

## KNOWLEDGE AND CONTINUOUS INNOVATION: THE CIMA SUPPORTING METHODOLOGY

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## **ABSTRACT**

Competition today is forcing companies to increase their effectiveness exploiting synergy and learning in Product Innovation. Literature, however, is still mainly focused on how Product Development projects, seen as isolated efforts, are organised and managed. Basing on preliminary results from the Euro-Australian co-operation project CIMA (Euro-Australian co-operation centre for Continuous Improvement and innovation Management), this paper proposes a model to explain how companies can gain a substantial competitive advantage by extending their innovation efforts to other phases of product life and by facilitating knowledge transfer and learning within the company and with other partner organisations.

## **INTRODUCTION**

To survive in a demanding and turbulent environment companies are investing a growing amount of resources and managerial attention to product innovation. Although these efforts are more and more continuous and involve partners outside the organisational boundaries on a global basis, most literature is still focused on New Product Development (NPD) projects seen as isolated efforts and on how they are managed and organised. In this paper we propose an alternative perspective: NPD projects are seen as steps within a more general process of Continuous Product Innovation (CPI) that, besides involving more products within a family, include phases of the product life cycle that follow the launch on the market. Evidence from best practice companies, for instance, shows how manufacturing, maintenance and service, though not integral parts of the development, can still provide valuable feedback and additional opportunities to innovate products. In this perspective Product Innovation, is a continuous and cross-functional process involving and integrating a growing number of different competencies inside and outside the organisational boundaries. Mastering the sharing and transfer of knowledge within this process can become a powerful competitive weapon, but requires new managerial skills. Based on an explanatory model, we propose a methodology to help companies in facilitating knowledge transfer and fostering learning in the process of Continuous Product Innovation.

In the next section we will define the research setting, introducing the concept of Continuous Product Innovation and focusing on how knowledge can be generated and transferred within the process of CPI. In the third section we introduce the methodology based on a behavioural model explaining how management can foster Continuous Improvement and innovation in CPI. Finally, in the fourth section, some applications of

the methodology are reported: according to the specific contingent situation management actions are suggested to companies.

The research is being developed within the context of the Euro-Australian co-operation project CIMA (Euro-Australian co-operation centre for Continuous Improvement and innovation Management). The aim of the CIMA project is to facilitate co-operation and knowledge/technology transfer between European and Australian organisations through the establishment of a Co-operation Centre that will promote and support bilateral activities between the two continents. The first Euro-Australian «trial» project conducted in such environment aims at developing a methodology to support companies in managing learning and continuous improvement in the Product Innovation Process. The methodology is being developed by a consortium of 5 European and 3 Australian research centres, is tested in 8 companies and will be applied to a sample of 150 companies in Europe and Australia. This paper describes some of the results of the CIMA trial project, focusing in particular on the methodology of Learning in Product Innovation, reporting its first applications in Italy, Sweden and The Netherlands.

## **KNOWLEDGE MANAGEMENT IN PRODUCT INNOVATION**

Starting from the early 80's, a renewed interest has been placed on Product Innovation. Under the joint pressure of an increasingly demanding and global market and of the accelerating pace of technological change, both management scholars and practitioners became aware that companies need to compete on quality and speed in product development. One of the main consequences of this focus was the emergence of product innovation models almost totally focused on the management of the New Product Development (NPD) process. Integration among different phases of a project, Heavy-Weight Project Management and autonomy of the project team were considered as synonymous with best practices. *Concurrent engineering* was thought to represent a long lasting paradigm for product innovation management.

Next, in the early 90's, a new stream of studies emerged which enlarged the perspective. Studies demonstrated how focusing on single projects is not enough to sustain competition. Success depends even more on exploiting synergy among projects, for example by fostering commonality and reuse of design solutions over time [i, ii]. In this perspective attention progressively shifts from single projects to a project family [iii, iv] and to the process of learning and knowledge transfer and reuse [v, vi]. These streams of literature, however, consider product innovation as occurring only within the boundaries of the product development process. Downstream phases in the product life cycle are still important for innovation but only as long as they represent valuable sources of information or constraints that should be anticipated and considered during development [vii]. Evidence is emerging, to the contrary, that other phases in the product life cycle may actually represent additional opportunities to innovate products. This is a direct consequence of rapid product development and time to market reduction: several companies, especially in rapidly shifting environments, purposely release to market products that are not fully optimised, followed by a rapid almost continuous stream of enhanced releases (i.e. software industry).

The boundaries and the concept itself of product innovation are therefore changing dramatically. Feed backs and opportunities coming in from the field phases are not only stored for feeding next generation product development projects, but can also provide valuable opportunities for product innovation within a product life cycle. These two dimensions are combined in the model of Continuous Product Innovation (CPI) proposed by Bartezzaghi, Corso and Verganti [viii]: on one side CPI embraces not only NPD (*Concept, Product & process design and product launch*), but also subsequent phases in

product life cycle (*Improvements in Manufacturing, Customisation in Sales and Installation and Enhancements and Upgrading during Product Use*), and on the other side it moves the traditional perspective from a single product to a product family. As long as we look at a product family, moreover, we include in the CPI process all the interactions among products in the family. Hence, innovation may concern a product that is in its development phase, a product that has been already released to market, or a transfer of solutions between products. All the directions among phases highlighted in the model, constitute a very strong potential for learning and for innovation which could be exploited only by an active effort for designing and implementing adequate mechanisms to enable this transfer of knowledge. Every knowledge transfer can be fostered by particular enablers whose successful implementation strongly depends on the actors involved and their influencing the process, and on the typology of knowledge that is managed. Referring to emerging literature on knowledge management, some dimensions should be taken into account when analysing knowledge transfers in CPI. For instance the *level of dissemination*: depending on the specific culture of the organisation emphasis can be placed at sharing knowledge and fostering learning at different levels going from individuals, to groups, to the organisation as a whole or even the inter-organisational system. The *scope of knowledge* can be either *component* knowledge, which refers to the mastering of specialist skills and technologies and their embodiment into components, or *architectural* knowledge, which refers to how components and skills are integrated and linked together into a coherent whole [ix]. A third dimension when analysing knowledge concerns the degree of abstraction and generalisation or applicability to different situations [x]. A fourth characteristic of knowledge is the *degree of articulation* or *embodiment*. In order to facilitate knowledge transfer and prevent its drain, organisations can embody knowledge into vehicles as, for instance, design solutions, standard methodologies and procedures, or organisational structure and routines [xi]. Embodied knowledge is more easily transferable [xii] but then tacit one is more effective but difficult to imitate [xiii] Companies, therefore, should be able to effectively manage both the processes of embodiment of *tacit* knowledge into *articulated* forms and, internalisation of articulated knowledge into tacit forms [xiv, xv]. Awareness and explicitation, moreover, are fundamental to make knowledge questioned and, if necessary, changed [xvi]. A fifth characteristics of knowledge concerns the *setting of knowledge transfer*: depending on the relations between the process where knowledge is generated and the process where it is subsequently applied, we can distinguish intra-process and inter-process knowledge transfer [vi]. Intra-process transfer takes place when both the acquisition and the use of knowledge occur within the same project or process. Inter-process transfer, takes place when knowledge acquired is applied on different process on time. All these dimensions can help in interpreting the process of acquiring, transferring, consolidating and applying knowledge in order to design appropriate enablers to foster and sustain it. In the next sections, starting from the application of CIMA methodology, we will put forward a model to explain how management can foster learning in CPI.

## **SUPPORTING KNOWLEDGE MANAGEMENT IN PRODUCT INNOVATION: CIMA METHODOLOGY**

The CIMA methodology is designed to be used by researchers acting as facilitators to help companies in fostering and sustaining the process of continuous learning in product innovation. It comprises a process that involves first of all mapping a the current level of continuous improvement and learning within product innovation, identifying strengths and weaknesses and then suggesting enabling mechanisms which could be implemented by the firm to stimulate continuous improvement and learning, depending on specific

contingencies. The main engine underpinning the methodology is the contingent model of learning in CPI, which makes use of the CIMA tool to gather data and to feed back to companies, and of the CIMA database to compare practices and suggest actions.

This section mainly focuses on the explanatory model for learning in CPI. The model is derived from analysis of ten case studies carried out during the project. Data was gathered during semi-structured interviews, using a common questionnaire, with the main actors in each company's CPI process.

The CIMA explanatory model describes the learning and knowledge generation processes within product innovation in terms of a number of interrelated variables. The variables are: Continuous Innovation (CI) performance; behaviours underpinning continuous innovation and learning within PI; levers that can foster these behaviours; company contingencies; and continuous learning/innovation capabilities. The relationships between these variables are depicted in Figure 1

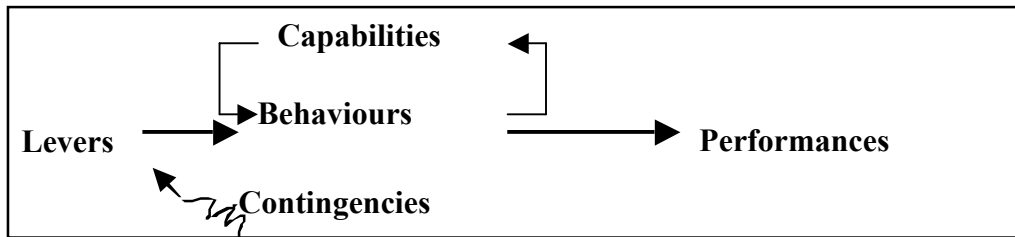


Figure 1 Elements in the CIMA explanatory for learning in CPI

The *performance* is the result of improvement activities carried out in the product innovation process. It can be 'measured' by, for instance, looking at the generation of improvements, and the diffusion of improvements and learning experiences within and between product innovation projects.

The CI performance is achieved by a set of eight particular *behaviours* enacted by individuals, such as creating, using and transferring knowledge; aligning improvement activities with strategic goals and objectives; and experimenting with new solutions. These behaviours can be influenced by the implementation and application of *levers*. Levers are mechanisms that managers use when managing the product innovation process, even though they may not be consciously trying to stimulate learning. If adequately oriented, however, these decisions can have a substantial influence on a firm's attitudes and practices in creating, storing and transferring knowledge. Eight categories of lever have been identified: product family strategies; innovation process definition; organisational integration mechanisms; human resource management policies; project planning and control; performance measurement; design tools and methods; and computer based technologies.

The *contingencies* are factors that influence the choice of levers to foster behaviours (for instance the size of the company, the market situation, and product and process complexity).

The *capabilities* can be described as integrated stocks of resources that are accumulated over time through learning, or established through deliberate decisions. These stocks of resources include internalised behaviours, technical skills, organisational routines, and corporate assets (i.e. Information Systems, databases, libraries, tools, and handbooks). The level of a company's CI capabilities determines the efforts that are needed to stimulate the corresponding behaviours.

The methodology involves four main stages: (1) selecting the focus of the exercise; (2) mapping the firm's contingencies, performances, behaviours and levers; (3) analysing

the data gathered to identify areas of poor learning/improvement performance and areas of good performance; (4) discussing proposed improvements with the company. The methodology has been tested in a variety of company situations. Examples of its application are reported in the following section.

## INTERPRETING CASES THROUGH THE MODEL

The CIMA methodology described in previous section of the article has been applied to several companies in order to suggest specific mechanisms which can be implemented to foster behaviours and thus CI performances. In the following paragraph results from three applications of CIMA methodology in Italy (company X), Sweden (company Y) and Netherlands (company Z) are reported. As an example, one of the diagrams used in the methodology is reported for the Italian case.

Company X operates in the tractor industry which is characterised by increasing concentration and globalisation. Strong emphasis on the renewal and enlargement of the product range, and a recognised excellence in product design allowed company X to survive and grow in an industry that is elsewhere dominated by competitors that are far bigger in size and availability of technical and financial resources. Once a national-based company with strong roots in its local environment, company X has recently followed a plan of acquisitions of traditional competitors and is today one of the world leaders in the high segment, with an interesting portfolio of famous tractor marks. This increased size and complexity and the competitive pressure for further reduction of time-market and better use of critical resources, call today for a quantum leap in effectiveness in how knowledge is shared and capitalised over time across different sites and product families.

Use of the CIMA methodology highlighted integration and *Improvement diffusion within the PI process* (P3) as the key improvement area to be addressed and subsequently behaviour 4 (*Individuals integrate knowledge among all different phases of Product Innovation*) as the key behaviour to enhance (figure 2). A joint diagnosis with company's managers outlined how this situation was responsible for reworks, design changes during production phase and other critical effects that are hardly managed by R&D department.

Drawing examples of management practices in similar cases from the CIMA database, alternative interventions were discussed and finally an integrated plan of actions on different levers was decided. This includes: redesign of the project manager's role and of the project work team (L3), introduction of a product platform strategy (L1) and of a structured database to store and retrieve projects knowledge throughout the company (L7 and L8).

At the global company Y, a leading company within the telecommunications industry, a small R&D centre was studied. This unit, which is specialized in a specific technological field, is organisationally a part of a larger unit, but is geographically isolated from the rest of the company. The R&D centre was established a few years ago as an attempt to handle the shortage of skilled engineers by providing interesting jobs in an attractive environment. As the centre mainly performs research and development tasks for development projects spanning several organizational units, and time is the main performance parameter in this extremely dynamic industry, it is easily understood that the demands on effective and timely co-ordination are substantial.

Using the CIMA methodology to map the CPI process, it was seen that the R&D centre on a general level performed well with respect to knowledge transfer and learning. The area that emerged as the most important one to attend to was *improvements coherence with corporate goals* (P2). This pointed at the importance of enhancing the frequency and diffusion of behaviour 1 (*individuals and groups use the organisation's strategic goals*

*and objectives to focus and prioritise their improvement and learning activities*) in the innovation process. The relatively limited display of this behaviour was discussed with the site manager, who meant that it most likely was a result of their way of working. Performing rather clearly demarcated tasks within large projects made it difficult to have a clear picture of strategies and goals at a company level. The two factors that were seen to contribute to this problem were the lack of a clearly communicated product family strategy, which to some extent can be explained by the unit's short history, a constant lack of time, and an outspoken opportunistic behaviour, and the limited focus on process improvements. The latter being further complicated by the integration problems between the units involved in R&D due to geographical distances and different interpretations of company-wide models and processes.

The mapping and the following analysis clearly revealed a need for an increased use of a product platform strategy (L1). However, also the introduction of new performance measurements (L6) that take knowledge transfer and learning into account in a more explicit way could be recommended.

Company Z is a large Dutch company, specialised in designing and producing integrated defence systems for command & control, sensor and communications purposes. An important contingency is *product and market complexity*, articulated in high internal complexity due to size, dimension, lead-time and life-expectancy of the systems, which are developed by different partners, contractors, subcontractors and then integrated and high external complexity, due to different goals of partners (political constraints). Other contingencies are *high technology innovation*, as defence-industry is highly innovative, combining IT, radar-technology with naval systems expertise, and *high political complexity*, due to decision-making process and national government and industrial interests.

Using the CIMA methodology in mapping three related projects it was concluded that B3 (*individuals use part of available time/resources to experiment with new solutions*) and B4 (*individuals integrate knowledge among all different phases of Product Innovation*) were not exercised to their fullest potential. Process improvement is heavily emphasised at the moment, thereby "neglecting" product innovation (B3). It was also concluded that there is no explicit and explicitly articulated product family strategy or (more general) a product innovation strategy (L1). However when looking at daily practice the conclusion is that there is more or less a clear emerging strategy with derived goals.

Drawing examples of levers from the other CIMA-cases (of companies in similar circumstances/contingencies) possible interventions were discussed. Human Resource Management activities (L4) such as the development of specialist skills, departmental assessment and development plans can contribute to intensifying B3. Also L5 contributes, such as project planning and control systems directed at improvement projects. A last lever can be found in L6 (performance measurement) where feedback systems and benchmarking activities can be beneficial, as well as measures for creativity (for instance number of improvements proposed). In improving B4 other levers were discussed such as L2 (innovation process definition): the activities in developing a new innovation process and implementation of it could be diffused to a bigger part of the company. L3 (organisational integration mechanisms) can have effects as well, such as temporary teams and/or liaison roles and cross-disciplinary meetings. Spreading results of the new PI-process is of importance in stimulating, diffusing and increasing frequency of the behaviours. Human Resource Management activities such as job rotation policies can be of support.





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