EXPLORING CHARACTERISTICS OF INNOVATIVE COMPANIES: A CASE STUDY IN SPAIN

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ABSTRACT

In this paper we present the results of an exploratory study about specific organizative characteristics that innovative companies possess. This study is part of a wider research work about the innovative behavior of firms (Camelo et al, 2001). The case study about four organizations included in the Andalusian Innovations Network reveals that certain factors do exist which behave as the literature supposes they should, along with other factors which are also worthy of consideration given that they contribute to improving our understanding of innovation within a company.

I. INTRODUCTION

The innovative activity of organizations as a response to the ongoing changes in the environment, and the competitive advantage that can result from such innovative behavior, has attracted the attention of several researchers who try to identify the factors that favour innovation (Damanpour, 1988; 1991; Wolfe, 1994; Damanpour, y Gopalakrishnan, 1998). The emergence of new structural designs, the increasing importance of the interorganiative relationships and the development of information tecnologies, pose new questions that are worth investigating (Ruigrock et al., 1999; Daft y Lewin, 1993; Hitt, Keats & De Marie, 1998).

Our purpose is double: on the one hand, we want to know if the innovative firms, our object of study, present the characteristics that the most recent literature consider key to innovation; on the other hand, we propose some research questions that will be tested in a future study with a wide sample of innovative companies in Spain.

Even though a wide range of literature has been published on the subject of innovation, the contradictory aspect of the results achieved means that it remains a subject of interest. One of the first problems faced when initiating research into the matter is that of its conceptual and typological delimitation. Although, epistemologically, the word "innovation" has a clear meaning – to make something new -, the different ways in which it has been treated in literature make it necessary to clarify exactly which concept of the term is being used. (Gopalakrishnan & Damanpour, 1997; Tidd, Bessant & Pavitt 1999; Cumming 1998; Escorsa & Valls 2000). Innovation in the widest sense of the term, or organizational innovation, is related to the putting into practice of new ideas or solutions (Quinn 1979; Tidd, Bessant & Pavitt 1999; Escorsa & Valls 2000), and supposes the

introduction of change, be it technical or technological (in the case of products or processes), commercial or market, financial, social (related to human resources), administrative or organizational (Frascati Manual of the OCDE[1]; Damanpour 1991; Sánchez & McKinley 1998; Pavón & Goodman 1981; Yamin, Gunasekaran & Mavondo 1999; Wolfe 1994). This, basically, is the concept of innovation put forward by Schumpeter (1996).

A more restrictive version of the term is that of technological innovation, related to the introduction of new or improved products, or services, onto the market and/or the use of new or improved production methods or processes (Oslo Manual of the OECD/EUROSTAT 1997[2]; Braun 1986; Sidro 1988). Or as O'Sullivan (2000) points out, those processes by which productive resources are developed and used in order to generate products of a higher quality or lesser cost.

Furthermore, for some authors, it is not a sufficient requirement that the product be introduced onto the market or that the process be used (Oslo Manual of the OECD/EUROSTAT 1997; Audretsch & Acs 1991), but that it must also be successful (Pavón & Goodman 1981; Sidro 1988; Cumming 1998; Sánchez 1998b, Escorsa & Valls 2000; & Pavitt 1984) or be sold effectively (Guellec 1999). Burgelman & Sayles (1986) point out that the success criteria for innovation is commercial, whilst for invention it is technical.

Another distinction made with regard to innovation is in reference to its environment. For some authors it is necessary for the product or process to be new (or improved) on the market or even in the world (Pavón & Goodman 1981, Cumming 1998), whilst for others it is enough for it to be new (or improved) for the company (Oslo Manual of the OECD/EUROSTAT 1997; Damanpour 1991; Sánchez & McKinley 1998; Tushman & Nadler 1986; Nelson & Rosenberg 1993). In this sense, Guellec (1999) differentiates between two different types of innovation: global, when the novelty is for the whole economy, and local when the novelty only applies to a restricted entity such as a company.

A third aspect is the type of innovation being addessed. The existing typlogies differentiate between organizational innovation versus technological innovation and global innovation versus local innovation. In accordance with our purpose, we can differentiate between product innovations and process innovations (Tushman & Nadler 1986; Archibugi, Evangelista & Simonetti 1994; Pavitt 1984; Camelo et al 2001**;** Tidd, Bessant & Pavitt, 1999; Archibugi, Evangelista & Simonetti, 1994); according to their incorporated degree of novelty, between radical innovations and incremental innovations (Oslo Manual of the OECD/EUROSTAT 1997[3]; Pavón & Hidalgo 1997; Tidd, Bessant & Pavitt 1999; Detienne Koberg & Heppard 2001; Garmain 1996; Shenhar, Dvir & Shulman 1995; Tushman & Nadler 1986; Green, Gavin & Aiman-Smith 1995). Paying specific attention to the type of event necessary for innovation to take place, a differentiation has been made between tacit-explicit innovation, systematic-autonomous innovation and simple-complex innovation (Gopalakrishnan & Bierly, 2001).

Two final aspects, of a general character yet relevant to the study of innovation, are those regarding how to measure the output of innovation and its impact upon the results of an organization. With regard to innovation output, this may be measured on the one hand using deeds of industrial property (patents, utility models, etc..), and, on the other, from those new or improved products which have been launched onto the market and/or those new or improved processes which have been successfully introduced.

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[1] De Oyarzábal (1985)

[2] The definitions of the second version of the Oslo Manual (1997) have been used in the second Community Survey on Innovation 1997/1998 (EUROSTAT, 1999) in which all the member countries of the European Union collaborated along with Iceland and Norway; and likewise in the national surveys on innovation in Australia, Canada, Czech Republic, Hungary, Korea, Mexico, Poland, Russia, Slovac Republic, Switzerland and Turkey (Muzart, 1999).

The use of patents as an indicator of innovation presents diverse limitations, as not all innovation made in a company is patented (Sánchez 1998). The tendency to patent varies according to the sector (Mansfield, 1986) and companies may prefer other, different forms of protection (Mansfield, 1986; Arundel, 2001; Quintero 1997; Buesa 1998, Buesa & Molero 1998). Even for a single company the number of registered innovations usually varies according to the patent statistics analysed (Watanabe, Tsuji & Griffy- Brown 2001)[4], it being foreseeable that a company may use patents only when it perceives the existence of technological competitors (Gumbau, 1994). Finally "a patent is a sign of new technical knowledge, but fails to indicate if such knowledge has any economic value given that only those innovations which have been successfully introduced onto the market may be regarded as innovations" (Sánchez 1998b, p. 98).

On the other hand, Kingston (2001) has noticed a new tendency in the case of complex technologies, where patents may prove to be a disadvantage to companies if they prevent other companies from accessing knowledge, as they could miss the opportunity to establish standards in their sector. Patents would not be used, therefore, in order to prevent other companies making use of the innovation, but as a currency of exchange which would allow cross-licences to be obtained, and in this way allow access to other innovations. This might lead companies to patent a large number of incremental innovations.

With the aim of overcoming any problems which may arise from the use of patents as assessment criteria for a company, it would seem correct to complete the said indicator with the introduction of new or improved products onto the market. It therefore becomes obligatory to obtain such primary data by means of some type of survey procedure, given the absence of any data bases which include such information (Sánchez 1998).

With regard to the impact which innovation may have upon the results of the organization, several different approaches have been used: the way in which it may affect several variables such as cost reduction, sales increases (González, Jiménez & Sáez 1997), the participation of the new products in the company's total sales or turnover (Eurostat 1999, Buesa 1998; Buesa & Molero 1996 & 1998) or the participation of the new products in exports (Buesa 1998; Buesa & Molero 1996; Fonfría 1999; Rodríguez 1999). Kuczmarski (2000) proposes the return on innovation, new product success rates, cumulative revenue and profit and growth impact as performance indicators for innovation.

In this sense, in a study of 237 Australian manufacturers, Yamin, Gunasekaran & Mavondo (1999) found that those companies possessing high and moderate levels of organizational innovation (product, process and administrative) do better than those with low levels of innovation in all the performance measures used (ROI, ROA, market share, performance ratios, etc.), although highly innovative companies do not out-perform moderate innovators in all indicators.

In our research we have opted to contemplate innovation in products and processes, to consider as innovation that which leads to a new or improved product, be it the object of a patent or not. We differentiate the environment of innovation, that is to say, if it is new to the whole world or only to the market in which the organization acts and, finally, we consider both the investment designated to innovation and any income produced by the results of the same.

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[3] Only in product innovations.

[4] His study shows, for example, how two Japanese companies have more patents registered in the Japan Patent Office than in the US Patent Office, which can be explained either by the difference in the cost of registering patents or by the market strategies being followed.

II. INNOVATION AND ORGANIZATIONAL CHARACTERISTICS

Of all the different variables which have been considered in current literature and in the integrated model of innovation which we have used as a reference (Camelo et al. 2001), in this paper we have focused upon the incidence of the organizational characteristics on the said process. It is these variables which, in the opinion of certain researchers, determine innovation to a great degree (Damanpour, 1988, 1991; Kim, 1980; Kimberley and Evanisko, 1981; Wolfe, 1994).

This explains the amount of work dedicated to determining which organizational structures and which management processes either promote or hinder innovation. What has traditionally been approached is the question of whether organic structures are more favourable than bureaucratic or mechanical innovation, in the terms of Burns and Stalker (1961), technological or administrative innovation, radical or incremental innovation or the initiation stage of innovation as opposed to introduction itself (Damanpour, 1991; Damanpour & Gopalakrishnn, 1998). Results obtained to date have yet to provide a consistent reply to such a question.

The origins of this lack of consistency are to be found in diverse questions. On the one hand environmental conditions may affect the relationship between organizational structure and innovation, which makes it advisable to include the environmental variable into the study of any such relationship (Damanpour & Gopalakrishnan, 1998). On the other hand, the wide range of approaches used prevents generalisation concerning the results obtained from research. In this sense Wolf (1994) mentions several different areas where researchers should reduce ambiguity if research findings are to be made comparable. First, the different stages of the innovation process need to be clarified, because the effect of certain variables within the organizational structure upon innovation may be different depending on the stage of the process under consideration. For example, complexity has a positive influence during the initiation stage and a negative influence during the introductory stage, whilst formalisation and centralisation have the contrary effect (Damanpour, 1988; Tornatzky and Fleischer, 1990; Wolfe, 1994). Second, the type of organisation should be considered since the tendency to limit each investigation to a single type prevents comparisons between organizations within different sectors or activities. Finally, the attributes of innovation under study and the measures employed, must be more clearly specified since each organizational variable may exercise a different influence depending upon the type of innovation being considered (e.g., administrative or technical, radical or incremental, product or process), If the measure being used for innovation fails to reflect these attributes, it would be inappropriate to assume that different types of innovation have the same determinents (Wolfe, 1994). Clearer specification of these aspects may help produce to more consistent results in research and enhance generalizability across studies.

Although effectively a certain degree of dispersion and ambiguity does seem to exist in the treatment of those questions relevant to the stage of innovation, the type of organization and the type of innovation under study, research which relates organizational structure and innovation does maintain a certain degree of uniformity regarding the use of Burns y Stalker's (1961) bureaucratic and organic organizational forms and the variables which characterise them: complexity, formalisation, centralisation, vertical differentiation, etc. Nevertheless, the natural evolution undergone by organizations in an continued attempt to be more competitive has substantially modified the type of relationships and communications, both intra-organizational and inter-organizational, which is forcing researchers to focus their investigations upon new conceptions of the traditional parameters arising from innovation. In this sense, Miles et al. (1997) describe the evolution which organizations have undergone

throughout different stages: standardisation, based upon a hierarchical structure; customization, which acts on the network structure; and innovation, using the "cellular" form in which the company is organised into smaller companies or cells. Daft & Lewin (1993) highlight the following as characteristics of these new organizational forms: horizontal in structure, decentralised decision making, tolerance of ambiguity, capacity for renovation, empowerment, permeability in both internal and external limits, self-organising units, etc. Ruigrok et al. (1999) consider the organization to be undergoing a three-dimensional restructuring: the structure (reducing number of levels, decentralising decision making and adopting flexible forms based upon projects), processes (by the use of information technology, new ways of managing human resources and the establishment of both vertical and horizontal links) and organizational limits (concentrating upon key businesses, outsourcing activities and establishing strategic alliances). In this context the flexibility, the creation of awareness and collaboration are considered to be essential features of the new organizational forms (Daft & Lewin, 1993; Volberda, 1998; Whittington et al., 1999).

This new scenario has led to a rethinking of the traditional paradigm that organic structures (not very formalised, decentralised, with few hierarchical levels) favour innovation, as the analysis of "organizational forms" has become enriched by the incorporation of new dimensions or new concepts of traditional dimensions, which leads us to pose different questions regarding their connection with innovation.

Flexibility

For example, flexibility; an essential attribute in the traditional organic models, is now being contemplated from multiple perspectives which go far beyond the idea of a not very formalised organization. Duncan (1976) had already referred to flexibility when he spoke of the ambidextrous model quoted above. Years later, Tushman & O´Really (1996) used the term "ambidextrous" to describe organizations which were able to successfully introduce both incremental and radical changes, based on the congruency between strategy, structure, culture and persons. Miles & Snow (1986), for example, have characterised their prospective organizations, able to develop innovative products and technologies ahead of their competitors, as owners of flexible structures, amongst other attributes. Flexibility and, therefore, innovative capacity has been equally considered a characteristic of the so-called "modular" organizations (Langlois & Robertson, 1992; Schilling & Stensema, 2000), which have been defined by Daft & Lewin (1993) as organizations undergoing continuous change and learning processes which solve their problems by means of interconnected, co-ordinated and self-organised processes, all of which enables them to adapt to new challenges and opportunities (Post, 1997; Sánchez & Mahoney, 1995; Sanderson & Uzumeri, 1995). As a way to achieve modularity Hitt (1998) proposes outsourcing, hiring contingency staff (part time, temporary or on contract) and alliances. "Modularity" may thus be considered to be the qualifier of a highly flexible organization.

The work of Ayas (1996) on the way in which an airplane manufacturing company developed new products describes a structure made up of a "network of self-managed teams" in which flexibility is made apparent by increases or reductions in size in answer to those needs imposed by the corresponding development stage of the new product

A more specific formulation of the relationship between flexibility and innovation is made by Sanchez & McKinley (1998) and which refers both to structural flexibility and that of the production process. The former is measured in terms of the "youthfulness" of the organization, considering more elderly organizations to possess a

strong structural inertia which has a negative influence upon flexibility. The latter is measured in terms of "customization" or "product flexibility" (Vickery et al., 1999), because when a company reaches an agreement with the specifications of a client it becomes necessary to make investments which will facilitate the necessary modifications to the productive processes. This attribute will have to be based upon a re-defining of the roles and responsibilities which must be widely adopted, which is considered to be one of the principles of the design of innovative organizations (Dougherty, 1992) and create the context which makes the generation and exploitation of knowledge possible. Specifically, the primary research question that we explore in our research is:

Do the innovative organizations which work essentially according to the specifications of their clients resort to greater use of contingent contracts and sub-contracts in order to achieve organizational flexibility?

Communication

A second organizational characteristic worthy of the attention of those interested in the study of innovation refers to the way in which communications take place within innovative organizations. This is an aspect which cannot be detached from the concept of flexibility as this, by definition, requires that many business processes not be too formalised. The basic idea is that an excessive formalization of communications could hinder the development of solutions to those problems of innovation which require the collaboration of different areas (Von Hippel, 1998). Innovative organizations must therefore have routines at their disposal that can cut across any limits established by the organizational structure (Pitt & Clark, 1999). This means substantial modifications to the traditional use of information as a source of limited, controlled power and converting it into an instrument with which to increase efficiency, which is spread throughout the organization and made available by electronic means (Daft & Lewin, 1993). Effectively, new technologies have placed communication processes in a different dimension and have given rise to the emergence of the so-called virtual teams made up of individuals situated at separate locations who are able to communicate instantly with each other via internet, intranet or video-conferencing (Hitt, Keats & De Marie, 1998). Without doubt, this form of communication within the innovative organization will require a new notion of work as a social process of collaboration in which people interact regularly yet informally and in which each individual has a clear vision of the global project (Dougherty, 1992). Therefore, a second question to be explore is:

Do the innovative organizations use informal communication processes, based on new information technologies, which the majority of the organization's members would be able to access?.

Besides, it can only be expected that fluency of communications will be greater in flatter structures, a characteristic which has also been shown in relation to the innovative capacity of a company (Quinn, Anderson & Finkelstein, 1997). In this sense, Hull & Hage (1982), consider that vertical differentiation, which gives rise to higher structures, will have a negative effect upon innovation as it would hinder communication between levels and inhibit the flow of innovative ideas. Therefore, the third question to research is:

Is the existence of a reduced number of hierarchical levels a characteristic of innovative firm?.

Inter-organizative reationships

Communication is not only spreading and becoming more unconstrained within the limits of the company. One of the aspects related to organizational design which has taken on greater significance over the past

few years is related to the progressive indefinition of company limits and the creation of business networks by means of strategic alliances. Information flow, therefore, not only between functions but also between designers, suppliers, clients and other companies, may have advantages for innovation because it enables new alternatives to be simultaneously put to test, thus providing a rapid learning process. Furthermore if these networks are decentralised, with more entry points for new companies, the possibilities of new ideas being generated is substantially greater (Langlois & Robertson, 1992).

This inter-organizational information flow is also a characteristic of modular systems that, on the other hand, present us with the dilemma of what amount of knowledge can be shared with other companies within the network without causing a high risk of losing key capabilities (Lei, Hitt & Goldhar, 1996). The very intangible character of this flow may cause an organization within the network to obtain extremely relevant information from another regarding products or processes, without the latter even being aware of it. the philosophy which must inspire relations between these organizations, based upon collaboration and not competition, is not always a guarantee against certain opportunist behaviour.

The so-called "learning laboratories" are also based upon the transmission of information across organizational limits. Leonard-Barton (1992) defines them as virtual research organizations made up of networks and alliances, in which one outstanding activity is the "investment" in travel expenses so that teams are able to investigate new technologies in other companies, visit client companies and imitate competitors, etc. So, the last research question is:

Is a characteristic of innovative companies to belonging to a network of companies and, in general, the development of collaboration agreements with other organizations which implies the transmission of information between all of them?

III. CASE STUDY

Our case study has been carried out on four innovative firms, that were selected because they belong to the Andalusian Innovation Network, as well as different sectors. In each case we had a personal interview with a manager related to the innovative activity (in one of the cases, the interview was made with the CEO). In addition, we prepared some questionnaires addressed to a minimum of three people in each company (the CEO, the Production Manager and the R & D Manager). The questionnaire included a combination of multiple-choice, Likert scale and semantic differential scale questions

The four companies are: CANLA (manufacturer of citrus derivatives and other agricultural products), MP (manufacturers of elevators), ACISA (dedicated to the manufacture, installation and conservation of urban and inter-urban, signalling and traffic control lighting, lighting systems, beacons and guidance for airports and heliports, presence and access control systems, etc..) and ISOFOTON (manufacturer of photoelectric and thermal energy panels). Three of these may be considered to be small or medium-sized companies. Size has been one of the variables considered with regard to its incidence in innovation, whether it be speed or the type (Gopalahrishnan and Damanpour, 2000). Regardless of size, all four companies act on international markets.

FINDING RESULTS

Innovation in companies

In **CANLA** we came across innovation both in products and processes. The former mainly arising from market demand, given that products are made to order following client specifications. Those products which have been introduced are new to the company, but not new on the market. Nevertheless, some new products are currently undergoing tests and producing positive results, and if these could be considered as new to the market if they are manufactured. One new product was launched onto the market in 1999 and two products in 2000, a large quantity of products were improved: five in 1996, four in 1997 and 1998, nine in 1999 and two in 2000. Product innovation is characterised mainly by the use of new raw materials or new components, but new technology is not usually incorporated. Process innovation is achieved by taking into account any suggestions regarding improvement coming from staff or at the initiative of the production manager with the aim of increasing efficiency. It can be stated that certain process innovations are linked to the introduction of new products which require modifications or adjustments to be made in the factory. The impact of new products upon sales is 10% whilst for improved products it is 15%.

MP basically seek product innovation. The ideas which lead to such innovation come from different sources: the sale department put forward ideas for product improvement arising from observation of market needs, the production department make suggestions as to how products can be re-designed, the R&D department take care of creating and improving chips, and general management also provide ideas of a diverse nature. MP launched seven new products in 1999 and six in 2000. According to data released by the company, MP is currently working on one patent and seven utility models, with more envisaged for the future. The company intends to patent its innovations because they see this to be the behaviour of their competitors. The impact of new products on turnover is 25% and for improved products 60%, with 2% of sales being dedicated to R&D expenses and up to 5% to total expense on innovation.

ACISA launched a new product onto the market annually between 1997 and 2000, except in 1999 when it launched two (radical product innovations); made improvements to existing products in 1998 and 1999, and two in 2000 (incremental product innovations). These are products which present a certain degree of novelty to the company's market, but not for everybody, and characteristically incorporate new technologies or a combination of existing technologies, new functions or new components. Process innovation has also taken place as the company was obliged to develop its own technology as this could not be purchased on the market. With regard to resources dedicated to product innovation, the company allocated on average 5% of sales to R&D during the period 1996-2000, a percentage which rises to 6.5% if the total expense on innovation is taken into account. The impact of both new and improved products was 5%.

The way in which a new "product" is born is diverse: projects which people were working on before entering the company, the identification of possible problems or improvements which could be incorporated into a lighting or traffic regulating system, etc.., and from this point on "own technology" projects are developed: computers for RENFE trains, data collection systems to control vehicles crossing frontiers, wireless communications systems for trains, beacon systems for airports (which facilitate the automation of airport traffic).

ISOFOTON has not introduced any major product changes, with the exception of some design modifications consisting mainly of the production of panels with more cells. But it has made important innovations in its processes as it has manufactured its own production equipment at well below the market price. Up until recently, when the sector has grown considerable, there were no suppliers of productive equipment,

which meant that it had to be made. Advances have also been made with regard to a simplification of the productive process in an attempt to increase efficiency. Thus, from a twenty-four step process with efficiency cells of between 12 and 13% in 1985, using solar arc technology they have passed to a current six-step process with efficiency cells of 15%.

These innovations have not been patented, given that an analysis of the finished product does not reveal the secrets of its manufacture. It is pure "know-how" which cannot be copied, and that is what really protects Isofotón from its competitors. This contrasts with the large number of patents registered by Sanyo (Watanabe, Tsuji & Griffy-Brown 2001), one of the companies operating in the same sector.

Ideas on how to improve productive equipment partly arise from observing what our suppliers have to offer, that is; what is available on the market. With regard to making improvements to processes, the R&D manager attends conferences and congresses, etc.. where some good ideas are to be found, although the company is also open to any suggestions proposed by its machine operators. The remuneration system, however, does not directly promote either innovation or the generation of new ideas.

Another source of ideas is the University, with which a good relationship is maintained, given that it also provides specialised personnel and funding for projects. In fact, the R&D strategy of Isofotón is in some way linked to several universities. Specifically, Isofotón participates in a series of projects of a strategic nature with long term horizons which, if successful, will lead to a completely new product, as the use of alternative materials is being investigated. This would provide Isofotón with a radical product innovation and permit them to make a qualitative leap which would differentiate them from their competitors.

Organizational characteristics: flexibility, hierarchical levels, communications, collaboration with other organisations

In **CANLA,** the management team is made up of just three people: a manager (agricultural technical engineer), manager of a factory (agricultural technical engineer), and a quality manager (superior industrial engineer)[5]. The co-operative has a permanent staff of thirty-five to forty unskilled workers[6] whose job descriptions are not clearly defined, temporary staff, however, reaches levels of between 350 and 400. Economic matters are handled by an external auditor.

A characteristic of this company is the high degree of flexibility to be found in the productive process where the machines are rapidly adapted to those new products to be introduced or manufactured at any given time. The workers are very versatile and within the management team the functions of the different member can be carried out by others. Another aspect worthy of mention is the importance of informal communication and the speed with which the three members of the management team make and put them into practice decisions regarding the introduction of new products or any improvements to be made to the productive process.

Communications between workers and management are free-flowing, which may partly explain the absence of work groups. They do not have an intranet and nor do they have any special collaboration or relationships with other companies.

[5] A retired chemist uses the co-operative's facilities to research new products, although to date CANLA have reaped no benefits from this activity.

[6] The members contribute their harvests to the co-operative in return for a price which depends upon the quality delivered, and usually above the market price. Only one member of the co-operative works for the same

The group **MP** has a staff of around 800, of which 550 belong to MP elevators. In general three different levels can be identified within the organizational structure: general management, management and the rest. relationships are informal with the general management keeping in contact with all staff. they have an R&D department with a staff of forty. Surprisingly, MP does not have a Human Resources department. The company makes little use of outsourcing with regard to manufacturing (it has its own manufacturing plants for all components) but other activities within the value chain have been outsourced: their clients are small installation companies who in turn number construction companies and property maintenance groups among their clients. This means that the relationship between MP and their clients is a very close one (their R&D staff are in constant, direct contact with customers), because it is the client who has to install and later maintain the product manufactured by MP. Collaboration agreements exist with the university (Engineering School) and the Aragón Technical Institute (ATI). They do not normally make use of temporary staff. An intranet is available, although access to information is restricted to only part of the staff.

In **ACISA,** the number of workers employed in 2000 was 253, 11% of which belonged to management and administration, 60% to production, 14% to sales and 15% to R&D. 65% are permanent employees and 35% temporary. Twenty-five employees work in the R&D department (year 2001), mainly industrial or telecommunications engineers, physicists or IT specialists. This department is not very hierarchical in nature and communications are informal. Generally speaking, the different areas do not function as isolated departments and employees carry out diverse activities (development staff may work on the improvement or installation of a product for a client and those in lighting may also work in traffic). We can therefore state that the company is not very formalised. Work groups are established in order to develop projects which other companies participate in as ACISA makes great use of external collaboration. For example, they have found the basic research carried out by the university (Engineering School) to be of great use, subsequently assessed by ACISA management in terms of the technical and commercial viability of a product. Furthermore, for project development it is usual to seek collaboration from other companies by creating consortiums (one is being considered for the airport beacon system). ACISA resorts to outsourcing for certain stages of the production process (assembly, welding, etc..). They also possess a certain degree of flexibility with regard to installation and maintenance work, resorting to contracts “per job”. The company has an intranet which can be accessed by the majority of its employees. The hierarchy of the company has four levels.

In **ISOFOTON**, who currently have over 300 employees on the payroll, decision making is quite decentralised at a departmental management level, where decisions may be taken directly for example between the operations manager and the R&D manager, with no necessity to consult the general manager, simply reporting back to him at a later meeting. This decentralisation translates into rapid decision-making, which is one of the competitive advantages of Isofotón.

Collaboration between particular organizational units is a characteristic feature of this company: R&D management are in close collaboration with technical office management (both belong to the Operations Dept). For instance, in the technical office part of management personnel time is dedicated to projects from R&D management; furthermore, technical office management take charge of developing productive equipment, an activity which should be co-ordinated with process improvements carried out by R&D management. The personnel working in these units are physicists, industrial and telecommunications engineers.

Data concerning company performance is provided at an annual convention attended by managers of a certain level within the company, who then pass on the information to the work units they are responsible for. ISOFOTON has an intranet, but not all employees have access to it (only to manager level). Their policy on subcontracting is similar to that described for MP, that is; the activity of installation (and not for particular production stages) which is carried out by local installation companies with which they maintain close collaboration agreements. They also have collaboration agreements with several universities with which they are developing different projects.

IV. DISCUSSION

The comments suggested from the data which has been gathered is that, with the exception of MP, these companies do not feel the need to protect their innovations by patenting them. This result is consistent with the aforementioned literature concerning a general preference for other forms of protection other than patents (Arundel 2001; Buesa 1998; Buesa & Molero 1998).

Another observation is that those companies which are to be found in very concentrated sectors (Canla, Acisa and Isofotón) make numerous innovations to their processes whilst the company acting within the least concentrated sector (MP) has hardly made any process innovations. Galende (2001) finds support to the hypothesis that "a greater market concentration leads to a greater development of process innovations". Our case study seems to indicate that concentration within the sector itself is also related to the innovation process. The theoretical explanation lies in the fact that if productive assets are not very specific, then a limited number of companies would be unable to build up a market which would be sufficiently attractive for companies have any interest in supplying them with equipment or machinery. This would oblige those companies in the sector to develop their own technology, as this would not be available on the market or would be very expensive if it did. If a description of Isofotón's competitive environment is also taken into consideration, in which the key factor is not so much the product as the cost structure of production, this makes innovation focus even more on the process rather than the product, in search of maximum efficiency.

With regard to the research questions we have raised, we can say that with the exception of ISOFOTON, all the companies produce according to client specifications, they all make use of subcontracting for specific activities within the value chain and, in certain cases, resort to temporary or short-term contracts. All of these attributes were considered to be relevant dimensions for the study of flexibility.

All four companies possess simple structures which are not over hierarchical with regard to the number of levels, although this could be explained by their dimension, at least in the case of the three medium-sized or small companies. Communication processes were found to be informal in all cases, just the way they were described by their management, thus facilitating speed in decision making related to change or incorporation leading to new outputs. However, the use of information technology as a means of increasing employee awareness of those matters considered most relevant to the running of the company is not common to all and in some cases where it is available, access is limited to certain organizational levels.

With regard to the final question which we raised, it can be pointed out that three companies belonging to the high technology sector (Isofotón, ACISA & MP) have reached collaboration agreements with other organizations. At this point the role played by the university in its innovative capacity must be highlighted. This

has also been observed in other research work and contexts (McMillan, Narin & Deeds 2000; Etzkowitz et al 2000).

As a conclusion to the above we may state that an analysis of four cases has shown that patents are an indicator which does not accurately reflect the innovative output of a company; production under client specification is positively related to innovation in products and processes; the subcontracting of non-key activities would appear to be a practice of innovative companies who wish to gain flexibility; the tendency towards horizontal structures and informal communication systems, encouraging speed in decision-making; the use of information technology does not seem to be an innovative factor in small and medium-sized companies, and, the importance of belonging to networks and of cultivating relationships with universities as a means of obtaining knowledge which in turn facilitates innovation.

Other relevant variables which have not been analysed, but which have arisen during research and which must therefore be taken into consideration are those concerning the influence of market composition and competitiveness, the technological complexity and knowledge required for innovation, and the versatility or polyvalence of the people concerned.

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