CO-DESIGNING BROAD SCOPE OF TECHNOLOGY-BASED APPLICATIONS IN AN EXPLORATORY PARTNERSHIP

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Keywords: user-oriented technological design, D4 method, exploratory partnerships, innovation, CK theory

1. Introduction & Objective

Joint-ventures, sub-contracts, co-developments, alliances, R&D consortia ; inter-firms partnerships have been strongly increasing for two last decades and becoming a major issue in the field of management and design research. This paper presents an industrial practice which consists in co-designing a broad scope of technology-based applications in an exploratory partnership [Segrestin, 2005]. First, we propose a brief overview of inter-firm R&D cooperations and focus on an emerging flexible organization in the field of innovation : exploratory partnerships. From a more detailed description and a presentation of MINATEC IDEAs Laboratory®, we emphasize on the strategic role of technology in partnerships which gather a large number of partners. Finally, we propose a user-oriented technological design method called “D4 method” [Piat, 2005] through its recently implementation on a microfluidic technology. This method has been already tested in confidential EDF projects but its experimentation in a multipartners context has revealed some interesting aspects. We present D4 method's features with respect to other creativy tools and we finally argue that this method fits very well in technology-centred exploratory partnerships. Indeed, "D4 method" permits to identify and to manage carefully the shift from community based co-operation to complementary based co-operation.

2. Exploratory partnerships & enabling technology

2.1. Exploratory partnerships : an emerging flexible organization

2.1.1. From co-exploitation to co-exploration

In order to cope with the global competition, companies are required to speed up the pace of new products development, as improving existing products is not enough anymore. Many authors argue that exploring new possibilities and exploiting existing resources is not easy to combine in a unique structure *(“an ambidextrous organization”)* but is a condition required to the success of a firm [March, 1991]. A solution widely adopted is achieved through the establishment of cooperative partnerships. These structures are usually qualified as *organic* [Burns, Stalker, 1994] to differ to traditional mechanistic organizations. Ideally, they are able to value outside knowledge, to come out with *dominant design* [Abernathy, Utterback, 1978] in order to innovate radically. These innovative structures also represent a new way to consider collective actions and R&D inter-firms cooperations. Traditional “customer-supplier” relationships (co-exploitation) which focus on the respect of “quality-

cost-delivery" shift to more upstream partnerships (co-exploration also called co-innovation). In fact, regarding to new products development, inter-firms cooperations are established earlier and earlier in the design process (figure 1). Formerly suppliers strictly fulfilled technical specifications (sub-contracting) ; then co-development has appeared and stressed the "supplier" role in the cooperation process. Exploratory partnerships are the more recent organizational form of this phenomenon so that, notions of "supplier" and "customer" have almost disappeared. Contrary to co-development partnerships or sub contracts, the object (or service) to design in an exploratory partnership is not identified when the contract is signed, functional or technical specifications do not exist yet.

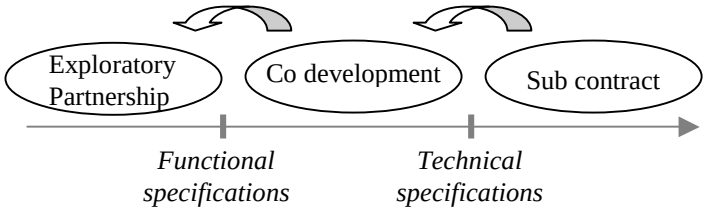

Figure 1. Exploratory partnerships in design process

2.2. MINATEC IDEAs Laboratory® : a technology-based exploratory partnership

MINATEC IDEAs Laboratory® is an exploratory partnership located in Grenoble, next to French Center of Research in Micro-nanotechnology, MINATEC. This innovation platform was created in 2003 by France Télécom (a telecommunication operator), ST Microelectronics (semiconductor company) and Commissariat à l'Energie Atomomique (CEA, a French government-funded technological research organisation). The laboratory has been progressively opened to new partners. Today, MINATEC IDEAs Laboratory® is composed of six industrial partners - EDF, CEA, France Télécom, Rossignol, Essilor and a confidential partner - and two academic partners from Grenoble - Université Pierre Mendès France, Université Stendhal. The laboratory's missions are to generate new applications (products or services) using micro-nanotechnology while following a user-oriented design approach. Laboratory's activities include different competencies like sociology, management, design, electronics, informatics and so on. According to the large scope of partners' businesses, the new applications cover a large domain like telecommunications, home automation, sport and leisure or even electronic interfaces. Since its creation, some products were developed like a digital pen (Stylocom) which allows handwriting recognition.

2.3. Research question

In MINATEC IDEAs Laboratory®, a quite original but also problematic issue is that partners are not only sponsors (like the famous MIT Media Lab for instance) but they are also decision-makers and they participate actively in the innovation platform. Thus, all of the laboratory's projects are managed by the 8 partners that allocate necessary resources (human, financial and technical); each project implies the 8 partners. As mentioned previously, partners' businesses are not similar : they are not compulsory interested in the same final products (or services) but at least in creating new knowledge [Nonaka, 1994], which can be re-used in their specific domain. The first challenge was to define *common purposes* accepted by all the partners [Barnard, 1968]. In MINATEC IDEAs Laboratory®, a main *common purpose* is their common interests in enabling technology. When contracting with the MINATEC IDEAs Laboratory®, a new partner is able to access the CEA's micro-nanotechnology resources. Rather than working individually with CEA, each partner accept to share some activities (as 'creativity phases' for instance) and thus to share the costs and risks associated. Consequently, emerging technologies play a crucial role in MINATEC IDEAs Laboratory®, because of the fact that they do not address a specific market (market and customers are not known *ex ante*), whose functionalities can be explored through many sectors and so, by many industrial partners.

As a consequence, we can formulate our research question as follows : “How to co-design new technology-based applications in spite of partners’ divergent interests ?” This paper suggests that “D4 method” can be an efficient tool to co-design broad scope of technology-based applications (figure 2).

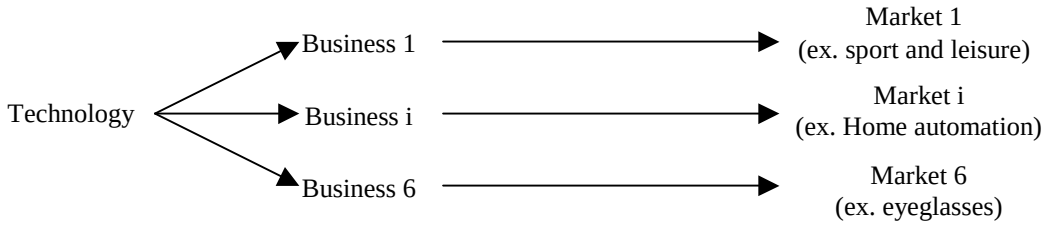

Figure 2. From a single technology to different markets

3. D4 : a user-oriented technological design

3.1. Overview of “D4 method”

Even if this paper is not intended to describe precisely the method which has been discussed elsewhere [Piat, 2005], we present a brief overview of its main steps (figure 3).

The “D4 method” are constructed in a four-step framework as follows :

- D_1. The analysis of the technology's elementary properties
- D_2. The ability of groups of properties to meet generic functions
- D_3. The translation of these functions into specific markets
- D_4. The re-evaluation of the characteristics of technology

The three first stages concern the technology at the state of development reached. The last stage gives the ability to drive the technology to new functionalities. We called this method "D4" as an acronym for : Deconstruction, Declination (or Declinaison), Destination, Decision. The two first stages are comparable to analysis and synthesis processes but in our case the synthesis process is oriented to the needs to satisfy. The following gives a close look at each stage. It can be considered as a user-oriented technological design as well as a convergent method with user-oriented design**.**

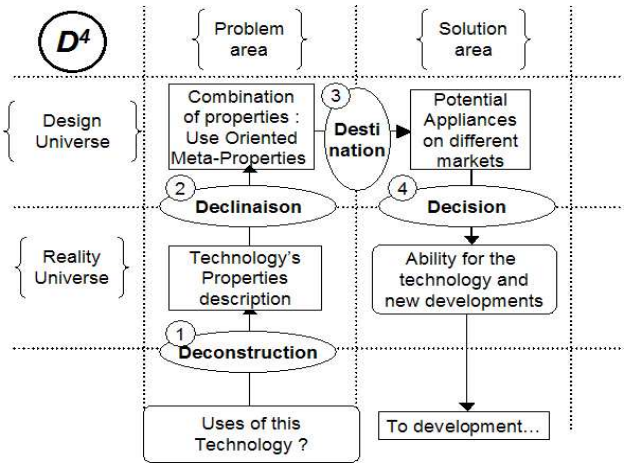

Figure 3. Schematic diagram of D4 design process.

3.2. "D4 method" explained by "CK theory"

The following section introduces "D4 method" through "CK theory" [Hatchuel, Le Masson 2006, Hatchuel, Weil, 2002] (figure 4). This latter enables to better realize the reasoning in question when designing a concept (C_0). According to "CK theory", "D4 method" begins in the space of "Knowledge". In this first stage, participants and experts explored properties about the considered technology (D_1). Then, properties are merged into generic functions (D_2). At the end of D_2, there is a *disjunction (shift from K to C)*, generic functions are turned into concept (C_1). The initial concept (C_0) is expanded by adding new generic functions (ex. a product used in mobility). Then, a *conjunction (shift from C to K)* operates, the concept (C_1) is set in the industrial partners context. At this moment, firms knowledge is required (customers, needs, …), and then a new concept is designed…

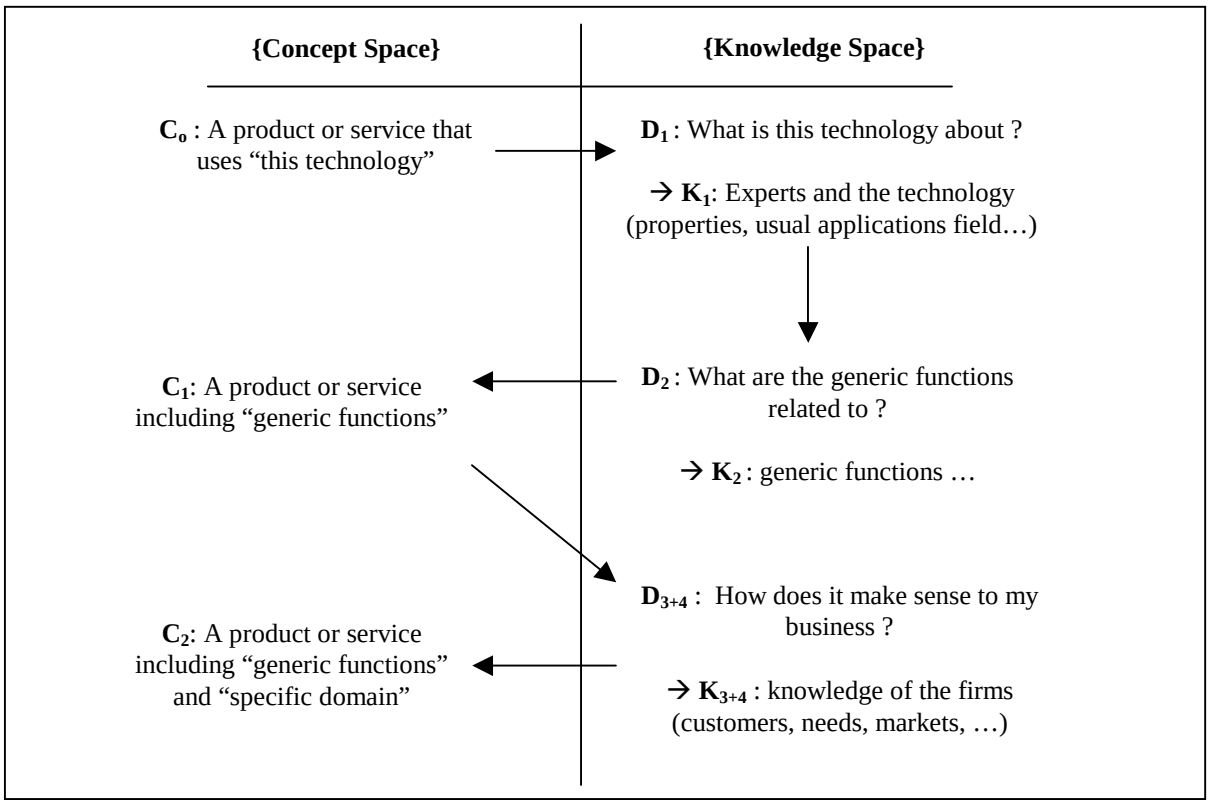

Figure 4. "D4 method" explained by "CK Theory"

3.3. "D4 method" : position in the state of art

Management of inventiveness and creativity tools are common issues in R&D and scientific literature. In spite of their heterogeneity, one can distinguish some common stages in their process : identification and formulation of the problem, idea generation ("divergence" phase : to come up with ideas) and idea selection ("convergence" phase in which ideas are specified and evaluated).
In the case of "D4 method", the process begins with an initial question : How to give value to this technology among a business ?

Many different techniques exist and can be used in each of these stages.
For example, considering idea generation, they can be divided into different categories depending on the initial questions and the type of reasoning :

- techniques that deal with technical problem solving : TRIZ [Altshuller, Shulyak and Rodman, 1999]…

- association of ideas : Brainstorming, Mind Mapping, talking pictures, focus group, Brainwriting …
- analogy reasoning : analogies, six thinking hats, Morphological analysis …
- analytical reasoning : discovery matrix …
- psychological approach : daydream …

In the case of "D4 method", the first two steps follow analytical reasoning (combining properties in a systematic logic); when generic functions are created (end of D2), the D3 step is comparable to a classical brainstorming session. The last step D4 is an evaluation phase involving technical experts and potential users, some creativity tool like angel's advocate can be relevant.

In general, technological aspects are not really discussed in traditional creativity session; it is even considered like a barrier to inventiveness. In our approach, we try to combine technological and user views.

4. Experimentation : "D4 method" applied to a microfluidic technology

4.1. Development of the session and data collecting

Experimentation occurred in MINATEC IDEAs Laboratory® at the beginning of November 2007. The session lasted half a day and aimed to find new ideas from a microfluidic technology. The assistance was composed of twelve persons (all of laboratory's industrial partners were represented) who knew hardly anything about "D4 method" and about microfluidic technology, one technical expert and the authors conducting the session. In order to increase creativity, we called on various skills [Amabile, 1998] like engineers, human sciences researchers and marketers. The latter was recorded.

In the first step, the technical expert presented the technology and then the audience was invited to debate. In order to guide the sessions and to stimulate audience, leaders of the session used a check list of technical properties (volume, weight, temperature range…). During this first step, which was longer than expected, 36 technical properties were reported (ex. "The device required is light", "This technology mixes liquids" or "The device uses low power"). From the combinations of these properties , 10 generic functions were written-off (ex. "It could cool down a surface", "It changes a surface into a touch-sensitive surface "). The third step, was a classical brainstorming method. Subgroups of 2 or 3 persons were organized and 31 ideas were generated (almost 5 ideas per industrial partners). Finally, all these ideas were discussed, our expert giving for each of them, an assessment of its technical feasibility (table 1).

Table 1. Some quantitative results

Number of step (Duration)	Output
D_1 (50 min.)	36 technical properties
D_2 (70 min.)	10 generic functions
D_3 (80 min.)	31 ideas
D_4 (35 min.)	Assessment of ideas' technical feasibility and potentiality

4.2. D_2 : a critical phase

The second stage was the critical moment of the session. Above all, success of the "D4 method" depends on the originality of the generic functions. In our multipartners context, this step is also a strategic moment because the partners are able to re-use these generic functions and brainstorm for their own business independently. Indeed, generic functions can be considered as an interesting

“input” for “creativity phases”. However, we observed that audience was not able to find generic functions by itself and we had to assist them more than expected. Generic functions can be reached by the following principle (table 2). Combinations could be performed systematically but it would have taken too much time. For that reason, we selected properties considered as original and changed them into generic functions. This critical issue could be subjected to further researches (syntax, automation…).

Table 2. From D_1 to D_2 : toward an example

D_1 : Properties	Transition : Sentence building	D_2 : Generic functions
- The technology functions with puddle -The technology functions within a large temperature range	It is possible to spread liquids over a surface from a large temperature range	- Warming surfaces up - Cooling surfaces down - Coloring surfaces according to temperature - …

5. Managing the shift : from community to complementary modes

Inter-firms partnerships are considered since 80's like strategic leverages in management of R&D; it even consists like a key factor of the actual fourth-generation R&D. Collaboration during creativity phases is still quite rare even if we can observe a global trend to integrate suppliers through technological problem solving. Regarding MINATEC IDEAs Laboratory®, the fact that they are more than two enterprises and not concurrent imply to manage two different cooperation forms : community cooperation and complementary cooperation. According to Dameron [Dameron, Joffre, 2007], community mode can be defined *when actors share a same identity, same common objectives like a specific asset (e.g. technology).* On the other hand, complementary cooperation *occurs when each member makes use of/his her skills in order to gain power or obtain some form of compensation. This is based on individual interest like co-development phase.* A condition to the success of this kind of partnerships consist on managing correctly these two modes of cooperation and their transition ; we used D4 has a mean to help partners to co-create applications in a community cooperation's way and to create necessary conditions to develop ideas in complementary cooperation approach (figure 5). Indeed, two first steps can be performed with all partners (community partnership). As soon as generic functions are provided (end of D_2 step), partners are able to continue work for themselves and brainstorm in their own intern R&D : individual work can begin. They can also get close to a specific partner (complementary partnership). Finally, "D4 method" has been experimented with three other technologies and agreements about specific applications were concluded to formalize complementary cooperation between two partners.

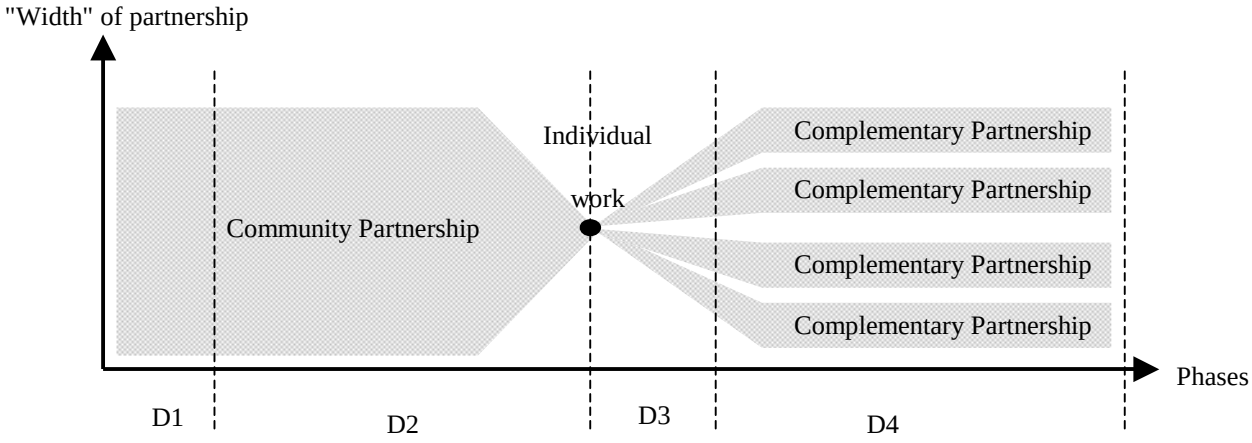

Figure 5. The shift from exploratory partnership to co-development driven by "D4 method"

6. Conclusion

In spite of the limited duration of the experimentation, the outcomes obtained are entirely satisfactory. All partners got their specific ideas, each of them being technically pre-evaluated ("*today, we know that this idea can be carried out*" according to our expert) and may be patented. According to the technical expert, "D4 method" was an opportunity to prospect new customers, to give value to his technology and to outline new perspectives of development. "D4 method" has proved to be a relevant tool to co-design broad scope of technology-based applications in an exploratory partnership. It fits well with in an exploratory partnership, in which the common purpose is not to develop specific products but to explore together a technology in order to get knowledge. Finally, "D4 method" is a way to explore a technology without being constrained by the fact that partners' businesses are not similar. According to us, "D4 method" facilitates the shift from a community partnership including a large number of partners to a complementary partnership with a number of partners more reduced (figure 5).

References

Abernathy, W. , Utterback, J. , "Patterns of Industrial Innovation", Technology Review, Vol.80, No.7., 1978, pp 40-47.

Altshuller, G.S., Shulyak, L., Rodman, S., "The innovation algorithm: TRIZ, systematic innovation and technical creativity", Technical Innovation Center, Worcester, MA, 1999.

Amabile, T.M., "How to kill creativity?", Harvard Business Review, Vol.76, No.5, 1998, pp 76-87.

Burns, T., Shalker, G.M., "The management of innovation", Tavistock Publications, third edition, 1994.

Dameron, S., Joffre, O., "The good and the bad: the impact of diversity management on co-operative relationships" The International Journal of Human Resource Management, Vol.18, No.1, 2007, pp 2037-2056

Piat, G.," From user-oriented design to user-oriented technological design", Proceedings of 14th International Conference on Management of Technology, IAMOT, Vienne, 2005.

March, J.G., "Exploration and exploitation in organizational learning", Organization Science, Vol.2, No.1, 1991.

Segrestin, B.," Partnering to explore: The Renault-Nissan Alliance as a forerunner of new cooperative patterns", Research Policy, Vol.34, No.5, 2005, pp 657.

Nonaka, I., "A dynamicTheory of Organizational Knowledge Creation", Organization Science, Vol.5, No.1, 1994, pp 14-37.

Barnard, C.I., "The functions of the Executives", Harvard university Press, 1968.

Hatchuel, A., Weil, B.,"C-K Theory: Notions and applications of a unified design theory", Proceedings of Herbert Simon International Conference on "Design Science", Lyon, 2002.

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