KEYWORDS: Innovation, project-related information, special products, architects

1. INTRODUCTION

Innovation in a branch of any industry is important if one is to keep up with the changes in regulations, and with the wishes and requirements of clients. Although product innovations are desirable given the added value they offer to firms and their clients, the construction industry would seem to attach little importance to innovations.[1] Incremental process innovations are thus the most common sort of innovation in this branch (Pries 1995). There are various conditions for achieving innovation in an industry; the dissemination of information, the subject of this paper, is one of them (Rogers 1962).

Generally speaking, then manufacturers are seen as the ideal product developers. Other parties do however also take initiatives towards product innovation. Architects play an important role in initiating the development of component parts in specific building assignments. In planning a building architects come across elements that cannot be realized with standard products. In situations like this they have the choice of adapting the design to existing products or initiating the development of new products. To achieve good results with the development of special components, the architects must be open to collaborate with others. For this they need production facilities, and hence the support of a manufacturer. In most instances they will also need complementary expertise from other people in the preparatory phase, such as constructors or other advisors. Deliberately or otherwise, the architects employ many strategies to manage the available manpower, means and knowledge in this product development process (or PD process) while operating within the margins of the building process. For instance, they have to allow for codes and standards that might stand in the way of the application and development of new products. Insurance companies, clients, financiers, manufacturers, engineers, contractors, politicians, project developers and even fellow architects may place obstacles in the way of architects' initiatives to develop new components.[2] Architects should be prepared to anticipate and respond to these obstacles during the PD process.

Before looking at information dissemination in detail it is important to draw a distinction between two categories of products; standard products and special components.[3] The standard product is produced independently without any assistance on the part of the client. All products are identical, even though the manufacturers can include a number of varieties in their product line, differing for instance in colour or measurements. The manufacturers will know precise requirements for which the product in question must comply. In the case of a special component the manufacturer may receive a request from the client that cannot be addressed with a product from their product line; a completely new product must be developed for this specific building assignment.

This paper will discuss the information exchange in relation to the development of special components initiated by architects. Information exchange concerning standard products will be investigated where it is relevant to these of special components.

[1] For a comparative innovation rating of the different industries, see Arthur D. Little (1996).
[2] See Mieke Oostra, lecture, 'De architect als componentontwerper', for Boosting at Octatube 24-2-1999
[3] Based on Mick Eekhout's (1997) distinction between standard, system and special products.

2. PRODUCT INNOVATION AS THE MOTOR FOR THE CREATION OF NEW KNOWLEDGE

New knowledge is usually developed in response to a lacuna that requires resolving in order to achieve a certain goal. The development trajectory for new products is ideally a process in which lacunae of this sort come to light. In their book *'The knowledge-creating company'* , Nonaka and Takeuchi (1995) show that product development is the main process in which new knowledge is generated in organizations. This is true for manufacturers, which is the perspective from which Nonaka and Takeuchi wrote their book; but is also true for architects. In analysing development processes for special components, the manufacturers must show how production processes can be initiated in such a way that the products delivered comply with the desired architectural concept.

There is considerable debate in business administration literature at present about learning organizations (Senge 1990; Schön and Argyris 1978). The development process for a special component is actually a learning experience for different contexts; (1) the individual, (2) the team that is working on the product in the architectural firm or department, (3) the architectural firm or department itself and (4) members of the building team involved in the development of the product during the building process. One feature that is specific to development processes for project-related components is that one usually has to call on the co-operation of different professionals and firms that form no part of any of the umbrella organizations. Together the people involved form a 'learning' development team. Learning is defined as follows:

> 'Learning means to undergo a process by which - implicitly or explicitly - knowledge is enriched.' [4](Weggeman 1997 p42)

It should be remarked here that it is not knowledge that is exchanged by the team members, but only the information component of knowledge, also known as explicit or codified knowledge. Implicit knowledge is not communicable as information because the experiences, skills and attitudes that comprise this form of knowledge cannot be shared (Weggeman 1997). In order to make knowledge communicable the implicit knowledge component must first be transformed as far as possible into explicit knowledge. Explicit knowledge is knowledge that is communicable either verbally or in writing and is also called information. The production of knowledge does not need to be a goal for any of the above learning experience contexts: it is a means for arriving at a product that more effectively meets the client's requirements than a directly-obtainable standard product. However, not every person, team or company is equally good at converting this knowledge into a product. In this connection, Hamel and Prahalad (1994) speak of resource leverage; how much added value can the developer or team extract with regard to the new product using the means at their disposal. One way of improving the resource leverage is to formulate what Jacobs (1996) calls B-HAG's: Big Hairy Goals, or ambitious goals.[5] To sum up this knowledge-assimilation process, two steps are important in the development process of special components:

- generating or finding the required information
- converting this knowledge into a quality product

This paper will discuss the first point in detail.

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[4] Translated from Dutch into English by the author.

[5] Prahalad & Hamel (1994) talk here of *stretch & leverage*, while Senge (1990) uses the term 'creative tension'.

3. TWO SORTS OF INFORMATION

In this connection the two sorts of information mentioned by Davidson (1998) are interesting: (1) project-related information and (2) general information. He defines them as follows:

> 'Project-related information, as its name implies, denotes information that is particular to an individual project and is accumulated during the project-related processes of design, manufacture and construction. General information is, at least in principle, available to nourish the processes of any construction or any research project; it is accumulated constantly as more and more is learnt about building-related technology, and about the application of the human and natural sciences to building.'

These two sorts of information are found in different contexts and time scales. Project-related information is built up at the start of a building assignment, by the different members of the building team. These members also have to find a common form in order to communicate for the duration of the project. When the project is realized and all decisions concerning it have been taken this information largely disappears. Only a part is stored in archives or kept for maintenance purposes. The same goes for a part of the information linked to the development processes of special products. This information has not disappeared but it only remains in the form of experiential knowledge for the people concerned.

The information needed for developing a new product is a combination of these two sorts of information.

4. HOW ARCHITECTS DEAL WITH INFORMATION

A case study by Emmitt (1997) has shown that architects only start to search actively for information about products when they feel the need to do so during the design process and not before. This makes for great frustration on the part of the manufacturers, who sees the architects as the most important specifier of their products, despite the fact that the architects are hard to access. (Emmitt 1997, Pawley 1990) The information with regard to building products is also less structured than conventional consumers' products:

> '... the specifier can not refer to a publication which provides comparative product assessment, unlike for example the potential car purchaser, who can refer to specialist journals which provide comparative information about cost, performance and value for money.' (Emmitt 1997, p.33)

In describing the specifications for a new product or process one can only rely on experience, advice from colleagues and one's own judgement. Architects mainly prefer then to use products with which they have already had experience. (Mackinder 1980) One third of all architects stated that the policy of their firm was to avoid using new products unless it was unavoidable. If a project had to be completed quickly the remaining firms also showed a conspicuous tendency to stick to 'the palette of favourite products'.

According to Emmitt (1997), the most important thing in disseminating information of building products is not communicating the information to architects but the architect's ability to look for

this information. This is not the whole story, because it would suggest that the full responsibility for the dissemination of knowledge of building products and technical possibilities lay with the architect. The manufacturer too has an important role; it is important that information is disseminated in a way that architects can find it at the time when they need it and that the architects are capable of finding this information. When this is the case, the information provided will have to conform with what the architects are looking for and they will also have to be able to understand the information and be able to make use of it.

The search process described here concerns information that is generally available. On the other hand if an architect decides to initiate the development of a new product, then the architect requires supplementary knowledge. To find manufacturers with the required knowledge, architects can consult the trade literature to find clues which manufacturers possess the desired expertise and which are open to developing a new product. A role is played here by whether or not the firm has an innovative image. The trade literature is only used here as a guide to finding a correct source of the potential information. The information that is sought is however not to be found in these media but will come to light through direct contact with the manufacturer, and not their literature.

During this development process an intelligent architect will make as much use as possible of the knowledge that the building team has at its disposal.

> 'Due to the different professionals and specialists operating on construction projects each site will have its own peculiar knowledge base, and those who facilitate the construction process are tasked with making the best use of the temporary knowledge base.' (Gorse and Emmit 1998)

Of course architects can also try and manage the organization of the building process themselves and so exert a favourable influence on the conditions laid down for the development of components with regard to the following factors (Oostra 2000a):

- time available,
- money available,
- quality of the information available,
- communication between the members of the development team,
- and the atmosphere in the development team.

The more influence the architects have in the building process the more possibilities they will have of influencing these factors

5. INFORMATION EXCHANGE WITH REGARD TO INNOVATION IN THE BUILDING INDUSTRY

In the case of standard products it is in the manufacturers' interest that potential specifiers are made aware of the existence and advantages of their products. It is to their immediate advantage to make their new product known as widely as possible among those involved in the building industry, especially those who exercise influence on the choice of building products. These people however are interested in different aspects of the product. With a broad, but carefully measured, dose of information to the different interest groups, the manufacturers can increase the chance that their products will also be adopted. For example in launching the INFRA+ floor, the

Dutch firm of A+ has made a deliberate use of different information channels.[6] An article was published in Architectuur & Bouwen (a Dutch building magazine); advertisements were placed in Cobouw (a Dutch building paper); a stand was rented at a trade fair for the building industry; contact was sought with people working on projects that were about to be implemented; well-known people were invited to the opening of the trial project; a folder was made and distributed; thought was given as to which market should be focused; thought was also given to the name of the new floor, and the sales arguments were presented namely: which argument would be the most persuasive and how to sell as many floors as possible without threatening the interests of any of the parties involved in this project. With all these activities the manufacturer made sure that information about this product became part of the industry's general stock of information. However, the aim of manufacturers in general is not to give away as much information as possible about the product, but to convince the specifiers to use the product and seek contact with the manufacturer. One manufacturer described it as trying to get a foot in the door.[7]

The standard products used for exteriors are subject to fashions. McDermott (1998) for instance points out that certain construction styles and products come in and out of fashion. Similar problems will therefore reoccur and the same mistakes will be repeated even though all the technical problems were solved at the previous usage. McDermott gives the example of a study into the causes behind the breaking of toughened glass wall cladding in Australia. In the final report that appeared in 1961 the causes were explained and it was shown how they could be avoided in future. The knowledge acquired was implemented in the industry, but not long after the report appeared this sort of facade fell out of fashion. Now that curtain wall construction is again widely applied, roughly the same problems have recurred. McDermott also writes:

> 'It would appear that the knowledge in this case had disappeared from the industry's consciousness, or become "lost" to all, with the exception of some individuals who are aware of the report's existence.'

Knowledge that forms a part of general information is therefore subject to erosion. If it is no longer drawn on it disappears from the stock.

Therefore one cannot even speak of an ideal information flow with regard to standard building products with everybody informed about all the technical possibilities, as shown above. Furthermore, communication with regard to standard products approximates the ideal more than is the case with special products.

6. DISSEMINATION OF INFORMATION WITH REGARD TO SPECIAL PRODUCTS

Information acquired in the context of a specific building project is not usually disseminated by the industry as it is not in the interest of any of the parties involved. If the manufacturer is planning to further develop a special product and to include it as a standard or new item in their product line, the manufacturer will also try to draw attention to the "qualities" of the

[6] Part of a case study forming a portion of a Ph.D. thesis on the role of the architect in product development. (Oostra 2000b)

[7] The differences in interests between architects and manufacturers in trade literature are described by Charles Rogers (1998).

components. Project-related information is thus transformed into general information. The other parties who assisted in refining the original product or usage, including the architect, do not have any interest in separately drawing attention to the building component. The architects' main concern was to achieve publicity for the buildings they have realized or are about to realize. It may be that if a building receives publicity, then information about the specially developed components related to it will also emerge. But this is not guaranteed, as publications may avoid mentioning the fact that innovative products have been used (Oostra 1998). Project-related information thus remains unavailable to parties who are not involved in that building project. One case in point is the use of Lignostone, a material normally used for hockey sticks and rings in gymnastics. It was used in the support structure for a facade in the Teylers Museum extension in Haarlem, on the initiative of the Dutch architectural office of Hubert-Jan Henket. The manufacturer, who specializes in sports articles, has no plans to produce building components, and therefore will not make the public aware of the innovative application of their product. The architectural media, as it turns out, have also paid little attention to the innovative use of materials; even when it is mentioned, the language is at times misleading since the material is referred to as wood (Oostra 1998). Providing information about new products is however, not an explicit aim of architectural publications. If no one has any direct advantage from a project-related product becoming known, then the project-related knowledge about special products will not pass into general knowledge. Dissemination of knowledge about this material is frustrated.

Knowledge about previously developed project-related products thus remains a hidden presence in the form of implicit knowledge in the minds of the people who were involved in the process at the time. It may well be that one of the team members in a new building project will pass on information to other building partners if they are faced with a similar problem, and if a request for a solution is made. This implicit knowledge then comes into the hands of others. The dissemination of this sort of knowledge is very limited, so innovations based on it have little chance of being used or taken a stage further. Dissemination in this way depends on the size of the network available to the parties involved and on the opportunities used to convey such information. Innovation thus ends up being largely dependent on chance.

The case study on Lignostone (Oostra 2000b) illustrates an important information flow resulting from constantly changing teams in building projects and informal contacts. The formal channels used to disseminate information about standard products do not work well in relation to knowledge connected with project-related products. Because the formal channels are not used, these changing teams and informal contacts are crucial in the dissemination of project-related information about the branch of industry in question. This information flow is however inadequate for information distribution. The changing project teams thus have both a negative and positive side in the information perspective. On the negative side, each project has to reinvent its form of information exchange and the people have to learn to work together. In addition, once the project is completed, these relations cannot be exploited for the following project. On the positive side, the restructuring does help to circulate information about innovations in the industry. Unfortunately because the dissemination is only ad hoc, information about product innovation often fails to reach the people involved in construction who would at that moment benefit most from this knowledge. If the innovations were to be made more easily accessible, the speed of dissemination of information would increase and the application and improvement of these innovations by others would also be accelerated.

7. CHARACTERISTICS OF INFORMATION EXCHANGE

The exchange of information between manufacturer and architect has different characteristics depending on the type of product. In seeking information about standard products the following matters play a role:

- time; the availability, that is, of the technical information at the moment when the architect needs it.
- costs; can the product be applied within the budget framework.
- suitability; can the product be fitted technically and visually into the whole.
- risk involved; architects like to know the risks they run with the application of certain products.

With regard to special products the following matters influence the architect's choice for a certain manufacturer:

- openness to experiment; the manufacturer should be open to trying out new things.
- engineering; the manufacturers will also need to have relevant knowledge and production techniques at their disposal.
- costs; an indication of the amount of money necessary to develop the products.

8. INFORMATION SPECIALIST

In Holland, a whole range of new initiatives have emerged that function as intermediaries between architects and manufacturers. Firms such as Robin Hood Productions and Aldus have taken on the task of developing special products. In practice these firms give a structure to the information flow between architects and manufacturers. These newly emerging firms illustrate a need for an intermediary, in the form of an information specialist. This information specialist does not have to be a firm or a person; it can also take the form of a database. In this database the general information can be presented in a more structured way, comparing products for achievements and aesthetics. Project-related information can be transformed into general information by gathering information on special products and inventorying knowledge from different manufacturers. The aim of this type of database is not to provide general value judgement – e.g. 'this product or manufacturer is better than that other one' - but to list for architects and other specifiers the differences between products and, more specifically, what explicit knowledge is held by the manufacturers. As a result, the architect and other specifiers can make a more informed choice. With the aid of the programme of requirements or project brief, the architects can see what products are worth considering in terms of the technical requirements. The architects then give their own value judgement to the product aspects considered in the database, resulting in a rating of the available products. The advantage to architects of a database like this is that it is always available, whenever required. If this information specialist happens to be a person and not a database, it has an additional advantage for architects in that one can make enquiries about the information provided. There are also advantages for manufacturers. It makes it easier for them to introduce new products because clients can base their decisions on the opinion of an independent instance. This diminishes the effect of clients waiting another to take the lead in applying the new product, because nobody wants to be first with a product whose drawbacks are unknown. Another advantage for manufacturers is that one can deduce from the database what gaps may be in the market and where they can take advantage with a new or adapted product. Besides architects, the following parties will benefit from this type of database:

- building users
- owners
- financiers
- building contractors
- consultants

The organisation involved in realizing and maintaining the database could also function as a catalyst agent to structure demands from the industry. The demand side of the market is at the moment diffuse and unorganized. The emergence of consumer organizations on the consumer market have justified their existence in this respect. In a business-to-business market it is also in clients' interests to organize themselves.

The government could play a role by providing subsidies for this type of database, with the aim of encouraging innovation in the construction industry. In Holland, for example, the government has intervened more than once by providing subsidies to projects where sustainable building was a priority and by formulating new regulations. All of this with the aim of fostering innovation in the industry in theme of sustainability. Every new theme however calls for a new and different intervention. If the parties on the demand side in the building industry were to organize, the number of product innovations would increase without further intervention by the government being necessary.

9. SUGGESTIONS FOR THE IMPROVEMENT OF INFORMATION EXCHANGE

In fostering innovation in building a distinction needs to be drawn between project-related and general information. Architects use general information in the development process for special products as a step to find manufacturers. Besides drawing from their own experience, they use trade literature with this end in view. This literature is however inadequate for this use. To stimulate the development of special products by architects additional information has to be available. There is a need therefore for an intermediary between architects and manufacturers. This role is being taken on by a number of newly emerging firms, but these only reach a small group of architects. To encourage product innovation on a larger scale relevant information needs to be made generally available. A database via the internet is ideal here. An independent body would have to make an inventory of the various projects using special components already realized. Information would need to be provided about the parties concerned together with a short description of the product developed. Ideally, there should be a survey available of the production facilities of the different manufacturers involved in the building industry, with an assessment of their technical knowledge. In Holland the association of Booosting[8] has the potential for this. They have the proper contacts and objectives even though they do not yet have the financial means to realize and maintain such a database.

Booosting already collects information on innovations in the building industry, also on the topic of project-related components. The organisation retrieves most of her information via an informal network of the committee members and other Booosting members. Some projects are derived from publications of the Ministry of Economic Affairs or other publications. By contacting the innovative architects and manufacturers and inviting them for a meeting the information of these projects is disseminated under attending Booosting members and a few

[8] An association of architects and manufacturers who are enthusiastic advocates of innovation in the building industry.

guests. Information about these projects is summarized in a newsletter, and eventually reaches a more general public.

In order to stimulate innovative projects, Booosting offers members a link on their Web-site and provides services for members who want to start a Web-page. However, the information provided on the sites of manufacturers is very general, and not very relevant for architects and other specifiers. In general a manufacturer's site only mentions some business figures, the available standard products and how the manufacturer could be contacted. The information that Booosting gathers for their meetings in contrary, is highly interesting for innovative architects. But only a small number of architectural firms are members and not all members find the time to attend the meetings. It would be an improvement if the information collected by Booosting could be made accessible via the Internet. It is therefore Booosting's intention to put the information of the newsletters on the Internet in the near future. When more funding becomes available, it would be possible to collect and structure information in a more systematic way. This would ensure a source of information that is valuable too all specifiers. Information on standard and special products could be collected, catalogued and compared on their performances. Stories on the realization of special products would disseminate project-related information on product development processes and technological possibilities and would inspire other people to innovate. For this information the informal network of Boosting would have to be used. Standard products could be compared in analysing one comparable product cluster after another. Here the information can be obtained by contacting manufacturers on basis of existing (collections of) trade literature. When no official reports on the required product information exist, additional tests will have to be performed. In questioning the manufacturers involved, an inventory can be made with information on their expertise. The database with the results could be made accessible via Booosting's Web-site. A search-engine should make this database accessible on names of participants (manufacturer, architect, contractor, constructor etc), type of material and product type. An adjacent comment-room could be constructed where manufacturers, architects and other specifiers can make remarks on the results. Architects and other specifiers can also express here their experiences with existing products, and they can place questions on matters they want to solve but could not find a proper answer to.

By converting specific parts of the project-related information into general information and by structuring general information, this type of database would stimulate innovation within the industry.

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