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MANAGING EARLY DESIGN PHASES IN SME'S: THE CONCEPT PRODUCT

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1 Introduction

This paper aims to introduce the methodological and organisational contribution of a project meeting a French institution for innovation and technology transfer, the new product design and innovation research laboratory of Angers University and ROSSIGNOL S.A., an enterprise specialist of waste collectors and sanitary equipment. The research project is to implement an innovation organisation in a SME. This new organisation manages the early design phases in a concurrent engineering way to facilitate intern creativity in SME. The structure implemented aims to stimulate and manage innovation to sustain the SME activity. The project objectives are to create innovative product, to catalyse innovation by the organisation, to transfer new methods to innovate in SME and to develop an innovation culture at ROSSIGNOL S.A.

2 The product concept problematic

Early new product development is a problematic for industry. Searchers have to express processes and organisations that optimise the emergence of new products. An organisation emerged in 2001, the research, innovation and development (RID) [1]. This organisation recommends a concurrent engineering design in the early steps of designing products. This new innovation department have specific task to stimulate innovation in the R&D process. In the sense of Hatchuel, this type of organisation is fitting big companies that can support a new department implementation. One of the innovation department tasks is to prototype new ideas to transfer them and develop them on next product generation afterward. In the automotive industry, the concept car is the perfect illustration of that intermediary representation. This prototype is showing a certain research and development step and reflects an innovative image of his manufacturer. This concept is a tool to stimulate and capitalise innovation. Our research project is emerging from the analysis of this new department tasks, and the transfer of these tasks for Small and medium enterprise (SME's). It aims to implement a tool called "concept product", an analogy of "concept-car" for all activity sectors. It concentrates innovative concepts that emerge of the SME's organisation.

This is a special artefact which has to be build with a dedicated process. This representation of a design step is orientating the designer for the future product. The concept product described in this article is a tool to manage these artefacts in the early design phases.

The formalisation of this tool is the objective of our research project. The methodological and the organisational dimensions are observed. The method processes have been built in analogy with experimentation in automotive industry. The research work consists of adapting five methodologies for SME'S: TRIZ method, creativity methods, competitive intelligence, design trends identification method and concept product building method, a combinatory method to obtain product concept architecture. A concurrent engineering model has been chosen to support the organisational configuration. This organisation must drive the methodological model and have to manage the different representations of the concept product.

One of the objectives of this project is to show the importance of concurrent engineering to manage innovative concept in the early design phases. Maxant and Piat [2] notice that it's necessary to create tools to introduce concurrent engineering in the design process. In their sense, the product concept is a tool to federate different actors of the design product process. MOORE and HALBROOK [3] show that perception actually differs when they evaluate a concept and a real product. Concept product needs to be very descriptive and evaluated as a first representation of a product attribute.

This research project is involving three actors: the product design and innovation laboratory of Angers university, ROSSIGNOL S.A., a French SME's specialist of waste collector and sanitary equipment and a French institutional centre for innovation and technology transfer (CRITT productique Pays de Loire). The results of this experimentation are the last part of this article.

3 Product concept design methodology

3.1 Product concept

The product concept terminology is born by analogy with "concept car". The "concept car" is a representation of different concept developed by the innovation department. It's a communication tool to show innovative functionalities on a real prototype. We think that this sort of tool can be used to capitalise intern innovative concept and to stimulate innovation in SME's. Christofol in 2002 [4], distinguished three type of product concept. Christofol distinguish three types of product concept [5]:

The communication concept product (show-car for example) that are exposed in the exhibition to demonstrate the enterprise dynamism and innovativeness;

The marketing concept product: it is a formalisation of a next generation of a product and which allows testing the product with the future client;

The intern product concept or confidential demonstrator that federates advanced research in diverse domains like ergonomic, design, material...

Our research program considers the third one: the intern product concept. It is a real tool for early design phases because it's an object that federates all the actors of designing product process. It is a tool to communicate the different innovative concept to the future developers of product.

Early and stable product definition is constantly cited as key of success for innovation [6]. It's an objective for the attribute of the concept product. Moore and Halbrook show that perception actually differs when they evaluate a concept and a real product**.** So, concept product needs to be very descriptive and evaluated as a first representation of a product attribute. The product concept design methodology tries to answer to these problematic: The concurrent engineering way to design it is a key to define stable concepts in the early design phases. The crossed fertilisation of the different design process actors brings an earlier evaluation of the potentiality of the new concept.

The product concept is composed of three attributes types: stylistic attributes, technical attributes and research axis attributes. These three attributes is the results of an analysis of emerging concept in the ROSSIGNOL S.A. experimentation. The product concept design methodology contains the methods to produce these attributes and to capitalise them in a prototype and a knowledge management tool. These design methods is described in §4.

3.2 Methodological hypothesis

Five innovative methods have been implemented to produce these attributes. All these methods have been validated for big companies as design methods [4]. These methods are the competitive intelligence method, TRIZ method, offer and trends analysis, creativity methods and a product concept building method. The research effort has been to transfer this method to an SME's organisation and to adapt it for the designing of product concept. All these methods are described afterwards in our project context.

The competitive intelligence

The objective of this method is to survey knowledge source such as internet, exhibition or any sources that can bring strategic information for future products designing [7]. This method aims to inform in real time the actor, to analyse the information with a SWOT analysis [8], to create value with this strategic information and to capitalise this knowledge production and manage the knowledge flow. To stimulate creativity, the survey is multi-sectorial to find technology transfer or innovative model. To validate these objectives, we have transferred a survey plan and a knowledge management tool.

TRIZ method

TRIZ or "inventive solving problem theory" is offering a structured approach compatible with analytic and logic thinking method in helping them to solve problems with creativity. TRIZ method is generally described as a solving problem method for complex case [9]. The method indicates idea directions and finding concept help. The major error in the TRIZ method comprehension is to think that it produces a complete solution. TRIZ do not solve problem: it stimulate creativity direction to solve problem. This way of seeing the method is very important to see the way we are using it for the design of product concept. TRIZ methodology is used to model problematic linked to the product. The contradictions of the problematic are bringing a constraint growth which discovers new innovation direction to stimulate creativity [10].

Offer and Trends analysis

This method aims to formalise and to design stylistic attributes. Seven parts compose the method: influent universe research, illustration research, mounting and categorisation, lookup table formalisation (CFUT), trends plank description and designation, attributes selection and trends plank production [11]. The influent universes are the related activity sectors which have common sensory attributes. For example, for a sanitary accessory, the aquatic universe is an influent universe. An illustration research is done on this universe to have a data basis which is classified and categorised to produce a trends plank. This production is described to extract different stylistic and sensory axis which will be product attribute.

Creativity methods

We called the creativity method, all the methods that have these two indissociables objectives [12]:

- stimulate the manifest of creative attitude (stop clamping)

- optimise the creative process in a specific research case for a better orientation of the creativity working period

The objectives are to help actor of creativity working period to produce the biggest amount of original ideas. There is not an only method but some methods. The creative actor is using complex and contradictory approach, melting liberty and rigour, converging and diverging exploration [13]. With this approach, the creative actor must have multiple method which be combined to stimulate creativity in different manners. All the method contains a generic approach that can be described by a few steps: thematic research, thematic formulation, direction of solution research, evaluation and choice of solutions.

Product concept building method

This method is also called “the innovation game”. This method is the evaluation of all the creative contents and the different attributes of a potential product concept. The aim of this method is to define product concept architecture. It’s a mixing of the higher potential concept that emerges from the creative production. The potential is evaluated with three dimensions: the coherence, the originality and the feasibility. This evaluation is done by all of the project actors which represent a panel of expert who evaluate the concept in their expertise domain. A description of the concept product attributes is done for further development. The next step is the detailed designing of the product to build a prototype of product concept.

4 METHODOLOGY DESCRIPTION

This description shows the articulation of these different methods to design a product concept. To model the methodology, we have chosen the SADT model [14]. This systemic approach shows the link between the three global tasks of this methodology: the product concept architecture design, the detailed design of concept product and the management of innovative knowledge.

4.1 Global model of the three method task

Three principal tasks are realised in this method: the product concept architecture design, the detailed design of concept product and the management of innovative knowledge. These three tasks bring the project to the production of a product concept prototype. Two other exits are also produced: innovative function transferred to the future generation of product and innovative knowledge. This level of description shows the global objectives of the project: managing innovation with a concurrent engineering tool: the concept product. The following paragraph will described in detail these three tasks.

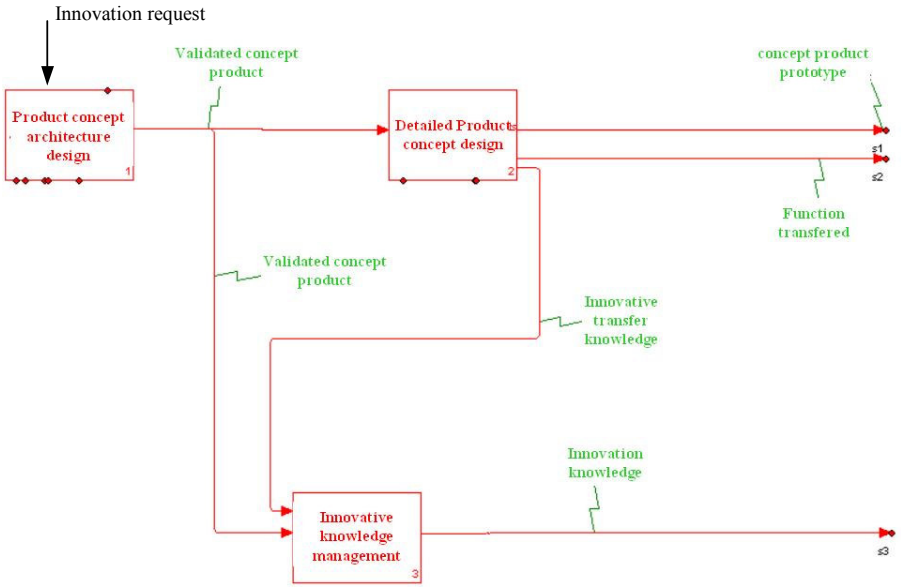

Figure 1. global model

4.2 Product concept architecture design

The first step of building concept product is to produce a creative content to define an architecture which federates all of the innovative function studied in the product concept project. The central method is the concept product architecture building method. In this task, the other methods are producing content to have a real choice in the different attributes potential. This model shows the three types of product concept attributes: technical attributes, stylistic attributes and research axis attributes. Those last ones is impulse by competitive intelligence method and TRIZ method. They are orientating the strategic reflexions on the futures product generation and they are giving information to prepare new creativity working period on new research thematic. The stylistic attributes are determinate by the offer and trends analysis. Some styles and some values are proposed to be associated to the concept product. Creativity method is used to supply innovative and technical ideas. The concept product building method transform the attributes produced to structure it in a concept product architecture which is coherent with the project value. The different architecture is evaluated to define a potential described by three indicators: the coherence, the originality and the feasibility. The validated architecture is described and is the entrance of the detailed concept

product design. For the organisational point of view, each method has its working group. These groups are defined in §5.

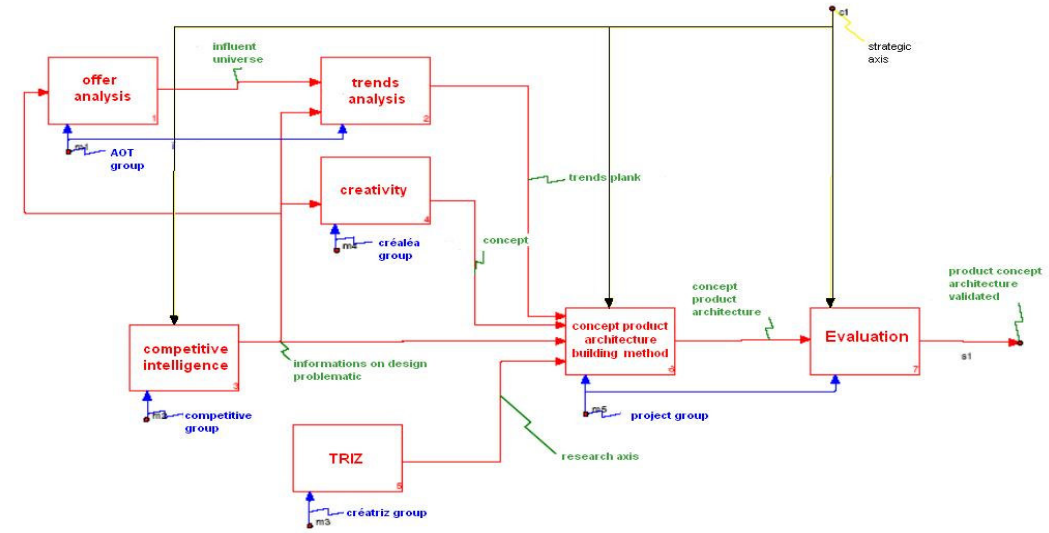

Figure 2. Product concept architecture design model

4.3 Detailed product concept design

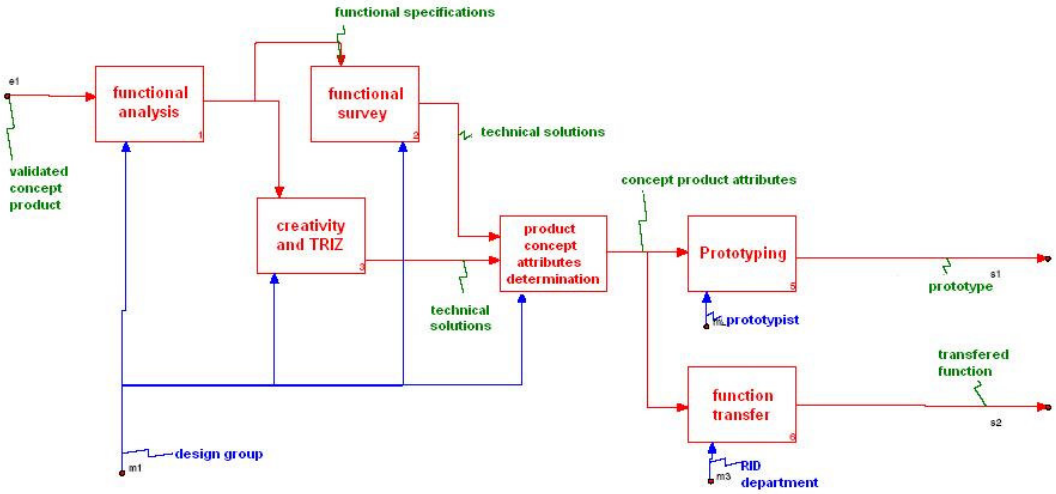

Figure 3. detailed product concept design model

The second task is the detailed concept product design. The architecture is divided into functional parts. The first task is to validate the needs with a functional analysis to establish a

first specification. A strategic survey is done on the state of the art of possible existing solution or existing component that can respond to the specifications. At the same time, a creativity work is done to find new technical solutions. All the different alternatives are capitalised to be evaluated. When a solution is validated, the attributes of the solutions is prototyped and transferred in the future product generation.

4.4 Innovation knowledge management

This activity is transversal and is driven all along the process. For the moment, this process is modelled as if it were linear. In fact, the frequency of use of the five activities described is suiting the innovative knowledge flow which is a constant flow.

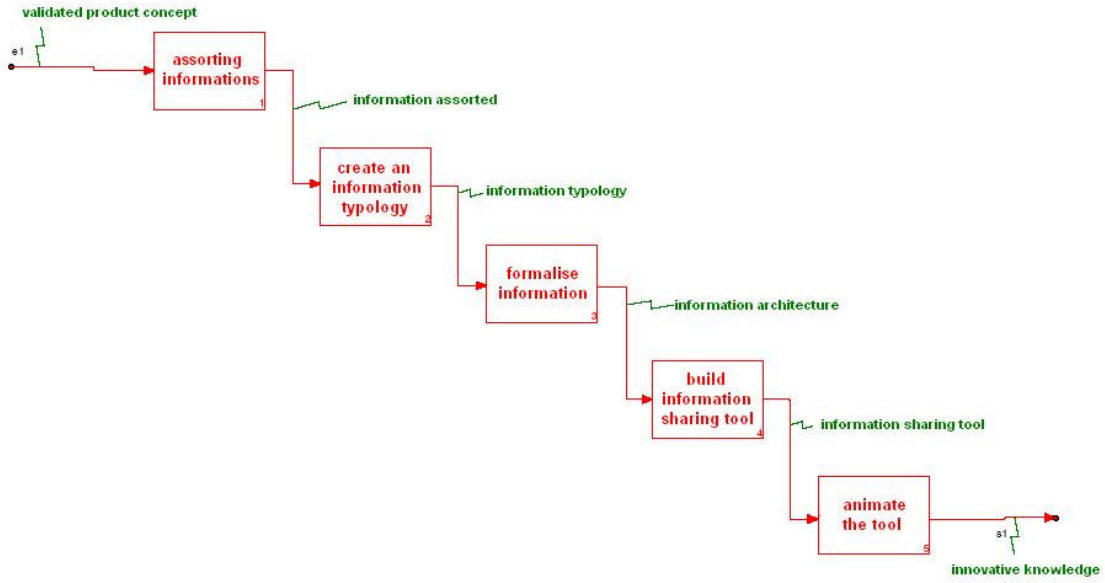

Figure 4. Innovation knowledge management

So, all these five activities are done at the same time but for different innovative knowledge. The five activities is the assorting of information, create an information typology, the information formalisation, build the information sharing tool and animate this tool.

5 ORGANISATIONAL MODEL

This model is describing the support organisation of the method. It's a concurrent engineering organisation type which includes expert groups. The department in charge of the animation and the constitution of the different groups is the research, innovation and development unit. Working groups are built to drive the methodology process. These groups have been designed to organize concurrent engineering in the process. All the actors of the working group are coming from a specific department with an expert appraisement that serves to the task. The point of view confrontation is needed for the future product concept diversity. The figure 5 diagrams the different working groups and their belonging to other bigger groups.

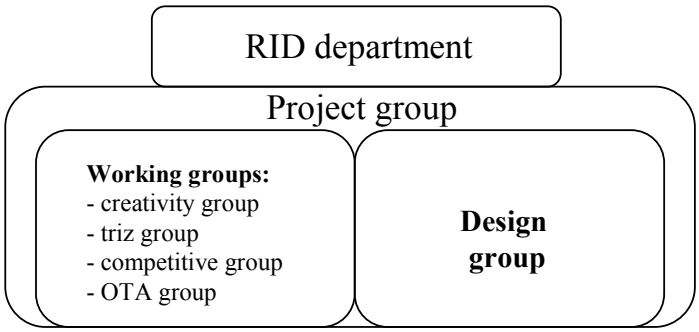

Figure 5. groups diagram

The different groups implemented will next be defined and their missions will be explicated.

5.1 RID department

This department is driving the innovative working groups and compiles all the working groups cited afterwards. Its missions are to drive the innovative process and to facilitate the working period. He's including an innovation committee which evaluates and orientates the strategic axis of the project. This committee is composed of the executive committee and the entire actor of the project. This department is divided in two sub-groups: the working groups and the design group.

5.2 The working groups

There are four of them: the "creativity group", the "triz group", the "competitive group" and the "offer and trends analysis group". Each group is carrying out a method to produce innovative content. In the ROSSIGNOL case, the "creativity group" was composed of seven people: a facilitator coming from the university to help the group on the method process, two R&D engineer, one purchasing agent, two market managers and one method engineer. All the groups were respecting that diversity of actor to work in a concurrent engineering mode.

5.3 The design group

this group is in charge of the achievement of the concept product. For each concept architecture validated, a group is created to drive the detailed product concept design. This group is composed of at least one actor of each enterprise department. The actor that have participated to the working groups are mixed to bring a competence diversity in the design group. This group is in charge of the functionality transfer to the next generation of product.

6 THE ROSSIGNOL S.A. EXPERIMENTATION

6.1 Project objectives

The research team of CPNI laboratory is waiting for an experimental validation of the concepts (tool, method and organisation) which are hypothesis for their research. The laboratory will transfer all the methods that he masters (TRIZ, ATC...). The objectives for the laboratory are:

- To model the tool, method and organisation to place it in a design process;

- To integrate the actor design approach in a concurrent engineering and in a virtual environment;

- To evaluate technically and ergonomically the virtual reality interface;

ROSSIGNOL S.A. is waiting for learning skills to build concept product to:

- stimulate creativity and initiate the development of innovative product;

- facilitate the concurrent engineering in new product development;

- To find possibility of technology transfer for their activities;

- upgrade its ideas and to communicate them;

The aim of the product concept project is to create new products, to catalyse innovation, to use new working methods and to develop an innovation culture in ROSSIGNOL S.A. organisation. Four research universes have been investigated: mass audience for waste collector, mass audience for sanitary equipment, professional waste collector and professional sanitary equipment. To achieve this, the project has last two year divided into phases of one year: one on the waste collector design (mass audience and professional) and a second on the sanitary equipment. At this time, the first phase is done and the second is beginning.

6.2 Research protocol

In compliance with other research protocol on cooperative and simultaneous engineering **[10][11][12]** and according to the participant observation technique which we have retained for our data collection, we have applied the following data collection protocol:

After an intern audit consisting in interviewing the design process actors and studying the anterior project case, we have established a first representation of the R&D organisation. Then, we have coached the implantation of the RID organisation and we have introduced the actors to the innovation tool and method allows. To conclude, a feedback has been done to model the new organisation implanted and the dynamic of its implementation.

Three observation levels are retained: the project and its process, the product and its intermediary representation (for example, a prototype is an intermediary representation) and the actor and its interactions and its knowledge status

6.3 First phase results

Competence growth

One of the first results is the implementation of an innovation culture. To measure that impact, an audit has been made at the end of the first phase. All the actor of the project have emphasized on the competence growth in the innovation method. This transversal project has

built a mutual enrichment and the importance of concurrent engineering has been validated. The possibility of idea expression and capitalisation in the early design phases have been appreciated by all the actors. Effectively, before the project this expression was tacit and generally never comes off.

Operational results

The operational results concern all the creative content and the transfer results of the project. The offer and trends analysis working group have retained 25 marketing criterion to analyse their offer and categorise it in 25 influence universe, then they have built 10 trends board that corresponds to the 25 influence universes. The creativity working group has express a total of 400 ideas. 50 concepts have been formalised with the ranking of this idea basis. The TRIZ working group has studied the resolution of 15 contradictions to produce 30 concepts and 22 research axis. The competitive intelligence group has chosen to implement an automatic survey system on internet. This implementation is still running.

Two concept products have been designed. Each of the concept products contains seven innovative functionalities. After studying the functionalities, one of the concept products is totally prototype and the other give rise to the prototyping of two functionalities and the virtualisation of the other part of the concept product. Two patent produced by the project have been filed.

6.4 Research perspectives

The future works on the project is to improve the innovative knowledge management and the tool which will drive the project. The measurement and the drive of the concept product performance need to be created. The time parameter had to be more included in the second phase. This second phase on the sanitary equipment has begun in November 2004 and will finish in November 2005.

7 CONCLUSION

The aim of this project is the implementation of a new organisation and some design methods in a SME'S to stimulate innovation. The results of this project are reinforcing our hypothesis that the concept product project is a good way to stimulate innovation.

To bring concurrent engineering in the design process, an innovation unit and a method process have been implemented. The first results is the formalisation of this process and the two theoretical models proposed in this article.

The new organisation brought by the RID in SME'S provides a new form of concurrent engineering. It's a non permanent department that brings the collaborative work in the early phases of design process. This conclusion is validated by the last audit of the actor. The diversity of the working group has facilitated the innovative content production. The adaptability of this organisation is suiting to a SME's.

The RID implementation project at ROSSIGNOL S.A. shows it first results the principal achieved objectives are :

- To stimulate creativity and initiate new product development in a pro active approach;

- To increase the different SME's interoperability of professional skills,

- To enhance the value of ideas and to diffuse them easily by a knowledge sharing tool.

- To revitalize innovation and develop the SME's,

- To initiate the emergence and the sharing of innovative knowledge,

From the ROSSIGNOL S.A. point of view, the objectives have been released. This project enables the implementation of an innovation approach and the innovative culture approach. Nine functionalities transfer work on process for the future product generation. Two patents have emerged of the project. The concurrent engineering brings new reflex that enables a better comprehension the potential of a knowledge crossed thin thinking in the innovation process.

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