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PROPOSITION OF A MATURITY GRID TO ASSESS NPD AGILITY

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ABSTRACT
Since the mid 90's, the manufacturers need to renew continuously their product offers, to thrive in more competitive and turbulent markets. However, the implementation of continuous innovation approaches impacts their existing NPD process, in terms of organisation, processes and skills. The issue addressed in this paper is how can they integrate in continuous way innovations into their NPD process, without to degrade its performance objective? By mobilising the literature on continuous innovation, open innovation and agility, we argue that these manufacturers need to have an agile NPD process to successfully absorb innovations into the NPD process. The main contribution of this paper is the presentation of the NPD agility concept with its associated capabilities. Four practices areas are suggested, to assess the NPD agility. Combined with the identification of four maturity levels and associated engineering practices, they constitute the analysis framework of a maturity grid, aiming at assessing the NPD agility. This research is performed in partnership with PCO Innovation, a consulting company, willing to support its clients on this new issue.

Keywords: NPD agility, RID model, open innovation, maturity grid, consulting

1 INTRODUCTION
Since the mid 90's, the manufacturers need to renew continuously their product offers, to thrive in more competitive and turbulent markets. The implementation of continuous innovation approaches impacts the existing NPD process, in terms of organisation, processes and skills. Indeed, observation of design practices show that the design processes can be strongly disturbed by innovative concepts and project. To illustrate the kind of disturbances occuring, the case of the hybrid engine can be used [1]. It has been reported by some consultants of PCO Innovation, having observing the difficulties encountered when introducing some major changes in the product architecture. The manufacturer was an engine manufacturer. To face new environmental regulations and provide an "environment friendly" engine, it has been obliged to innovate, by switching from combustion engine to hybrid engine. New technologies have been used and the product architecture has been strongly modified. It notably led to the integration of two engines into one product's architecture and the use of more electronic technologies to manage the transmission and combustion part. As the NPD organization is very often *coupled with the product architecture to develop* [2], this product architecture evolution has strongly disturbed the optimised NPD process stakeholders. It has introduced a lot of changes in terms of knowledge, expertise and collaboration. At the level of engineering practices, new actors have been involved and new interface jobs have been created, such as the mecatronic profile (combining both electronic and mechanic skills). Some engineers had lacked their marks, in terms of requirements managements, validation criteria of the solution and associated know-how to develop it. Moreover, a new profile was created - the product architect - to master the *integrity of the product* [3]. This person had to develop new architectural knowledge, to master the consistency between product structure and final customer needs. This case illustrates well the kind of disturbances introduced by an architectural innovation at the level of NPD practices. The challenge for large companies is to keep their efficient processes while they have to manage all these changes (new knowledge, new partnerships and new product architecture). They notably need to adapt their standardized design process and evolve in a highly uncertain context.
Our partner, PCO Innovation, is a consulting company supporting these manufacturers (its clients) to optimize their NPD performance, notably with the implementation of a Product Lifecycle Management (PLM) approach. Its consultants are used to support its clients on the entire product

lifecycle, in terms of organization, process and information system. To face the new innovation issue of its clients, PCO Innovation has decided to complement its existing expertise with some knowledge on the successful implementation of a continuous innovation approach. More precisely, its goal was to develop a diagnosis methodology, to assess the NPD performance of its clients in a context of continuous innovation. This research aims at responding to this demand. It does not focus on the exploration and innovative design activities, but on the successful integration of the results from these activities into the NPD process. To achieve this goal, key concepts of literature have been mobilised, such as the Research Innovation Development (RID) model [4], the paradigm of *open innovation* [5] and the concept of *agility*. Based on the analysis of this literature and some exchanges with consultants, the concept of NPD agility has been developed, identifying the key capabilities of an efficient NPD process, and the agile practices areas to master. Finally, a maturity grid has been developed to diagnose the NPD process performance in a context of continuous innovation. This paper is structured as follow. Section one presents our research method. Section two presents the issue of innovations absorption by the NPD process. Section three presents the NPD agility concept. Finally, section four presents how can the concept of agility be mobilised, to create the NPD agility concept, used as an analysis framework within a diagnosis tool.

2 METHODOLOGY TO BE USED

An action research approach [6, 7] has been adopted, in order to develop ”*actionable knowledge*” [8], intended to be useful and at the right level for the practitioner. The research approach was based on three main steps:

- **Phase 1: exploratory study**

To identify the characteristics of an efficient NPD process in a context of continuous innovation, three sources of data have been used. Some data were collected during semi-structured interviews with manufacturers from different sectors, mainly clients from PCO Innovation. The goal was to identify their difficulties encountered when innovating, and the implemented solutions to face them. A literature review on the performance of a NPD process in a context of continuous innovation has been performed, as well as some exchanges with consultants, experts of NPD performance management. This exploratory phase led to the two following conclusions:

- An efficient NPD process should be able to absorb innovations at the NPD process, without to degrade its performance
- Agility would contribute to perform it with success.

- **Phase 2: diagnosis tool development**

Based on multiple iterations between consultants and searchers during workshops, this phase led to the development of the diagnosis tool framework. This last one allows to breakdown the agile NPD concept into capabilities, process areas to master and maturity levels required to define each practice by level. To improve the preliminary framework, its functionality and completeness have been tested with consultants. The *functionality* criterion assesses to which extent the analysis framework is suitable to the different manufacturers with whom consultants are used to work. The *completeness* criterion verifies if the topic of NPD performance in a context of continuous innovation is well covered by the evaluation areas.

- **Phase 3: Application in industrial settings**

A prototype of the tool has been developed, and should be applied by consultants of our partner with industrial settings, to get feedback and make improvement concerning its *usability*. This application phase will also verify the *utility* of the diagnosis tool. The tool utility corresponds to the ability to easily identify improvement areas and recommendations that consultants could implement into its client after this diagnostic. These four criteria – *functionality*, *completeness*, *usability and utility* – were usually applied in similar research works concerning the development of assessment tools for improvement in product development [9-13].

3 THE ISSUE OF INNOVATION ABSORPTION BY THE NPD PROCESS

The context of continuous innovation results in “*a programmed and systematic effort to generate innovations using all possible product or service values that can be improved (technology, usage,* *logistics, symbols, societal values)"* [14]. The absorption of innovation at the NPD process obliges manufacturers to modify their "*design strategy*" [15], by exploring and combining new design choices and related competencies [14]. This paper focuses on the NPD process ability to adapt to such product change, such as the one described with the "hybrid engine case". To achieve this goal, two key literature concepts are mobilised, to define the issue of innovation absorption by the NPD process.

- The RID model underlines the key issue of articulation between innovation oriented activities and development activities.
- The open innovation concept is used to show the key issue of selection and valuation of results from innovation activities into the NPD process.

3.1 Identification of results from Innovation (I) oriented activities

The context of continuous innovation requires some new organisational structure, to be able to explore new value and concepts and develop new products. Through their RID (Research Innovation Development) model, [4] have underlined the necessity to identify a third function –called innovation (I) function –complementary to the traditional R&D activities. The goal of this function is to perform activities that the NPD can not do: explore new values, knowledge and product concepts, in order to suggest new dominant design alternatives. The isolation of the function (I) allows not to disturb the development activities (D), aiming at developing a solution with well defined criteria, by using existing knowledge. It is interesting to notice that the performance objectives are very different between the (I) and (D) oriented activities. The study of the RID model (Figure 1) underlines the critical transition from (I) oriented activities to (D) oriented activities. Indeed, the first ones focus more on exploration whereas the others focus more on execution and optimization. In addition, the outputs of the function (I) introduce some uncertainties for the (D) oriented activities, by providing new value proposition, new concepts…etc. As a consequence, it is assumed that the optimised process of NPD might be disturbed by the results of the (I) oriented activities, requiring some evolution of the NPD process to cope with the new product to develop.

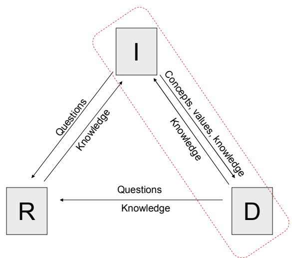

Figure 1: the articulation issue of the Innovation (I) and Development (D) functions of the RID model [1]

This research work is a continuation of existing work on innovative design and focuses on the successful valuation of innovative results providing by (I) to (D) oriented activities.
According to [9], the (I) oriented activities mainly allow a double C-K expansion, by exploring new concept (C) and new knowledge (K). In the tradition of architects, designers or engineers, the word "concept" means "*an innovative proposition to be used as a basis for initiating a design project*"[14]. As an example, a shock absorber manufacturer could work on the following concept: "a car stuck to the road". It has no logical status, that is to say, one can not say that is "*true, false, uncertain or undecidable*" [14]. A piece of knowledge is a proposition with a logical status for the designer or the person receiving the design [14]. Different kinds of exploration projects can exist, aiming at questioning in a more or less breakthrough way the existing dominant design and associated knowledge. Without going into detail, these projects can lead to different types of results [16]:
Each of these exploration types can create four different kinds of results:

- V1: explored concept but leaved unfinished because of time or resources lack
- V2: explored concepts, transmitted to the function (D) to be valued as commercial product
- V3: new used knowledge, and valuable for other products
- V4: new knowledge not used during the design process but valuable for other products.

3.2 Selection of results provided by Innovation (I) oriented activities for valuation

The exploration activities of the innovation function (I) are important, but would remain simple inventions as long as they are not valued on a given market. The study of the *open innovation* [5] paradigm allows the identification of some key valuation issues for the NPD process. First, it announces the transition from "*closed innovation*" to "*open innovation*". It means that the results from the exploration phase can be either valued internally or externally. Indeed, in the open innovation paradigm, the R&D boundaries are considered as more "*porous*" and better connected with the external environment (Figure 2). Hence, when results from the (I) oriented activities such as innovative concepts are considered too risky or not enough adapted to the innovation strategy or the business model, they will not be integrated into the NPD process. Furthermore, they can be valued differently, with the creation of start-up, licensing, creation of new market, evolution of the current business model of the firm…etc. The valuation process depends to a large extent to the business model of the manufacturer, defined as "*an intermediate construct that links the technical and economic domains*" (p. 69, [5]). During the selection phase, it must be used as a filter, to integrate only product concepts that fit with the existing business model. As a consequence, the valuation decision process is a key step before the NPD process.

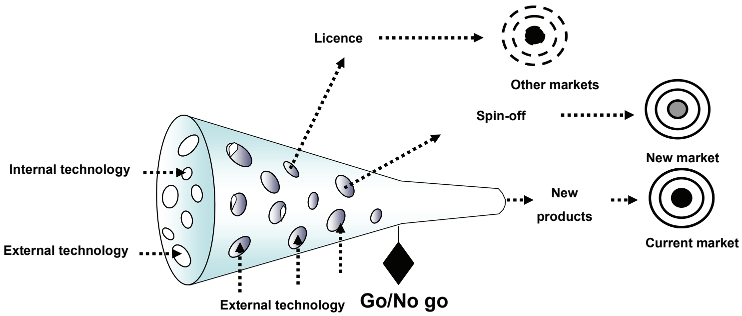

Figure 2: The open innovation paradigm representation [5]

4 NPD AGILITY: TO FACILITATE ABSORPTION OF INNOVATION

The case of the hybrid engine has underlined the impact of a product architecture change on the exiting NPD process. From the analysis of the RID model and open innovation concept, it is possible to identify the characteristic of an efficient NPD process in a context of intensive innovation.

4.1 Agility as a characteristic of an efficient NPD process

By focusing on the successful articulation between the (I) oriented activities and the (D) oriented activities described in the RID model, it is considered that an efficient NPD process must be able to absorb successfully the results from the function (I). It must also cope with the uncertainty and associated risk introduced by the valuation of these results. Moreover, it must be able to adapt itself to the new product to develop, without to degrade its performance objectives. Indeed, the (I) oriented activities lead to results questioning in a more or less breakthrough way the existing dominant design, as well as existing knowledge. It can lead to the creation of new value proposition, new function, new architecture, that the NPD project will need to develop. As the problem solving structure of an organization mirrors very often the conceptual and technical structure of the product [17], it is assumed that the results of these activities requires to realign the organization with the new product to develop. Notably by coupling the existing organizational structure decisions with the product architecture [2]. As a consequence, it is assumed that the more breakthrough the exploration is, the more the NPD might be disturbed by the results of the exploration, valued for a given NPD project (results V2 and V3).

The assumption made in this paper is that agility contributes to the successful adaptation of the NPD process to the new product to develop and can facilitate the absorption of innovation. For this reason, a literature review of the concept of agility has been conducted.

The concept of agility was introduced by [18] in 90's with the concept of agile manufacturing. It aims at reaching four objectives: *enriching the customer, co-operating to enhance competitiveness,*

organizing to master change and leveraging the impact of people and information. It qualified a production system able to "*shift quickly (speed and responsiveness) among product models or between product lines (flexibility), ideally in real-time response to customer demand (customer needs and wants)*"[19]. Since, this concept has been applied to many other areas, such as the entire value chain [20], the supply chain [21] and information system and software [22]. More recently, it has been applied to the company scope [23] and at the strategic level [24]. In this literature, the authors focusing on product development agility [25, 26] describe this capability as relying on flexibility to face late customer requirement changes. The ones focusing on agile software engineering [27] explain how agility can lead to a balance between strict processes and individual flexibility. Moreover, the concept of agility is mainly studied as the ability to react to exogenous changes.
The literature review allows the identification of two required capabilities of agility: anticipation and reaction, as summarized in Table 1.

Anticipation	1. "*A continual readiness to change*" [28] 2. *"Ability of an organization to detect changes "* [29] 3. "*Sense, perceive and anticipate changes*" [30]
Reaction	4. "Make a significant shift in focus, diversify, configure and re-align their business to serve a particular purpose rapidly as the windows of opportunities open " [31] 5. Change proficiency:competency to cause and face change [32] [23]. 6. "Changing the patterns of traditional operation, and casting off those old ways of doing things that are no longer appropriate " [33]. 7. Flexibility [30] and reconfiguration capability [31] 8. Resources fluidity [24] , which " involves the internal capability to reconfigure business systems and redeploy resources rapidly

Table 1. Anticipation and reaction: two key capabilities of agility

Informed by findings from literature and taking into account the internal changes due to the introduction of results from innovation oriented activities, the following definition of the **NPD agility** is introduced: "*the capability to smoothly absorb the results from the innovation oriented activities, by selecting for development only the one having an acceptable impact on the NPD performance, by identifying their impact and the action plan, preparing for adaptation, adapting and quickly restabilising; and by imagining other ways to value not selected results (external valuation or internal valuation postponement)"*.

4.2 The three capabilities to obtain an agile NPD

Based on literature on agility, it is considered that the NPD agility depends to a large extent on two capabilities: anticipation and reaction, in case of internal valuation. Based on the literature on open innovation, it is also assumed that NPD agility depends on a third capability, aiming at selecting for internal valuation only the results of the function (I), having an acceptable impact on the NPD project.
As a consequence, the NPD agility depends on the three following capabilities:

1. **Selection:** capability to select for internal valuation only results from innovation, having an acceptable impact on the NPD performance objectives.
2. **Anticipation**: during early phase of the NPD project, capability to identify changes and impact of the results from the function (I) and to prepare the NPD to face it, notably by defining an action plan.
3. **Reaction**: during the NPD project, capability to adapt to changes as well as to quickly restabilise.

Compared with agile manufacturing, NPD agility aims at adapting the organisation to the innovation to develop, which is a change proactively decided.
It is assumed that the **anticipation capability** relies on two sub-capabilities:

(1) Impact analysis

It is necessary to identify the impact of the function innovation results on the NPD project. For example, when the product architecture is strongly modified, the manufacturer needs to anticipate the impact on its organisation, skills and knowledge, information flow…etc.

(2) Preparation for adaptation

The NPD agility depends to a large extent of the project preparation, during early phase. The research work of Verganti [34] on the role of early phase and the notion of planned flexibility is used.

According to him, early phase can be used in four different ways: to solve problem with early use of downstream information, to plan flexibility in early phase to better adapt during development, to combine these two approaches or to do nothing (strictly reactive mode). In case of agile NPD, it is assumed that early phase must serve as a problem solving phase and preparation phase, to prepare the NPD to react.
It is assumed that the **reaction** capability relies also on two sub-capabilities:
(1) Adaptation
According to the degree of breakthrough associated to the results of the function (I), the NPD will need to be adapted. It depends strongly on the dynamic capabilities of the manufacturers, defined as "*the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments*" [35]. The manufacturer needs to realign the development organization with the new product architecture to develop [2].
(2) Quick restabilisation
After the adaptation, the manufacturer needs to recover from adaptation, by restabilising the practices around routines, in terms of information flow, collaboration between actors…etc. This restabilisation can be implemented on several projects.
These four sub-capabilities of an agile NPD process are illustrated on the Figure 3 and are required to successfully value internally innovations within the NPD process.

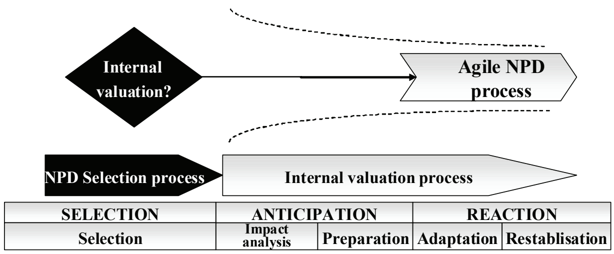

Figure 3: Representation of the required three capabilities of an agile NPD process

After the identification of the three capabilities of the NPD process, the maturity grid development led to the next step: identify which practices area can be used to assess these three capabilities.

4.3 The four agile practices areas to obtain an agile NPD (agile PAs)

Four agile practices area, called "agile PAs" in the following have been identified by mobilising the literature, the results of interviews and experience of consultants. They constitute a proposition to begin an assessment.
The first one supports the process of selection. The three last one support the process of internal valuation (within a NPD project)

- The agile PA "multiple valuations management"
- The agile PA "uncertainty management"
- The agile PA "knowledge management"
- The agile PA "collaboration management"

They are represented on the Figure 4, to show the link between the two processes, the three capabilities and the four agile PAs to master, in order to obtain an agile NPD.
Hence, (1) **multiple valuations management** allows the selection of which project can be valued internally, and which one should be valued externally or have a postponed internal valuation. Then, when some projects are selected for internal valuation, it is necessary to (2) manage **uncertainty created,** by anticipating the impact of the results from the function (I) on the NPD performance and define an action plan to implement. Then, it is also necessary to master the (3) **collaboration management**, as well as the (3) **knowledge management,** to know which knowledge is lacking and identify where and how to get it.
(1) Multiple valuations management
The agile PA "multiple valuations" aims at identifying the portfolio of valuable results and decide how to value it (internally when the impact on NPD performance is acceptable and when it fits with the business model) or externally, by using the business model as filter).

This concept has been built from the literature on *open innovation* [5] and on the *C-K design theory* [14]. It is assumed that a prerequisite of multiple valuations is the definition of the business model by both technical and economical profile. The business model definition requires four main elements: the

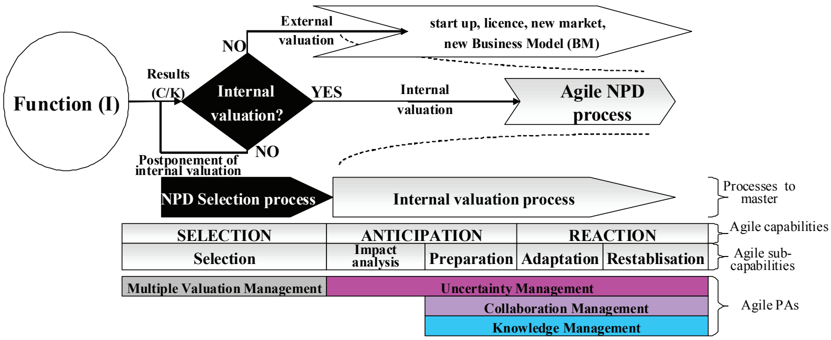

Figure 4: Positioning of the four agile PAs to manage in order to obtain an agile NPD process

value proposition, the resources and capability required to develop the concept and the solution, the layout of the value network, and the economic model defining how to make money [36]. It is assumed that the business model definition can be used as a criterion to select or not project for internal valuation. Second, it requires the identification of the "***valuable results portfolio***", defined as the ***"set of knowledge and concept issued from the RID functions, and valuable internally or externally"***. The format can be widely different such as semi-product, prototype, project idea, innovative concept and results from the exploration (concept and knowledge). Finally, the manufacturer needs to implement a formal valuation decision process, to decide how to value this "valuable results portfolio". The internal valuation consists on: valuing internally elements of the "valuable results portfolio" when their impact on the NPD has been judged "***acceptable***". An ***acceptable impact*** is "***an impact that can be managed at the NPD project, thanks to a smooth absorption of change without to disturb too much its performance objectives***". The external valuation consists on imagining new external valuation ways, for the valuable results portfolio which can not be valued internally with spin-off, licensing…etc.

(2) Uncertainty management

The agile PA "uncertainty management" aims at identifying changes created by results from (I) selected for development, in order to manage their impact, thanks to the definition and implementation of action plans.

The development of innovative product creates a context of market and technical uncertainty: "*coping with market uncertainty greatly complicates the already difficult challenge of managing technical uncertainty, because resolving the technical uncertainty depends on which market the technology is intended to serve*" (p. 12, [5]). Many parameters are still not defined or the information on them is lacking or immature [37]. In practice, the notion of uncertainty management is very often called "risk management". Indeed, uncertainty and risk are closely linked, notably because a *risk* is *"a potential impact due to the consequence of uncertainty*"[38]. Uncertainty can also lead to *opportunity*, when the impact has a positive consequence [37]. It is assumed that manufacturers need to identify and limit the impact of change, which can either be caused by a change at the structure level of the organisation (independent from the project) or a change impacting directly the NPD project. Five sources and impacts of change have been identified: *the organization, the project, the process, the technologies and the product.* Some of them are directly linked to the results of the innovation function, such as product and technology.

- ***New technology introduction*** is a potential source of uncertainty, notably when the company has not the relevant knowledge to manage the integration of this technology within the product.
- ***Product*** **change** can be a source of uncertainty, when some modifications are performed. For example, a change of the value proposition made to the customer can require some evolutions in terms of new function, product architecture, the interfaces between subsystem…etc. Each of these changes can impact in a more or less breakthrough way the product and process

development, notably in terms of collaboration, organisation…etc.

Others are more concerned with structural change, impacting the project performance, but not directly linked to the results from the function innovation, such as organisation, process or information system change.

- ***Organisation change*** can have some impact on NPD project performance. For example, a reorganization of roles and responsibilities within a department (logistics, engineering…etc) can disturb the organisational routines.
- ***Process change*** can impact a NPD project. For example, a change of methodology to manage the verification and validation can impact for example the quality and time objectives of a NPD project.
- ***Information system change*** can disturb the NPD routines. For example, the modification of the engineering department tool might impact all the actors used to work in collaboration with engineers, such as persons from purchasing, logistics, manufacturing…etc.

As these changes create uncertainty they are potential sources of risk that need to be managed.

(3) Knowledge and learning management

The knowledge management allows the identification and mobilization of the relevant knowledge and skills to face these changes and limit their impact on the NPD project. It relies on three agile practices: ***new knowledge absorption, skills and job reconfiguration and the use of learning from project n to project n+1.***

In order to be able to mobilize the relevant knowledge, the manufacturer needs to identify the lacking knowledge and how to get this knowledge (either internally or externally).

Then, it needs to get this knowledge. Externally, it is possible by having *absorptive capacity* [39] , in order to "*identify external knowledge, assimilate and exploit it internally»*. Nevertheless, it creates new challenges such as confidentiality management and intellectual properties management. Internally, it is possible to get existing knowledge by optimizing knowledge sharing between projects, notably by implementing multi-projects management for example [40].

Finally, the NPD process as to be modified by capitalizing on learning from first projects, either during the design activity or by using the feedback from the market [16].

(4) Collaboration management

The collaboration management aims at mobilizing the relevant actors (internal and external) to guaranty the product integrity. The *product integrity* [3] combines *internal integrity (consistency between the function and structure of the product)* and *external integrity (how well a product's function, structure, and semantics fit the customer's objectives, values, production system, lifestyle, use pattern, and self-identity* (p. 30, [3]). The internal integrity requires internal integration, by coordinating actors of the NPD (internal and external). External integrity requires the manufacturers to take into consideration the voice of the customer during the entire NPD project. From that perspective, internal integration depends on ***the multidisciplinary collaboration and the supplier collaboration***. The external integration relies on the external integrity management with the ***requirement management***.

These four agile PAs should lead to an agile NPD project, able to absorb the results of the function (I), or refuse the absorption when too disturbing, and looking for new ways of valuation, either by postponing the internal valuation and identifying it in the "valuable result portfolio" or by imagining an external valuation way. These four agile PAs constitute the framework of the diagnosis tool, presented in the next section.

5 PRESENTATION OF THE MATURITY GRID

5.1 Format and objectives of the tool: specification of consultants needs

Some consultants of our partner were asked to specify which tool format would best suit their practice, in order that they use this concept as an analysis framework during a mission.

The consultants were interested in having a tool supporting their interaction with a client during a diagnosis mission. It should provide a series of questions and some elements of best practices in order to identify improvement axis. Moreover, the tool should focus on capability assessment and be modular enough to be continuously improved and updated with the experience of the consultants. A maturity grid format has been retained to develop the diagnosis tool, as it encompassed these characteristics. Indeed, a maturity grid allows the prediction of the organisation capability to achieve objectives [41], the identification of gaps [42] and improvements [43]. The diagnosis tool has been developed, by drawing inspiration from the work of [42], which explains the main characteristics of maturity grids, how to build and apply them.

5.2 Assessment focus and structure of the tool

Maturity grids have usually a set of dimensions or "*key process areas*" to assess, with a description of performance characteristics with different levels of granularity [42, 44]. The main steps to build a maturity grid are the selection of the key process area and their subheadings. Then, the selection of maturity levels, as well as the respective description of each cell, being at the intersection between a maturity level and a key process area [45]. In this research work, the capability of a manufacturer to obtain an agile NPD is assessed, by focusing on the four agile PAs, previously defined in section 4.3 (Table 2). To build the tool, the set of relevant questions associated to each agile PA has been listed. Then, agile practices have been identified from these questions. Finally, only one or two questions have been kept by agile PA, with the associated optimal answer.

Agile PAs (key process areas)	Agile practices (usually called subheadings)
Multiple Valuations Management (MV)	MV1. Business model definition and use MV2. Valuable results portfolio management MV3. Valuation decision process management
Uncertainty Management (U)	U1. Change identification U2. Impact analysis on NPD U3. Definition and implementation of the action plan
Knowledge and learning management (K)	K1. New knowledge absorption and skills reconfiguration K2. Learning management on several projects K3. Continuous learning
Collaboration Management (C)	C1. Requirement management C2. Multidisciplinary collaboration C3. Suppliers collaboration

Table 2: The four agile PAs and associated agile practices.

The four maturity levels of this tool have been defined (Table 3), by embedding the three capabilities of an agile NPD previously identified: selection, anticipation and reaction.

Level 1 **"Rigid"**	Level 2: "**Frontal Responsive**"	Level 3 **"Planed Responsive**"	Level 4 **"Agile"**
• No selection of innovation project for internal valuation • No anticipation of change and no reaction • NPD project objectives not achieved	• Selection of some project for internal valuation • No anticipation. Late reaction • NPD performance objectives partially achieved	• Selection of internal valuation when the impact can be managed • Anticipation and reaction, but no quick recovery from change • NPD performance objectives achieved but with some disturbance	• Selection of internal valuation, external valuation and report of internal valuation • Anticipation and reaction • NPD performance objectives achieved without disturbance

Table 3: The four levels of maturity retained for the maturity grid

To each agile PA is associated a set of three grids, leading up to 12 maturity grids to assess the four agile PAs, The format of each grid is adapted from the template proposed in the work of [11], with a series of questions for discussion, a description of the practices associated to each level of maturity (one to four) and a description of the ideal situation. As an illustration of the retained format, the Figure 5 presents the grid of the practice Business Model definition and use, from the multiple valuations management agile PA.

V1 - Business Model definition and use				
Definition: "Business model collaboratively defined and used a a filter to make valuation decisions"	**Ideally** **The business model definition is the result of a collaborative thinking from the different employees of the firm (both technical and strategical profiles). Each employee knows how to translate the business model at an operational level, to rely on it during the decision process. The business model is used as a filter to know what to value internally (notably by performing an impact analysis of the selected concept) and to value externally.**			
Discussion questions	**Level 1**	**Level 2**	**Level 3**	**Level 4**
V1.1.Does the definition of your BM is collaboratively defined (strategical and techical profile) and known by your employees?	No definition of the business model	Collaboratively defined but known by employees	Strategically defined and known by employees	Collaboratively defined and known by employees
V1.2 To which extent do you use the business model as a filter to make multiple valuation decision?	Not taken into account	Business model used for internal valuation only	Business model used for valuation but without impact analysis of the selected concept on the existing NPD organisation	Business model used for valuation coupled with an impact analysis of the selected concept on the existing NPD organisation
V1.3. When you design a new solution, do you systematically adapt the associated business model and communicate the change to the employee?	No questioning of the business model definition	Adaptation of the business model but late communication of the change to stakeholders	Adaptation of the existing business model with communication but long recovery from this change	Adaptation of the existing business model and early communication to face and recover quickly from this change

Figure 5: Valuation decision process grid of the agile PA: Multiple Valuations Management

This tool should support the practice of consultants, by providing an analysis framework to guide face-to-face interviews with a client. To perform the diagnosis, we recommand to perform individual interviews with representatives of key skills involved in the NPD process (i.e. risk manager, product project manager, NPD process manager, information system manager, knowledge manager…etc). During these interviews, the consultant can use the different grids, by asking questions and grading the practices with a maturity level (1 to 4) according to the answer of the client. The objective is then to analyse the results of the different interviews and identify the strengths and improvement area of the NPD process for each agile practice area. We recommand to make a collective feedback to the group of interviewed persons. This feedback time should be conceived as a team exercice. It should promote multidisciplinary exchanges and awareness of agility issues of the client. It should also allow a collective identification of an action plan to improve the NPD process agility.

6. CONCLUSION AND PERSPECTIVES

This paper is in line with existing research works on innovative design and aims at understanding how to facilitate the valuation of results from exploration projects within a NPD project. It has two main contributions. The first one is the proposition of the conceptual framework of *NPD agility*, in order to facilitate the valuation at the NPD level of results from the function (I) without to disturb the performance objective of the NPD. The second one is the presentation of the structure and objective of a diagnosis tool, based on the paradigm of NPD agility, to assess the capability to be agile and absorb innovations at the NPD level. From the literature on innovative design and open innovation, the characteristic of an efficient NPD process have been identified. It should be able to successfully absorb results from (I) oriented activities, be able to optimize the commercial valuation and be agile to cope with change and uncertainty. From that identification, the concept of NPD agility has been developed, as well as a maturity grid based on this concept. The result is the identification of three capabilities to have and four practices area to master to obtain an agile NPD process: multiple valuations management, uncertainty management, knowledge management and collaboration management. After specifying the needs of the consultants of our partner, these four agile PAs have been used as the framework of a diagnosis tool. This tool is composed of twelve maturity grids, with three maturity grids by agile PA. The next step will be the application of this prototype tool in industrial settings, to verify the usability and utility for consultants using it.

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