INNOVATION AMBIDEXTERITY IN MEDIUM SIZE ENTERPRISES

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Abstract

The ability to explore new horizons while exploiting current capabilities is necessary for enterprises to attain long-term success. The theory of organizational ambidexterity studies the paradoxical relation between exploration and exploitation. At its current level, this theory identifies several antecedents of ambidexterity but do not provide a way to identify the optimal combination for a given organization. In this paper, we analyse the emphasis on exploration and exploitation of two complex approaches to product development: Lean Development and Design Thinking. This analysis and the comparison of the two approaches provides us two models of ambidextrous organizations. The fit between these models and the specificities of intermediate size enterprises span the formulation of several propositions regarding the barriers and opportunities of these enterprises. This paper opens the way for a greater understanding of ambidexterity among medium-sized enterprises.

Keywords: Innovation, Organisation of product development, Ambidexterity, Medium size

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Please cite this paper as:
Surnames, Initials: *Title of paper*. In: Proceedings of the 20th International Conference on Engineering Design (ICED15), Vol. nn: Title of Volume, Milan, Italy, 27.-30.07.2015

1 INTRODUCTION

To achieve and sustain competitive advantage, firms need to exploit at their best their current capabilities but also to explore new ones: innovation is critical to maintain competitiveness. Medium-sized enterprises face a specific challenge in R&D organizations as they have significant R&D teams but limited resources to dedicate to innovation.

The tension between exploitation and exploration is referred in literature as *Organizational Ambidexterity* (Duncan, 1976; Simsek, 2009). Since medium-sized enterprises have limited resources (North et al., 2001) exploration and exploitation behave as the two ends of a continuum (Gupta et al., 2006) which result in a trade-off situation. Therefore balancing these two fields of activities is the main challenge for medium-sized enterprises (Cao et al., 2009; Chang and Hughes, 2012).

Medium-sized enterprises are usually implementing new methodologies and tools in order to improve their exploration or exploitation capabilities, instead of implementing them as a mean to excel at both. Following the competitive gains obtained in manufacturing processes through *Lean Manufacturing*, the *Lean Development* approach is seen by managers as an opportunity to increase productivity and efficiency in the product development process. Encouraged by success stories, they see *Design Thinking* as a potential solution to gain competitive advantages through ground-breaking innovation. Whether and how these different approaches are improving or disturbing the balance between exploitation and exploration in medium-sized enterprises remains unclear in the literature.

The main objective of this paper is to operationalize the notion of ambidexterity by analysing the implementation of lean product development and design thinking in medium-sized enterprises. In the first section we will explore the ambidexterity literature to see what types of solutions are proposed in terms of organization. Then we will describe how lean product development and design thinking can be seen as a methodological framework to analyse ambidexterity in R&D teams. Finally we will link each antecedent of organizational ambidexterity to the common characteristics of medium-sized enterprises and formulate propositions regarding organizational ambidexterity in these enterprises.

2 AMBIDEXTERITY LITERATURE

The word ambidexterity originally designates the ability to use both hands equally well. When it refers to organizations, a common definition is the ability to pursue exploitation and exploration at the same time (Simsek, 2009). To understand organizational ambidexterity, a temporal approach (Simsek et al., 2009) and a multilevel approach (Simsek, 2009; Turner et al., 2013) are needed.

On one hand, the temporal aspect of ambidexterity allows us to distinguish two situations: an ambidextrous organization can pursue exploitation and exploration simultaneously or alternately. On the other hand, ambidexterity can be achieved at different levels of the organization. In their multilevel approach, Turner et al. (2013) consider the organizational, unit and individual levels. Simsek et al. (2009) used the temporal and multilevel approaches to describe different kinds of ambidexterity but they did not consider the individual level.

The combination of the temporal and multi-level approaches should a-priori describe six different types of ambidexterity, but since exploration and exploitation are two distinct fields of activities (March, 1991) consciously engaging in both of them simultaneously at the individual level is impossible. Below we describe the four types of ambidexterity identified by Simsek et al. (2009) then we complete the multi-level approach to describe the fifth type of ambidexterity. This typology is summarized on Figure 1.

As said earlier, simultaneous ambidexterity is not accessible to individuals. However it can be achieved at the unit level if the unit is composed of complementary individuals. When ambidexterity is achieved this way, Simsek et al. (2009) talk about *Harmonic Ambidexterity*. If all the individuals within each unit are aligned, ambidexterity can be achieved at the organizational level if the organization is composed of complementary units. In this case it is referred to as *Partitional Ambidexterity* (Simsek et al., 2009). If all individuals (and therefore all units) are aligned within the organization, the focus of the whole organization can switch between exploitation to exploration regularly. In this situation Simsek et al. (2009) talk about *Cyclical Ambidexterity*.

If a multi-unit organization where each unit is focused on a single field of activity is ambidextrous, it is either already achieving partitional or cyclical ambidexterity. If it is achieving ambidexterity alternately and across unit, the cyclical or the partitional type is likely to be expressed with more intensity: the organization may appear as a partitional organization with regular exchanges of

individuals between units, or it may appear as an aggregation of cyclical units working on different domains but sharing resources and knowledge. However, Simsek et al. (2009) theorize a situation in which the output of a unit is the input of another and reciprocally. They name this situation *Reciprocal Ambidexterity*. However this type of ambidexterity seems more adapted to describe a network of organizations, in which ambidexterity is fully achieved at the network level (Simsek et al., 2009; Stadler et al., 2014).
Finally, an organization may be composed of individuals able to alternate between exploitation and exploration without being aligned within each unit. Such an organization, at a given time, could be described as *Harmonic*. However, in *Harmonic Ambidexterity* individuals are not presumed able to switch between exploitation and exploration, so they can be specialized in a field of activities. Therefore we will use the terms *Specialised Harmonic Ambidexterity* to describe what we previously called *Harmonic Ambidexterity*, and the terms *Generalised Harmonic Ambidexterity* to describe the fifth type of organizational ambidexterity.

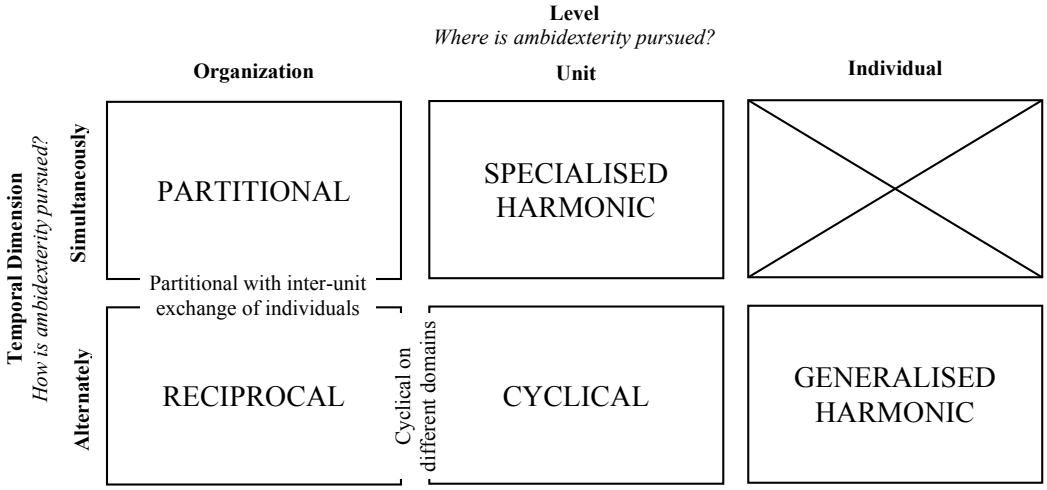

Figure 1: Ambidexterity typology extended from the one of Simsek et al. (2009)

Exploration and exploitation were first theorized as two fields of activities competing for scarce resources (March, 1991): organizations had to find the best trade-off to maximize their competitive advantage. Gupta et al. (2006) considered that if resources were not a constraint these two concepts may not behave as the two end of a continuum but rather be orthogonal to each other. In addition to resource constraints, organizational ambidexterity is conditioned by a multitude of parameters like centralization, culture strength, formalization, routinization, risk aversion (Borrèl, 2013); organizational inertia, desirable organizational outcome (Martini et al., 2013); human, social and organizational capital (Kang and Snell, 2009). By limiting our study to medium-sized enterprises, we reduce the variation of these factors.
Since ambidexterity has been pointed out as a factor of success, organizations may actively try to become ambidextrous. What are the methodologies currently deployed to improve exploration and exploitation capabilities? Enterprises looking for efficiency and reactivity to existing markets tend to adopt Lean approaches, while the ones looking for innovation and diversification show their interest in Design Thinking, C/K or Agile approaches. Interestingly, Toyota and IDEO – the enterprises where Lean and Design Thinking were respectively stemmed from – were used by O'Reilly and Tushman (2013) as examples of ambidextrous organizations. In the next section, we describe how we analysed the respective contributions of Lean and Design Thinking to the development of ambidexterity.

3 METHODOLOGY

In order to describe the effects of Lean Development and Design Thinking on organizational ambidexterity, we determined whether or not their constitutive principles and items were related to exploration, to exploitation and to organizational ambidexterity. We took into account the expected effect on the organization's knowledge and the explicit links with the development phases. Our grid of analysis is summarized in Table 1.

March (1991) defined that (1) exploitation activities renew and expand the organization's knowledge and beliefs while (2) exploitation activities reinforce and homogenise the organization's current knowledge and beliefs. Exploitation also encompass (3) the acquisition of knowledge about the organization itself (March, 1991). From this perspective, we consider that a principle is contributing to organizational ambidexterity if it (4) encourages a rapid diffusion of new knowledge within the organization, or if it (5) aims at balancing the acquisition of new knowledge and the refinement of existing knowledge.
When considering a new product development, early development phases – also called front end of innovation – embed essentially activities such as search, experiments, idea genesis, or discovery (Koen et al., 2001). These activities belongs to exploration (March, 1991). On the contrary, later phases are more exploitation oriented as they concern refinement, implementation and production (Koen et al., 2001; March, 1991). Therefore we consider that (6) principles explicitly related to early development phases are related to exploration, while (7) principles explicitly related to late development phases are related to exploitation. From this perspective, we consider that a principle is contributing to organizational ambidexterity if it (8) eases the transition from the early development phases to the later ones, or if it (9) aims at balancing the workload between development phases.
The relationship between some principles and organizational ambidexterity can be ambiguous. When such a principle arises, we will try to use insight from other authors to clear the ambiguity. If (10) the principle can still be interpreted in two ways that implies opposite effects, we will mark it as ambiguous.
Once the general effects of Lean Development and Design Thinking on organizational ambidexterity have been framed, we will compare these two approaches using the product development framework of Kahn et al. (2006). This framework is based on new product development best practices and comport six dimensions. This comparison enables us to formulate propositions linking the specificities of medium-sized enterprises to organizational ambidexterity.

Table 1: Analysis grid of the relation to exploration, exploitation and ambidexterity

Symbol (Relation)	Exploitation	Exploration	Ambidexterity
X (Related)	(1) Renew and expand knowledge (6) Explicitly related to early development phases	(2) Reinforce and homogenise knowledge (3) Acquisition of knowledge about the organization (7) Explicitly related to late development phases	(4) Diffusion of new knowledge within the organization (5) Balancing acquisition of new knowledge and refinement of existing knowledge (8) Eases the transition from early to late development phases (9) Balancing the workload between development phases
A (Ambiguous)	(10) The principle can be interpreted in two contradicting ways		
- (Unrelated)	None of the above		

4 LEAN DEVELOPMENT AND DESIGN THINKING

Lean Development and *Design Thinking* are two approaches of product development that were created through practice. These two methodologies are based on different structures, processes and skills. In this section we describe how they affect organizational ambidexterity.

4.1 Lean Development

Lean Development is the transposition to studies departments of Lean Manufacturing: organizations should thrive to produce customer value while reducing waste. Morgan and Liker (2006) decomposed the Lean approach in 13 principles. In the following paragraphs, we apply our analysis grid (Table 1) to these principles. Our analysis is summarised in the Table 2.
The principle 1 is to distinguish between customer-defined value and waste. Value is what the customer is willing to pay for; activities that do not add value are wasteful. This recommendation is twofold: first it implies that the organization receives new inputs on customers; in a second time the organization has to identify waste which is mostly internal to the organization. Since the organization learns on the world then on itself, this principle is related to both exploration and exploitation. However, while added value of product development activities in downstream phases and short term

pressure from customer can easily be emphasized by a lean approach, the value of long term exploration is harder to visualize (Dal Forno and Forcellini, 2012). This inequality is susceptible to introduce a bias toward exploitation, and make the link to ambidexterity ambiguous.
The principle 2 is to frontload the design process to explore alternative solutions early. Since it emphasizes early development activities domains it is related to exploration.
The principle 3 is to create a levelled product development flow. Attention is given to resource management and the optimization of the process itself. This optimization falls into the field of exploitation as it relies essentially on internal feedback.
The principles 4 and 13 encourage standardization. They can be considered as related to exploitation only since Chen and Taylor (2012) expect standardization to diminish the disruptive innovation capability. However, according to Morgan and Liker (2006), standardization allows the organization to gain flexibility, thus enable exploration. Moreover the organization should implement communication mechanisms to identify the elements worth standardizing (Martinez León and Farris, 2011). These mechanisms diffuse new and older knowledge alike, and so are related to ambidexterity. Since a direct link with exploration was not found, we consider these two principles to be related to exploitation and ambidexterity.
The principle 5 is to appoint a chief engineer to establish then carry the customer value. Therefore an individual will directly impact the balance between exploration and exploitation as he can be more or less be sensible to the potential bias mentioned in our analysis of the principle 1.
The principle 6 is about balancing functional expertise and cross-functional integration. The balance is aimed at easing the transition from new concept generation to new concept implementation. Therefore this principle is related to ambidexterity.
The principle 7 is about towering technical competences in engineers. Morgan and Liker (2006) describe engineers becoming specialists of their field under the tutoring of senior engineers. The transmission of knowledge depicted here contributes to the homogenisation of the organization's knowledge, thus is related to exploitation. The principle 7 can also lead to expanding knowledge but this exploration is limited to closely related domains. Since the principle 7 is related to both exploration and exploitation but with different magnitudes, it is not related to ambidexterity.
The principle 8 addresses the integration of suppliers in the product development. Since the principle aims to ease the transition between early and late phases of the development, this principle is related to ambidexterity.
The principles 9 and 10 are about building a culture of continuous improvement. These principles are subject to interpretation. For example it can be understood as supporting the refinement of existing solutions or as supporting the exploration of new solutions with the continuity of evaluation criteria. Therefore we mark them as ambiguous.
The principle 11 consists in adapting technology and tools to fit the people and the processes. This principle aims at optimizing the development process and is related to exploitation.

Table 2: Analysis of the 13 principles of Lean Product Development

#	Constitutive principles of Lean Development	Exploration	Exploitation	Ambidext.
1	Establish customer-defined value to separate value-added from waste.	X	X	A
2	Front-load the product design process while there is design space to thoroughly explore alternative solutions.	X	-	-
3	Create a levelled product development process flow.	-	X	-
4	Use rigorous standardization to reduce variation, thereby creating both flexibility and predictable outcomes.	-	X	X
5	Develop a chief engineer system to integrate development from start to finish.	-	-	X
6	Organize to balance functional expertise and cross-functional integration.	-	-	X
7	Develop towering technical competence in all engineers.	X	X	-
8	Fully integrate suppliers into the product development system.	-	-	X
9	Build in learning and continuous improvement.	-	-	A
10	Build a culture to support excellence and relentless improvement.	-	-	A
11	Adapt technology to fit your people and your processes.	-	X	-
12	Align your organization through simple, visual communication.	-	X	X
13	Use powerful tools for standardization and organizational learning.	-	X	-

Finally, the principle 12 is about alignment within the organization. Morgan and Liker (2006) describe visual communication as a tool to share the objectives of development projects – i.e. to allow all the stakeholders to identify value and waste. This principle is related to ambidexterity in the same way as the principle 5.
An organization following the principles described above does not use *Partitional Ambidexterity* or *Cyclical Ambidexterity*. The main type of ambidexterity witnessed is *Specialized Harmonic* one, which is attained within the project management team: a cross-functional unit. *Generalized Harmonic Ambidexterity* may be used within each functional unit but the ambiguous effect of the culture of excellence does not allow us to state on this point.
This analysis revealed that Lean Product Development is more related to exploitation and balancing mechanisms than to exploration. Therefore the implementation of this approach can make the balance tilt in favour of exploitation. The integrative role of the chief engineer impacts directly ambidexterity at the organization level: if the individual is not skilled at balancing exploration and exploitation, the balance of the whole development project may be disrupted. On a longer temporal scale, the top management team impacts the organization's ambidexterity through the organizational learning process they implement, and the career paths they guide individuals on.

4.2 Design Thinking

Design Thinking is an approach developed and promoted by Tim Brown, the CEO of IDEO. This approach is based on integrative thinking: it acknowledges the interdependence between function and form, and the need to develop both simultaneously. By putting more emphasis on the desires and needs of users than the efficiency of existing architectures, this approach encourages disrupting innovation. We conduct our analysis according to the mindmap of Design Thinking (Brown, 2008) which is composed of 22 items. Our analysis is summarised in the Table 3.
The item 1 is to expect success and to allow resources accordingly. According to our analysis grid, this item is not related to exploration, exploitation or ambidexterity. However, as presented in section two, loosening resource constraints has a positive effect on ambidexterity.
The items 2, 3, 6 and 14 are about identifying unanswered needs. Such needs are always susceptible to exist in dynamic environments, but people may not be aware of their own needs thus observation is required identify them. This acquisition of knowledge belongs to exploration.
The item 4 is about analysing the business constraints. Since the organization actively seeks new knowledge on its environment, this activity is exploratory. However this new knowledge is susceptible to limit the domain of new product exploration, and so contributes to balancing knowledge acquisition and knowledge reinforcement. Therefore this item is related to ambidexterity
The item 5 is the involvement of many disciplines from the start. The build-up of heterogeneous teams enables the reformulation of problems and fosters the acquisition of new knowledge. Moreover, heterogeneous teams contribute to the homogenisation of knowledge. Since this item contributes to the acquisition of new knowledge by several functions and to the diffusion of pre-existing knowledge, it is related to exploration, exploitation and ambidexterity.
In the item 7, the role of space is identified as central to localise and mediate all knowledge produced. Brown (2009) recommends the use of a project room as it emphasises the production of stories and exploration. This room – similar to a Lean Obeya room – also facilitates the exchange of knowledge and the immediate exploitation of the knowledge produced during exploration. This item is related to exploration, exploitation and ambidexterity.
The item 8, looking for alternative solutions using new technologies, is related to knowledge acquisition and exploration.
The item 9 leads to knowledge homogenisation in order to exploit the current assets of the organization, and so is related to exploitation only.
The items 10 and 12 recommend synthetizing available information. This synthesis is a way for the development team to share common representation and therefore is an exploitation activity. However, the framework generated during this activity can be used for systematic exploration by enabling the combination of elementary concepts or by highlighting lacks of knowledge. This systematic exploration is complementary to the organic exploration of brainstorms (item 11).
The item 13 is related to ambidexterity as it recommends integrating new and existing knowledge.
The items 15 and 18 are recommending the use of prototyping and experimentation. In Design Thinking, these activities are viewed as a learning process that allows exploring and learning about the

requirements and needs, focusing on the customer but also testing new technologies opportunities (Leifer and Steinert, 2011).
The item 16 recommends telling more stories. The novelty of such stories is not crucial: the purpose is to transmit the intentions of the development team to the rest of the organization to ease the completion of the project. This item is related to ambidexterity.
The item 17 is about general communication on the early phases of the project. As in the item 16, the aim is to ease the execution of the rest of the project.
Similarly the role of design team to help marketing to elaborate and define a communication strategy – item 20 – is critical to exploit the design rationale and the value proposition elaborated during the design phase. This item is related to ambidexterity, but also to exploitation as it stresses an easily overlooked exploitation activity.
The recommendations 19 and 21 are reminders that the team must exploit the information generated and transform the design rationale into concrete value for the users. These items are related to exploitation only.
Finally, according to the item 22 once the product is on the market the development team starts another project. Therefore resources are removed from a project undergoing exploitation activities, and added to the early phases of a new project. This item is related to exploration.
The Design Thinking approach is closely related to *Partitional Ambidexterity* as the development team disengage from the project once it reaches the production phase. The need to ease the transition from the development team to the rest of the organization is emphasized and reinforces this partitioned aspect of the Design Thinking organization. Since a structuration in several units is never mentioned in this approach, we cannot say if *Cyclical* and *Reciprocal Ambidexterity* can be present or not in such an organization. Individuals able to switch from exploration to exploitation are present among the development team so the organization is using, to some extent, *Generalised Harmonic Ambidexterity*. The combined presence of *Generalized Harmonic Ambidexterity* and *Partitional Ambidexterity* makes unlikely the presence of units using *Specialized Harmonic Ambidexterity*.
The Design Thinking approach is closely related to exploration and to the transition from exploration to exploitation. In this approach, exploitation of the existing assets of the organization is expected to happen through the build-up of a heterogeneous development team. Ambidexterity in this approach relies essentially on the initial knowledge and the integrative skills of the development team.

Table 3: Analysis of the 22 items in the mindmap of Design Thinking

#	Items of Design Thinking	Exploration	Exploitation	Ambidext.
1	Expect success. Build implementation resources into your plan.	-	-	-
2	What's the business problem? Where's the opportunity? What has changed?	X	-	-
3	Look at the world: observe what people do, think, need, want	X	-	-
4	What are the business constraints?	X	-	X
5	Involve many disciplines from the start	X	X	X
6	Pay close attention to "extreme" users such as children or the elderly.	X	-	-
7	Have a project room where you can share insights, tell stories.	X	X	X
8	How can new technology help?	X	-	-
9	Are valuable ideas, assets, and expertise hiding inside the business?	-	X	-
10	Organize information and synthesize possibilities (tell more stories!).	X	X	-
11	Brainstorm. Make many sketches, concoct scenarios.	X	-	-
12	Build creative frameworks (order out of chaos)	X	X	-
13	Apply integrative thinking	-	-	X
14	Put customers in the midst of everything; describe their journeys	X	-	-
15	Prototype, test, prototype, test...	X	-	-
16	Tell more stories (they keep ideas alive)	-	-	X
17	Communicate internally – don't work in the dark!	-	-	X
18	Prototype some more, test with users, test internally	X	-	-
19	Execute the Vision. Engineer the experience.	-	X	-
20	Help marketing design a communication strategy	-	X	X
21	Make the case to the business – spread the word	-	X	-
22	Move on to the next project – repeat	X	-	-

4.3 Comparison of Lean Development and Design Thinking

In this section we compare Lean Development and Design Thinking on the six elements of the product development framework of Kahn et al. (2006): people, strategy, process, portfolio management, market research and performance evaluation. The results are summarised in the Table 4.

Lean Development and Design Thinking show two differences in terms of people. The first difference is that Design Thinking teams systematically include external experts to bring new knowledge about the customers and their needs while Lean Development teams are essentially composed of members of the organization and suppliers. The second difference is structural: in the Lean approach the team members are still attached to their respective units and the project room is only used for regular meetings; in the Design thinking approach the project room is a working place and team members are freed from the constraints of their units of origin while they work on the project.

The strategies of the two approaches are different. Design Thinking projects start with unanswered users' needs then try to answer these needs with current capabilities and new technologies. In that sense it promotes a double exploration on market and technologies. On the contrary, the introduction of new technologies in Lean Development is done through the validation of technological bricks prior to the development project: new products can only be based on these validated elements. This strategy aims at the production of quality products at a reasonable cost by decoupling the research on market and technologies.

The main difference between Lean Development and Design Thinking development processes is their degree of formalization. In order to coordinate its different functions and resources, the lean organization schedule the entire development process then adapt this schedule as the project is going on: following the planning is the responsibility of every member of the organization. The Design Thinking process is more flexible: it is not prescribed and it is the role of the project leader to guide the team through the steps of the development.

In a Lean organization, each project is scheduled: resources are actively monitored and their allocation is dynamic. Standard processes are key elements: portfolio management is done through the consolidation of the different project schedules. Design Thinking resorts to roadmapping rather than scheduling because of the low degree of formalisation of the processes. Resources are allocated at the beginning of the project and correspond to first estimations of the total development project cost: division of work is not made initially but is part of the work. This approach is more based on strong cooperation than coordination or predefined tasks. For example, Market research in Lean Development is under responsibility of the chief engineer but in Design Thinking the whole development team participates actively to this research.

Both approaches rate performance according to customer value; however the concept of value they use is different. In a Lean organization, the chief engineer is the voice of the customer, He is supposed to know the field and to experience users' needs then he translates these needs into functional requirements with the development team. Performance is evaluated in regard of these requirements. In a Design Thinking organization, value is evaluated directly by the users through prototyping and testing.

Table 4: Comparison of Lean Development and Design Thinking

#	Elements of comparison	Lean Development	Design Thinking
1	People	Cross-functional team	Mix of internal and external experts
2	Strategy	Decoupled market / techno exploration	Coupled market / techno exploration
3	Process	Scheduled	Agile
4	Portfolio management	Schedule consolidation	Roadmapping
5	Market research	Lead by the chief engineer	Done by the development team
6	Performance evaluation	Technical performance measurement	Customer satisfaction measurement

5 BARRIERS AND OPPORTUNITIES IN MEDIUM-SIZED ENTERPRISES

As mentioned earlier, limiting our analysis to medium-sized enterprises allows us to limit the variation of the mediating factors of ambidexterity and to formulate more coherent propositions.

First, medium-sized enterprises have limited resources and it is common for these organizations to be unable to afford separating innovation and development units. Limited human and financial resources are obstacles to the pursuit of *Partitional Ambidexterity* (Raisch and Birkinshaw, 2008). Similarly, we

do not expect medium-sized enterprises to attain *Reciprocal Ambidexterity* across units because the organization cannot afford to maintain redundant units. We note however that the pursuit of this type of ambidexterity at the network level is not excluded. *Proposition 1: medium-sized enterprises naturally tend to avoid Partitional and Reciprocal Ambidexterity.* The consequence of this proposition is that medium-sized enterprises willing to implement an exploration oriented methodology should look at other approaches than the two presented in this paper.

Another characteristic of medium-sized enterprises intensive centralization of decisions (Nicolescu, 2009). In our analysis of Lean Development and Design Thinking, we highlighted the pivotal role of the chief engineer in the former approach and its impact on the balance between exploitation and exploration. *Proposition 2a: among medium-sized enterprises, the balance between exploitation and exploration varies more than among large organizations.* Authors also point out that medium-sized enterprises lack of managing skills (Ropega, 2011). Under validation of the proposition 2a, we formulate the *Proposition 2b: in average, medium-sized enterprises are less capable to balance exploitation and exploration than large organizations.* These propositions have two complementary implications: firstly, there is a higher potential of performance improvement through the pursuit of organizational ambidexterity among medium sized enterprises than among large organizations; secondly, in the case of medium-sized enterprises organizational ambidexterity can enhanced by training managers so they can understand and act in favour of organizational ambidexterity.

In this article, we identified the formalization of the development process as a characteristic of an exploitation-emphasising approach. Therefore we expect formalization of the development process to be related to an imbalance of activities in favour of exploitation. However this expectation is not extended to large organizations since their extended resources tend to erase the trade-off relationship of exploitation and exploration. *Proposition 3: among medium-sized enterprises high formalization of the development process is associated with an imbalance of activities in favour of exploitation*. This proposition does not imply that formalization and exploration cannot be related; however it implies that current practices may be improved either by (1) formalizing and scheduling the activities of the fuzzy front end to a greater extent, or by (2) identifying an efficient way to balance formal and informal activities.

Design Thinking explores market and technologies alongside while Lean Development separates them in distinct work streams. However both approaches enhance organizational ambidexterity: the consistency of exploration activities may impact the exploitability of the knowledge produced. *Proposition 4: medium-sized enterprises conciliating market exploration and technologies exploration attain higher levels of combined exploration and exploitation than the others.* This proposition implies that organizational ambidexterity can be improved without changing the allocation of resources between exploration and exploitation.

6 CONCLUSION

The main contribution of this article is bringing a new lightning on the links between operational activities and ambidexterity mechanisms by analysing two complex but consistent approaches to product development.

In this paper, we extended the organizational ambidexterity of Simsek et al. (2009) by adding a fifth type of ambidexterity: *Generalised Harmonic Ambidexterity*. This type of ambidexterity may be present to some extent in Design Thinking development teams.

Our analysis of Lean Development and Design Thinking showed that the former is more closely related to exploration and balancing mechanisms than to exploration and that the latter is more closely related to exploration and integration mechanisms. In the case of Lean Development, ambidexterity mechanisms are present at the organizational level (the integrative role of the chief engineer) and at the unit level (cross-functional interfaces, coordination mechanisms and shared values). The Lean approach can be associated with *Specialised Harmonic Ambidexterity.* In the case of Design Thinking, the ambidexterity mechanisms involved are at the unit level only (building-up of heterogeneous teams and shared knowledge). Design thinking can be associated with *Partitional Ambidexterity* and *Generalized Harmonic Ambidexterity*.

Finally, considering simultaneously our analysis and the constraints of medium-sized enterprises, we were able to formulate propositions about the ambidexterity of these enterprises. Field observations are now necessary to test these propositions.

The present analysis was limited to organizational ambidexterity and did not explore thoroughly the inter-organizational level: the impact of Lean Development and Design Thinking on the suppliers of medium-sized enterprises.

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