Small and medium district enterprises and the new product development challenge

Evidence from Italian eyewear district

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Abstract *This study describes the results of an empirical research on a sample of small and medium enterprises belonging to one of Italy's most important local manufacturing systems: the eyewear district. The main objective of the project was to suggest ways of improving new product development within the small and medium enterprises of the district. Data were collected from five buyer firms and 49 subcontractors, and experts of the local system were interviewed in order to acquire information on the product development process. The study: highlights the distinctive aspects of eyewear products and the consequent design and manufacturing specificity; maps the product development activity; identifies difficulties and problems SMEs usually encounter in these activities; and suggests how improvements can be made.*

Introduction

Literature dealing with the product development process in large-scale industries is abundant. However, there is general agreement that the new product development (NPD) process is not adequately studied in small and medium enterprises (SMEs) and models and tools specifically focused for these units are lacking. This deficiency is particularly evident where SMEs located in industrial districts are concerned.

The innovation process in SMEs possesses certain distinguishing features that would suggest a specific approach to NPD activities. When compared with large-sized firms, the innovative process in small units is more informal and less structured, the base of managerial competencies is limited, availability of financial resources is lower, the attraction towards skilled labour weaker and the propensity for interaction with other firms is limited.

Other characteristics are related to the setting of the industrial district (ID). Here the innovative process benefits from a number of favourable conditions. In particular, the social activities that characterise IDs provide better channels for the diffusion of information and knowledge than do other contexts. This exchange of information usually takes place through informal channels, such as inter-firm mobility of skilled workers, and the exchange of ideas within families or clubs. On the other hand, the strong division of labour that characterises IDs can hinder a comprehensive view of NPD activities, so the

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"concurrent" management of innovative processes becomes more difficult. In addition, "systemic" innovation is not favoured.

This paper presents the results of a research project whose main objective was to provide SMEs located in the Italian eyewear district with practical suggestions and advice on management so they could improve their NPD activities.

This eyewear district is one of Italy's most important local manufacturing systems. It is characterised by the presence of some large-sized companies (the world-wide top four are located here) and by a network of SMEs, usually subcontractors of the larger ones. As in other districts, it is going through a phase of transformation. While the larger units are generally able to improve their NPD activities, the smaller ones are sluggish regarding this critical process. The study is addressed to SMEs producing or assembling a finite product. These are a minority – although important – of the population of the district firms. However, the study also provides some suggestions for SMEs operating as subcontractors and involved, to various extents, in NPD activities.

The layout of our work is as follows. In the next section the theoretical references that have guided the research are briefly sketched. The following section describes the objectives and methodologies, then the main results are given in the penultimate section and suggestions for making improvements are then presented.

Background

Effective NPD has become the focal point of competitiveness in many industries, particularly those where product life has shortened, competition increased on a global basis, and customer demand for greater product variety has grown (Maylor, 1997; Pisano 1997). Consequently, research on best practices in product development, that is, practices and methods which make firms good product innovators, has increased (see Abdalla, 1999; Griffin, 1997).

Analysing these contributions we can note that most are ascribable to concurrent engineering (CE) tools and techniques. CE suggests an "integrated" design approach, that is, a systematic approach to the integrated, concurrent design of products and processes. This would force developers to consider all elements of the production cycle right from conception to expedition, including quality, cost, schedule and user requirements. The main idea of CE is to integrate all the functions involved in the project, including external ones, i.e. suppliers and customers. The most widespread CE tools and techniques – grouped according to their goals – are:

- Reduction of the number of parts, by product modularization, standardisation of parts and project simplification.
- Manufacturability and assemblability, achieved using techniques such as design for manufacturing (DFM) and design for assembly (DFA).

- Project schedule and development time reduction, where tools such as work breakdown structure (WBS) and overlapping (OL) can be helpful.
- Product assessment using, for example, failure mode effect analysis (FMEA).
- Customer satisfaction, evaluated by value analysis and engineering (VA/VE) tools (De Toni *et al.*, 1999).

There are many articles listing the advantages of these "concurrent" methods and tools, used in alone or, preferably, in groups (Maylor, 1997; Ettlie, 1997; Loch *et al.*, 1996). A large number of these practices are more effective if the suppliers are involved. Various empirical investigations have shown that supplier involvement in NPD can be beneficial with regard to the quality of new products and the costs and time of their development (see Wynstra *et al.* (2000) and Dowlatshahi (1998) for a review of this topic).

Thus, the literature on best practices in NPD is abundant, but most of the research is oriented towards large companies (Wu *et al.*, 1995; Weber *et al.*, 1999; March-Chordà *et al.*, 2002). The few exceptions may be located in two main areas of research:

(1) *Critical success factors.* Analysing a sample of small and medium-sized Spanish firms, March-Chordà *et al.* (2002) show that the most common obstacle to innovation among SMEs is the excessive cost of product development projects. The uncertainty of market acceptance is the second major difficulty. In addition, the study shows the key role played by top management support, the low levels of formalisation in such projects and of multi-functionality, autonomy and capacity for self-regulation of the project units. Rinholm and Boag (1987) document empirically the importance of formal control procedures for success in NPD in small technology-based firms. Romano (1990) analyses the factors affecting the level of product innovation in the settings of small enterprises. Among the key factors, Romano (1990) lists ability to transform ideas into concrete and formalised plans, reliance on adequate process technology and highly skilled employees, ability to capture market needs. Finally, Eversheim *et al.* (1997) focus on the issue of information technology for the successful implementation of CE in SMEs.

(2) *Practical approaches.* Among the papers, the work of Usher (1996) must be mentioned. He proposes a strategy, for implementing CE, based on a cyclic approach for continuous improvement. Albin and Crefeld (1994) elaborated a check list for early input tracking and monitoring of NPD projects in small companies. Others have a precise industrial connotation. For example, Weber *et al.* (1999) describe an electronic consulting system that supports aeronautic SMEs on their way towards CE. Wu *et al.* (1995) propose an integrated product design methodology and tested it in a company producing toys.

With some exceptions, therefore, papers addressing the problems and tools needed for the implementation of NPD activities in small organisations are lacking. However, the innovation process in this context has characteristics that would suggest a specific approach (see Freel (2000) for a review on these topics):

- *Informal processes*. The innovation process in small firms is often informal and weakly structured. Informal communication may, however, promote and facilitate innovation by speeding up decision making.
- *Culture and management competencies*. Many "small" entrepreneurs have mainly a technical-productive education, and neglect the importance of investments in software as opposed to traditional machinery. Being a complex, inclusive process, innovation requires an eclectic base of managerial competencies and resources. Management deficiencies within small firms are postulated to include poor planning and financial evaluation, inadequate delegation, lack of functional expertise, discontinuity of management staff (Noteboom, 1994) and insufficient marketing endeavour. In addition, the development process depends greatly on the role and personality of the owner/manager. This role is of critical importance, as the latter often performs many tasks, e.g. technological assessment, building and maintenance of external links, internal communication and human resource development.
- *Skilled labour*. Small firms may be hampered in their ability to recruit, train and retain highly qualified competent personnel, since they are often unable to match the wage opportunities, carrier development opportunities or job security given by large firms (De Toni and Nassimbeni, 1996). Accordingly, small units are disadvantaged in the market for skilled labour, a resource which is essential for successful innovation particularly during the early stages of product development (Hadjimanois, 2000).
- *Finance*. Access to finance and supposed equity gaps are commonly cited barriers to innovation in small firms. Many of them lack the relevant co-specialised assets that would qualify them for benefits to be used for innovation.
- *External information and linkages*. In many units, the absence of specialists makes the search for information more costly or misdirected. As far as interfirm relations are concerned, disadvantages of scale and the shortfall of resources and competencies should urge small firms to look for access to external sources. However, often individualistic attitudes and poor awareness of external opportunities prevail in these units (De Toni *et al.*, 1995; Nassimbeni, 2001).

There do not appear to be any papers on the specific problems of NPD in IDs. However, various authors point out the characteristics of the innovative

process that typically develop in IDs. We can observe how the district localisation mitigates some of the limits mentioned, but can generate others:

(1) District firms benefit from external economies (the presence of agencies that offer specific services, a specialised labour market, support infrastructures, lower transport cost, greater facilities for interaction thanks to geographic proximity and common cultural identities, etc.) (Nassimbeni, 2003). Thus, the district location mitigates problems related to:
   - information access and exchange;
   - difficulties in developing and managing inter-organisation relationships; and
   - the availability of a skilled workforce.

(2) On the other hand the strong division of labour (specialisation), and the consequent fragmentation of production tasks that characterise the ID, hinder the "concurrent" management of innovative processes. Moreover, they prevent the development of product and process holism required for effective NPD activities. Thus, path dependency towards only a few (mainly) productive tasks emerges. Finally, it does not favour "systemic" innovation. Robertson and Laglois (1995) observe that in the past industrial districts benefited from the rapid exchange of information, thanks to the firms' geographical proximity and the high mobility of personnel. However, when innovation involves changes that span stages of production or even industries, specialisation might retard the realisation that an innovation produced for one purpose could serve other needs. Moreover, innovations adopted at one stage of the process could prove to be sub-optimal for efficiency at other stages.

This problem is particularly relevant nowadays, when many scholars are questioning the future of the local system. In the era of globalisation is the district formula maintaining its vitality, is it beginning to decline, or is it just changing shape? No unequivocal answer to this question can be found in the literature. On one hand there are those who think that globality is showing up all the limits of local industrial systems (Ferrucci and Varaldo, 1993; Gottardi, 1996; Grabher, 1993). On the other we find experts who consider the contraposition between global and local only apparent (Becattini, 1999; Porter, 1990, 1998; Fabiani *et al.*, 1998; Signorini, 1994). The literature indicates various positions regarding the prospects of local systems in the new competitive context. However it is a widely shared opinion that global economy is modifying the traditional territorial forms, changing their inner ties and strengthening their need to open up to the outside (Amin, 1993; Rullani and Romano, 1998). The district firms, both those that are situated at the end of the production line and those that cover intermediate phases, are now urged to make changes on numerous fronts. End-producers are becoming more aware of

the need to rethink the organisation and localisation of the value chain activities. Among these, product development must be placed at the forefront. At the same time, the local subcontracting network, which in the past carried out most of the productive work, now must extend its expertise and capabilities beyond the production task. The ability to manage all aspects concerning product development has become critical for these units too.

Objectives and methodology

This research project aims at suggesting ways to help rationalise the phases and activities leading to the manufacture of eyewear in SMEs. The objectives were:

- Highlight the distinctive aspects of eyewear products and the consequent design and manufacturing specificity.
- Map the product development activity, singling out the organisational interdependence between the units involved (internal and external), possible overlapping of activities and the milestones in the process.
- Identify difficulties and problems SMEs usually encounter in these activities.
- Suggest how improvements could be made.

In the next two sub-sections the main characteristics of the industry, the district examined, and the research methodology are briefly outlined.

The eyewear industry

Data on this industry were collected by sources such as the National Association of Factories of Optical Articles (ANFAO, 2000, 2001), the Local Manufacturers Association (Assindustria Belluno, 2001) and former research work (Databank, 1997, 1998).

Italy is the foremost country for frame production, in fact four Italian companies are the world-wide leaders. This sector therefore represents a significant part of the Italian "fashion" industry. In 2000 the Italian eyewear sector registered productions valuing around 1.75 billion (70 per cent exported). This business is concentrated in the area we considered. The production value of the districts is 1.44 billion, with 13,700 employees in 820 companies (ANFAO, 2000). Indeed the industry has been present in this district for more than a century. Traditionally it was characterised by the following aspects:

- high concentration of production units;
- prevalence of small companies;
- strong relations, both competitive and co-operative, between the firms.

During the last few years, the eyewear industry, and the district we are considering, have been confronted by significant changes. Although Italy still maintains its leadership (Italian producers claim 54 per cent of the world

market (ANFAO, 2001)), Asian producers have become more competitive, since the quality/price ratio of its products has improved considerably. The Italian association of factories making optical articles estimates that in China alone around 90,000 employees work in this industry, where the wages are about 20 times lower than in Italy (ANFAO, 2001).

Clearly Italian producers cannot compete on price, but on greater product differentiation based on design, quality and customer service. A study by Databank (1998) on the key competitive factors in the eyewear industry shows that product innovation immediately follows "distribution capability" and "trademark" as an important factor. Consequently, new skills and competencies are required by Italian manufacturers. In the first place, commercial competencies are needed, since the trademark has become the main vehicle for selling. It is essential for a firm to be able to link its brand name to well-known stylists and designers. Then the need for superior marketing and distribution resources arises. To find a niche in the market, greater financial means and higher sales volumes are requested. The most significant changes probably concern NPD activities, where the ability to develop new products in ever shorter times are required, though nevertheless guaranteeing the quality standards that distinguish "made in Italy" glasses on the international market.

Product innovation is strategically important not only for end producers, but also for subcontractors of parts and workings, as the possibility of promptly changing or customising the product depends also on the design and innovation capability of the supply network. One of the most important vendor selection criteria is therefore its ability to sustain an advanced technical dialogue with the main contractor, quickly adapt to changes in product engineering and contribute to product innovation. In other words, the dense network relations that characterise the district situation call for all the participants to pay particular attention to the NPD process.

Research method

The study used a database gathered during a previous investigation on district evolution (Nassimbeni, 1999a). Data are updated to year 1999 and refer to a sample of 54 firms, five main contractors and 49 subcontractors. The district is characterised by the presence of a limited number of main contractors (producers and/or final product assemblers, usually medium to large-sized firms) and a dense network of small enterprises (usually subcontractors). This way the phenomenon could be analysed from both the buyers' (large producers) and local suppliers' points of views. All these units are located in the district area.

Main contractors were selected according to their size and importance to local subcontracting systems. Both in terms of sales (more than 60 per cent of overall district sales) and product typology, this sample can be considered satisfactorily representative. Among the five main contractors, three are

large and two medium-sized enterprises, according to the definition of the European Commission[1]. The study, focused on SMEs, considered only the latter two. The remaining 49 enterprises are all small or medium enterprises that operate as subcontractors to the five main contractors mentioned above. Some of these, however, also produce an end product.

Two different approaches were used to collect data: one of which was a multiple case-study analysis of main contractors in conjunction with a survey of subcontractors. Mainly qualitative information was gathered from the main contractors (i.e. the evolutionary dynamics of the eyewear industry and the strategic response of large producers): the multiple case-study approach is appropriate when a detailed analysis is required of a phenomenon that can be described mostly in qualitative terms (Flynn *et al.*, 1990). When the aim of a research project is mainly to describe events and outcomes in order to understand the process and the environment, case-study research is commonly applied (McCutcheon and Meredith, 1993).

In contrast, a survey was carried out among the subcontractors to collect mostly quantitative data (firm's size, managerial and technological characteristics of firms, etc.). A larger sample of firms was required here since the population of subcontractors in the district is far greater than that of main contractors. The questionnaire was developed by the research group and tested on three firms. As specialised interviewers carried out the survey, they were able to collect qualitative information and subjective opinions on the evolution of the district and the prospects of small local units.

In addition, we carried out structured and un-structured interviews with experts (managers of local agencies for district development, consultants and professionals with experience in the sector) to obtain greater detail on some aspects of the process and a clearer idea of the current difficulties of SME.

Results: eyewear development process and specificity

Here the phases involved in eyewear development, as described during the interviews, are briefly summarised. The account is deliberately simplified and is a generalisation of a process that can differ according to product typology, the technology used and the entity of external resources.

Design and production particularities of glasses

They can be described as follows:

(1) The variety and variability of shape and structure of the product, as a consequence of three interrelated determinants:

- The close link to fashion, which determines seasonal variations (form, size and colour)[2].
- The shorter life of the product, with the consequent need continually to renew the product and change the process. At present the larger

groups renew approximately 40 per cent of their production lines every year.

- The growing segmentation of the market, with corresponding product and process requirements. The eyewear market has progressively changed and product standardisation has been replaced by a policy of differentiation. Thus, the complexity of forecasting, product design, manufacturing planning and control phases has been enhanced.

(2) The variety of technology and processes required as a consequence of the number of materials used in different (plastic or metal glasses) or in even the same product (e.g. glasses with plastic rings and metal temples or models made entirely of plastic but with metal decorations).

(3) The large number of internal and external units involved in the process: the external stylist, at the early stages of the process, as well as the suppliers, involved in the design and in the manufacturing stage. It follows the urgent need to integrate the responsibilities and competencies of this network of contributors.

Product development activities

The above-mentioned specificity requires a careful design approach, which should take into account all the technical constraints, so product and process engineering phases must be closely integrated. For example, the NPD process for metal-framed glasses (the foremost product) is the following (Figure 1).

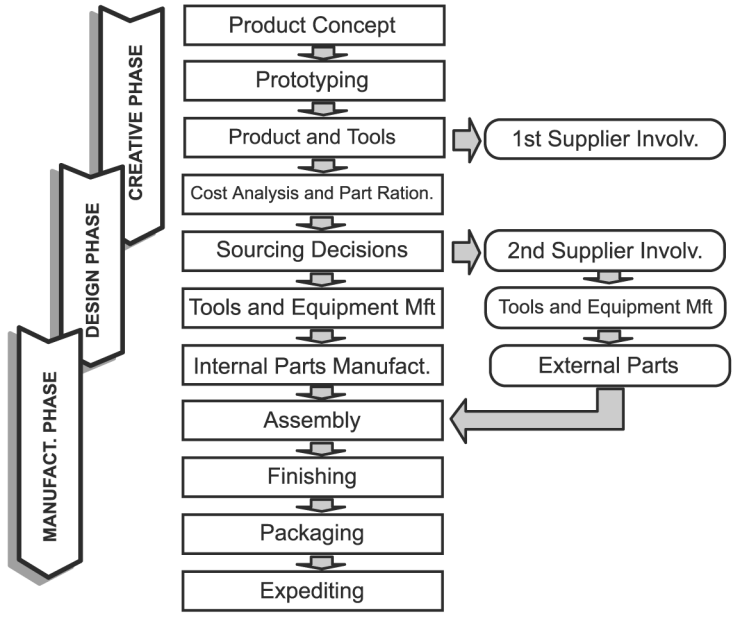

Figure 1.
The flow chart of activities

The first step is product concept resulting from a market analysis and has the objective of formalising the initial idea of the new model. Next comes prototyping when the prototype of a new model is constructed according to the original design, so the new-style eyewear becomes tangible. The similarity between the aesthetic idea of the product and actual result obtainable can be verified from the prototype and, at the same time, difficulties in processing and the specifications needed identified. Then product and tools design starts. The new model is broken down into its various components (temples, rings, end-pieces, nose-pieces, bridges, hooks) and the technical specifications and a detailed design for each is made. At this point the first supplier involvement takes place. It can assume different forms depending on the buyer's design choice and the supplier's profile:

- suppliers of standard components;
- suppliers of co-designed components;
- suppliers of parts entirely designed by the buyer.

Regardless of the amount and type of involvement, this is the moment when co-design begins. Some suppliers are invited to take part in the development activity and the type and characteristics of the components to be manufactured are disclosed to them. Next follows the cost analysis and part rationalisation. Here manufacturing cost is estimated and ways to rationalise the components defined in the previous phases are detected. For example, a standard might replace an *ad hoc* component, different materials can be selected, the product mix can be limited, etc. When the design phase has been concluded, a decision must be taken on which parts are to be made externally and by which suppliers (sourcing decision). This choice involves not only suppliers of parts, but also small workshops capable of carrying out specific operations.

Once the designing activities have been completed and the models chosen, tools and equipment are prepared and internal or external manufacturing begins (second supplier involvement). It is important to contact the suppliers promptly so as to reserve their productive capacity and fix the working times and delivery dates. At the same time as components are being manufactured, the tools for welding must be produced. Once the parts have been delivered, the cycle of assembly begins, i.e. welding of the ring pieces together to which then the temples are joined to complete the samples. Finally the operations of finishing, packaging and expediting to the sales channels are carried out.

The macro-phases

The preceding activities highlight three macro-phases:

(1) *Creative phase*. This consists of mainly creative activities aimed at the formalisation of the aesthetic content of the product. Stylists and designers take care of the stylistic aspects, the innovations derived from shape, particulars and colour variations.

(2) *Design (technical) phase.* Converts the product concept of the new model into a project containing the technical specifications and manufacturing tools.

(3) *Manufacturing phase.* The tools needed to produce the new model are constructed and tested and their manufacturing arranged.

These phases should be connected and overlapped. Indeed it is important that the contributions made by the "creators" benefit from contact with the product developers, just as it is necessary for the design project to be successively verified with the people responsible for manufacturing.

Current problems

This NPD mapping analysis enabled us to identify some typical problems faced by the SMEs. They are mostly organisational and managerial problems that can be summarised as:

- Poor or rough formalisation of the steps in product development. We think that significant improvements in NPD performances could be obtained by a clearer reconstruction of the phases, activities and tasks.
- Weak connections and overlapping between the creative, technical/design and manufacturing phases. Instruments for organisational co-ordination that would link the different competencies and responsibilities are lacking. As seen above, overlapping of some activities not only is possible, but also necessary, although only few firms have systematically tried to achieve it.
- Limited monitoring of the temporal milestones. Therefore delays are frequent.
- Difficulties in integrating and synchronising the external contributions, which – as mentioned before – occur in almost all the development stages.

On the subcontractors' side we encountered several problems related to the technological and managerial tools used[3].

Among the 49 companies surveyed, only 4.1 per cent have an electronic data interchange (EDI) or Internet-based link with the supplier and 2.0 per cent with the customers. The level of use of modules and standardised components evaluated on a five-point Likert scale is equal to 1.76, and that of DFM and DFA practices is 1.91. The use of techniques for defection analysis is equal to 1.3. computer-aided design (CAD) and computer-aided manufacturing (CAM) instruments are present in 8.2 per cent of the firms investigated, though it is planned to introduce them in respectively 28.5 per cent and 16.3 per cent of the cases. According to the interviews, three factors hinder their use:

(1) the level of investment, judged to be too high for the volume of products manufactured;

(2) the low level of importance that entrepreneurs attribute to the design phase;

(3) the difficulties they have in understanding the potentials of such systems.

Innovate product development activities in the SMEs: some suggestions

Downstream from the analysis of the NPD processes, we tried to individuate ways to re-appraise and re-organise these activities. The first type of intervention concerns the cultural sphere as this is where we encountered the main obstacles to innovation. Some deeply-rooted assumptions regarding the NPD process exist in the firms analysed and need to be changed. Much of the following section is the result of a knowledge-based approach to NPD. It is one of the most interesting of the recent developmental directions in this field of research (see Nonaka and Takeuchi, 1995; Leonard-Barton, 1995; Balasubramaniam and Tiwana, 1999). Subsequently we concentrate on organisational and managerial practices, changing some basic assumptions.

According to our data and the opinions of several experts interviewed, some deeply-rooted assumptions which hinder the improvement of NPD activities need to be changed. Large firms have already modified their way of thinking, but the cultural inertia of SMEs is much stronger. These assumptions are related (Figure 2) to:

- *Product value*. In the past, consumer behaviour was almost entirely influenced by product functionality i.e. correction of a visual pathology. The product therefore required purely technical features, such as practicality and comfort. Later the consumers' attention moved away from the corrective function and towards aesthetic characteristics,

Related to:	Current assumptions		New assumptions
• **Product value**	Material, bound to its functional use	⇨	In great part immaterial, bound to its capacity to recall new "scenarios" for use and to identify a style
• **Designers' task**	To solve the technical problems and detect efficient solutions for mft	⇨	To capture explicit and implicit mkt requirements, to represent a vision, to impose a style, to identify and integrate potential sources for innovation
• **New Product Development**	A sequence of mostly technical activities, a chain of distinct responsibilities	⇨	A process connecting distributed knowledge, a shared responsibility
• **Knowledge**	Mainly explicit, articulated in specialist domains, owned by distinct professional categories	⇨	Also tacit, spread in pluralistic domains, considered as a collective patrimony
• **Organisational Design**	Rigid work distribution (knowledge fragmentation)	⇨	Hierarchical level reduction, inter-functional teams with extended tasks, mgt by process and projects
• **Local system**	A source of efficiency and flexibility	⇨	The locus of contextual and tacit knowledge, a source of distinctive capabilities

Figure 2.
"Current" and "new" assumptions

intrinsic quality and image. Nowadays the product value is, for the most part, intangible, linked to its capacity to identify with a style. However in SMEs the idea that the product value is mostly "material", "tangible" and connected to its "functionality" is still widely held.

- *Designers' task*. The dominant assumption is that the designers' and product developers' task is to solve technical problems and suggest efficient manufacturing methods. In contrast today they must also develop the ability to capture explicit and implicit marketing requirements, to represent a vision. Since – as we have seen – the market is crying out for continuous and faster product updates, there is the need to identify and integrate all potential sources for innovation (new product materials, colours, treatments).
- *NPD*. It is often considered to be a sequence of mostly technical activities, a chain of separate responsibilities. The idea of NPD as a process that involves distributed skills, knowledge and responsibilities has not yet been fully assimilated.
- *Knowledge*. Another deep-rooted assumption concerns the knowledge requirements of designers and the concept of knowledge itself. It is mostly considered in its explicit form, possessed by distinct professional categories. Knowledge needs to be implicit, and should be viewed – to some extent – as a collective patrimony.

What are the consequences of these assumptions on organisational design and local system involvement?

- *Organisational design*. Even though organisational roles and responsibilities are often confused within the sampled SMEs, a rigid (functional) distribution of work prevails, which recalls the classical separation between cognitive and executive work, between "thinking" and "doing". This division leads to a fragmentation of knowledge and skills. We believe that organisation should be thought of in a different way, for example reducing the hierarchical level, creating inter-functional teams with extended tasks, and management by process and projects. In such a way distribution of the knowledge and skills required would be improved, sensibility to intangible aspects of product value greater, and a more effective access to external resources acquired. In other words, it is the right time to discard the current division between functional work and knowledge. Activities previously carried out in a sequential manner must now be converted into overlapping processes that will favour the exchange of knowledge and mutual feed-back.
- *Local system involvement*. Traditionally, the local system was considered a source of efficiency and flexibility. However these advantages have been reshaped since subcontractors from the Far-east or eastern Europe now offer more favourable cost-structures, and the fragmentation of the

production tasks leads to problems of co-ordination and control. However, it has been pointed out in the literature (see Becattini and Rullani, 1996; Corò and Grandinetti, 1999; Nassimbeni, 1999b), that the local system can maintain a central role as a "locus" of contextual and tacit knowledge, a source of distinctive capabilities. How changes in the local system are considered, and consequently the criteria used for the selection and integration of local subcontractors must be updated. Our data show that almost all main contractors are rationalising the supplier base and selecting a reduced number of local subcontractors. Therefore, the prospects are still good for those small district subcontractors who are able to sustain an advanced technical dialogue with the main contractor (using, for example, CAD-CAM systems), innovative work materials (such as: titanium, nickel-free and copper-beryllium alloys), and connect up to buyer's operational systems (using for example production planning and control systems compatible with those adopted by the buyers). In other words, these units need to improve their "relational" receptivity so they can exploit their patrimony of technical expertise and manufacturing tradition.

Managing the NPD as an inter-functional and inter-organisational process

Starting from these "new" assumptions, operative suggestions can be grouped into three steps:

(1) *Process description*. This consists in the identification of the phases, activities and tasks involved in the entire development process. As pointed out above, the sequence of activities and the corresponding responsibilities are frequently vague, not formalised and confused. It is important that all organisational units involved in NPD have a clear understanding, and not just a sectarian view, of the complete process. The first step is then to separate the process into basic activities (work breakdown structure).

(2) *Process re-design*. The second step is to compile a GANTT diagram indicating the activities, times and any possible overlapping. Following the interviews we tried to identify the activities that constitute the critical path, and any possible overlapping. The results are shown in Figure 3. We also attempted to identify the milestones in the process, that is, the main appointments which determine the temporal evolution of the process. These are:

- *At the end of product design*. This is the moment at which the "creator's" drawing (usually of a greater number of models than will be actually manufactured) has been re-elaborated and transformed into technical specifications. Thus the new model has been completely defined and is now ready for industrialisation.

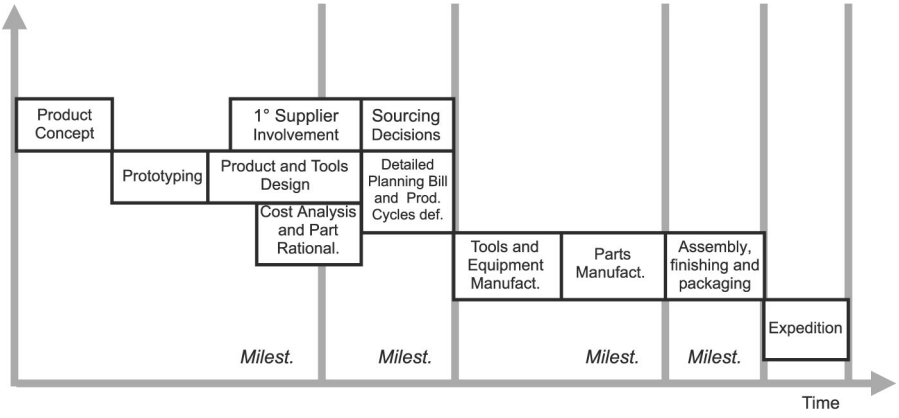

Figure 3.
Overlapped phases and milestones of NPD

- *Upstream from manufacturing*. At this point the costs and times (based on the suppliers' lead times) have been estimated, and the decision made regarding which work must be carried out externally. It is advantageous to examine the situation at this stage to see whether the model is viable in terms of times and costs. It is also the right time to verify if the design can reconcile the creative work of the stylists with the economic and productive constraints put forward by the technicians.
- *Upstream from assembly*. This is the moment when the manufacturing of components and assembly tools has been concluded.
- *Start of the distribution phase*. The last checking step is situated at the end of the assembly phase, that is, before selling the product to the wholesaler. This phase should be taken into consideration right from the beginning of the NPD. In fact, the distribution lead time can be significantly high for small producers, since they generally have not got their own selling points (this notably increases the risk of not meeting the launching date on the market).

(3) *Process innovation*. That is the implementation of practices targeted at a more efficient management of NPD. These practices can be sub-divided according to the area of intervention:

- *Organisational area*. In many of the companies investigated it has become necessary to move beyond the present functional structure and adopt matrix forms, i.e. introduce project teams guided by a project manager. Development teams must be formalised and instructed so they can integrate the contributions made by professionals from different units involved in the NPD process. Involvement must regard the external "creators" (stylists) and be extended also to the suppliers.

The logic of partnership with external resources should be developed, aiming at more stable and participative relations. A continuous flow of information (concerning the technological potentials and the capacity constraints of the downstream phases) is particularly important during the first phase of NPD, when it is easiest to introduce modifications and the impact of the decisions on the cost is greatest. The firm's "transactional" environment needs to be extended because significant opportunities (market extensions, co-operation with other firms, etc.) can be found beyond the boundaries of the district or the local system. Greater emphasis should be placed on "boundary spanning" units i.e. units (product development, as well as procurement and sales) and roles that create the link between external and internal networks and play the part of information gatekeeper concerning the evolution of adjacent environments.

- *Managerial area*. Some of the CE techniques, such as FMEA, quality function development, DFM/A tools, together with project management techniques could be very useful. Prototyping, which lessens the risk of error and helps design, is of great importance and should be extended.
- *Technological area*. The adoption of technologies to support development, in particular CAD and CAE interfaced with NC systems, can make NPD much more efficient, so errors and consequent modifications can be forestalled. These technologies, at present mostly used in making moulds, could be extended to other phases. Nowadays the cost of such instruments is not excessive and is well within the reach of SMEs. Another area in which it would be advisable to invest is communication technology. Data communication networks speed up information exchange between buyers and suppliers and establish direct contact with the customers. An on-line product catalogue linked to an efficient delivery system would bypass the long and slow distribution channel on which the SMEs now rely.

Conclusions

In this paper we present the main results of a research project aimed at rationalising and improving the NPD process in SMEs of the Italian eyewear district. On the bases of empirical evidence, the specificity of this product and the main steps in its development were identified. Then, the problems and limitations usually faced by the SMEs are highlighted. Finally, the study suggests appropriate methodologies for NPD.

Many limitations mentioned in the literature on NPD activities in the SMEs are confirmed. For example SMEs often resisted the introduction of several CE tools. Most of the units examined are not aware of CE principles and the benefits they can bring. Managerial resources are limited and they have little

technical know-how on re-engineering or continuously improve processes, and how to select appropriate tools from the large number of CE supports. As a result the steps in PD are poorly formalised. There are weak connections and overlapping between the various phases, monitoring of the temporal milestones is limited, and integration and synchronisation of the external contributions are unlikely.

On the other hand, empirical evidence suggests that the scarce availability of financial resources is not the real barrier. The methodology for NPD proposed here does not require large financial investments as it is mainly based on ways to improve the allocation and use of available resources. In the first place it requires changes in cultural attitudes. Enterprises need to learn the role played by intangible determinants of product value, redefine the profile and the tasks of designers, and think of NPD as a process rather than a sequence of distinct responsibilities. Moreover the importance of knowledge must be re-discovered. It is not merely a basin of theoretical or scientific ideas or codified practices, but a pluralistic, shared dominion of tacit expertise.

The consequences of organisational design affect, *in primis*, product development. Echelons, previously considered of minor importance as they are only involved at the end of the value chain (such as customers or suppliers), nowadays acquire new importance. Attention to knowledge-related aspects is particularly important for the enterprises considered. They operate within a district system with a tradition for manufacturing and where localised expertise exists. In order to exploit these distinctive capabilities "relational architecture" should be developed. We point out the opportuneness of decisional decentralisation, the use of inter-functional teams with extended tasks, and management by process and projects. It is also important to develop the proper technological network infrastructure, which means building not only the physical channel, but also a common language, procedures and operative logic that are the basis of a true link with external resources.

District localisation should facilitate the enterprises in many of these transformations. Within districts there is a greater propensity to interfirm relationships. However, the local industrial system usually communicates through informal language and interactions are mostly based on trust. Today instead formal language, codified knowledge, and shared standards are requested in order to develop alliances and interactions on enlarged scale.

In conclusion, although the methodology proposed could possibly be applied also in non-district SMEs, the district environment influences its implementation, facilitating some interventions (extension of the transactional environment, access to shared expertise) and hindering others (project formalisation and scheduling, "concurrent" management of the process).

These changes are not easily understood and achieved by entrepreneurs with a predominately productive background, but the future of many small units probably depends on them.

Notes

1. According to the European Union regulation, an enterprise can be considered small or medium-sized if it has less than 250 employees and a turnover lower than 40 million Euro. Moreover it must be independent, that is, 25 per cent or more of its equity cannot be controlled by large-sized enterprises.
2. As already pointed out, eyewear is now almost completely governed by fashion trends. The trademark has become one of the most important competitive weapons. The most famous fashion stylists (Armani, Valentino, Ferrè, etc.) carefully choose the eyewear manufacturers that they will entrust with their brand name, privileging those equipped with greater productive and commercial solidity. Sound management of the brand calls for investments in research and development and a solid commercial structure. Collaboration between stylist/designer and producer is no longer just occasional as in the past. It has become a medium to long-term investment.
3. The questionnaire used in the survey collected information on:
   - NPD and quality management practices. Using five-point Likert sales, we collected data on: design for manufacturability or assembly practices; component standardisation; product modularization; and use of defect analysis technique.
   - The technology adopted in PD and manufacturing activities. Using dichotomous variables (presence or absence of the technology), we collected data on the use of CAD, CAM tools and EDI or Internet-based communication tools.

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