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SUPPORTING NEED SEEKER INNOVATION: THE RADICAL INNOVATION DESIGN METHODOLOGY

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Abstract
Driven by a utilitarian perspective, the question of useful innovation and creating essential values is set. Such innovation should lead to cover or alleviate significant pains which are not satisfactorily covered by existing solutions. Radical Innovation Design (RID) is a structured methodology for exploring the front end of useful innovation in need seeker mode. In this paper, the fundaments of RID are presented for the first time and illustrated on the search for radical innovations for a handitennis wheelchair of a champion. The most original part of RID stands in the problem setting stage which starts with re-expressing the ideal need to set the issue playground - for usefully thinking in the box - in which two worlds are populated: the world of problems or pain points and the world of usage scenarios. The determination of value buckets has been automated by matrix representations of dependencies between problems, usage scenarios and existing solutions. A subset of opportunistic value buckets are further addressed in the problem solving stage for focused ideation, to ensure performing "blue ocean" innovations, i.e. in not yet explored usage and problem situations.

Keywords: Innovation, essential value, user pains, usage situations, innovation methodology

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1 EXPLORING THE FRONT END OF USEFUL INNOVATION

According to Jeremy Bentham (2009), the British philosopher of the 18th and 19th centuries, maximizing the overall well-being of sentient beings is equivalent to minimizing their pains and thus creating values for them (2009). Inspired by this statement and in the context of designing a product for a market, it is not trivial to determine which useful design solution is adequate to cover or alleviate existing pains of some market segments which are not satisfactorily covered by existing solutions.

The *utilitarianism* theory (Bentham, 2009) defines "*usefulness*" of a solution as its ability to improve the well-being of humans and to diminish their *pains* in different situations. There is no accurate definition of a useful solution. From the author's viewpoint it is something related to *essential* needs or essentials values as those described in the lowest layouts of Maslow pyramid – like eating, drinking, health... – or at a higher level but linked with a significant suffering – like mood disorder such as depression or bipolarity, loneliness, difficulty of living in society -. The notion of *essential* value has also been defined in the context of *Bottom of Pyramid* (BoP) by Prahalad (2005; 2002) who tries to reconcile the billions people living in extreme poverty with the delivering of essential products and services. But even, in developed countries, essential needs are numerous and badly or partially addressed. For directly addressing them, companies or designers should better adopt the so-called *Need Seeker* innovation strategy first introduced by Boston Consulting Group. Indeed, Boston Consulting Group has stipulated that firms follow at least one of three innovation strategies: *Need Seeker, Market Reader, Technology Driver*, depending on the focus put on the customer, the market or the technology. Booz and Company (see (Ohtonen, 2014)) defines them as follow:

- Need Seekers, such as Apple (US), Dyson (UK) and Oxylane (France), make a point of engaging customers directly to generate new ideas. They develop new products and services based on superior end-user understanding.
- Market Readers, such as Hyundai, Caterpillar and Loréal, use a variety of means to generate ideas by closely monitoring their markets, customers, and competitors, focusing largely on creating value through incremental innovations.
- Technology Drivers, such as Google and Bosch, depend heavily on their internal technological capabilities to develop new products and services.

After a recent Booz and Company study (see (Ohtonen, 2014)), following a Need Seekers strategy offers the greatest potential for superior performance in the long term. These companies are effective at both the ideation and conversion stages of innovation and they consistently outperform financially.

Being predominantly Need Seeker is not easy; it can be made by two ways:

- Using lead-users (see (von Hippel *et al.*, 2011)), their insightful refreshing ideas and dreams and their testimonies on usage and pain points. This is the case of Oxylane company in France – sport equipment and outdoor-.
- Having a visionary leader like Steve Jobs (Apple) or James Dyson (Dyson), the company growth and the number of product references being limited by the imagination and control power of a single brain.

There is thus a need for a methodology investigating growth territories or strategic value niches for generating disruptive innovations beyond immediate customer expectations and in a cooperative and multidisciplinary manner and a secure way. After Motte et al (2011), it can be done thanks to an adapted organization and special methodologies and processes. In terms of organization, Millier (1999) insists on the necessity to manage antagonism and balance between exploration and exploitation of new idea territories. Christensen (2003, 2011) say with different words that for succeeding disruptive innovations, companies must not put too much emphasis on customers' current needs, and work on how to adopt new technologies or business models that will meet customers' unstated or future needs. In terms of methodology, Christensen (2003, 2011) proposes the jobs-to-be-done concept and defines it as *"a framework which is a tool for evaluating the circumstances that arise in customers' lives. Customers rarely make buying decisions around what the "average" customer in their category may do — but they often buy things because they find themselves with a problem that they need to solve. With an understanding of the "job" for which customers find themselves "hiring" a product or service, companies can more accurately develop and market products well-tailored to what customers are already trying to do."* For this and other works on innovations, Clayton Christensen has been designated as the most influential management thinker in the world (see The Washington Post paper (McGregor, 2013)). Ulwick (Ulwick, 2005) has extended it in a principle of design-outcomes segmentation instead of a conventional a priori customer segmentation.

Inspired by these ideas, Yannou et al (2009) and He et al (2012) have adapted this user-centered perspective to model the market demand model in a design engineering platform through the representation of usage contexts. It has been called the Usage Context Based Design (UCBD). Next, Yannou et al (2013b) have proposed the *Design by Usage Coverage Simulation* principle for evaluating with coverage indicators how much a new product or product family (Wang *et al.*, 2013) may cover in a dominant way a number of usage scenarios characteristics of the targeted user/consumer group. Proceeding that way, they show that innovative designs may be proved to be dominant –i.e. ranked first because performing better- on a subspace of usage situations; these designs are then naturally in a "blue ocean" (after Kim and Mauborgne (2005)) which is almost a guarantee of success when launching an innovative offer.

2 INTRODUCING THE RADICAL INNOVATION DESIGN METHODOLOGY

The author has been influenced by a number of previously mentioned ideas and approaches. *Radical Innovation Design* (RID) methodology is a structured process for exploring the front end of innovation in need seeker mode. RID has been successfully applied on about 30 innovation projects since 5 years along with 20 companies. In this paper, the fundaments of RID methodology are presented for the first time and illustrated on the search for radical innovations for a handitennis wheelchair of a champion. This example has been chosen since it is not subject to non disclosure agreement.

Albert Einstein said *"If I had an hour to solve a problem and my life depended on the solution, I would spend the first 55 minutes determining the proper question to ask, for once I know the proper question, I could solve the problem in less than five minutes."* Following that maxim, The author (Yannou *et al.*, 2013a) structured the RID process in two macro stages of problem setting (see Figure 1) and problem solving (see Figure 2). Radical Innovation Design® is a methodology because it is based on 1) structuring principles 2) a stage-and-gate process (see also (Cooper, 1983; Cooper, 1990; Cooper, 2001)) very detailed in the early problem setting like Cooper suggested in (1988), 3) a list of 9 expected templated deliverables along the process, 4) two computerized tools such as the DSM-Value-Bucket tool described in the present paper and the UIPC-monitor tool (Yannou *et al.*, 2015a), 5) already several successes in company contexts since after 30 RID innovation projects with about 20 companies, several innovations are being to be launched on the market.

The goal of RID methodology is to maximize the potential value creation inside a legitimate design perimeter called ideal need. RID is a systematic exploration/exploitation process of value creation opportunities through a series of stages making the inventory of usage situations (or scenarios) and pain points (or problems) users may live. RID uses at the same time 3 perspectives:

- The perspective of an economist: design is considered as a probabilistic theory of value creation,
- The perspective of an industrial designer: design starts with the know-how for observing users – their usages, pain points, needs…- and inventing new usages,
- The perspective of a design engineer: knowing how to measure utilities to create, gather evidences and bring serious proofs of concept using the most adequate technologies.

The author in (Yannou *et al.*, 2013a) showed that the more the design team completes the successive RID deliverables, especially in problem setting, the most likely the innovation outcome is to be successfully launched on the market. To that aim, it is proposed to monitor innovation process with four proofs to consolidate along it: Utility, Innovation, Profitability and Concept, this is the UIPC model described in (Yannou *et al.*, 2015a; Yannou *et al.*, 2013c).

The problem setting starts with the reframing of the *initial idea* submitted by the innovation project initiator into an *ideal need*. Let us start with the example of need seeker innovation on the wheelchair of a handitennis champion. It has been the actual innovation project initiated by a 22 year old handicapped female student who is nearly ranked 30th in the world championship ranking and who wants to win in Rio-2016 Paralympic Games. She came with the initial idea of "*to lighten at most her handitennis wheelchair*". Such a goal would have led to a carbon fiber high tech wheelchair. Making lighter the wheelchair is not an objective in itself; it has been reframed into the following ideal need: "*to be performing on every tennis point in every game situation.*" This ideal need is a "box perimeter" inside which investigation must be pursued at its extreme limit. Contrarily to most of people about creativity, the author do not believe that "*thinking outside the box*" is the must, but it is more efficient to "*thinking inside the box, providing the box is large enough and well defined*."

Continuing with RID process, two worlds are investigated concurrently within the *ideal need* perimeter (see Figure 1):

- The world of problems. It consists in inventorying, quantifying and causally ordering the miscellaneous pain points, counter-performances, dissatisfactions, needs, that users may experiment.
- The world of situations. It consists in inventorying, qualifying and sizing the usage situations that users live and in which problems occur with more or less intensity.

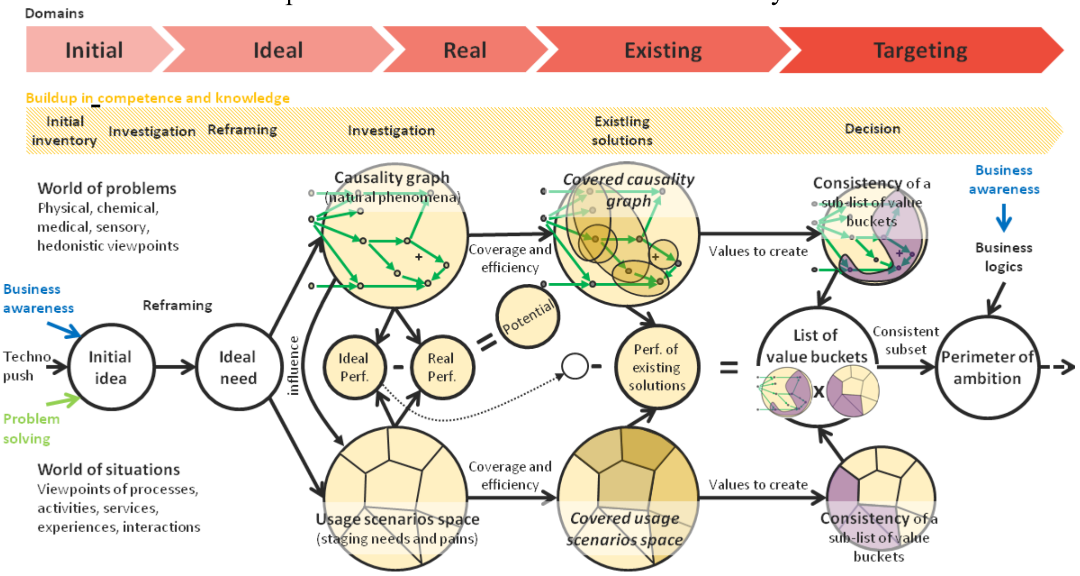

Figure 1. The problem setting macro-stage of Radical Innovation Design® methodology

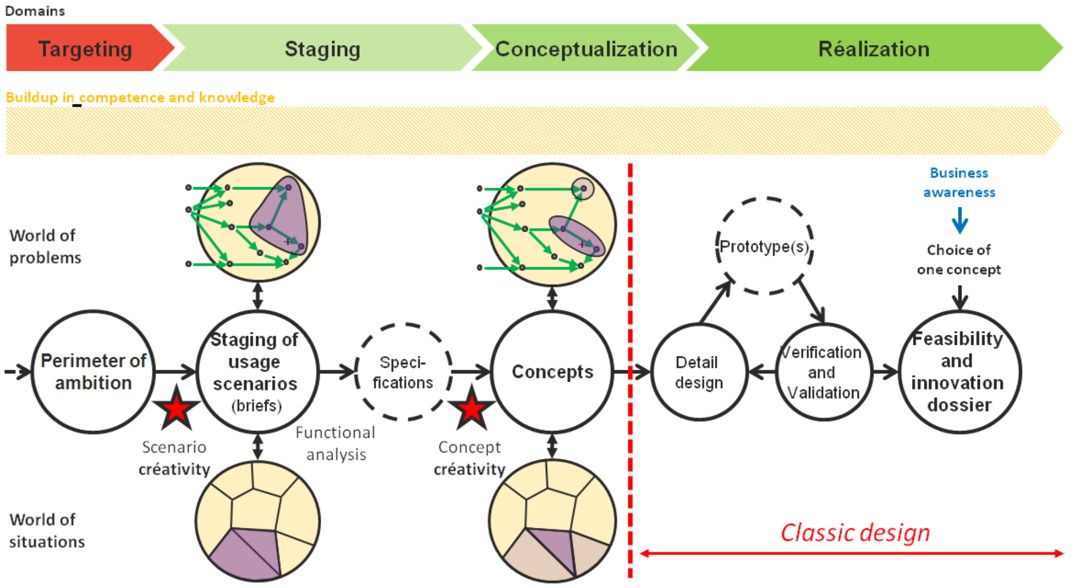

Figure 2. The problem solving macro-stage of Radical Innovation Design® methodology

Defining the *real* world consists in building a *causal graph* (of problems) and a *usage scenarios space* of characteristic usage situations (see Figure 1). Next, as *existing* solutions may partly cover problems in usage situations, a *covered causality graph* and a *covered usage scenario spaces* are derived from the careful analysis of the conditions (usage scenarios) and effectiveness/efficiency of service delivery (problems/pain points more or less relieved). Next, in the final *targeting* stage of problem setting, a list of weighed value buckets are derived as being the combinations of important problems occurring during very characteristic (frequent) usage situations and for which few existing solutions exist or are really effective/efficient. From this list of value buckets, a perimeter of ambition is defined by the project team, including a) a subset of relevant value buckets, b) other (problems x usage-situations) currently covered by existing situations but that consumers consider as "must have", c) these previous choices being compatible between them and with the present offer portfolio and customer segmentation of the company (represented by "business logics" in Figure 1).

3 BUILDING AND COVERING THE CAUSAL GRAPH OF PROBLEMS AND THE USAGE SCENARIOS SPACE FOR THE HANDITENNIS WHEELCHAIR

The determination of value buckets has been partly automated by a matrix representation of dependencies between *problems*, *usage situations* and *existing solutions* and by a computational mechanism leading to the *DSM-Value-Bucket* tool (see also (Yannou *et al.*, 2015b)). This approach and tool may be affiliated to *Dependency Structure Modelling* approaches (Eppinger *et al.*, 2012).
In Figure 3, the causal graph is represented as causal paths leading to *point loss* problem and it is further graphically covered by four existing solutions. Here, some modelling techniques of causal graph representations are borrowed from the system dynamics practice (see for instance (Schaffernicht, 2007)). For simplicity, 4 problems out of 16 are retained, namely: *time loss* (moving), *injury of the racquet hand*, *loss of ball power* and extended *tiredness* during the match.
In Figure 4, a graphical tessellation of typical usage situations during a match is represented. Proximity of two usage situations means a high probability of time precedence (or in other cases, proximity of user types). For simplicity, 4 usage scenarios out of 8 are retained, namely: *serve*, *shot in move*, *ball receiving* and *start moving* to hit ball.
Practically, a pre-screening of problems is made and a first version of the causal graph of problems sketched. Next, the list of typical usage situations is established and for each usage situation an observation protocol is designed and followed to get a deep understanding of the pains/problems possibly occurring in this usage situation, for measuring them (frequency, repeatability, importance, consequences) and carrying out a *root cause analysis*. It goes far beyond the classical *personas method* storyboarding usage situations with weak rationale of the situation representativity and no measurements of pain points. For instance, here, the serve situation has been carefully studied: gestures have been recorded and analyzed, ball speed has been measured as well as serve accuracy, ability to serve aces, double faults rate. In addition, it has been observed that a back and forth translation as well as a rotational twist of the wheelchair occurred during the serve. It is obviously due to the translational freedom of the four wheels and the rotational freedom of the two caster wheels. An additional investigation in root causes led to experiment the gains to block the four wheels during serve (+30% in ball speed) or to only block the rotation of caster wheels (+20% in ball speed).

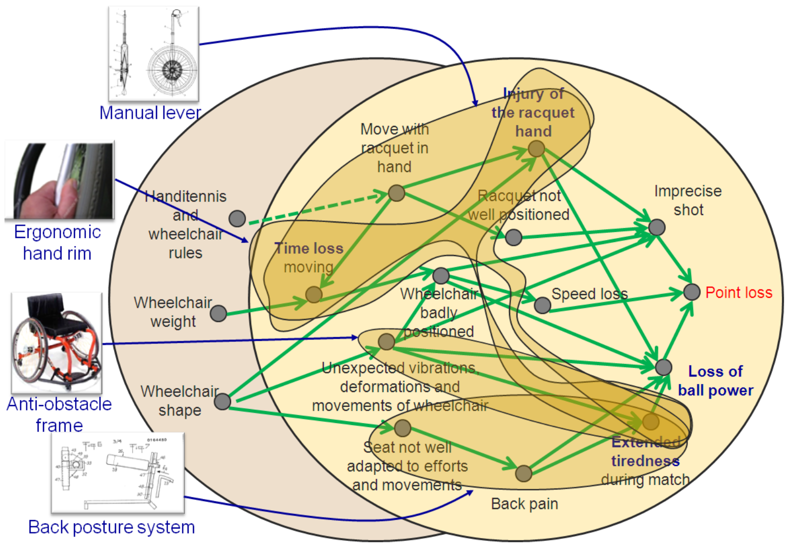

Figure 3. The covered causality graph for the handitennis wheelchair issue (see Figure 1)

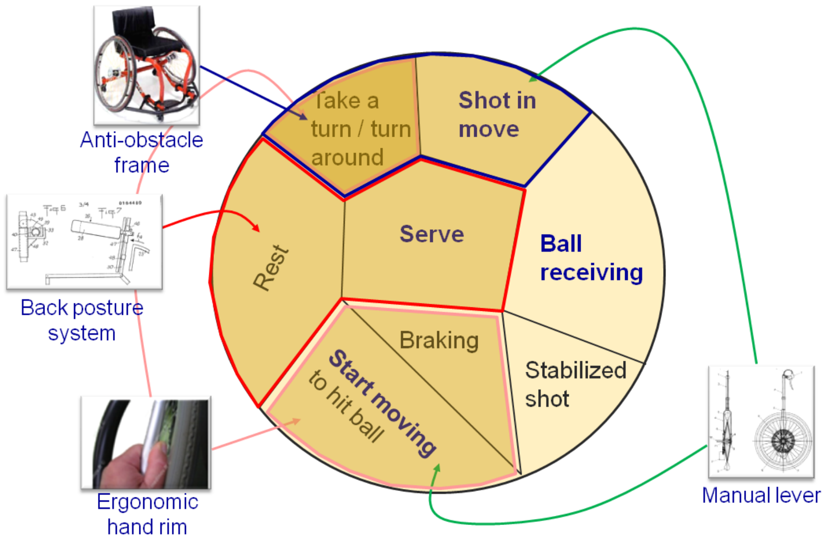

Figure 4. The covered usage scenarios space for the handitennis wheelchair issue (see Figure 1)

4 THE DSM VALUE BUCKET ALGORITHM

The determination of value buckets has been automated by matrix representations of dependencies between problems, usage scenarios and existing solutions (see also (Yannou *et al.*, 2015b)). Three matrices A, B and C are built along the problem setting stage of a RID process described in previous sections. The first matrix A (see Figure 5) expresses which problems occur during usage scenarios, the second matrix B how much existing solutions cover problems and the third matrix C how much existing solutions are useful in usage situations. Combining these three matrices results in a matrix E of value buckets as being the combinations of important problems occurring during characteristic usage situations and for which few existing solutions are useful or efficient.

Matrix A is named the "Ideal performances matrix" and links problems (columns) and usage scenarios (rows) with an intensity scale from 0 to 5 for expressing how much (or often) a problem occurs in a usage scenario. The meaning of the intensity scale is {0=null; 1=weak; 2=moderate; 3=average; 4=important; 5=very important}. For instance (see Figure 5, matrix A):

- The *racket hand injury* mainly occurs when the player *starts moving*, pushing with her hand to propel the wheelchair, grasping the racket and the hand rim at the same time.
- There is an important *power loss* during *serve* due to an uncontrolled twist of the wheelchair.

Matrix B is the "(solutions X problems) matrix" and expresses the relevance of an existing solution for a given problem with the same qualitative scale from *null* (0) to *very important* (5). For instance (see Figure 5, matrix B):

- The *ergonomic hand rim* is very relevant for avoiding *racket hand injury*.
- The *ergonomic hand rim* also partly avoids *time loss*.
- Both the *back posture system* and the *manual lever* are good for relieving the *generalized tiredness*.

Matrix C is the "(usages X solutions" matrix" and expresses the relevance of an existing solution in a given usage scenario with the same qualitative scale from *null* (0) to *very important* (5). For instance (see Figure 5, matrix C):

- The *manual lever* is very efficient during *start moving* situation and moderately during *shot in move*.
- The *back posture system* is efficient during the *serve* situation.

At this stage, an "Intrinsic Value Buckets matrix" D is computed as the subtraction between the "Ideal performances matrix" A expressing importance of problems to solve in usage situations and the matrix multiplication C x B expressing the average relevance of existing solutions in (usage, problem) cases. Of course, this difference is normalized to get each number at both sides of the subtraction comprised between 0 and 1. Moreover, one introduces a "bucket filter" BF, a real number comprised between 0 and 1 and being 0.5 by default, to eliminate the least important (usage, problem) cases, following formula (1).

$$\mathrm{IVB_{ij}} = \mathrm{Max}\left(0, \frac{\mathrm{A_{ij}}}{\mathrm{Max_{kl}(A_{kl})}} - 2 \times BF \times \frac{\mathrm{CB_{ij}}}{\mathrm{Max_{kl}(CB_{kl})}}\right) \quad (1)$$

Finally, the *importance* of problems (relatively to the ideal need) and the *size* of usage scenarios are assessed, again through the 0 to 5 intensity scale (see Figure 5, *size* and *importance* introduced in the surroundings of matrix D). The rationale for weighing problem importance and usage size must be captured. The RID framework encourages keeping the traceability of exploration/exploitation and decision making. For instance, the logic for justifying the problem importance may be:

- Ball power loss and time loss moving should be importantly improved in the champion play.
- Tiredness and hand injury are second order issues for the champion play.

The rationale for justifying the size of usage scenarios may be the scenario frequency (comparing the number of times serving and shooting in move) and of its importance for winning a point (80% of serves in handitennis are winning points).

A last "Normalized value buckets matrix" E is computed to augment intrinsic value buckets with importance of problems and size of usage scenarios, following formula (2).

$$\mathrm{NVB_{ij}} = \mathrm{IVB_{ij}} \times \mathrm{size_i} \times \mathrm{importance_j} \quad (2)$$

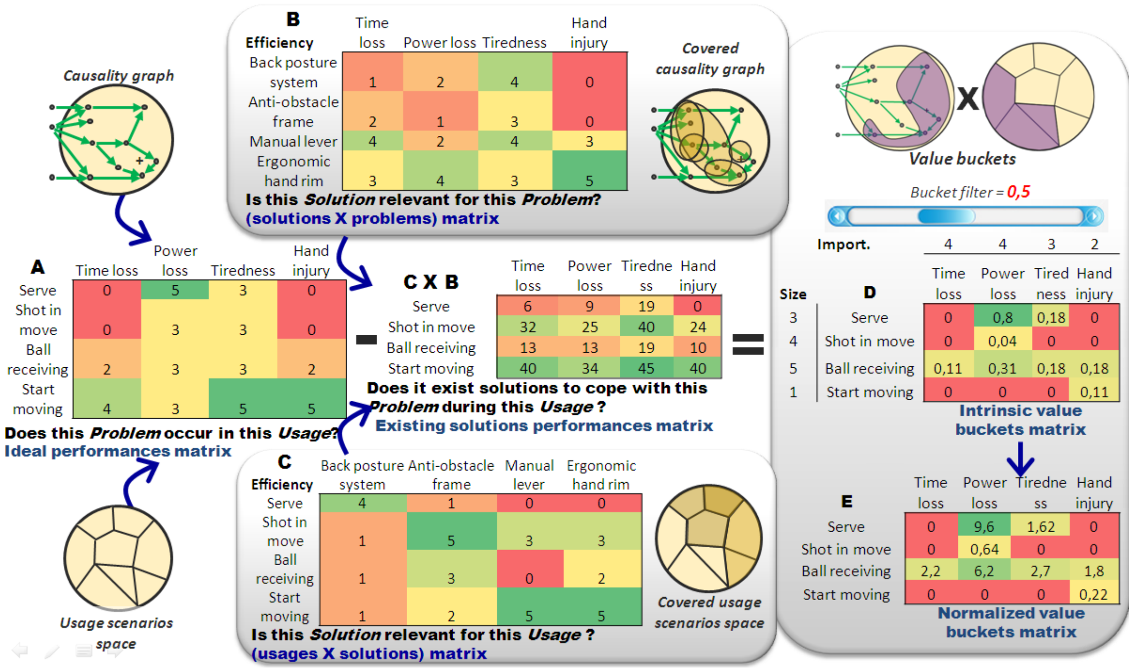

Figure 5. The DSM Value Bucket data streaming and computation mechanics (refer to Figure 1)

Two important value buckets are revealed for the handitennis wheelchair project; their matrix coordinates are (1,2) and (3,2) (see Figure 5). The designer team is asked to verbally interpret them and they come up with these natural justifications:

- Value bucket #1 (1,2): The *loss of power* during *serve* is partly due to the (observed) wheelchair twist.
- Value bucket #2 (3,2): The champion player is late on the position for *receiving the ball*, and consequently she returns the ball with *power loss*; this is due to her right hand grasping the tennis racket and at the same time moving the wheel.

5 VALIDATION AND DISCUSSION

For briefly illustrating the relevance of such fine interpretations of revealed value buckets, the readers are invited to look at the two-stage ideation process starting from the value buckets in Figure 6 and at the fruitful outcomes of this ideation process in Figure 7 (comments of these outcomes are out of the scope of this paper). The DSM value bucket tool (see also (Yannou *et al.*, 2015b)) opens the way of automating the radical usage-driven innovations along with a systematic investigation and representation of problems or pain points and usage scenarios. RID methodology may be somewhat compared to known innovative design methodologies like TRIZ, QFD or axiomatic design and design thinking. Compared to TRIZ, RID uses a causal graph for representing the problem structure whereas comparable substance-fields representations in TRIZ (see (Savransky, 2000)) are used for representing imperfect solutions. In the same manner QFD and axiomatic design may be used to represent the propagation of the voice of the customer into the product components and design parameters, but little is done to characterize the problem opportunities especially in the light of what the other existing solutions use to efficiently perform or “cover”. Finally, RID demonstrates that it exists other ways than the design thinking prototype-and-learn experimental loop, being a more rational manner to investigate need-seeker problems.

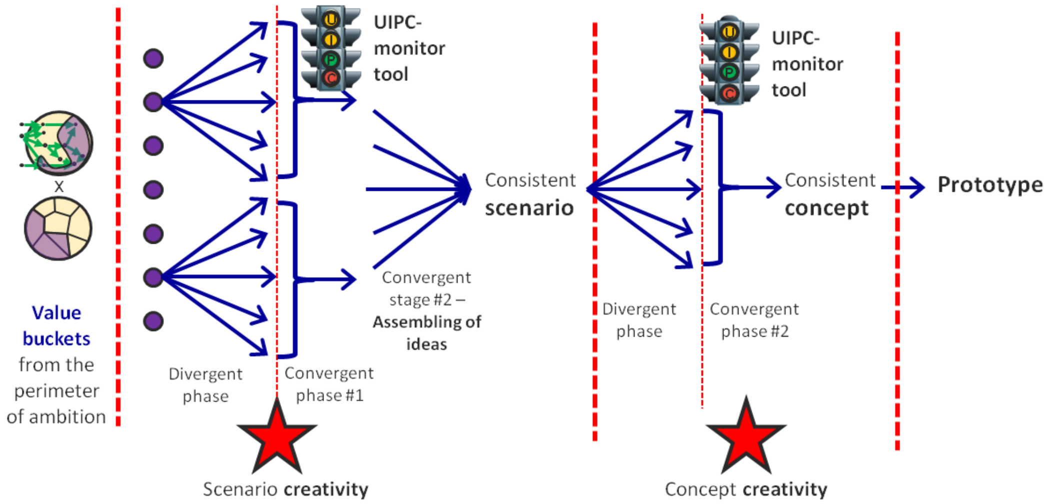

Figure 6. The two-stage ideation process starting from the value buckets included in the perimeter of ambition (refer to Figure 2)

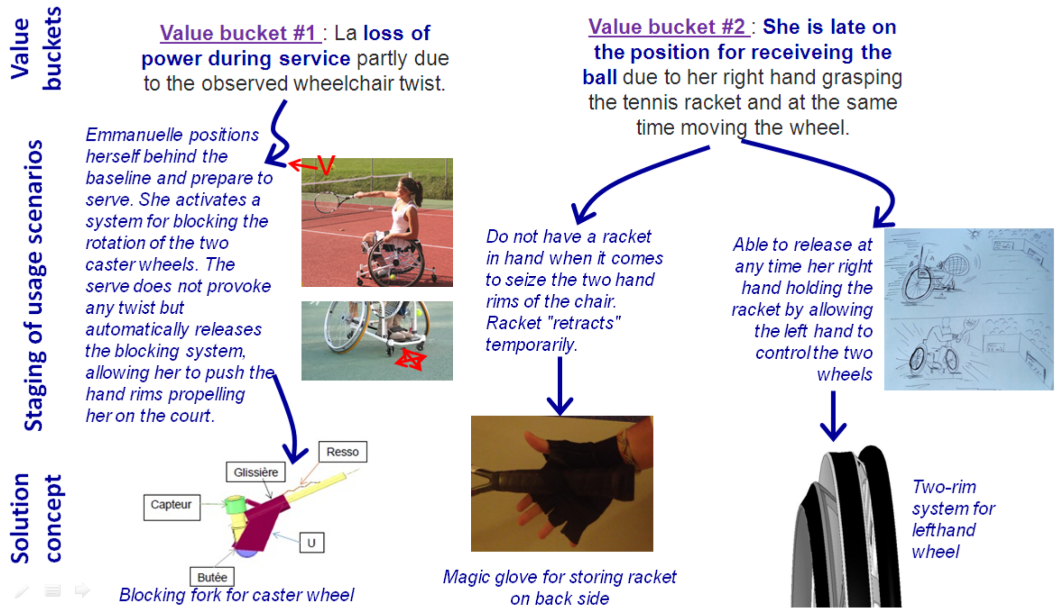

Figure 7. Illustration of the two-stage ideation process (scenario creativity and concept creativity) starting from the two value buckets identified for the handitennis wheelchair

6 CONCLUSIONS

The most original part of RID methodology stands in the problem setting stage which starts with re-expressing the ideal need to set the issue playground – for usefully thinking in the box - in which two worlds are addressed: the world of problems or pain points and the world of situations or usage scenarios. The two spaces – problems and usage scenarios - are populated with real world situations. For this purpose, some modelling techniques as causal graph representations and persona method are used. Then, a first “ideal performances matrix” of the DSM-value-bucket tool (see also (Yannou *et al.*,

2015b)) allows to cross problems with usage scenarios to express in which usage situations people are subject to pains. Next, existing design solutions – commercial solutions or patents - are identified and their coverage of the two spaces is modelled. Here the DSM-value-bucket tool proposes to represent the coverage effectiveness and efficiency of both problems and usage scenarios by two appropriate matrices: the Solution-Problem matrix and the Usage-Solution matrix. Multiplying both matrices allow to come up with the likelihood for the existing solutions to satisfactorily answer to one problem arising during one usage scenario. Subtracting this matrix with the "ideal performances matrix" results in a final "value buckets" matrix highlighting which problem is worthy to be addressed in an innovation project. The last step of the RID problem setting stage is to select a subset of opportunistic value buckets to further address in the problem solving stage, so as to ensure to perform radical innovation on "blue ocean" – i.e. not yet explored – usage and problem situations.
The author has proposed a method for structuring and automating the discovery of value buckets during the front end of need seeker innovations. The interest of need seeker innovations have been revealed by people like Christensen (2003, 2011) and Ulwick (2005) but no one before had implemented these ideas in a design engineering process. The DSM Value Bucket tool was designed two years ago and has already been applied successfully to 14 innovation projects with 10 private companies, plus the "handitennis wheelchair project" presented in this paper. Future works will validate the relevance of the most rated resulting value buckets to the light of launching disruptive products after opinion of lead users.
The RID methodology has been applied along years in many different situations (see Table 1), providing the followed process has been to investigate worlds of users/pains/usage-situations: in companies of different sizes (very small, SMEs or world size companies), in different industrial sectors, in different business situations (BtoB, BtoC, BtoBtoC...), in product or service situations and even when the challenge was to find essential values to create in technology push contexts (despite the apparent contradiction with RID fundaments).

Table 1. Diversity of successful applications of RID methodology in (essential) need seeker mode for 5 companies in 2014

Company	Size	Sector	Business	Innovation model	Product or service
AAA	SME	Automotive marketing	BtoB BtoC	Market pull (Techno push)	Service
BA SYSTEMES	SME	Robotics	BtoB	Techno push	Product
MK SANTÉ	Very small	Healthcare and handicap	BtoB BtoC	Market pull	Product
orange	World	E-healthcare	BtoB BtoC	Market pull (Techno push)	Service
trèves	World	Automotive	BtoBtoC	Market pull	Product

In addition, a similar algorithm, but more sophisticated, for improving the well-being of humans and diminishing their pains in different situations, has been applied following the utilitarianism theory perspective. Indeed, the different deadly falls scenarios of the elderly people have been investigated (see (Bekhradi *et al.*, 2014)) to ensure that new designed products and services are likely to bring essential health, social and economic values. Starting from a disparate literature on elderly falls' issue, the author has first built a usage scenarios space – by Bayesian-like approaches -. Next, the usefulness and the coverage ability of three design solutions have been evaluated by simulation – using expert rules -over a tessellation of usage segments. In addition, a simulator has been developed to assess the potential of non or poorly-covered usage segments to deliver insightful information in order to truly be a need seeker in the front-end of innovation. The Radical Innovation Design process has consequently also been followed here, which tends to show that this reasoning process for usefully innovate is maybe general.

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