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DEFINING A STRATEGY OF INTEGRATION OF PACKAGING DEVELOPMENT INTO PRODUCT DEVELOPMENT

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ABSTRACT

This paper presents support for guiding the strategic activity of integrating packaging development into product development. This support consists in the description of 4 integration strategy models and a guideline based on the packaging specificities to help the planner define his or her own strategy. This strategy definition support can be operationalised without great effort.

Keywords: integrated product development, packaging development, integration strategy

1. INTRODUCTION

In a global and highly competitive economy, companies have now adopted an increasingly integrated approach to product development. Not only are companies working towards integration of functions (e.g. marketing, production, design) and a parallelisation of development tasks; they are also considering the product in its entire life cycle. However, as pointed out in three surveys among Swedish companies, [1], packaging logistics has been left out from this integration trend. The reasons are multiple, but leaving packaging development out of product development can often result in delays, poorer product quality (e.g. product damaged during transport because of inadequate protection), and thus increased costs.

In [2], the theoretical conditions for integration of packaging development into product development were studied, and it was suggested that a more adaptive integrated product development model be proposed. This general recommendation is applied in this paper, and support for guiding the strategic activity of integrating packaging development into product development is offered. It consists of 4 integration strategy models that the planner can use as a basis to develop his/her own strategy, as well as a guideline to pilot him or her through his or her choice.

This approach is presented in greater detail in Section 2. The guideline is developed in Section 3, and the strategy models are proposed in Section 4. The last section presents how this support can be further refined.

2. APPROACH ADOPTED FOR INTEGRATION OF PACKAGING DEVELOPMENT INTO PRODUCT DEVELOPMENT

In order to develop the strategy definition support, the following working steps have been followed: 1) in order to define the boundaries of this work, the concept of integration has been clarified; 2) IPD models from the literature have been reviewed in the light of the problem at hand; 3) the specificities of the integration of packaging into the product development have been investigated; 4) the different approaches to the definition of strategies have been studied, as they are part of the theoretical framework behind the strategy definition guide. The results of these working steps are presented in the next sections. The approach is then described in the last section.

2.1. An operational definition of integration

The concept of integration in product development is often opposed to methods and processes in the "traditional", sequential, product development process. Industrialization resulted in a specialization of the professions contributing to the product development process. This in turn resulted in organizational structures where people worked in a project more or less isolated from each other, meeting only during official design reviews to assess and decide on the progress of the project. Each function of the company handled its part of the product development project and delivered its results to the next concerned function. This system held well until the 1980s, when time and costs were not as important an issue as the demands on the product. As competition increased, the situation changed and there was an apparent need to integrate the different functions in order to reduce costs and lead times of the product-to-be, while ensuring its required quality.

The shift from traditional product development to integrated product development implies changes in:

- the organization of the company,
- the organization of development teams,
- the mentality of the product development actors and
- development of an adequate IT system.

As observed in [3], the integration has to be horizontal (integration during each phase of a product development process) as well as vertical (integration among the different functions). Horizontal integration mostly concerns issues of developing collaboration among people within the functional team and ensuring compatibility of information within the Information System (IS) on the time axis, throughout the product development. Vertical integration merely concerns the compatibility among the tasks performed by different functions and of the IS resources.

Thus integration, in a development process comprises the following:

- The parallelisation of the development tasks (main target of the concurrent engineering or simultaneous engineering);
- Collaboration among the different functions of the company (engineering, production, marketing, etc.);
- Sharing of relevant data between the functions.

These three points provide an operational definition of the concept of integration.

2.2. Integrated product development models

Deriving from the definition of integration, a product development model consists in:

- an integrated product development process model
- an organization model (OM)
- an information system model (ISM).

Although there is a general consensus on the need of integration of all actors participating during the whole product life cycle, the integrated product development models proposed in the literature focus solely on vertical integration among the three functions of marketing, design and production [4-7]. Only in [8] is business/finance also considered as a function (Figure 1). [9] is the only work known to the authors where packaging development is integrated with the product and process development in the framework of concurrent engineering. Her model is discussed in Section 2.3.

The models found in the literature are general in nature, and concern in reality the particular case where all the functions of the company and the tasks are highly interrelated (i.e. there is total integration). The driving force behind this approach is that the planner has at hand all the information pieces necessary for a total integration: he or she just needs to take away the unnecessary pieces to adapt the general model to the company. The questions “how?” and “to which extent?” the integration should take place are nevertheless rarely addressed in the literature referred to above.

Finally, these models remain on an abstract level. They do not take into account the complexity of networks of customers, suppliers and partners which implies, among other things, cultural differences among companies, the problem of trust and secrecy, the definition of an IS model (the exchange of data needs to be defined clearly; see the efforts presented by the automotive industry – via SASIG [10] – to the development of product data standards to simplify data exchange). The versatility of the product development organization must be considered. The actors change more often from project to project than within a single company. The company responsible for the whole project must decide whether it will establish long-term relationships with different actors, and the nature and intensity of these collaborations. These criticisms show that implementation is a very important and complex step towards accomplishing the desired integration.

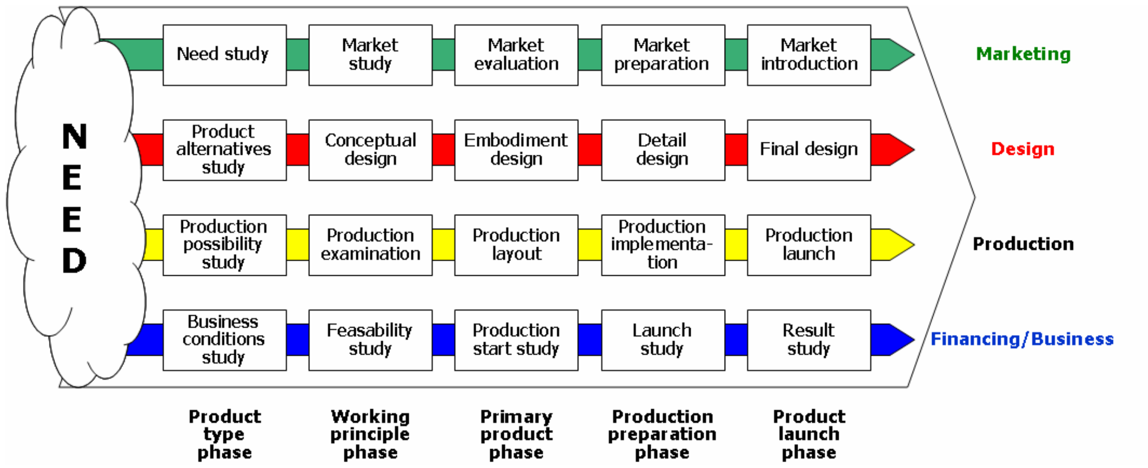

Figure 1 General Integrated Product Development Process Model [9]

2.3. The specificities of the integration of packaging development into product development

Packaging is traditionally considered apart from product development mainly for the following reasons (see also [1]):

- Packaging is linked with logistics: it protects the product during storage, handling and transport.
- Packaging is also linked to production, as the product has to be packaged.
- Packaging is not a competence within the engineering functions of the company.

The few considerations that link packaging to product development are the legal ones (packaging needs to be labelled, for example for traceability) and aesthetic ones (the packaging “sells” the product).

[9] puts the packaging development process together with the manufacturing and testing development processes. Packaging is defined as above, and most of the development tasks concern manufacturing line design.

[2] questions this point of view, and proposes a new view of packaging in the context of the total product life cycle. During the conceptual design of the product, the list of functions that the product has to fulfil during the whole product life cycle is established. It is unlikely, though, that the product alone can fulfil all of these functions, mainly because if the design solutions for some functions hinder the proper treatment of the product during use, these functions are discarded and performed by the product itself (another reason being that many products are designed with only use in focus). Packaging is thus seen as an add-on to the product that fulfils many product functions during manufacturing, transport, storage, even sometimes installation and recovery. This relocates packaging development at the heart of product development, instead of confining it to process development. At a functional level, packaging could even be considered more than an add-on or an extension: it is a part of a product and deserves the same attention.

This holistic view of product development generates new challenges. As mentioned above, packaging is not a core competence of the company, which focuses on the technical aspects of the product during use. Indeed, what we are dealing with is the integration of a product development system (the packaging) into another one. Thus the development of packaging requires competences that are often to be found outside the company. Even outside, these competences are scattered among, for example, the design agency, the packaging supplier, the packing machine supplier…

A product development policy that wants to take packaging into account has to make choices between in-house development, in-house manufacturing, strategic alliances with partners from the packaging industry, new product development organization, etc. By referring to the GIPDPM in [8], one can see that packaging, as a part of the product, can indeed be taken into account at every step of a product development project.

2.4. Defining strategies

In this section, we review the different approaches employed by executives to define corporate strategy, of which the company’s general product development model —process model (GIPDPM), organization model (OM) and information system model (ISM) —are essential parts of the product policy definition. Defining the company strategy consists in defining the company for tomorrow and control whether it is fit for today. This involves different tasks, and there are different approaches:

- One approach is to analyse the present in order to decide for the future: driving forces of the market (SWOT analyses) precede the positioning of the company on different market segments and the definition of the competitive advantage for different Strategic Business Units (SBU) [11].
- Another approach is to focus on the future: Experts' analyses try to predict future trends, develop different scenarios and try to find invariants in these scenarios. These invariants help in defining the most accurate strategies, or, among existing strategies, the strategy that gives the most positive outcome (that is, the most robust one). Eventually, one of these scenarios is chosen [12-14].
- A third approach is to focus on the company organization: develop an organization that is flexible enough to react in a very short time to the fluctuations of the environment and learn from them (see e.g. [15,16]).

In the case of manufacturing companies, a SBU is mainly related to certain market segments and also to a certain product portfolio. Each SBU decides, among other things, on a product policy, which is based on the analysis of the target segment, the core technologies of the company and the overall corporate strategy. The product policy will contain the following: The product portfolio (lists of new products, products to further develop, products to abandon, see [17] pp. 17-18); product planning (see [18]); an adequate general product development procedure; the organization to perform the different product development.

Indeed, any reconsideration of, say, the core technologies of the company within a SBU primarily concerns functions of the products whose technology is not possessed by the company. This can result in joint ventures or acquisitions.

2.5. The adopted approach

Section 2.3 showed the specificities that packaging brings into product development, and Section 2.2 showed the limitations on the current models of integrated product development. In Section 2.4 it was briefly recalled how strategies are built. From these considerations, the following approach has been adopted.

Defining strategies: we see the three strategy definition types presented above as complementary to some extent, although they have been most often opposed to each other (see e.g. [19]). Our work is identified with the first and second types. It is important to make a strong analysis of the present, but also to have deep insights into the possible futures.

For that purpose, four general types of strategies are presented instead of one general integrated product development model, from which the planner can develop a GIPDPM, a related organization model (OM) and an information model (ISM) adapted to the company. They define different degrees of integration. Scenarios-like, they should help the decision-maker in dealing with the following strategic reflections: whether or not it should be part of the core competencies of the corporation, and how to integrate it in the general product development procedure of a given SBU.

Packaging specificities: we defined packaging as an extension of the product. The consequence is the following: at the conceptual level, there are some types of functions the product has to fulfil that can be implemented into either the product or the packaging. Likewise, a set of working principles types (or modes of operation) corresponding to the functions can be defined. Finally, product physical properties and elements (hereafter called physical elements) can refer to the functions and modes of operations. Basically, the decision-maker has to choose among these three sets of factors, which will be part of the product and which will be part of the packaging. This makes it possible to define the degree of integration of packaging development into product development. These factors can also be used partially to choose among the 4 models. The use of the factors is described in greater detail in the next section.

4 generic lists of functions, modes of operation and physical elements and product family elements have been developed. These factors are based on the study and modelling of the system (product+packaging). They are explained and presented in [20] and are reproduced here in four tables in the Appendix (note that the denominations of the factors types have been changed in this document in the interest of simplification). The tables also show a mapping between functions, modes of operation and physical elements lists.

Product development models: The model presented in Figure 1 is the point of departure. Following the definition of integration presented in Section 2.1, the model comprehends:

- The organization of the product development process (need of a general integrated product development process model, together with a resource breakdown structure that states the role of the different actors, including the packaging suppliers);
- The collaboration among the different functions of the company;
- The information system model.

Many other considerations apply to make final decisions, such as economic, organizational and cultural ones, but these are independent of the packaging specificities. They are thus beyond the scope of this study. The outcomes of the application of the strategy definition method presented are merely *suggestions* that will help the planning of the company's general product development models rather than normative off-the-shelf solutions.

3. PLANNING THE STRATEGY OF INTEGRATION OF PACKAGING DEVELOPMENT INTO PRODUCT DEVELOPMENT

The application of the adopted approach is presented in this section.

The planner is purposely granted a large room to manoeuvre. He or she has at disposal the description of 4 possible strategies integrating packaging development into product development and the set of packaging-specific factors to help him or her in making a more informed choice. The first step is merely to appropriate the different strategy models that can be as much scenarios or sources of inspiration the company could adapt. In order to use the factors, the planner can proceed as follows (the whole procedure is illustrated Figure 2):

3.1. Reduction of the number of factors

The factors are different depending on the type of product. The factors have been developed for mechanical, food, and pharmaceutical industries. The planner needs also to select the factors according to the SBU type of industry. (Note that only the mechanical industry-related factors are presented in the Appendix.)

Even within a type of industry, the factors do not apply to all products. The planner then has to discard the factors that do not concern the company's product assortment:

1. "Function" factors: consider which functions will be fulfilled by the product or the packaging and discard the functions that will be fulfilled by the product, so that only the functions concerning packaging (and thus integration of packaging development) will remain.
2. "Product physical elements" factors: the product physical elements are either physical solution types that fulfil the set of packaging functions (example grip systems) or elements that need protection against the environment (e.g. surface finish). The planner has to consider whether the product will take over some of the packaging physical elements and whether the product will be less sensitive to the environment (for example, less sensitive to corrosion).
3. For each "mode of operation" factor: same reasoning as in 2. applies here.
4. For each "product family" factor: consider whether they apply to the company's product portfolio.

The factors show some dependency. A function can imply some modes of operation which in turn are embodied in the product physical elements. These are not one-to-one or one-to-many mappings, however. It is thus necessary to map each category towards the other separately. This can be easily done by the help of a relational database system. The mapping elements are given in Tables 1 to 4 in the Appendix.

First use of the selected factors: support for strategy planning.

The natural approach would be to set up an objective function, use the factors as criteria and perform a multi-criteria decision analysis in its simpler form, for example with the help of a screening matrix (see [18]). However, this approach does not hold in our cases for at least three reasons:

1. Most of the factors' importance is context-related. To some products, some factors are irrelevant, to others, they are extremely important. Sensitivity to vibrations, for example, is a negligible factor for some products, but in [21] this was the starting point for the development of a specific protection system during transportation. It is thus not possible to describe the strategy models by the help of the set of factors, nor is it possible to weigh the different factors a

priori and give them an absolute value of importance.

2. At a strategic level, many factors cannot be known or determined precisely.
3. In order to choose a specific strategy, many other questions need to be answered that are not driven by packaging specificities, but by an economic and organizational corporate perspective. Such questions are: Is packaging a competitive advantage in the market segment considered? Does it need to be a core competency? To what extent does integration diminish costs: development costs, manufacturing costs, over-head costs? To what extent does integration diminish development time? How deep must be the integration in terms of collaboration (e.g. meetings with developers) and information exchange? What is the cost of re-organizing the SBU?

There are some other possible approaches that could help the planner make a more informed choice, with fewer constraints than a multicriteria decision analysis approach. They all require more information than is actually available, though. Some of them will be the object of further research and are described in the last chapter of this document, but at the current stage of development of this investigation on the integration of packaging into product development, a simple heuristic is proposed. Based on some criteria *and* on the importance of these factors given a certain product, some factors will have more influence on the integration degree of packaging development into product development (it is also not the same as weighing the factors). One rule of thumb is then that the more factors that are important given a certain product and that have a potential influence, the more the planner should consider the strategy models that have a strong integration degree. This heuristic remains highly qualitative, but also allows the planner greater freedom. The factors' influences on the integration level have been assessed by the help of 4 criteria, and three levels of influence have been determined:

- direct influence (DI): the factor can directly influence the degree of integration of packaging development into product development. Those factors should be taken into account whatever the product type.
- potential influence (PI): the factor can be important for some types of products. In those cases, the factor can directly influence the degree of integration of packaging development into product development.
- minor influence (MI): except for some exceptions, the factor will not influence the degree of integration of packaging development into product development.

The 4 criteria were:

- Impact on amount of work for design development
- Impact on amount of work for manufacturing development
- Manufacturing investment
- Consequence if the factor has not been taken into account.

The levels of influence are presented in Tables 1 to 4 in the Appendix. Most factors have little influence, but they still give an indication of the needed integration degree; this is a point that the planner must keep in mind during decision-making.

3.2. Second use of the factors: definition of the GIPDPM

The planner needs to specify in which activities of the GIPDPM packaging issues have to be considered. Most packaging-related tasks will necessarily involve the factors: when discussing the product functions, the function factors will be on the table, during conceptual design, modes of operation will appear, when dealing with solutions, product physical elements have to be taken into account. A mapping of these factors to the integrated product development tasks has been done. This is presented in [20] but is reproduced in Figure 3, together with the first strategy model. Knowing where packaging can or should be integrated, the planner can define the GIPDPM with more accuracy and describe how to handle packaging issues. This mapping can then be re-used at the tactical and operational levels:

- The tactical level is the planning of a peculiar product development project. The project manager adapts the GIPDPM to the particular project and can take packaging into account
- During the project execution, when a factor is "met", the product development team knows how to deal with the packaging issues.

The mapping presented in Figure 3 exposes where the factors are the most likely to appear during a product development project. It is also possible that they appear elsewhere because of a specific product development context. The factors concern mainly the GIPDPM part of the integration, because the product development activities are directly product-dependent. Indeed, the OM and ISM definitions involve other issues that are less product-dependent.

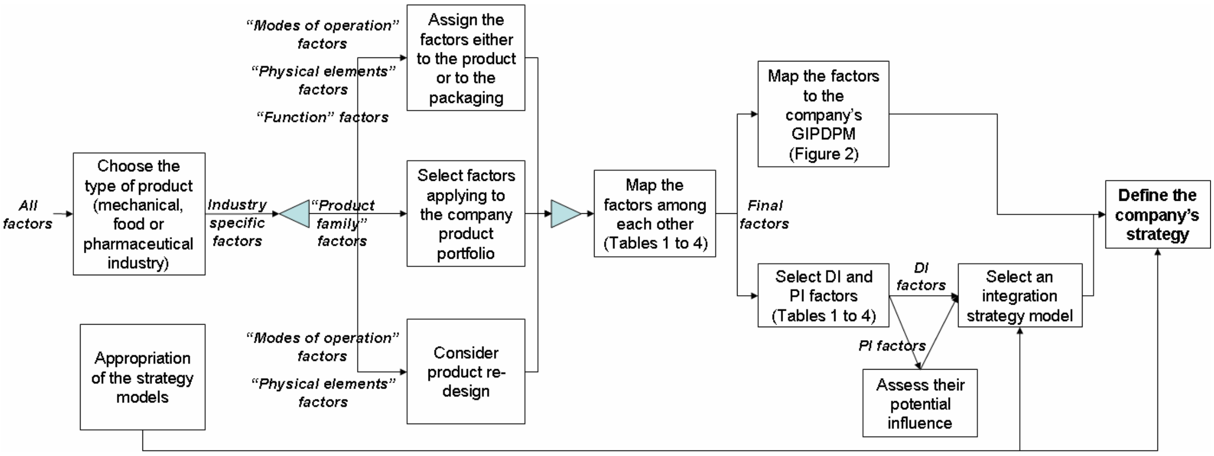

Figure 2 Planning the integration strategy

4. STRATEGY MODELS

4.1. Possible strategies of integration

We have identified 4 types of strategies. In Section 2.2, it was stated that integration concerned the definition of a GIPDPM, an OM and an ISM. These 4 types of strategies present different degrees of integration within the 3 integration dimensions stated above.

4.1.1. Total integration

The packaging is considered to be a part of the product, on the same level as any functional part of the product; thus the product development phases are intertwined with the packaging development phases. For example, during the need study, the functions of the product and the functions of the packaging are not separated. This has the real advantage that the functions are not affected *a priori* to each of the parts, which complies with the spirit of consumer need specifications, which is to describe the need without any technological solution. For instance, protection against climate hazards can be assigned either to the product and/or to the packaging. If the product during use has to deal with such hazards, there is then no need to assign this function to the packaging. Packaging is also not a fifth domain in the integrated product development that would be added to marketing, design, production and business/finance, but integrated in each of these domains, as illustrated in Figure 3. In the case of mechanical products, packaging design is also considered to be a part of the engineering design domain along with the mechanical, electrical, electronic design departments. Packaging design in this case is a core competence of the company.

As in [8], the functions participating in the product development are marketing, design, production and business/Financing. In [18], the product development team is constituted of a core team and an extended team. As a reason for choosing the total integration strategy, packaging should be present in the core team. However, such a constitution raises some objections. First, packaging competences are scattered in the four main functions involved in product development. Second, a larger core team will not necessarily lead to more efficient product development. In [22] it was shown that teams including more functions do not have any positive impact on time reduction or project failure reduction (p. 496). Another possible model of organization would be to have a core team, function core teams and an extended team. The member of the function core teams would collaborate more promptly to the project and be represented by the heads of their respective functions at top product development review meetings. This team model is represented in Figure 4.

The company's information system does not need *a priori* specific adjustments, as packaging is integrated inside the company. It is likely, however, that competence in packaging has been obtained

by acquisitions of specialized companies. In such cases, the resources are scattered around the globe and more integrated product data management and communication may be needed. Such solutions are provided by a range of actors like PTC (Windchill), Dassault Systems (Enovia) or UGS.
The total integration model can be considered as a generic product development model if abstraction is made from the networked product development that occurs in the other cases below.

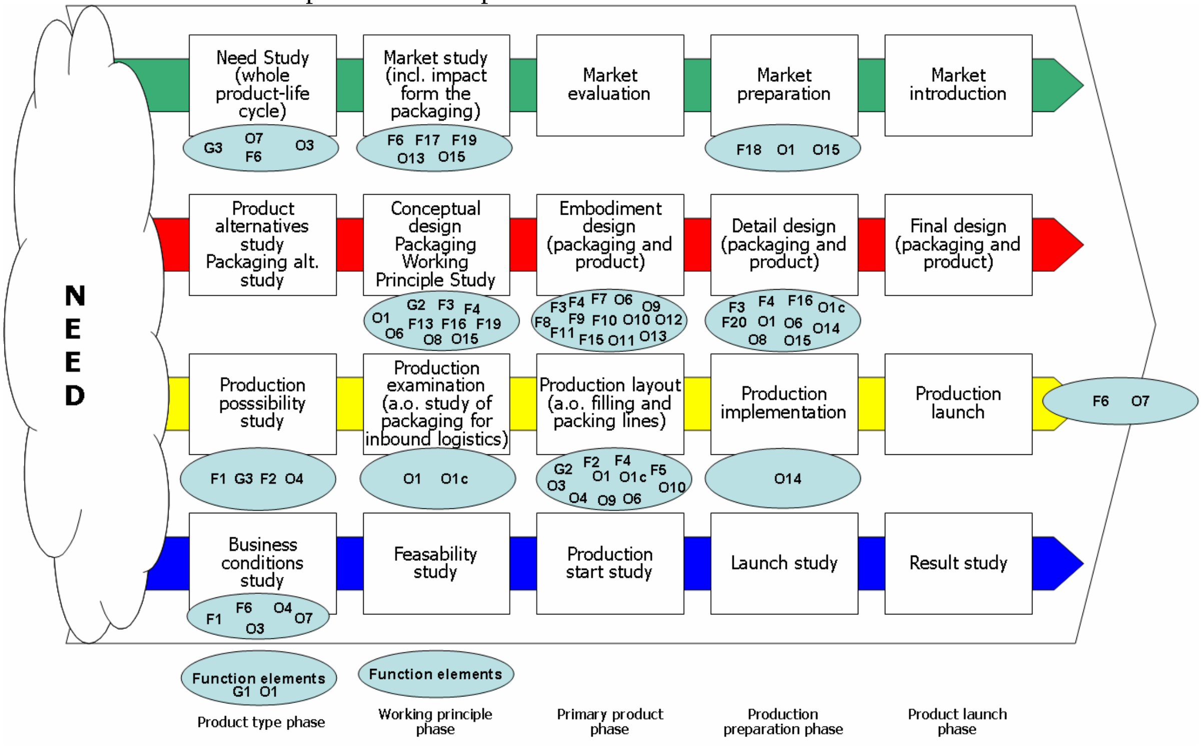

Figure 3 Example of IPD model with total integration of packaging and product development.

Note: F6 and O7 are "horizontal" factors that are present in all the production function activities; the "function" elements and G1 and O1 are "vertical"factors that are present along all the functions activities during the product type phase (and the working principle phase).

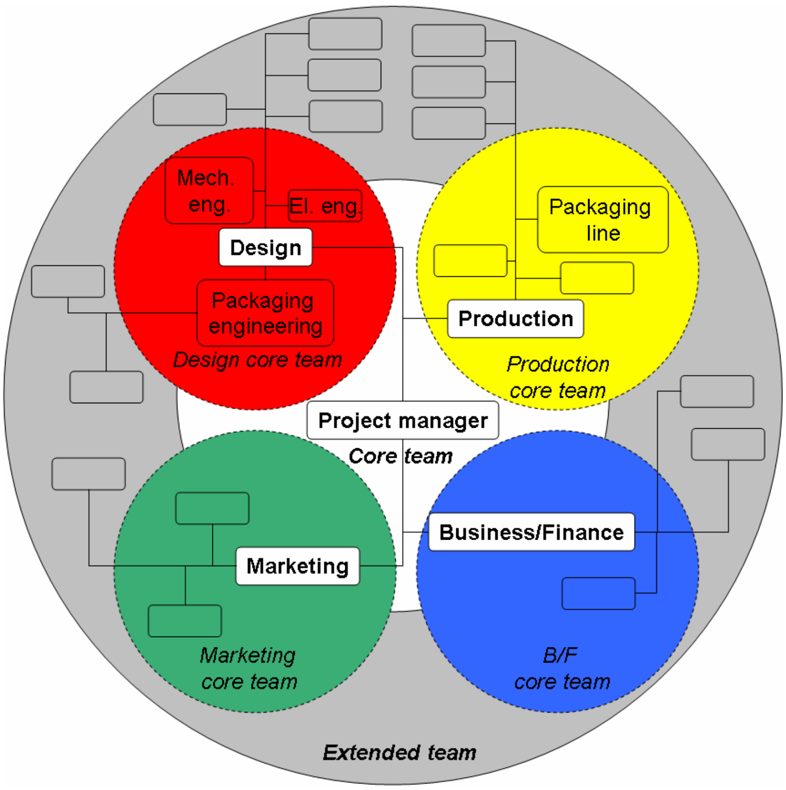

Figure 4 Total integration team model

4.1.2. Extended enterprise

For both the extended enterprise and virtual enterprise strategy models, we use the terminology of [23]. In the extended enterprise, the product company chooses not to have packaging as one of its core competencies, but packaging development is still sufficiently intertwined with product development to need a strong, long-term partnership with the packaging company(ies). This means that the organization of the involved companies must fit in order to optimise the co-operation: integration of the product development procedures of the different companies and creation of bridges for collaboration among the different functions of the company at the operational level. Horizontal integration is particularly emphasised since there is a need of compatibility between tasks performed by different actors. The data management solutions, such as the Product Life Management System (PLM) must also be harmonized in order to ensure the sharing of the relevant data. The extended enterprise also involves the whole supplier chain, but this is beyond the scope of this paper, as the integration of logistics is not discussed in this study. An example of an information system model is presented in Figure 5. The packaging-related partners will need to interface with the company's SCM, ERP, and PLM (or in the latter case, have the same authoring computer-aided and documentation tools).

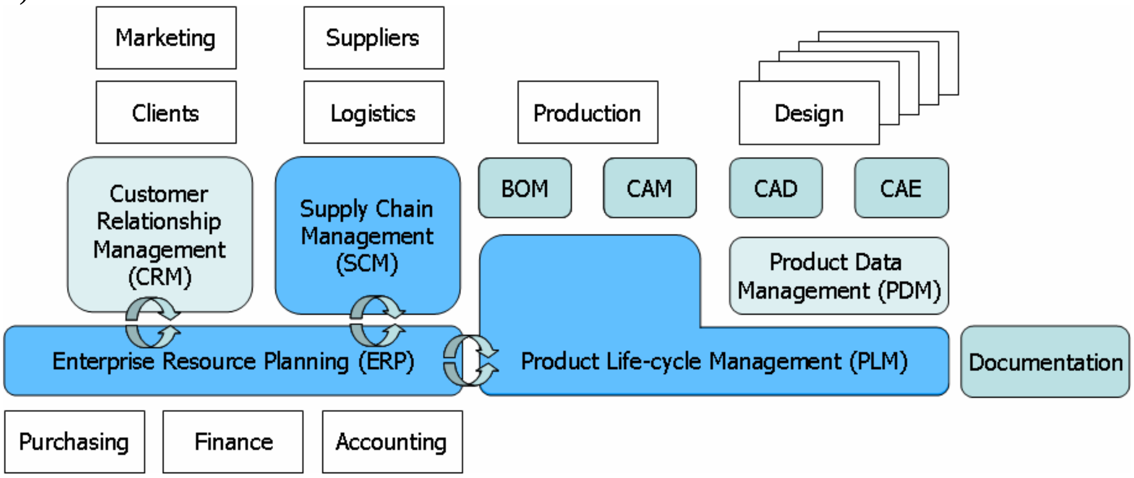

Figure 5 Example of Information system model

4.1.3. Virtual enterprise

The virtual enterprise has much in common with the extended enterprise. The main difference is that the partnership here concerns a particular project more than a range of projects. It is up to the strategy planner to anticipate whether packaging development will be intense for punctual projects. A virtual enterprise is managed merely at the tactical level, as the general product development procedure of the company needs not to be profoundly changed; the adjustments are only necessary for the project at hand. However, it relies heavily on a sophisticated ISM, whose implementation has to be decided at the strategic level. It can also be similar to the one presented above. As well, the organization of the company does not need to change, but the culture of the corporation is at stake. The employees must be flexible enough to adapt to the new temporary enterprise they will work for. The company needs thus to be prepared at a strategic level to be part of a virtual enterprise. The whole supply should also be taken into account, but as explained above, that is beyond the scope of this study. Note that a virtual enterprise can become extended if the collaboration becomes more permanent.

4.1.4. Supplier-buyer

Finally, in many cases, the packaging can be seen merely as a component of the product and then it should be treated as such. At the strategic level, it is a matter of choosing the right supplier. It is nevertheless still important to devote as much care for the packaging as for any component (following the general philosophy of this paper that packaging is not external to the product): early investigation for the packaging specifications, integration in the production line, impact on the voice of the customer, etc. Moreover, packaging involves several actors: printer, labeller, etc. This means that it is important to consider it in the product planning, not only in the late product development phases.

4.1.5. Packaging as a SBU

There is also a fifth type of integration. The company can decide to create a new SBU dedicated to packaging. This is a matter of corporate strategy. In contrast to business strategy, which concerns strategies within a SBU, corporate strategy is "what businesses the corporation should be in and how the corporate office should manage the array of business units" ([24], p. 43). The "packaging SBU" can be an internal supplier of the other SBUs and even consider the possibility of being an actor in the packaging market. This allows for a higher control of the product value given to the customer while the SBU responsible for packaging development remains in competition with other suppliers.[1] This strategy, however, is loosely based on the degree of integration between packaging and product. It can be the necessity either of total integration or of an "extended enterprise" strategy model that triggers this strategic decision. Furthermore, this strategy defines a new core competence inside the company, but there is still a need for developing a general product development procedure including packaging within each SBU, and to decide whether it will be in a total integration, extended enterprise[2], virtual enterprise or supplier-buyer form.

5. CONCLUSION AND FUTURE RESEARCH

This document has presented support for guiding the strategic activity of integrating packaging development into product development. Based on 4 integration strategy models and a guideline, this support should help strategy planners define their own integrated product development strategies.

The integration strategy models are purposely presented in a loose way: planners appreciate it when the description of a strategy is not just "a list of bullets" [25]. Moreover, the strategy definition support can be operationalised without large effort; the modelling has been made in such a way that it could be implemented in a simple relational database system.

The next step towards the development of the support is three-fold. First, as was stated, the influence of the factors towards integration degree is context-dependent. It would be possible to make more informed choices by studying empirical cases and assigning a statistically based value of importance for each factor. In that way, it would be both possible to define a strategy model based on empirical data and easier to choose a relevant strategy model. This task would be modelled as a *classification task*, an alternative to multicriteria decision systems. This heuristic is about determining to which class (strategy model) an element (the planner's individual strategy) belongs [26], and many different methods are available to match a class with an element (see e.g. [27]). Second, instead of (or in complement to) 4 integration strategy models, the planner could choose among components that could be pieced together to cast a product development model. The strategy models can be made more modular by already separating the GIPDPM, OM and ISM. The classification task would then become a *configuration design* task. Finally, the issues of integration of packaging development into product development should be also tackled at the tactical and operational levels.

APPENDIX: LIST OF THE ATTRIBUTE ELEMENTS (MOTTE ET AL. 2007)

Table 1 physical elements

	Physical elements	Infl.		Physical elements	Infl.
O1	Nature of the product	PI	O9	Product structure	PI
O1c	Solid	PI	O10	Product elements	PI
O3	PP_System* is labelled	MI	O11	Weight	PI
O4	PP_System is sterile	DI	O12	Product temperature	MI
O6	Dangerous (e.g. cutting) surface.	PI	O13	Product aesthetic characteristics	MI
O7	Product composition and/or geometry prevents storage	MI	O14	Surface finish	MI
O8	Grip elements	MI	O15	Product instruction	MI

**PP_System*: both the product and packaging together

[1] Note that the need for total integration can lead to this strategy, but other considerations, like the company's will to extend and diversify its activities, can also play a role.

[2] The denominations *extended enterprise* and *virtual enterprise* is meaningless here as the SBUs are part of one company, but the main principles of these two strategy models still hold to help in defining the co-operation among SBUs.

Table 2 Modes of operation

	Modes of operations	Mapping Table 1	Infl.		Modes of operation	Mapping Table 1	Infl.
F1	PP_System made sterile	O4	DI	F10	Sensitivity to humidity	O10	MI
F2	Product is packed/filled in uncontaminated atmosphere	O4	DI	F11	Sensitivity to light	O10	MI
F3	Product is/can be aggressive against the packaging	O6	PI	F13	Dirt from the environment	O13	MI
F4	Product is/can be aggressive against the handling personnel	O6	PI	F15	Sensitivity to corrosion	O9,O10	MI
F5	Product is stored	O7	MI	F16	Product is pollutant	O6	PI
F6	Product is transported	O7	PI	F17	Packaging opening system		PI
F7	Impact	O9,O10, O11	PI	F18	Help the user to understand how to use the product	O15	MI
F8	Vibrations	O9	PI	F19	Packaging performs the use together with the product	O15	PI
F9	Sensitivity to temperature change	O12	MI				

Table 3 Functions

	Functions	Infl.	Mapping Table 2	Mapping Table 1
Te1	Necessary information must be present on PP_System	PI	F18,F19	O3, O15
Te2	PP_System must be sterile	DI	F1,F2	O3, O4
Te3	Protect the environment against the product	PI	F3,F4,F16	O6
Te4	Need of packaging for internal distribution: need for storage	MI	F5,F6	O7
Te5	Product shipping constraints	PI		O7
Te6	PP_System easy to handle	MI	F17	O8
Te7	Protect the product from the environment	PI	F7,F8,F9,F10, F11,F13,F15	O9, O10, O11, O12, O13, O14
Te8	Protect surface appearance (against scratches)	MI		O13
Te10	The packaging needs to be recovered	MI		
Te11	The product needs a support to be installed	PI		O9, O10
Te12	Aesthetic considerations	MI		O13
Te13	Prevent the product from being hazardous to use	MI		O6, O9, O10, O11
Te14	Packaging easy to handle	MI	F17	

Table 4 Product family factors

	Product family factors	Influence
G1	Frequency of change of form among the different products	DI
G2	Number of products to pack /day	PI, but, together with G3 or G4, DI
G3	Pallet product shipping	PI, but, together with G2 or G4, DI
G4	Mix/Multiple product ship	PI, but, together with G2 or G3, DI

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