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A VALUE APPROACH IN INNOVATIVE PRODUCT DEVELOPMENT: ARE CONVENTIONAL METHODS AND TOOLS SUFFICIENT?

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1. Introduction

In today's literature, the concept of innovation is acknowledged as being very important for the subsistence of any company, as it can provide competitive advantages, help increase margins or give access to new markets. However does this mean that innovation is always good or should always be a prime concern? This may depend on the industrial environment of the innovation considered. Can the new values created for the firm and its partners by the innovation make up for the risks and the changes related to its development?

In the aeronautic industry for example innovation can be very complicated. Depending on the criticity of the system, the expectations in terms of reliability can be extremely high and innovation a difficult challenge. An indicator of this criticity is the design assurance level. It ranges from A (catastrophic) to E (no effect) [Radio Technical Commission for Aeronautics and European Organization for Civil Aviation Equipment 2000]. A firm producing system with high criticity knows it will have a very hard time to convince the certification authorities and their clients that their new products will work as well as the previous ones. As a consequence, most new products have important similarities with the former ones in order to decrease the points that need to be re qualified. But how should a company deal with an innovation radically different from what it has been doing in the past? Specific approaches and tools exist to manage the transition from the old product to the new one. Are they always adapted to every industrial context? Innovation is often presented as the result of a well defined process including analysis of the customer's need, conceptual design, detailed design, etc. But everything does not always go according to this theoretical scenario. In some cases, innovation comes from an idea that is believed to have some potential. What kind of approach can be adopted in such cases?

In the following article we are going to study the case of an aeronautics integrator developing an innovation significantly different from the products they usually sell. This company belongs to a major American group. The systems they produce have a B design assurance level. In this study we choose to focus on the values created by the products since its increase is the factor that can enlighten us on the appropriateness of innovation. The question of cost analysis is voluntarily left for the future. Studying cost requires a defined industrial solution and we want to keep every option open. During the first step of this study we are going to investigate what are, according to the literature, the different kinds of values that can be created by a company. We will then present our industrial context. On the one hand we will expose our analysis of the enterprise and innovation based on a former study using systemic analysis. On the other hand we will discuss various interviews carried out in the firm. Based on this duplicate analysis we will list the characteristics that any method must respect to be fitted to our particular case: the capacity to take into account multi-dimensional independent aspects. The third step will be to identify and characterise some of the existing tools used in industrial engineering to

manage the value created by a product and the supply chain that manufactures this product. We will then determine the appropriateness of these tools for our situation. We will show that the classic methods are not sufficient to design the new organization to provide the new product when the innovation is too different from the original product in terms of technical nature and of value created. We will then present the approach we promote for the conception of a new system. Finally we will conclude on its limits and on the work that needs to be completed in order to have a satisfying tool.

2. Literature overview of the concept of value

As we have seen, the values that are going to be created or destroyed by our innovation are a key factor when it comes to the decision of launching or not the innovation. Is seems then essential to define precisely what kinds of values we are discussing.

Value is a notion on which every organisation management or tool is based. Maximizing the production or minimizing its destruction is always the objective of any such structure. This value is crucial to the survival of the organization and depending on the type of organization, it can take different forms. According to the AFNOR [AFNOR 1996], value is "*the judgment passed on an object based on the user's expectancies and motivations formulated in a quantity increasing when all things being equal, the user's needs fulfilment increases and/or the expense related to the object decreases.*"

For a long time, enterprises adopted a taylorian point of view regarding value. In a context where demand is much greater than supply, the economic value was the only one taken into account with a focus put only on costs and profits. With the supply increasing, the need to diversify from competitors gets bigger and the signification behind the term "value" broader. It begins progressively to include quality and on time delivery [Lebas 1995].

The meaning of value evolves then with the economy. With the introduction of the concept of knowledge economy, new kinds of value appear: knowledge, know-how, innovation… [Le Masson et al. 2006]. With supply chains getting more and more complex and the apparition of outsourcing, the quality of communication between actors begins to be also taken into account as a potential value for companies [Eckert and Clarkson 2004].

Finally, the increasing focus put on the notion of sustainable development during the 1990s made firms understand the capacity they have to create or destroy societal values. Now, notions such as social, environmental and ethic performances and employee satisfaction are prized inside a company as a competitive advantage [Déjean and Gond 2003].

The conclusion of this analysis is that value can take different forms. A same object can create different values for different stakeholders. In the following of this article we are going to analyse our industrial context, taking good care to determine which kind of value is created and who is the stakeholder impacted.

3. Industrial context analysis

The case we are studying is a small aeronautics integrator, part of a major American group. This small firm has developed a new technology related to the extinguisher equipping the aircraft. The use of this technology can give the company a competitive advantage.

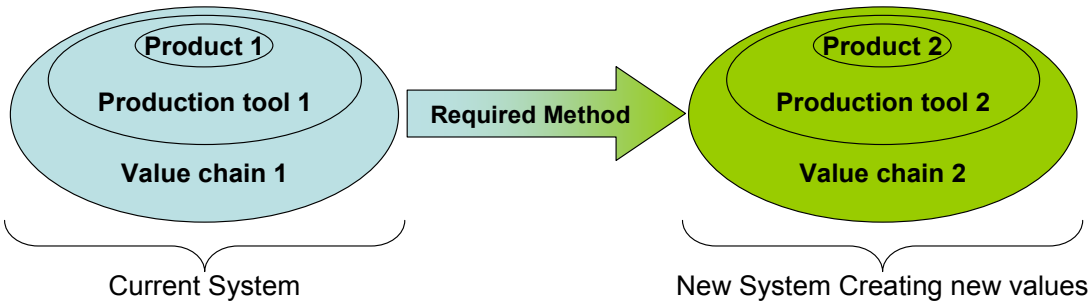

Figure 1. Required methodology perimeter

Management wants a method that will help them manage the technology developed. This method must englobe the supply chain, the production tool and the product and give keys to determine if the risks that launching the innovation represent are worth taking. We are going to use the concept of value chain, developed by Porter [Porter 1986]. The method must also tackle the form this value chain must take in order to minimize these risks and maximise a value creation adapted to the strategy of the firm (see figure 1).
Our first action will be to analyse the industrial environment to determine the criteria this method must satisfy to answer these questions.

3.1 Previous works on the subject

Our previous research [Petetin et al. 2009] on the topic have focused on the characteristics of the innovation studied and on the analysis of the firm that wants to develop it. The characteristics of the innovation were studied through an analysis of the criteria employed in the literature to classify the different types of innovation. This enabled us to determine the key characteristics of our innovation: a high technical incertitude and the radicalism of the innovation for the firm.
The characteristics of the innovation being known we concentrated on the firm developing it. We used the modelling of an industrial system [Bocquet and Schindler 2008] based on the works of LeMoigne [LeMoigne 1990] to represent the industrial system we are studying. Thus we obtain a structured representation of the company based on four different views: teleological (what is the purpose of the system), ontological (what constitutes the system), functional (what does the system) and genetic (how does the system evolve) (see figure 2).

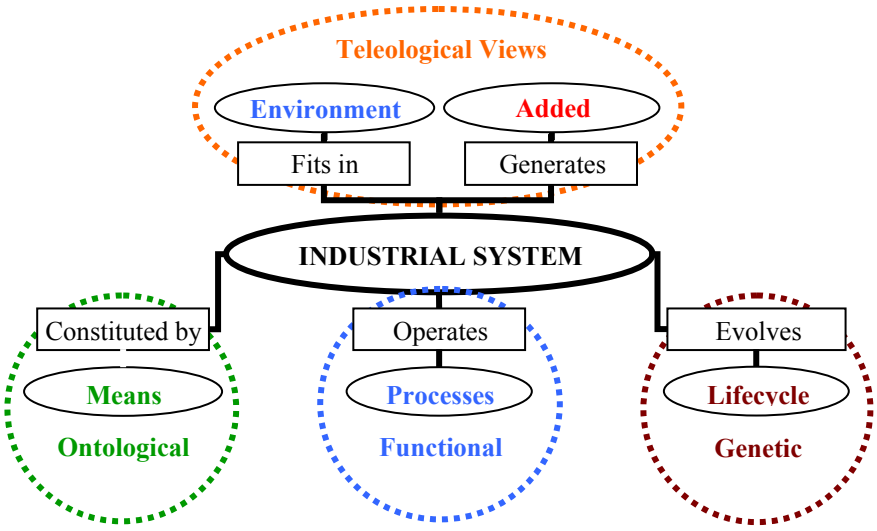

Figure 2. Systemic analysis of an industrial system [Bocquet and Schindler 2008]

We then crossed this representation of the firm with the characteristics of our innovation to assess the different sectors that would be impacted by the innovation. The result of this study showed that all the different systemic views of the industrial system were impacted by the innovation:

- Teleological view: the product available on the market is going to be radically different from the products manufactured by competitors.
- Ontological view: Because of the highly technical nature and the radicalism of the innovation, the knowledge required to develop and produce it are new for the firm and not available internally. Moreover, for the same reasons, the firm does not possess the material means required to produce the innovation.
- Functional view: first the design process of the firm (appropriate for incremental innovations) and then, naturally, part of the production process will need to evolve in order to be adapted to the new situation. This evolution could be limited to the internal level or involve other solutions (externalization, external growth, etc.).

- Genetic view: in addition to all the impacts listed above that will induce mutations in the firm (hiring, technology acquisition, external growth…), the development of the innovation will also impact the strategy of the enterprise, the aim being to increase the firm's marketshare and to make it reach a size which would be more fitted to its situation (fixed cost, etc.)

All these factors, impacting the operational, tactical and strategic levels, show that the introduction of the innovation must be carefully done. Dedicated tools, able to deal with all these points simultaneously (since the related decisions are not independent) must be used. These tools must also be able to deal with the depth of the different changes listed. The value focus we chose to adopt conducted us then to investigate further the teleological view. This was carried out through series of interviews inside the company that helped us to determine the different values created and the related stakeholders.

3.2 Interviews

In order to further analyse our application case we completed this work with a few interviews carried out inside the company. The aim was to get more information on the needs and expectations of different stakeholders for the industrialization of the innovation to help us asses the changes in term of value creation that the innovation would induce. The methodology we followed is based on that advocated by Dudezert [Dudezert 2003]. The people interviewed were working in different areas of the company in order to obtain as broad a vision as possible. Nine persons were interviewed: the chief executor, the technical director, the chief financial director, the operations director, the commercial director and two people of his team, the quality manager and the purchasing manager. Each interview took place at the subject's desk or work station to ensure he was as comfortable as possible. It began with a rapid presentation of our work and objectives to help him understand the purpose of the dialogue and our position. A discussion as free as possible was then established centred on a few selected fields:

- The current system, its characteristics, benefits and drawbacks.
- The market that the firm addresses currently with this product and its position.
- The innovation whose introduction we are working on, its characteristics, benefits and drawbacks.
- The different stakeholders that could be interested in the new product, their characteristics and the reasons for their interests.

This helped us to bring light into several aspects:

- Current product: The current product relies on a technology that is several decades old. No innovation has been carried out on it for a long time. It is characterized by a very high reliability. The main component of this product is provided by a sole supplier. This is due to the difficulties that qualifying a new supplier would generate and the length of time it would take to achieve the same degree of reliability with a new supplier.
- Market: There are two different markets: the original equipment manufacturer market (OEM) and the repair market. The most profitable of these for the firm is the repair market. It brings high margins that balance a certain lack of profitability in other products and increases the volume on which development and qualification costs can be amortized. However the company faces competitors who copy its product at a lower cost and gain significant market shares.
- Innovation: It is characterized by a high degree of technical incertitude. The technology innovation is not well controlled by the industrial partner that manufactures the key component. However no other supplier has been contacted. As a matter of fact, the number of potential suppliers working on this topic is voluntarily kept at its minimum to ensure the non-disclosure of the technology.
- Different stakeholders: Several stakeholders were identified (see figure 3)
- The company employees: The innovation would bring them better conditions of safety and the recognition of their know-how by the group that owns the company.

- The company itself: It would bring them a competitive advantage as well as a better image in terms of innovation and environmental impact in a market that demands it. It would ensure a higher market share in the repairs market (innovation hard to copy) and could help the firm to increase their market share in the OEM market. Finally it would economise on some investments related to employee safety and give evidence of the value they add to the group.
- The customers: Innovative products would ensure a better impact on environment in a context of strengthening regulations. It would save them some logistics costs. It would increase the safety of their employees and diminish the related costs. It could also decrease the mass of a minor system in their products.
- The group: They would also use the innovation on their products with the same advantages as their filial.
- Public authorities: It would decrease some safety related risks in the location of the firm's premises. They could provide subventions to help the innovation development.
- Certification authorities: They set the requirement for the qualification of a new product.
- Former product suppliers: The innovation being launched would induce a significant decrease of the business our firm has with them. If the technology is still used on other products, this could lead to an increase of their selling prices.
- New Product suppliers: They would gain a new business.

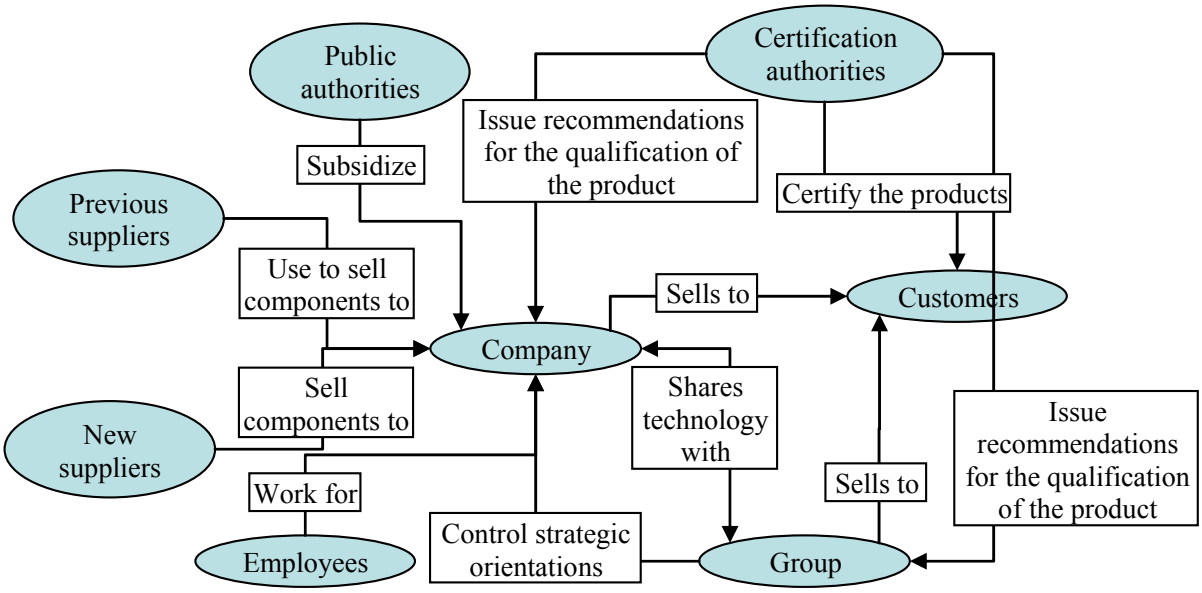

Figure 3. Relation between the different stakeholders

From these results we can conclude several points. On the one hand, new values, numerous, complex and related to different stakeholders, would be generated by the introduction of the innovation (see figure 4). On the other hand, the risk of a technical or financial failure would have a significant impact on the image of the company in the eyes of customers and the Group. These risks are all the more significant since our firm is not used to carrying out radical innovations. This justifies our value-based approach.

3.3 Synthesis

Based on these two analyses, we can begin to draw conclusions regarding the way we want our values to be created by the new product. We are currently facing three different aspects regarding the value creation management. The first one, dealing with strategic aspects of the enterprise, is the question of the multiple and different type of values we want to create and for which ones of the numerous

stakeholders. We must take this richness into account while managing the value creation. Can generic methods take such richness into account?
The second question, dealing with tactic and strategic aspects, concerns the industrial solution we will select for the creation of these values. As we have seen, the chosen solution must ensure a high reliability of the final product. This incurs the need to have the supplier increase the maturity of its processes. The industrial solution must also ensure good control of the problematic linked to the intellectual property. A fitted method should be able to deal with the important changes existing on multiples areas of the firm between the two situations: before and after the innovation implementation in order to limit the risks of failure. Two different kinds of risks have to be taken into account: the technical and strategical risks.

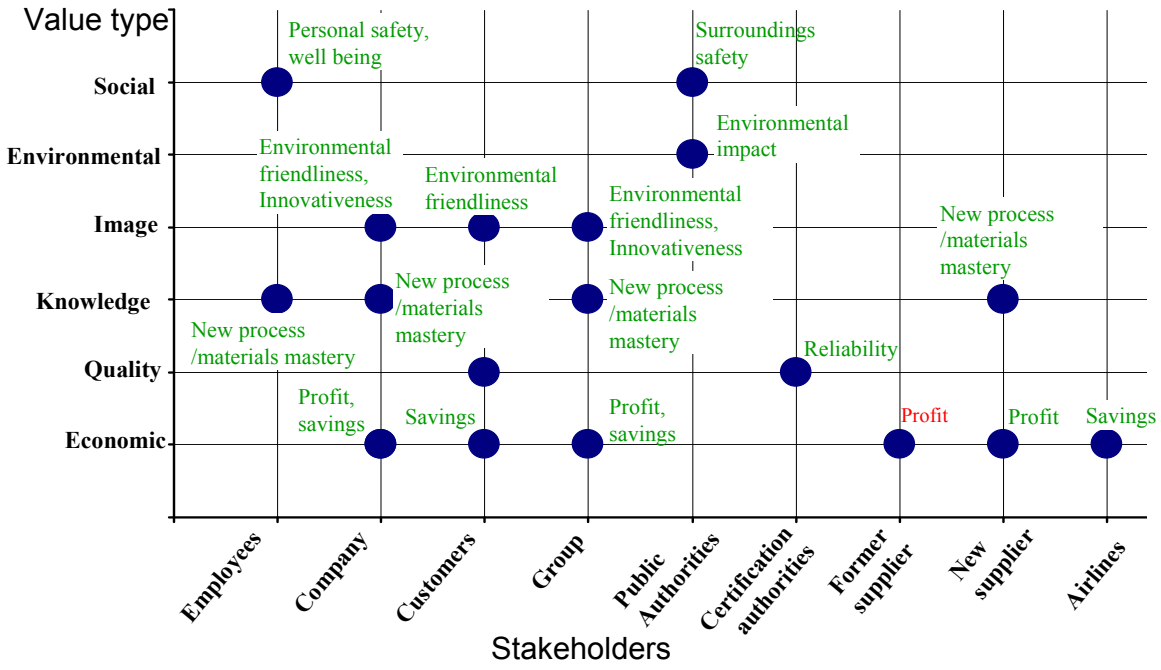

Figure 4. Main values and related stakeholders created by the innovation

Finally, the third question, dealing with operational and tactical aspects, is the piloting of the value creation. We must ensure that the values created will keep a satisfying level.
A suitable method for us is then going to be a tool that can simultaneously take into account high variations in values, stakeholders and processes, and integrate the technical and strategical risk (see table 1). Does such a tool exist?

Table 1. Level of the requirements

Requirements	Level
Strategical risk management	Strategical
Creation of different values	Strategical
Different stakeholders involved	Strategical
Supply chain evolution	Strategical/Tactical
Technical risk management	Tactical/ operational

4. Different methods and adequation

Now we have precisely defined the requirements our environment requires for efficient method, we can begin to investigate the existing ones. However, the idea of value is very complex and quite unclear and since, as we have seen, we want to take different kinds of values into account a specific

focus on this topic is necessary. Consequently, our next step will be to describe the significations we put behind this concept.

4.1 Internal or external strategic focus

As we have seen, value creation is a key area for the survival of a firm. Consequently, it needs to be integrated in the strategic approach of the company. Two different points of view can be adopted regarding the creation of the values we just reviewed. Some think it is essential to base the value creation strategy on the internal strength of the firm: it's the internal focus. An example of this approach is the Resource Based View: a tool that analyses the resources of the firms that presents an interesting value creation potential. Barney [Barney 1991] gives four attributes that can help assessing this potential:

- Valuability: capacity a resource has to exploit strengths or neutralize weaknesses of the firm.
- Rarity (characteristic necessary to procure a competitive advantage to the firm)
- Imperfect imitability (characteristic necessary to ensure the advantage is sustainable)
- Difficult substitutability (ensure that no other strategically equivalent resources can be found by competitors)

This approach has been extended afterwards to knowledge (Knowledge Based View) as being an immaterial resource with particular characteristics (transmission, stocking…)

Others however, partisans of the external focus, advertise that the key to any successful value creation strategy must be the study of the firm environment and the adequacy of the value created in the firm and this environment. The first works regarding the influence of the environment on a firm's performance are those of Porter [Porter 1979] who underlines the existence of five forces impacting the performance of an industry: threat of new entrants, threat of substitute products, suppliers' bargaining power, customers' bargaining power, competitive rivalry in the industry. This model enables oneself to analyse the competitive advantages a firm might have and thus the profits it can gain from it.

Another model based on an analysis of the environment is developed in the stakeholder theory. This models aims to take into account different kinds of values, especially non-economic and different kinds of stakeholders. Lepineux [Lépineux 2003] for example enumerates five categories: shareholders, internal stakeholders (employees and trade union), operational associates (customers, suppliers, subcontractors, banks, insurance companies) social community (authorities, associations, NGOs…) and natural environment. Such an approach is especially useful when one is faced with a complex situation with lots of different values to take into account.

Both of the points of view described above are of course non exclusive. Several authors emphasise the fact that the most efficient strategy is to take both elements into account: ensuring a good adequacy between the strength of a company and the opportunities its environment presents [Martinet and Reynaud 2001]. In our particular case, we have seen, the approach we must adopt needs to take internal (lots of variation inside the company) and external (different values created for different stakeholders).

4.2 Existing methods

Now we have described the different values a firm can create and the strategic approaches a firm can adopt regarding it, we must define what are the different tools that can help us manage this value creation. We selected different tools that we felt were the most used in the industry and the most discussed in design science. For each of these tools we will assess how it fits in with our particular problematic.

The classic methods can be of two different kinds: local or global depending on the point of view they adopt on the value created. Local methods only treat the value generated by a single activity. A classic local method is the Activity Based Costing (ABC). ABC displays the different activities that are part of the functioning of a company. And distributes the cost of any of these activities on every product, depending on the use the product has of these activities. This theory (later extended to Activity Based Management and Activity Based Budgeting) however cannot be applied to our case. It only deals with

economic values and do not take many stakeholders into account. They do not include any questioning on the strategical and technical risk.
Value Analysis is an other local value management tool. It was developed by Miles in the middle of last century and is based on functional analysis. It consists of designing a product while taking into account the value created by every function it accomplishes. One can then limit the design cost and raise the quality of the product in concentrating only on the function expected by the end-user. This tool is part of a larger approach called Value Management (VM). According to European and British standards, *"Value Management integrates the operational managers' efforts with those of higher management [. . .] by concentrating objectively on outcomes which are in line with overall corporate objectives, in preference to local or short-term priorities''*. For our case study, this approach has the advantage of enabling different values and stakeholders to be taken into account. However it does not treat the way a new value chain should be established. Neither does it helps us to mange technical and strategical risks.
Global methods on the other hand deal with the value generated by an entire organisation and not only by a single activity. Amongst these tools we find all quality-related tools. The Deming Wheel (PDCA) is a methodology that can be used to implement new processes. It is based on the repetition of four steps: process planification, process execution, theoretical and real results comparison and eventually analysis of the differences and process update to solve the problems picked out. Another example is the Total Quality Management that advocates the importance of quality in every activity to ensure a sustainable response to the client's needs. Other quality tools such as Six Sigmas, Ace, etc. exist but they all present the same drawbacks in the context of our case study. They allow different values and stakeholders to be taken into account but not as many as required. And, where they can help manage the technical risk, they deal with the strategical risks we face.
The last method we are going to detail is the Balanced ScoreCards (BSC). The use of BSC is relatively new since it appeared during the 1990s. Their purpose is to reconcile the strategic and the operational visions in the global measure of the performance of a firm. BSC will concentrate on four perspectives [Michalska 2005]:

- The financial perspective that represents the vision the shareholders have of the company
- The customer perspective representing the vision the customers have of the company
- The perspective of internal processes, dealing with the processes that need to be improved in order to be more competitive.
- And the development and learning perspective.

The first step will be for the managers to elaborate targets in each perspective that need to be reached in order to fulfil the company's strategy. The fulfilment of these targets will be measured through indicators. The BSC will present through these indicators the position of the firm in relation to its strategic targets.
For our case study, the BSC presents many advantages in the way it mixes operational and strategic focuses. It also treats simultaneously all the aspects of the firm and the management of technical and strategical risks can also be integrated in this approach. However once again, the stakeholders taken into account are relatively classic (employees, shareholders, customers) and this limits the number of values that can be integrated in this tool. Finally, one can ask if this tool can deal with the level of changes considered in our case study since it does not give any indication as to how to transform the supply chain to reach the different targets.
As we have seen, the classic methods are not enough to tackle the implementation of a technical and strategical innovation inducing important changes in the enterprise in terms of product, processes and values created. The purpose of all these tools being to manage the value, they reach their limits when it comes to designing a radically new value chain. What is required in our case is a dedicated value chain creation tool. This is what we are going to present next.

4.3 SCOS'D

Based on what we have developed, we have chosen to adopt a tool reconciling the stakeholder theory (that will ensure that the value/stakeholder pair is taken into account) and systemic analysis (that ensures a global and simultaneous approach). This tool named SCOS'D (Systemic for Complex

Organisational systems' Design) was developed by Schindler, Bocquet and Dudezert and used for the design of a healthcare R&D center [Schindleret al. 2007].
The first step according to this method is the definition of the system considered and its division into sub-systems if required. Each system is then studied and separated in different phases. For each of these phases, the different stakeholders are looked for and their expectations studied. The next step is to define how the system considered is going to live up to these expectations and then to define the deliverables that satisfy the expectations. For each of these deliverables the associated process is described and then broke down into activities. For each of these activities, the resources associated can then be listed and their cost evaluated. One can then verify that the execution of the process results in the creation of the expected values. This whole process ensures that each resource used contributes to the creation of a value required by a stakeholder.

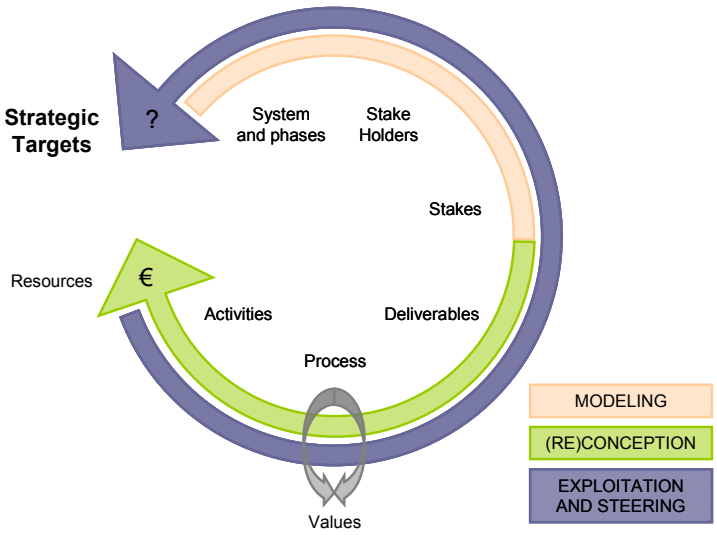

Figure 5. SCOS'D methodology from [Schindler et al. 2007]

In the context of our case study, this methodology presents several advantages. First, the different stakeholders and the associated values are well taken into account. Secondly, since it designs a new system, it ensures that the different gaps existing will be taken into consideration. However, risks are not considered in this approach. Yet, as we have seen, we face risks that can significantly impact the project, some technical (process reliability…) some strategical (cash-cow product replacement…). Some changes in the area of risk management are therefore required in order to adapt it to our needs. The solution we are currently working on is to consider the absence of risk as a value the system would create. Thus, the risks aspects would be taken into account from a global point of view. From a more local point of view, the use of specific tools such as FMECA (Failure Modes, Effects and Criticality Analysis) will be necessary to control the technical risks. Besides, to better evaluate the strategical aspect, the option we retained is to use this model to generate several scenario that could then be compared in term of value created, cost generated and risks associated. This scenario will be based on different approach that can be adopted by the firm: offering the new product to different group of customers at different prices, hiring the know-how to manufacture the main parts of the product or get it from a subcontractor, rent the usage of the system to customers instead of selling it.

5. Conclusion

In this study we have tried to evaluate different methods to implement an innovation in a defined industrial context. This context has been studied through a systemic analysis and series of interviews that helped us precise our need. This need has been confronted with the most used and discussed methods and tools. These classical management tools were found not adapted to our situation. None of them are precise enough to take into consideration all the essential aspects we defined: multiple stakeholders and associated values, strategical and technical risks, radical evolution in the production

system. The use of these tools is limited to minor changes in value chains and is not efficient when major evolutions are required. The SCOS'D methodology we finally adopted, whose purpose is the design of organisation, seems better fitted. In addition, we will use specific risk management tools to ensure the technical mastery. Different scenarios of the innovation introduction will be elaborated and compared to asses the impact of the different strategies. Multi-criteria decisions analysis will then be required to guide the management during their choice between the different options.

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