Ceramic Tile Design: a Case Study of Collaborative New-Product Development in Fashion-Driven Chains

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Abstract

This paper studies ceramic tile design chains, as representative of those collaborative New-Product Development (NPD) processes where the presence of very different origins of designs and the fast changes of the market strongly condition the process. We have studied this particular circumstance by way of what we have called the "stimulators and stimuli framework" that proved helpful to obtain computer supported NPD models for ceramic tile clusters.

Keywords: Collaborative product development; Ceramic tile products; Design chain.

1. Introduction

This paper focuses on improving the management of the process of new-product design and development within the particular context of a cluster of enterprises that cooperate to form a network of mutual intra- and inter-firm relations.

Results come from an empirical study conducted on enterprises of the ceramic tile industry in the province of Castellón (Spain). There are two reasons for considering this particular sector. First, it has been reported that teams developing new products under rapidly changing technological or market conditions deserve special attention [1]. And we shall see that fast market changes clearly dominate New-Product Development (NPD) in the ceramic tile industry. Second, numerous firms in the ceramic sector concentrate in our neighborhood, in the province of Castellón (Spain), and today it ranks as one of the world's leading producers.

We hypothesized that an important feature to obtain computer supported NPD models for ceramic tile clusters was to realize that they are "fashion-driven" sectors, i.e. sectors where the rapid market changes greatly condition the management of the NPD process.

In the following section we outline the related work. Then, in the third section we briefly describe the case study. Section 4 shows that, when adopting collaborative design practices in clusters of SMEs, competitiveness must be improved by strengthening the interrelations among many "actors". Besides, if they belong to fashion-driven chains, the presence of very different origins of designs (generic market and commercial requirements, specific demands by customers, the firm's own ideas, and so on), and the fast market changes results in particular situation that greatly conditions the NPD process, which we have studied through what we have called the "stimulators and stimuli framework". Finally we describe our approach for a) finding the complex stimulators and stimuli framework that helps to customize the particular NPD models, and b) turning it into a suitable set of roles that results in a computer supported NPD process fitting such particular conditions. The paper ends with the main conclusions.

2. Related work

Process design of NPD has been extensively studied. The work by Harmancioglu et al. [2] is perhaps the closest reference to our own study. They conducted a collective case study at three strategic business units that operate in the building materials industry, i.e. in low-technology markets. Hence, some of the conclusions they obtained are relevant to our study. For instance, enterprises working for low-technology markets face the challenge of balancing formality and flexibility, and they tailor their NPD approaches based on environmental dynamics. They adopt more centralized structures and formalized processes in dynamic and uncertain environments, and their processes are tailored to the immediate requirements of their environments. However, their theoretical framework is not valid in our case because: a) our work is aimed at collaborative NPD, and b) their study did not include fashion-driven enterprises, where value may not be provided by "allocating additional effort to technical activities and less to customer interactions and markets information gathering".

Collaboration is vital in our case. Swink et al. [3] stress the relevance of factors such as a collaborative work environment, design manufacturing integration or project activity overlap (concurrency) to distinguish

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between efficient and inefficient NPD projects. But it has been widely described as a complex process. In the words of Harmancioglu et al. [2], there is no 'one-size-fits-all' solution. In their realistic and myth-breaking work, McIvor et al. [4] argue that communication problems were identified during "early supplier involvement" (ESI) in a series of case studies involving a number of multinational corporations. Typical issues included poor guidelines for supplier involvement, integration of suppliers with company systems that were not implemented correctly or standardization efforts hindered by outdated information.

Computer tools that facilitate collaborative NPD are also needed, such as Product Life-cycle Management solutions (PLMs). A well-known fact is that tools that assist in 'high-level' cooperation tasks, like web-based engineering design tools, offer the opportunity to cut the cost of the product development process [5]. However, adapting these tools to design chains is a complex issue, especially in inter-enterprise and collaborative design environments. The work by Aziz et al. [6] is one of the most straightforward and comprehensible reviews on collaborative product development aided by diverse computer tools. They include a good diagnosis of the problems that are dealt with, namely the lack of support tools for SMEs and their specific requirements. We strongly agree that: a) only large enterprises have been the target of PLM vendors, b) configuration changes in global PLM or mapping the business-to-business (B2B) links are difficult, long and costly, and c) some tools neglect the management of intellectual property in VE. We also agree with Aziz el al. in that moving from document-centric PLMs to knowledge-centric systems would be a bonus. However, we hypothesize that the solution by Aziz et al. is not valid in the ceramic tile industry, as design in this low-technology sector is not CAD-driven. It is what we call "fashion-centric", as the rapid market changes greatly condition the management of the NPD process while the technological changes, although also valuable, are less critical. Hence, CAD-driven PLM tools like Windchild or the P2P described by Aziz et al. would not be valid in our context.

Moreover, some suitable new commercial "web-based "project management system" and "collaborative environments" were released by the time the work by Aziz et al. was published. Those applications are still high-priced and complex, but their customization is now easier than that of the previous PLM tools, and their cost may now be assumed by the OEM or shared among limited partners. Chang [5] claims that web-based tools related to product development may be applied to foster companies' operational excellence. In our analysis we considered factors that Chang points to as being necessary for successful product development, such as communication, information sharing, collaboration, design verification and team management.

To sum up, to our knowledge, the generic approaches and the case studies reported in the literature on collaborative engineering and on virtual enterprise projects are not fully applicable to ceramic tile clusters because those studies come from sectors where: a) the projects are very complex; b) they require the latest cutting edge technology; c) they involve firms with a great leadership capacity; or d) they do not evaluate recently available non-CAD-centric and design-oriented PLM tools. Furthermore, we also hypothesize that the NPD process as a whole is greatly conditioned by the stimulators and stimuli framework.

3. Case study: Ceramic Tile Design

The authors acted as external multidisciplinary agents through the 'CE-TILE' project [7] [8], aimed at solving the work and information management problems related to the NPD process in what we called 'Ceramic Design Chains'. The simultaneous goal was creating an enterprise model that benefits from the services provided by the Internet and web technologies.

The information on interactions taking place among the different participants in the design chain throughout NPD projects (i.e. the strategy) was obtained as a side result from and interview process aimed at determining the processes in the ceramic design chain. The interviewing process included firms that produce ceramic tiles, ceramic moulds, trim pieces and colorings, and is described in [9]. Although the study included a very small number of firms (i.e. it is not valid as a statistical sample), our findings corroborate those obtained by Chiva and Alegre [10]. The firms that were interviewed and analyzed fit into a particular pattern of behavior from the classification proposed by these authors: they are Design Followers (or "Bigtechpushers" [10]).

First a spokesperson was established for each ceramic tile enterprise. Then, organizational charts were studied to determine the departments involved in the design and development process. This allowed us to go into design activities and processes in depth.

Interviews in supply companies were conducted with the people in charge of interactions with manufacturer enterprises in the design and development process. These interviews were directed towards identifying the exchange of information and existing collaborations.

Along with this information, companies also provided documentation linked to their own product and design and development process, such as procedures concerning the quality management systems used for their design and development processes (ISO 9001:2000), or internal documents from certain departments that also contained information about the design process.

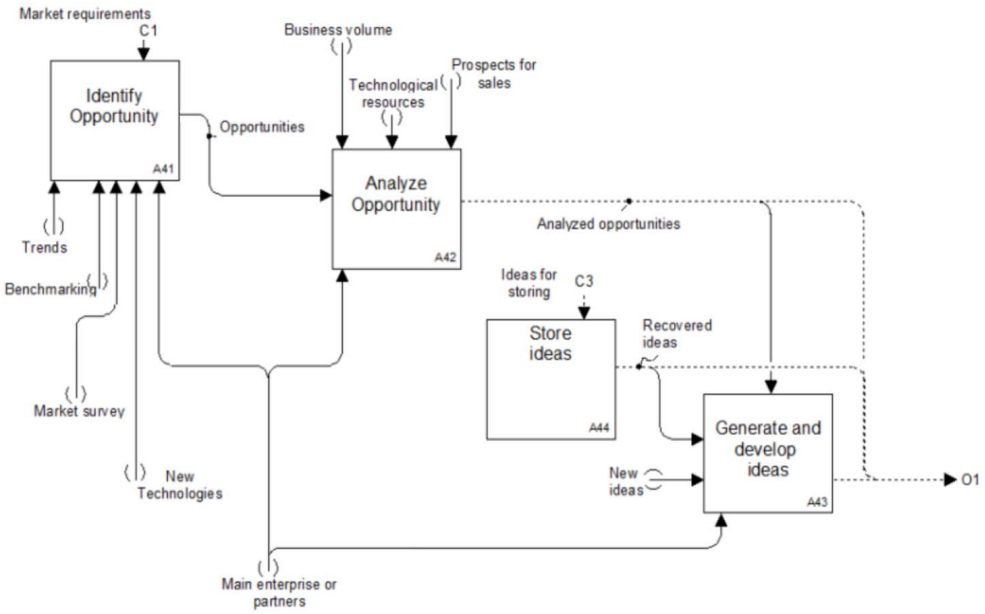

Figure 1. Ideation process modelled in IDEF0 (CEDAM)

The information gathered was formalized through an IDEF0 "as-is" model representing activities as they were taking place (see one example in Figure 1). More specific interviews were also conducted, to obtain information about the nature and content of information systems software (such as databases, ERP system, etc.). The form for managing information about activities was adapted from the MOKA approach (Stokes, 2001). Both forms eased the structured capture and recording of information during the interviews, while also establishing the scope of the knowledge required.

Finally, the representation of the activity model for the desired state ("should-be" model) was tackled directly with an "improved" IDEF0, (IDEF0+) [8].

4. Fashion-driven Ceramic Tile Industry

The ceramic industry is strongly market-oriented. Firms must be aware of preferences of a) end consumers and b) the dealers who commercialize their products. According to Blesa and Bigné [11], most of the activities inherent in the market-oriented business activity of tile manufacturers generate satisfaction and "dependence" in dealers. The higher the quality of the information shared in the distribution channel, the more willing dealers will be to accept some degree of dependence in their relations with manufacturers.

Thus, while adopting collaborative management practices, competitiveness must be improved by strengthening the interrelations among "actors", including firms in the design chain, as well as customers and dealers. Creativity, especially in collaborative new product groups, is a result of communication and interactions within the team [12]. It has also been shown that suitable collaboration with suppliers can provide manufacturers with important advantages in R&D. At the same time, the loyalty between dealer and customer forces them to improve their relations and processes. Moreover, the relationships that arise must be integrated and improved because, despite the current high level of cooperation among firms, it is not always possible to achieve true collaboration that yields the best results. Over ten years ago, Dickson et al. conducted a survey of chief executives in small, high-growth companies [13]. Results showed that fewer than half of the CEOs (Chief Executive Officers) taking part in the study thought that customers', dealers' and suppliers' involvement in the design process was well managed by their firm.

A study of the main origins of designs, the factors that characterize the planning and execution of projects, and the elements used for communication gave us some reasonable evidence of what can be construed as certain weaknesses and strengths in the interactions in the process of designing and developing ceramic products.

4.1. Stimulators and Stimuli framework

In our study we observed the presence of different actors and different kinds of relationships among them [8]. We named these actors "stakeholders", following the definition by Claros Salinas et al. [14]: "a person who is involved in the design. The following were considered the stakeholders in the ceramic design chain (figure 2):

- Ceramic tile manufacturing industries, in which there are many functions and departments involved in the design process, including marketing, commercial, design, development, manufacture, logistics, etc. Some ceramic tile firms, however, do not have their own design and/or development departments.

• Firms that manufacture ceramic colorings and glazes; in recent years, in addition to supplying these components and providing technical assistance, these companies have also begun to offer new fully developed designs. By so doing they also provide innovations in new decorative and aesthetic effects.

• Design offices, which sell their own designs to ceramic tile manufacturers.

• Industries that produce special trim pieces and design and make complements for basic pieces, such as borders, skirting or steps.

• Firms that provide supplies and machinery, like manufacturers of moulds. These also collaborate by providing technical advisory services and conducting studies to test relief patterns, etc.

• Customers, who include area dealers or delegates, and give their opinion with respect to the selection of models, make suggestions, etc.

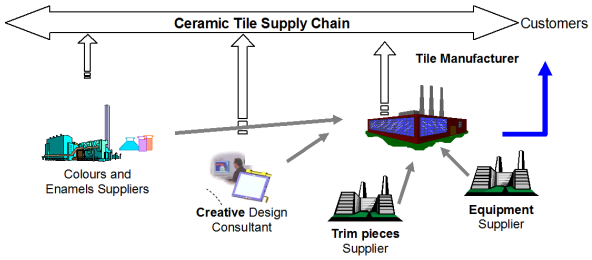

Figure 2 The ceramic tile supply chain

We also discovered that the general cycle of project development is determined and limited by the international trade fairs, where manufacturers present their new products. In the case of this sector, perhaps the most important fairs held throughout the year are Cersaie in Bologna, Cevisama in Valencia and Coverings in Florida. The pressing demands with regard to development times have led to a pronounced tendency to focus efforts annually on just one or two of these fairs at the most. Therefore, the different projects undertaken for a trade fair (which are called a programme) will have to be managed globally.

In what follows the different origins of the designs in the ceramic design chain have been classified according to their stimulators (the different members who, at some particular time, can take the initiative of launching a new design) and the types of stimuli (reasons that can set off a new design process).

Ceramic tile firms are one of the most important stimulators of new designs. One of the most important stimuli is the set of requirements that the marketing and commercial department laid down as general lines that designs are to follow and which are the result of analyzing information from customers, observing fashion trends or investigating competitors' work. Other stimuli are the ideas that can arise in the design, development and R&D departments independently of the guidelines suggested by the marketing and commercial area. Novelties in manufacturing and materials technology and processes constitute another of the chief stimuli for ceramic tile firms, although a large part of this information about innovation is obtained through contacts with firms that supply components such as glazes or equipment. Lastly, there are also specific demands from commercial agents requesting a particular product to satisfy the express requirements of a certain customer.

Glaze industries have their own design departments and may offer new designs to the ceramic tile manufacturers. For this stimulator, similar stimuli were identified: the generic requirements of the market being one of the main sources of new designs. These firms have their own commercial staffs that are responsible for identifying the tendencies for each season. More and more glaze manufacturers now have their own designers, who often propose novel ways of using materials and technologies. These designs produced by the firm itself are sometimes shown at internal exhibitions or trade fairs, which are attended by tile manufacturers in order to choose the designs that best fit their needs. Another possible origin of a new design lies in the demands of customers (which in this case come from the ceramic tile manufacturers) when they commission the design of a new product.

Design offices supply tile firms with new designs, and therefore represent another stimulator of the process, but these enterprises do not centre their attention on novelties in processes and technology. Firms that produce special pieces provide tile manufacturers with decorative trim pieces. The work carried out on research into innovative technologies and processes is not as important as in glaze firms. Sometimes, firms supplying trim pieces hold their own internal trade fairs so that they can offer their customers their latest designs, in the same way as glaze manufacturers. Finally, mould firms cover the needs of ceramic tile manufacturers, but do not usually propose new designs. Nevertheless, they do sometimes suggest modifications for technical reasons, for example, to make it feasible or easier to manufacture a certain product. And some of them even offer complex designs including complex relief patterns. The increasing use of complex relief patterns favors the association of the know-how of mould manufacturers and the work of firms dedicated to design.

The variety of stimulators and stimuli (Table 1) is one strength for the sector, since it therefore has a wide range of sources from which designs can be generated. This allows for the creation of competitive environments in which different design proposals compete to reach the market. Nevertheless, the strict restraints imposed by the dates of the trade fairs frequently mean that the authors of new designs do not have the flexibility and freedom they need in the process of creation; rather, they find themselves working against the clock to get the product finished in time. It is not unusual for the development work carried out by the different firms in the chain to be duplicated.

		MAIN STIMULATORS				
		Tile manuf	*Glaze ind.*	*Design office*	*Trim manuf*	*Mould firms*
MAIN STIMULI	*Generic market and commercial requirements*	✓	✓	✓	✓	
	The firm's own ideas	✓	✓	✓	✓	
	Specific demands by customers	✓	✓	✓	✓	✓
	New processes and technologies	✓	✓			✓

Table 1. The main Stimulators and Stimuli in the origin of Ceramic Designs

4.2. Roles and Collaboration Management

Our proposal for the management of the stimulators and stimuli framework involves establishing an explicit set of roles. In ceramic tile design, the multidisciplinary teams in the project (technical staff dedicated to operating tasks for the development of the product) correspond to inter firm teams that cooperate in the design of new products for a trade fair. However, these are not usually established formally and true collaboration between departments and partner organizations does not occur. The technical work done by the multidisciplinary teams must be coordinated and directed by technical coordinators, i.e. members of staff with enough knowledge and capability to make decisions. In ceramic design processes there are specialists with a thorough knowledge of the product, i.e. designers, engineers, technicians, etc. who are responsible for coordinating each stage of the project. In contrast, it is not always easy to find a figure that leads, supports and takes responsibility for the overall management of ceramic development projects. Yet, this is a fundamental role in the management of the project, and is usually played by a project manager or supervisor, normally with the aid of a steering group. In our experience this role is often played down in many organizations, as in the case of the project manager. With respect to the processes of phase approval, there are two roles whose functions are currently performed in an informal manner. The first is a commission made up of a group of members of management staff, partners and/or customers, who decide on the future of each project as each stage moves on to the next, and the second is that of expert assessors who evaluate whether milestones are being reached and generate information to lend support in decision-making. Lastly, attention must also be drawn to the role of quality facilitator. This person guides the process, the focus being on ensuring its quality and on directing the implementation of methodologies or tools.

The roles defined for each type of project are created in the PLM tool. The next step is to assign the particular human resources needed for each role, bearing in mind their specific capabilities and their availability. A supervisory role should be set up for each element that the project is divided into (stages, tasks, checkpoints, etc.), as well as for the project itself, to allow for ongoing monitoring of the fulfillment of requirements and deadlines. The people in charge of the elements of the project are the technical coordinators defined earlier. In the pilot study, the duties in each of the stages were entrusted to members of the technical staff, who were responsible for coordinating the work and the partial results of each stage.

The person in charge of the whole pilot project was an overall manager or administrator who carried out mainly management duties, such as creating the actual project in the application (from a previously defined template), adapting it to the specific needs (structure, roles, allocation of resources to the roles and assignation of authorizations, establishing the programme and the main goals to be accomplished), creating a virtual collaboration space for the project and defining the authorizations for it, creating phase approvals and designating those in charge, and so forth. Inter-firm multidisciplinary teams, on the other hand, were defined by setting authorizations and permissions (reading, writing or administration) for each participant and each element in the PLM tool. The multidisciplinary work is made easier by using collaborations, which are created in the web tool and linked to the collaboration-dedicated PLM tool. Collaborations allow documents, folders, images, etc. to be shared by participants by granting them permission to visualize, access and modify such material. It is also possible to set up discussions and other tools that can be used as a communication forum. All this is then used to configure and reinforce the vision of "virtual work teams" in the project, as well as to facilitate communication among members of staff who are working together.

Finally, the study also included the definition of a quality facilitator, that is to say, a general implementation supervisor, who was not necessarily involved in the daily work. Indeed, in the pilot study this job was performed by the person in charge of quality in the ceramic tile manufacturing firm. This role was not assigned the responsibility for any tasks, checkpoints or other elements in the project. Nevertheless, it is a key figure for guiding and supporting the process, and took part in the training sessions on using the PLM tools to be applied, as well as other workshops about modeling and improving design processes, where they provided valuable information about ceramic processes and knowledge on how to improve them.

In sum, the definition of roles and the assignation of authorizations clearly delimit the different duties and responsibilities in the execution of each element of the project. Establishing a schedule for meeting goals enables carrying out an exhaustive follow-up of

performance. At the same time, the templates or models act as a basis for defining sequences in the processes, and this allows configuring workflow systems that are automated to varying degrees.

5. Conclusions

We have outlined one feature that greatly conditions NPD projects in the ceramic tile design chain and forces the development of suitable strategies, i.e. the fast changes of the market that produce a particular need for interaction among many actors.

Our pilot study validated the importance of the fashion-driven feature in clusters of SMEs. Moreover, we showed that the stimulators and stimuli framework conditions the management of NPD processes through the definition or roles.

Lastly, as we understand it, the conclusions of this work may not constitute a great novelty for certain business sectors working with "cutting edge technology", but they are a step forward for the Spanish ceramic sector. This is mainly due to the presence of "Bigtechpushers" and the weakness of having to cope simultaneously with many different stimulators and stimuli, which are peculiarities that make it difficult to apply solutions tailored for more hierarchically structured sectors. Furthermore, the study can be useful as a guide to obtain solutions that fit other industrial sectors also driven by constraints other than technology, such as production, sales or fashion.

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