# Organizing The Innovation System For Reusability: The Case Of Made-To-Order Markets

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# ORGANIZING THE INNOVATION SYSTEM FOR REUSABILITY: THE CASE OF MADE-TO-ORDER MARKETS

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**Abstract**

This paper examines the transfer of designs between projects within firm in the context of made-to-order producing companies. This practice is also known as knowledge reuse. Past studies has provided a detailed account of the strategies and processes involved in the reuse of technologies. Nonetheless, a large portion of this research was based on evidence collected in mass-producing companies. This paper attempts to develop a complementary framework to identify the strategies involved in reusing technologies in the made-to-order context. Data were drawn from three aerospace companies based in Israel. Two strategies emerged from the empirical evidence: exploit product success and design for reuse.

Keywords: technology transfer, innovation, production systems

**Organizing the Innovation System for Reusability:**
**The Case for Made-to-Order Markets**

## Introduction

Since the beginning of the 1990s, the acceleration of new product innovation has gained more attention as the costs associated with slow product development have increased (Gupta and Wilemon, 1990). Some of the factors leading to the speed up of product development process were increased competition and growing market demand (ibid.). Poor definition of product requirements and technological uncertainty during product development were two possible factors for delays in product development projects. To overcome these obstacles and in order to stay competitive, some companies have recently reorganized their innovation systems in a way that limited the effect of technological uncertainty and provided processes that assist in well-defining the product roadmap and the technological capabilities needed to achieve product success. This approach was coined ‘reusability’ (Cusumano and Nobeoka, 1998; Markus, 2001; Victor and Boynton, 1998). Reusability of technologies and components is also has been considered as one of the factors that contribute to the management of product development as a multi-project environment (Clark and Fujimoto, 1991; Nobeoka, 1995; Meyer and Utterback, 1993; Cusumano and Nobeoka, 1998).

Only recently has research paid attention to the growing trend in intensive R & D and manufacturing firms to reuse technological platforms and components (Cusumano and Nobeoka, 1998). The body of knowledge on reusability as process innovation and managerial practice has grown in recent years revealing the many links to other managerial and engineering practices such as, the management of product family (Meyer and Utterback, 1993), modularity (Baldwin and Clark, 1997), coordination mechanisms

(Sanderson and Uzumeri, 1994) and the organizational design (Cusumano and Nobeoka, 1998). These mechanisms, when integrated, represent the organization of the innovation system to support reusability. Nevertheless, thus far, studies emphasized the organization of innovation systems in companies producing for mass-production markets such as in the case of Toyota and other automobile manufacturers (Cusumano and Nobeoka, 1998), Sony (Sanderson and Uzumeri, 1994) or the electronics product industry (Meyer and Utterback, 1993). The context within which these studies were carried out has led to specific conclusions and recommendations to managers, though valuable; however, cannot be generalised to other industries that operate in different contexts. This paper attempts to present a competing framework for the organization of the innovation system for reusability by addressing the following question; how do companies operating in made-to-order markets organize their innovation systems to support reusability of technologies?

To anticipate the findings of this study, this paper argues that based on an in-depth study of three companies, operating in made-to-order markets, two strategies to organize the innovation system are offered; *exploit product success* and *design to reuse*. Lastly, the application of the proposed framework to mass-production markets is assessed and conclusions are made.

**Reusability in Mass-Production Markets**

The literature that addresses the theme of reusability is diverse and often takes a rather different angle on the same thing. Reusability was studied from a multi-project management (Cusumano and Nobeoka, 1998), software development practices (Banker and Kauffman, 1991) and Knowledge Management Systems (Markus, 2001). Victor and

Boynton (1998) positioned the reusability process as the highest stage in their model for internal growth, suggesting that the central theme in reusability is modularity in technology, products and processes. In essence, these studies and others refer to the same thing: the process through which project-specific components are shared by a set of projects or products (Meyer and Utterback, 1993). The objective of this process, from a company perspective, is the same; to reduce R & D costs, accelerate product development, improve responsiveness to customers by enhancing learning in specific areas, and achieve better integration across projects in R & D environments (Cusumano and Nobeoka, 1998).

The product platform, which refers to the content of the design and the components shared by a set of products, is at the heart of the product family. A product family typically addresses a market segment, but not always (Meyer and Utterback, 1993). An example is the Sport Walkman by Sony, which is based on the Walkman product platform versions, or Toyota, which manages the ES 300 and the Supra models as one product family and yet targets two different niche markets, luxury sedan and sport respectively (Cusumano and Nobeoka, 1998).

So far, some organizational mechanisms stood out as crucial factors in facilitating reusability. The matrix organizational form was identified as one central element in transferring knowledge and designs between projects (McCollum and Sherman, 1993). Nevertheless, the matrix organizational structure is not free of problems (Peters, 1979). For example, one area of tension is the struggle for higher level of authority between the project manager and the functional department manager, in particular when it comes to decisions around technical problems (Cusumano and Nobeoka, 1998:160). Another issue relates to the responsibilities and the physical location of engineers. Yet recent years have seen a shift from the traditional matrix organizational form. Cusumano and Nobeoka (1998) offer an insight into some of these structures. In particular, they describe the *Differentiated Matrix* structure as a mechanism in which project manager and functional managers share authority. Nonaka and Takeouchi (1995:161) offer the ‘hypertext’ structure for knowledge creation, which combines a formal organisational structure and a non-hierarchical, self-organising organisational structure. Yet the challenge has always been in forming an organizational structure that on the one hand promotes knowledge creation and on the other hand supports the transfer of knowledge and designs between projects.

The integration of project specific-knowledge across projects is also essential for the reusability process. To achieve high level of project-specific knowledge integration across projects, companies such as, Toyota nominated chief engineers to oversee multiple concurrent projects (Cusumano and Nobeoka, 1998; Sobek et al., 1998). Among many other responsibilities, the chief engineer enhances the rapid transfer and sharing of new designs among multiple projects. In addition, Toyota created a variety of working structures supporting the development of design tasks across projects. A similar integration mechanism was also found at Sony (Sanderson and Uzumeri, 1994). These working structures are flexible and may change according to management recognition of the degree of either inter-project or cross-functional learning required in this process.

Coordination across projects was indicated as another crucial element for reusability (Cusumano and Nobeoka, 1998). The literature suggests several cross-functional mechanisms that ensure the coordination of activities across an R & D division from the conception to the production stage of the product (Hauptman and Hirji, 1999).

Cusumano and Nobeoka (1998) map out four possible scenarios in which designs transfer coordination processes may take place. The first scenario is *New Design,* which enables the incorporation of the latest technology or totally new designs without putting too many restrictions on the development team. The second is *Concurrent Technology Transfer,* which suggests that a new project borrows a platform or a component from a preceding project before the preceding project has completed its design work. Cusumano and Nobeoka suggest that this type offers effective and efficient technology transfer process. The third is *Sequential Technology Transfer,* which describes a case in which a project inherits a platform or component from a base project that has finished its design work. In this case the second project reuses a relatively old component and changes may have to be forced in the reused component in order to adjust the transferred unit to product specifications. Cusumano and Nobeoka conclude that sequential transfers may not be as efficient or effective as concurrent technology transfer (also see Thompson, 1967). Lastly, *Design Modification*, which describes the case of a project that reuses a platform or component without needing to borrow components outside the project: for example, when a project team is designing a series of product generations by using the same technological platform.

Cusumano and Nobeoka (1998) conclude their analysis in one main statement, arguing that *concurrent technology transfer is the better practice for companies seeking to reuse technological platforms* (ibid.:189). Indeed, in the context of their study, companies should plan in advance situations where two projects of the same product family overlap in order to maximise the technology transfer effect. This conclusion is appropriate in the context of industries designing and manufacturing products for mass-production markets such as the automobile or the electronic goods industry. Companies operating in mass-production markets tend to launch generic R & D projects and therefore are in position to plan well in advance an overlap between two sequential projects of the same product family.

However, companies that operate in made-to-order markets are rarely in position to plan overlaps between projects, in particular of the same product family. The nature of made-to-order markets dictates different game rules in which companies launch a project once winning a tender and only after all the contract documents are signed. In a complete contrast to companies operating in mass-production markets such as Toyota, Nissan and other car manufacturers, companies that operate in made-to-order markets respond to tenders and rarely initiate their own self-financed R & D projects.

Thus, this raises the question: how do companies operating in made-to-order markets organize their innovation systems to support reusability of technologies?

## Research Approach

An in-depth study of three companies operating in the military-product industry in Israel was carried out between 1997-2000. The defense industry is characterized by a line of products tailored according to the specification of the client. In this sense, the defense industry operates in made-to-order markets.

Between 1997 and 2000 a two-phase study was carried out to examine the organization of the innovation system that supports reusability in the studied companies.

Interviews were conducts with over 100 engineers, managers and technicians involved in R & D projects.

The distinctive strength of a case study method is its ability to deal with a variety of evidence, documents, questionnaires, interviews and observations. In particular, in exploring an emerging field and its unknown practices, as in the example of reusability, a case study method seems highly appropriate. In other words, the study adopts Laurila's (1997: 222-223) view that "the feasibility of the case study approach is thus based mainly on the opportunities it creates for observing and describing a complicated research phenomenon in a way that allows analytical organization" (Eisenhardt, 1989; Tsoukas, 1993).

Moreover, in Yin's terminology (1989), the case study design is eminently justifiable in this particular situation because the case serves a revelatory purpose. The observation of, and insights into issues surrounding intra-corporate organisation of the innovation system should amount to a significant empirical contribution.

Following a pilot study with ten top managers from five leading electronics defence companies in Israel, a more detailed study of the product development environment at three military-product companies, Elisra, Rafael and TAMAM, was then carried out. Data analysis emphasised the research unit of analysis – the organization of the innovation system to support reusability of technological platforms and components. A detailed and careful analysis made it possible to distinguish between modes of organization in made-to-order markets in contract to those in mass-production markets.

## Industry and Company Background

The electronics defence industry in Israel is a second-tier world-leader supplier of electronics defence products. Much of its reputation was built on its proven products in the battlefield. During the 1960s and 1970s the Israeli defence industry grew dramatically because of the high level of tension in the Middle East and the weapons-sale embargo imposed by several European countries. These conditions prompted the Israeli government to develop in-house capabilities to produce defence products. During the 1980s and the 1990s, following the fall of the Soviet bloc, the Israeli defence industry experienced a dramatic decline in sales, and consequently the number of employees in the industry dropped from 80,000 in the early 1980s to 18,000 by the end of 1996 (Inbar and Zilberfarb, 1998). The forced cancellation of the ambitious Lavi fighter project in 1987, due to prohibitive costs and American opposition, contributed greatly to the reduction in military production labour (Klieman, 1998).

The Lavi project led the Israeli electronics defence industry to concentrate on the upper level of defence design and production, and to acquire unique knowledge and capabilities with the financial support of the Israeli and US governments and technology transfer from the US. Amongst the areas developed during the 1980s there was an increased concentration on sub-systems and specialised components. There was a move into the area of ‘smart weapons’, which combine hardware and software devices in various sub-systems and mainframes: for example, laser sensors, night vision optics, communication equipment, diagnostic systems, air-to-air missiles, air-to-land missiles, pilotless drones, and electronic warfare systems. In addition, upgrading and retrofit data packages were designed and put out for sale on the open market. Among the leading electronics companies in Israel is Elisra Electronics Systems Ltd, Israeli Aircraft Industries (IAI), with its range of subsidiaries including TAMAM and Elta, and Rafael.

Elisra Electronics Systems started to develop electronic warfare systems as a three-engineer business, and has since grown to become a leader in domestic and global markets. With some 800 employees, the company has an amalgam of capabilities in the areas of electronic and mechanical engineering. Elisra enjoys strong relationships with the Israeli Air Force, which has assisted the company in developing broad engineering capabilities. In addition, Elisra provides technology tailored to the needs of a long list of customers, including some of the world's leading armed forces. In 1999 Elisra has become Elisra Group, made up of Elisra, Tadiran Spectralink and BVR, three companies in the area of warfare systems, data link systems and pilot rescue systems. Elisra Group's operations profit in 2000 increased 300% from $4 million in 1999 to $12 million in 2000. The Group's gross profit in 2000 was $50 million, 25% higher than in 1999 (Dror Marom, Globes, 16/01/2001). Despite operating in markets that are greatly influenced by global politics and economics, and are also regarded as monopolistic and homogeneous, Elisra remains a business-orientated company and bases its product development strategy on innovative technological solutions according to its clients' needs.

TAMAM Division, located in the centre of Israel, is an integral part of the Israeli Aircraft Industries' Electronics Group, which in turn is part of Israeli Aircraft Industries (IAI), a state-owned business and a global leader in military and commercial aerospace technology, accounting for approximately 50 per cent of Israel's defence exports in late 1990s. Founded in 1953, and a limited company since 1968, IAI has achieved impressive results, being ranked 30th in the 1998 list of the world's 100 largest aerospace manufacturers, with sales reaching $1.87 billion (Amnon Barzilai, Haaretz, 09/08/1999). Since its foundation in 1964, TAMAM has specialised in advanced electro-optical systems, navigation and inertial technologies for use in air, land, sea and space platforms. It has developed a close working relationship with the Israeli Defence Force, which has assisted TAMAM in producing solutions for modern military users. Amongst the company's main products are day/night electro-optical payloads for helicopters and fixed-wing aircraft, and night targeting systems for helicopters. TAMAM employs 860 highly experienced personnel of which 200 engineers and scientists and 300 technicians. TAMAM is in the process of shifting its identity from a research-driven to market-driven organization. This shift is the result of several factors including a declining sympathy towards losses exhibited by the Israeli government, a shrinking government support towards generic R & D projects, and the move of international defense conglomerates into TAMAM's market niche as global defense procurement shrunk and competition intensified.

Rafael, established in 1958 and located in the north of Israel, was until recently a sub-unit of the Israeli Defence Ministry (MoD). In 2001 Rafael has become a government-owned company after many years of negotiations between government officials, top management and trade unions. Since it's foundation, Rafael has gained the title of 'the national laboratory for defence research and development'. During its early years Rafael concentrated on research and development activities, and only during the 1960s did it extend its capabilities by starting to produce defence systems in order to avoid quality problems induced by a faulty knowledge transfer process between Rafael and its sub-contractors. Enjoying the financial support of the MoD, Rafael has for many years focused on developing in-house, sometimes double, capabilities in technological areas that consume much of the organisation's resources and create internal competition. In recent years Rafael has developed two different personalities. On the one hand, it has tried to act as a commercial company driven by profit and markets. On the other hand, it has continued to perform the role of a national defence laboratory focusing on R&D and paying little attention to costs. Because Rafael is responsible for 80 per cent of the generic defence R&D for the Israeli government, government officials found it difficult to transform the company while also preserving its unique R&D capabilities. In addition, the massive financial support provided to Rafael by past Israeli governments has come to be questioned by the Israeli public. For example, despite the increase in sales in recent years, Rafael has shown a loss of $375 million since 1994. In 1999 Rafael broke all previous records in recording a $1.1 billion backlog of orders with a loss of at least $42.5 million. Rafael has posted a first-ever annual profit of $2 million in 2000, compared with a $30 million loss in 1999 and $80 million in 1998.

**Organizing for Reusability: Case Studies Findings**

The three case study companies pursued the reusability strategy by papering the slogan "avoid reinventing the wheel" in their project management and product development activities. Yet three different ways to organize the innovation system have emerged from the empirical data. These three ways to organize the innovation system will be outlined here.

**Organizing for Reusability: Elisra Electronics Systems**

The innovation system at Elisra was managed in a top-down management style. The chief scientist, an experienced engineer, was nominated to oversee reusability activities and foresee potential reusability of specific hardware and software components. Several mechanisms were put in place in order to facilitate reusability of technological platforms.

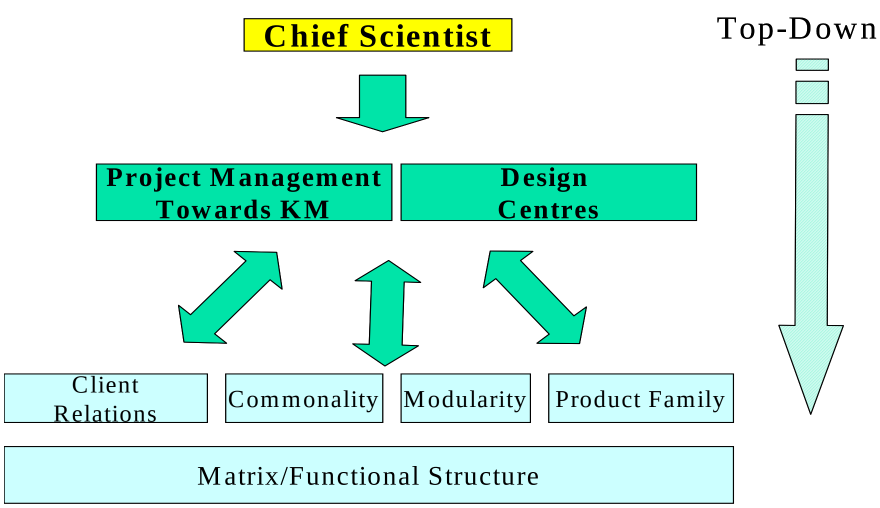


Figure 1: The Organization of the Innovation System at Elisra

In addition, Elisra introduced design centres which operated as functional groups within the matrix organizational structure providing services to project teams. One example is the ASIC (Application Specific Integrated Circuit) team which acted as a knowledge centre for ASIC developments. The justification for centralising ASIC developments in one group was to reduce the costs associated with the learning of the ASIC development and increase the possibility to reuse ASIC designs across different projects. In addition, the Chief Scientist has reorganized projects in three-phase order in which the development stage followed the conception and the integration stage followed the development. The purpose behind this organization was to focus project teams during the conception stage on knowledge transfer and reusability through numerous design review sessions. The YellowPage Knowledge Transfer organizational structure was put in place in order to increase visibility to existing solutions within Elisra and hence to support reusability. Elisra also reorganized its technology management practices by putting an emphasis on commonality across development tools and software packages in the R & D Division and by encouraging engineers to design new components in a rather modular way (Baldwin and Clark, 1997). Elisra also restructured the organization of projects of the same product family by placing a program manager responsible for several projects of the same technological platform. And lastly, Elisra invested in client relationships by bringing the client into the R & D process and allowing the client to participate in design and product development sessions. It was argued that by implementing these organizational, technological and managerial mechanisms Elisra has organized its innovation system in a way that attempted to design reusable hardware and software components, transfer existing solutions between projects and through interactions with clients constantly learn about future needs and market trends.

**Organizing for Reusability: TAMAM**

TAMAM focused on linking shared project requirements to the pool of expertise through the centrality of the system engineer in the development process. System engineers, the experts who hold knowledge about the various technologies and solutions that can be reusable, were previously located in the professional directorate. Initially, this location of the system engineer was logical because of their engineering orientation.

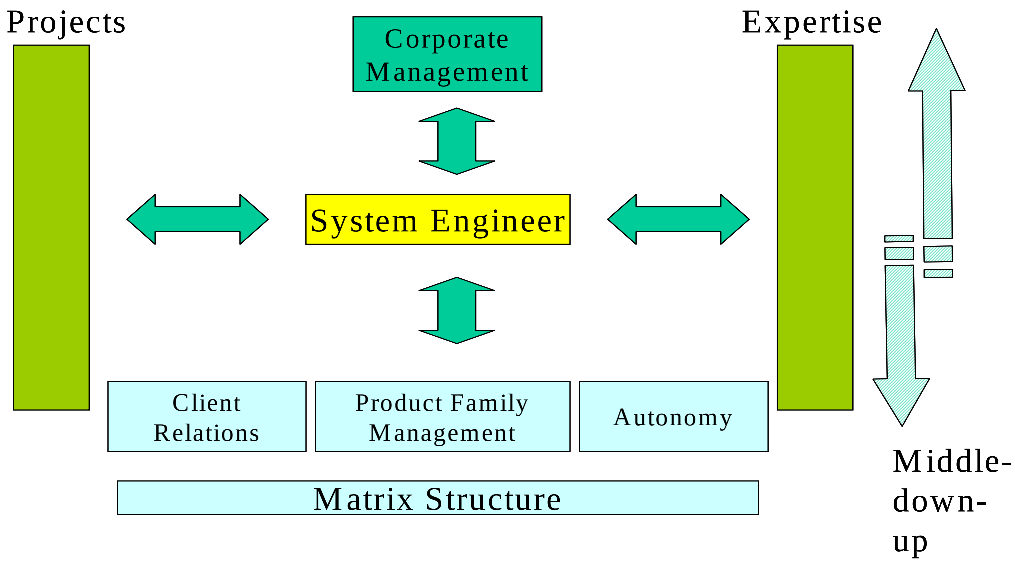


Figure 2: The Organization of the Innovation System at TAMAM

However, from the reusability perspective, system engineers as part of the professional directorate were not effective. Their exposure to new projects, client's requirements in these projects and the technological base that the client would like to see were all limited and often relied on reports that the project management team provided. Thus, the role of the system engineer has changed, and metaphorically they have been relocated into a space between project management and the professional field. In reality, system engineers become more involved in project management activities. The management style that emerged from this organization of the innovation system was of middle-down-up. The system engineer would launch a reusability effort with project managers and once successful, the initiative will be reported to top management. In addition, other mechanisms were put in place to support reusability at TAMAM. The organization of projects in programs settings helped creating islands of product families which share and reuse technological designs and platforms. TAMAM utilized the matrix structure by allowing engineers to participate in multi-project activities. The autonomy given to engineers and technicians, alongside a rather loose project management practice, has enabled the transfer of knowledge across projects and thus contributed to the reusability of designs. Some indication for a growing awareness to introduce commonality across development tools and to raise awareness to modularity in designs was observed however with little done in managing these activities. TAMAM also maintained close relationships with clients and in most cases clients were involved in the development process. TAMAM has organized its innovation system in a way that mainly supported the transfer of existing solutions in house between projects.

**Organizing for Reusability: Rafael**

Rafael relied on social networks to promote the reusability of technological components and platforms. Reusability has taken place at the lower level of the organisation, driven by project managers, engineers and technicians. Social networks at Rafael were well-established, developed over many years of shared research interests, of a high level of autonomy (Sherman and Nadler, 1996) and of loose job descriptions, which all facilitated informal interactions between individuals and groups (Wenger, 1998).

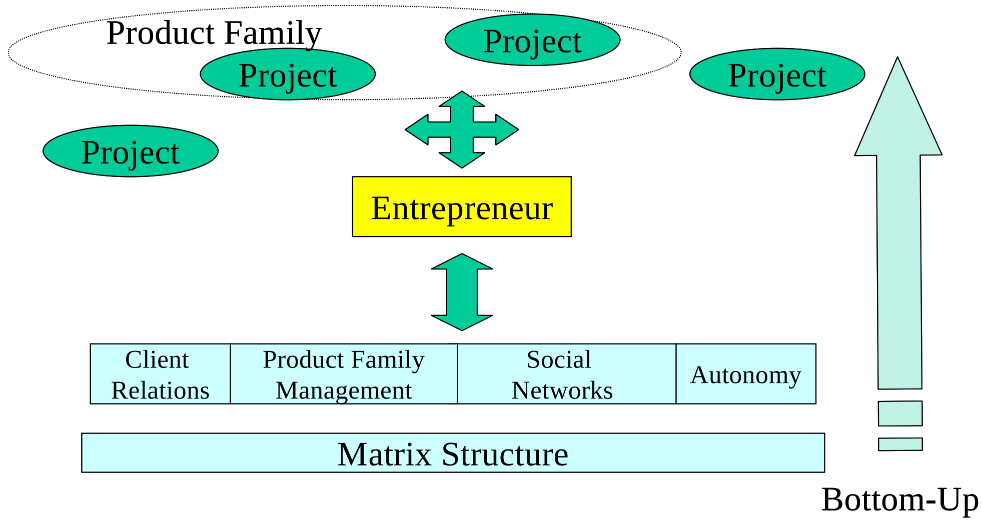


Figure 3: The Organization of the Innovation System at Rafael

At Rafael, reusability activities were generated at the project level during either the design stage or while the team has encountered a problem in the design.

In either case, the person who identifies the opportunity to reuse a component from a base project becomes the internal entrepreneur for the reusability process (Nonaka, 1994). During this process, this person harnesses more people and creates a network of experts who attempt to solve the problem (Floyd and Wooldridge, 1999). Data show that the entrepreneur is usually one of the more experienced engineers in the project, who has been with the company for many years, established network centrality within the professional field (Pfeffer and Salancik, 1978), and hence is usually free to pursue their own goals and gain structural autonomy (Floyd and Wooldridge, 1999). To achieve the build up of ad-hoc network, the flexibility of the matrix structure was needed (McCollum and Sherman, 1993). Rafael also reorganized projects in program settings allowing better visibility within the product family to existing solutions. Maintaining close relationships with clients, by inviting them to participate in the development process, has tremendously assisted Rafael in sensing future needs and thus tailoring solutions based on in-house existing capabilities. Rafael reorganized its innovation system in a way that mainly allowed the transfer of existing designs between projects. There has been very little evidence for any investment in designing reusable components at Rafael.

**Two Strategies to Organize Innovation Systems for Reusability**

Two distinct strategies to organize the innovation system for reusability emerged from the data. These strategies refer to the vertical integration of technologies, components and knowledge which resides in projects. These strategies target the build up of either long- or short-term competitive advantage but can be also integrated. The strategies proposed here are:

⇒ *Design for Reuse*. This strategy aims at designing platforms and components for potential reusability in the future. The organisational and managerial capabilities supporting this strategy are aimed at setting standards to guide engineers to design components with a thought in mind that the base design will be reused in the future. For example, modularity and commonality support product design for potential reusability in the future. Another example is a Design Centre (e.g. at YellowTech), which produces ASIC solutions with a view to sharing these components between projects. These capabilities aim to improve the process of reusability by introducing technological platforms that have been designed in line with some reusability procedures, tools and metrics. These organisational mechanisms are located outside the matrix structure and tend to create an infrastructure that the entire matrix structure and its elements operate upon (see Figure 4). In contrast to Cusumano and Nobeoka's (1998) proposition, which argued that in the case of new design the potential for technology transfer is low, this strategy suggests that a new design actually paves the way for an effective reusability strategy yet this scenario does confirm that new designs, particularly for reuse, require the longest lead time (ibid.:116; Clark and Fujimoto 1991).

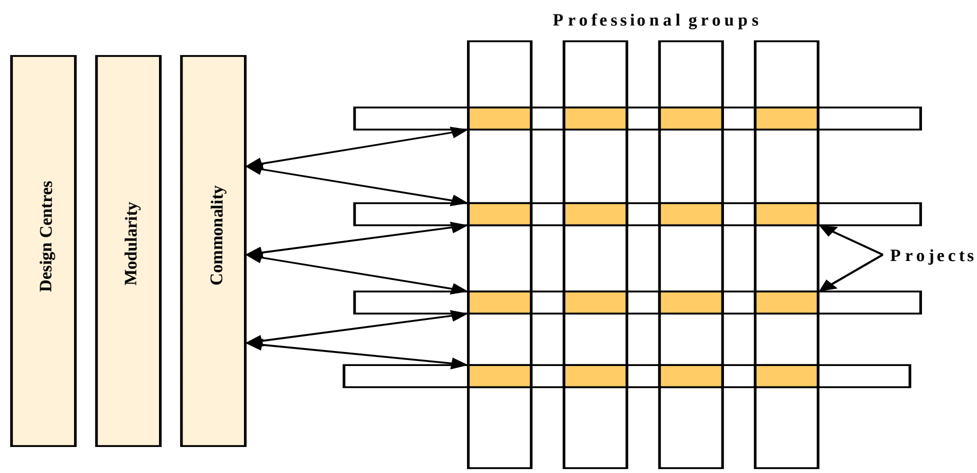


Figure 4: Mechanisms Supporting the *Design to Reuse* Strategy

⇒ *Exploit Product Success.* This strategy aims at exploiting product and technological platform success by transferring components from the base project to others. In this case, the process can be either sequential or concurrent (Cusumano and Nobeoka, 1998). The organisational capabilities that support this strategy are aimed at opening communication channels between projects, making existing solutions and technologies visible to others, and creating links between projects. Some of these capabilities are, for example, the matrix structure, knowledge transfer structure at YellowTech, interactions with clients, integration with Sales, and the horizontal coordination of concurrent engineering activities by cross-functional teams. These organisational mechanisms are within the matrix structure (see Figure 5).

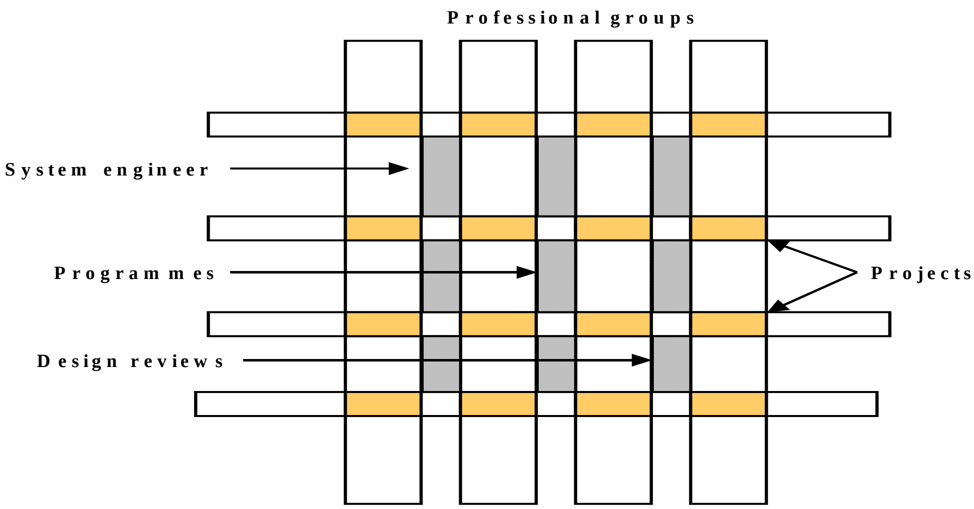


Figure 5: Mechanisms Supporting the *Exploit Product Success* Strategy

As seen above, the studied companies organized their innovation systems in three different ways. Elisra has built wide range of capabilities supporting the *exploit product success* strategy and yet introduced organizational and technological capabilities that promote the *design to reuse* strategy (See Figure 6). Elisra has constantly perused the integration between these two strategies in order to expand reusability opportunities in new products. TAMAM has invested in developing capabilities that sustain the *exploit product success* strategy with some indications for developing capabilities that promote the *design to reuse* strategy, however lacking the integration between these two strategies (See Figure 6). Rafael invested in developing capabilities for the *exploit product success* strategy but hardly developed capabilities that support the *design to reuse* strategy (See Figure 6).

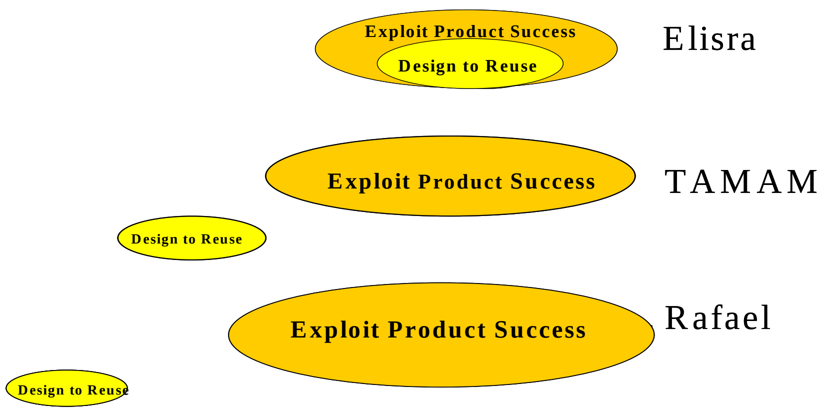


Figure 6: Reusability Strategies at Elisra, TAMAM and Rafael

**Reusability: Future Research**

The two strategies offered in this paper allow R & D managers to exploit the efficiencies that the reusability of technological platforms and components may offer (Cusumano and Nobeoka, 1998). These strategies are free of any project planning considerations neither these strategies are tender-dependent.

Yet the framework offered in this paper is induced by the in-depth study of one industry in one country. Further research in other industries and countries is needed to validate the proposed framework.

In this quest, some questions remained unresolved and thus invite further investigation and development. One fundamental question is; which strategy should be core and which peripheral. In our opinion, the answer to this question is embedded in the on-going discussion about management's ability to strike a balance between exploitation and exploration activities within the firm (March, 1991; Lewin et. al., 1999).

The *design to reuse* strategy is an exploration activity in which new process innovations are introduced such as, design centres and technology management practices, changing the way the organization innovates and sustains competitiveness. The outcome of this activity, in addition to a set of reusable technological components, is also a new set of practices. On the other hand, the *exploit product success* strategy is the institution of existing practices harnessed to the effort of reusing existing solutions. As demonstrated above, most of the observed organizational capabilities associated with the *exploit product success strategy* at the studied companies were introduced well before the reusability activity has become central to the innovation system. From this perspective, the *exploit product success* strategy is an exploitation activity. Thus, the proposed reusability strategies are the two edges of the same continuum (Koza and Lewin, 1998) redirecting the discussion to the theme of striking a balance between exploitation and exploration adaptations. Yet evidence from this study suggests a tendency to invest in exploitation adaptations in order to cope with changing markets. Would this mean that the studied companies are falling into the self-destructive path in the long run in favour of immediate returns gained in a rather quick adaptation to exploitation tactics (March 1991; Levinthal and March 1993)? Such a conclusion can be drawn from a longitudinal study of reusability exploration and exploitation adaptations in the defense and other industries.

A successful application of either reusability strategy requires an appropriate organizational form, one that supports knowledge creation and yet facilitates the transfer of knowledge and technological designs to other projects. In particular, the theme of organizational form becomes crucial as competition game rules change and intensify (Volberda, 1996), as it was demonstrated in the defense industry. Thus far, the matrix organizational form has proven to be the foundation upon which new organizational forms are built such as the hypertext (Nonaka and Takeouchi, 1995), the differentiated matrix (Cusumano and Nobeoka, 1998) or perhaps the matrix/functional found at Elisra.

Further research is needed to reveal additional organizational forms that support the reusability process.

Lastly, there is a need to establishing a correlation between modes of organizing for reusability and product success. Thus far, studies have attempted to establish a correlation between reusability and productivity however were mainly interested in software development projects applying Business Object practice (e.g. Banker and Kauffman, 1991). Cusumano and Nobeoka (1998), who studied the organization of the innovation system for managing multi-project environments at Toyota and other automobile manufacturers, in which reusability has played a major role, have claimed that recent years' improvement of the studied companies' competitive edge may possibly be linked to the reorganization of the innovation systems. Nevertheless, further study needs to target and identify the impact on product and market performance by specific organizational, technological and managerial mechanisms involved in the organization of the innovation system for reusability.

## Conclusion

In this paper we explored the concept of reusability and some modes of organizing innovation systems in support of this practice. We also proposed managers two strategies to organize innovation systems for reusability; *exploit product success* and *design to reuse*. These reusability strategies, unlike previously proposed approaches (e.g. Cusumano and Nobeoka, 1998), are generic and may be applied in both mass-production and made-to-order markets. Lastly, this paper highlights some areas stemmed from this study that are in need for further development of the reusability theory.

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