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A TAXONOMY OF COLLABORATION IN SUPPLY CHAINS

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ABSTRACT
The success or failure of a product design and development (PD) project depends strongly on the r contributions from its various suppliers. This is specifically the case when these suppliers do not ju provide off-the-shelf items, but also contribute to the design and development of the final product. Identification, evaluation, selection, negotiation, contract signing and finally collaboration with suppliers crucial and necessary steps towards potential success. This paper argues that a supply chain must be designed and deployed step by step while the product design is being frozen. This article presents exploratory results about a general framework called CEPS (Co-Evolution of Product design and Sup Chain) to integrate supply chain design and deployment coherently with product design. We focus suppliers' contribution and propose criteria to classify the collaboration situations connecting them t given company and assess the *a priori* risk associate with these situations. This classification help company to evaluate potential risks of a PD project which integrates suppliers.

Keywords: Product design and development, Supply chain design, Supply chain deployment,

1 INTRODUCTION
Designers in a company should regularly interact with the designers of their suppliers. In an ideal wo suppliers get involved when their part of a product is specified. However, the reality this is not that e because long lead times force early design freezing and modifications to design decisions could af suppliers, while suppliers not meeting their specifications can affect other design decisions [1]. Not al the suppliers are known at the beginning of a product development project, and any product change m propagate through the whole product and thus the supply chain [2].
The selection of suppliers is vital for every project, as they impact deeply on strategic decisions as wel the day-by-day tasks of everybody ([3], [4], [5]) or as Dowlatshahi in [6] puts it "An improved design one part proposed by a supplier may affect the cost of the part, the cost and ease of manufacturing processes, the processing time of the part, the quality of the part and product produced, the level of inventory required, the logistical support required for the product, and the post-service support required the product".
But, product design and supply chain management are rarely looked at together. Designers do not alw think about the supply chain when they are designing. In many companies they have little influence on selection of suppliers and only meet engineers from key suppliers. On the other side, buyers interact v many suppliers but hardly ever interact with their engineers and designers.
Supply Chains are very often conceptualized as emerging structures either from the view point of high-le strategic considerations or short-term optimizations of cost-quality-delay criteria. Choi in [7] defines structure of a supply network as "a pattern of relationships among firms engaged in creating a sellabl product" and adds "… regardless of the structure that will eventually emerge over time, the underly purpose of structure is of control activities". Since the idea of emerging structures become recognize early 80's, structural and functional aspects of supply chains received significant scientific attention, see instance [8], [9] or [10]. As efficient supply chains can reduce time-to-market significantly by suppor innovation, they become of increasing importance in all industrial sectors. Supply chains are more and m considered as complex systems, which need to be designed, deployed and controlled. This paper stresses fact that a supply chain must be designed and deployed according to tradeoffs obtained by negotiati between decision makers, designers, and engineers. These aspects have to be considered jointly with dynamic influences between the product design/development and the supply chain design/deployn

process suggested by [11], [12] or [13]. With other words, the supply chain should be designed and deployed step-by-step while freezing product concepts.
One of the very first questions arising at the beginning of the supply chain design process is supplie selection due to their impact on the success or failure of a PD project. Suppliers selection was b considered according to the business context both by the academic literature ([14], [3]) and by compan see [15] or [16]. However, the idea developed here is that before making any decision regarding a poter partner, a company should aim to understand and evaluate the risks associate with this selection. propose a taxonomy of collaboration scenarios based on partners' contribution either to the specificat design or manufacturing of products. This allows us to represent partners on a risk diagram mapping design and/or manufacturing risks for the PD project. Using these concepts a company can determine m efficiently the most relevant selection procedure for its partners minimizing as much as possible the risl PD failure.

Section 2 reports on existing research on mutual influences between product design and supply cl design/deployment. Supplier selection methods are also briefly discussed. In sections 3 and 4, authors present some results studying the suppliers' contribution in a PD project, and introduce in section 3 nascent methodology we call CEPS (Co-Evolution of Product Design and Supply Chain) which contai global framework and tools to link product and supply chain design processes. The CEPS methodol studies and models links between *product design/development* and *partners' network design/deployn* within a PD project (see [17] for instance). The goal is to analyze and model the interactions and dependencies between design and supply chain management while product concepts are gradually be frozen. Section 4 discusses concepts necessary to establish the collaboration scenarios taxonomy. Tl risks are then represented in a risk diagram. Discussions, in section 5 followed by some conclusions end paper.

2 RELATED WORK

Let us first come back to main concepts of the supply chain theory. Among other definitions, Choi Hong consider a supply chain in [7] as "a network of firms engaged in manufacturing and assembly of p to create a finished product". Browning has a similar understanding of a supply chain, as "a networl customer-supplier relationships and commitments that drive activities to produce results of value" [18 supply chain evolves either in its rules of engagement, collaboration protocols or memberships. Therefor is necessary to qualify such a complex structure. In their paper, Choi and Hong propose to define a su chain according to the degree of *formalization* (referring to the degree to which the supply networ controlled by explicit rules, procedures, and norms that prescribe the rights and obligations of the indivi companies that populate it), *centralization* (centralized or decentralized network) and *comple* (horizontal, vertical, and spatial) [7]. The horizontal dimension of complexity refers to the number of t while the vertical dimension gives the number of partners per tier. Finally, the spatial dimension tak account of partners' geographic distribution. To really understand the complexity of a supply chain, i necessary also to understand the pair wise relationships between suppliers and the company and tl directly between suppliers, if they collaborate.

In a PD project, contributions of suppliers could begin at the development phases and last till the recyc phase. While collaboration and co-operation within an organization during the product design are of upn importance [19], the issues become more critical if the design and development is extended to suppliers. projects are managed to a large extend in terms of global efficiency [20]. But the first step to achieve th supplier selection, which has received lots of interest from the scientific community; see [3], [21], [22] very complete survey done by Benyoucef *et al.*[14]. For instance, Croom gives a set of criteria used to se a supplier in a pair wise relationship [4]. He separated operational criteria from relational, based on a st made on the UK auto industry and observed that the relational criteria were used differently for new con and existing suppliers.
In the 1970s methods for supplier selection were evolved using highly formal criteria such as price, de etc. [14]. This evolved towards methods employing more qualitative criteria including design constrai but, without including designers in discussions and negotiations [21], [6]. A good discussion of organizational aspects of supplier selection can be found in [6]. He highlights the fact that supplier selection has to be done keeping in mind that all of the supply chain actors have to be engaged in a "v win situation for all; otherwise it will not last for long". While connecting buyer and suppliers is a

traditional issue of collaboration between firms, 'these relationships have not, however, included the designer and the crucial and strategic product design'.
To understand the selection context better functional and organizational view points need to be conside While the organizational point of view focuses on persons or departments in charge of selecting partne functional view point looks at abstracted activities or processes without taking account of execution resources. According to this distinction, Dowlatshahi studies the organizational relationship between buy suppliers and designers arguing to make several recommendations, for example that even if designers interact with suppliers, buyers should be in charge of sourcing, supplier selection, and supplier certificat Others look mainly at functional aspects of selecting partners by proposing a more or less exhaustive lis selection criteria (see for instance, [14], [22], and [20]) and more or less powerful selection methods, see instance [23], [24]. Interested readers could refer to the very complete list of selection criteria in [3].
The scientific interest about partner selection criteria and methods underlines the fact that early supp involvement is an accepted idea even if it is not always applied in reality [25]. Danilovic reports in [20] the incorporation of suppliers into a firm's development process is considered a key to a shorter development cycle and better products. He refers to a study carried out by Weiss et *al*. in [27] concluc that the situation in many other industries is similar to that in the aerospace industry. They benefit fro high degree of supplier involvement in the development process based on long-term relations and e supplier involvement in design and development teams, joint risk identification and risk sharing, as wel joint target costing. Automotive industry is also hugely dependent to its suppliers and final assemblers Often companies assemble or manufacture just a small portion of the final product, suppliers do the rest. Therefore the huge potential impact of suppliers on the final product pushes companies towards ever cl collaboration with suppliers. Nevertheless, the collaborations with suppliers remain still very low leve every development phase according to [21], even though he reported that 60-80% of components in aerospace industry in general and in particular the Swedish military aircrafts come from suppliers. Ma and Braiden suggest (based on a survey over 58 UK companies from electronic and mechanical sectors) early suppliers involvement depend directly on the criticality of the item and on the management style of company are possible reasons for the discrepancy between the level of supplier involvement suggestec literature and actual industrial practice. This idea is echoed by Humphreys in [3].
Another explanation is also possible. If a company determines clearly what the external needs for collaboration (technologies, techniques, know-how, tools, etc.) are and if it could assess the impending r before any contact is established with potential partners, it could use selection methods and criteria m efficiently. Therefore the research presented in this paper is mainly focused on possible contribution scenarios of partners in a supply chain. This paper classified partners influence on the PD project to l firms to gain a better understanding of the way that suppliers could jeopardize or enhance project succ To do so, in section 3, we propose first a methodology which aims at identification of supplier contributi in a PD project.

3 THE CEPS METHODOLOGY

The supply chain cannot be designed and developed without considering product characteristics products rarely can be designed and developed without using suppliers' support either for design or manufacturing. Some pioneering work had already focused on this necessary conjunction of product supply chain. Vonderembsea considers the design of supply chain as an issue of product design [11]. idea of simultaneous design of product, process, and supply chain was first proposed by Fine in [12] a Fischer in [13].
This paper presents the framework of the CEPS (Co-Evolution of Product design and Supply Ch methodology to understand these mutual dependencies first and to be able

- identify the roles of suppliers;
- help decision makers in assessing risks of collaboration scenarios;
- select relevant partners;
- manage bilateral constraint between product design/development and supply chain design / deployment.

3.1 Recursive Description of a Supply Chain

A supply chain description is composed of companies linked together according to a logical depende schema. The structure of a supply chain is mainly a lattice. Nodes represent companies and ec correspond to flows of items and data. Every node uses several input flows to produce outputs.

description of a supply chain requires a definition of appropriate borders. To do so, we look at a sup chain from the point of view of a given company. Every time that we focus on such a company, we ca the *Focal Company* (FC). The structure of a supply chain, seen by a FC, can be subdivided into two pa its suppliers and its customers [27]. Each part can be also defined by: 1) the number of considered par tiers, and 2) the number of partners considered in each tier. These two past parameters correspond to horizontal and vertical dimensions of the complexity defined in [7]. It becomes then obvious that the su chain differs from one FC (e.g. A in Figure.1) to another (e.g. C2 in Figure.1). A FC might itself be pa several supply chains (for instance, Supply Chains of the company A).

This article studies the supplier part of the Supply Chain.

After receiving specifications or requirements from customers, the FC needs to establish whether the n requirements can not be met by existing products. Otherwise it needs to launch a PD project based on t specifications and look for known and unknown suppliers to find a feasible concept for the product.

The idea of the supply chain design and deployment for our purpose consists of designing the suppliers' of the whole supply chain, step-by-step as the product design knowledge increases.

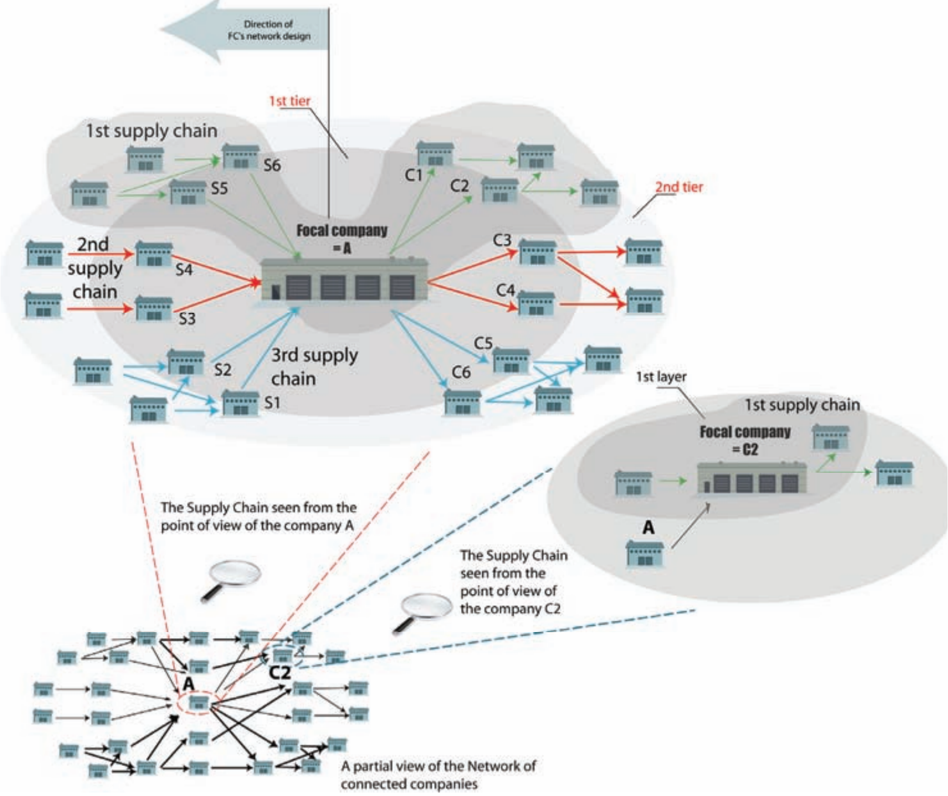


Figure 1 – Networks of partners

3.2 What is a supplier?

The ANSI/EIA-632 [29] standard defines a systematic approach to engineering or reengineering a sys (simple or complex software, hardware, etc.), incorporating best practices that have evolved during th second half of the twentieth century. This standard distinguishes between two classes of products which developed within a system engineering project: *end products* and *enabling products*. An end product is " portion of a system that performs the operational functions and is delivered to an acquirer." (page 77 EIA-632 Standard). An enabling product is an "Item that provides the means for a) getting an end pro into service, b) keeping it in service, or c) ending its service. Enabling products are used to perform associated process functions of the system—develop, produce, test, deploy, and support the end produ train the operators and maintenance staff of the end products; and retire or dispose of end products that no longer viable for use." (page 47 in the ANSI/EIA-632 Standard). This distinction between end enabling products can be used a first criteria to classify suppliers.

Now, let us look at the lifecycle. Several entities are necessary to allow any transformation to take place inputs, b) data, knowledge and know-how, and c) resources and tools. These standard elements v introduced by the early works on the IDEF0 model (see [28]). Therefore, either for end products or enab products, the following classes of suppliers can be distinguished:

- **Suppliers of inputs.** Mainly comprising suppliers of raw materials and components, these suppl correspond to the traditional definition of suppliers. They provide necessary items to produce products or enabling products. The quality, delivery time, etc. of the inputs are generally speci by the FC.
- **Suppliers of knowledge and know-how.** These partners offer their competencies to the FC (designers, experts, …) for any phase in the life cycle of the product. These suppliers can classified into two finer sub-classes: (a) Suppliers who work on data, i.e. companies that use specifications from the FC as input. This corresponds to the typical definition of consultants Suppliers who work on data **and** items. These suppliers receive specifications or ne accompanied by the physical items. The job of these suppliers is to make some transformations add a specific value to these items sent by the FC. In the traditional operations managen vocabulary, they would be called sub-contractors, for example a company that galvanizes a m part.
- **Suppliers of resources and tools.** They provide technical resources and necessary tools for transformation of the product or its description. Software or hardware suppliers, pallet' suppli cutting machines, … are some of the most common examples of this class of suppliers.

3.2 The framework of the CEPS methodology

The CEPS framework, in Figure 2 studies the co-evolution of product design/development and the sup within a PD project. Typically this is an evolutionary process, as companies design products by modification and try to maintain key suppliers between generations of the product.

A product lifecycle can be subdivided into four main phases: development, production and sale, usage recycling, whereby development ranges from product planning to the end of production rump-up (see [3 PD project concerning platform product needs to consider platform planning, selection of platform parts modification of platform. Both the end product and the enabling products go through these lifecyc However, as shown in Figure 2, different enabling products have to be ready at different stages of the product's life cycle.

The PD project timeline has been included between of these processes as a reminder that all of th activities and processes are carried out in parallel. This timeline divides the figure into two parts: the part concerns the end product and its enabling products, while lower part represents the supply chain des and deployment process. The supply chain *should* be designed and deployed while the product's desig progresses as an ongoing activity of the purchasing department, following four main steps: prelimin design of the supply chain, detail design, validation and verification, and network exploitation. These st start after the strategic sourcing alliance formation independently of a specific PD project, see [6] h taken place.

The parallel position of supply chain design/deployment and the phases of the product design/developn indicates that these steps need to be carried out together. The product and the supply need to co-evolve.

Preliminary design of the supply chain defines the main characteristics of the product and target valu various criteria for supplier selection. To do so, designers should provide concepts for the end produ Based on the suppliers' capability, concepts are then selected for system and detail designs of the en product or new designs are commissioned. These track records are the verified basis for the supply cha detail design. This activity is performed in two intertwined steps: supplying requirements and fine-tu supplier selection. The requirements define the need of future collaboration, while the selection of suppl can be fine tuned uses these requirements to investigate, assess, evaluate, and select partners. The qualit the collaboration, the effort and effectiveness of suppliers are monitored during the network exploita phase. This phase represents a control activity and is performed during the whole project execution.

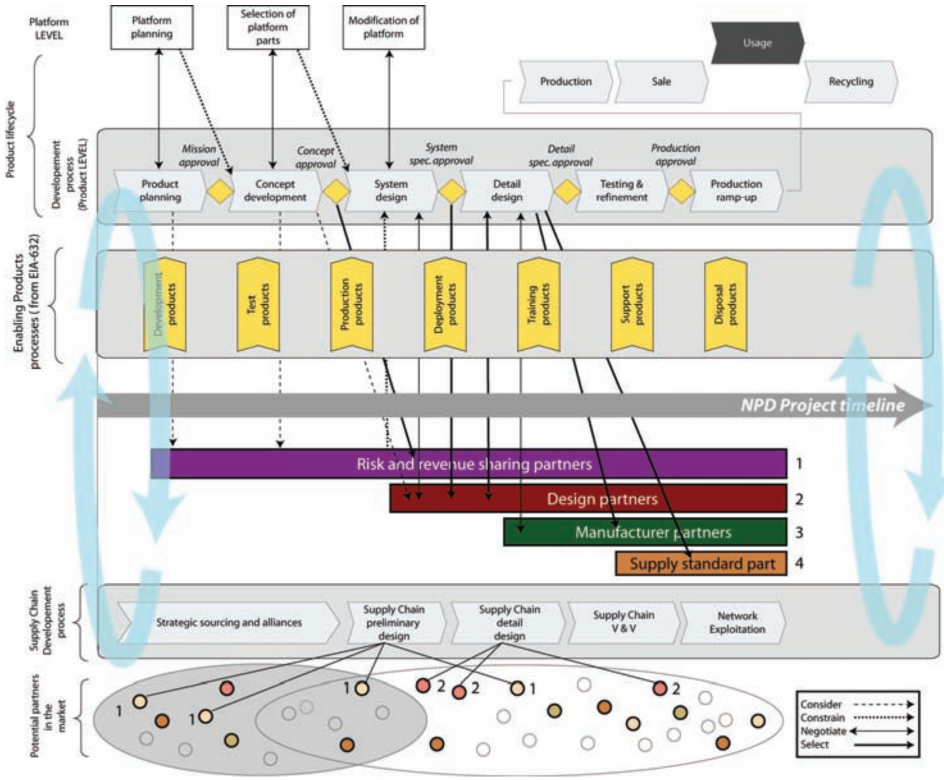


Figure.2 – General framework of co-evolution of product/partners' network

Four classes of suppliers are shown in the middle of the framework: According to the suppliers' involvement level in the project:

- *Risk and revenue sharing partners* that participate in the project from the beginning. A suppliers, often one or two partners, belong to this category due to the needed contribution and tr
- *Design partners* do participate in the definition or partial definition of the product. Due to t early involvement, these partners play an important role in the project.
- *Manufacturing partners* receives specifications provided by the FC and/or its design partners.
- *Standard part sellers* are those companies that have less responsibility than the others for the er supply chain, besides traditional product quality.

Finally, the arrows on the figure represent the logical relationship between various end product developn phase and the four classes of suppliers.

4 FIRST STEPS TOWARDS PRODUCT-SUPPLY CHAIN LINKAGE IN THE CEP: METHODOLOGY

The ultimate goal of the study presented in this article is to determine a risk "profile" of collaborati within the supply chain based on suppliers' contribution to the final product. This risk profile is basec the required collaboration scenarios for each component of the final product. To do so, we identify vari possible collaboration situations, according to simplified life cycle phases and discuss them accordin; their potential a priori risks.

4.1 Structural Code for collaboration scenarios and notations

The model of the whole product development project, as presented in the previous section can be simpli into two main phases specification definition, which occurs during product planning or reaches into conceptual design and if sometimes carried out by different players and design, which ranges f

conceptual design to testing and verification, to which we add a manufacturing phase, which covers t
production ramp up and the actual production. In the CEPS methodology suppliers are looked at basec
their interactions with the FC. In order to give an overview of these possible interactions the follow
writing conventions are adopted: Specified is noted by S, Designed by D, Manufactured or producec
M, In-House by I and, Partner by P.

We associate every component of a product with a code according to the way that it is specified, desig
and manufactured, either in-house or by a partner. This code has 3 variables where each of them has at n
two values: I, P. For each of the phases, we put I if the phase is performed internally, P if it is car
out externally. While not considered in this paper, the notation could be extended to use *IP* if an activit
executed collaboratively by the FC and its partner and if a group of partners participate in the activ
synchronously or asynchronously.

Table 1 shows various possible collaboration situations for a given item. The first half of the table look
companies who specify the product and might have other supply design or manufacturing, the second lc
from the suppliers' perspective, where the customer has generated the specification.

Table.1 – Supply chain collaborations' codification

	Specify	***Design***	***Manufacture***	***Item code***	***Comments and most common situations***	***Code Example***	***Industrial Examples***
The FC is in charge of specifications definition. The PD project is launched by the FC	I	I	I	(I,I,I)	Specified, designed and manufactured in house.	(I,I,I)	-Renault Megane (product) specified, made
	I	I	P	(I,I,P)	Specified and designed in house, manufactured by a supplier.	(I,I,S5)	-Composite Aquitaine [P] for Airbus [I]
	I	P	I	(I,P,I)	Specified in house, designed by a supplier and manufactured in house.	(I,S4,I)	-Lotus [P] powertrains for GM [I] -Pinifarina [P] car body for Peugeot 406 [I]
	I	P	P	(I,P,P)	Specified in house, designed by a supplier and manufactured by a supplier.	(I,S1,S2)	-Bosch [P] spark plug for Renault [I]
The FC is not in charge of specifications definition. The PD project is launched by the customer	P	I	I	(P,I,I)	Specified by the customer, designed and manufactured in house (Engineer-to-Order).	(C1,I,I)	The specific A380' cabins parts made of composite materials specified by Airbus, designed and made by Aquitaine Composite.
	P	I	P	(P,I,P)	Specified by the customer, designed in house and manufactured by a supplier.	(C2,I,S3) (C2,I,S3)	Airbus specifies some parts of the cabin. Aquitaine Composite designs them and a supplier in Morroco makes the parts.
	P	P	I	(P,P,I)	Specified by the customer, designed by a supplier and realized in house.	(C3,C3,I) (C3,S2,I)	The product is specified by a car maker, designed by Pinifarina and made by the FC.
	P	P	P	(P,P,P)	Specified by customer, designed and manufactured by suppliers.	(C4,C4,S5) (C4,S2,S5)	This could be the case of military products where an item should to be managed by the FC as a black box.

To understand the risk in a supply chain, the *design risk* and *manufacturing risk* need to be considered.
design or manufacturing risk corresponds to the "price" that the FC has to "pay" to recover possible err
faults and failures made by a partner. These criteria are used to assess how likely a supplier is to provic
faulty contribution. The risk associate with design and the risk associate with manufacturing can be see
dimensions of a *risk diagram* to position various collaboration situations identified in Table 1 and explai
in next section (see Figure 3). It is also necessary to consider also specification risk. Even if this ris
discussed hereafter, it is not marked on the risk diagram, because specification identification is perfor
either by the customer or the FC and never by the supplier. The risk diagram focuses on suppliers.

It is possible to assign a risk value to every product's component. FC's internal risks are denoted by r_s,
and r_m and partner's risk by R_s, R_d and R_m respectively for specification, design and manufacturing
Table 2, these various risks are commented indicating who should take the responsibility for the occurre
of any error, fault or failure in the product.

Table.2 – FC and partner's risks

Components	Who is responsible ?	Comments
r_s	FC	The specifications are not mature or correct and risks are assumed by the FC.
r_d	FC	The deisgn is performed by the FC and risks are totally assumed by it.
r_m	FC	The manufacturing activities could be error-prone and risks should be totally assumed by the FC.
R_s	Partner	The specifications made by the customer are not mature or correct. Risks should be assumed by the customer.
R_d	Partner	The design is performed by a partner and risks should be totally assumed by it.
R_m	Partner	The manufacturing activities could be error-prone. The risks should be totally assumed by the supplier.

As, the recovery cost increases exponentially with each phase of the design process any non-detected er fault and failure in specification will have consequences on the design and the manufacturing phases. the same reason, every non-detected error made during the design will have consequences on manufacturing. Therefore specification risks are more critical than design risks which are in their turn m critical than manufacturing. It is then possible to write two risk expressions: $R_s > R_d > R_m$ and $r_s > r_d >$ where ">" operator stands for "more critical than".

4.2 Collaboration scenarios and their risks

The risk diagram has design involvement on the horizontal axis and the manufacturing involvement on vertical axes. The diagram in Figure 3 is a closed surface limited by highest level of involvement of par in both design and manufacturing. For every collaboration situation a risk box is put on the diagram representing its potential position. The degree of involvement is correlated to the potential risk. It is poss to argue both for a positive correlation (the greater the involvement, the greater the risk) or a nega correlation (the lower the involvement, the higher the risk). A greater share of the task leaves more sc for error, while a little involvement leaves little opportunity to identify potential mismatches. Theref every box could move on the horizontal axes and/or vertical axes reflecting the contextual modification particular supply situation based on suppliers' degree of expertise in design and manufacturing and the t the FC has in them.

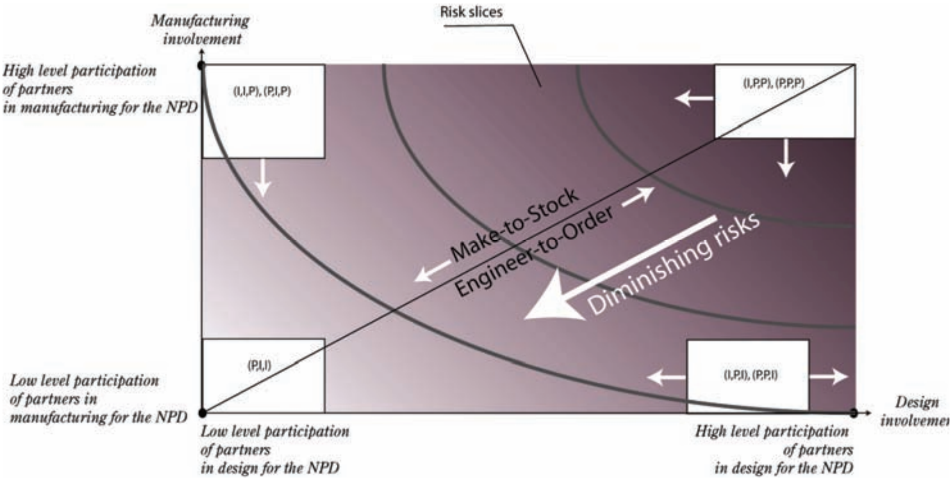


Figure.3 – Participation level of partners

Following the classification in Table 1, the specific risks can be placed on a risk chart in Figure 3:

- Case n°1: (I,I,I). Components are specified, designed and made by the Focal Company. partner participates to this process. The risk expression is $r_s r_d r_m$ and no box is put on the design/manufacturing risk diagram.

- Case n°2: (I, I, P). Components are specified and designed internally by the FC but made b partner. As the partner's involvement in manufacturing is high the risk box is put on the upper position on the diagram. The manufacturing risks could be lower based on the supplier's expert the box could move downwards. The risk expression is $r_s r_d R_m$.
- Case n°3: (I, P, I). The product is specified by the Focal Company, designed by a partner an manufactured again by the FC. This is the case for instance of Pininfarina which designed the body of Peugeot 406 or Lotus which designs powertrain for GM. The risk expression is $r_s R_d r_m$. The main partner's risk is a design risk, Rd, which could have direct implications of manufactu afterwards. The risk box is put on the lower right position with possible reduction of r (movement towards left). The risk should be assumed totally by the partner supposing that the specifications were correct.
- Case n°4: (I, P, P). This could be the case of those components, which can be bought fi catalogues. Partners do not participate to design efforts (for example Bosch spark plugs Renault); the supplied components are already designed and manufactured. In other situatio could be the case of a component specified internally by the FC and a partner or two diffe partners design and manufacture components based on these provided specifications. The expression is $r_s R_d R_m$. As partners participate in the design and manufacturing of items, the risk is put on the right upper-right position of the risk diagram with the possibility to have a reduced in both dimensions (two directions of movement of the box).

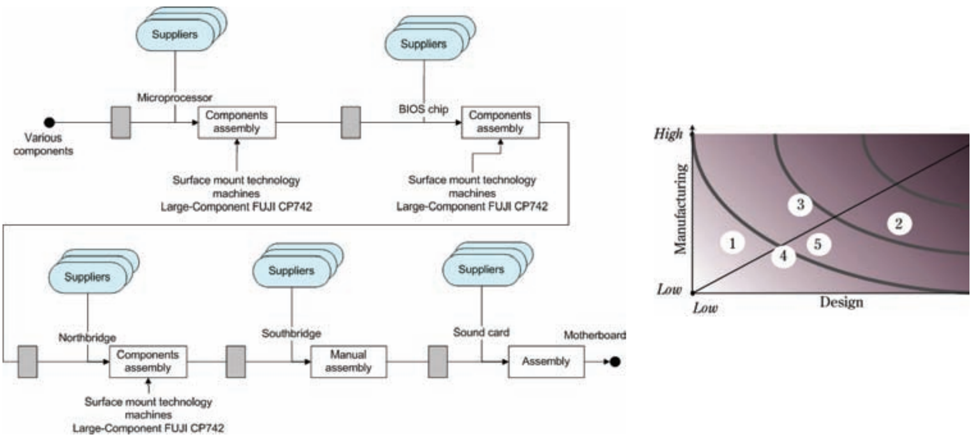
These past four cases represent those situations where the customer provides requirements and the FC co launch the PD project. In the following collaboration situations, the customer provides the specification the product.

- Case n° 5: (P, I, I). The component is specified by the customer and designed and manufactu internally by the Focal Company. The PD project of the Focal Company is launched based on th specifications. The project does not face risks arising from the partner during design and manufacturing. The specific A380' cabins parts made of composite materials specified by Airl designed and made by Aquitaine Composite reflect this collaboration situation. Therefore, no bo put for this collaboration situation on the risk diagram. The risk expression is $R_s r_d r_m$.
- Case n° 6: (P, I, P). Component is specified by the customer, designed by the FC and manufactu by a partner. In this case, presumably the customer has a contract with the Focal Company. Fr the customer point of view the component is designed and manufactured by the FC based accord to its specifications even if in reality, the FC uses a partner for manufacturing. For example different supply chain Airbus specifies some parts of the cabin. Aquitaine Composite designs th and a supplier in Morroco makes the parts. This risk for the FC is limited to manufactur Therefore the (P,I,P) box is on the upper-left side of the risk diagram with possible moven downwards. The risk expression is $R_s r_d R_m$.
- Case n° 7: (P, P, I). The product is specified by the customer but designed by one of its partner. FC produces the part based on the designed files provided by the partner's designer. The ris mainly design risk. This justifies the position of the risk box. The risk expression is $R_s R_d r_m$.
- Case n° 8: (P, P, P). The component is specified by the customer, and designed and made by o partners. The only data that the FC needs to know are those ones which allow it to assemble the to the final product. This could be the case of military products where an item should to be mana by the FC as a black box. The risk expression is $R_s R_d R_m$ however this risk cannot be considerec the FC because the customer has direct relationship with other partners. The risks are to be assu by the customer. Therefore, no box is put on the diagram.

It is important to note that in every collaboration situation, whatever the sources of risk are, the whole project can be delayed or over-cost leading to loses for all of the supply chain's members, but specific for the FC.

4.3 Illustration of the usage of the risk diagram

How the risk diagram of the CEPS methodology can be used will be illustrated with a made-up exan from the electronic industry based on real technical data. Imagine that a FC provides motherboards laptops. The Table 3 shows the very simplified Bill-Of-Materials of a motherboard where only five la components are shown. In fact, in this industry, large, medium and small components are assembled on motherboard in separate operations using different placement machines (Figure 4.a). The exampl focused on the Northbridge which is in charge of data exchanges between several components such as memory or the CPU. The problem for the FC is to identify risks of using a (I,P,P) collaboration with of the potential suppliers of the Northbridge of the motherboard.



(a) (b)

Figure.4 – Participation of partners and partners potential risk diagram

According to the business context, the FC managers could represent the potential risks of each of the potential suppliers of the Northbridge on a risk diagram. All of these companies design and manufacture component by their own. Therefore, their potential risks may be assessed by the FC based on their business relations with them and any other source of business intelligence and benchmarking. A assessing design and manufacturing efficiency of each supplier, the final result could be shown in a r diagram (Figure 4b) allowing the FC's managers to take account of this parameter before any seri negotiation takes place. In Figure 4b every white circle corresponds to one potential supplier. In a r situation, these circles correspond to the design and manufacturing risk estimates for each supplier.

Table.3 – Potential suppliers of 5 large components of a motherboard

Components	***Supplier (example)***	***Supplier's component (example)***	***Potential suppliers***				
Microprocessor	Intel	Intel pentium MMX	Freescale	NEC	AMD	IBM	Sun Microsystems
North bridge	Acer	ALI M1521 A1	NVIDIA	SIS	Intel	ULI	ATI
South bridge	Acer	ALI M1523 A1	NVIDIA	SIS	Intel	ULI	ATI
Sound card	yamaha	OPL YMF7158-S	Mustek	NVIDIA	SoundPro	Crystal	Creative Labs
Bios chip	dell	inspiron 8500	American megatrends	insyde Software	Phoenix Tech.		

5 CONCLUSION

This article focused on the supplier involvement in design and manufacturing of components for a gi Focal Company. The success or the failure of product development projects depends strongly on t partners' contribution. However, this paper suggested that better knowledge about the potential risks associated with partners is crucial in the selection of partners. If these risks are assessed as early as possi they can be managed more efficiently. To do so, it is necessary to design and deploy the supply chain at same time that the product design evolves.

We presented first, the CEPS framework, which aims at providing tools and methods to allow a m efficient management of these two processes, building on the definition of supplier is proposed in the AINSI/EIA-632 Standard, which distinguishes between end products and enabling products.

Every component of a final product is somehow a generator of a collaboration situation with suppli Based on this observation, we have then analyzed various possible collaboration scenarios by distinguish between three main activities, which are specifications determination, design and manufacturing, in term potential risks for the FC. This allows drawing a risk diagram based on design risks and manufactu risks. This risk diagram could be used for an *a priori* evaluation of the involvement of potential suppli An illustrative example of the possible usage was provided at the end of the paper.

Authors know that these ideas must be put into practice in order to consolidate them. In a real case, potential risks of a supplier must be assessed based on the knowledge about the potential partner gain within the company or collected from outside. A risk diagram could be used during two steps. At the early stages of a PD project, this could be used as a tool which allows establishing the short-list of rele suppliers. Design and manufacturing risks could be assessed in a soft manner without using com algorithms or methods. Then, once the knowledge about the product concepts increases, the risk diag definition can use more precise tools, where risks are assessed combining experts judgment with analysis methods, such as statistics or multi-criteria decision-makings.

The ability to associate design/manufacturing risks with every component of the product structure allo designers also to think of design/manufacturing risks of the whole product according to various levels of engineering Bill-Of-Materials. The authors work on this issue by working on methods to calculate design/manufacturing risks of a product using the detailed risks of its components.

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