

# LESS DESIGN RESSOURCES THANKS TO MERGING COLLABORATIVE DESIGN AND LEARNING NETWORK FOR INNOVATIVE DESIGN

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## ABSTRACT

The aim of this article is to show the link between collaborative design (having as an objective to share for designing together a new system), and the learning network for innovative design (making it possible to exchange knowledge and to learn together how to design). Indeed, in a design performance improvement preoccupation, it is relevant to identify the common characteristics, to allow companies to achieve savings (time, money and technical) that a (at least partially) mutualized management of their learning in innovative design and their activities in collaborative design provides.

*Keywords: Collaborative design, learning, network, performance, mutualisation*

## 1 INTRODUCTION

In a nowadays hostile competitive environment, a companies success initially relies on a reduction in cost/time and an increase in quality. But this is no longer sufficient. Indeed, many companies choose to be different from their competitors by always offering new products. Thus it becomes necessary to increase their innovation capacities [1].

Moreover, the complexification of the products and the systems sometimes requires the involvement of companies with very specialized skills. Therefore companies have to weave bonds with new partners (due to missing knowledge and competences) in order to design new products together. This is the birth of collaborative design. Many of the CSCW (Computer Supported Cooperative Work) tools provide a computerized environment which help the designers to fulfil a common aim by working together [2, 3].

However, in order to put new products on the market, the company has to be reactive by increasing its innovation capacity. To do so their have to increase the effectiveness of their design activities, especially the collaborative design activities. There also have to increase their knowledge and competencies to innovate, especially in their design methods.

Thus, more and more, companies must place themselves in a quasi continuous learning position, allowing the integration of permanent evolutions in knowledge and tools to assist design. Nevertheless, based on efficiency, it seems relevant to join other partners to carry out this learning. The learning network for innovative design, seems particularly suitable to create a favourable context in order to develop the companies capacity to learn how to innovate.

We want to build a learning network for innovative design. For that, we count on the mutualization of resources between collaborative design and learning network for innovative design. This mutualization should facilitate the development and the setting of such networks which will contribute to the improvement in the design performances.

Firstly, we define the terms related to the group activity, that is, communication, coordination, cooperation and collaboration in order to define collaborative design ; we will in addition present the learning network for innovative design born from the interactions between three components, namely, the learning, the design and the network. Secondly, we will identify, from a methodological point of view, the objective of this contribution that is to compare these two activities (collaborative design and learning network for innovative design) in order to identify the common core of criteria on which the companies can rely on to be more efficient and to increase their performance in design. Thirdly, we

will illustrate this research with a case study from a consortium creation experimentation seeking to increase and improve their capacity to innovate by adopting a new organization and new tools linked with their design activities. We will conclude on three possible sources to improve the performance in design.

## 2 COLLABORATIVE DESIGN AND LEARNING NETWORK FOR INNOVATIVE DESIGN

### 2.1 Collaborative design

The objective of this paragraph is to define the collaborative design as well as possible ; this is why we will consider the definition of the terms to know that are attached to the design group activity : communication, coordination, cooperation and collaboration. These terms, extensively used in the literature, do not however have a clear definition, nor a unanimous approval [4].

#### 2.1.1 *Communication, coordination, cooperation and collaboration*

Any working group assumes an interaction between the people concerned ; *communication* allows first of all the main interaction between these actors. This makes it possible to exchange ideas, to enrich them and to combine points of view. In this direction, the communication allows not only the acquisition of knowledge but also the generation of new knowledge. This exchange limits in addition uncertainty inherent to the design project. The communication can take diverse forms according to the situation : words, writing, drawings, gestures, postures,... that are combined to express without ambiguity the matter to be explained [4, 5, 6]. Communication is thus unavoidable in any working group, including the designing activities. Moreover, the communication act can be performed independently of a common objective between the entities in communication : it is the principal difference with the other terms [7].

*Coordination* is a group of rules and procedures making it possible for a group to function efficiently and in harmony. The coordination concerns real task management [8]. It defines an order and a static structure, making it possible to maximize the working group [9]. We see right away appearing two dimensions in the concept of coordination : one related to the task management, concerned with a strong logic of work organization (what we call *organisational coordination*), and another dimension related to the working group, which calls more upon managerial competences based on a good knowledge of the competences available within the group and a capacity to associate them in order to achieve the common goal (what we call *cognitive coordination*).

Unlike coordination, *cooperation* is in the action field. One speaks here about a cooperative process. In more general terms, cooperation is « *the collective action by which subjects contribute to the same result* » [4]. Cooperation is characterized by pooling, by at least two companies (in a vision between firms), of a fraction of their resources (division of material or immaterial credits) for the continuation of objectives united in a given space such as to obtain reciprocal advantages. If a given activity interdependence results from this, the partners remain autonomous, in other word, outside of this cooperation [10]. In a cooperative action companies are engage voluntarily [11].

*Collaboration*, on the other hand concentrates on the process of joint work itself [12, 13]. Thus, collaboration requires a strong engagement with a group spirit, as well as a maximum adhesion with the goals and the common results [6, 14]. This explains why an increased trust between partners is necessary [12]. With the aim of answering as well as and as fast as possible to the problems arising, the partners have a common space in which to store and share information ; this space gathers knowledge and competence (formalized, structured, arranged,...) in order to be easily available for all the actors [15].

To conclude, these four terms, communication, coordination, cooperation and collaboration, contribute differently to the characterization of a working group. Indeed :

- communication is an essential tool to group exchanges ;

- coordination is a means of organizing the working group, in which we distinguish :
  - organisational coordination
  - cognitive coordination
- whereas cooperation and collaboration return to the working group process :
  - cooperation is focused on the participation in a common work ;
  - collaboration is focused on joint work.

Let us see in the following section, how these terms allow us to characterize collaborative design.

### **2.1.2 Collaborative design**

In collaborative design, they are the designers of the whole of the group who work together to design the product according to the customers specifications. The project leader as well as the project group (designers of different companies together, being knowledge and competent in various fields) seeks to build and maintain a shared problem vision and to solve them together [16]. Each one contributes according to its specific knowledge [12]. Milestones can be foreseen to make a pooling on work, in order to obtain the hierarchy downstream, and to define the following tasks to carry out. The goals or sub-goals are nevertheless never defined beforehand [4]. Designers of various fields gather to exchange information, expertise, ideas, resources in order to solve together the problem arising ; in this context the communication between members, in addition to coordination, appears vital [17]. The collaborative activity is synchronized and coordinated throughout the process of collaboration in order to build and maintain a shared design problem or a situation between all the actors, in order to solve together arising problems [16, 18]. This however is not sufficient, and one should not neglect the social and organisational aspects necessary to the collaborative design [18].

By using the terms defined earlier on, we can conclude that two mechanisms intervene in collaborative design :

- coordination of the various designers knowledge which must make it possible to create a reference frame of mutual knowledge so that their overlap makes it possible to solve the problem. It actually requires cognitive coordination ; it is indeed based on knowledge management to contribute together to a common objective
- collaboration between actors, i.e. joint work to achieve a common goal.

Ostergaard and Summers identify six major characteristics in the collaborative design activity : team composition, communication, distribution, nature of the problem, information and design approach [19].

## **2.2 Learning network for innovative design**

Former work had led us to define the learning network for innovative design as the meeting of three fundamental concepts : innovative design, learning and network [20]. These enabled us to identify nineteen criteria, resulting from the bonds and interactions between these various concepts.

According to our proposal, such learning network includes individuals of various organizations juridically autonomous, in order to create a favorable organisational context, stimulating the learning processes, the creativity and consequently, the innovation. Such a network is centered on the learning act and gives an essential place for the enrichment of the competence of its members. This enrichment is achieved by the transmission of explicit or implicit knowledge, the experience sharing and the widening of reflexion. It thus makes it possible to learn by practice, i.e. by the confrontation of ideas, knowledge or experiments between the partners. This division of knowledge and creation of new collective knowledge then allows each of its members, to increase its effectiveness in their own project and consequently, to increase the total performance of their company.

The learning network for innovative design seems to be a strategic instrument able to be used as a lever with the interlocking of the process of collective learning, and from there on, allowing registered companies in actively involved in innovation, the less conductive ones adopting an autonomous way. It is a place where the capacity to learn how to innovate can be born and develop starting from the exchange and of the participation in various common activities.

### 3. LINKS BETWEEN COLLABORATIVE DESIGN AND LEARNING NETWORK FOR INNOVATIVE DESIGN

Starting from the present environmental context and its problems, this work proposes to define a methodology of work which will stimulate innovation. The steps that we used are as follows :

- to survive the companies must innovate. To innovate they must have an effective capacity to innovate and engage their innovation process,
- in order to be able to innovate, it is necessary to have knowledge and competence as regards design as well as methodologies of design,
- to have these resources, it is necessary to learn, to exchange, to share.

We focus on two activities that allow an increase in this capacity to learn, to exchange and to divide : collaborative design and learning network for innovative design. In order to satisfy the particular need for the companies in terms of costs, it appears important to us that the company is capable of mutualize specific resources to these two activities (Figure 1).

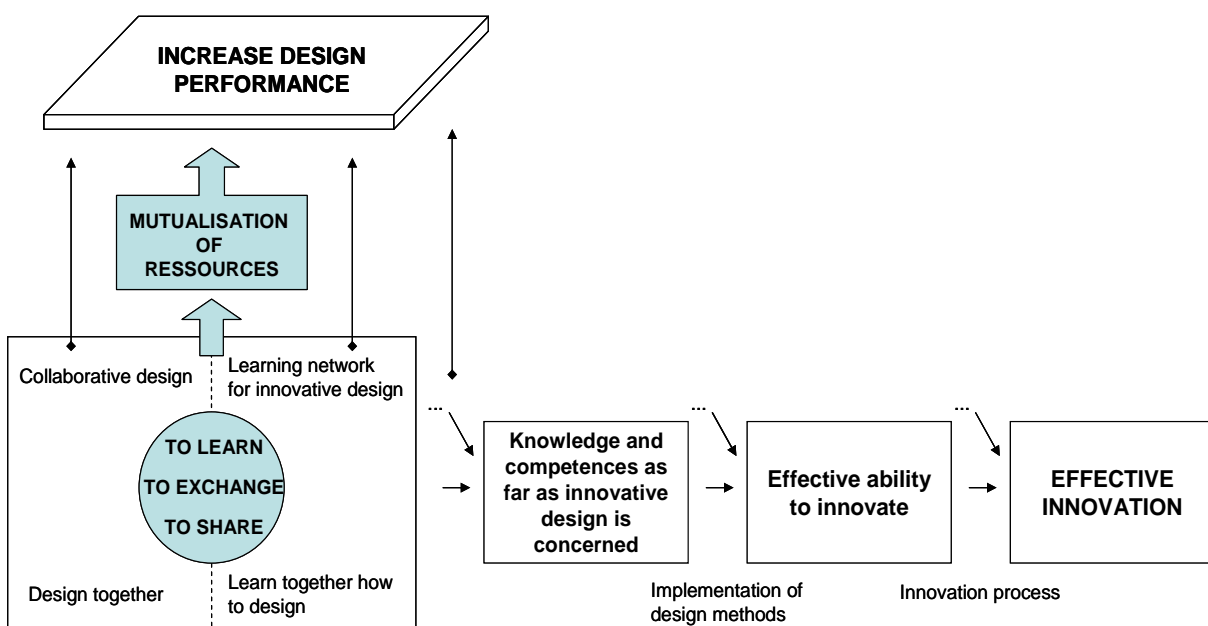


Figure 1. How to increase performance in innovation ?

That is why it is useful to establish the link we will establish the link between the collaborative design, having as objective to share for design a new system together, and the learning network for innovative design, allowing to exchange knowledge and to learn together how to design. Taking into consideration characterization and the share of the taxonomy of Ostergaard and Summers [19], and the characterization made by Maranzana and Gartiser [20], we end with three criteria families allowing to describe these two activities : those related to partners, those related to the design object and those related to the learning together (Figure 2 and Table 1). Some criteria are common (like those related to the partners) ; others are specific (to collaborative design : those related to the design object ; to the learning network for innovative design : those related to the learning together).

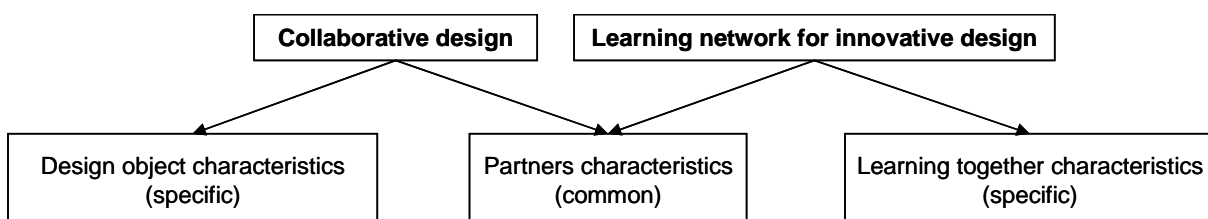


Figure 2. Characteristics of collaborative design and learning network for innovative design

### 3.1 Presentation of characteristics

#### 3.1.1 Common characteristics : criteria linked to partners

By establishing the link between the work of Ostergaard and Summers [19] and those of Maranzana and Gartiser [20], one finds three poles making it possible to characterize partners : team composition, communication and distribution (Table 1, line 2).

#### 3.1.2 Specific characteristics : criteria linked to the design object

The specific characteristic of the collaborative design is at the level of the design object ; various authors [5, 19] have characterized this activity thanks to the nature of the problem, with information created, used, modified or exchanged and with the design approach (Table 1, line 1).

#### 3.1.3 Specific characteristics : criteria linked to learning together

Concerning the learning network for innovative design, the specific characteristic is on the action to learn together [16, 20]. Table 1, line 3 enumerates the various criteria going from the need for an intermediate actor to the role of trust between the partners.

Table 1. Collaborative design and learning network for innovative design characteristics

	Collaborative design <small>(Collaborative design taxonomy from Ostergaard and Summers [19])</small>	Learning network for innovative design <small>(19 criteria from Maranzana and Gartiser [20])</small>
<b>DESIGN OBJECT CHARACTERISTICS</b>	<p><b>NATURE OF THE PROBLEM</b></p> <ul style="list-style-type: none"> <li>- Type (novel, routine)</li> <li>- Concurrency (serial, parallel)</li> <li>- Coupling (level)</li> <li>- Abstraction (level)</li> <li>- Scope (number of domains)</li> <li>- Complexity (level)</li> </ul> <p><b>INFORMATION</b></p> <ul style="list-style-type: none"> <li>- Form (design artifact, background)</li> <li>- Management (ownership, permission to change, security, change propagation)</li> <li>- Perceived level of criticality</li> <li>- Dependability (completeness, reliability)</li> </ul> <p><b>DESIGN APPROACH</b></p> <ul style="list-style-type: none"> <li>- Design tools (consistently applied, applied occasionally, not applied)</li> <li>- Evaluation of progress (self-assessment, assessed by outside parties)</li> <li>- Degree of structure (company policy, chosen by team, free)</li> <li>- Process approach (generative, variant)</li> <li>- Stage (classification of task, conceptual, embodiment, detail)</li> </ul>	
<b>PARTNERS CHARACTERISTICS</b>	<p><b>TEAM COMPOSITION</b></p> <ul style="list-style-type: none"> <li>- Group (culture, size)</li> <li>- Individual (expertise, personality)</li> <li>- Team member relations</li> <li>- Leadership styles</li> </ul> <p><b>COMMUNICATION</b></p> <ul style="list-style-type: none"> <li>- Mode (verbal, written, graphic, gestures)</li> <li>- Quantity (duration, frequency)</li> <li>- Syntax (language, translators)</li> <li>- Proficiency of the team (techniques, technology)</li> <li>- Dependability of resources (availability, reliability)</li> <li>- Intent</li> <li>- Intent</li> </ul> <p><b>DISTRIBUTION</b></p> <ul style="list-style-type: none"> <li>- People (geographically, organizationally, temporally)</li> <li>- Information (geographically, organizationally, temporally)</li> </ul>	<ul style="list-style-type: none"> <li>- Culture (high diversity of culture, built common culture and identity)</li> <li>- Optimal number of partners (minimum 2, maximum to be determined)</li> <li>- Kind of partners</li> <li>- How are the links between the partners build ? (forced, voluntary)</li> <li>- Human relationships (low, high)</li> <li>- Structure (formal, informal)</li> <li>- Organization (non hierarchical, hierarchical)</li> <li>- Evaluation system of the network and recognition system (forced, combined)</li> <li>- Communication between the partners ?</li> <li>- Intensity of the exchanges (low, high) and duration of the network (to be determined)</li> <li>- Exchanges between partners               <ul style="list-style-type: none"> <li>- what is shared ? (all tacite and explicite knowledge)</li> <li>- how is it shared ? (personnal exchanges, using the learning network, sum=0 or 0)</li> <li>- with which logic ? (accumulated, integrated)</li> </ul> </li> <li>- Buisness sectors of the partners (different, same, complementary)</li> <li>- Proximity of the partners (geographic, electronic, the two)</li> </ul>
<b>LEARNING TOGETHER CHARACTERISTICS</b>		<ul style="list-style-type: none"> <li>- Specificity of network's assets (low, high)</li> <li>- Management of opportunist behavior (confidence, control, using hostages)</li> <li>- Intermediary actor ? (yes, no, its job)</li> <li>- Autonomy of the partners ? (autonomy, independency, interdependency)</li> <li>- Agreements between partners ? (yes, no, tacit, explicit, written or not)</li> <li>- Degree of trust between the partners ? (defiance, confidence)</li> </ul>

### 3.2 Ressource mutualization

The company being inevitably constrained to a cost control, it will be necessarily to look for some sources of economy. We have just shown that collaborative design and the learning network for innovative design have some shared characteristics as well as specific characteristics.

Thus, we think that implement an optimal of these characteristics in the development, or at least the choice of learning network for innovative design which the company will enter, should enable him to realize economies of scope. This would obviously have a favorable cost impact, but also on its designing performance since there would be, thanks to the mutualization of certain dimensions not only of the activities of design, but also of the learning activities allowing a rise in competence on the design activities (Figure 1).

The sources of economies can be found at two levels (Figure 3) :

- in the common characteristics related to the partners. The collaborative design companies already have a partners network, their partners having also their own networks. The idea is to build a learning network with partner with whom one works already in collaborative design. We point out the human dimension, meaning the individual and not the organization, as an actor of the act of learning. Thus to build or to take part in such a learning network for innovative design, in which people are already involved and with whom one is accustomed to work (other companies, universities, consultants), contributes to the introduction of trust, a major network element, in particular to learning because it is non hierarchical. The faster that trust is installed makes it possible for the network to work more quickly on its learning problems.

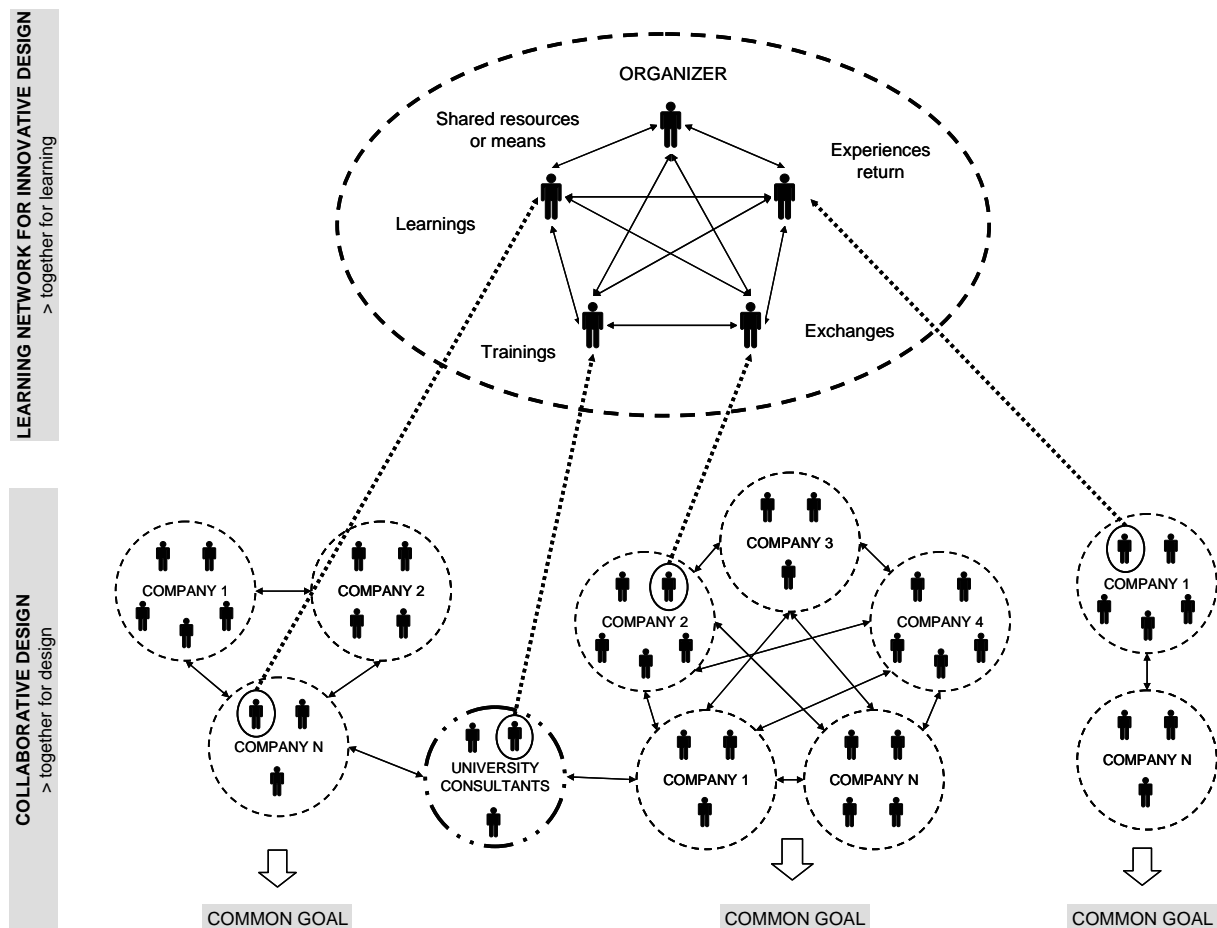


Figure 3. Collaborative design and learning network for innovative design

- in the specific characteristics of collaborative design related to the design object : the idea here is to make it possible for the network members to learn starting from projects that are interesting and useful for them. In the context of economies of scope, we can here incite the companies to base themselves on their collaborative design projects to feed their learning network for innovative design in case study, in objects to which to learn. Obviously, this is possible in two conditions :
  - that they are the same people who are implied in the collaborative design project and the learning network for innovative design at the same time ;

- that the collaborative design activities and learning network for innovative design do not work on the same dimension : the designed object for collaborative design, the step and knowledge necessary for that in the learning network. Thus, the learning network partners can work on their own projects and not on academic cases, thus enabling the learning effectiveness to be improved.

#### 4 CASE STUDY : OBSERVATION OF A CONSORTIUM BUILDING

Since a year we are observing the construction of a learning network for innovative design through its formal structure. Various partners are involved in this consortium : industrial companies, universities and consultants<sup>1</sup>. Various elements of this consortium illustrate well our matter.

Nature of the partners :

- there are partners from different spheres (enterprise, consultant, universities),
- the partners have varied competences and multi-trades.
- some of the partners have previously worked together (especially in collaborative design).

*Conclusion : it seems that it is because some of the partners know previously each other that they decide to be involved in such a network.*

Reasons for which the partners take part in the consortium :

- to learn together an inventive design methodology,
- to acquire a competing advantage.

*Conclusion : using some know-how coming from previous experiments allow partners to define common goals for the consortium.*

Means of founding trust :

All the partners do not know each other. However, some of them have already worked together. But it is in any event obvious that trust must be created within the network. In the facts, two means are present to contribute to this :

- the contract negotiation phase, because it makes it possible for the partners to learn with better knowledge itself and exchanges, and because all the questions related to intellectual property have already been taken care of in the contract itself.
- the installation of a steering committee and seminars of exchange : allowing each one to express itself, to know better each other, and so to increase trust.

*Conclusion : the partners use previous knowledge in collaborative design activities to define contract and intellectual property in the learning network.*

Network contents : the learning objects :

- training,
- design practice benchmarks,
- development of specific tools,
- experience feedback from each company on specific design projects (on its steps and not on the results).

*Conclusion : the partners use previous collaborative design activities to build learning objects. This is interesting for each of them because they are real cases and they can have access to all dimensions. But it is possible because they focus on « how (they do this or that) » and not on « why ». They can then share on the method instead of on the content.*

General conclusions. Economies of scope have been realised because of :

- the mutualization of the learning costs,
- the mutualization of the new development tools costs,
- the economies of scope related to the use of support of collaborative design activities.

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<sup>1</sup> The consortium is still in a building state. Confidentiality agreements bind us to these organizations and prevent us for the moment to name them.

## 5 CONCLUSION

In this paper we have devoted ourselves to establishing the link between the various characteristics of collaborative design and the learning network for innovative design. It can be noticed that these two concepts have a common characteristic (criteria related to the partners) and specific characteristics (those related to the design object and those related to the learning together). With an aim of creating learning network for innovative design we identify two sources of economies of scope : to build the learning network for innovative design with partners who already work together on collaborative design ; and, to learn starting from interesting and useful projects for the partners, the idea being to be based on the projects of collaborative design to feed the learning network for innovative design in the event of studies. The observation of the creation of the « TRIZ Consortium » has enabled us to illustrate our matter.

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