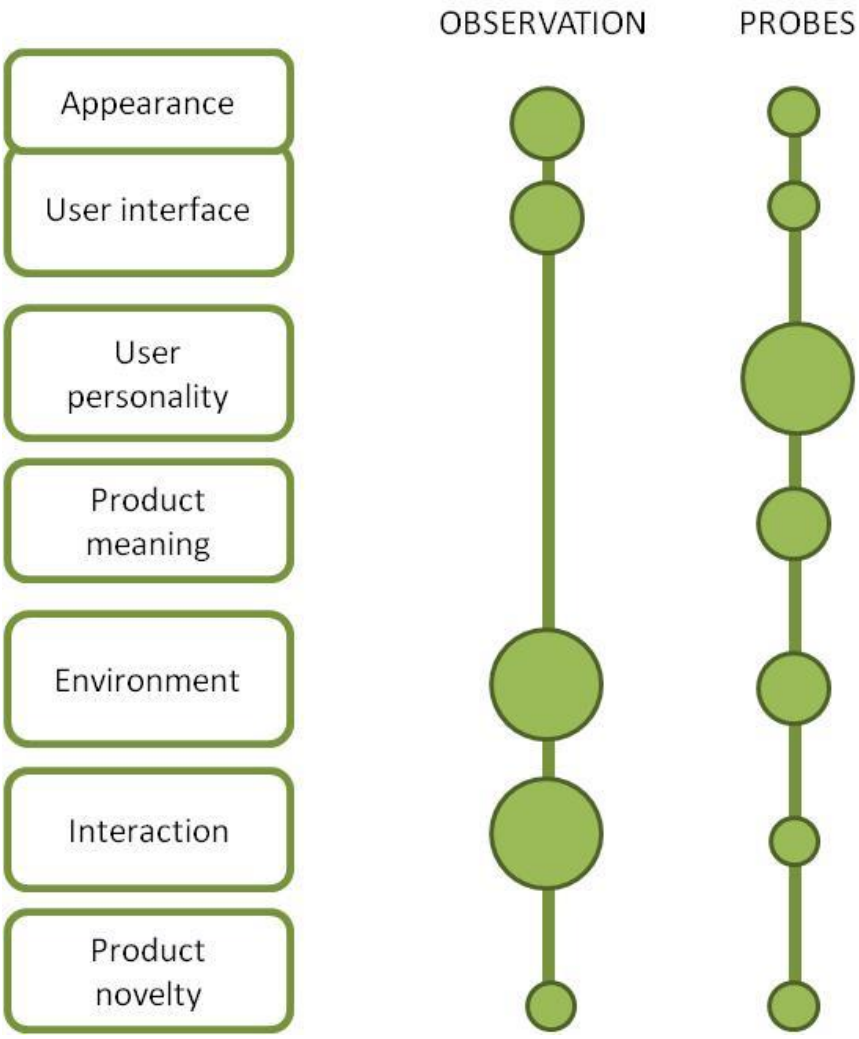

Figure 4.8 – Observing and Probing Methods Applied to the User Experience

Hence, the two methods discussed in the process of observation need to be considered as complementary in the centred-design process. In general, probing can be useful in identifying an

overall figure before focusing the attention on more detailed observations (observing). Probing is also able to communicate in a proper and direct way various information about the user, while in the case of observing the data collected must be subjected to a process of identification of the correct meaning. The utility of visual material such as photos, illustrations and collages is evident and it supports the idea that multisensory stimuli, associations and multiple interpretations may increase the results.

CHAPTER 5

The Conceptual Framework

After we concluded the first phase of literature review, we needed to have a prior view of the general constructs or categories we studied and their relationships. As Miles and Huberman (1994) suggest, we made this through the construction of the conceptual framework(s) that underlies the research. Our frameworks explain the main concepts that are to be studied from now on, the key factors and the presumed relationships amongst them. Building a conceptual framework forced our researcher to think carefully and selectively about the constructs and variables to be included in the study. The starting point was, of course, the literary analysis conducted so far. Following the division in strategy and process side, we constructed two models of analysis. The first one was thought to investigate real case studies in chapter 6; the second one to design the new methodology, refining and improving it in action research chapter 7.

5.1 The Research Questions

If the concept of innovation and its importance in the life cycle of a company are now consolidated issues, our feeling is that, generally, the most common way to innovate is through technological substitutions, according to the traditional methods of Market Pull and Technology Push approach. As we discovered through the literature review, in recent years theories that seek different fields of application have been developed. After that critical analysis of authors'' contributions, we have now all the pieces to wrap-up what we collected surveying the literature about the answers to our research objectives. In doing so, this fifth chapter adds an extra level of precision to the main objectives of the research, explicating what exactly we want to reach in terms of final proposal, defining the research questions.

Particularly the two research questions are:

- ***(RQ 1)**: Which strategy can guide companies in valorising existing and new technologies, in order to identify new application fields far from the traditional ones?*

- ***(RQ 2)**: Which is the process that companies need in order to identify novel applications enabled by existing and new technologies?*

They represent the base on which to build the conceptual framework, as it is an instrument to explore the reality, as well as a model to guide the definition of the final proposal.

The framework follows the logical division made in the literature review phase, distinguishing between two components: strategy and process. The idea is to provide *not one but two related models* that start from the two research questions defined above. Each of them is built on the critic analysis of the literature investigated, in order to find the literature gap in which to place the proposal of the research. Both for the strategic and the process side, a recap of the established theories and methods investigated so far is first made, critically focusing on what is considered to be missing from

the point of view of this research. After that, the analysis moves towards the generation of the frameworks, as an initial step to achieve the alternative proposal.

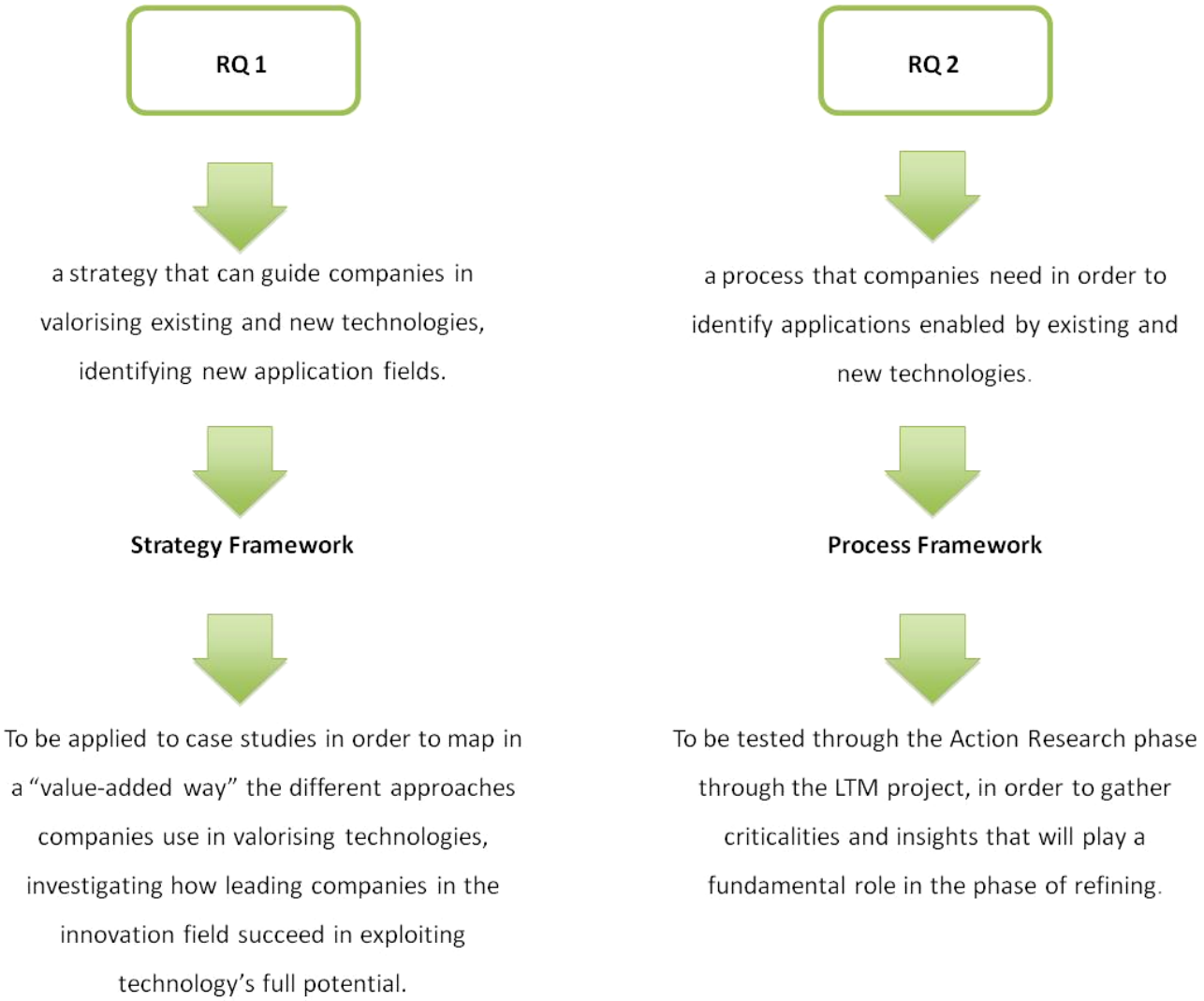

Figure 5.1 – From Research Questions To The Frameworks Generation

5.2 The limits of existing innovation strategies and the Strategy Framework

According to the literature, *on the strategy side (RQ 1)*, studies of innovation strategy have often focused their investigations on two different domains: technologies and markets.

The *technology strategy* approaches, surveyed in the first part of the literature review, are a first attempt to investigate on methods to unveil potential applications. The resource-based approach, first, is based on the idea that a firm's competence is the actual source of sustainable and long-term competitive advantage. The interesting point is that it is not a matter of strengthening the actual competences of a company, but of considering them as a starting point to build competences in order to reshape competition and create new industries or to redefine the boundaries of existing industries, targeting latent needs or forcing changes in the purchasing attitude of customers. Porter's framework is also a possible solution to discover applications starting for new or existing technologies, but it generally relates to key factors that are merely oriented to the evaluation of strategic advantages or disadvantages in terms of technological management and competition. It is a matter of being the first mover to gain a competitive advantage, or following existing technological implementations that suite with the company strategy, knowhow and environment. Even if we do want to consider the market dimension beside the technology, we are not trying to do this in terms of market structure and positioning within an industry, but in terms of research and creation of new markets, as the Blue Ocean approach describes.

The *Blue Ocean strategy,* in fact, works on the shift to the role of competition in business strategy, searching for more interesting and promising markets. In this sense, companies must break out of the competitive and imitative trap and rather than striving to match or outperform the competition, they must cultivate innovation. Only going beyond incremental improvements, totally new ways of doing things can be reached. However, the business strategy described with the Blue Ocean also works on a single direction, that is the research for new markets, new businesses, with a basic absence of strict bounds about the implementation on new technologies or the achievement of new meanings. Compared to our objective, this is a sort of myopic view, since our research aims to identify a strategy to unveil the full potential of new (or existing) technologies. It is limiting in this sense to focus on the

unique dimension of market or on the single dimension of technological improvement, as Porter explains. They are, of course, attempts to increasingly move beyond the improvement of functional performance, but we need to address a deeper redefinition of the reason why their clients buy and use a product, that is what we call a "radical innovation of product meanings". In other words, whereas the wide body of literature explored deals with strategic innovation, we still lack robust theoretical frameworks that explain how companies can successfully propose new experiences and new interpretations of what a product is meant for, in order to achieve new applications, unveiling the full potential of technologies.

A concrete step towards this direction is Verganti's concept of *Technology Epiphany*, together with the innovative approach of *design-driven innovation*, which represents a significant contribution that focuses on this still rather unexplored area.

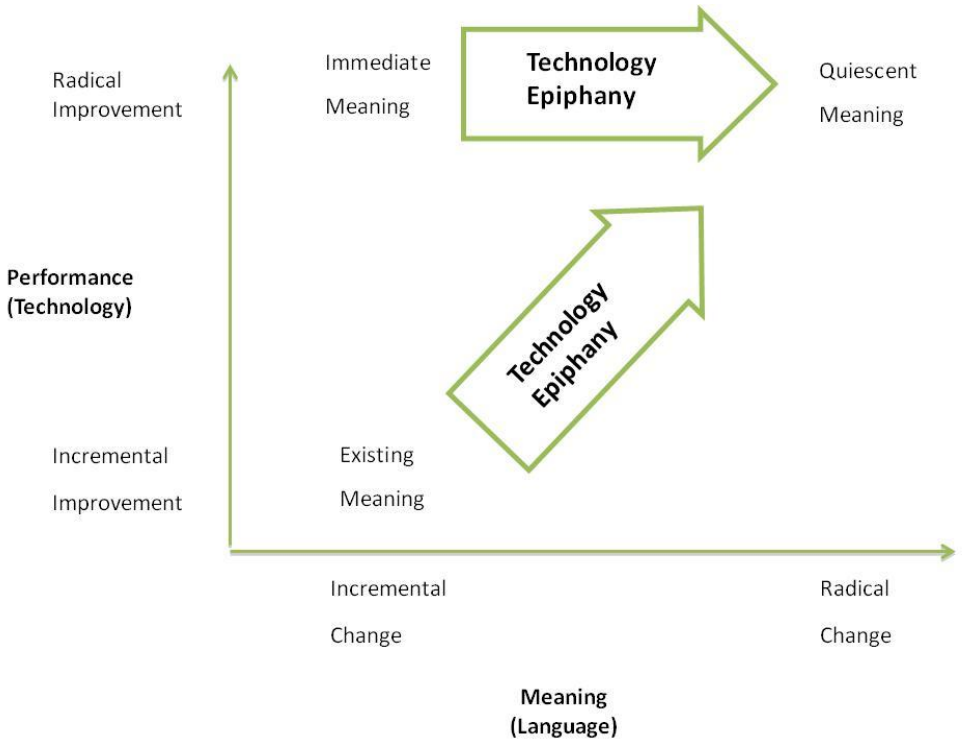

Figure 5.2 – The Concept of Technology Epiphany

In contrast with the business and technology strategies, the innovation of product meanings is considered to be the strongest enabler of radical breakthroughs: as shown in figure 5.2 (that we already examined in the literature review about the design process) only when companies uncover

the more-powerful quiescent meaning of a new technology the full potential of technological breakthrough is achieved. It is to say that a Technology Epiphany is usually much more disruptive to competition than the technological breakthroughs itself. Starting from this information, collected from the literature, the challenge in answering to RQ 1 is to give shape to a model able to consider the space of innovation as a three-dimensional construct. It does not only have to match changing in meanings with technological improvements, but it also has to consider a third dimension, that is the one directly related to the output of the Blue Ocean Strategy analysis, that is to say the research for new markets. This approach allows us to conciliate the three different perspectives of technology, business and design strategy, touching an increased depth of analysis and providing an added value that is essential for our scope: *the possibility to weigh the enablement of new meanings both on the dimension of market and technological improvement.*

Verganti's model represents the starting point to build our framework, according to the central role the concept of Technology Epiphany plays in our thesis. However, what we want to extract from it is the ability of radically new meanings to envision scenarios that do not exist yet. It implies to picture an idea into a new context that often coincides with an unknown market space. So, considering the impact of the achievement of new markets, and taking a cue from the model that Öberg and Verganti developed in 2012, we also consider a transverse axis the maps the achievement of new markets. The final result is a three-dimensional model, the axes of which move toward new markets, new technologies or new meanings. This takes shape into the *strategy framework*, described below:

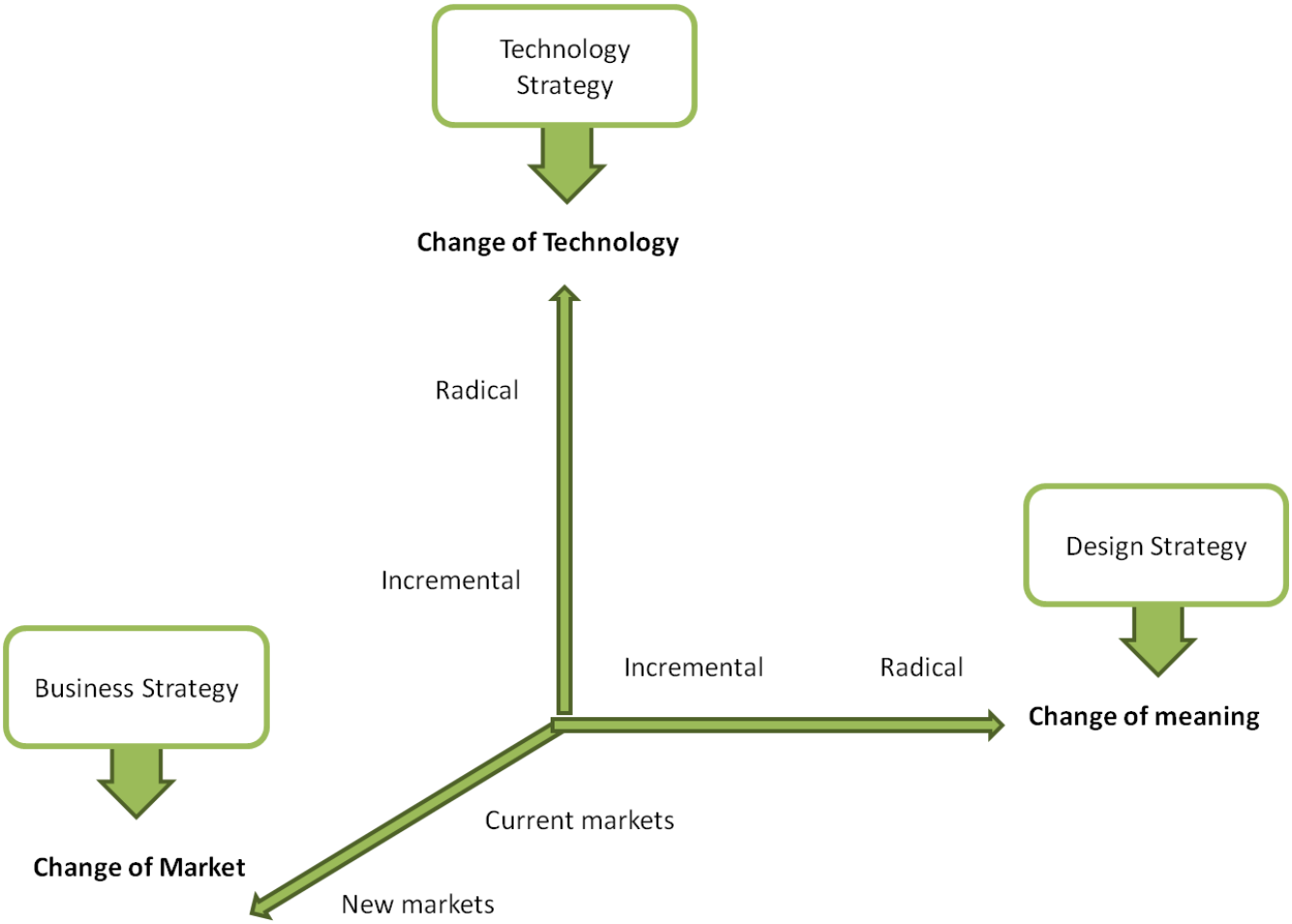

Figure 5.3 – The Strategy Framework

Note that innovation of meanings can be based on existing or new technologies. For example, in 2003 the German company *KUKA Roboter Gmbh*, a major player in the robotic industry, released the "Robocoaster" (S. Scaetzle, C. Preusche, G. Hirzinger, 2009) that was based on available robotic technology (indeed it's an adaptation of an existing product). It consists of a robotic arm with two seats at its end to host people. During the ride, which people can design before, the robotic arm lifts the passengers in the air, swirls, stops suddenly, and turns them upside down and in many directions, with different speeds and dynamics. It challenges the existing paradigmatic interpretation of what an industrial robot is, not used for improving efficiency, but for entertainment. The *Robocoaster* is not just a creative idea that fits perfectly within what is meant as "business as usual". It is a revolutionary change in what industrial robots are meant for, that provides a radical change in meaning starting from an existing technology. A close example in the same word is the "*RobotStudio*" simulator

introduced by ABB Robotics, which required, on the contrary, the development of new software applications. Through *RobotStudio*, clients can visualize the operations of a robot in their plant before they actually buy and use the product. They may better predict how to effectively use a robot and design a better manufacturing process. The meaning therefore moved from selling an efficient robotic arm to selling knowledge on how to use it: even a slow robot may be more valuable than a faster one if it is used in an effective way.

Similarly, considering the dimension of markets innovation of meanings concerns both existing and new markets. The *RobotStudio* is targeted to traditional robotic clients, such us industrial manufacturers, but still it implies a radical change in the reason they buy robots: from searching for speed and efficiency, to searching for knowledge about how to use robots. The *Robocoaster* instead brings robotics into a totally new arena, transforming roller coasting from a ride that is predictable and standard to an experience that is unpredictable and customizable by passengers.

Whichever the case (either an existing or new technology is applied or an existing or new market is targeted), this framework gives us the chance to focus on an innovation process where new meanings are searched for and designed, as a way to provide more value to customers and compete better, or different.

5.3 The need for a new procedural perspective: the Process Framework

In parallel to the Strategic dimension, to give *an answer to the RQ 2 on the process side*, we develop here a second framework, logically related to the first one, which considers the impact that the process has on the innovative dimension. Again we start from what the authors we mentioned in the previous analysis describe as the methods that are considered to be effective approaches in order to reveal new potentialities and consequent new applications of technologies.

The feeling we stated in the introduction of the thesis, that companies usually tend to focus only on a technology-push approach, was supported by the analysis of the literature. Particularly, in the *technology process* the internal analysis that brings to the construction of the *technology/applications matrix* shows how the technological innovation is driven by the technological skills that are present or can be effectively developed within the company environment: parameters like the resources availability or the understanding the technological environment are essential in this sense. It is a process that clearly evaluates technologies according to the current state of art of the internal resources and possibilities of the company itself. The transversal analysis of the external context, based on techniques like technology scouting or lead users and key customers monitoring, is a first attempt to consider a second dimension oriented to the market side focusing on the sustainable use of technologies and their integration with the business strategy. However, it clearly refers to customers' needs and possibilities offered by the market, with a typical market-pull approach. The matrix itself, in fact, is the result of the integration of opportunities offered by internal technologies and market demands, defining a match of the two traditional approaches to innovation (market-pull and technology-push).

The *Blue Ocean process* is particularly interesting if we consider the component of values, expressed by the concept of "*New Value Curves*". This process gives companies the method to explore how they can reconstruct buyer value elements across alternative industries to offer buyers an entirely new experience. Companies should consider eliminating factors they have long competed on, sometimes with a fundamental change in what buyers value. Uncovering and eliminate the compromises the industry forces customers to make, companies can discover entirely new sources of value for buyers

and to create new demand and shift the strategic pricing of the industry. This approach is significantly oriented to the definition of new application fields, searching for new and unexplored markets. It matches with the purpose of the thesis, but only partially. If it is true that the Blue Ocean process gives instruments to uncover new potential markets, it is hard to say that it is directly related to the expression of the full potential of technologies (new or existing). There is not a particular reference on how to manage the process in terms of exploitation of technology potentialities, which, on the contrary, is crucial for the purposes of our research. The conceptual framework must take into account the possibilities offered by the Blue Ocean in terms of definition of new markets, but it needs an intermediate dimension that links this exploration on new application fields with the technology side.

The most appropriate actor for this role of interpreter and mediator between new markets and technologies is the Design side. The literature described the *design process* as an essential pillar in the first steps of definition of the innovation process, aiming at giving focus to the process direction, as interpreter of company's needs and enabler of new points of view. *Briefing activities*, in particular, are the generators of a lead for the all, as a set of instructions that set out what are the objectives and parameters of the design project, what is the information to be collected before and what is the precise direction of the process of innovation. *Scenario building* is also a useful tool, especially when the number of variables to be considered is very high and the conditions to predict the future are complicated. It is a technique to the develop descriptions, stories as texts or videos that involve specific characters, events, products and environments. The *cultural probes* explored in the literature review are a specific tool in order to do it, providing the opportunity to explore the ideas of both new products and new businesses in a realistic future.

According to what stated above, for the purposes of our research, in the process of innovation we do need to consider the impact that the business strategy has on the innovation process, from the market side and, at the same time, we cannot consider technology and design processes as two different means, but we need to evaluate that interplay that Verganti explained, enabler of new meanings. At the same time we want to achieve through the conceptual framework is a lower level of uncertainly, giving a bottom line, a structure to the process, in order to implement an innovation strategy, to follow a precise path and to perceive a defined end point. The result is a framework

structured on three different levels, which enables the integrated vision from the business, design and technology sides, evaluating the relationship between people (potential customers and markets) meanings and products:

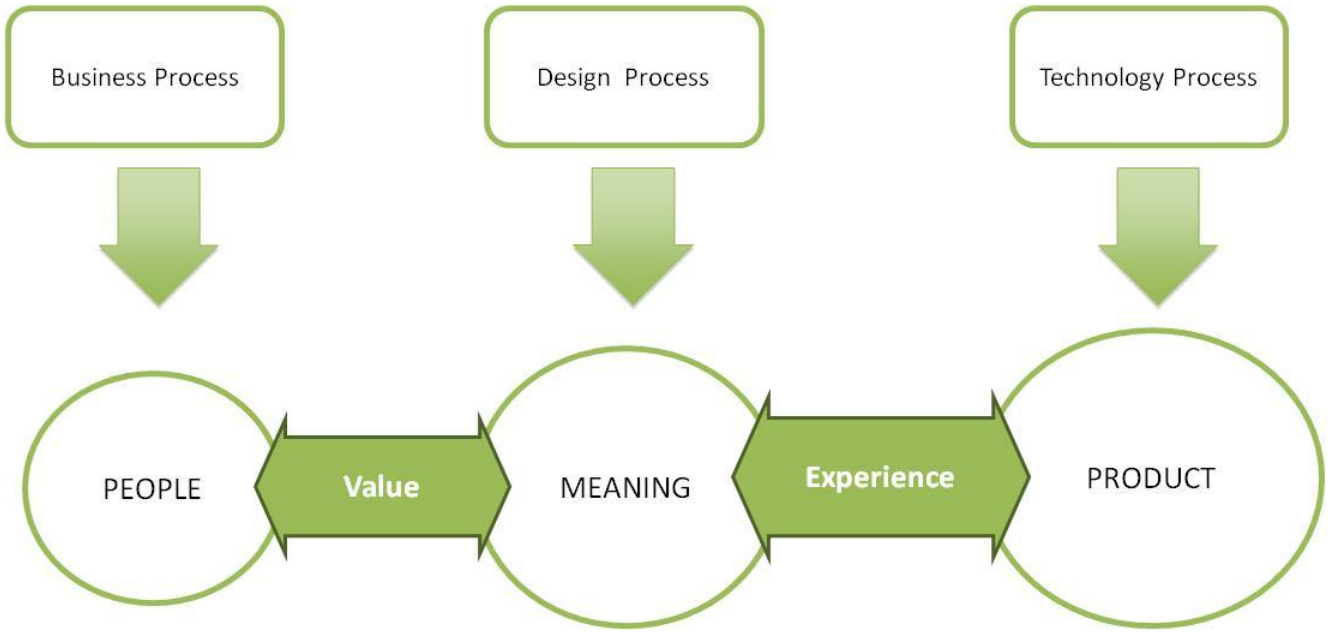

Figure 5.4 – The Process Framework

The technology process acts on the product characteristics, eventually introducing a new technology, so the dimension of the product obviously changes, because the way the solution is provided changes. The experience that links the dimension of product to the dimension of meanings is closely linked to the process that consumer lives, therefore to the activities and the relations between different phases. It is made up of tangible and intangible benefits associated to the product. Acting on the product side new functionalities can be introduced, but it does not mean that they will give a new kind of experience to customers, or it could be, but the reasons why customers buy products remain unchanged. The dimension of meanings, in this case, stays intact. Contrarily, when the experience provided by the intrinsic characteristics of the technology matches with completely new reasons why customers buy products, then the interplay between technology and meaning is activated and a Technology Epiphany is generated.

The business process, instead, that represents a strategic approach (the Blue Ocean one) that leads to the discovery of uncontaminated “Blue” markets, searches for entirely new sources of value for

buyers, creating new demand that shifts the strategic pricing of the industry. The new value curve intercepted embeds a Value that from a "design driven" point of view is complementary reached thanks to new meanings embedded by products, which intercept new markets in the opposite direction.

The exploitation of the potentialities embedded by technologies, which pushes towards new values on one side and towards new experiences on the other, is achieved thanks to the *Design Driven Innovation*. In our framework the Design Driven Innovation starts from meanings: a company finds out new solutions in terms of meanings conveyed by the product, changing the reasons why people approach to it. When the new innovation process deals with the achievement of different (eventually unexplored) markets, adding a new value to the product that reaches different kinds of people, different customers. In addition when Design Driven Innovation manifests in its most disruptive form, the process also touches the area of products, because it is strictly connected to a technological breakthrough that matches the change in meanings. When the interplay works and a technological breakthrough is associated to a new meaning embedded by the product, the full potential is stimulated and the new applications fields can be activated. Recalling what we explained in the introduction, what happens in this process is that technologies offer opportunities which are of course not infinite, but are greater in number than those imagined by early developers. As shown in Figure 5.5, especially at the first stages of the product development process the opportunities are great in number, when the meaning of a precise technology is not defined yet.

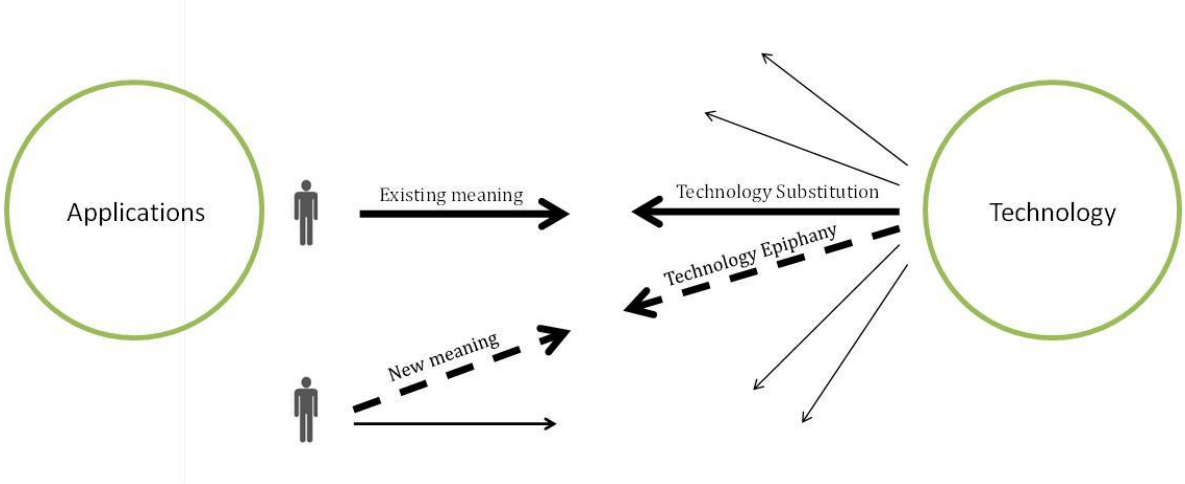

Figure 5.5 – The Interplay Between Applications and Technology

The greatest number of the possible applications will often represent a technology substitution in a clear Technology Push perspective, deriving from the companies' research and development activities, or pulled by the market, getting a new product development as a direct consequence of explicit needs expressed by the consumers. In this way the existing meaning of a technology is embraced and a radical Design Driven Innovation has not to be expected. But the real challenge we are dealing with is to achieve the most potential applications discovering and embracing new meanings, through what was defined in the previous chapter as a Technology Epiphany. It involves a process of research and analysis in unusual application fields, with unusual customers, towards unusual and powerful meanings.

Since our research is definitely "meaning-oriented", we propose an additional breakdown of the model that helps in identifying the interplay between technology and meaning that will be particularly useful also in the final part of the thesis, since the phase of Action Research is clearly based on a design-driven approach:

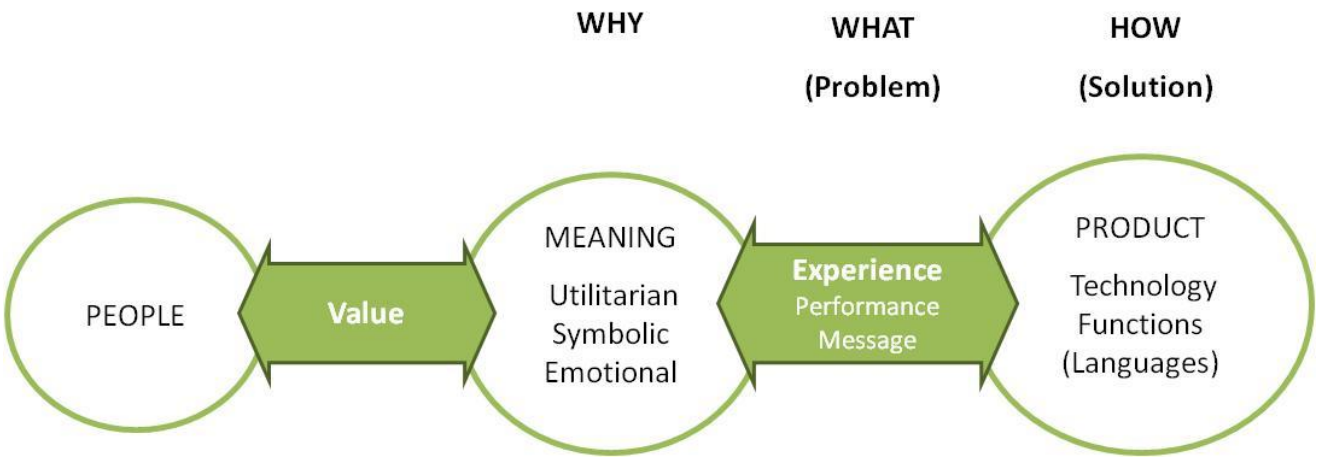

Figure 5.6 – The Process Framework

The first dimension (WHY) of the model represents the reasons why customers approach to product/service. The meaning here represents everything is utilitarian, emotional and symbolic in the product. The first one represents the performances linked to the product: the quality of being useful and solving the problems it has been thought for. The emotional meaning is strictly connected to the sensations that the product communicates to the user: the feelings, the images that the product

evokes in the consumer mind. In the end every objects is a symbol, then each of them means something: a state of mind, a social status, values and ideals. The symbolic meaning is linked to the capability of the product to tell something to other people: consumers buy a product because it embeds a message they want to communicate.

The second dimension (WHAT), that is the connective point between meanings and functions, represents the experience customers enjoy. It is closely linked to the process that consumer lives, therefore to the activities and the relations between different phases. Customers, choosing a product, decide to live a unique experience made up of tangible and intangible benefits. Technological and functional performances have to be mixed with messages and meanings attached to product and brand in order to offer a complete experience. In recent years, in fact, imaginative, emotional and evaluative components of the consumption experience became more and more relevant: what consumers are increasingly seeking in brands and products are new forms of psychological satisfaction that go beyond simple consumption. Fantasies, feelings and fun play a fundamental role in the experiential choice of customers, losing its original form of pure rational choice. Intangible and emotional aspects enhance their weight. For these reasons companies nowadays offer more than simple product attributes: they try to establish themselves on the market through meanings represented by the brand and the symbolic values. The success of a firm is strictly linked to the experience it can provide to the customer in the form of performances and messages. Functional features, technological performances and product quality play a fundamental role in the process of achieving people approval. Nevertheless these elements are not enough: meanings and messages conveyed by products and brand have to strike customers, capturing their hearts and minds (Dell'Era, 2010).

The third dimension (HOW) deals with languages and technologies embedded in the product, which provide the solution to the problem stated by people. It represents tools that allow users to live concretely the experience. Technologies refer to the intrinsic characteristics of the product, which are its building blocks from a functional and semantic perspective. Both perspectives are crucial on this dimension. In fact, the solution provided doesn’t only stands behind functionalities embedded by product, or technologies that characterizes it; very often, it is a precise language through which products talk to people that often plays a fundamental role. Nintendo Wii accelerometers, for

example, don't give the direct solution to people by themselves, they are a tool to speak a different language, to live behind the way people used to play console games, giving new solutions to innovative experiences.

What is crucial to understand in order to clarify the exact meaning of this model is the way design-driven innovation acts according to the model: it obviously starts from meanings: a company finds out new solutions in terms of meanings conveyed by the product, changing the reasons why people approach to it. When Design Driven Innovation manifests in its most disruptive form, the process involves all the three dimensions, also touching the "HOW" area. It involves a change in functions and messages that people experience, also modifying languages and technologies to express the new purposed meanings. In this way *new technologies activate the achievement of new applications.* However, what is more likely to happen in the reality, is that Incremental innovations in meanings occur more than breakthroughs: companies like Alessi, for example (Verganti, 2009), has showed that a firm can have a deep innovative nature, but only mastering radical innovation of meanings, being a follower in technological breakthroughs. When a design-driven approach like this is introduced, customers buy products to satisfy different reasons, eventually experiencing new performances or messages, but product technologies, stay unchanged. This scenario is still interesting, since it can also be, according to our research questions, that *existing technologies activate the achievement of new applications.*

Concluding, the final objective associated to the building of the conceptual framework is to evaluate this interplay between the design and technology side, also taking in consideration the business side, considering that when the technological breakthrough driven by meaning is able to generate a new value for customers, then the purposes of the business strategy are also achieved, reaching a new market. On the one hand, the strategy framework triggers the understanding of the processes adopted by companies in the case studies, in order to map the different approaches used in valorising technologies, investigating how those leading companies in the innovation field succeed in exploiting full potential of technology. On the other hand, the process framework constitutes the baseline for the definition of an innovation process that valorises the thesis objectives and purposes, after being tested through the action research phase with the *Light Touch Matters* project, in order to gather criticalities and insights from partners, which will play a fundamental role in the phase of refining.

CHAPTER 6

Case Studies Research

Case study research represents the path that led us to the definition of a grounded answer to the RQ1. Through case studies we identified and mapped the different approaches that the selected companies use in order to valorise existing and new technologies, analysing criticalities and strength points. Focusing on specific projects, whose outputs represent radically innovative applications, we narrowed the research focus, gathering qualitative and quantitative evaluations. The final cross case analysis allowed us to have a complete framework about strategies guiding companies towards innovation. Through a comparison of the results related to each project, we defined the optimal approach an organization should follow in order to exploiting full potential of technology.

6.1 Cases, Companies and People

In the spread field of innovation management, we identified a basket of companies that are generally considered to *be leader*. We focused on the research for those ones that have been particularly successful in being *innovation-driven* over the recent years, also searching for companies that managed projects that involved interesting breakthroughs. We came up with 4 companies that represent our "concrete" research in the real world: details about the companies we studied and the contacts we interviewed are reported below:

	People interviewed	Role in the company	Place, date and time
ITALCEMENTI S.p.A.	Ing E. Scalchi Dott.sa B. Fassi	Innovation and Marketing Area Manager Communication Assistant at New Products and Applications Marketing department	Bergamo (BG) October 09, 2013 2 h
PIRELLI Tyre	Ing. De Cancellis	Circuit Manager	Milano (MI) October 10, 2013 2 h
	Ing G. Audisio	Tyre Systems & Vehicle Dynamics Director	Milano (MI) October 18, 2013 1,5 h
PELMA S.p.a	Ing. M. Pelucchi	Sole director	Bassano Bresciano (BS) October 11, 2013 2 h
TETRA PAK	Ing M. Cereda Ing A. Rendina	Consumer Concepts Manager Key Competencies Director	Modena (MO) October 22, 2013 3 h

Figure 6.1 – Interviews Details

Each case study starts with an initial framing of the company, through a general overview on the company profile. Then a classification of the characteristics of the companies' offering is conducted, in order to have a more precise idea of the business the cases deal with. A whole paragraph is dedicated to the analysis of the innovation management that distinguishes each individual company, followed by the presentation of the *specific projects* we decided to analyse. In this central section the main objective is the description of what we considered to be particularly interesting for our purposes, evidencing the peculiarities of each of the projects in terms of innovative achievements. Every case study ends with the identification of the *added value* attributed to each project, together with an understanding on the *strategy* behind it. The final cross case analysis allowed us to have a complete framework about strategies guiding companies towards innovation. Through a comparison of the results related to each project, we defined the optimal approach an organization should follow in order to exploiting full potential of technology.

6.2 Italcementi

Figure 6.2 – Italcementi Logo

6.2.1 Company Profile

With an annual production capacity of 65 million tons and 53 cement plants, considering also the companies consolidated by equity, Italcementi Group is the world's fifth largest cement producer. Along with the cement plants, Italcementi Group's industrial network includes 10 grinding centres, 7 terminals, 449 concrete batching units combining the expertise, know-how and cultures of 22 countries across four continents.

The Parent Company, Italcementi S.p.A., is one of Italy's 10 largest industrial companies and is listed on the Italian Stock Exchange. Founded in 1864, the company achieved important international status with the take-over of Ciments Français in 1992. Following a period of re-organization and integration that culminates in the adoption of a single corporate identity for all Group subsidiaries, the newly-born Italcementi Group began to diversify geographically through a series of acquisitions in emerging countries.

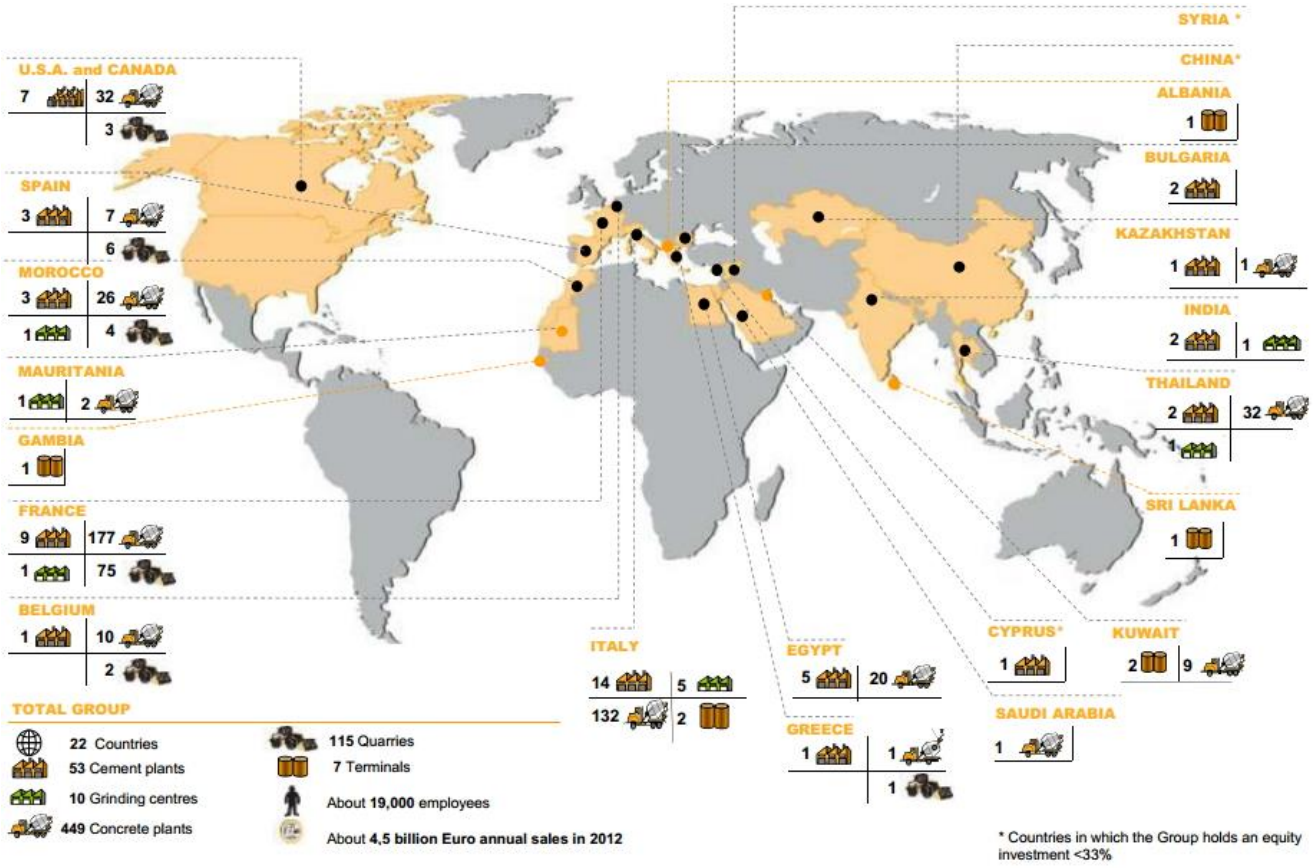

Figure 6.3 – The Geographically Diversification of Italcementi Group

Through the activities of its advanced Research and Innovation centres in Italy and in France, among which the new *i.Lab of Bergamo* stands out, the Group intends to anticipate market trends and requirements giving priority to environmental issues and the optimization of resources.

6.2.2 Business

Italcementi Group manufactures and distributes three main product lines: cement, aggregates and ready-mixed concrete. The group aims to optimize production across the markets, providing a complete solution for customers' needs at the lowest possible cost, strategically integrating its activities.

Cement is made from a mixture of 80 per cent limestone and 20 per cent clay. These are crushed and ground to provide the "raw meal", a pale, flour-like powder. Heated to around 1450° C in rotating kilns, the "meal" undergoes complex chemical changes and is transformed into clinker. Fine-grinding the clinker together with a small quantity of gypsum produces cement. Adding other constituents at this stage produces cements for specialized uses.

Aggregates are made from sand and gravel extracted from quarries. Around 60 per cent of aggregates are used in road construction. The remainder is used to produce concrete.

Concrete is a mixture of cement, aggregates, water, admixtures and additions based on formulas that conform to predetermined strict technical specifications. Concrete is either mixed on the building site or delivered "ready-mixed" by specialized suppliers.

Figure 6.4 – The Products

6.2.3 Innovation management in Italcementi

"*We believe in the importance of innovation not only in the development of new products, applications and services, but also in our management approach*".

Enrico Scalchi – Innovation and Marketing Area Manager Italcementi.

Innovation applied to the continued search for sustainable architectural solutions represents for Italcementi the strategic lever to create its own competitive advantage, whilst contributing to improving the quality of life and the environment. In this context, Italcementi aims to become a cutting edge cement-manufacturing group capable of transforming a commodity into a technologically advanced product at the service of the building community. For this purpose a specific Innovation Department has been created in 2010 in order to recommend and approve projects for new products and applications.

At the heart of Italcementi Group's innovation are the laboratories based in Bergamo and Paris, where the daily work of about 170 researchers, including chemists, geologists and engineers has made it possible to file over 92 patents in the last decade. Italcementi Group's new research centre, known as "*i.Lab*" is located in Bergamo. The new construction boasts a surface area of 23,000 m², of which over 7,000 m² totally devoted to research laboratories. Italcementi Group has developed a network of international scientific cooperation consisting of research centres, universities and companies of the building and building material industry. The current network includes 10 external centres, 30 companies and 26 Italian, European and non-European universities.

Finally, the group has recently launched an *innovation project* for the development of high-performance products that can be effectively adapted to specific user needs. The project aims to act as a reference model for industrialization in the building sector, using a partnership approach between Italcementi Group and its customers to market exclusive innovative products resulting from this integration.

From the point of view of the innovation approach, as declared by Scalchi during the interview, "*Both Technology Push and Market Pull streams are active. Solely concentrating on Technology Push could lead to a lack of contact with the final market: it is important to balance the two approaches to completely seize the market opportunities. There are researches that arise in laboratory; in this case the challenge is to transform developed technologies in potential useful application and define an efficient method to address the research work. Technology Push often leads to radically innovative results, but at the same time it generates a risk related the low economic return. In fact, most of the innovations developed in laboratories represent market niche innovations, directed to specific élite*". Over the interview we analysed the process of identification of new technologies. Scalchi stated that the main inputs are represented by:

- *macro-trends* (low CO2 emission products and processes, use of recyclable raw materials, reduced water consumption and low energy clinkerization).

- *European projects*.

- *Networking*. From the connection with research centres, universities, scientific committees, different research fields are identified and screened.

- *Intellectual property analysis*. It is absolutely important to constantly monitor the filed patents: these could lead to the identification of interesting technological perspectives.

- *Competitive intelligence*.

In Italcementi the network of scientific cooperation is a fundamental element to success. Such shared effort is focused on reducing time to-market in terms of industrialisation and marketing of new products, services and processes. This approach integrates perfectly with the positioning of i.Lab at the *Kilometro Rosso Scientific Park* where multidisciplinary Methodology provides key support to research and development activities. "*Italcementi started up research projects with Brembo and Mario Negri, two companies based in Kilometro Rosso, approaching lines of research absolutely far from the building business*". The company uses to prioritize the identified technologies, following the criteria below:

- *Accordance with the company strategy*
- *Evaluation in terms of commercial exploitability*
- *Market potential*
- *Innovation life-cycle*

The identification of technologies is following by the application fields research. The *Innovation Department* plays a central role in this phase, addressing the future steps of research, applying filters and clarifying the direction. Potential applications stem from different sources: the research project itself, the Innovation Department and finally the customers. In the first case researchers find out new application fields; downstream the Innovation Department assesses the attractiveness of the application and evaluates the match with the market's needs. On the other hand inputs come from the final customer who manifests explicit needs: the Department struggles to find out a compelling solution in terms of product. In numbers: 40% of projects stem from customer explicit requests: this is the percentage of incremental innovations developed in the company; 50% of all projects leads to radical innovation: 70% originates from internal research, the rest derives from the external. 10% represents supporting projects to existing products.

Innovation process is monitored in terms of results: innovative solutions are evaluated through a parameter called *innovation rate* – the ratio of revenues generated by innovation projects to total Group sales. Particularly, products that currently do not exist in market, with a life cycle of 7-10 years, represent 10% of the innovation rate. Innovations that do not exist in the specific country represent 50% on the parameter, whereas products not owned by the specific customer affect the innovation rate with the 40%.

6.2.4 The selected Project: Effix Design

This project represents a perfect example of *maximum valorisation of technology*: material which becomes creative matter.

Effix Design is a mortar featuring high strength and enhanced aesthetic properties, capable of ensuring great attention to details of trendy designers and of opening new creative path to designers of décor elements. A polymorphous material by nature, Effix Design plays with shapes and materials. Easy to work, it is especially suitable for making small architectural elements, thin and slim, with smooth or worked surfaces.

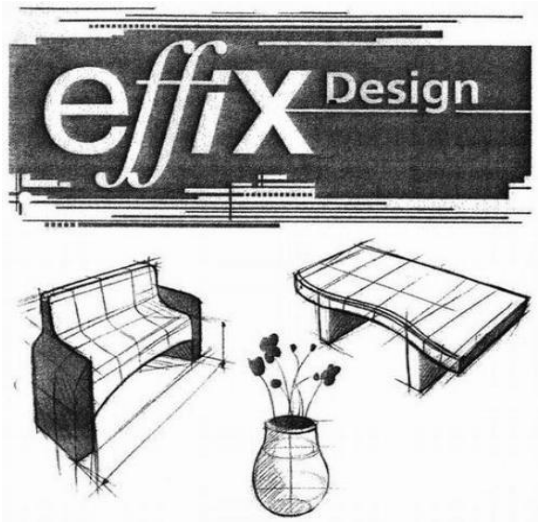

Figure 6.5 – Effix Design - Logo

How did this radical innovation step out? Engineer Scalchi explained the process that led to this changeover in what is traditionally considered concrete. "*Actually Effix Design is the result of an accidental process. Consisting of fine aggregates, glass fibres and additives, Effix Design was originally conceived as a copy of a competitor's product developed for structural applications. The high-performance mortar was limited from the point of view of the application field because of the risk of patent protection. As the other materials developed, it represented a part of the exhibition based in iLab direct at visitors, representing company's outcomes in terms of materials and technologies. A group of designers accidentally noticed Effix Design for its particular durability and remarkable*

elasticity, potentially suitable for making slim non-structural objects and decorative elements. Hence, Italcementi, supported by architects and designers' suggestions, identified a new application field for concrete, far away from the traditional one: interior and outdoor design elements in urban environments."

Figure 6.6 – Different Uses of Effix Design

Particularly trendy in terms of its mineral appearance, Effix Design is available in white base, which can be coloured by adding mineral pigments to obtain a broad range of different colours. By adjusting the saturation density of the pigments, the range can be expanded to provide endless decorative options. These new artistic prospects are further enhanced by the ability of Effix Design to elegantly blend with other materials such as, for example, aluminium, glass and steel, making it ideal for creating special-design chiaroscuro effects.

As anticipated this new type of concrete is perfect for a broad range of applications:

- *Furnishings*. Structures for upmarket shops, private villas, corporate headquarters, public places, prestigious lobbies. Effix Design is not only extremely pleasing to the eye, it also benefits from exceptional properties which ensure stability and long life, major factors as regards all projects made to be installed outdoors.

- *Concrete interiors.* Thanks to its unique qualities and range of available colours, Effix Design is ideal for use in the kitchen and extremely appealing in all other home interiors. "*Easy to install, it combines aesthetics and light weight and is able to equal even the most audacious shapes, providing an until now impossible creative freedom. In this ongoing quest for trends*

and shapes, I particularly appreciate its capacity to combine with the mould material. The brightness and final material effect are surprisingly realistic". These are David Margin's words, a stylist and creative designer who used Effix Design to create a totally innovative lamp, proposing a completely new luminous experience.

- *Jewellery.* Thanks to its particular durability and strength, Effix Design permits extending production to even small decorative objects: fineness and light weight are granted thanks to a broad range of finishing colours, left to the free interpretation of the artist. For the contemporary jeweller, Patric Fabre, Effix Design is at the bottom of the creation of a necklace, inspired by the water universe.

The enormous potential of this new material is testified by the interest demonstrated by one of the leading Italian Design Factories Companies, *Alessi*. Italcementi and Alessi join forces to launch the international "*#Concrete in Design*" contest dedicated to young designers interested in finding new forms of expression with i.design EFFIX. Through a web platform for design with new products and digitization of the creative process, young designers will be asked to create a table centrepiece for outdoor use by using the new applications and potentials offered by i.design EFFIX. The winner will be announced in December 2013 and in February 2014 s/he will participate in a workshop organized by LPWK Design Studio by Laura Polinoro, who has been working with Alessi for years for the organization of design workshops all around the world. The project sent during the contest will be examined in detail and improved to obtain a new product to be proposed for a future Alessi collection.

6.3.5 The Strategy behind and the added value

Effix Design is an example of *innovation strategies mix*: the project merges *Technology Epiphany and Blue Ocean strategy*, combining radical improvements on the functional, semantic and market dimensions.

As technology innovation, Effix Desing represents a new type of concrete, with incredible properties of durability and elasticity that make it a unique material. Particularly, *Effix Design* is a very fluid off-white mortar that contains all pre-mixed powders, sand, and alkali-resistant glass fibers. Its formulation with fine elements allows to obtain perfectly smooth and uniform surfaces and excellent reproduction of the shape of the moulds used.

Concrete meaning has been totally revolutionized: from a mute, grey, static material to a seductive, flexible and coloured matter. Concrete becomes a source of inspiration for the design creativity: it combines aesthetics and light weight, able to equal even the most audacious shapes, providing an incredible creative freedom. From a concept of heaviness and rigidity to an idea of lightness and flexibility, the meaning of concrete has been totally overturned! "*What I appreciate most about this material is that it has a soul; even using the same ingredient, one piece is never the same as another. A trump card for a creator of unique objects like myself!*" Jean-Eudes Massiou, artist and cabinet maker testifies the ability to convey emotions and feelings, a totally new aspect linked to the idea of concrete. Technology and its features becomes an enabler of new product meanings: the identification of new materials, surface treatments, manufacturing processes is combined with the definition of innovative meanings, celebrating what we called in literature Technology Epiphany.

Market dimension is also touched in this case: a *leap in new markets takes place*. This factor enriches the simple concept of Technology Epiphany, including a typical element of Blue Ocean strategy. Thanks to its unique features Effix Design is ideal for making furniture and non-structural elements. The innovative material pushes Italcementi to the discovery of application fields absolutely far from the traditional ones, like the indoor and outdoor furnishing, site amenity and jewellery sectors. Its unique qualities and range of available colours, Effix Design is extremely appealing in all home

interiors: Patrick le Ray, architect and interior designer, has conceived a trendy “concrete” fireplace, whereas Henry Rabardy has chosen Effix Design to create a modern concrete kitchen.

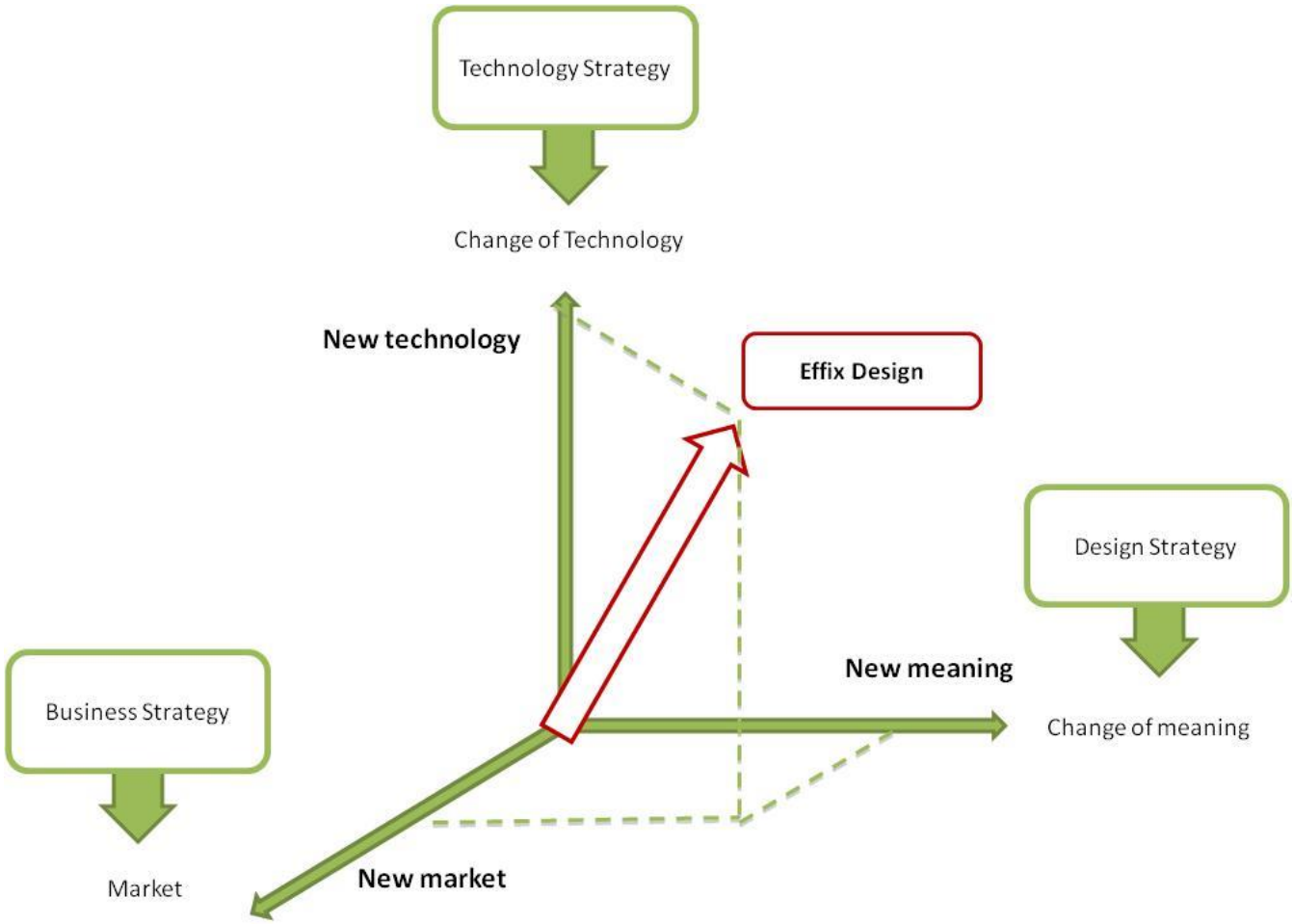

Figure 6.7 – Effix Design in The Strategy Framework

As showed by the figure 6.7 Italcementi occupies the farthest position from the origin. The strategy framework depicts a triple innovation on the three axes: market, meaning, technology. As described, a combination of new technology, new meaning and new market takes place: the first two elements

create a Technology Epiphany, the third one is the Blue Ocean key concept. The result is a mix between the two strategy approaches: actually the first one represents the interplay between technology-push and design-driven innovation (what Verganti called Technology Epiphany), whereas the second one is W. Chan Kim and Renée Mauborgne's Blue Ocean Strategy. Hence, Italcementi both reveals the quiescent meaning embedded in technology and creates new demand in an uncontested market space.

This project and the strategy behind will lead the company towards incredible achievements in profit and image. As stated by Scalchi "*Thanks to the launch of Effix Design, Italcementi is supposed to reach extraordinary results not only from the economic perspective, but also in terms of brand awareness. The company will embrace a wide category of "noncustomers", unlocking a new mass of consumers that did not exist before*". Scalchi presented the expected results for 2014, focusing particularly on innovation rate index: "*We planned to have an exceptional growth of the parameter. For last 5 years Innovation Rate has been lightly increased (roughly 1% per year); in 2015 it is expected to double grow comparing to 2013. Within two years, estimated time in which the technology will become established, a relevant impact of revenues generated by Effix Design to total group sales will take place, marking an extraordinary positive impact on the Innovation Rate*."

6.3 Pirelli Tyre

Figure 6.8 – Pirelli Logo

6.3.1 Company Profile

Founded in 1872, Pirelli is the world's fifth largest tyre manufacturer. The company has 22 tyre manufacturing facilities in 160 countries on five continents and employs over 37,000 people. The Company, unlike lots of others from the compartment of tyre production, focuses almost 100% of its activity to only tyres (it also produces cable steel cord, and filters). Pirelli's products are characterized by high standards of quality, in terms of performance, safety and environmental impact, also in line with the company's 'green performance' strategy. This happens thanks to a strong and constant focus on research and development, with an investment around 3% of revenues each year in this area, which is one of the highest levels of research investment in the tyre industry. Having been involved in motor racing since 1907, Pirelli is currently the single tyre manufacturer for Formula 1™ for the 2011-2013 championship seasons and for the World Superbike Championship. This is also an important challenge in terms of technological innovation and is a key means of promoting the Pirelli brand. The high quality products, the popularity of the Pirelli Calendar, the prestigious involvement in Formula 1™ and the company's involvement in the fashion industry all contribute to the success of the brand throughout the world, with an estimated value of €2.27 billion.

6.3.2 Business

Pirelli designs, develops, manufactures and markets tyres (for motor vehicles, industrial vehicles and motorcycles) and steel cords. The manufacturing structure of the company consists of 22 plants in 13 countries throughout the world (Argentina, Brazil, China, Egypt, Germany, United Kingdom, Italy, Mexico, Romania, Russia, Turkey, United States and Venezuela), and a commercial network that covers over 160 companies.

The business consists of two main segments*: Consumer* (about 70% of total revenues) deals with tyres for motor vehicles, sports utility vehicles (SUVs), light commercial vehicles and motorbikes; and *Industrial* (about 30% of revenues), which means tyres for buses, heavy trucks, agricultural machinery and steel cords, the fundamental strengthening element for radial tyres. These businesses are in turn focused on two different sales channels: original fit, directly focused on manufacturers, and replacements, replacement tyres for vehicles already on the road. Pirelli's technological skills and innovative approach have allowed it to consolidate agreements with the most prestigious motor vehicle and motorbike manufacturers in the world.

Figure 6.9 – Pirelli Tyres

In the car tyre sector, Pirelli offers a range of products focused on high and ultra-high performances, aiming to combine a notable level of stability and safety in all driving conditions with elevated grip and road holding even at high speeds. These tyres are particularly suitable for powerful, high

performance cars, the qualities of which they are designed to exalt. At the same time, within the motorcycle sector, the group offers one the industry's most comprehensive ranges. Production takes place in the two factories at Breuberg in Germany (where MIRS™ technology is used) and at Gravataì in Brazil. Pirelli Tyre is represented in this product segment by the Pirelli and Metzeler brands: the first is characterized by a strong sporting attitude and is aimed at a clientele generally associated with the world of competition, while the second is more comfort-oriented and is aimed a clientele more inclined towards intensive road use and long distances. Within its ranges of tyres for industrial vehicles, Pirelli Tyre has progressively reinforced its commitment to the markets in developing countries characterized by a growing demand (investing in production capacity in countries such as Brazil, in the Middle East and in China) and has increasingly focused on the production of tyres with a higher technological content. In continuous consolidation, both in terms of products and industrial scope, the truck sector has recently seen the introduction to the production processes of many of the concepts behind the MIRS™ technology that have permitted the launch of the Pirelli Amaranto™ family of giant high perform-ance and high reliability tyres.

6.3.3 Innovation Management in Pirelli

Innovation and research are Pirelli's most distinctive hallmarks. The Company has pioneered new technologies in order to have an online integrated management system, from supplies to production, from distribution to sales, with the ultimate aim being to create value.

Innovation is primarily managed by the R & D function that is recognized in all hierarchical levels as critical to the company. The innovative spirit is very much geared to the improvement of product performance: "*Pirelli is a very Product Driven reality* - said Ing. De Cancellis – *so the product features and potential areas for improvement of performances dictate the guidelines of the different business strategies. Within the enterprise, depending on the specific application field, the specific resources*

dedicated to innovation are various, with different functions and different people involved in different areas". Regardless of the specific group involved in the innovation process, a common point is the reliance on collaborative projects to widen the scope of the process:

- Collaborations with the basket of suppliers, mainly coming from the chemical industry, with a medium-term horizon (reasoning in terms of feasibility, manufacturability and return on investments in research in the order of a few years);

- Research in collaboration with research centres and Italian or foreign universities (including the Polytechnic of Milan), with fewer operational constraints and a consequent time horizon more oriented to the medium-long term;

- Scouting generated by a screening of ideas among the internal researchers who independently develop ideas and concepts and open then these issues outwards: towards the market if there is related existing need or request; to universities and research centres when it comes to issues which are still far from the current reality of the tyre industry.

According to Ing. De Cancellis' words, the world of rubber is quite closed with a very high specificity of technologies and materials, and in particular the tyre is the best expression of the sector, both volumes and resources involved and size of companies. Therefore the development of new technologies has long been an incremental and progressive characteristic. Typically, a new technology is developed as an evolution of existing technologies, which are then replaced through technology substitution. A possible breakage of these schemes happens when they try to search for a response in different materials, especially when, relatively to a certain issue, they have reached a excessive degree of saturation and stability. Specifically, the innovative drive that distinguishes Pirelli, comes in two different perspectives:

The product perspective. Although the product area is a mature field (given the state of the art in the business of tyres), the challenge of Pirelli is to seek an offering to the automotive sector that meets needs and demands that have still no answers. Pirelli looks for new technologies, which may not be

the immediate evolution of existing ones, to add or change features of the product. Examples include projects such as:

- *Run Flat*: a tyre that can run deflated for Kilometres, without affecting the safety and quality of driving. Although this tyre introduces a new characterization of “extended mobility”.

- *Self-Sealing*: a tyre with an internal component that repairs a puncture or damage in an autonomous way, within a certain degree of damage. It performs its functions in the same traditional way of other tyres, but it incorporates an additional new function never thought before.

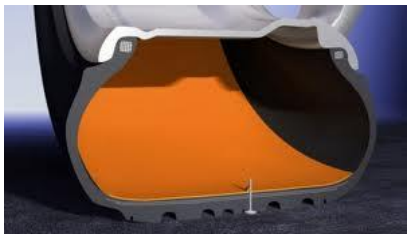

Figure 6.10 – Tyre Layers

The process perspective. Innovations that are part of the innovation process have a common factor which is derived from the theoretical foundations of the functioning of the rubber, with particular reference to the materials involved in the process. In everyday issues, the common element for the material specialists is the balance of performance: since the early 80's a magic triangle was the representation of this concept, based on the triad of conflicting wear and tear, conserve energy and wet grip, in which the improvement in performance of one pair on variables worsens the third one. Today rather than triangle the proper representation is a magic polygon, since the profile of the product performance is considerably sophisticated, because both the degree of sophistication of the market and the sensitivity of the end user has considerably grown over the years. Today it is also a matter of comfort, noise emissions, dry grip etc. So, the polygon is made up of a series of performances, some of which are in conflict with each other, according to the basis of the theoretical foundations of this issue. Basically, the research for performance aims to the partial resolution of these conflicts. A technology breakthrough points to the enlargement of the “performances radar chart”, as they call it in Pirelli. In some interesting cases, some conflicts have been resolved. An example of that is the introduction of the *green pneumatic,* an highly energy efficient tyre, solving the big conflict between efficiency and wet grip, solved through the introduction of silica in the process materials.

Lastly, Ing. De Cancellis underlined the importance of what is considered to be the group's innovation engine: “Pirelli Labs”. It represents the Group's pole of technological excellence. Born in May 2001 with a starting investment of 135 mln Euros, the research centre at Milano Bicocca is active in the field of photonics and optical fibres and employs about 150 researchers. The emphasis on Innovation has allowed the development of new businesses in the real estate field; here too Pirelli has made its mark, both in the great initiatives of development and in the management and increase of value of properties. Pirelli Labs, has carried out numerous research projects representing the hub of a network of qualified international partners, including the Massachusetts Institute of Technology, the Georgia Technical University, CNR, ENEA and the Milan Politecnico University, and domestic labs such as CORECOM and CORIMAV.

Pirelli Labs have focused on the following specific fields of activity:

- new-generation optical components and chips based on nanotechnologies;
- new materials and processes for tyres;
- sensors and telemonitoring;
- fuel cells.

124 researchers work in the various functions of Pirelli Labs, and a number of specific R&D projects are financed through grants to students attending partner universities.

6.3.4 Selected Project: Cyber Fleet

Figure 6.11 – Cyber Fleet Logo

Pirelli Cyber Fleet is the most recent innovation from the integrated package of services and solutions for better fleet management. Ing. Audisio told us that *"the research on this device was born consequently to a scandal in the US that involved Firestone, after a few people died because of tyres that burst while driving. This fact brought the Us Government to impose a law that includes the installation of control devices on cars. This law will be also official in Europe before November 2014 and this is the reason why Pirelli, and other tyre manufacturers started investing in this technology".* What happened in the reality, then, is that Pirelli's project moved further, trying to make the best out of this opportunity. Basically Pirelli tried to valorize this technology, so that the commitment to the end user moved towards the offer of a solution to ensure that the tyre itself is properly maintained during his lifetime, to help fleet managers to achieve a level of superior efficiency of the all vehicle. The state-of-the-art management system, which is already a well-established reality for European and South American fleets, automatically monitors tyre pressures and temperatures. Cyber Fleet (trademarked Pirelli technology) optimizes fleet running costs, as it allows fuel savings to be made and streamlines the efficiency of tyre maintenance and pressure checks. Developed for fleets and distributed by Pirelli dealers, Cyber Fleet is offered alongside tyre sales and maintenance services. Throughout 2012, Cyber Fleet was tested on 43 heavy goods vehicles equipped with 322 tyre-mounted sensors, which covered around 15 million kilometres in Germany, Sweden, Italy, Turkey and Brazil. The tests concluded that fuel costs were reduced by around 1000 Euros per vehicle over the course of a year (depending on the price of fuel in each particular country). As an essential tool when it comes to fleet management, thanks to real time automatic monitoring of tyre pressures and temperatures, Cyber Fleet not only delivers reduced running costs but also lowers CO2 emissions, as well as improving safety standards on the road.

Figure 6.12 – Cyber Fleet Detail

In detail, the sensor is attached to the tyre inner liner, it is suitable for all sizes of tires/ speed codes, weighs less than 25 grams and gives a service life of 300K miles. It is available in both static and dynamic mode: in dynamic mode, full integration with a telematics system Allows real-time data capture from sensors attached to the inside of each tire, transmitting information to a functioning centralized database. Any anomalies in tire pressure or temperature are signalled immediately to both the driver and the fleet manager.

The benefits that Cyber Fleet ensures are related to:

- Driver safety: The monitoring of the pressure/ temperature of the tyres allows the user/ fleet manager to prevent tire failure and accidents;
- Duration Of Tyre: Through proper management of pressure, the tyres wear less, lasting more;
- Car safety: The position of each tire can be constantly monitored;
- Cost efficiency: The correct inflation pressure of the tyre reduces rolling resistance and fuel consumption. The pressure control is easier and faster.

Ing. Audisio reveals that: "*even if at the moment this technology is a reality destined to commercial vehicles, it is very likely a future extension to the range of tyres for cars too*". He also talked about the future developments planned for TMS, which go far beyond and enable numerous other applications.

For example, the repairer will be able to preload the sensor, using the bar code it already has, with the data of the tires mounted on the car, whose board electronics will be able to recognize whether you have installed summer or winter tyres, adjusting then the characteristics of the vehicle with the type of coverage. It will be possible to allow the only assembly of tyres approved for that exact model of vehicle. In the field of heavy transport the TMS will be valuable to measure the temperature of each tire, whose overheating typically depends from the components of the braking system, which often generates fires. In the future it is possible that the sensor will detect wear and general condition of the tires, warning the owner of the vehicle of the need to replace them. In short, as critical to safety, the tire will become an important aid to the safety itself, thanks to miniaturized components housed inside it.

6.3.5 The Strategy behind and the added value

Cyber Fleet is the result of Pirelli's commitment to the end user to offer, in addition to the traditional performances of the tyre, a solution to ensure that the tyre itself is properly maintained during his lifetime, providing a concrete feedback on performances to drivers and helping fleet managers to achieve a level of superior efficiency of the all vehicle. Actually, on the market sensors that detect the tire pressure are already present, more and more common on vehicles with low range, but what Pirelli offers is something that goes far beyond, for data integration, exploitability and transmission. The tyre, in fact, talks to the driver and the operator of the fleet transferring all information about life, operation and use of each tyre. In addition to the downloading of the data in a static way, Pirelli system integration reaches the highest value with the on-board systems that lead to a dynamic and real-time transmission of tyres pressure and temperature, to the driver and to the fleet manager. These features make Pirelli Cyber Fleet a concrete Technology Epiphany, which takes expression in the introduction in the world of rubber of an electronic technology, enabler of a new meaning that is the *"intelligent" tyre.* In fact, from the technology side, the final product that had always made up of

rubber and plastic, integrates now an electronic sensor, named Tms (Tyre Mounted Sensor) and placed on the inner wall of the tyre. This is a radical innovation on the innovation of technology, since it does not simply replace the sensors existing placed on cars that collect information from tyres, but moves the sensor itself in the inside of the tyre, adding a totally new component to the final product. The Technology Epiphany takes places in consequence of *the interplay* between the technology described above and the shift on the dimension of meanings: the original idea related to the tyre, as passive support to the vehicle movement, is completely replaced to the new concept of tyre as a smart element that collects information, talks to the driver and interprets the main actor in the monitoring and control of the key elements for the vehicle management. The driver and the fleet manager receive signals like pressure drop, temperature, level of efficiency, co2 emissions. The tyre has got an active role, that is something more and better than a simple point of contact between a vehicle and the road. To adopt a term used by Ing. Audisio, with the Cyber Tyre, Pirelli *"wanted to give the use of speech to tyres". The market dimension*, instead, remains unchanged. The needs and the reasons that lead the customer to purchase Pirelli's tyres with cyber fleet technology are different (there is an economic return in terms of savings when you buy cyber fleet, in addition to a matter of safety and performance improvement) but the target market does not move from the current one, since they would replace the traditional tyres on cars. Although the tyre gained completely innovative characteristics and related meanings different from the traditional ones, the market reference does not change.

In the graph above the shift of the dimensions of technology and meaning is expressed, through a mapping on our conceptual framework. The Cyber Tyre is placed on the up-right part of the graph, since the change in meanings from "instrument that enables the vehicle movement" to "smart part of the car that gives you feedbacks related to performances" is activated from a technological breakthrough that is the installation of the Tms sensor inside the tyre.

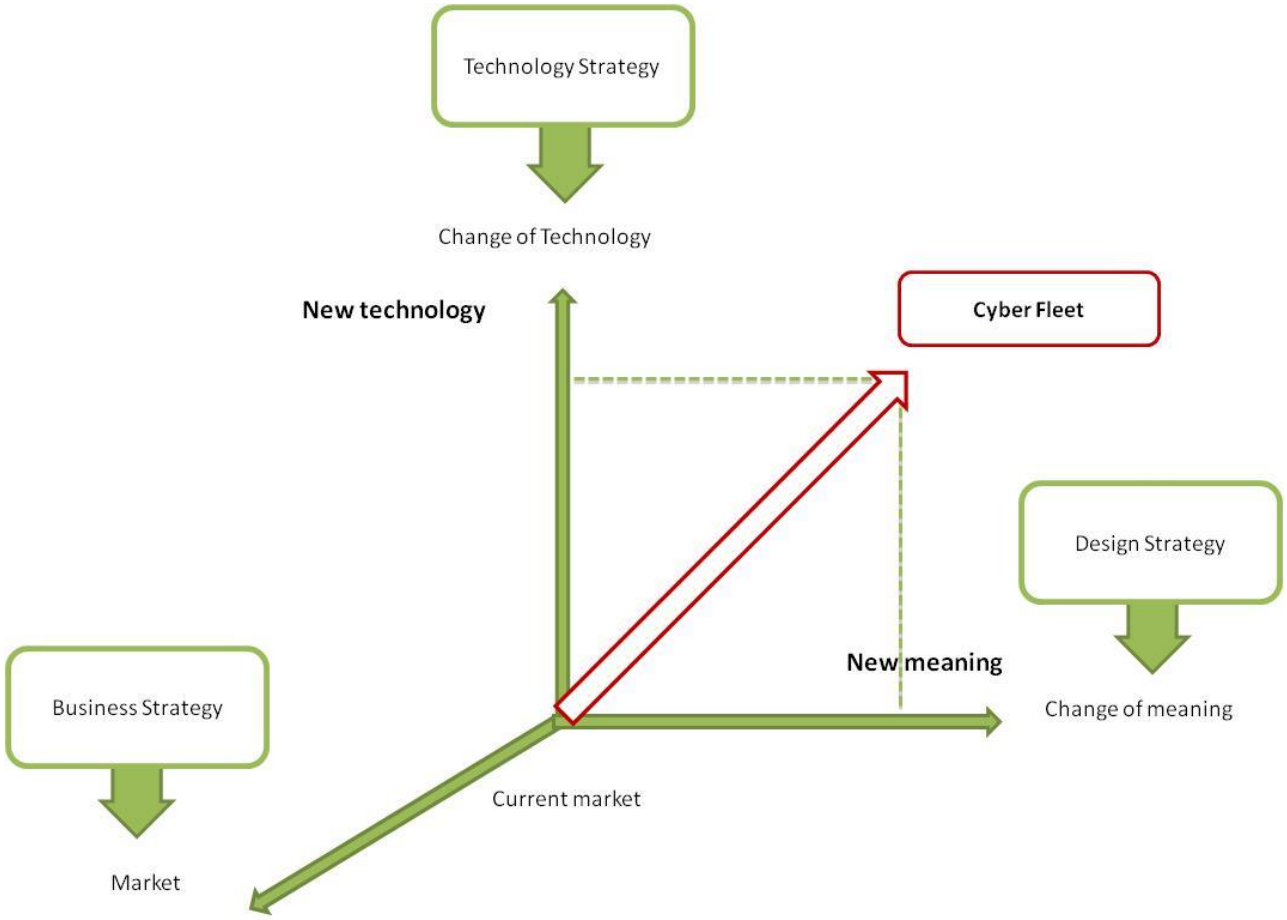

Figure 6.13 – Cyber Fleet in The Strategy Framework

The Technology Epiphany discussed above led to the creation of a product that, according to Ing Audisio, "*has the potentialities to represent a source of great value, because we're offering something never before seen in a tyre".* According to the forecasts revealed by the Engineer, in the next 5 - 10 years all lorries will mount tyres with sensors Tms that will lead to greater driving safety and to a significant reduction of operating costs: a vehicle equipped with Cyber Fleet, which notifies you when the pressure drops with consequent increases in fuel consumption and indicates the degree of wear and so the need to replace the tyre, can bring concrete and sure savings of 1000-1500 Euros per year. Although the technology is not properly present in the market yet and therefore it is not possible to verify the added value, it is possible to find a point of substantial strength, which emphasizes the importance of the Cyber Fleet: basically the project was born from the need to anticipate a regulatory European Union which, as mentioned, is expected to enter into force by November 2014 and deals with the mandatory use of control systems. From the industry side, the creation of this sensor for

monitoring and control has a high possibility of exclusively representing a source of cost. In fact, when content becomes mandatory for complying with the regulations, the client does not recognize a premium price related to the investment and therefore the winner of the competition is the manufacturer that is able to develop the technology at the lowest price, minimizing development costs. What Pirelli was able to implement is an intermission to generate added value, turning a cost center into a profit center. We must recognize that in this sense the Technology Epiphany recognized in the Cyber Fleet product plays a crucial role: it is in consequence of the change in the meaning that the customer identifies this added value, being willing to recognize a premium price. The price, which he would not pay for the installation of a sensor required by law, is recognized, instead, for the adoption of a system that becomes intelligent, that communicates with the client and that generates value translated into benefits of performances and savings.

6.4 Pelma

Figure 6.14 – Pelma Logo

6.4.1 Company Profile

Pelma was established in Bassano Bresciano in 1962. Their core business is the production of expanded polyurethane, providing each customer with personalized service, answering to different market needs. This is possible thanks to the wide range of Pelma polyurethane foams, consisting of products with different physical and mechanical features and different reaction to fire. Through the years the Company has built a modern and dynamic image of itself and its name has become synonymous with quality and reliability. The construction of the new location, south of Bassano Bresciano, that took place in 2000, is the result of an intelligent project, where the space assumes a real synergetic value with every single process both of production and management.

6.4.2 Business

The Cutting Department, in concordance with the company policy, makes use of computerized high-tech machineries and equipment. Controlled by skilled workers, these particular machineries are able to offer reliable and adequate answers to the different market demands.

Besides that, Pelma does not only produce *polyurethane foams*, but cuts them in *different shapes* (such as mattresses, cushions and pillows) reaching different customers' need and also including in the companies supply chain processes that are usually managed by intermediate clients.

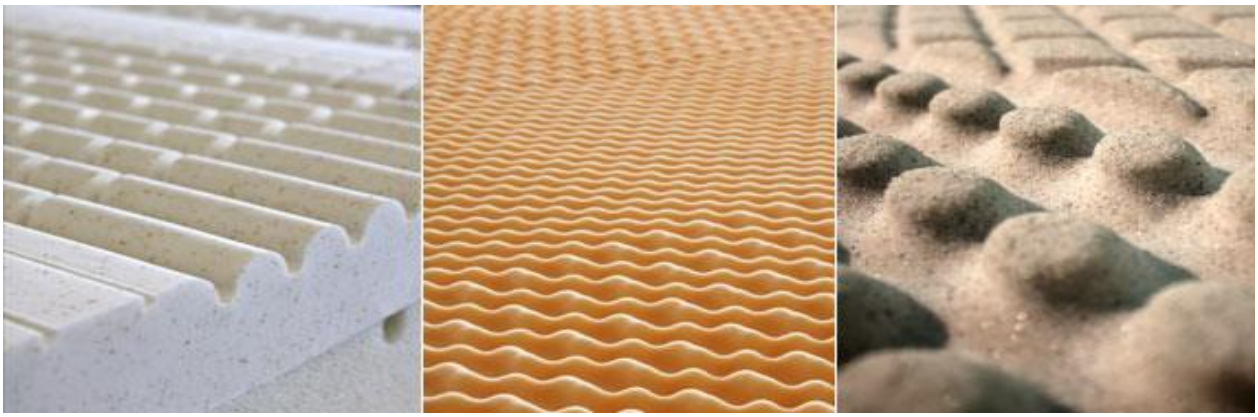

Figure 6.15 – Examples of Polyurethane Foams

Referring to the innovative attitude of Pelma, Ing. Pelucchi stated that the right combination between human resources and technologies plays a fundamental role in Pelma. The best expression of this fact is the installation of the *VPF (Variable Pressure Foaming)* system, which allows the production of foams with high-quality mechanical and physical properties, with an improvement in stratigraphy, and with a better consistency in long periods of time.

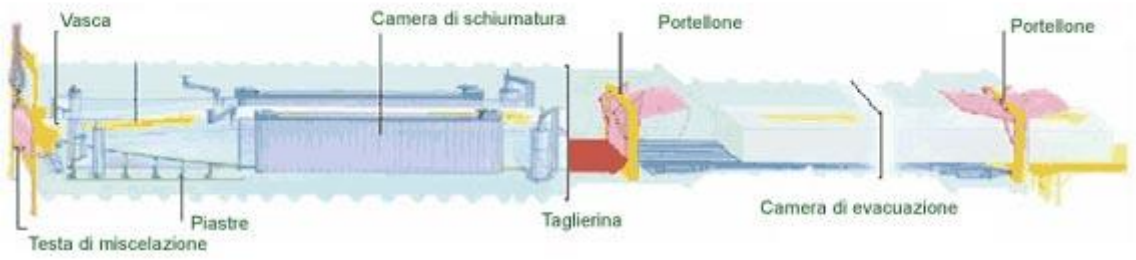

Figure 6.16 – The Variable Pressure Foaming System

Thanks to VPF (Variable Pressure Foaming) System, an innovative foaming method, we improved the production processes. As a matter of fact Pelma is the only company in Italy that employs this exclusive technology. In this way the quality has improved continuously and the specifications of the product can be constantly tested during the process. This technology is mainly based on vacuum and pressure foaming process variables. The chambers of VPF system can be considered as closed reactors where the pressure can be constantly fixed and controlled. The VPF gives the possibility to obtain a wider range of products, creating new foams with improved properties. Putting it in simple terms, it is matter of manipulation of pressure, volume and temperature, that allows Pelma to create sophisticated products. For example, manipulating the Lift of materials, they can create very hard products that are, at the same time, extremely light.

Today the offer is spread over a wide range of polyurethane foams, consisting of products with different physical and mechanical features. Beside the technologies and materials described later in the selected project, the main ones are:

- The foam, which has the load bearing index that is directly proportional to the density of the product. They are particularly suitable for chair and couch stuffing and for outdoor furniture;
- Everflex, with a medium-high density, suitable for couches and mattresses;
- Allsoft, consisting of Polyurethane foams that are distinguished by their softness that is clearly expressed by a low resistance to load deflection and compression;

- Safety foam, that being fire-resistant is used where special features of safety (for example in public places, such as cinemas, hospitals, hotels and prisons) are required;

- Soffio Plus, characterized by the softness of natural feather with the elasticity and resistance of flexible polyurethan foams, widely used to create armrests and, combined with other products, backrests in sofas and armchairs;

- Natura, that is not only a medium/high density polyurethane available as conventional, high resilience and viscoelastic, but also contains renewable raw material;

- Touch, that has elasticity, softness and fire-resistance levels higher than other ordinary high-quality foams, guarantees the high quality of shape and softness of upholstery in touch.

6.4.3 Innovation in Pelma

As Marco Pelucchi said, *"the year 2000 was a real boundary line between the past and the future*". The decision to move in the new building in the southern part of the city came from the will of setting a concrete change in the business philosophy, switching from providers of big quantities to providers of good quality. They also had strong belief that the market would have been receptive, leading to a rebirth of the business itself. The second important innovative turning point was the decision of significantly changing the core business. Contrary to the most of competitors, Pelma decided not to sell foam in blocks anymore, but to cut and shape it in order to directly reach the final client. Shapers, cutting machines and other machineries cover the all cutting technology in Pelma, cutting the different layers, assembling different typologies of polyurethane and shipping it to clients. This decision means a completely different approach to clients, becoming more sensible to customers requires, not only in terms of material properties, but also in terms of want and needs. This innovative

impulse, that turned Pelma from provider of foam to provider of products, significantly reflects on three cornerstones of Pelma innovative philosophy:

A matter of Shape... and of Substance

This is the philosophy which characterizes Pelma products and allowed them to improve researches and services. Their commitment has led them to the fulfilment of a long term project: being capable of facing the market complexities thanks to the professional capacities of people who believe in this challenge.

Pelma gives shape to ideas

Thoughts and creativity of Pelma designers find their fulfilment in Products: precise and safe. Products are subject to sophisticated control processes and allow architects and designers to see their projects to be realized. It is a cooperation which allowed Pelma to achieve certain awareness in providing specific features in all its products, which are guaranteed during the time.

Always one step ahead

Pelma is aware that only the right combination between human resources and technologies will allow the company to look at the future with confidence and security. Pelma has always cared about product quality and innovation, that are the basis of their efforts and investments. The activity of their research and Development Laboratory aims to create new sophisticated products, which are able to satisfy the customers' needs. The new VPF (Variable Pressure Foaming) system is just an example of this approach. The Pelma R&D methodically:

- Verifies quality and features of raw materials;
- Checks the most important technical values for each lot;
- Checks the features of fire-resistance of the foams;
- Develops new formulations for the creation of new products.

They also work in association with the most important European institutes for the creation and the certification of foams.

6.4.4 Selected Project: Slow Emotion

Figure 6.17 – Slow Emotion Memory Foam

The Slow Emotion is a polyurethane mattress with unique characteristics of comfort related to the peculiarities of the material: a slab of layers of polyurethane that “memorizes” the body shape, never gets warm maintaining a range of temperature between 18°C and 20°C and guarantees a sanitized and clean environment. The concept behind Slow Emotion has its roots in the radical turn that the company faced in the 2000s. As stated by M. Pelucchi *"that radical change led us to integrate downstream, becoming suppliers of the final product to the customer rather than intermediate actors in the supply chain. This choice is the result of our belief that the end market would have been receptive and sensitive to a significant improvement in the quality of the product*". Slow Emotion, in fact, belongs to a series of projects sons of the company's transformation. After they stopped selling the raw material in blocks, directly reaching the final customer, the quality of the finished product was the variable for which the client could recognize a premium price. In the case of mattresses, the quality of the material results in the quality related to the sensorial experience to the touch and to the comfort of the product itself. The concept of Slow Emotion, in fact, is based on the idea that the mattress is the primary physic object the human body is in contact with while resting and consequently it is the first defendant for a feeling of wellness and comfort in the sleep phase. The highest level of comfort is achieved when, lying on the bed, the spine is properly supported without generating unnatural deformations that temporarily modify the bone and muscle structure of the

body. Furthermore, other key features are the thermo-physiological comfort for which the mattress must be a sterile and sanitized environment, together with a fresh and pleasant feeling to the touch at the same time. The Slow Emotion embeds all of that. First of all the Polyurethane itself, for its intrinsic characteristic, ensures the proper breathability of fabrics and of the mattress, preventing the generation of an unpleasant feeling of moisture that becomes the ideal environment for the proliferation of mites and bacteria. In addition two new technologies enable the peculiarities of the Slow Emotion:

1 - Termofresh is a new technology recently implemented by Pelma, which allows the polyurethane not to get warm when in contact with a human body. The research in this application field started consequently to an explicit need: il riscaldamento che subisce il poliuretano non è tollerabile su un prodotto su cui il consumatore spende un'intera notte. Il mercato tessile aveva già trovato un rimedio al problema della conservazione della temperatura, con l'applicazione di una nuova tecnologia nell'abbigliamento tecnico sportivo, ideando un tessuto traspirante, ma conservatore di calore allo stesso tempo. La tecnologia è stata esportata ed introdotta nelle fasi di lavorazione del poliuretano.

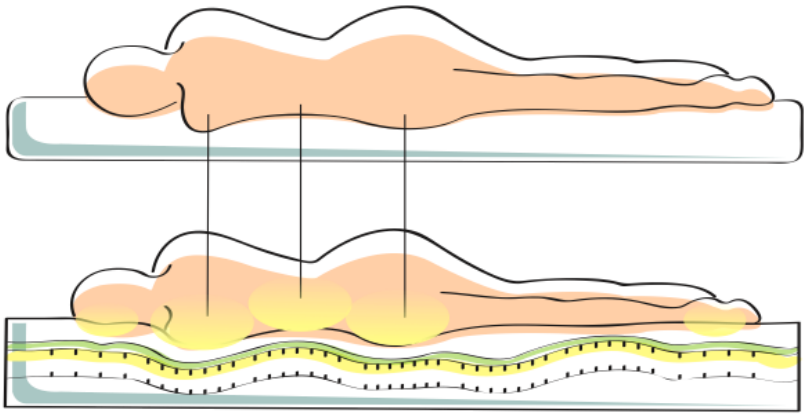

Figure 6.18 – Lying Body Temperature Changes

The Thermic characteristic is obtained through the use of special "Phase Change Materials": accumulators of latent heat that exploit the phenomenon of phase transition to absorb incoming energy flows, storing a large amount of energy while keeping constant their temperature. The PCM are solid at room temperature, but when this grows and exceeds a certain threshold, which varies depending on the material, they liquefy accumulating heat that is deducted from the ambience. Similarly, when the temperature drops, the material solidifies and releases heat.

2 - The visco-elastic foam, also called “Memory foam”, has a cellular structure able to respond to body’s temperature and to conform to the body’s shape. This makes it able to maintain its original shape. Memory foam was originally developed by NASA for use by astronauts, to help them during periods of increased G-Forces, such as lift off and re-entry. The idea was to create a foam that would sense the body temperature and the weight of the astronaut and then gently conform to the shape of the body, providing the perfect amount of support over an extended period of time. During the years the development of this particular technology has never stopped and started to be widely used for its particular ability to sense the body temperature and weight and for its ability to absorb vibrations. When we sleep the weight of our body is normally spread on the mattress in particular areas (shoulders, hips and pelvis), which are called “pressure points”. This causes a reduction of blood pressure: for this reason, even when we sleep, our body keeps moving to reduce this pressure phenomenon and to avoid irritating formications.

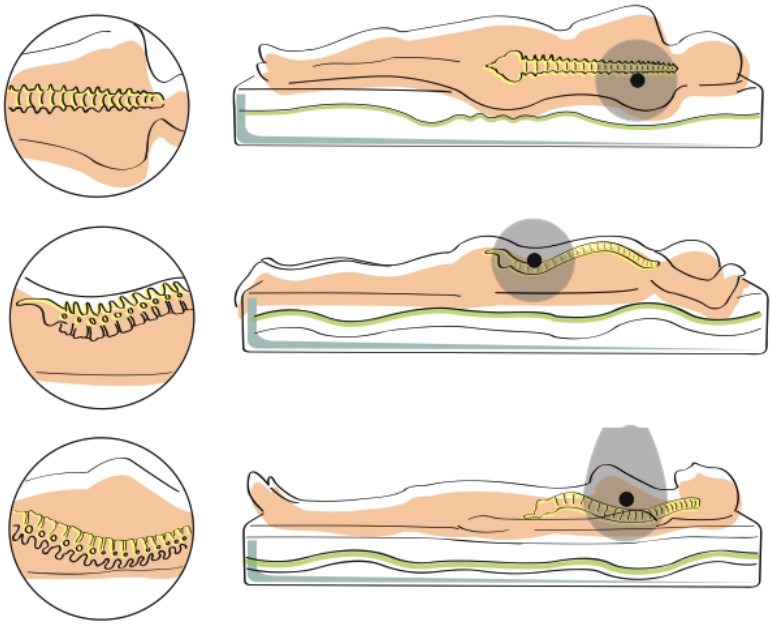

Figure 6.19 – Support to the shoulders and back areas

The weight is spread equally on the whole mattress, reducing pain and keeping a constant spinal pressure, while the material is constantly fresh and sanitized. Sleeping on Slow Emotion, which “remembers” the shape of the body and offers a sensation of freshness and cleanness, makes the sleep significantly quieter and relaxed (for there are fewer changes of position during the rest) providing a unique sensation of wellness and comfort.

6.4.5 The Strategy behind and the added value

The need to create a unique product, perceived by the customer as an enabler of feelings of pleasure in the resting phase, was the focus of the redefinition of the product concept, making Slow Emotion a pure example of TE. The mattress is enriched with innovative features, abandoning the meaning of passive support to the body rest and acquiring, instead, a new meaning of *"enabler of emotions"* ensuring as much physical as psychological wellness and comfort.

From the technology side, phase change materials were imported by the industry of 'technical sportswear while the visco elastic was a project born out of NASA. Both technologies had nothing to do with the polyurethane, before the application of them as enablers of comfort and wellness. The polyurethane foam with Termofresh technology ensures a temperature range between 18°C and 20°C degrees and a neutral environment that completely prevents the emergence and proliferation of pests. The techno visco elastic, instead, is the basis of the ability of the mattress to support properly the spinal structure. From the perspective of meanings, the name itself, "Slow Emotion", shows the change in the concept of the mattress, which leaves the passive role of comfortable support to the human body and becomes instead an active character able to "convey emotions" ensuring a “psychological” comfort. Thanks to the technical characteristics described above, the product offers a very innovative thermal comfort compared to more conventional materials such as latex or wool. It adapts in a unique way to the shape of the body and provides a feeling of pleasure in contact with the

skin, an experience of wellness, linked both to the touch as to the posture. This thermo-ergonomic comfort translates into a psychological comfort: it is a set of values and items ranging from taste to the habits of individuals, from the propensity to favour a more or less soft backing up to the desires related to multi-sensory aspects. A mattress with these features enhances the human body as a sensitive organ capable of producing continuous stimuli and sensations due to the close physical interaction with the supporting material, towards a new meaning that is based on the wellness in the experience of the rest. The market dimension, instead, remains unchanged. Although the mattress gained completely innovative characteristics and related meanings different from the traditional ones, the market reference does not change. The needs and the reasons that lead the customer to purchase the mattress are different (hence the polyurethane mattress will eventually be preferred to that classic one) but the target market remains the traditional one, since the mattress itself a primary good, for every house and every bedroom anyway. The chart below exactly summarizes this change in the dimensions of technology and meaning, mapped on our conceptual framework

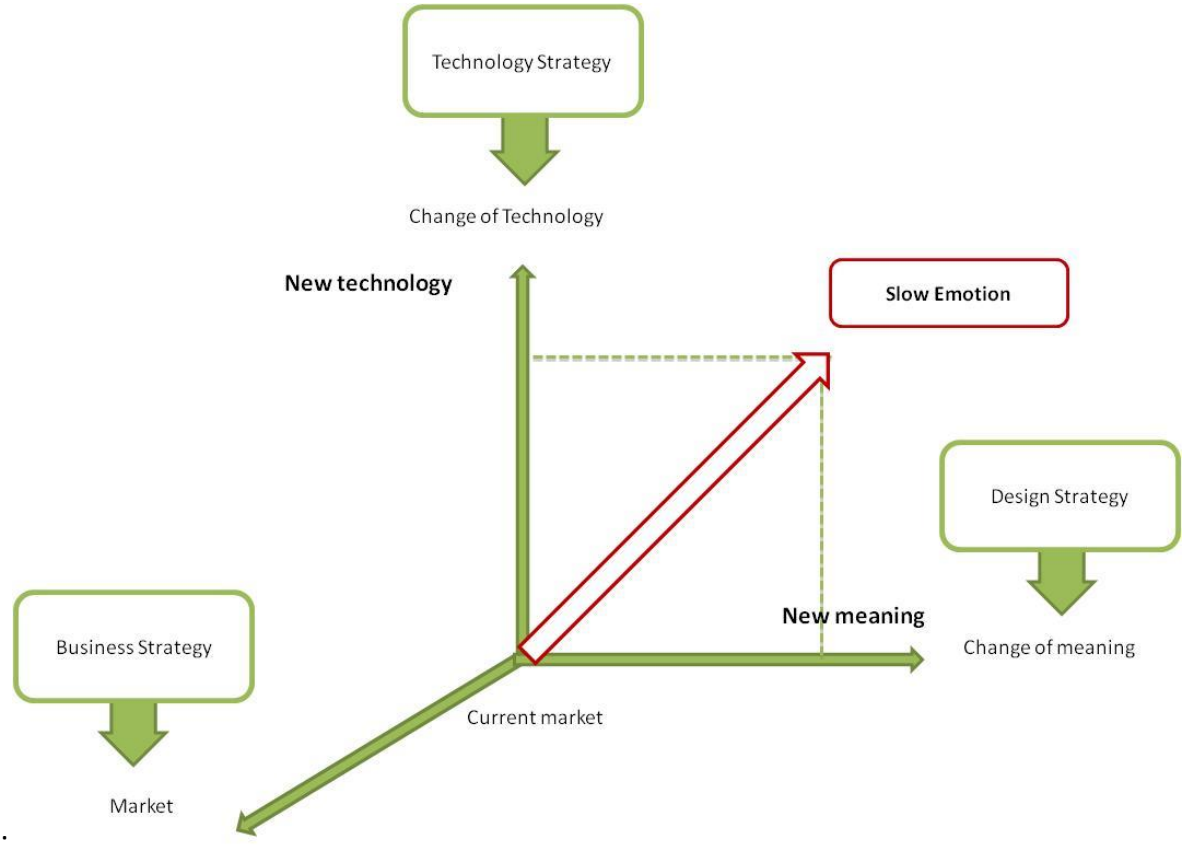

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Figure 6.20 – Slow Emotion in the Strategy Framework

Pelma position is in the up-right part of the graph, as the expression of a Technology Epiphany, that includes a change in meanings associated to an implementation of novel technologies. The Slow Emotion, in fact, is a clear example of how the hidden potential of a technology, which in this case is related to the technological component of the polyurethane, is fully expressed by the creation of new meanings. The polyurethane material itself was already a completely new material in the world of mattresses. The phase change technologies and the visco elastic properties helped to create a unique product, activating a previously unthinkable possibility: this "memory shape" mattress, hygienic and fresh, is a way more than a comfortable mattress; it is an item that reacts to the human body, transmitting feelings and emotions, becoming an enabler of resting more than a supporter.

One of the last reflections that Marco Pelucchi spelled out was the fact that such a strong push for innovation came from the radical turn that the company faced in the 2000s, recalling what explained above in the description of the selected project. Convinced that the market would have been receptive and sensitive to the choice of transforming the company from suppliers of raw material to suppliers of high quality finished products, Pelma reviewed the all business strategy and philosophy. As a consequence of the radical integration downstream, at the time of the transformation, Pelma left a consistent slice of the market to the competitors that were still competing on quantity. *"On the Italian market* – explained Ing. Pelucchi - *there are 12-13 actors in our industry and this is a pretty high number if you consider the market dimension. Pelma was the 3rd company in terms of market share, so when we left a big slice to competitors, we fed all of them, from the largest to the smallest."* However, the actual situation is that Pelma share is up to appreciable levels again, while competitors are starting moving towards a world they still don't know, with a considerable delay (because they have always competed on cost and quantity). Pelucchi identifies in Slow Emotion the great potential that lies behind the creation of a new concept of mattress: a potential that is the result of the change experienced by the company, that has expanded its horizons and its own goals, redefining the rules of the game. Slow Emotion was the enabler of an innovative meaning, generating a completely new need that now Pelma is able to satisfy, differently from competitors that were not able to see this potential.

6.5 Tetra Pak

Figure 6.21 – Tetra Pak Logo

6.5.1 Company Profile

Counting over 22,000 employees operating in more than 170 countries, Tetra Pak represents the world's leading food processing and packaging solutions company. Tetra Pak is one of three companies in the *Tetra Laval Group*, a private group originally based in Sweden. The other two companies are DeLaval and Sidel.

Tetra Pak was founded by Ruben Rausing and built on an innovation by Erik Wallenberg, the Tetrahedron packing, from which the company name was derived. In the 1960s and 1970s the development of the Tetra Brik package and the aseptic packaging technology made possible a cold chain supply, substantially facilitating distribution and storage. Since 1951 the company has been providing hundreds of different types of carton packaging, preserving the nutritional value and the taste of products and consequently greatly facilitating the distribution of food.

6.5.2 Business

Tetra Pak provides a range of different packaging and processing solutions and consequently supplies complete systems of processing, packaging and distribution within various fields. The company's offer includes two macro-categories:

Packages

Figure 6.22 - Packages

The variety of packages can be segmented into four different categories:

- Aseptic packages: this category includes packaging systems that keep liquid food safe and nutritional for up to 12 months, without the need for preservatives or refrigeration.
- Chilled packages: Tetra Pak has three packaging options for products that need to be distributed and stored chilled.
- Food packages: Tetra Pak has a package system that makes it possible to sterilize food products inside the carton package.
- Straws.

Equipment & services

Figure 6.23 – Equipment and Services

Processing equipment

Tetra Pak offer includes complete solutions and equipment for all the processing steps of numerous products, providing automation solutions and aseptic technology. Specifically the company supplies a complete portfolio of processing solutions for dairy, cheese, ice cream, beverages and prepared food, enabling producers to achieve operational efficiency and quality in production.

Filling machines

Tetra Pak supplies a complete range of flexible filling machines, suitable for the different typologies of packages and foods. Every model is characterized by:

- Compact design
- Flexibility
- High automation
- Safe hygiene in food processing

Distribution equipment

Distribution equipment includes conveyors, accumulators, cardboard packers, crates, roll containers and film wrappers. The elements are specially developed for Tetra Pak packaging lines and packages. Equipment provides different distribution unit solutions in order to ensure protection to products on their way to retail.

Service products

The service products are grouped into the following service families:

- Automation services: the automation services with comprehensive global capability secure performance and reduce unplanned stops.
- Environmental services: the environmental services help to reduce environmental impact and operational costs.
- Improvement services: this service category delivers quantifiable and sustainable improvements in operational performance, such as reduced waste, increased uptime and enhanced staff capability.
- Installation services: installation services regard the start-up phase, particularly the layout design and engineering, re-siting or refurbishing existing equipment.
- Maintenance services: maintenance services secure equipment performance by ensuring minimal production disturbances, utilizing skilled engineers combined with cutting-edge methodologies and technology.
- Parts and logistics services: this category includes the management of parts inventory and orders.
- Quality management services: Tetra Pak provides basis through which monitoring and recording quality data. The services include analysis quality performance and recommendations regarding possible pro-active improvement actions by specialists.
- Remote services: this category aims at solving unplanned stops and predicting possible failures.
- Training services: training services deal with working principles of mechanical and electrical components in order to ensure desired end-product quality.

6.5.3 Innovation in Tetra Pak

"*A company that doesn't innovate cannot compete and ultimately cannot provide. […] innovation is not only about technological achievement, it is also about social and economic innovation*".

These words, pronounced by Dennis Jönsson, Tetra Pak CEO and president, thoroughly explained the position assumed by the company regarding innovation. Since its birth, Tetra Pak has been deeply characterized by the innovative mould. Unlike most of new companies, Tetra Pak founder Ruben Rausing started by studying the market to be able to map out what his future company should be able to do. Following which he researched the technical requirements. Tetra Pak represents one of the most successful examples of innovative company; this aspect is testified by the numerous awards the company achieved over its existence. The aseptic packaging technology has been called the most important food packaging innovation of the 20th Century by the Institute of Food Technologists and the Royal Swedish Academy of Engineering Sciences, called the Tetra Pak packaging system one of Sweden's most successful inventions of all time. The machine behind the flourishing research activity consists of 11 R&D centres and it is fed by an annual investment of € 330 million. The basic structure is made up of different platforms, each one dedicated to single projects, with specific expertise related to technological machines and packages. The real challenge is to create interfaces aimed at integrating package and machine, making the two elements compatible.

In order to deeply understand the current innovation management process in Tetra Pak we interviewed Antonio Rendina, Key Competencies Director and Massimiliano Cereda, Project Manager. The first part of the interview was centred on the different typologies of projects developed in Tetra Pak: *"[…] the company handles two different types of projects: product development and technology development."* The product development projects are focused on the enrichment of product functionalities adopting existing technologies; the innovative nature is incremental. The largest amount of projects in Tetra Pak is product development. On the other hand, technology development projects are more disruptive: they aim at closing technological gaps emerged from a foresight analysis.

The innovation management process refers to the single unit of analysis: the *platform*. Particularly, each platform manages road maps of different products: the road maps are intended to define and formalize the enhancement process of the performance of specific products. The as-is situation is compared to the technological configuration needed to achieve the objectives defined in the previous step: gaps come to light and technology development (*TD*) projects start up. During the TD project, loops come out: reiterations among potential technologies, applications and desired performances are not infrequent. Let's deepen the process, analysing the path at the base of the definition of necessary technologies. The path includes two steps:

- Identifying interesting technologies, even coming from different industries, intended to ensure the performance defined in the product road map.
- Technology Know-How sub-process. The mechanism aims at mapping the current knowledge in the company and measuring the entity of technological gaps between the as-is status and the desired condition, showing the efforts Tetra Pak should make in order to close the gaps.

Massimiliano Cereda stepped-in declaring that "*[..] The whole mechanism involves different functions and merges together design and technology. In the phase of identification of enabling technologies, the expertise of the front-end function plays a fundamental role. The function identifies the competence areas and defines the related target values. Downstream, the TKH process reveals the technological deficiencies and brings to light gaps. Through TD Tetra Pak closes the gaps and fills the technological lacks, leading the company to the achievement of target performances defined in the road map and related to the single product*." The process is depicted in the Figure 6.24.

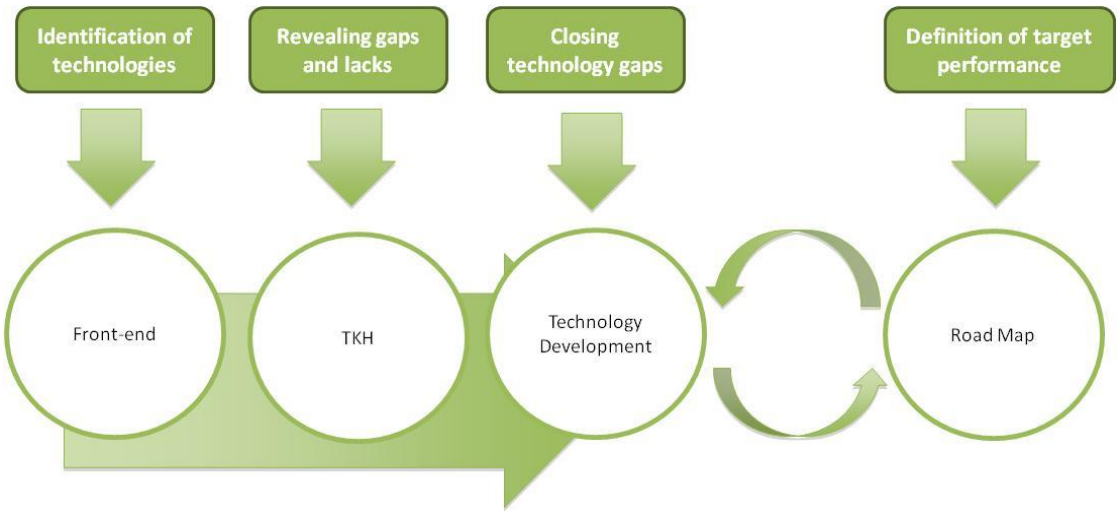


Figure 6.24 – Innovation Management Process in Tetra Pak

Inputs to innovate come from two directions: technology development and market. The related approaches, the pull and the push one, lead to different result in terms of innovation content. In the first case the basic idea is that innovation drivers are embedded in the market: the pull approach aims at responding explicit needs expressed by the consumers. Instead, the push approach is based on the company's R&D activities that, through the development of new technologies, allow to create new products and add value to the business. Obviously the radicalism of the innovation is greater in the push approach: it allows to develop disruptive applications.

"Actually the real dilemma in Tetra Pak", revealed Antonio Rendina, *"is the way to proceed in the middle term"*. There are *three different directions* the company can move in:

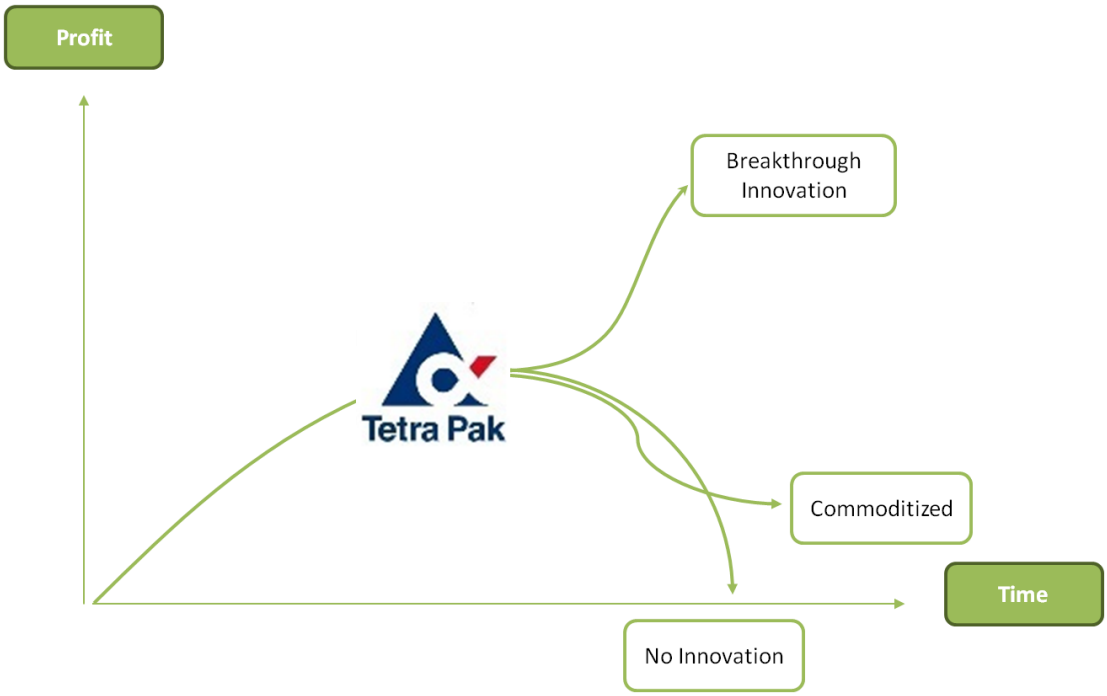


Figure 6.25 – Tetra Pak in the Middle Term

Tetra Pak is aware about the necessity to radical innovate and about the threat represented by the low-cost producers. This state of consciousness is leading the company to gradually create the condition to facilitate the generation of breakthrough innovations. Currently the Swedish company is activating some tools that can enable the innovation process in a radical perspective. First of all there is a shift of investment from development product project to technology development project, in order to stimulate the generation of new technologies. Furthermore a forum dedicated to the innovative priorities has been recently established with the purpose to identify focus areas and the related innovation projects. Matching innovative priorities and new business ideas, potential areas of interest emerge: the company has the possibility to identify breakthrough innovations within the set of focus areas.

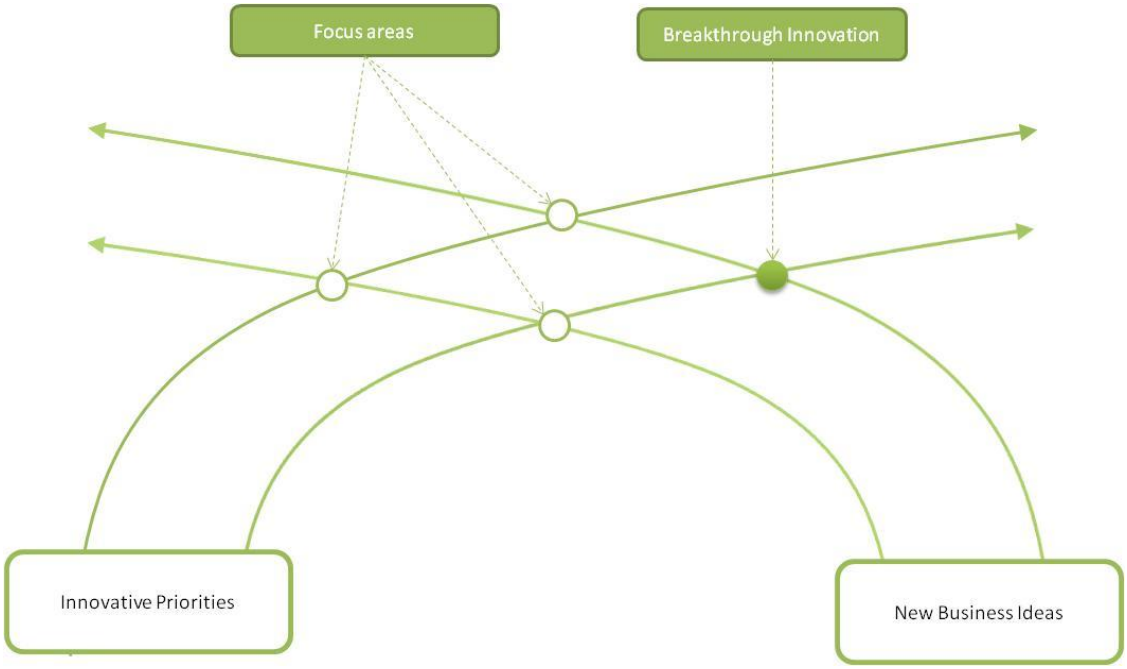


Figure 6.26 – The Identification of Breakthrough Innovation in Tetra Pak

The output of the process of identification of the breakthrough innovations originate from a deconstructed mechanism in which the members of the forum make evaluations exclusively based on their perception about possible evolutionary scenarios and sensations referred to the context. The final step consists in defining a priority list of projects to be launched by the "innovation forum".

6.5.4 The selected project: DreamCap

Massimiliano Cereda presented a project focused on developments in caps and closures based on consumer insight and technology innovations. "*Caps and closures are one of the unsung heroes of the packaging world*", says Massimiliano, "*they must be user-friendly, enabling easy opening and closure, pouring or drinking experiences*". As with many developments at Tetra Pak, innovation of caps and

closures is done with the consumer and final customers in mind: the company develops new closures based on global market insight and ethnographic research to ensure that the caps meet a consumer need. As a concrete example of Market Pull approach Massimilano presented the *DreamCap case*.

Launched in 2011, the product represents a recent example of cap designed to meet the growing consumer demand for drinking on-the-go. "*Consumers want packages that deliver convenience and support their hectic lifestyles, in response to global demographic shifts driving changes in the ways, times and places in which people want to enjoy their beverages*". Tetra Pak developed DreamCap to deliver comfort, convenience and style to those consumers who want to enjoy liquid dairy products and juice on-the-go.

Figure 6.27 – Tetra Pak DreamCap

Part of the innovation process for the DreamCap was watching how consumers interact with packages, and obtaining their feedback on packages and prototypes. As a result of the consumer research sessions, the project team found that most people drink straight from a carton package in three different ways:

- some suck the beverage out;
- pour it into their mouth;
- pull the liquid from the package using their mouth.

Downstream the team struggled to define the correct size of the closure in order to provide an optimised drinking experience for everyone. After many tests, Tetra Pak found that an opening with a diameter of 26mm represented the best size to ensure a comfortable drinking experience. “The large 26mm opening fits the mouth and gives the consumer control of the flow of the liquid by allowing them to pull the liquid at the rate and quantity that they want to consume. Subsequently, opening and closing with DreamCap is easy, as it has a one-step screw cap that provides fully resealable convenience.”

The highest obstacle was to overcome in fitting the large closure on a small package, in order to provide a package that was convenient for on-the-go consumption, but also poured well. The found solution was that the opening could no longer just be on the top of the package but also had to straddle the side. The team discovered that positioning the closure like this provided the best functionality for consumers. In order to do this effectively, Tetra Pak utilised Pre-Laminated Hole technology to create a seal that went across the opening at the top and side of the package to ensure that the beverage stays fresh and safe. The seal is then broken when the cap is turned for the first time.

Figure 6.28 – DreamCap Detail

Challenges with developing DreamCap, such as how to have a large cap on a small package, required the company to develop about 50 different prototypes. Once designers created a compelling prototype, the project team field-tested it to gain customer feedback before the global launch.

6.5.5 The Strategy behind and the added value

DreamCap is a clear example of *Market Pull approach* in which new products are the direct consequence of explicit needs expressed by the consumers. The item proposed meets consumer demand: it delivers value to customers as it offers what customers want in a different way comparing to other beverage producers. Guided by market drivers, DreamCap represents an excellent case of incremental innovation: enrichment of product functionalities originate from the evolution of explicit social scenarios. In order to provide the best functionality for consumers the company focused on the introduction of a technology coming from the plastic industry: specifically Tetra Pak utilised Pre-Laminated Hole technique to create a solution that ensures the best drinking experience ever.

Innovation strategy in Tetra Pak is focused exclusively on the core business (providing processing and packaging solutions for food). The direction in terms of innovation, aims at the market the company is currently active in: company's intention is to concentrate R&D efforts on the application field Tetra Pak has always focused on. In order to map the strategic path followed by Tetra Pak we used the strategy framework developed in chapter 5: we examined in depth the different elements related to the model proposed, in order to analyse the way the company proceed to valorise new and existing technologies.

According to these analyses, the diagram reveals the incremental approach in terms of technology innovation Tetra Pak is based on. The company aims at enriching product functionalities referring to explicit customer's needs, adding existing technologies coming from other industries or developing new ones stemmed from R&D centre. This strategy approach does not consider the entrance into new markets, rather than the research of a new meaning connected to existing materials. The only direction took is towards change in technology: the company strives to define novel technologies internally or identify interesting ones screening different sectors in order to fulfil consumer's needs and requests.

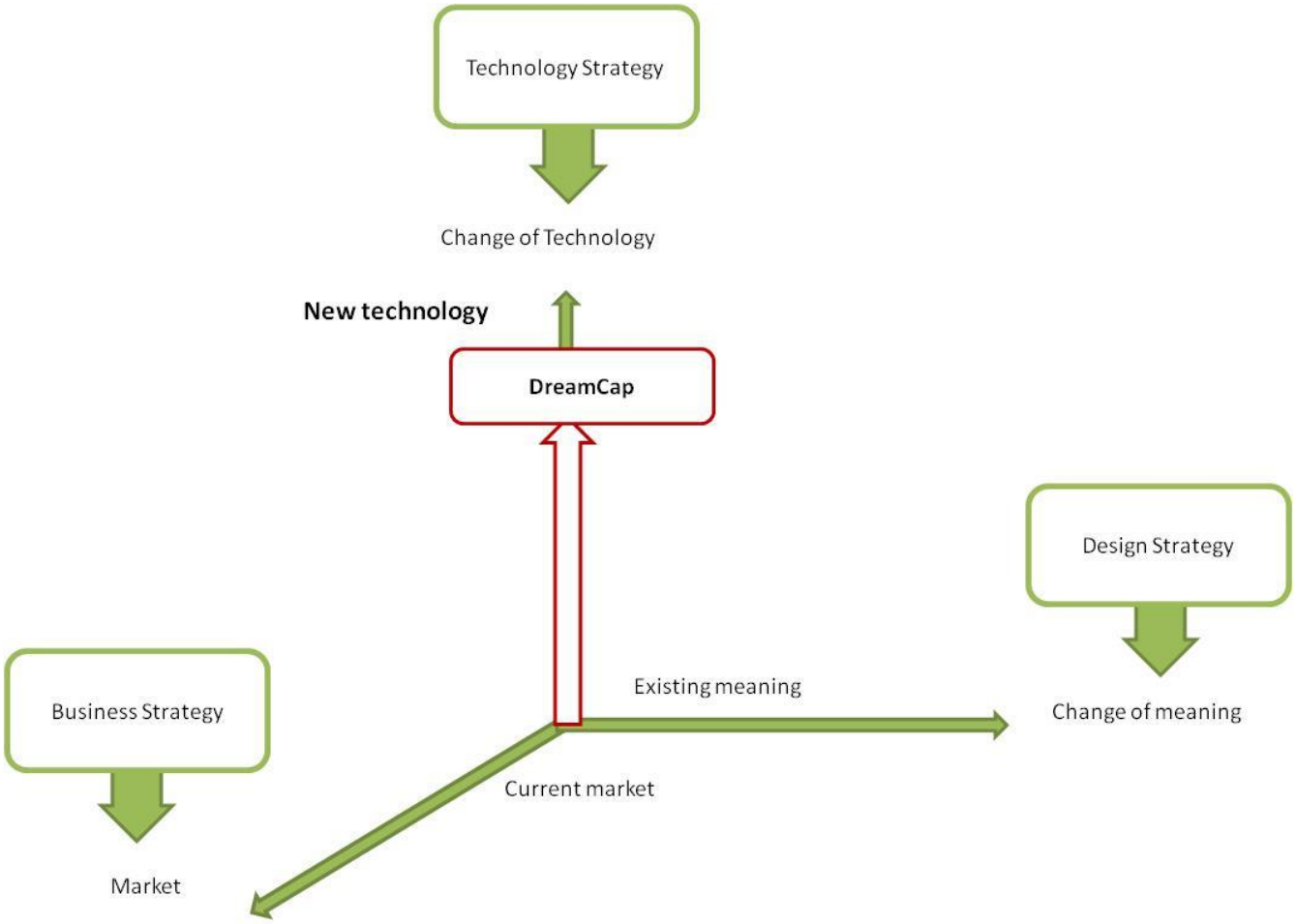


Figure 6.29 – DreamCap in the Strategy Framework

As anticipated in the previous paragraph Tetra Pak is aware about the necessity to radical innovate and pursue breakthrough innovations: in the interview Antonio Rendina talked about the concrete risk represented by the *low-cost producers*. Simple technology innovations are not enough to grantee a leading position in the business: the company is moving towards a strategy approach that conceives the identification of new application fields. Tetra Pak is going to focus on building up a path that leads to the generation of *breakthrough innovations* aimed at ensuring a sustainable success. Since the company realized the importance of radical innovation led from technology breakthroughs, there has been an increase in terms of investments in R&D Department in order to raise number of technologies internally identified. Tetra Pak's purpose is that to broaden the offering, unveiling new application fields in which existing or new technologies could be spreading out. Referring to the strategy framework, we imagine that in a short time Tetra Pak will occupy the up-right quadrant,

enhancing the effort in developing innovations both in technologies and meanings, coming out with new applications different from the traditional ones. In this case boost towards innovation would come from different dimensions, eventually discovering new market or embedding new meanings.

6.6 Cross Case Analysis

In this last section of case studies research we analysed data across all of the cases in order to identify similarities and differences among the approaches adopted by selected companies in valorising new and existing technologies. Particularly we mapped the different strategies within the framework, placing each company in a specific area of the 3D diagram, basing on the movements on the three axes: technology, meaning and market. The higher is the number of axes affected by the innovation strategy, the more radical is the nature of the innovation developed. The case with the lowest impact in terms of innovation is that one represented by a movement on a single axis. The most disruptive situation takes place when a company occupies the farthest position from the origin, combining 3 different transfers on the all axes. The intermediate case occurs when a company implements a strategy that affects two dimensions. An approach that falls into this category is the combination between technology-push and design-driven innovation: a radical improvement both on the functional and semantic dimensions takes place, celebrating what Verganti calls a Technology Epiphany.

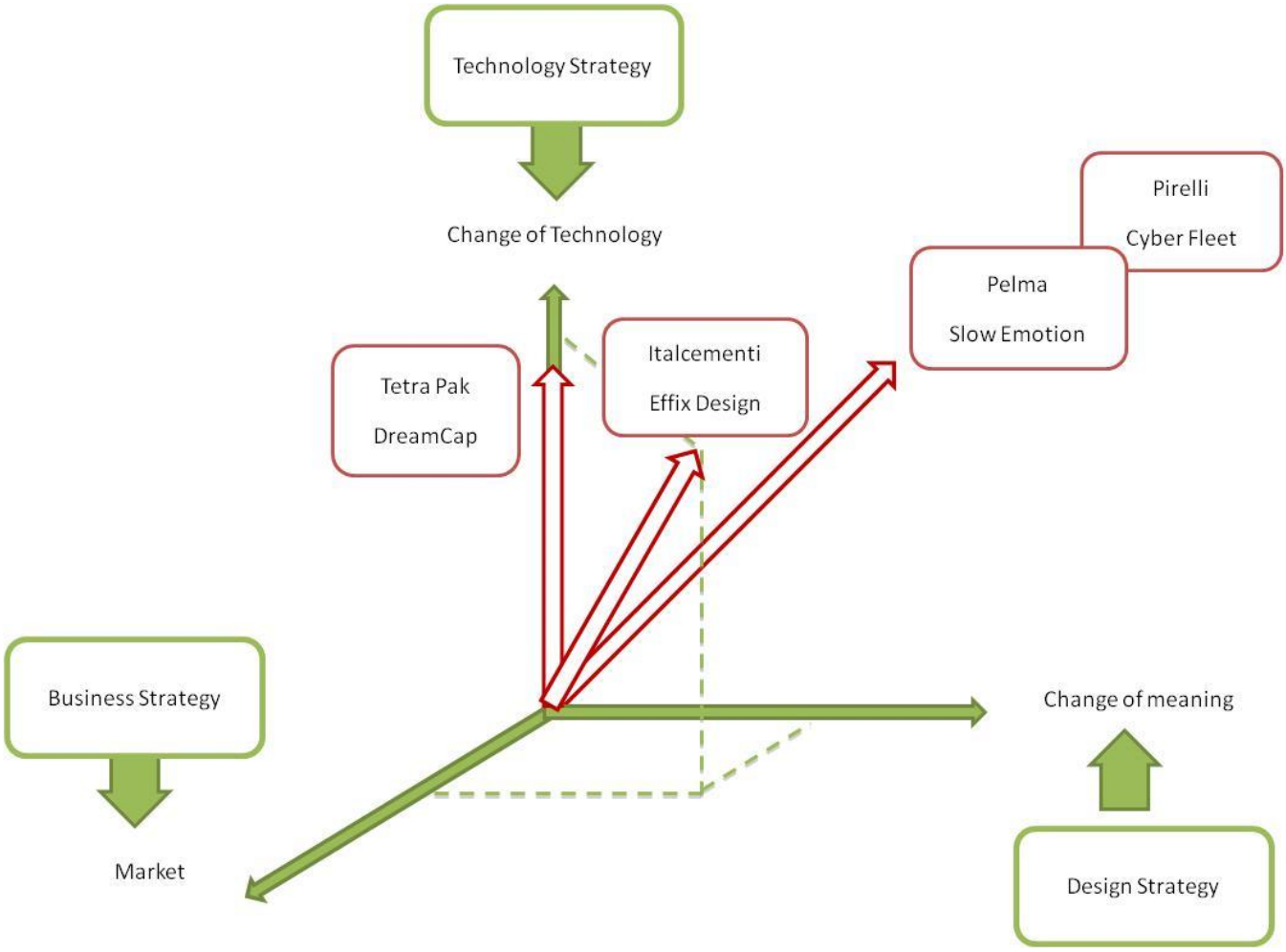


Figure 6.30 – Case Studies in the Strategy Frameworks

Analysing the selected projects we faced a varied situation. Pelma and Pirelli are positioned in the first quadrant, a space characterized by the interplay between technology-push and design-driven innovation. Both projects (Cyber fleet and Slow Emotion) represent a powerful change as the combination of radical improvements on functional and semantic dimensions; in other terms the two projects are perfect example of Technology Epiphany. Tetra Pak is placed on the technology axes, unveiling an innovation strategy focused exclusively on technology improvements. The company struggles to fulfil consumers' requests, enriching the functionalities of existing products through technology developments. The strategy innovation behind DreamCap is exclusively focused on explicit customers' needs: the ethnographic research is at the base of the approach used during the project. Only Italcementi occupied the most ambitious position, the farthest one from the origin, with a mixed approach that is the combination of Blue Ocean strategy and Technology Epiphany. The company

offers a unique material, with incredible properties in a non-structural market, totally revolutionizing the meaning of concrete. The following graph is the representation of the position of the selected companies and the related projects within the diagram. As depicted by the diagram three cases on four revealed the simultaneously moving on both the technology and meaning dimensions: two projects are examples of Technology Epiphany, one is an enriched Technology Epiphany (in Effix Design the market dimension is also touched). Furthermore, as stated by Antonio Rendina, Tetra Pak Key Competencies Director, the company is moving towards a new strategy that could lead to innovation breakthroughs. Therefore also the fourth company is abandoning the single axis in order to occupy a position on a plane or even on the space. Each case showed advantages linked to the strategy followed during the project, pointing out the added value due to the achievement of a Technology Epiphany (or even a “Technology Epiphany in Blue Ocean”). Supported by the following chart, we made a recap of the innovation approach behind the selected projects, also describing the results connected. In order to proceed with a one to one comparison we summarized the contents, referring to key questions used during the interviews:

	THE INNOVATION TRIGGER	THE ADDED VALUE	THE CONCEPTUAL INTERPRETATION
Questions Interviews	*What was the input to the implementation of this project?* *Which strategic reasons lie behind it?*	*Which benefits did the process make?* *How did the project spread the technology horizons?*	
ITALCEMENTI Efffix design	*"Effix Design was the result of a strategy aimed at reproducing a competitor's product developed for structural applications. Because of the hurdle represented by the competitor patent, the new technology was stored away, before the designer's insight".*	*"Thanks to Effix Design the company will embrace a wide category of consumers that did not exist before. In two years Innovation is expected to double grow comparing to 2013, with a simultaneous increase of total profits".*	Effix Design is an most powerful example of innovation strategies mix: the interplay between technology-push and design-driven innovation (Technology Epiphany) on one side, the Blue Ocean Strategy on the other.
PIRELLI Cyber fleet	*"We needed to make a step towards the requirements linked to the legal regulations that are already in force in the US and will be soon in Europe".*	*"We have been able to catch this opportunity, turning a cost center into a profit center: working on the applications related to the technology we created an intelligent tyre".*	Pirelli is a pure example of Technology Epiphany, since the innovation in technologies is the enabler of new meanings embedded in the tyres.
PELMA Slow Emotion	*"Convinced that the market would have been sensitive to the choice of transforming the company from suppliers of raw material to suppliers of high quality products, we reviewed the all business strategy and philosophy."*	*"Slow Emotion generated a new need that now Pelma is able to satisfy, differently from competitors that were not able to see this potential, because the mattress transmits now emotions".*	Pelma moves in the same direction of Pirelli: the interplay between the shift on the axis of meanings and that one on the axis of technologies is the generator of the Technology Epiphany.
TETRA PAK DreamCap	*"We use to explore customer needs: they want packages that deliver convenience and support their hectic lifestyles. DreamCap represents the response to growing consumer demand for drinking on-the-go".*	*"We aware about the necessity to radical innovate in order to defeat the threat of low-cost producers. The company working for the creation of the conditions to facilitate the generation of innovation breakthroughs".*	DreamCap is a clear example of Market Pull approach in which new products are the direct consequence of explicit needs expressed by the consumers.
Final Insights and Reflections	The strategic input was occasional, testifying that there is not a structured process behind the selected projects.	In different ways the new technologies contributed (or are going to contribute) to a radical change enabler of profitable application fields, different from the traditional ones.	The technological breakthrough enabled the activation of new meanings, even more radical and powerful when a new market is intercepted.

Figure 6.31 – Cross Case Interviews

The table above enables the construction of the answer to the first research question: *which strategy can guide companies in valorising existing and new technologies, in order to identify new application fields far from the traditional ones?* We conducted the case studies research to seek an approach that leads companies towards the exploitation of technologies, pushing them as far as possible compared to the as-is situation. Examining the data on the table we can draw the conclusions. In particular, the combination of the second and third columns (*The Added Value + The Conceptual Interpretation*) reveals the power of the combination of design-driven and Technology Push approach, associating the added value of each case to the innovative drive behind the Technology Epiphany: mixing radical improvements both on the functional and semantic dimensions a company can seize the technology full value. The maximum occurs when the disruptive meanings embedded in new or existing materials become manifest. Furthermore the exploitation of the potentialities of technology (deriving from new meanings) is even more radical and powerful when a new market is intercepted: not only the approach offers a radical innovation, proposing a new meaning related to novel technologies, but it also unlocks a mass of customers that did not exist before. Graphically the farthest point on the diagram represents the desired situation: the position expresses the combination of shifts on the three dimensions (Figure 6.32).

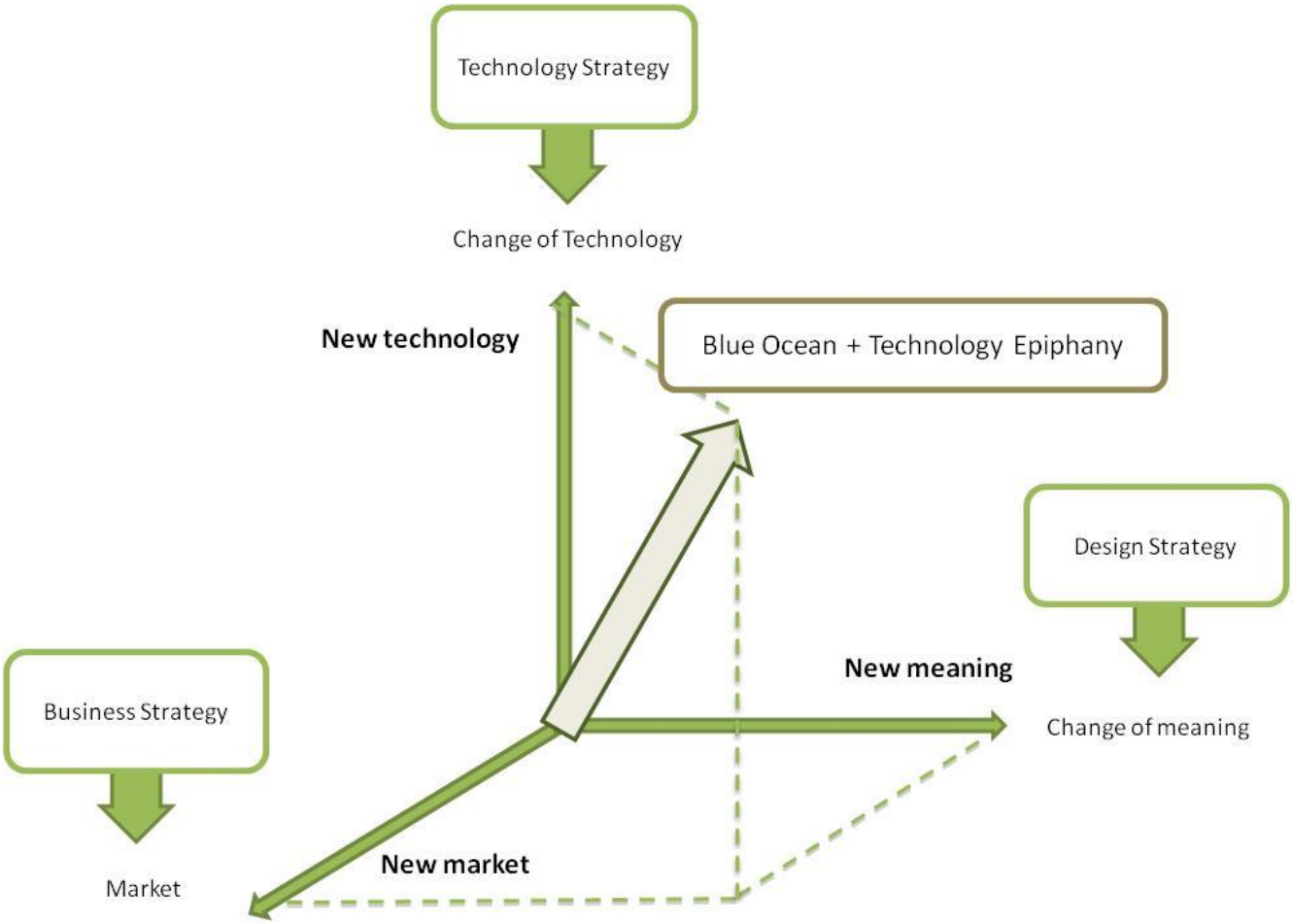


Figure 6.32 – The Proposed Strategy

We are actually able to extract a second significant output, which is the point of reflection of the following chapters, linked to RQ 2. It is represented in the link between the first and second column of the cross case chart *(The innovation trigger + The added value*): they reveals that the analysis of the strategy behind the selected project in each case study highlights an important factor for our research: behind each Technology Epiphany detected there is not a structured process that aims from the beginning to search for new applications. It rather aims to motivations more or less random that led to the occasional achievement of new meanings, sometimes for needs related to the business development dynamics, sometimes for pure serendipity. Instead, in the only case in which the TE was not found, that is Tetra Pak, we found the need for the company to make a sustainable change to their innovation process, starting from the definition of a strategy that abandons the traditional approach to innovation and moves towards the research for technological breakthroughs. Instead,

the situation is different for the other case studies. There, in fact, we were able to track down three very interesting *Technology Epiphanies*, exploring the context and the strategy behind them, but it was clearly shown that the achievement of these occurred in a non- properly governed way.

In the specific case of Tetra Pak, in the absence of an application in line with our research, we initially selected a project that could be a witness of the classical approach that the company uses to innovate, definitely away from the concept of Technology Epiphany. After that, more than the project itself, the reflection from the engineer Rendina turned out to be very interesting, explaining how Tetra Pak is aware that the current approach is not sustainable and, instead, they want to redefine the horizons of their innovation strategy. In order to cope with the danger represented by low cost competitors, the company intends to adopt a strategy and, consequently, a process, which supports the identification of technological breakthrough. Italcementi clearly reveals a lack of structure in the innovation process. Actually Effix Design is the result of an accidental process, basically based on serendipity. The technology full potential has been seized thanks to a group of designers, which noticed Effix Design for its particular durability and remarkable elasticity during the visit at i.Lab. This 2incident" testifies the importance of fortuity in the innovation process of Italcementi that does not derive not from a real desire to seek new application fields. In the Pirelli case study, the new meaning related to intelligence of the tyre is a consequence of the implementation of the sensors inside the wheel, which probably would had not occurred if there was not a need to move towards the requirements linked to the legal regulations that will be into force soon. The opportunity at the end has been enhanced, but the input was sporadic, with no awareness of the value that was behind it. So, the enhancement of technology was born from the need to comply with the rules imposed. Therefore, the input is not connected to the company's desire to innovate the meaning of technology, but rather to stick to a regulation. Innovation occurred fortuitously in a process triggered by an exogenous factor, not sought by the company.

Yet, from case studies it results that firms typically considered to be "driven" by innovation can create a particularly fertile environment for the themes of our research project. The laboratories such as i-lab or Pirelli are in general a context in which new materials and new technologies are continuously studied and developed. Even different processes of spin off from other areas often bring different technologies in the enterprise and, together with them, the potential they have, because imported

into a different sector. However, in these promising environments it occasionally happened, as demonstrated by the case studies, that new applications and possibly new markets has been traced by enabling Technology Epiphanies. The projects, in fact, are individual cases of "exception", among a basket of innovative projects that follow a traditional approach and provide in general the use of technologies in the fields of application they are typically associated with. If the Technology Epiphanies are born even when the company was not trying to move into new markets or new applications, we imagine that through a structured process, aimed at the promotion of their full potential, the number of results that tend towards new application fields would be significantly greater.

Therefore our precise goal is to provide a process based on a well-defined structure, targeted to the implementation of a Design Driven approach as an enabler of TE in new markets, stimulating those types of innovation with greater impact, in line with our Strategy Framework. This process revolves around the interplay between change in meaning and implementation of innovative technologies, starting with the Process Framework generated in the previous chapter. The empirical test of the process is presented in the next chapter, so that the first draft

CHAPTER 7

Action Research

The Light.Touch.Matters project represents the means we used to test the goodness of our process framework, as an effective way to give an answer to the research question 2. The action research was an opportunity to gather criticalities and insights from a real context, making our model running in a concrete environment. The chapter starts with an overall description of the project, followed by a deeper analysis of the workshops we had the possibility to attend: workshop 2 held in London and workshop 3 that took place in Munich. Those opportunities were crucial for the collection of information and the consequent refining of the overall process that bases on the process framework and that was first implemented in Light.Touch.Matters and then improved and stated in the last chapter of our Final Proposal.

7.1 Inside the L.T.M. Project

7.1.1 Project Description

What

Light.Touch.Matters. (Figure 7.1) is an EU-funded project that brings together product designers and material scientists, with 17 partners from 9 EU countries.

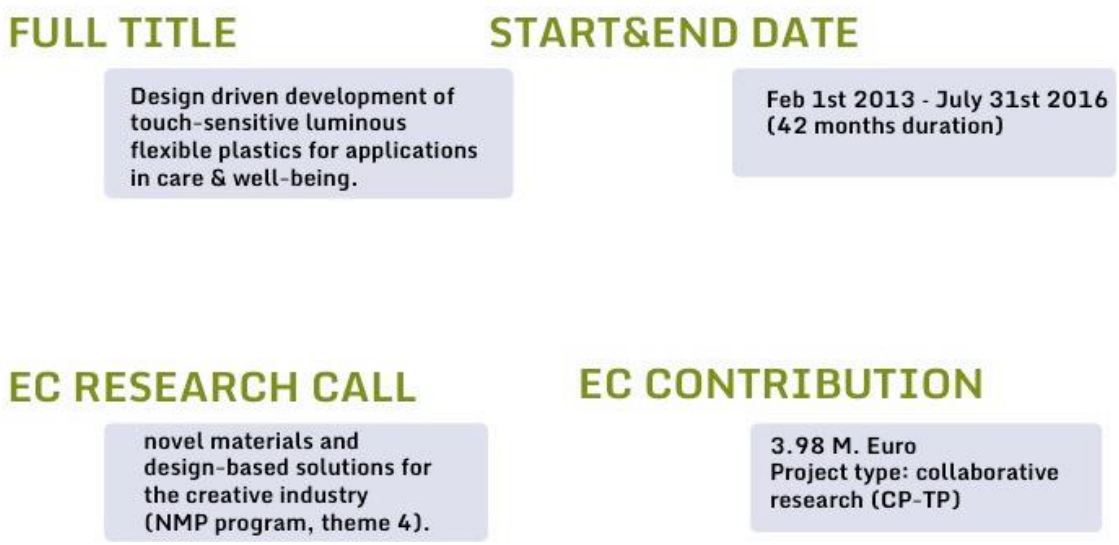


Figure 7.1 – Light.Touch.Matters Details

It is funded through a grant in the European Commission's 7th Framework Programme and will run for 3,5 years until July 2016. It started on February 2013, as a collaboration of designers and researchers to develop a new generation of smart materials that senses touch and responds with luminescence. The base technologies are novel *Piezo plastics and flexible OLEDs.* Being thin, flexible and formable, these *light touch materials* promise to revolutionise product interface design by integrating luminescence and touch in such a way that eventually the product becomes the interface. During the project, various technology demonstrators are developed to demonstrate the potential of such novel

interface technologies, principally within the domain of care, although opportunities for spin-off to other domains (e.g. automotive) are also addressed.

Why

Light.Touch.Matters objectives is to develop a new generation of smart materials that combine touch sensitivity with luminosity, based on latest developments in polymeric Piezo materials and flexible OLEDs. These novel light touch materials have great potential. Manufactured on plastic substrates, they will be thin, flexible and formable, allowing seamless integration into products. They promise to greatly expand design freedom and unlock totally new modes of product-user interaction, enabling us to take the next step in product design: *the product will become the user interface*. During the project partners look at the meaningful experiences that can be elicited by the materials that can inspire potential applications in products. On the other hand they study more closely in what way material properties elicit these meaningful experiences, through research into product-user interaction with the materials under development. Based on these insights, designers develop product concepts in three different iterations, in one coming closer to a market-feasible light touch product. Light.Touch.Matters primarily focuses on products for care and well-being applications that can help consumers feel better, monitor or improve their health and increase comfort, such as rehabilitation aids, wearable alarms, and diet coaches.

How

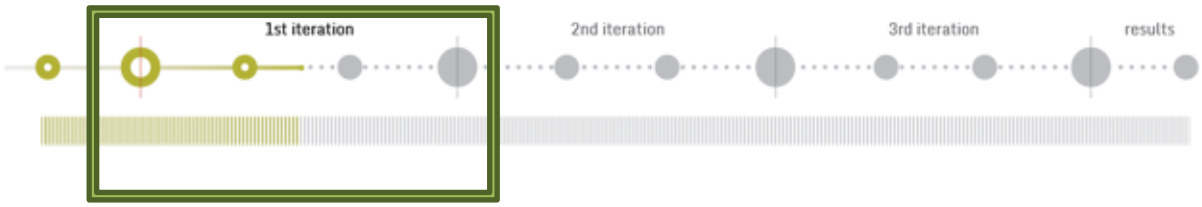


Figure 7.2 – Light.Touch.Matters Iterations

Light.Touch.Matters uses a design-driven research methodology based a comprehensive body of industrial product design knowledge that has been built up over the past decades. Beside the well-defined tools and methods used in the design SMEs partners, the contribution *of Politecnico di Milano*

as academic partner is in terms of overall methodology to focus and drive the project. This combination is new and has been tailor-made specifically to optimally suit the project. The core of this new methodology is to execute an iterative development processing which materials R&D is done in parallel to the iterative conceptualization and design of products that make use of the unique material properties. Three iterations are made in product concept ideation and development (Figure 7.2), where each cycle is an essential opportunity to learn: for designers, to learn what is really possible, and for materials researchers to learn what is really needed, allowing step-by-step updating and redefinition of target properties and reprioritization of tasks. This was thought to allow for convergence of the two main streams in the project, i.e. of design activity and materials R&D.

7.1.2 The role of Politecnico di Milano

While researchers and designers are an essential source of knowledge in terms of technology and applications, the universities involved in the project have got the role of facilitators in the innovation process, providing guidelines and significant insights about the common methodology. In fact, Light.Touch.Matters is not only a new product development process, but also a road to innovation that aims at bringing a significant heritage to participants, developing methods and theories that are expected to have applications also out of the bounds of the consortium in a not so distant future.

Politecnico of Milano (*Research team: Prof. Roberto Verganti, Prof. Claudio Dell'Era, Michele Loperfido, Stefano Corlianò*), in particular, was first involved in the project as collaborator with the Mälardalen University. Starting from 2014 Politecnico will replace the Swedish University, becoming an active part of the consortium. Specifically, our role as researchers of Politecnico hosted by the IDT (Innovation, Design and Technology) Office at the Mälardalen University focused on the planning and application of an overall methodology that facilitates the collaboration between the different

partners involved in the consortium. It was an active research to find a way to implement, further refine and assess the overall material R&D methodology, while at the same time developing a scientific body of knowledge on design-driven materials research. So, the overall process and set of tools will not only be used in the Light.Touch.Matters project, but it will also be an output accessed by other companies, material researchers, designers, manufacturers that face a similar challenge.

7.2 The overall Methodology

This project has an ambitious expectation: design a product that implies to explore design in a context where technologies are still not defined and, even more challenging, in which user needs and behaviors can be radically redefined. There are well established methods that enable designers and firms to design better products based on existing technologies and existing needs, usually based on problem solving approaches, starting from the users' needs. The methodology thought in Light.Touch.Matters, instead, is specifically structured to allow the designers to steer the materials R&D activity, for instance by setting and updating target specifications known from the design cycle to be valuable and by reprioritizing research tasks according to new insights and ideas.

7.2.1 The first version of the process

The project task is to execute an iterative development process in which materials R&D is done in parallel to the conceptualization and design of products that make use of the unique material properties. The initial process takes inspiration from the *process framework* described in chapter 5, considering the central role that the change in meaning owns in pushing the innovation in technology towards value-added results and creating value for new markets. For this reason, the steps we designed for developing the process reverse the traditional approach to innovation, starting from the

generation of meanings, towards the definition of the material properties and the following creation of the product concept. The envisioning of experiences is an intermediate step that links the new meanings to the tangible characteristics that the final product should embed. According to this logical path, the partners take five design steps (Figure 7.3) in each iteration, defined on the premise that radically new product design requires a fundamental redefinition of what products provide and how they are perceived:

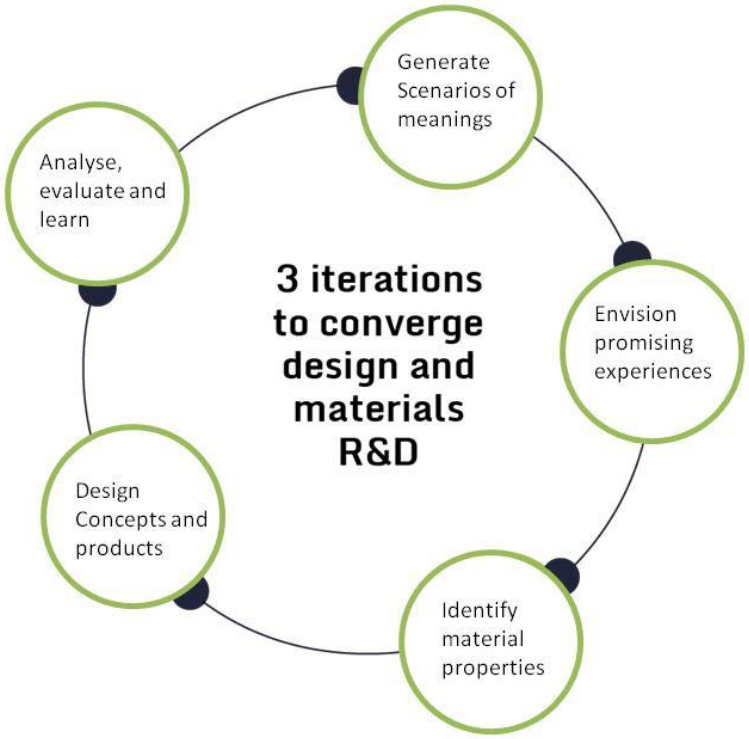


Figure 7.3 – Light.Touch.Matters Design Steps

1. Generate 'scenarios of meanings', making specific representations of the translations in meanings on which to leverage the experiences;

2. Envision promising new experiences, that can be offered by products and the product-user-interaction they provide that users will not explicitly elicit, but that they love once they are presented to them.

3. Identify the material properties, that are necessary to invoke these experiences, refining and updating of the required (objective and subjective) properties of the new smart materials to be developed.

4. Design concepts and products that have the envisioned experiences in input, filtrated by the intermediate translation into material requirements.

5. Analyze, evaluate and learn, as a specific step to complete the process and feed into the next iteration.

7.2.2 Methodology Iterations and Milestones

One of the best opportunities offered by Light.Touch.Matters is the possibility to iterate the process we developed *on a cycle of three rounds* (Figure 7.4) in product concept ideation and development. Each cycle is an essential opportunity to learn: for designers, to learn what is really possible, and for materials researchers, to learn what is really needed, allowing step-by-step updating and redefinition of target properties and reprioritization of tasks. This allows for convergence of the two main streams in the project, i.e. of design activity and materials R&D. Furthermore, these iterations enable the consortium to take into account the advancing knowledge in both streams and to exploit serendipitous discoveries.

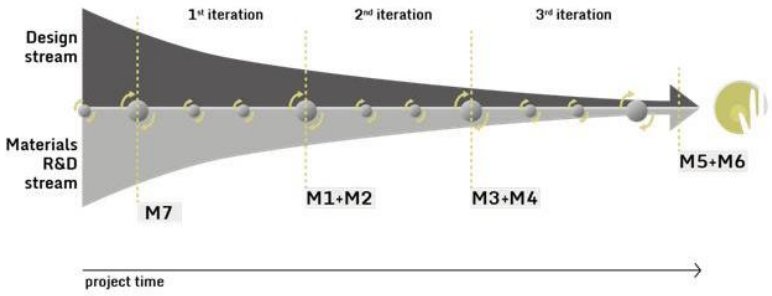


Figure 7.4 - Light.Touch.Matters Milestone

The product concept design is the key to understand how users will experience the new smart materials and interact with the products based on them. This activity stream feeds back into the material R&D activity. To ensure fluid interaction between both streams, four workshops are held during each iteration (the fourth also being the first one of the next cycle), providing ample opportunity for designer-researcher dialogue, ensuring that materials R&D is design-led and that design activity is materials-anchored. These workshops, each of which allows for several days of working together, creates a vibrant exchange of information and ideas between the design and the materials R&D stream in the project. They also set the stage for the execution of several joint tasks, in particular the identification of necessary and expected material properties, and provide an opportunity for external stakeholders to become involved.

7.2.3 The Work Plan

Light.Touch.Matters work plan has been divided into 8 work packages (Figure 7.5), that the project management side developed in order to approach the 5 steps of the innovation process from different angles and to facilitate the distribution or resources and tasks.

- WP1 develops contexts of use and envision meaningful experiences for ‘light touch materials’.
- WP2 contains all materials R&D work on the Piezo plastics and OLEDs
- WP3 develops product concepts with novel ‘light touch interfaces’.
- WP4 integrates the Piezo and OLED technologies into a single smart material
- WP5 showcases the ‘light touch materials’ technology & concepts
- WP6 concentrates all activities to successfully demonstrate and exploit project results.
- WP7 contains all project management and coordination activities, except for scientific management.

- Finally WP8, that is the main Work Package in which we were involved, guides the design-driven R&D methodology. Designer-researcher interaction is driven by 4-monthly workshops (four per cycle) planned, implemented and documented in this WP. In addition, it steers and validates the methodology to assure successful implementation, and (through WP6) shares it as best practice with creative and general industry.

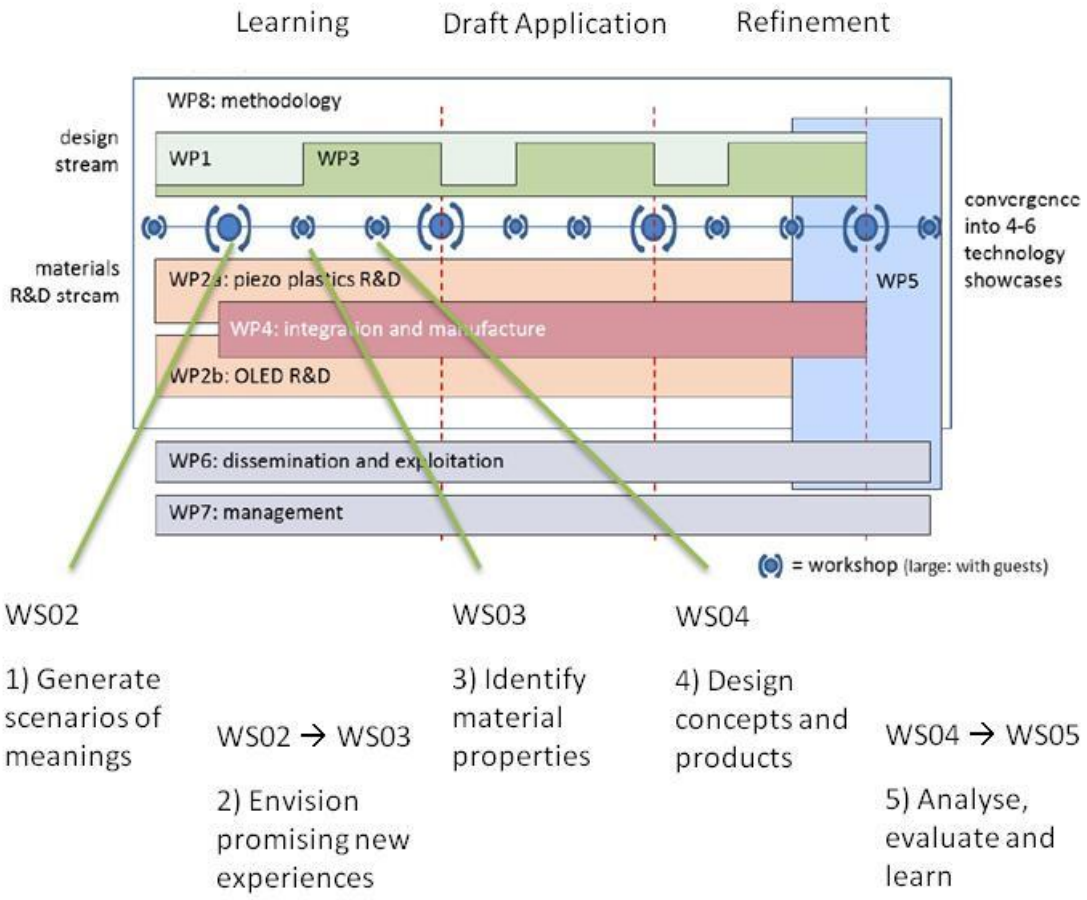


Figure 7.5 - Light.Touch.Matters Work Plan

7.3 Workshop 02 - London

7.3.1 Main Objectives

Workshop 02 represented the put into practice of the first step *"Generate Scenarios of Meanings".* Referring to the iterative development process on which the project is based, workshop 02 was the initial step of the learning cycle which represents the first design-research iteration. The second workshop ensured fluid interaction between both streams, providing ample opportunity for designer-researcher dialogue. Generating scenario of meanings included the redefinition of behavioural patterns in an envisioned new scenario based on culture, society and new technology, especially referring to health care and well-being environments. Scenarios of meanings enable the creation of breakthrough applications: scenarios imagine users' needs and aspirations, as a result of new technological opportunities and changes in contexts.

Summarizing, workshop 02 had two particular different objectives:

1. *Reflect on meanings.* Before focusing on the solution it is important to reflect on what is meaningful for people, understanding the unspoken aspirations and values associated to the world of well-being and healthcare.
2. *Learn how material researchers and designers currently identify new applications*. It means comprehending the different approaches they use to face new challenges.

In order to achieve these two different goals two short assignments for designers and material researchers have been provided during workshop 02, that represented the main inputs for the workshop 02 creative sessions. In particular the two different assignments allow designers to present new meanings of caring and wellbeing and material researchers to show new potentialities of Light.Touch.Matters technologies. To facilitate these reflections, universities provided the map of the

broad landscape of emerging meanings in the care and wellbeing environment, developing analyses and researching.

7.3.2 Agenda

Workshop 02 was held in London from the 4th to the 6th of June 2013: the first two days were based at Brunel University in Uxbridge, the last one at UCL (University College London). The entire consortium with all the seventeen partners took part to workshop 02.

Day	Activity
June, the 4th	*Session 1* Exploring the broad landscape of emerging meanings in care and well-being environment
June, the 4th	*Session 2* Workshop on scenarios of meanings in the care and well-being environment
June, the 5th	*Session 3* Workshop about the potentials of Light.Touch.Matters technologies
June, the 5th	*Session 4* Team working about emerging scenarios of meanings
June, the 6th	*Making Session* Exploring, through play and making, the ways in which materials can be used to communicate meanings

Figure 7.6 – Workshop 02 Agenda

After the introduction, the first session was about exploring the broad landscape of emerging meanings in the care and wellbeing environment, presenting trend analyses as source of inspiration for designers. The following session was based on workshop focused on the generation of scenarios of meanings: all the eight design SMEs showed a selected “area” within care and wellbeing environment and proposed scenarios of unspoken aspirations/needs/values. The first part of the second day was about a discussion on the Light.Touch.Matters technologies. Particularly material researchers

described the potentialities of specific technologies that can support scenarios of meanings in order to foster the designers-researchers interaction. Over these initial sessions we explained the methodological rules and, with the aim to stimulate the discussion during the creative session, we introduced the *"golden coins game"*. This is a creative way to encourage the exchange of knowledge between the two different worlds: golden coins, symbolically representing information exchange, enabled a complete comprehension of new meanings scenario and technological potentialities. In parallel, they represent a collection of the information originally missing, to be provided in the next iterations. As a conclusion of the first interaction, during the final team working six teams made up of designers, material researchers and facilitators consolidated the scenario of meanings leveraging on the potential of Light.Touch.Matters technologies. The third day was based in UCL (University College London) Institute of Makings. The final session of the workshop 02 allowed Light.Touch.Matters partners to explore the potential of a selection of materials, their sensory properties, and the different ways in which they communicate meanings. They were required to respond to a series of briefs, make a series of forms or objects, and then discuss, analyse and justify their making decisions to the rest of the group in a "critic" discussion at the end of the exercise. The novel objects made during this session allowed partners to examine the relationships between qualities or affordances of materials and their meanings. Workshop 02 ended with a wrap-up of the project, collecting feedback and suggestions on the topics we dealt with during the three days.

7.3.3 Inside workshop 02

7.3.3.1 Exploring the Landscape

Some universities and design agencies developed trend analyses and case studies in order to draw the broad landscape of care and well-being environment. In particular:

Studio Edelkoort (design agency) first provided ethnographic, demographic and trend analyses in the world of care and well-being. They used explanatory images and meaningful descriptions in order to stimulate the creativity and the imagination of the audience. They highlighted the streaming, focusing on the fluidity of matters and on the material capability to perfectly morph into the human body. The design agency exalted the role of humble design since it can fold matters into practical forms; in addition they pointed out the importance of improvising, of trying out something new. They also focused on the role of the enchantment: imaging another reality could enable partners to generate new meanings related to the world of health care and well-being.

We, as representatives of *Politecnico di Milano*, provided changes of meanings in "care and wellbeing" environment. Specifically, we presented a series of case studies related to specific shifts of meanings. Basing on the evolution of the context we offered a menu of new users' needs and aspirations in order to provide insights for the Light.Touch.Matters partners. We analysed 8 major trends, like, for example, the current shift in masculinity and on the increasing significance of a beauty regime for men, or the impact of internet in the way people communicate with one another. Concluding, universities provided a thorough map of world of care and well-being fostering the partners to reflect on new meanings and values.

7.3.3.2 Working on Meanings

As mentioned in the "objectives", in order to reflect on what the unspoken aspirations, values and needs demonstrated by people are, designers were invited to:

1. Pick an area within care and wellbeing and describe a scenario of existing and new needs/values in order to enable material researchers to better focus the development of the technologies;
2. Describe the selection criterion for the choice of the area;

3. Describe the scenario without focusing on solutions or technologies, but on unspoken aspirations, needs and values.

Over the session all the design agencies shared a presentation, showing the results, in order to foster material researchers to focus the considerations on people aspirations.

Figure 7.7 – Golden Coins Invested By Designers

Furthermore, to stimulate the discussion between the two parts during the creative session, material researchers could invest three *"golden coins".* As mentioned before one golden coin symbolically represents information. The golden coins game allowed material researchers to receive insights from the designer and focused on the further development of the technologies. We can sum up the sessions presenting a list of the four main areas selected by the designers:

1. *Personal care, beauty and fitness.* This environment comprises a set of values that offers a way of thinking about what is necessary for human well-being. Physical fitness refers to activities to improve, maintain and challenge our bodies, ourselves, and our relationships for general well-being. An interesting sub area is represented by *Caring for children*. By dedicating time on children's health, care & wellbeing, society would invest on an healthier next generation, hence

a better future population. Interaction languages between kids and simple technologies could represent a good opportunity for the entire consortium.

2. *Are they really frail?.* Elderly people are a large and expanding target group. Are we so convinced that elderly people are weak and powerless? Senior population hides a relevant potentiality: life experience. Elderly empowerment is an unexploited area to be further explored: reducing loneliness and isolation among the elderly could solve many social issues and reduce relevant healthcare costs.
3. *Trauma management.* At the moment there are very limited and poor resources to assist in patient rehabilitation. This area could reveal many opportunities aim to guarantee a 360 well-being state.
4. *Extreme problems*. Behavioural education and learning aids for people with developmental disorders, like autism or dementia, is an important social aspect. Disabled people desire to lead as normal and independent life as possible.

In order to simplify the reading we created a chart in which we summarized the results obtained in terms of unspoken aspirations, needs and values related to each area.

AREA	Personal care & Caring for children	Are they really frail?	Trauma management	Extreme problems
MEANINGS	Feeling good	Empowerment of the weak	Resilience	Accepted by myself
	Beauty from within	Motivation	Fail safe	Accepted as "peers"
	Prolonging youthfulness	Self-management	Reassurance	Accepted by relatives
	Social and DIY personal care	Getting out	Transparent	
	Thriving	Feel needed		
	Self-expression	Fun and communication		
	Balancing of energy and time			

Figure 7.8 – Scenarios of Meanings

The designers, supported by material researchers, found out a relevant number of meanings on which build up new scenarios and consequently breakthrough applications. The image below presents the main unspoken aspirations and values originated during the creative session, in a creative way we adopted in the workshop, using post-it on the wall to add one by one the new meanings to the four main categories:

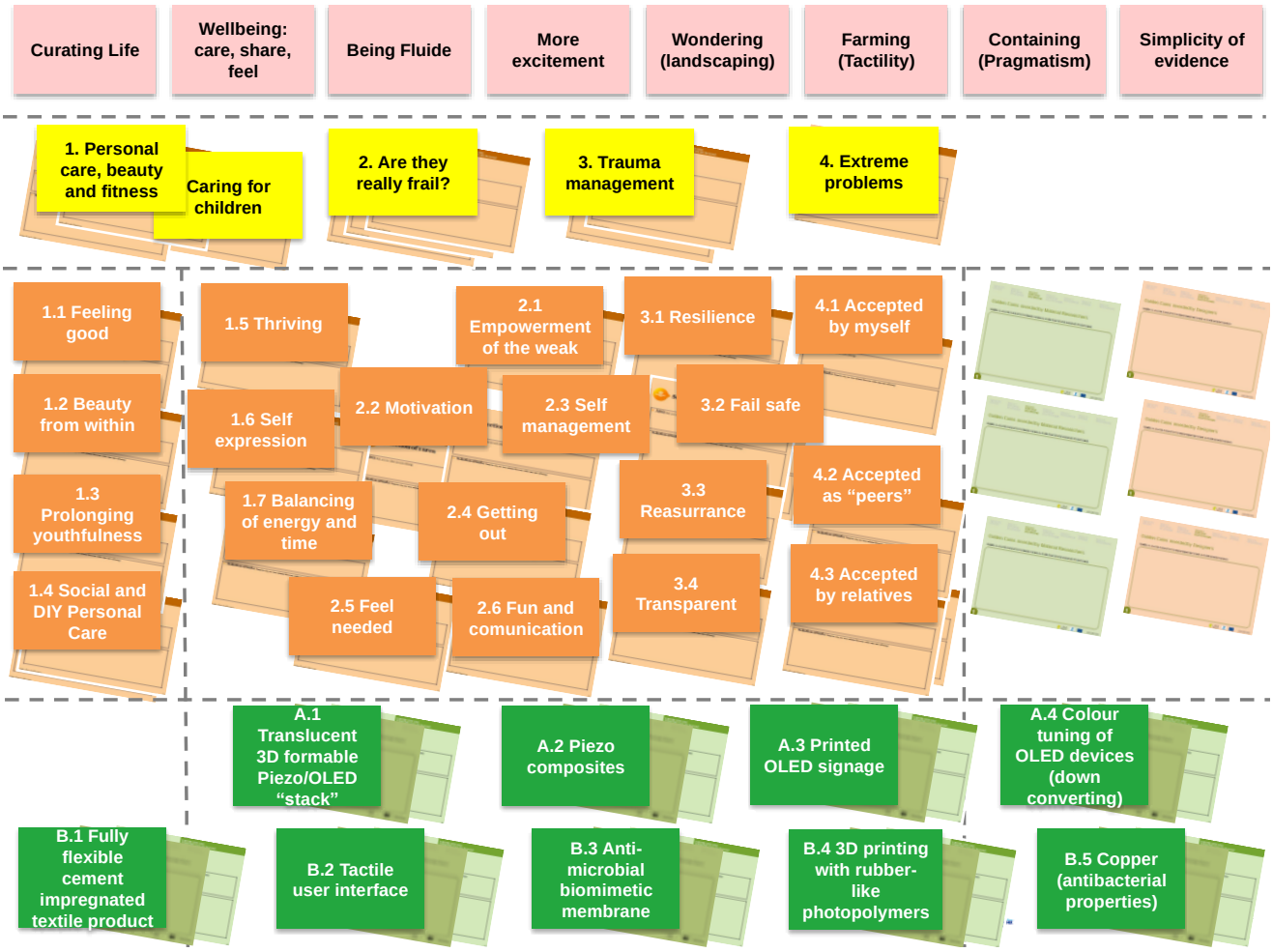


Figure 7.9 – Activity Mapping

Regarding the firs area, Personal care & Caring for children, one of the scenarios proposed is well expressed by the word "thriving": achieving physical results, people, especially seniors, receive a significant boost in terms of self-esteem. Technologies should represent a support able to show clear and simple feedback of people physic progress. Self-expression is another theme strictly connected to the first branch, in particular to caring for children. The values and concepts related are about learning and education: babies, being exploratory and sensorial by nature, have the need for tactile and rich media experiences in order to understand their environment and learn about the world they live. The Light.Touch.Matters material brings the opportunity to re-think educational materials by adding a layer of interactivity and sensory perception.

As concerns the second area, important values are motivation and self-management: the two concepts are consequential. To achieve autonomy it is necessary a good dose of motivation and self-esteem. Elderly people represent a precious source for society: thanks to their skills and experiences cumulated over the past, they can transmit important teachings. Hence it's important to inspire and enable elderly to have quality relationships and deep engaging communication to improve the quality of their life and disseminating knowledge. In this way elderly condition radically changes: from feel need to feel needed.

In the Trauma Management area one of the key elements to ensure is the reassurance. After operation patients are anxious and disoriented: in doing their recovery exercises they should feel safe and certain they are working out in the correct way.

Self-refuse is common in extreme situations: when someone suffers from chronic disease it's difficult to accept the reality. The basic aspiration for this target group is to lead a life as normal and independent as possible: society must guarantee the integration of disabled people through a complete understanding of their conditions. Healthcare costs will benefit from reduced costs due to the increasing independence of those individuals: they have to be accepted as peers, with the same potentialities and capabilities of abled people.

7.3.3.3 Working on Technologies

From the technology side, with the aim to make the designers aware of the potentialities of the Light.Touch.Matters materials, the assignment for material researchers, also consisted in a short presentation:

1. Identify one technology that could be considered interesting for care and wellbeing applications;
2. Describe the selection criterion for the choice of the technology;
3. Describe the potential of this technology.

Over the session all the material researchers shared a presentation, showing the results, in order to stimulate designers to envision disruptive applications.

Figure 7.10 – Golden Coins Invested By Material Researches

Furthermore, to stimulate the discussion between the two parts during the creative session, designers could invest two *"golden coins"* to get insights from the material researchers and generate meaningful scenarios.

The researchers mainly talked about different technologies, in particular:

- Translucent 3D formable Polymer Piezo/OLED "Stack";
- Piezo composites;
- Printed OLED signage on flexible plastic foils;
- Colour tuning of OLED devices (down converting).

They integrated the first list with secondary technologies relevant for the development of the project, such as: fully flexible cement, anti-microbial biomimetic membrane and micro-texture, 3D printing with rubber-like photopolymers and copper. material researchers focused on the specific properties of the Light.Touch.Matters materials, especially they underlined the power efficiency of OLED, and their ability to communicate changes, using lights. OLED are "free" from form-factor and can interact with people by using colour changes; one of the major advantages is the huge flexibility of colour

design, it's even possible to combine different colours in one device. On the other hand Piezos are extremely interesting: there are no real limits in their use, there is the possibility for widespread application in everyday life products.

7.3.3.4 Final team working towards exemplar ideas

The last session was based on a team working about consolidating emerging scenario of meanings leveraging on the potential of Light.Touch.Matters technologies. Every team, one for each area selected in the first session, was made up of 3 or 4 designers, 1 material researcher and 1 facilitator, with the aim of exploring a specific scenario developing, through different phases:

1. Finding out changes of meanings: from a current meaning to a new one;
2. Defining key features supported by enabling technologies, following the path: new meanings, key features, enabling technologies.
3. Giving exemplar ideas.

Figure 7.11 – Final Team Working Templates

We summarize here the results mapping meanings, features and enabling technologies in a chart, distinguishing among the different areas.

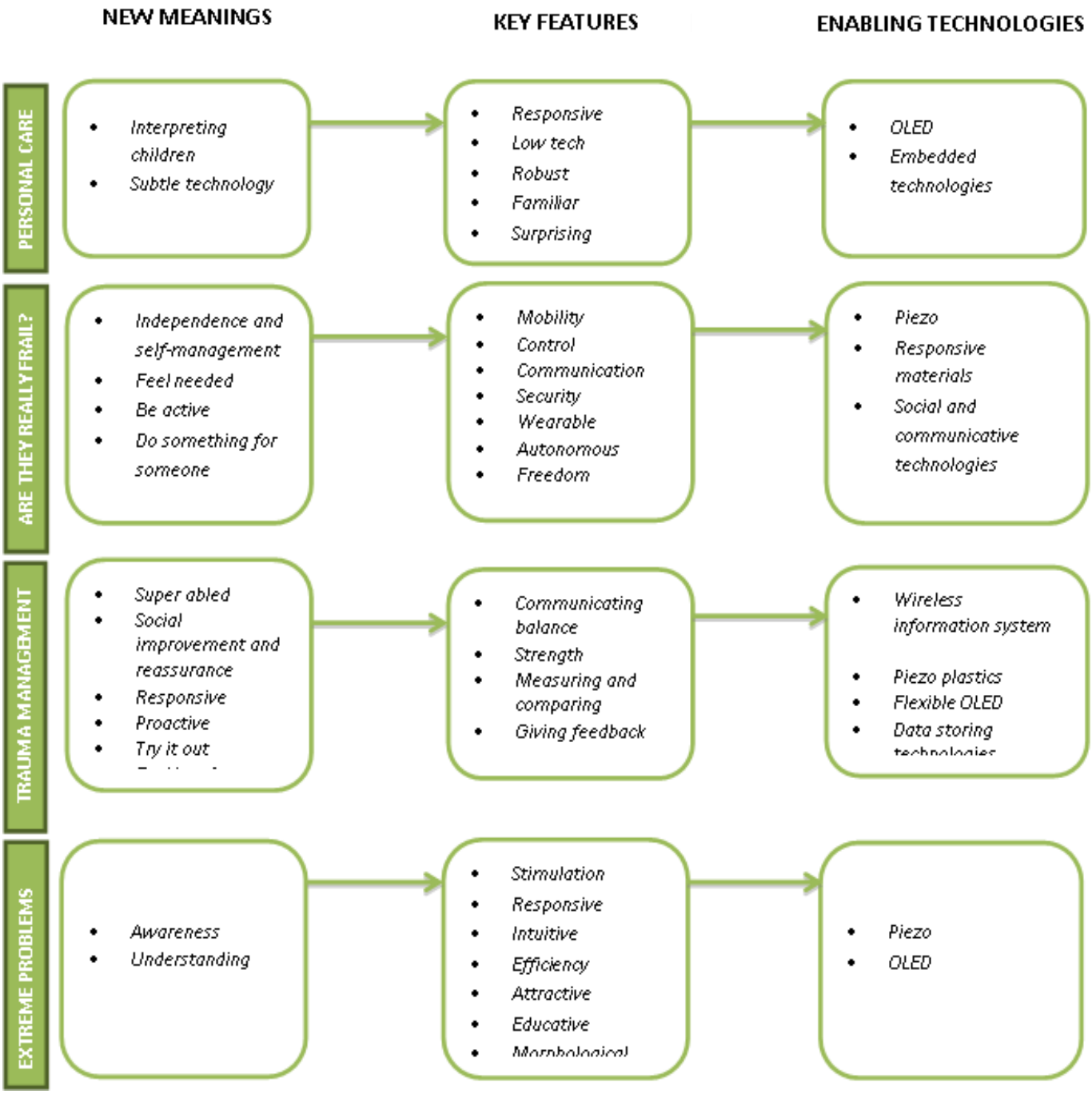


Figure 7.12 – New Meanings, Key Features and Enabling Technologies

These results represented the output for the next workshop: in order to envision promising new experiences it's necessary to be aware of the potentialities of Light.Touch.Matters materials and at the same time be conscious of values and needs demonstrated by people in the care and wellbeing environment. In synthesis scenario of meanings and technology features embody the trigger of the research process of new experiences that could satisfy unspoken aspirations identified in the previous steps.

7.3.4 Lesson learned

During the workshop 02 we dedicated a relevant effort on the activities required to ensure a successful dialogue between the worlds of design and materials. In particular we introduced the *"golden coins game"*, a creative way aimed at stimulating the discussion between the two actors, simulating the exchange of knowledge using chocolate coins. Actually the *"golden coins game"* has been a useful tool for different reasons.

First of all, it has represented a pleasant way to learn lessons in terms of process and tools during the first interaction. Each golden coin represented a missing data in the discussion between designers and material researchers. The *golden coins game* offered the possibility to understand which are the information needed to guarantee a complete awareness of the context and of the technological potentialities. Golden coins were invested by designers and material researchers, unveiling information lacks from both points of view. Especially designers denounced a shortage of technical aspects: they complained about the absence of data related to strengths and weakness comparing to alternative technologies. Designers didn't properly understand the potentialities of the materials, the added values of OLED and its limits. They did not understand the materials' features related to Piezo, nor the state of the art of the technologies in terms of existing applications. This information would have supported designers in generating solid and interesting scenarios. On the other side material

researchers invested their golden coins especially in order to better understand the business side of the research conducted by the design agencies, asking for social impacts and market opportunities provided by the meanings proposed. They wondered about the powerful of materials in helping people to solve social issues and fulfilling new aspirations. The researchers wanted to comprehend the context and the way in which new applications would have affected the society and its needs. All these data represent precious factors in order to focus the further development of the technologies.

Starting from a collection and classification of the questions obtained, we have identified a list of most significant "golden coins" invested by both categories.

Material Researchers' Golden Coins	Designers' Golden Coins
How can companies research and understand business opportunities to uncover new aspirations?	*What are the added values and the strengths of the technologies compared to the alternative technologies?*
What are the potential social impacts provided by new meanings?	*What are the limits and constraints of the technologies?*
How do proposed meanings relate to existing products already on the market?	*What is the state-of-the-art of the technologies in terms of enabled applications?*

Figure 7.13 – Material Researches and Designers' Golden Coins

The golden coins pointed out precious insights fundamental to facilitate the comprehension of technologies and related meanings. Material researchers should focus on the technological side, presenting all the material features, explaining both limits and advantages. A competitive comparison is necessary to comprehend the points on which focus. Another important information is represented by the state-of-the-art of the technologies in terms of enabled applications: designers want to know the progress of the technologies. Instead designers should focus also on the business and social side, showing the potential social impact provided by new meanings. Material researchers need to understand how the proposed meanings relate to existing products and the way they can affect the business. These elements represent the starting point in the R&D process: every partner should understand the features of the technologies and the potential meanings that may lead to new applications.

Golden coins represent also an effective way to stimulate a *bit-by-bit dialogue* between material researcher and designers: often the two sides don't offer enough information about specific aspects. Golden coins game is an interesting tool to facilitate the exchange of knowledge between the two categories, letting the opportunities to bridge the information gaps.

Finally, regarding the golden coins game, it will be useful split the game into two different parts, bordering the space and the content of the questions depending on the phase of the project: during the first dialogue all the queries should be about a specific argument (technological advantages and disadvantages comparing to the competitors), during the following dialogue the questions should be focused on a different topic (design features and technological properties).

7.4 Workshop 03 – Munich

7.4.1 Main Objectives

Workshop 3 dealt with the implementation of phase 2 *"envision promising experiences"* for 'light touch materials' and phase 3 *"identify of material properties".*

The initial objective of envisioning potential breakthrough applications of 'light touch materials' was primarily an abstractive and explorative activity, and the work shop 03 can therefore be seen as the diverging phase of the design stream. The workshop contained two main interconnected workflows: on the one hand we looked at the meaningful experiences that can be elicited by the materials that can inspire potential applications in products. On the other hand we studied more closely in what way material properties elicit these meaningful experiences. This work would feed into the generation of

design briefs for the product concepts to be developed in workshop 04. To understand the potential meaningful experiences the partners (the designers in particular) envisioned the entire product experience, focusing on the context of use in which potential applications are used and related trends.

Summarizing, after the trend analysis, the context mapping and the generation of different design scenarios made in workshop 02, workshop 03 had the following objectives:

- Before workshop 03 the designers, i.e. the eight design SME's were invited to reflect on the meaningful experiences, satisfying unspoken needs and aspirations of users, as already identified leading up to and during workshop 02.

  Also, the designers were invited to refine what they have already elaborated at the end of workshop 02 and propose one or two new/refined experiences they believe can embody the new meanings proposed in one of the following need areas:

  1. Personal care, beauty and fitness and Caring for Children;
  2. Elderly: are they really frail?;
  3. Trauma management (rehabilitation);
  4. Extreme problems.

- During the workshop 03 the designers were invited to refine what they have already elaborated at the end of the workshop 02 (area, meanings, connections between meanings, features and technologies) and propose one or two new experiences they believe can embody the meanings proposed in one of the main 4 areas stated above.
- During this phase designers could ask clarifications and additional information to the material researchers and Universities about the technologies they needed to provide the experience.

7.4.2 Agenda

The workshop 03 was held in Munich from the 10th to the 12th of September 2013: it was based at the offices of *Pilotfish Studio* and the entire consortium with all the seventeen partners took part to the workshop.

Day	Activity
Sept, the 10th	Session A Parallel session A: from scenarios to experiences to properties
Sept, the 10th	Presentation Presentation: Work Packages progresses
Sept, the 11th	Creative workshop 01 Discovering tactility
Sept, the 10th	Session B Towards specific design briefs
Sept, the 12th	Creative workshop 02 Integration of material properties

Figure 7.14 – Workshop 03 Agenda

After the introduction, the first session A was about that switch from scenarios built in the previous workshop to the presentation of the new experiences. The work of every design agency was presented, going through the assignments they made before the workshop. The experiences were described and explained and for every single one of them partners showed the related changes in meanings and the business impact and competition they imagined the experience could deal with. The following session was based on a presentation about the current state of art of the project, explain the results obtained and the plans for the future. The first part of the second day was a

creative workshop leaded by a design agency, which allowed partners to explore the potential of materials, to reinforce the idea that the tactile characteristic of products do change the way the user approaches the products themselves. The session B was held in the afternoon, defining the key elements for a design brief, that was an essential input for the generation of product concepts by the design agencies. The final session of the third day started from a brainstorming focused on potential applications of OLED and Piezo Electric materials, followed by a final integration and redefinition of the material properties defined in the previous days. The workshop 03 ended with a wrap-up of the work done, collecting feedback and suggestions on the topics we dealt with during the three days.

7.4.3 Inside workshop 03

From Scenarios to Experiences to Properties

The whole workshop 03 represented the implementation of the second step that belongs to the five design steps we defined in the Light.Touch.Matters overall methodology, which is the *"Envisioning of promising new experiences"*. So, the focus was on those experiences that can be offered by products and the product-user-interaction they provide that users will not explicitly elicit, but that they love once they are presented to them.

The starting point was the presentation of the assignments the designers were asked to do before the workshop. Every presentation dealt with the explanation of the new experience, provided by the description of the experience and the representation of images and that explain the exemplar idea (examples of promising new experiences are provided in the next paragraph). Then, the rest of the presentation around the new experiences was basically split in three essential parts, related to the experience itself:

- *Change in meanings;*
- *Impact and competition;*
- *Design futures and associated material requirements.*

Four to six Changes in meanings were presented, selecting meanings found in the previous workshop and moving to new meanings that can only be reached thanks to the new experiences proposed:

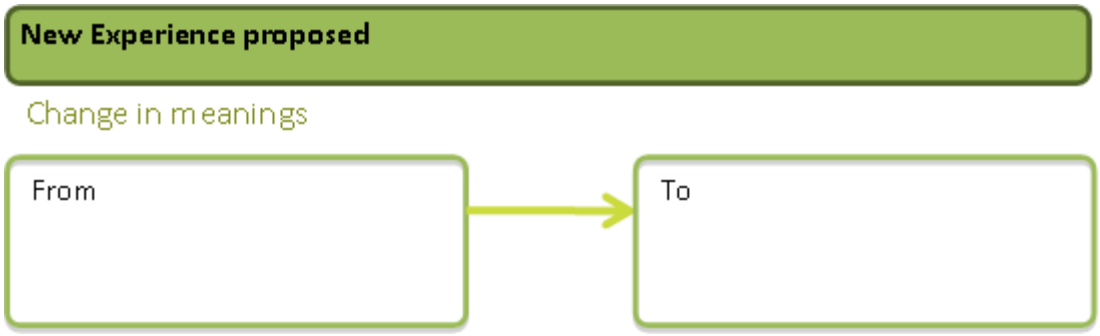


Figure 7.15 – Change in Meanings Template

After the description of the experience, details about the business and social impact of the experience were also presented, in order to give an idea of what are the business opportunities and the social impact associated to the experience and which products are considered to be competitors:

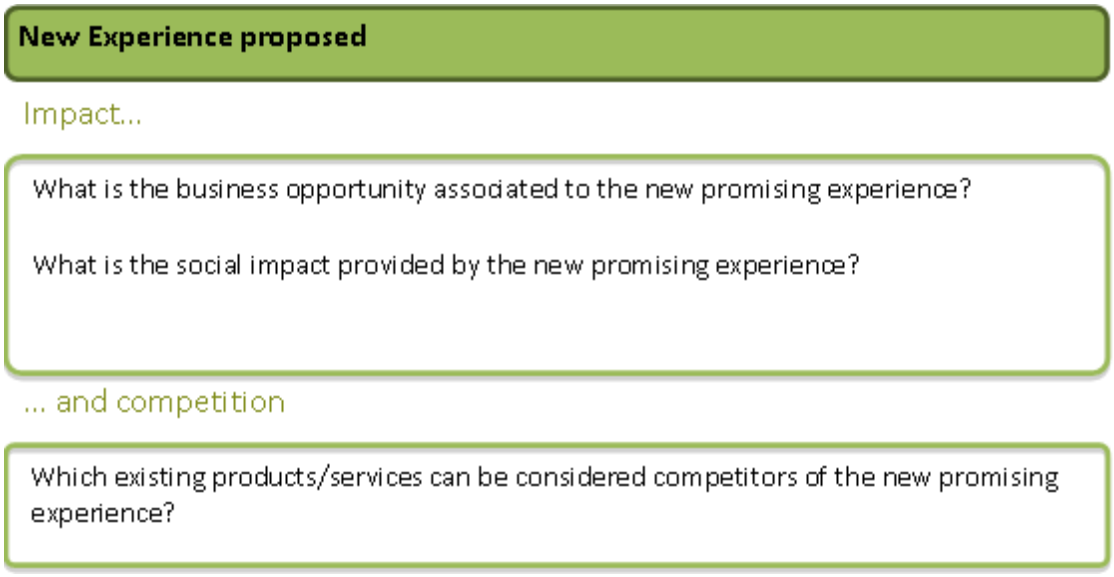


Figure 7.16 – New Experience Template

Finally, design futures were exposed in the last slides, together with the associated material requirements, as characteristics that the product needs to embed, in order to obtain a precise design future, connected to a precise experience.

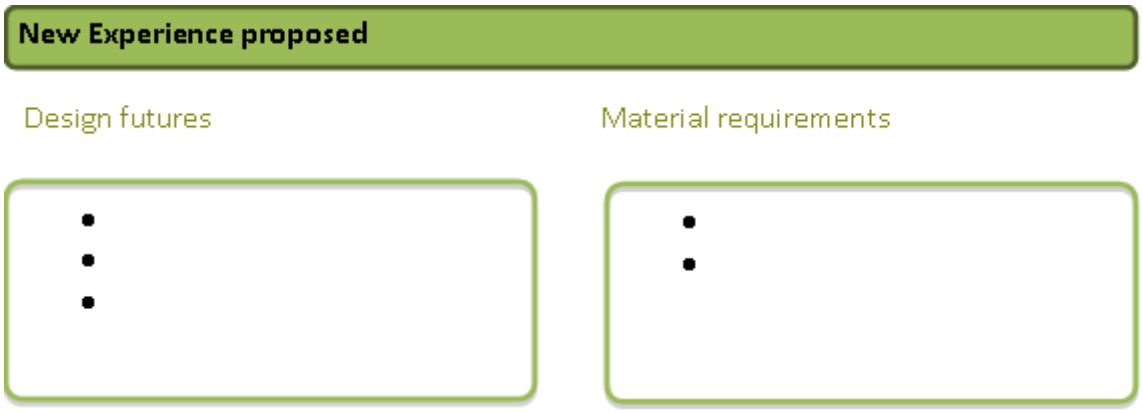


Figure 7.17 – From desogn Feature to Material Requirements

7.4.3.1 The New Experiences proposed

The presentation of some of the assignments (Session A) was the most substantial part of the workshop. The new experiences were thirteen in total and they had been divided by groups, according to the identification of the four main areas identified in the previous workshop:

1. Personal care, beauty and fitness / Caring for children	1. Intelligent Self Quantification	PFISH
	2. Ubiquitous Play	FF
	3. Lighting up Play	FF
2. Elderly: are they really frail?	4. Achieving Independence	BERLO
	5. Informal Communication	BERLO
	6. Enchantment as Empowerment	DIFFUS
	7. The Parasite Paradigm	DIFFUS
	8. Leisure activity, cognitive awareness and brain performance	GZE
3. Trauma management	9. Playing with rehabilitation	GZE
	10. Social Trauma Management	FJORD
	11. No More Loneliness!	LAMB
4. Extreme problems	12. Emotional demonstration	MINIMA
	13. Positive gestural and responsive experience	MINIMA

Figure 7.18 – Design Agencies Divided per Context Area

We are not going to go through every single experience, but we present here two of the most interesting cases developed by designers (two cases from Fuelfor and Berlo), to provide an example of the methods adopted, in order to give a more detailed idea of what was the work of designers and how they presented it.

FUELFOR - The New Experience: ubiquitous play:

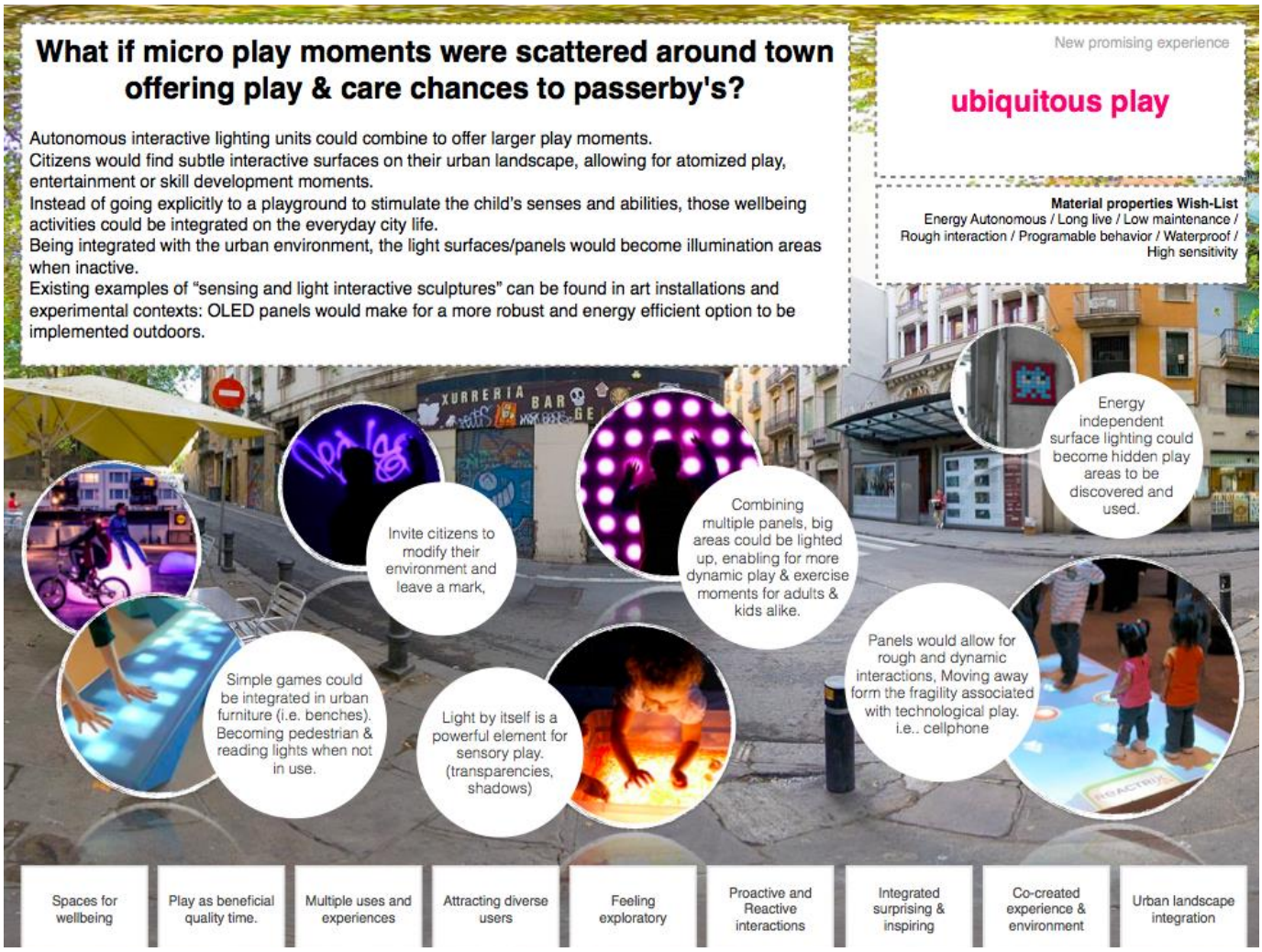


Figure 7.19 – Fuelfor New Experience: Ubiquitous Play

Changes in meanings

Spaces for Play
Public spaces targeted to children often fulfill exercise and activity needs, leaving untouched other areas like health or learning needs.

→

Spaces for Wellbeing
Public spaces targeted to children could combine play moments with health and emotional balance.

Unique value proposition
i.e. play = exercise = motor development
eing play the main functionality of a public park, there are a multitude of activities being carried on the space that currently aren't properly solved.

→

Multiple uses and experiences
i.e. Rest / Learn through play Users have different needs like, resting, learning and socializing throughout their play experience journey that require different objects, spaces and services.

Impact and Competition

What is the business opportunity associated to the new promising experience?

- *Offering technological add-ons to multiple urban furniture manufacturers and developers.*
- *Via standardized panels or custom-made installations.*
- *Opportunity to build an ecosystem of OLEDS that can be updated via software. Think: "Apps for street-lamps"*
- *Connectable panels will allow for targeting small, medium or large project.*

What is the social impact provided by the new promising experience?

- *Engaging citizens with their environment.*
- *Multiple wellbeing and fitness activities can be programmed, leading towards healthy citizens.*

Which existing products/services can be considered competitors of the new promising experience?

- *LED panels.*
- *Interactive projections.*
- *Personal devices (cell phones, tablets).*

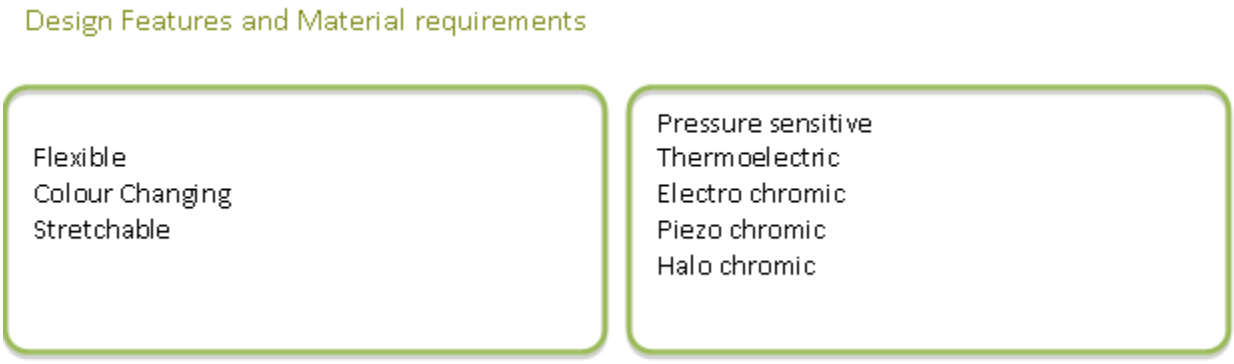


Figure 7.20 – Ubiquitous Play: From Meanings to Material Requirements

BERLO - The New Experience: achieving independence:

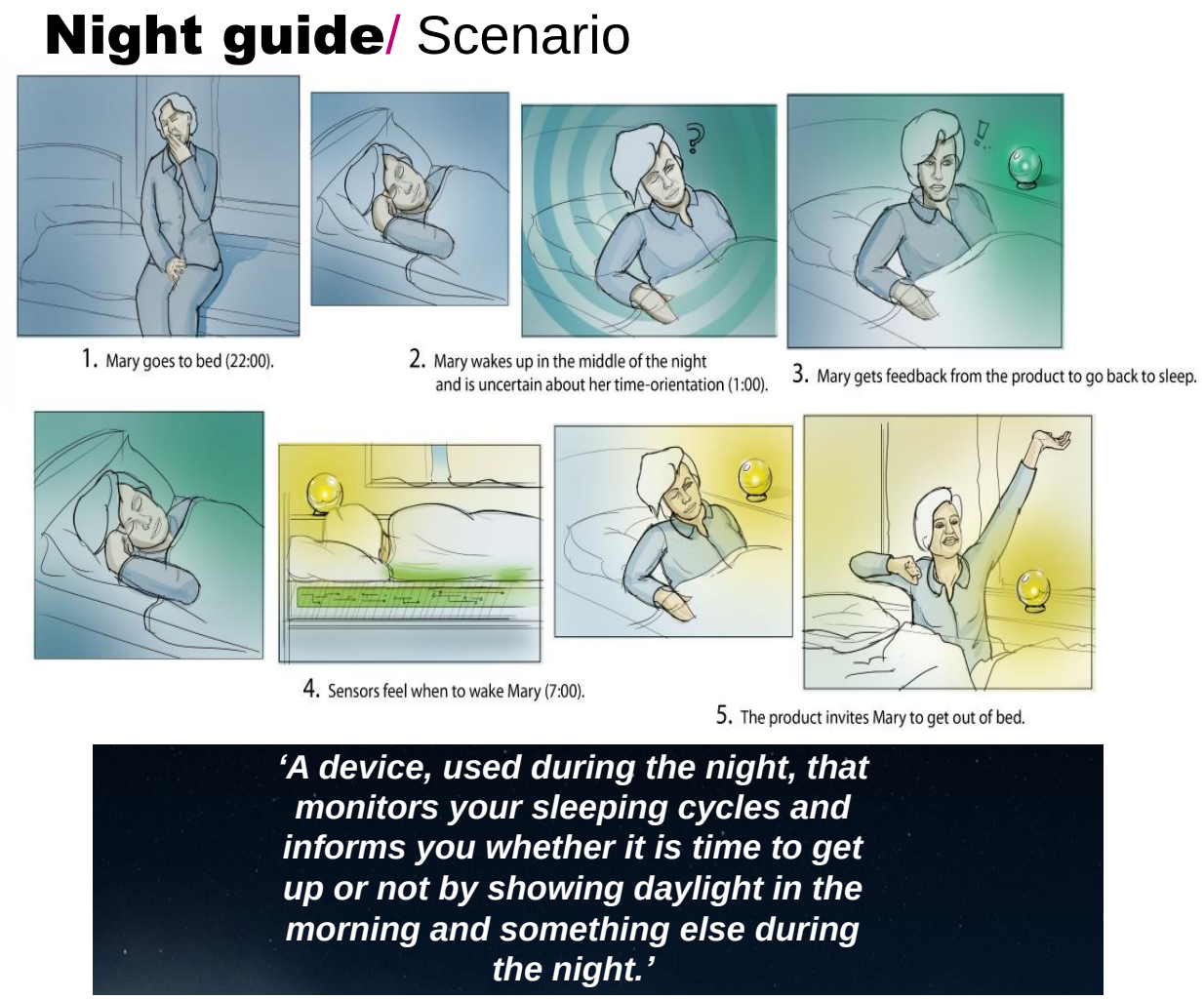


Figure 7.21 – Berlo New Experience: Achieving Independence

Changes in meanings

Dependence

People who relies on another as a primary source of wellness; subordination to someone

→

Independence and Self Management

Self-reliant; free from the influence and guidance of others. Ability to manage your own needs and desires

Treatment

Treat injuries.
People often get out of bed unintended, due to disturbed bio rhythm- common cause of injury.

→

Prevention

Prevent injuries.
Influencing bio rhythm to avoid people getting out of bed unconsciously.

Impact and Competition

What is the business opportunity associated to the new promising experience?

- *The target group of Alzheimer patients that have trouble with day-night rhythm will be growing in the near future.*
- *Getting up in the middle of the night easily causes injuries that lead to high health care cost.*
- *Less injuries reduces health care cost à insurance companies will be interested*

What is the social impact provided by the new promising experience?

- *Less injuries is better self esteem.*
- *Longer independency makes people happy.*
- *Lower chance for injuries = feeling of safety.*

Which existing products/services can be considered competitors of the new promising experience?

- *Wake up lights*
- *Apps to analyse and influence sleeping behaviour*
- *Light goggles made for bio-rhythm therapy*
- *Wake up pillow*

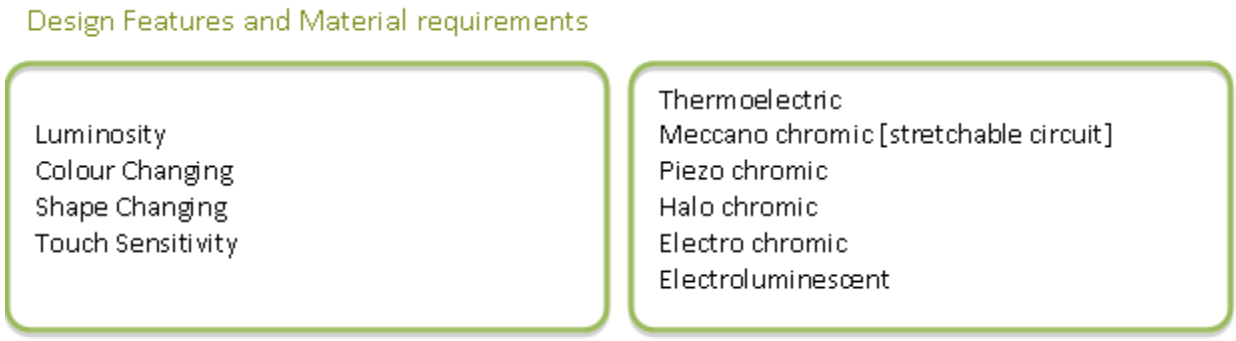


Figure 7.22 – Achieving Independence: From Meanings to Material Requirements

7.4.3.2 The Design Brief

To ensure that, in the design phase, designers work on the right products, address the right technologies, spend the right amount of time and effort, and deliver the right documentation and presentation of results, the generation of a "generic design brief" was the last objective of workshop 03. It has been thought to drive the consortium through the definition of the product concepts, starting from the work done in workshop 03, after the definition on new promising experiences and the following explanation of material properties.

Going from a generic brief applicable to all design SME's and aimed at all product concepts (approx. 20) to a specific brief applicable to the consortium (2-3 concepts per SME) involved five different choices and three guiding principles need to be considered.

3 Guiding principles:

1. make optimal use WP1 results, iteration #1;
2. refer to the Light.Touch.Matters material properties as identified in WP2, task 2.1;
3. keep in mind that the product concepts designed in WP3 are not an end in themselves; but are a means towards meaningfully informing WP2 + WP4, i.e. the materials R&D stream in the project.

5 Choices:

1/5. Design SME cooperating (if at all)

After the designers have made the brief specific for their bureau, ideally, eight bureaus will work in four teams of two bureaus each, with each team then jointly delivering four/six concepts. The designers have to consider with whom they'd like to join forces, e.g. based on skills, location, etc.

2/5. Areas (users/needs/meanings)

According to the areas identified in workshop 02 (Personal care, beauty & fitness; Caring for children; Are they really frail?; Trauma management; Extreme problems) designers will select one to work in, or simply reaffirm the choice they made earlier

3/5. Product category/functionality

In the Description Of Work the product categories and implicit key functionality were identified. The concepts to be designed fall under one or more of these categories. Also, designers are recommended to not choose too many categories, as this may hamper building up specific know-how in the constrained time

4/5. Light.Touch.Matters ambition level

Regarding the light touch materials, three different levels of technological ambition can be defined (low, medium, high), depending on properties or functionalities required (from existing to not foreseen functionalities). The designers should aim their various concepts at different Light.Touch.Matters ambition levels, if at all possible.

5/5. Product complexity

Likewise, product complexity can be set at low, medium and high levels, as an amalgam of the combination of touch and luminescence, of switching electronics and of physical integration. again,

designers should aim their various concepts at different product complexity levels, if at all possible and feasible.

7.4.4 Lesson Learned

Downstream of workshop 03, as we did for workshop 02, the validation of the methodology adopted translated into guidelines on design-driven material R&D methodology, as the major outcome in terms of research. Basically this work consisted in the collection of insights and criticalities that need to reviewed in order to improve the process of research and development. During workshop 03 the main effort was on the activities required to ensure a successful interaction between the processes of action and reaction. Again, the actors of this process where designers and material researchers, activating a collaboration that aimed to stimulate the transition from experiences to material properties. Precisely this point was the most critical part of the work shop. The iterative process showed a certain grade of inefficiency, at the point that the definition of material properties was poor and very disconnected from the experiences that designers presented. It is evident, from the output of the tables showed in the previous paragraph about the material requirements, that the OLED and Piezo properties required by designers are somewhat inconsistent, in the sense that they are not the immediate consequence of design features associated to the experiences. So, why the iteration with material researchers didn't work? And why the transition we expected to take place didn't go through? We gave an answer to this question referring to the feedbacks we had from the actors involved in the workshop.

Issues	Expected results	Actual Results
Transition from user experiences to material requirements	Proper material requirements are defined from the association to the design features.	The gap between the abstractness of the experience and the concreteness of the properties was too large. It is an excessive logical leap.
Interaction and cooperation between parties	The effective dialogue between the sides is guaranteed by an action-reaction interaction.	The action reaction interaction did not work and the effectiveness of the dialogue was compromised.

Figure 7.23 – Lessons Learned from Workshop 03

The first issue that came out was a problem in the structure and the concrete management of the workshop itself: the process of iteration between the design and technology side had been set on a process of action and reaction, in which designers and researchers alternatively took the floor, presenting what planned in advance. Instead, during the last day, an improvised section took place and it revealed to be very useful in terms of confrontation between the different parties. In other words *a "bit by bit" iteration* was a way more effective than a structured and locked presentation of contents. The designers had the chance to set an open confrontation, amplifying the discussion constricts and making explicit doubts and open issues still unsolved after the previous work shop. The most intuitive solution to this problem would be the enabling of a knowledge transfer performed in soft mode so that specific technical elements are more understandable to designers: a total of technologies to 360 degrees should be promoted. This objective can be achieved by placing a greater focus on the language of the presentations in order to facilitate understanding. In terms of contents, instead, what really didn't work was *the transition from experiences to material requirements* that was supported from just an intermediate step that is "design features", as an attempt to extract from the experiences some characteristics product-related that are more concrete and tangible then the experiences themselves. According to the opinion of designers, this method could eventually work in a context in which the material is precisely identified and the material properties are well known. Instead, this transition in Light.Touch.Matters revealed to be too complicated, particularly because the materials we dealt with were still new to the consortium. This fact represented an obstacle in the phase of collection of requirements because the technology characteristics and potentialities were not well defined. According to the first draft of the process tested in Light.Touch.Matters the phase of Concept Generation was subsequent to the identification of requirements. Instead, after the

feedbacks received, we are confident to say that the association “applicative concept – material requirements” could work, while the association “design features – material requirements” didn’t, precisely because the design features coming from experiences – and not from a well-structured product concept - had a poor level of definition and it was hard to find material properties of a kind of still unknown technology. In order to bridge the wide gap between experiences and material requirements, the process could be *broken up into smaller pieces*, so that precise product characteristics can be defined and then associated to the requirements. This modification to the process will probably be an important input for the second cycle of iterations, as well as an interesting insight for our final proposal, discussed in the following chapter.

7.5 The output of the Action Research

The output of action research is represented by a new process companies need in order to identify novel applications enabled by existing and new technologies. Specifically, the initial draft of the method was tested and refined through the Light.Touch.Matters project, providing a final version enriched with the lessons learned stemmed from the two workshops. Through partners’ criticalities and insights we were able to build up a more grounded process, introducing improvements aimed at facilitating an effective dialogue among the partners. The path we drawn is far from the traditional approach due to the complexity of the project we were involved in. Light.Touch.Matters aims at identifying and developing new applications enabled by the potentialities provided by polymeric Piezo materials and flexible OLEDs, with a specific focus on care & well-being environment. The entire consortium involved in the project is supposed to move towards new meanings enabled by smart materials on which to build up disruptive applications directed to a receptive market space. Therefore, the process we proposed is different from well-established methods that support companies in designing more attractive products based on existing technologies and existing needs.

Light.Touch.Matters implies to explore design in a context where technologies are still not defined and, even more challenging, in which user needs and behaviors can be radically redefined.

The context in which the initial exploration is set is the Health Care and Wellbeing industry. This is a pre made choice in order to state the transition towards a new market, a new mass of customers, and a new basket of application fields. The technology is also completely new, being a fully new generation of smart materials that combine touch sensitivity with luminosity, based on latest developments in polymeric Piezo materials and flexible OLEDs. The meanings the project is meant to identify represent the enablers of this transaction from traditional standard applications to radically new applications.

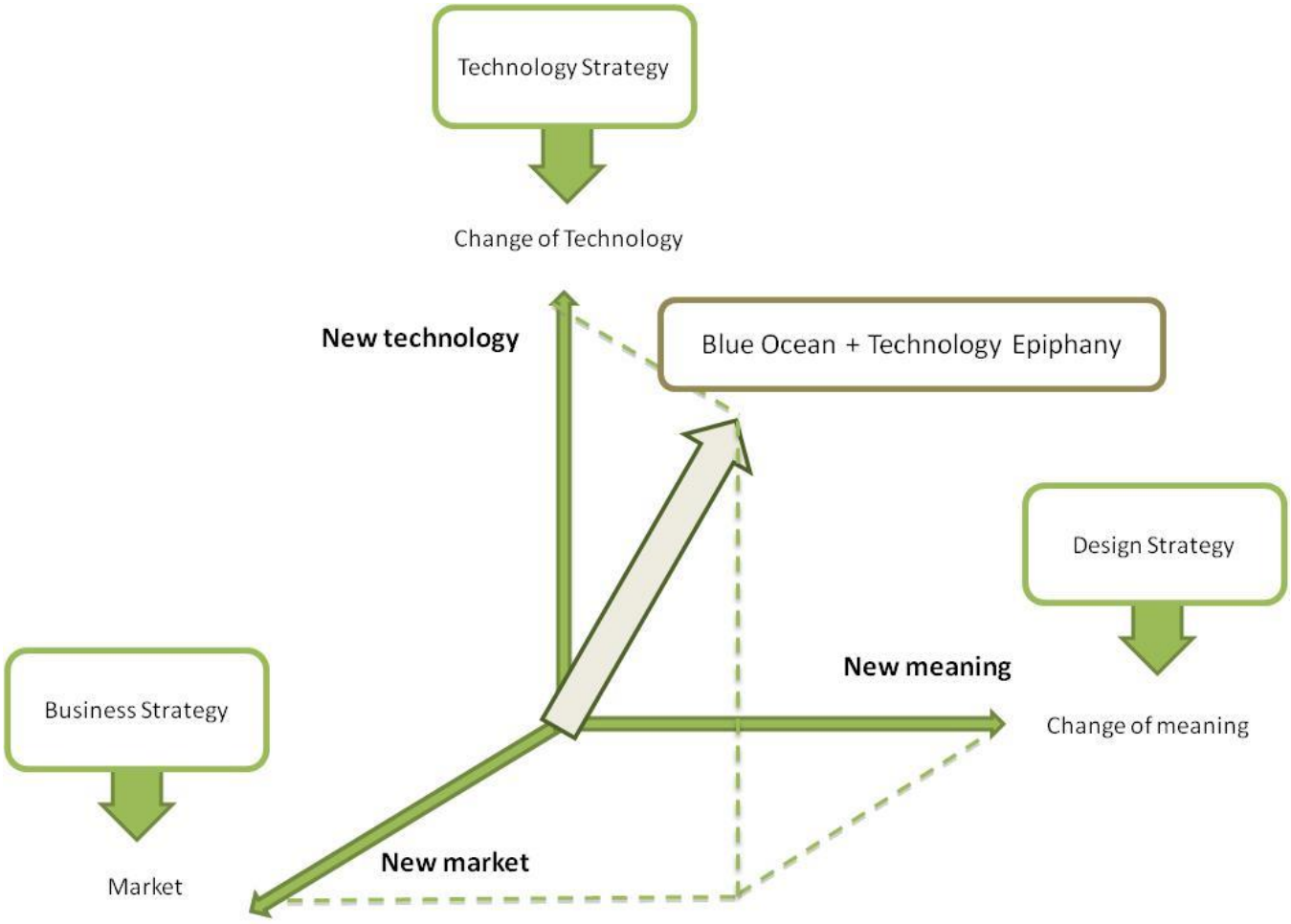


Figure 7.24 – The Proposed Strategy

The simultaneous shift on the three axes represents the situation with the strongest impact in innovative optical. Technologies become enablers of new product meanings, mixing research activities related to new technologies and studies about emerging lifestyles and societal values. In addition the company approaches a new market, providing a disruptive application to an unknown industry. This concept, typical of the Blue Ocean strategy, is combined with the concept of Technology Epiphany, giving rise to a complete strategy that touches all the dimensions.

7.5.1 Overcoming established methods

Methodologies that support companies in designing new products based on existing technologies and existing needs are addressed with several names and are based on problem solving approaches focusing on user observation, creative sessions, prototyping, and iterations. In order to set a reflection on the innovative results we obtained in Light.Touch.Matters, we started gathering information about established processes, collecting data about the methodologies generally adopted by designers. The particular focus was on the substantial part of the innovative process that deals with the exploration of the context and definition of the potential applications. The contribute of the design agencies that took part to Light.Touch.Matters was particularly useful in this sense. Analysing the different cases we identified the main phases and that characterise their approach to innovation: particularly in workshop 2, designers provided a brief description of the process, actors and methods usually adopted to face new challenges. They described the methodology typically used to discover the unspoken aspirations of people and satisfy the request coming from a potential client.

Shown below there is a selection of the contributions provided by the Light.Touch.Matters design agencies:

First, we report the example of *Van Berlo BV*, distinguishing among the different elements of the methodology.

From the point of view of the process, *Van Berlo* uses a standard approach that recognizes five phases. The first 3 phases include activities that are aimed to identify user needs and goals:

- *Research.* The first phase aims at understanding two important aspects: first, the scope and the goals of the project; subsequently the context and the users, specifically their goals and needs.
- *Explore.* The objective of the second phase is to verify early design concepts with the client and potential users.
- *Detail.* The third phase is about verifying more detailed designs with the client and potential users.

The actors involved in the initial phases of the process are typically one designer, one team leader, the client and the potential users. The typical methodology used in the "research" phase is made up of three different steps. Initially, the organization of a kick off workshop with the client (extracting as much information from the business case, future product and client as possible), after on-site visits at the clients customers and finally observations and interviews in the context of the (potential) user. In the "explore" phase a low-fidelity prototype is crafted (foam models, 3D printing); the additional tool used is the user test or group feedback session with potential users. The last step of the project considers the creation of an high-fidelity prototype (e.g. looks-like-real models, works-like real models, software prototyping, animations) and final user tests or group sessions with potential users (observed by the client or recorded/documented for the client).

FF Fuelfor adopted a structured process made up of three different steps:

- *Understand.* This phase includes framing and defining the brief through observations and interviews. A multi-stakeholder session allows the design agency to understand the personas and lead a spatial analysis. The Journey Map enables designers to build up a rich picture of the current experience based on the design research findings. It provides a structure to organize information about people, places and processes over time, incorporating both facts as well as feelings, using quotes, photos illustrations and text to bring the story to life.

- *Explore.* This step is made up of a series of sub-tasks: the scenario creation, the definition of experience and goal and the final ideation.
- *Test.* This phase is about prototyping, the evaluation and feedback.

Fjord's methodology rests on a process that includes an initial research based on the analysis of previous experiences and the study of scientific papers. The following phases are service prototyping and empathy mapping. The tools used are several, such as design storytelling, design fiction, role playing and body storming.

Grade zero generally follows four steps:

- *Studying* the ethical aspects for research;
- *Testing* results, consulting different sources, like scientific articles and organizations
- *Exploring* behaviour change, design methods and case studies.
- *Identifying* potential client.

Lamb's methodology is stakeholder focused: the central question is to identify the stakeholders and draw a detailed profile. In the Light.Touch.Matters project the agency started from a complete comprehension of the patient profile, studying his lifestyle and his motivations; Lamb analysed the patient expectations of outcome in long and short perspectives. The Design Agency also led research in parallel areas, like sport, military and apparel.

Minima's process is based on a triple research:

- *Primary research:* expert interviews in order to understand unspoken needs for persons working in selected area.
- *Secondary research:* internet searches, keywords and information collation, literature review for further keywords for internet searching and extraction of key issues.
- *Tertiary research:* internet searches, literature review.

Basically, there is a common thread among the description provided by the partners, that is a clear orientation to the observation and understanding of the context in which to set the project of

innovation. It consists in a macro phase of exploration that rotates around the user, his experiences, behaviour and needs. Usually a confrontation with the user himself follows, generating ideas, prototyping concepts and verifying their goodness through direct feedbacks. This path is actually attributable to a common matrix that is the base of the partners' methodology: *the Design Thinking*. The partners route their innovation path adopting processes and methodologies that all are more or less close to this approach.

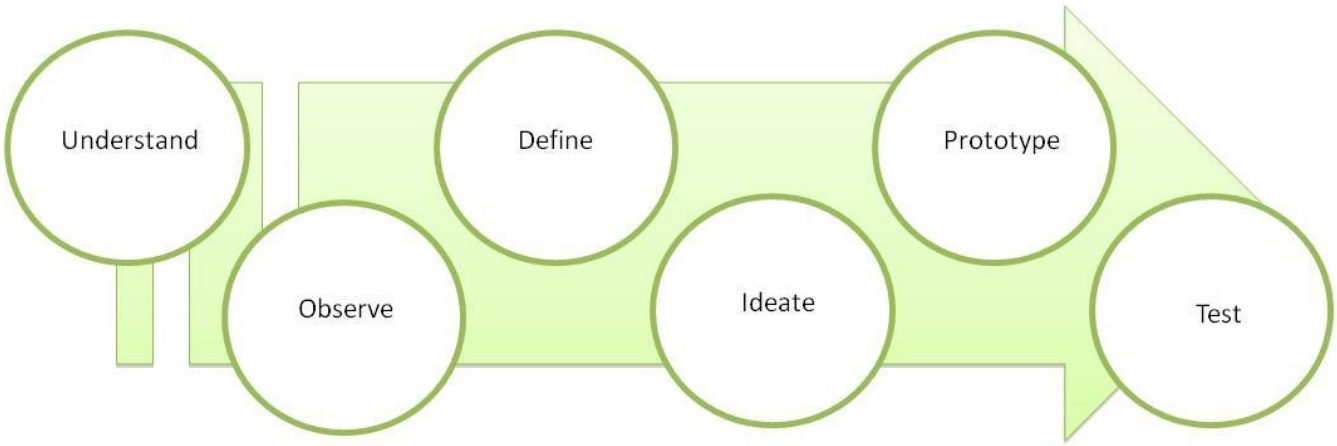


Figure 7.25 – Design Thinking Process

The Design Thinking, in fact, is a structured design methodology that has been optimized and evolved to the point that if used in a proper way is both the glue between all the figures involved in the project as a guarantor of the final result that respects the initial vision.

For the designer, the design approach is not always the same, but in general, the common point is the path of discovery and observing, and for all those who are particularly related to Design Thinking, it is also the opportunity to work on its idealization from the early stages of the project. This point is actually in common with our proposed methodology, since it is important that all the actors are involved in the process since from the first phases of the generation of meanings. In addition, in the Design Thinking, designers tend to involve the direct actors belonging to the whole production chain, strategy, development, communication, distribution and consumption. The multidisciplinary workshop described in the Design Thinking approach is one of the instruments with this role: expertly prepared and moderated by Design, it enables the identification of the project opportunities with an

operationally fast and punctual precision However these opportunities are significantly different, depending on the orientation of the exploration and analysis. In fact, the main difference with the proposed methodology lies in the approach that characterizes the initial investigation. As long as the partners start from the user needs and behavior it is difficult that a disruptive change in the application field takes place. In fact, according to our research, the real enabler of this change is the meaning associated to the product. So, even though the user experiences play a fundamental role in the process we designed, they are consequent to an earlier more crucial stage: the investigation on scenarios of meanings needs to come first, in order to intercept new meanings in the field of analysis, rather than existing needs and existing customer habits.

After the first stages of understanding and observing, the subsequent definition and development of the ideas that emerge in structured and reusable concepts, it is an extremely important step that occurs in the Design Thinking thanks to a constant dialogue with the interlocutors and to the communication of the synthesis of a much larger complexity. After this phase of setting and progress of the work, it goes without saying that the design is historically the motor of control of the processes of prototyping and user testing. Obviously this role is also necessary in our process and it is not significantly different, once the design features are set product requirements and characteristics are defined. Our effort in redefining the process, in fact, concentrates on the first staged of investigation and consequent conceptualization of the ideas, that are essential for the identification on new unexplored applications and markets.

7.5.2 Designing the Process

As said, the main input in designing the final process was the Process Framework, that we specifically ideated with a dual scope of driving the overall methodology in Light.Touch.Matters and using a real environment to test the model itself and the related process. The specific *path followed in the Project* is exactly the path we described in the Process Framework, that retraces the three dimensions that characterize a Technology Epiphany as expression of starting from meanings and moving towards specific OLED and PIEZO technologies (Figure 7.26).

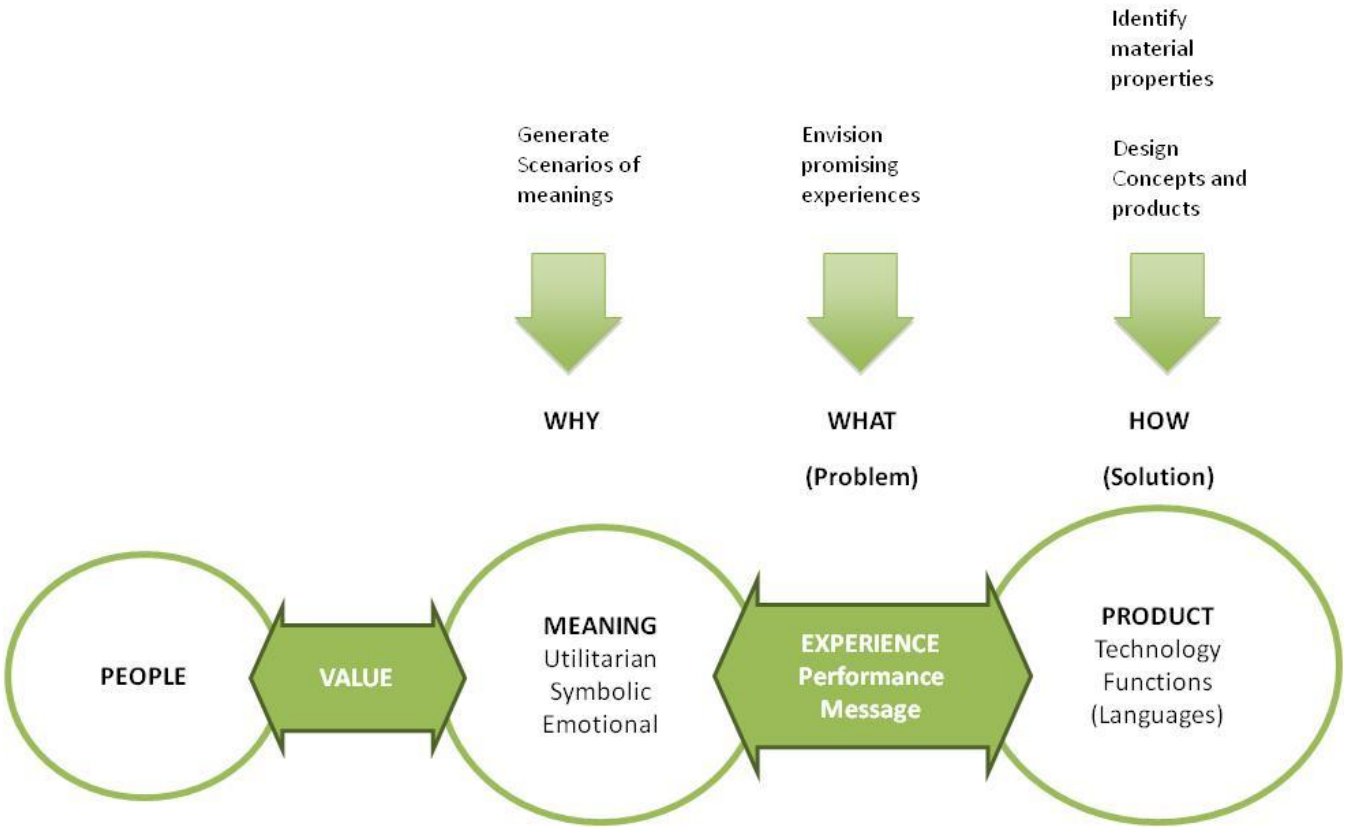


Figure 7.26 – The Process Framework

Workshop 2 was dedicated to the generation of new scenarios, in order to understand the reasons why people should get involved in the world of health care and well-being, in terms of *meanings*. We worked with *utilities, symbols and emotions* associated to the transitions in meanings every partner described in this first phase. Workshop 03, instead, activated the research for promising *experiences*.

The final task, in this sense, was the adoption of a clear vision of the problem, of the *performances and messages* the final product should embed, to give a precise experience to customers. This was basically what we did analysing the design features associated to each experience, where the message the experience wants to give can be only achieved through specific features. At the same way, performances translate into the material requirements defined for the OLED and Piezo technologies. The transaction from workshop 03 to workshop 04 and workshop 04 itself are part of the product development, towards the definition of the characteristics of the product, both in terms *of materials and technologies* it will embed and in terms of *functions and languages* through which it will talk to people, providing a particular experience. The last step of evaluation and learning after workshop 04, instead, is essential for the iterative characteristics of this long-term project based on cycles and rounds, but it actually loses meaning in our final proposal.

For the reasons that lie behind the differences described before, with the most known and established methods, the methodology thought is specifically structured to allow the designers to steer the materials R&D activity, for instance by setting and updating target specifications known from the design cycle to be valuable and by reprioritizing research tasks according to new insights and ideas. The process therefore validates *brand-new methods* for bringing design upfront in the innovation process, to understand how materials development can benefit from being design-led and learn how to set up a dialogue between material researchers and product designers. Starting from the logic of our Process framework, the *change in meaning* plays a crucial role in pushing the innovation in technology towards value-added results and creating value for new markets. The designed process involves steps that reverse the traditional approach to innovation, starting from the generation of meanings, towards the *definition of the material properties* and the following creation of *the product concept.* The *envisioning of experiences* is an intermediate step that links the new meanings to the tangible characteristics that the final product should embed. Basically, the main steps that compose our proposal are those ones introduced in the Light.Touch.Matters methodology, except for the last one that is significantly reviewed. Our process ends with a phase of testing and refining, because there is no iteration afterwards. Instead the last phase of the Light.Touch.Matters project was a phase of learning and analyzing what was made in the previous iteration, to feed into the next one. This is consequent to the fact that the Light.Touch.Matters process is a research project so, particularly in

the first iteration, the learning phase is even more important of the final output itself. The proposed methodology is based on a linear process and presented in Figure 7.27:

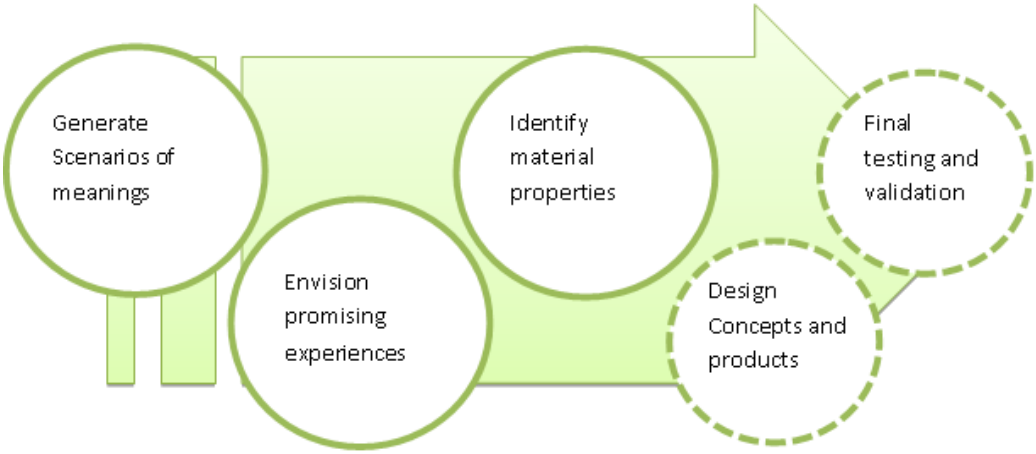


Figure 7.27 – Initial Process: The Proposed Process

In particular the graphs below reports in details the first three steps, objects of our analysis, including also the lessons learned out of the Action Research:

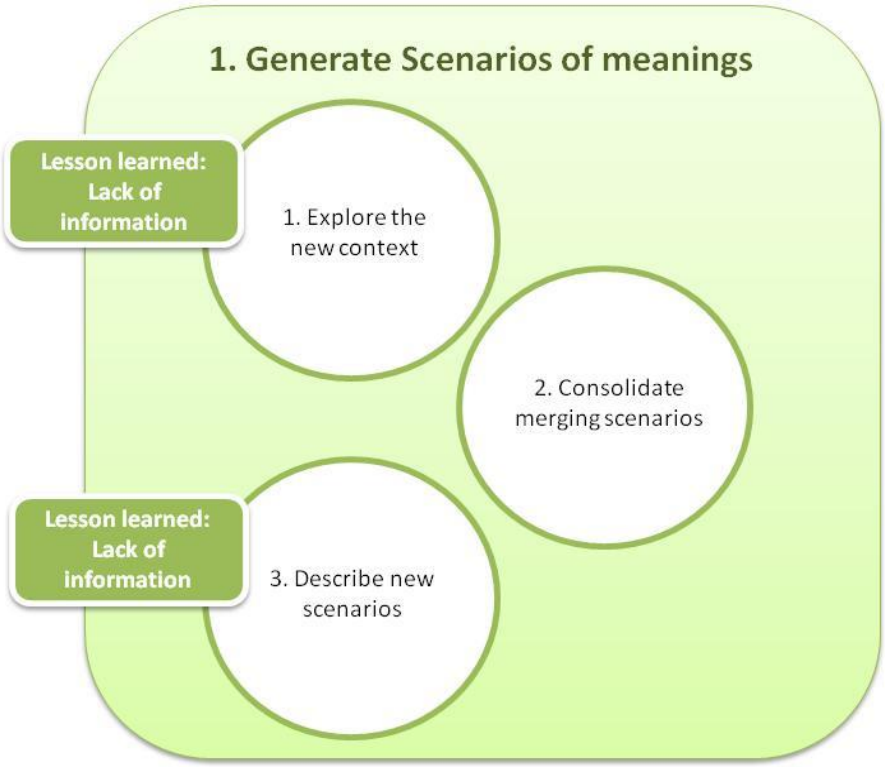


Figure 7.28 – Initial Process: Generate Scenarios of Meanings

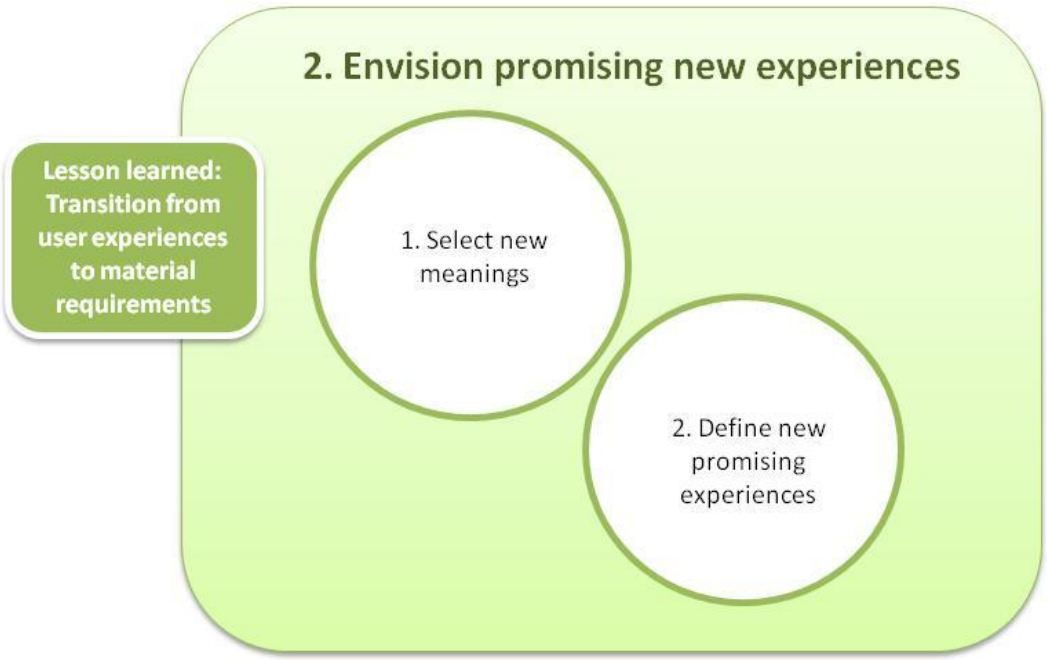


Figure 7.29 – Initial Process: Envision Promising New Experiences

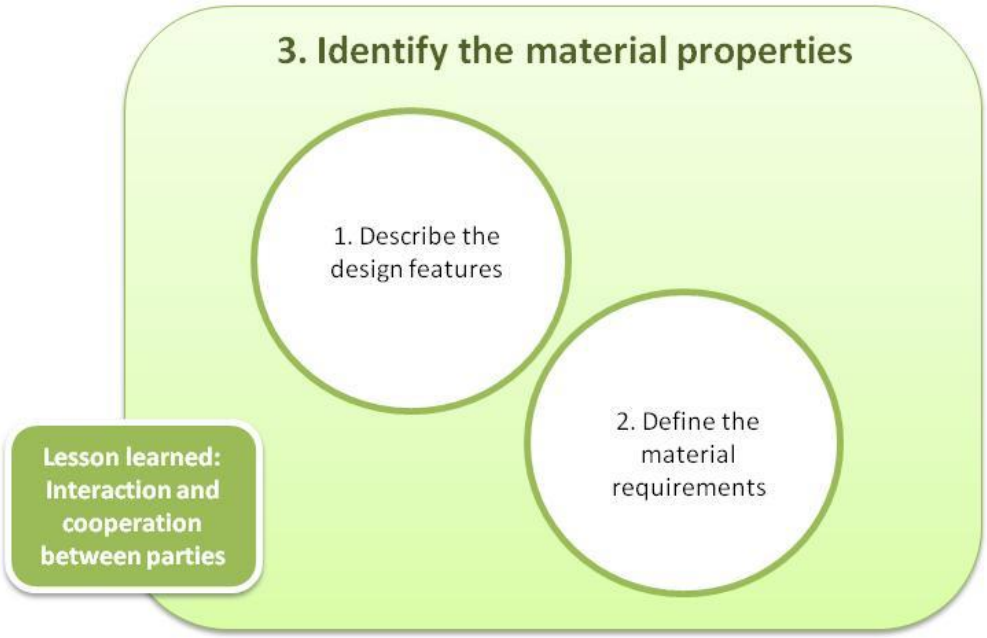


Figure 7.30 – Initial Process: Identify the Material Properties

As the graph shows, the process at hand does not include the concrete generation of the product: our thesis deals with the exploration of the context, generation of new meanings and experiences and finally the identification of the material properties. This focused research scope represents the reason

why the action research coincides with the first 9 months of Light.Touch.Matters — the entire duration of the project is 48 months and it ends with the proposal of concrete prototypes and final products.

The process first defined on the basis of what we stated above is described and refined in the next chapter, through the issues and challenges we collected from Light.Touch.Matters, synthetized in the Lessons learned we described in chapter 7. We made that collection of information with the clear intention of gathering important insights from the workshops, in order to reopen them in this chapter and refine the final process. Recapping, *the lessons learned* we got from Light.Touch.Matters where:

Issues	Expected results	Actual Results
Lack of information	Enough sharing of information to make actors aware about the potentialities of technologies.	Lack of information, especially regarding strengths and weakness of technologies. Not enough data related to the state-of art of the technology in terms of enabled applications.
Transition from user experiences to material requirements	Proper material requirements are defined from the association to the design features.	The gap between the abstractness of the experience and the concreteness of the properties was too large. It is an excessive logical leap.
Interaction and cooperation between parties	The effective dialogue between the sides is guaranteed by an action-reaction interaction.	The action reaction interaction did not work and the effectiveness of the dialogue was compromised.

Figure 7.31 – Lessons Learned Details

The argument of the next chapter starts from the collection of the issues coming from these lessons learned and translate them into modifications that represent an attempt to solve them. The added steps, the changes in crucial points of the methodology and the refinements of the process, bring to the generation of the final proposal, as a new Methodology for Finding New Applications, valorizing new (and existing) technologies.

CHAPTER 8

Proposal of a New Methodology

This last proposing chapter represents the real output of our master thesis. It is the concretization of a spread research that took shape since from the first pages of this document, from the definition of innovation and the framing of the overall work. The real input to the final proposal is the Action Research we made in the Light.Touch.Matters project as researchers of the Polytechnic of Milan. It was a phase of learning because we collected insights that contributed to the refinement of the model; it was also a phase of testing because it gave us the chance to implement the first draft of the process. Inputs from the case studies are also relevant, since the first description of the strategy is a reflection we obtained from the analysis of the projects and companies we interviewed. The precise output is the proposal of a structured methodology that helps companies in valorising the potentialities of technologies by identifying new applications.

8.1 The Strategic approach

This chapter aims at presenting the overall strategy that can guide companies in valorising existing and new technologies, in order to identify new application fields different from the traditional ones. As stated when we built the conceptual framework, analysing the literature about innovation strategy we realized that, in order to penetrate into new market domains, investigations have focused more on the applications of existing or new technologies. Instead, a less explored area is the innovation of product and service meanings. The strategy we propose involves three different directions towards innovation, that are technology, market and meaning becoming a three-dimensional construct. The logical path followed is the one described below:

From Technology breakthroughs …

Technological innovation may drive incremental improvements (such as longer life for batteries used in mobile phones) or quantum leaps in performance or breakthrough functions (such as mobile phones themselves). Radical innovation of technologies reflects the dynamics of advanced technological research. Often research follows the typical pattern of scientific discovery and technological development: the technological breakthroughs are followed by incremental improvements pushed into the market to answer a need for more performing products. Although technological breakthroughs have a disruptive impact on industries and can be source of long-term competitive advantage, our model considers two extra dimension that aim to enrich the innovation experience. The strategy proposed, in fact, bases on the concept that radical innovation stems from a combination of potential meanings enabled by technologies, that supports companies in facing new markets.

… To meanings…

The cornerstone of the final strategy is represented by the idea that each technology embeds a set of meanings. Meanings broaden the concept of technology itself, enriching the conception of a mere tangible material, adding to the functional feature also the symbolic one. Hence, if companies reveal the meanings embedded in a specific technology, they will embrace the opportunities related to the

material, seizing the utilitarian and emotional potential. Graphically the definition of a new meaning is represented by a shift on the semantic axes (Figure 8.1): this change is not an improvement of something already existing, but something that still does not exist and need to be created. It is a vision that does not become real until a company proposes it to the market and until users give meaning to it. Therefore, we conceived the radical change in product meanings as a process of "interpreting and envisioning". "Interpretation", because we are dealing with meanings, that, by definition, is the result of an interpretative process. Effix Design is a new interpretation of what concrete is traditionally meant for. "Envisioning", because we are focusing on the radical innovation of meanings. As demonstrated by the case study research, interpretation is not a linear process in which opportunities and ideas are assessed in the light of the existing context. It is not only a process of interpretation of an existing reality. The exploration of radically new meanings instead implies to envision a new scenario that does not exist yet. It implies to picture an idea into a new context that often coincides with an unknown market space.

… Towards new market spaces

Change in meanings offers the possibility to approach a totally new environment for the company: *Italcementi* faced the design world, a market absolutely far from the one the company has always competed in. Often new meanings enabled by technologies unlock a mass of customers that did not exist before, creating demand and providing the opportunity for highly profitable growth. Companies could approach new markets, activated by the radical change in meanings: the proposal of a new meaning offers the possibility to fulfil needs coming from a totally new industry. This approach contains the basic element of two different strategies. The first factor is *the Technology Epiphany*: it represents the output of the interplay between technology-push and design-driven innovation in which technologies become enablers of new product meanings. Research activities related to new technologies and studies about emerging lifestyles and societal values are mixed in order to introduce radical innovations in meanings. The second factor is the base of *the Blue Ocean strategy*: an organization should create new demand in an uncontested market space, or a "Blue Ocean", rather than compete head-to-head with other suppliers in an existing industry. Blue Oceans represent a vast, deep and not yet explored market space with wide potentialities in contrast with known and traditional areas where cutthroat competition turns the red ocean bloody. The combination of these

two approaches gives rise to the most powerful strategy in valorizing technologies and seizing their full potential.

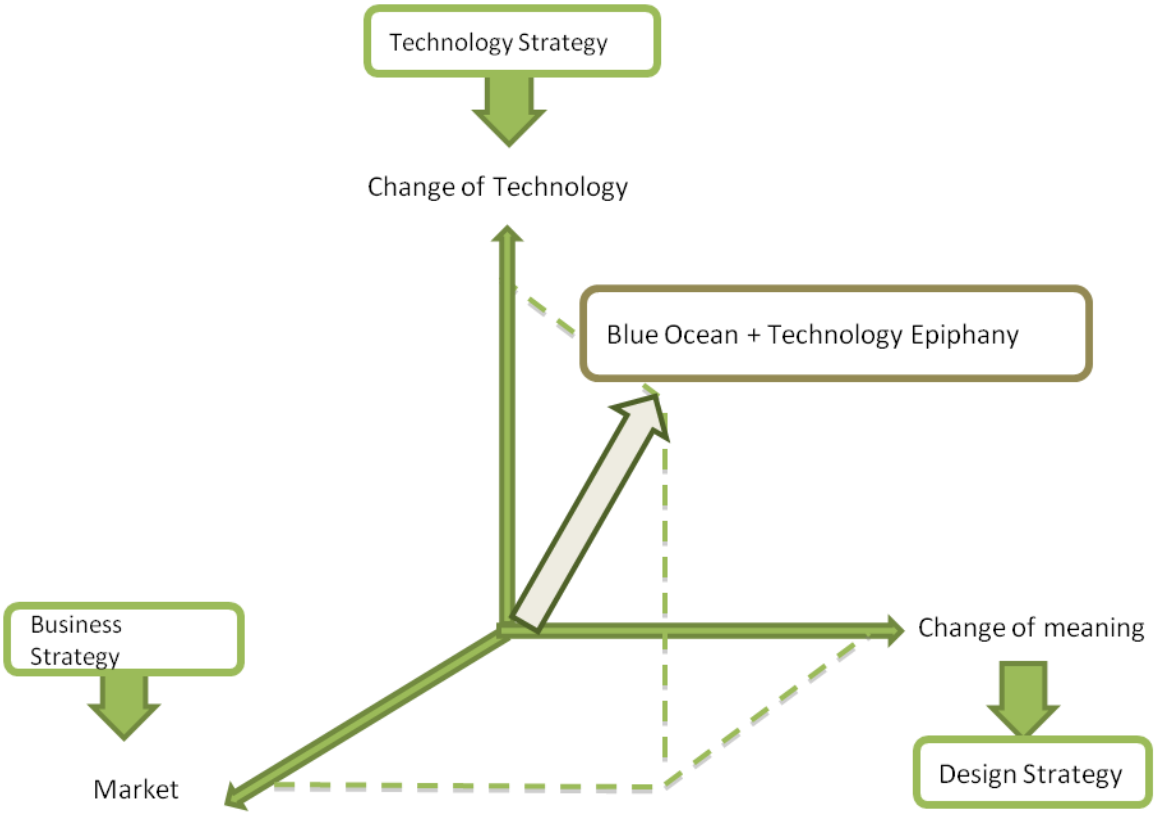


Figure 8.1 – The Proposed Strategy

Graphically the farthest point on the diagram represents the desired situation (Figure 8.1). The position expresses the combination of shifts on the three dimensions: *a company that moves on the three axes extracts the maximum value from technologies, defining application fields far from the traditional ones*. In order to grasp the full potentialities of technology, companies should work on both hard and soft aspects, struggling to find out high-performing technologies, envisioning new meanings and finally approaching new markets. Develops on the technological side are direct consequence of the R&D effort, while a change in the semantic dimension stems from a reinterpretation of what could be meaningful to users. The definition of new meanings related to technologies offers the opportunity to move towards profitable markets: radical changes in meaning represent the enablers of new market space, giving to companies the possibility to unlock a numerous mass of new consumers.

Hence, the question that immediately arises is: what is the process at the base of the identification of new applications and how companies can simultaneously move on the three axis? We provide the answer to this question in the next paragraph, giving the description of the proposed innovation process and its specific steps.

8.2 The Process

In this paragraph we present the process that companies need in order to identify novel applications enabled by existing and new technologies. The final proposal is the result of an initial draft refined with the lessons learned coming from the action research. We enriched the first process with insights originating from criticalities by Light.Touch.Matters partners, providing a well-grounded final version. Actually the process at hand does not include the concrete generation of product: our thesis deals with the exploration of the context, generation of new meanings and experiences and finally the identification of the material properties. This focused research scope represents the reason why the action research coincides with the first 9 months of Light.Touch.Matters — the entire duration of the project is 42 months and it ends with the proposal of concrete prototypes.

According to the considerations above, the starting point of the process is represented by the phase of “Generate Scenarios of Meanings”. This approach is far from traditional processes that are limited in terms of application fields. They usually base on technology substitutions, that derive from the companies’ research and development activities, or from the opportunities pulled from the market, that bring to a new product development as a direct consequence of explicit needs expressed by consumers. The second step of the process includes the envisioning of promising experiences: design features embedded in the final product come from the interpretation of messages and emotions attributed to user experience. Then the design features assume a more concrete acceptation through the translation into material requirements. These elements are the input for the final generation of concept. The graph below represents the path we designed, with a particular focus on the first three steps:

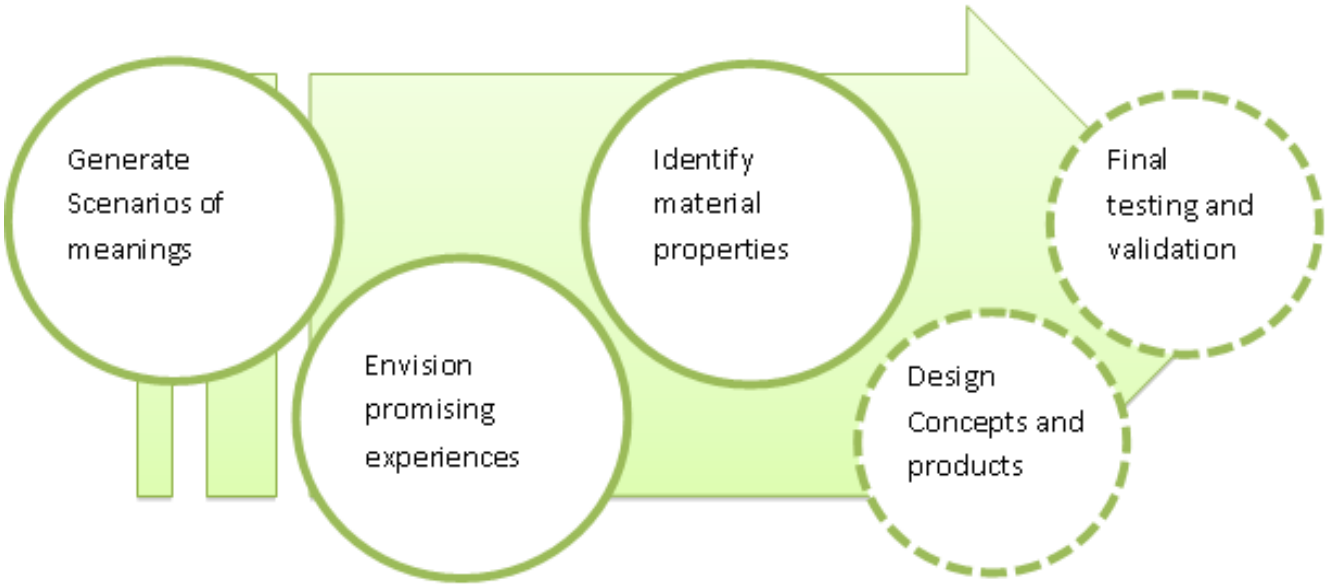


Figure 8.2 – The Process Proposed

First of all, what is really important to understand is the nature of the approach proposed. The process of envisioning new meanings, defining a direction to the development of technologies and researching new potential markets, bases on continuous interactions among firms, designers, users, and several stakeholders, both inside and outside a corporation. This way to proceed implies to develop arguments rather than finding optimal solutions. This perspective allows therefore to bring in the spotlight a major factor: *the role of debates*. Rather than focusing on solving (on the role of knowledge and methods), or on thinking (on the role of reflective approaches and emotional insight), this allows focusing on interacting (on the role of social dimension of innovation). Hence*, interaction, cooperation and discussion* are at the basic elements of the process.

The steps in which the process is decomposed are shown above (Figure 8.2). The first three phases represent the focus of our research. They are supposed to guide companies in defining a set of potential application related to the identification of experiences in scenarios built up on new meanings.

1. *Generate scenarios of meanings*, i.e. make specific representations (in images, words and/or animations) of how people give meaning to products in their life. They come from a redefinition of behavioral patterns in an envisioned new scenario based on culture, society

and new technology. Scenarios of meaning enable the creation of breakthrough applications since they imagine new needs and new aspirations of users, as a result of new technological opportunities and changes in contexts.

2. *Envision promising new experiences* that stem from the radical changes of meanings. This phase aims at creating experiences and situations based on new meanings defined in the previous step. During this step the envisioned meaning is enriched through additional details and concrete elements referred to the final users and the context of use, defining a new experience.
3. *Identify the material properties* that are necessary to invoke the new experiences. These are the properties that will be the focus for, and give direction and priorities to the material R&D in the process.
4. Design concepts and products. During this step a concrete solution is provided in order to grantee the new experience. The output of this phase is a product concept, on which build up economic and feasibility considerations.
5. Final testing and validation is a specific step whose main purpose is to provide feedbacks. The idea is to learn what works and what doesn't, eventually going back to the prototype and modifying it. Our proposal ends in a significantly different way compared to the Light.Touch.Matters project: the last phase in the action research is intended to learn and analyze what was made in the previous iteration, in order to feed into the next one.

We propose here an explosion of the phase we focused on, also presenting the step that are described in the next paragraphs:

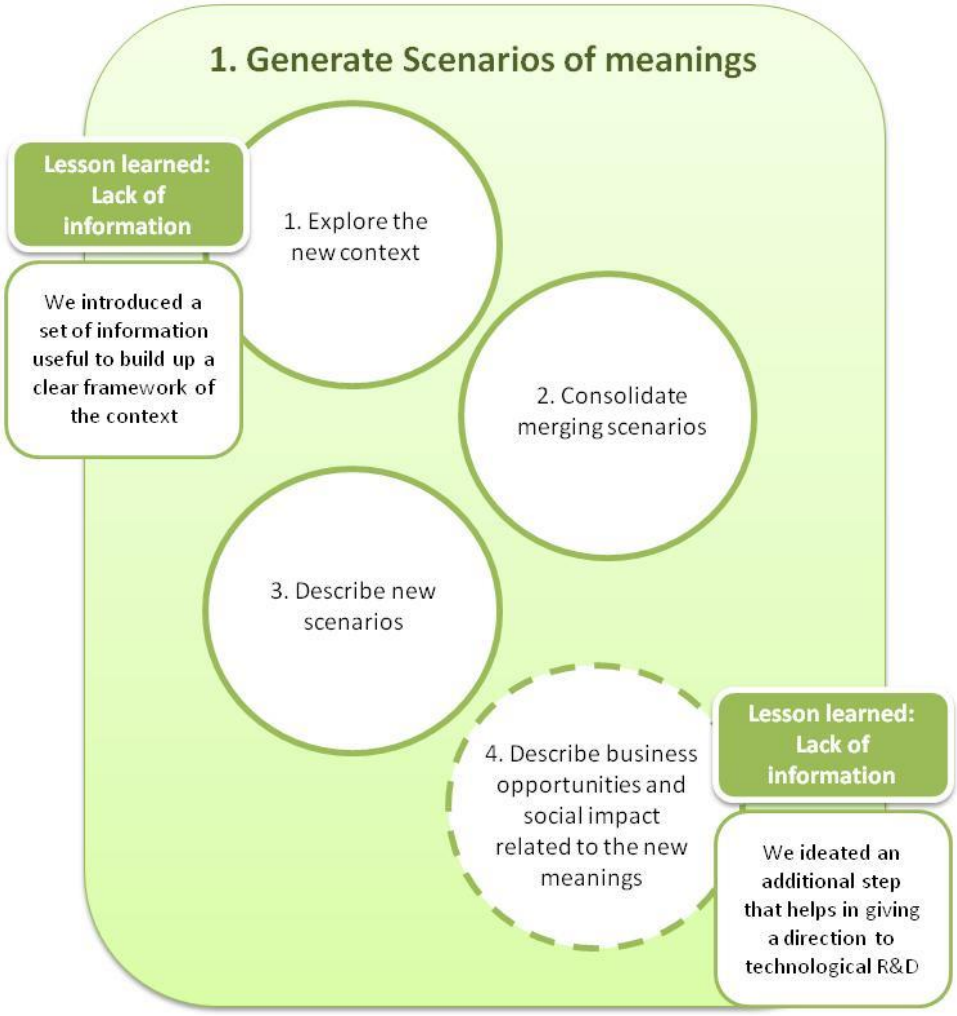


Figure 8.3 – The Proposed Process: Generate Scenario of Meanings in the New Process

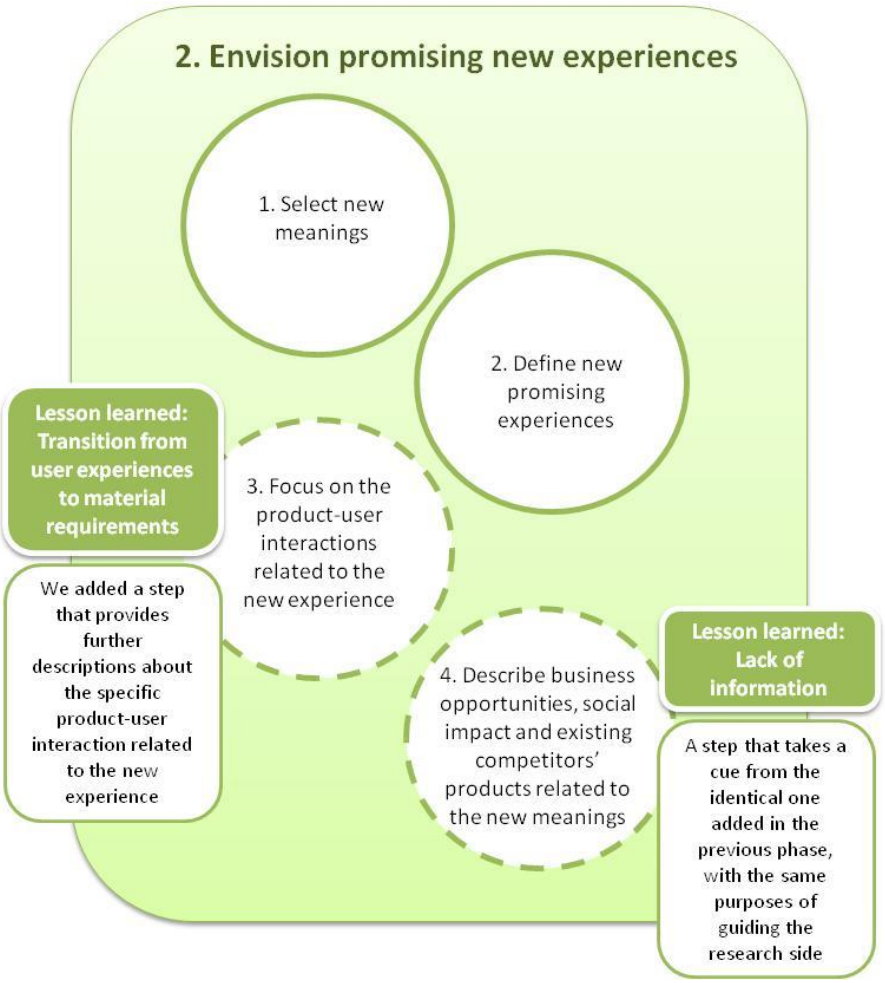


Figure 8.4 - The Proposed Process: Envision Promising New Experiences

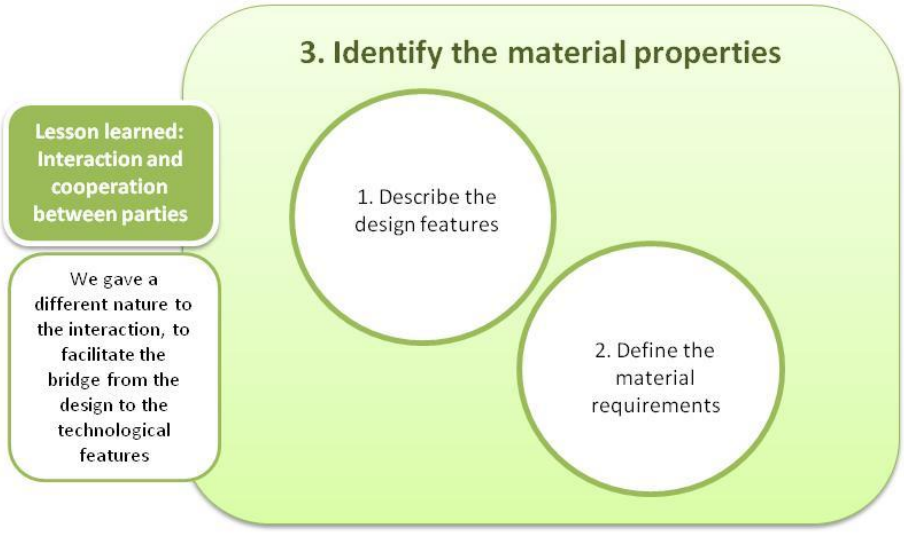


Figure 8.5 - The Proposed Process: Identify the Material Properties

As anticipated, the final output of the research is the result of an initial process refined with the *lessons learned* coming from the action research (Figure 8.6). We enriched the first model with insights originating from criticalities by Light.Touch.Matters partners, adding steps and tactics in order close the gap emerged (Figure 8.3, 8.4, 8.5). Below we present the lessons learned got from Light.Touch.Matters, defining the issues and the relative results.

Issues	Expected results	Actual Results
Information exchanged	Enough sharing of information to make actors aware about the potentialities of technologies.	Lack of information, especially regarding strengths and weakness of technologies. Not enough data related to the state-of art of the technology in terms of enabled applications.
Transition from user experiences to material requirements	Proper material requirements are defined from the association to the design features.	The gap between the abstractness of the experience and the concreteness of the properties was too large. It is an excessive logical leap.
Interaction and cooperation between parties	The effective dialogue between the sides is guaranteed by an action-reaction interaction.	The action reaction interaction did not work and the effectiveness of the dialogue was compromised.

Figure 8.6 – Lessons Learned Details

Finally, we also introduced an example in order to support the comprehension of the concepts presented. The example comes from an application ideated by *Berlo,* one of the design agencies involved in the Light.Touch.Matters project, that going through the steps of the Action Research proposed a concept of device that monitors the sleeping cycles and informs people (particularly people like elders that have trouble with day-night rhythm) about the correct time to get up. So in parallel to the description of the process, the evolution of the "*Night Guide"* from the change of meaning to the identification of the material properties supports the discussion.

8.2.1 Generate scenarios of meanings

The first phase of the process bases on the idea that *meanings* are significantly context-dependent. What is meaningful for users depends on the *socio-cultural context* in which a product is used, something that may vary considerably over time and space. This initial phase focuses on what is considered valuable in a specific environment, defining what is "*meaningful for people*" — why people do things, comprehending the unspoken aspirations and values associated to the examined world.

The output of this initial phase is not an idea or a solution, but, rather, a scenario; more precisely, a *scenario of meanings*. Scenarios of meanings contain new needs and aspirations that users imagine they could have in the new environment built up on new technological opportunities. Scenario of meanings comes from a redefinition of behavioral patterns due to changes in context strictly linked to culture, society and technologies. New scenarios enable the creation of breakthrough applications. Furthermore a scenario can be a report, but most often it takes the form of a mood board or a storyboard, tools widely used by designers.

This first phase is made up of different steps that lead to new different understandings of the context, bringing possible interpretations of what could be meaningful to users:

1. *Explore the context;*
2. *Describe new scenarios;*
3. *Consolidate emerging scenarios;*
4. *Describe business opportunities, social impact and existing competitors related to the new meanings.* ***– From Lessons Learned***

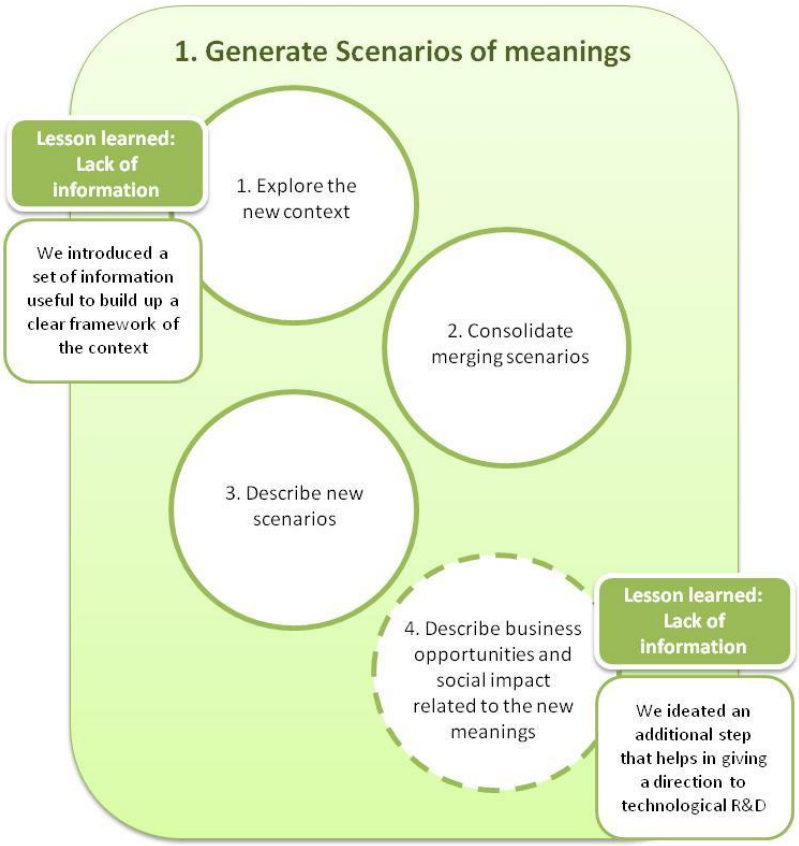


Figure 8.7 – Step 1: Generate Scenarios of Meanings

Step 1 - Explore the new context

The first step of the initial phase is represented by the exploration of the context. The environment is built up on soft and hard aspects. Particularly the information needed in order to draw a complete framework decomposes in three different elements:

- *Technological opportunities*
- *Cultural aspects*
- *Social elements*

The first information category is particularly critique: one of the lessons learned coming from the action research highlights the importance of the *comprehension of the specific features and possibilities* related to the technology at hand. It's fundamental to gather numerous data regarding the strengths and weakness compared with alternative technologies, identifying added values and limits. It is also necessary to specify the state-of-the-art of the technologies, reporting and describing

the current enabled applications. This information should be provided by researchers with a no-specialized jargon, using a language accessible to designers in order to generate solid and interesting scenarios. Through the action research we noticed the high level of criticality that takes place during this first iteration between technology researchers and designers. Aiming at ensuring an adequate information exchange, we positioned the golden coins game at this initial point of the process: it is fundamental that each actor in the innovation process is aware about technological main features and potentialities. The other two elements represent the soft side of the information, fundamental to intercept the macro-trends that define the landscape of the environment at hand. Companies may use different tactics in order get these data: the network represents the most effective tool. Through interactions with other companies, research centers, universities and scientific committees, companies could study the evolutions of society and culture that could impact their current and prospective client markets. By analyzing the evolution, the organizations may investigate how trends would affect the lives of people. The deep comprehension of these aspects — *society, culture and technology* — support designers in understanding the context in which to identify new values and needs. Meanings cannot be innovated by focusing on the details of a product or technical problem. In order to facilitate the next step we propose a decomposition of the context in sub-areas of interest on which build up scenario of meanings. In the "*Night Guide" example* the selected context of healthcare and well-being has been decomposed into 4 different areas: personal care and beauty, trauma management, are they (elderly people) really frail and finally extreme problems.

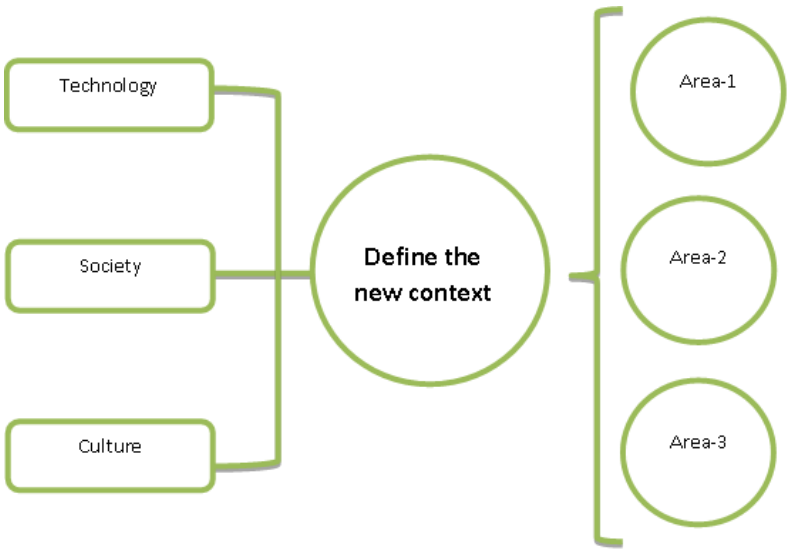


Figure 8.8 – Definition of the New Context

Step 2 - Describe new scenarios

The second step is represented by the definition and description of new scenarios of meanings on the selected areas. This phase is not focused on concrete solutions or technologies, but rather on *unspoken aspirations and values*. Designers should envision new user needs from the environment built up in the previous step, defining what would be meaningful for people in the context outlined. This task requires interpretive skills and the ability to define potential needs in the absence of explicit elements of comparison.

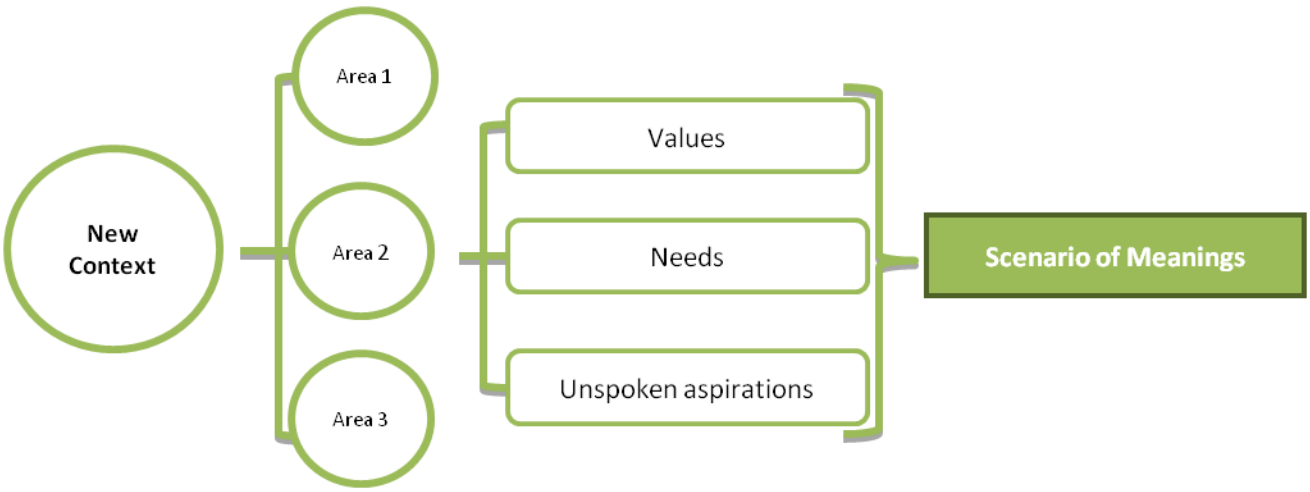


Figure 8.9 – Components of Scenario of Meanings

Step 3 - Consolidate emerging scenarios

The last phase deals with the consolidation of emerging scenarios of meanings, leveraging on the potential of the technologies at hand. It is made up of three different points:

1. Find out changes of meanings: from a current meaning to a new one
2. Define *key features* supported by enabling technologies, following the path: new meanings, key features, enabling technologies
3. Give exemplar ideas

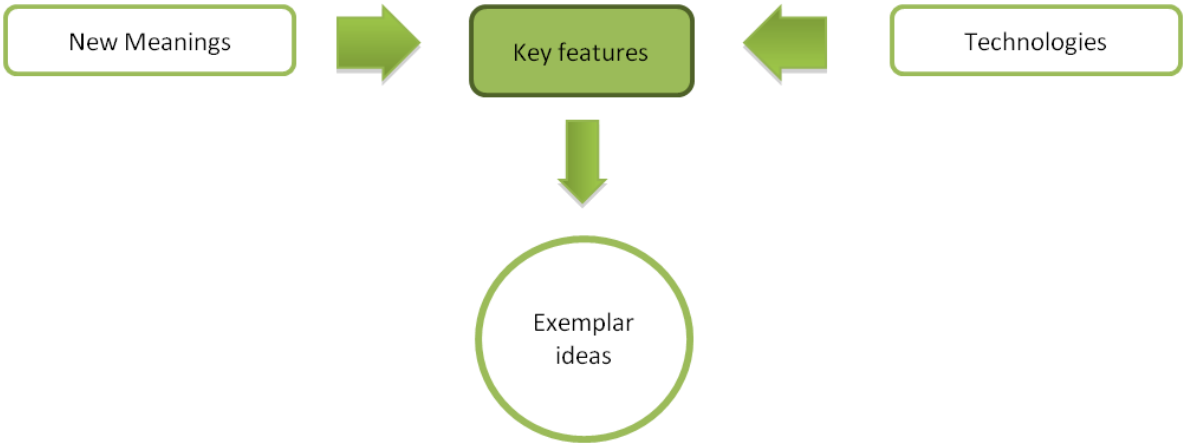


Figure 8.10 – The Definition of the Key Features

The first point is focused on the radical change of meanings. As anticipated in the initial part, customers make sense of a product or service according to their psychological profile, and of the cultural and social context in which they are immersed. Innovation of meanings works on a higher level and with a broader scope: it redefines the purpose and the utility of a product, by reinterpreting its relationship with the context. The radical innovation of meaning implies an act of proposing. 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 act of interpretation of new meanings is not based on the discovery of what is already there, but on a deliberate creation of new interpretations that do still not exist. It is not an act of seeing better, but of envisioning, of conceiving a new possibility (Verganti, R., & Öberg, Å., 2012). We provide here an example of changes of meanings, using the "*Night Guide"* case:

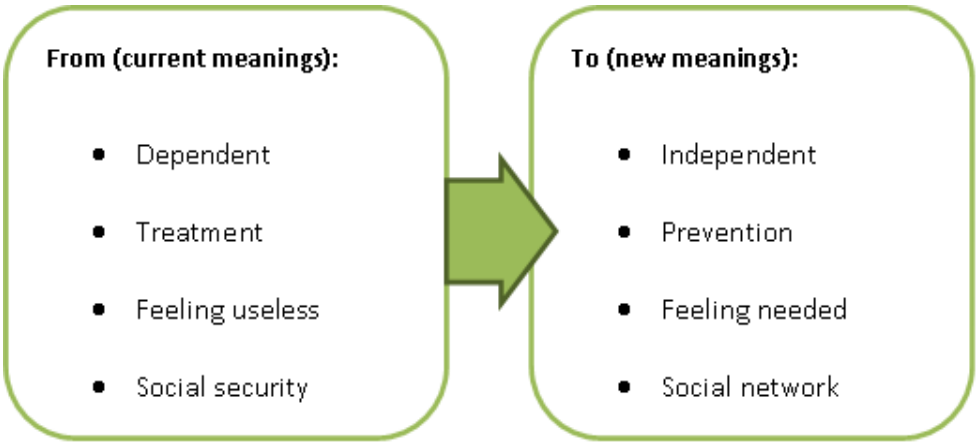


Figure 8.11 – Changes in Meanings

The second point is about the definition of key features supported by enabling technologies. In other words this step consists in mapping the key features linked to new meanings, that can be achieved through the use of the technologies at hand. These key features represent the bridge between technologies and new meanings; they are the performances the technology should ensure in terms of user experience. Finally in order to concretize the concepts dealt, it is recommended to give an exemplar idea of the potential solution the company has in mind. Obviously the solution has not to be defined in detail, it is not intended to be the final one and it is purely indicative. This final point could be skipped if the company does not have any idea in terms of final application.

Step 4 – Describe business opportunities and social impact related to the new meanings - ***From Lessons Learned***

This last step aims at identifying the impact of the new meanings on the business and social side. At this step it is important to provide the *potential business and social impact* of new meanings, defining how new interpretation and new possibilities can affect the context. This requirement comes from the lessons learned of the second workshop, in which material researchers complained about a lack of information. This step has been introduced in the process in order to grantee an effective exchange of information. In addition data about social and business impact can guide the development of the materials, giving the direction and priorities to the technology R&D in the process.

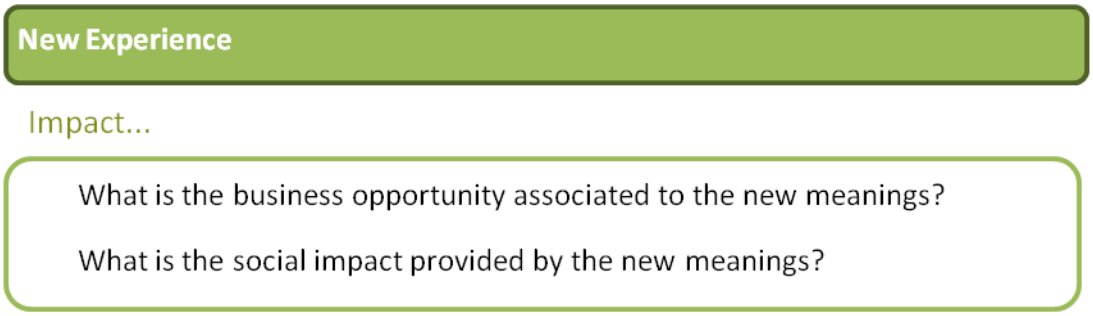


Figure 8.12 - Business Opportunities and Social Impact Related to the New Meanings

8.2.2 Envision promising new experiences

Users acquire meanings and not objects per se. On this concept is based the determination of *user's experience*: they directly stem from the meaning provided by product. This phase aims at creating experiences and situations based on new meanings previously defined. During this step the envisioned meaning is enriched through concrete elements about the final users and the context of use, defining a new experience. Elements elaborated in the generation of new scenarios are refined in order to propose experiences that can embed the new meanings envisioned.

This phase includes three precise steps:

1. *Select new meanings, choosing the most interesting ones that can be celebrated thanks to the new experiences;*
2. *Define new promising experiences through the entire product experience, focusing on the context of use in which potential applications will be used;*

3. *Add product-user interactions related to the experience, that give a more concrete acceptation to the experience itself -* ***From Lessons Learned***
4. *Describe business opportunities, social impact and existing competitors' solutions related to the new experiences -* ***From Lessons Learned***

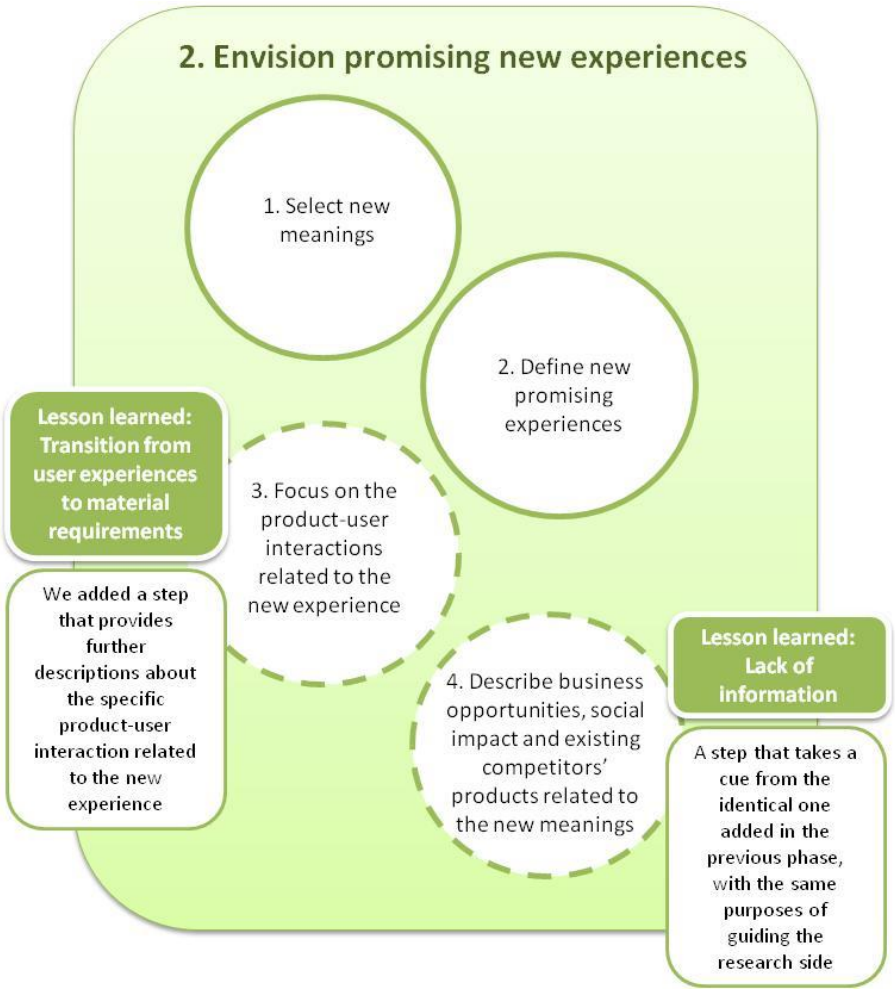


Figure 8.13 – Step 2: Envision Promising New Experience

Step 1 – Select new meanings

This step represents a sort of refining of the similar step in the first phase. During this step it is required to select *a set of meanings*, from a list generated in the previous phase, which converges towards the definition of a unique experience. From a set of meanings related to a precise area of the

context — coming from the step 3 "consolidate emerging scenarios" in the first phase — to a selection of certain meanings that represent the ones strictly linked to a specific experience.

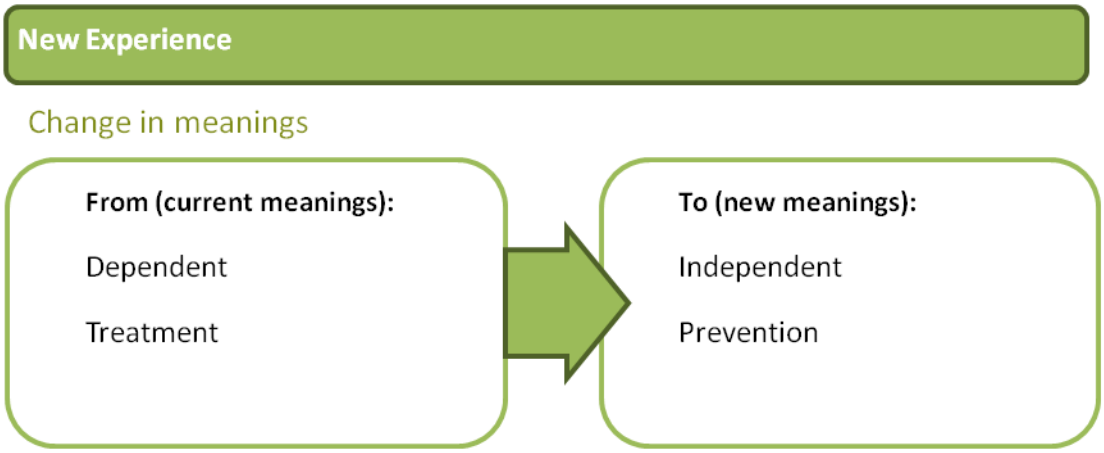


Figure 8.14 – Selection of New Meanings

Step 2 – Define new promising experiences

The experience to be drawn in this step is related to the interaction that users have with the product. It takes place on the dimensions of aesthetics, associations and emotions. So, the analysis focuses on *the meanings* conveyed by the final solution, together with the *aesthetic impact* (how the product is perceived through senses) and *the emotional impact* (which are the user's feelings in interfacing with the product).

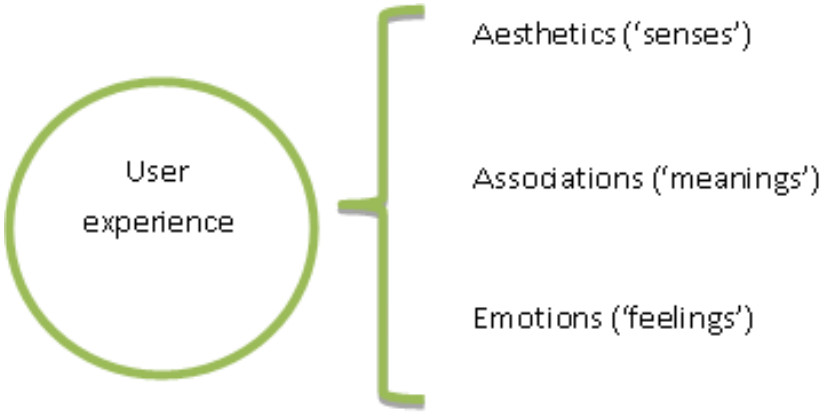


Figure 8.15 – Components of the New Experience

Meaningful material experiences can be assured when experiential components (sensorial experience, experience of meanings and emotional experience) and their interrelationships are fully understood. Cultural probes are usually indicated for the representation of these kinds of ideas. They describe people`s daily life, expectations and preferences and help designers in defining the experience. Whatever method is adopted, the aim is a unique one: defining how people live a precise experience, with focus on the enablement of new meanings. In the *Night Guide* example, the experience described has an old lady as main character. She goes to bed, wakes up during the night and gets a hint that it is not yet time to get up. She wakes up in the morning and the system gives feedback that it is OK to get up. The interactions users-product are: aesthetics (a soft and warm product), association (a friendly and reliable product) and finally emotions (product should convey meanings like feeling happy and relaxed).

Step 3 – Add Product-user interactions related to the experience - From ***Lessons Learned***

The lesson learned from one of the workshops evidences the shortage in concrete elements related to the experiences and this represents a strong hitch for the identification of material requirements. To achieve the objective of facilitating the translation from experiences to requirements we need to decompose the process into smaller steps. We introduced an extension of the description of the experience that defines more concrete aspects. It relates to the performances we described in the Process Framework and reports more specifically the modes of interaction with the product involved in the experience. This step is a pre-understanding of the characteristics linked to the design features, which were before the only intermediate element between experiences and requirements It does not provide concrete features (that are to be provided in the next phase), but gives indications about the “how”, “when” and “why” the user should interact with the product. This because, particularly when the process involves the use of completely new technologies, there is the risk that the technology itself stays disconnected from the user experiences, because of an absence of elements that enable the shift from the abstractness of the experience to the concreteness of the technology. We do not have any example from the Light.Touch.Matters project, since this was a lack in the process. We can imagine that elements belonging to product appearance could be: *wearable* (a sleeping mask, a hat,

headband, earpiece), *moveable object* (cuddle toy, bed sheet, pillow or other fabric part of the bed), or s*tatic* (fixed light armature, side table, (part of) bed frame). The Interactive characteristics could be represented by: Daily interactions during the night; Interactions only when needed; Gentle, calm during night (dim light, slow fading (warm) color, slow moving color); Ambient monitoring; Sensing body movement; Visual feedback.

Step 4 – Describe business opportunities, social impact and existing competitors' solutions related to the new experiences - From ***Lessons Learned***

This last step takes a cue from the lack of information that came from the lesson learned identified in the first phase. The impact of the new experience on the business and social side is identified. In parallel, existing products/services that could satisfy the envisioned experience are reported. The object of this additional step is to finally fill to lack of information we identified in the first phase "Generate new scenarios of meanings", providing the same issues with the same questions, but based on a different subject: the new envisioned experiences.

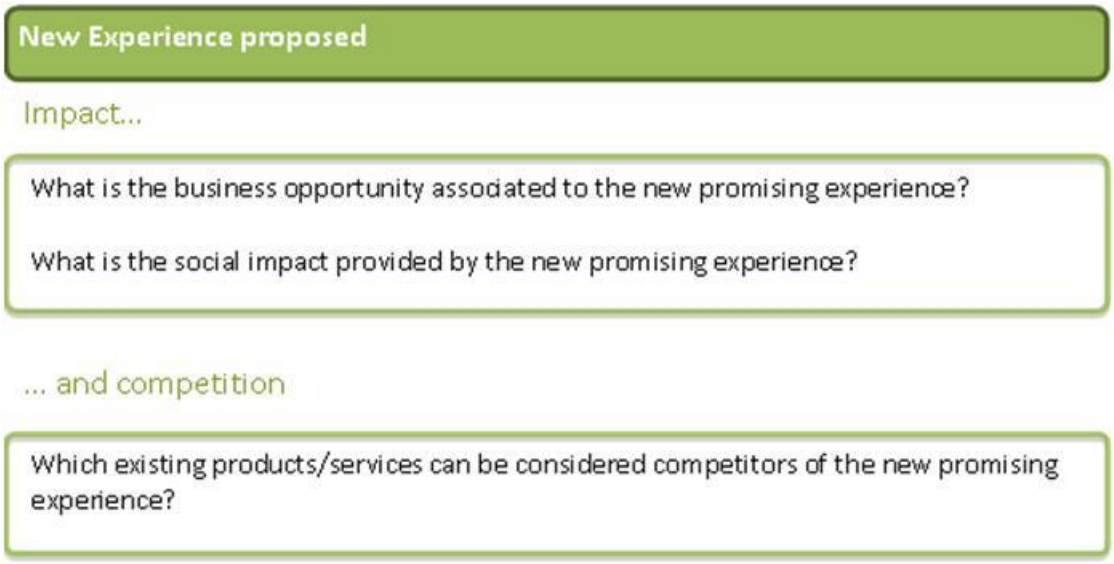


Figure 8.16 – Impact and Competition Related to the New Experience

The first question brings into the analysis the consideration of the impact on *markets, potential customers, opportunities and risks* linked to the market of products related to that particular experience. The social impact deals with soft aspects that will probably influence *society* because of the different meanings intercepted. Finally the last question aims to identify possible *solutions already existing* to satisfy that precise experience. It is not said that there is an answer for this last question. Actually, it is even more interesting when existing products are hard to find, because it means that there is a high chance that the process is oriented towards Blue Oceans.

At the time we noticed this lack of information, the workshop 03 still had to start. Consequently, while we missed this information in the first phase of generation of meanings, we actually had the possibility to implement this modification in the second phase and obtain a concrete answer. In the "*Night Guide"*, in particular, the Business opportunity associated to the new promising experience was:

- The target group of Alzheimer patients that have trouble with day-night rhythm will be growing in the near future;
- Getting up in the middle of the night easily causes injuries that lead to high health care cost;
- Less injuries reduces health care cost insurance companies will be interested.

The Social impact provided by the new promising experience was:

- Less injuries is better self-esteem;
- Longer independency makes people happy;
- Lower chance for injuries = feeling of safety.

The Existing products/ services that can be considered competitors of the new promising experience were:

- Wake up lights;
- Light goggles made for bio-rhythm therapy;
- Apps to analyze and influence sleeping behavior.

8.2.3 Identify the material properties

The objective of this last phase is to explore the material properties necessary to invoke the new experiences. These are the properties that will be the focus for, and give direction and priorities to the material R&D in the process. This step is the input of the product design phase, including the generation of the design brief. After the definition of user experiences and material requirements the design brief can be completed, providing a faithful guide for the final phases of the process.

The steps involved in this phase are:

1. *The description of the design features that come from the interpretation of the experiences proposed;*
2. *The definition of the material requirements, bridging the gap from experiences to properties and identifying the product characteristics linked to the design features;*

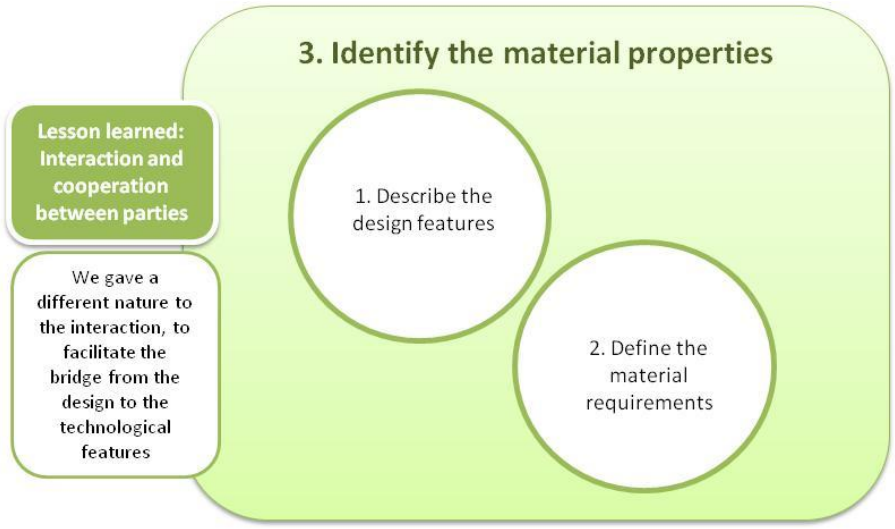


Figure 8.17 – Step 3: Identify the Material Properties

Step 1 – Describe the design features

A product experience results from the interactions the user has with product. These interactions are enabled by specific characteristics of the product itself, which will be identified in the specific requirements and connected to the experiences through the design features. So, the design features act as a bridge in this transition from experiences to properties.

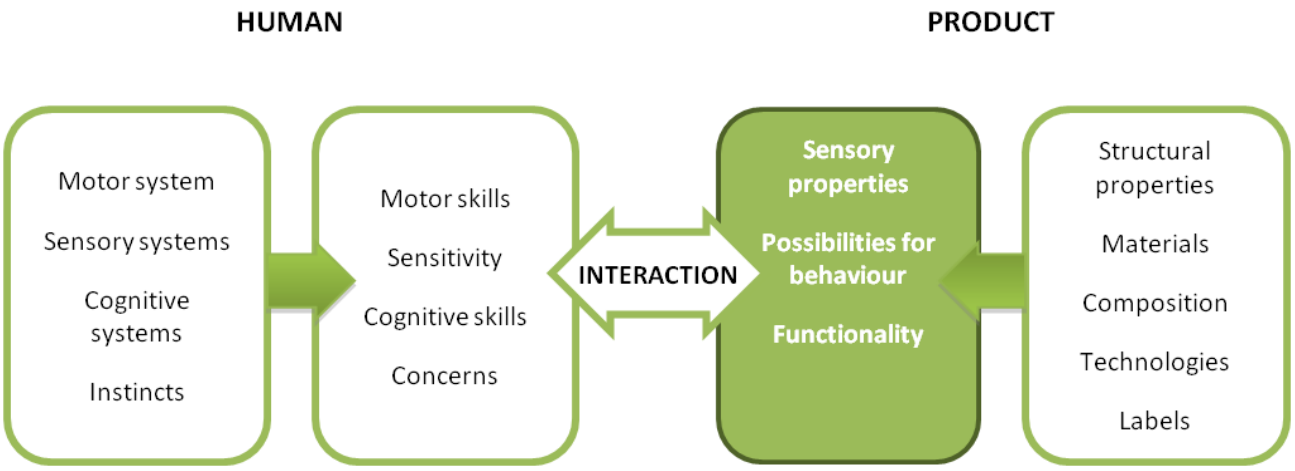


Figure 8.18 – Human – Product Interaction (N.J. Schifferstein, 2008)

The green column in the graph by Hendrik N. J. Schifferstein (2008) represents our idea *of design features.* It links the human side to the most technical side of the product. The design features can be defined thinking about what experiences are meant to offer to people and consequently thinking about the product characteristics that enable them. For example, the design features for the *Night Guide* are colour changing, luminosity, shape changing and sensitive to touch.

Step 2 – Define the material requirements

The *material requirements* are the enablers of the experiences. They represent the concrete aspects related to the product/technology that make emotions and feelings involved in the experience happen. They are strictly connected to the design features but they deal with the physical and more tangible aspects of the product. In the "*Night Guide",* for example, the design features expressed before, translate into material requirements of OLEDs and Piezo Materials that are: thermoelectricity, mechano chromatism and electroluminescence.

Obviously there is an unbalancing between the steps of defining design features and material requirements. Even though they are strictly connected, the first one is more a “design job”, while in the second one there is a greater contribution from the technological side. However, as previously discussed, in the first test of the process it was difficult to define concrete material requirements. Primarily because there was not a clear idea of the characteristics of such a new technology and secondly because the conceptual gap between the abstractness of experiences and the concreteness of the requirements was too spread and difficult to cover in one single step. It was hard because the interaction between the design and the technology side was set on a dialogue “action-reaction”, so that the designers were first supposed to imagine the design features and then the material researchers should have provided the requirements to give an answer to those features. The *interaction and discussion* between the parties needs to be more a “*bit by bit”,* so that both the steps of this phase are faced from both the design and technology side. This means that the workshop or meeting to be handled in order to complete this phase needs to focus on an open discussion and confrontation. In this way the designer-researcher dialogue is facilitated, continuously communicating and refining design solutions and material specifications.

CHAPTER 9

Conclusions

After the Final proposal has been stated, this final conclusions wrap-up the all work. In particular, this chapter is a synthesis of the main objectives and results. It starts with the recap of the issues that represented the engine of the research and brought to the definition of the leading research questions that guided the analysis. The definition of the overall results follows, describing the output of the thesis. The conclusions end with the definition of the extent of the work, considering that the topic we dealt with is part of such a spread field. We obviously faced limits, some in course of work, some others downstream the research, but we also found in those limits the opportunities for the near future and the follow-up for our dissertation.

9.1 Research objectives

The thesis is part of an extensive research project, whose objective is the analysis of the innovation process and in particular of the methodologies that lead to the identification of successful applications. In particular our dissertation is placed in the literary stream of innovation driven by design. The research described studied the links between technology and design, exploring the connections among user needs, product functions and meanings. Specifically, we focused on the fact that:

"*Technologies offer opportunities, which are of course not infinite, but are greater in number than those imagined by early developers*". As stated by Proni (2007) technologies unveil numerous possibilities, especially in the initial stages of the development. A multitude of these opportunities represent functional improvements and technology substitutions, producing a limited value compared to the specific technology full potential. This concept explicates the central problem of the thesis: the missing valorisation of technologies and the restricted application horizons identified by companies. Particularly the dissertation aims at defining a compelling strategy to valorise existing and new technologies, together with a process to implement the strategy, that companies need in order to exploit the technology full potentialities, identifying new application fields. In order to specify the purpose of the thesis we set two research questions, presented below:

- ***(RQ 1)**: Which strategy can guide companies in valorising existing and new technologies, in order to identify new application fields far from the traditional ones?*
- ***(RQ 2)**: Which is the process that companies need in order to identify novel applications enabled by existing and new technologies?*

The final proposal is intended to provide grounded and solid answers to the two questions that guide the entire research.

9.2 Main results

The research work ends with a proposal that aims at answering the research questions initially defined on the base of the outlined thesis objectives. The thesis output consists in a new methodology for finding new applications, starting from the opportunities offered by technologies. We first defined a strategic approach that guides companies toward this objective, then bringing it into practice and proposing a methodological process that allows to govern this approach.

In our proposal, from the strategy side, the innovation moves on three dimensions: *meanings, technologies and markets:*

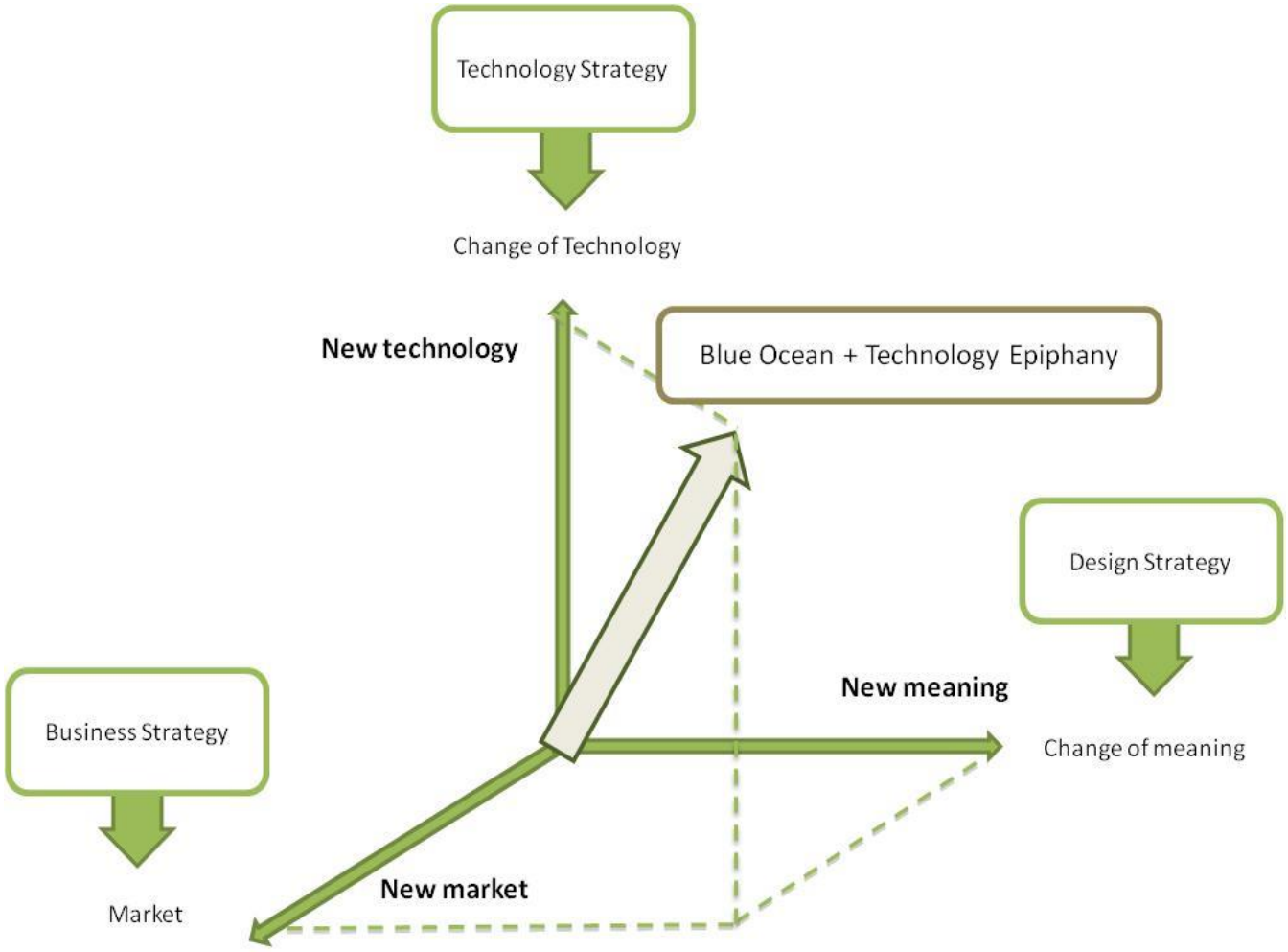
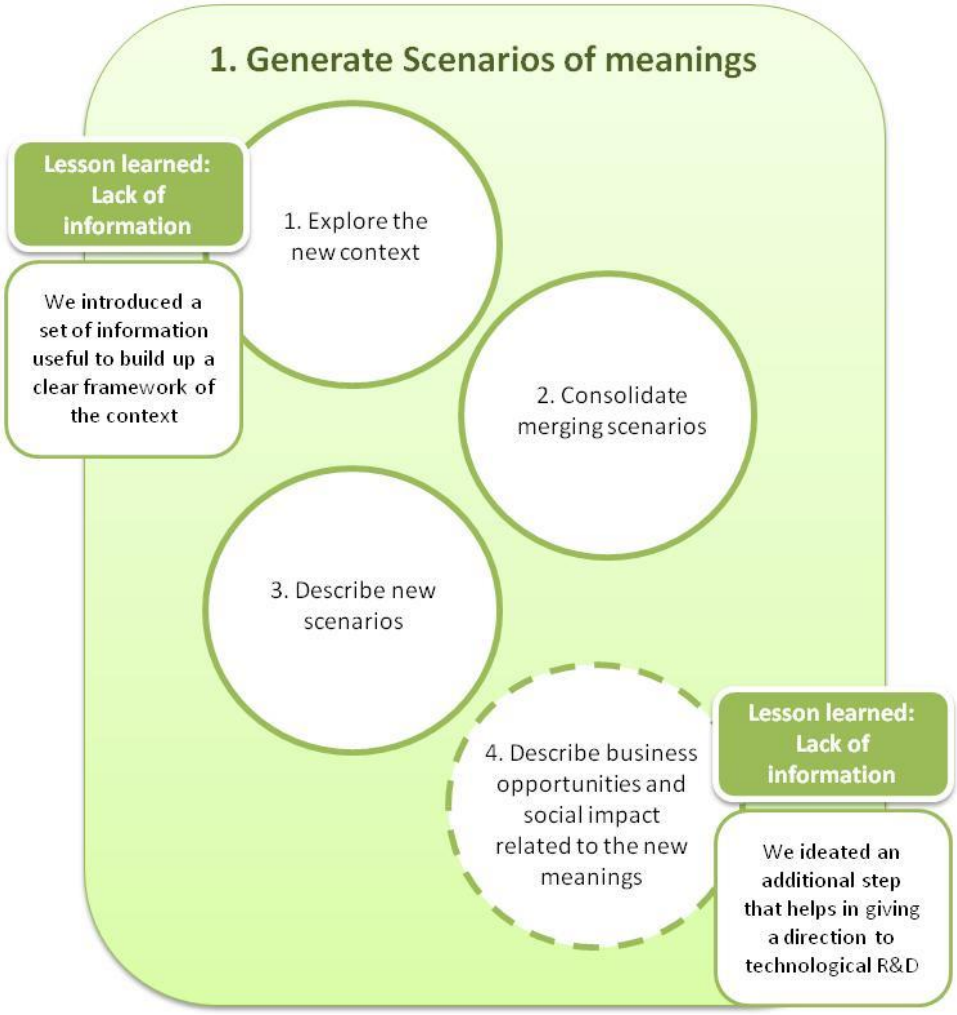


Figure 9.1 – The Proposed Strategy

The path proposed bases on the concept that radical innovation stems from a combination of new meanings enabled by new (and existing) technologies, which supports companies in facing new markets. The key concept of the final strategy is represented by the idea that each technology embeds a set of meanings. Meanings broaden the concept of technology itself, enriching the conception of a mere tangible material and seizing the technology full potential. Furthermore change in meanings offer the possibility to approach a totally new market for the company: new meanings are the enabler of untapped industries, unlocking a mass of customers that did not exist before. The strategy proposed merges two basic elements of different approaches. The first one is the concept of Technology Epiphany: it represents the output of the interplay between technology-push and design-driven innovation in which technologies become enabler of new product meanings. The second one is the cornerstone of Blue Ocean strategy: an organization should create new demand in an uncontested market space, or a "Blue Ocean", rather than compete head-to-head with other suppliers in an existing industry. In order to grasp the full potential of technologies, companies should work on both soft and hard aspects.

The subsequent and more concrete output is the translation of these reflections into a procedural methodology that companies need in order to valorize existing and new technologies, identifying novel applications. The methodology bases on the implementation of an innovative process that does not screen market opportunities, searching for existing needs, or technology opportunities related to technological substitutions. The proposed process (Figure 9.2), instead, starts from the generation of new scenarios of meanings, which represent the innovation triggers in the strategic approach defined. The abstractness of the first phase is translated into concrete features through the envisioning of new experiences, defining the relevant aspects of the product-user interaction. These aspects turn into material properties identified in the last stages, completing the output of our thesis and providing the input for the subsequent phases of product generation. The whole process is also thought in a way that enables designers and engineers to work together, enhancing that interplay between design and technology, enabler of new application fields.

This final proposal is of course limited by time and resources, as described in the next paragraph, but it also provides interesting insights and follow up for the next generations of research on this topic.


1. Generate Scenarios of meanings
Lesson learned: Lack of information
We introduced a set of information useful to build up a clear framework of the context
1. Explore the new context
2. Consolidate merging scenarios
3. Describe new scenarios
4. Describe business opportunities and social impact related to the new meanings
Lesson learned: Lack of information
We ideated an additional step that helps in giving a direction to technological R&D

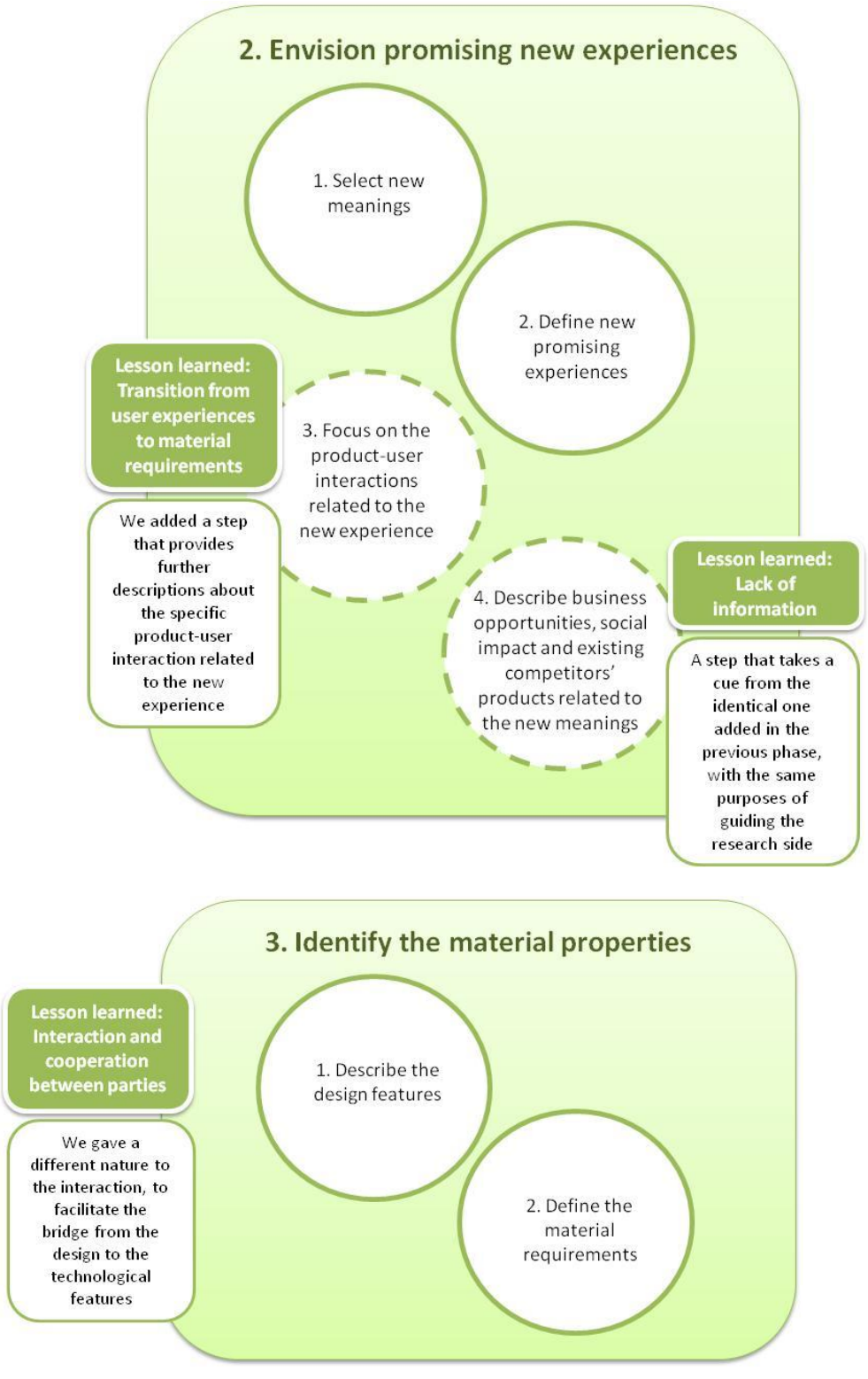


Figure 9.2 – The Proposed Process

9.3 Limits and follow-up

After the discussion of the thesis had been done and the conclusions directly related to the research had been provided, in this last chapter we want to define the extent of our work. There is a lot of information that exists around the topic we dealt with and obviously we cannot include all. In relation to this fact, we need to face some limits that are directly related to our research.

The most evident one is the temporal limitation that characterized our participation to the Light.Touch.Matters project. We were involved in the consortium for a period of time of 9 months, from February to October, while the whole project will last an additional 33 months .First we missed the first cycle closure, not being involved in the generation of product concepts and the final stage of evaluation and learning. Second, we are not able to verify if the changes we implemented in the process actually work, since we will not participate to the iterative cycles. In fact, the most characterizing feature of the second and third cycles scheduled in Light.Touch.Matters is the possibility to learn from the previous iterations and improve both the process of innovation and the final output of the project. For the reasons linked to this limit, the methodology proposed reminds to the objective that is only in part involved in the new product development process: the first part of exploration of the context, generation of ideas and definition of the main guidelines for the product construction. Rather than being a method for generating brand-new products, our methodology is the concrete input for the product concept generation. Obviously this does not have to be a stop, but rather a “handing on of the baton” to a second generation of researchers. It would be very interesting to resume the Light.Touch.Matters methodology in order to investigate the phases immediately subsequent to the topic of our thesis. We are convinced that the Light.Touch.Matters still as much to offer in terms of insights and reflections on the theme of innovation driven my meanings. It is a unique opportunity to work closely with all of the stakeholders of the project, collecting intermediate outputs, comments, shared ideas, that were essential for our research and will be at least equally important for further works.

In addiction a reflection can be made on the concrete application of our work. Our thesis focuses on material technologies: the research does not consider additional areas of investigation. The research

could be widened, so that the methodology proposed could be adapted and set in order to valorise the potentialities of other types of technologies. In this way it would be possible to generalize the concepts behind the thesis, making them available for inhomogeneous contexts. For example, the focus of the analysis could be shifted from hard technologies to soft technologies, studying how to shape the outcomes of the thesis on intangible entities. It could be interesting to understand how to expand the horizons of our research, redesigning the process on a specific *software technology*, drafting the path towards the valorisation of its potential. *Process technologies* are also an interesting research field: since the scope should be to spread the possible applications of the designed methodology, it could be interesting to study a field that is probably one of the furthest applications from ours. Obviously the all process is far from being simple; it is necessary to conduct case studies and tests in order to develop a compelling methodology that supports companies in maximizing the process performance, exploiting the full potential of the technologies behind. The thesis basic concepts could be translated into different spaces, redesigning the methodology and proposing additional elements.

Concluding, this dissertation is a first step towards opportunities and follow-up that will come: our methodology not only transfers a method, but it also offers insight and suggestions to next research generations, providing an input to the future analysis focused on innovation processes characterized by high complexity and considerable originality.

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