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Towards a platform for New Concept Development: when kansei and design-thinking approaches meet

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Abstract

This paper, part of a PhD research, focuses on ways to improve new concept development (NCD) activities. This research is done in collaboration with the Kansei Design (KD) division of Toyota Motor Europe (TME), a team composed of designers and engineers bringing a particular dynamism to research and development activities. The paper presents a new platform for NCD aiming to assist the flow of ideas for the creation of user experience. It integrates kansei methodologies as well as more classical design-thinking approaches and uses as basis the analysis of 13 past NCD projects.

The kansei approach to design pays particular attention to the different senses involved in the user experience as well as values, emotions and symbols perceived and felt. Kansei-based tools have a large scope. They can be used to provide design-guidelines but also at the creation and evaluation phases. They have also revealed themselves complementary to other approaches and in that way improve the quantity and quality of NCD methods available.

These synergies are particularly useful in a context of user experience creation including concepts (function, sensory attributes, values, emotions) and also design strategies.

Keywords: New concept development, design thinking, kansei design, innovation

1. Introduction

After having been centred on the formalisation of processes for new product development, researches are in the last decade also investing the field of its upstream parts: the NCD process. This stage is crucial for the introduction of innovation in new products.
The context of our research is the research activity of the KD division. Over the past 5 years, they investigated several aspect of the user experience through 13 NCD projects. Based on kansei approaches and design researches specific methodologies were created. As other NCD projects described in the literature, they used a lot of time and resources and had no clear framework to be based on. Today there is a need to improve and optimise the flow of ideas but also to better manage the knowledge and know-how acquired.
We will first go through a state of the art. It will help us to formulate research questions and propose hypotheses. Learning from the past researches and setting them again contributions from the literature will help us to validate the hypotheses by proposing a NCD platform.

2. State of the art

2.1. Design thinking and innovation

The term design thinking was first used by Rowe [22] for his description of processes used by designers in their work. Various models of flows of ideas have later been developed through processes and their characteristics and tools such as trend analysis, creativity or concept building were further studied. The scope of design thinking has also been extended to problems from various fields such as IT, Business, Education and Medicine [6]. Design

thinking can be characterised by practices (human-centred approach, thinking by doing, visualizing, combination of divergent and convergent approaches, collaborative work style), cognitive approaches (abductive reasoning, reflective reframing, holistic view and integrative thinking) and a specific mind-set (experimental & explorative, ambiguity tolerant, optimistic and future-oriented) [8]. It is now largely promoted by academics, research communities and consulting agencies and accepted within companies [4]. This tendency can also be observed with the new roles given to design in corporations using various ideation approaches [2]. Previously its activity was centred on a styling advisor function. It is getting more and more integrated in the development process and happens to have now a key role in the creation of the brand image and innovation strategies [3].
By looking at the definition of innovation from Van de Ven [26] ("ideas that have been developed and implemented") it becomes clear that design thinking has key inputs to provide. While defining the scope of design thinking Gero [13] went further. Without opposing the two notions, he made a distinction between "creation" that leads to intellectual property (IP) and "designing" to denote the activity that involves the production of consumable artefacts. He describes "innovation" as being the introduction or uptake of IP into these artefacts (products, processes or markets) meaning that "creation" and "designing" are involved in the innovation activity.

2.2. New product development (NPD) processes

Using the vocabulary introduced by Gero helps to distinguish 2 stages in the process of bringing new ideas to the market: the new concept development (NCD) stage that aims to create IP and the new product development (NPD) stage having as output consumable artefacts (Figure 1).

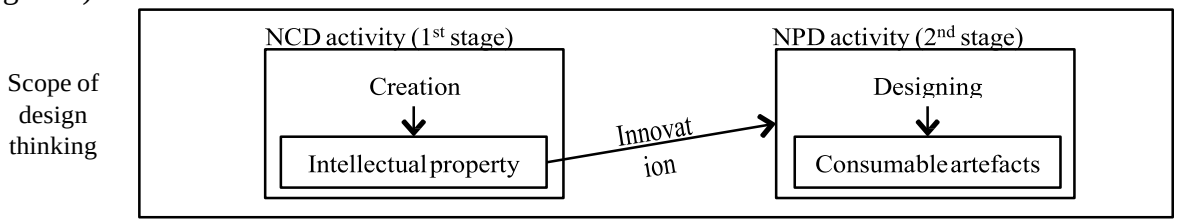

Figure 1: Interactions between Creation, Designing and Innovation (adapted from Gero [13])

Most of the models available in the literature focus either on one stage or the other. The coverage of 6 of them is presented on figure 2. The analysis of the NPD models shows that they have some common characteristics. They all present a prescriptive structured and logical model decomposition of the NPD stage into a pattern of sub-activities logically linked together. Each activity has an expected output that is checked at a gate before allowing the process to continue or requesting iterations. The interactions between the design teams and the outside world (clients, information source, experience,..) are also specified. Advantages can be observed for these NPD process frameworks. The design methods which formalise certain procedures of design and externalise part of the thinking processes permit to free the minds of the design team, make them therefore more ready for intuition and imagination and take the role of tangible mark, which is useful to find a path through wide investigation areas
[5]. Design thinking approach and a tangible structure are presented as being compatible and synergies appear. The major concern, linked to structural organisation of these processes is the stage-to-stage information dependency, which exclude non gate-specific information from decisions at the gates, reduces the project flexibility and brings managers in traps [15] [21].

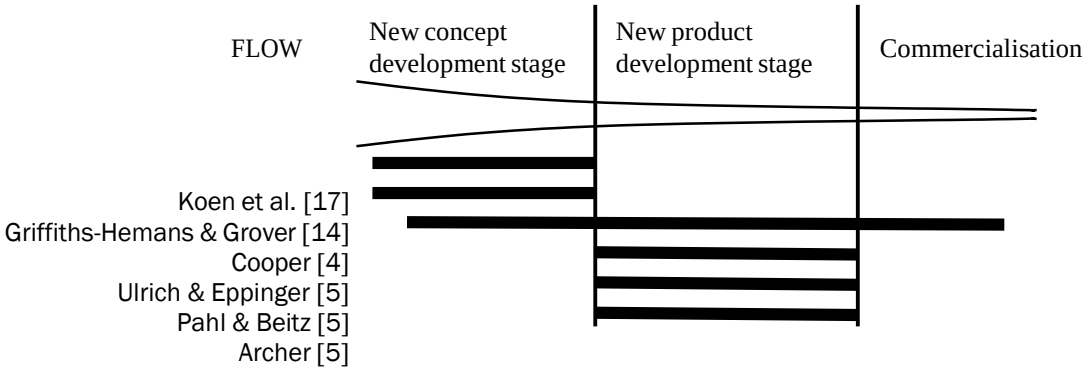

Figure 2: Comparison of 6 innovation processes

2.3. New concept development (NCD) processes

Typically the creation of IP comes prior the development of artefacts using it. Whereas the NPD activities are orderly following a project plan towards a rather certain date of commercialisation, the invention coming from NCD cannot be scheduled. The NCD stage is also called fuzzy front end (FFE) due to its more chaotic evolution, the uncertain outputs and the unpredictable amount funding needed [18]. Because of these fundamental differences, methods and tools from the NPD cannot usually be used for NCD.

The NCD stage can bring major competitive advantages but is at the same time recognized as being the most difficult of the innovation process because of its uncertainly [17]. Different frameworks have been presented in the literature screening the NCD stages. They describe a common language linked with the process and recommend actions. Three of them are represented on Figure 3.

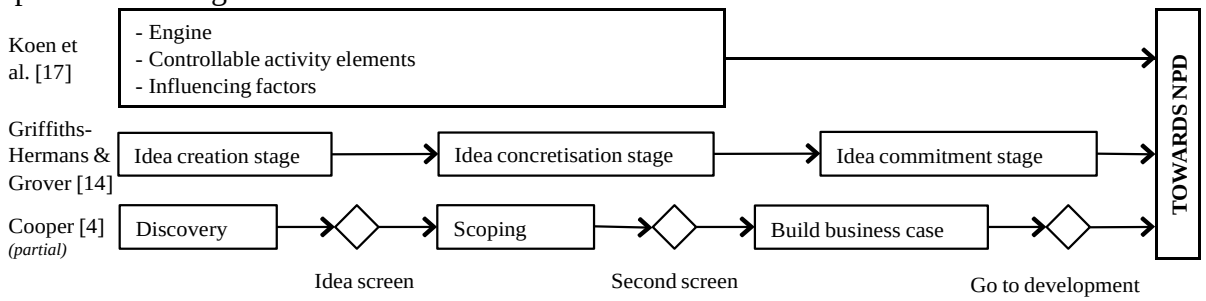

Figure 3: Comparison of 2 front-end processes

The NCD model by Koen et al. [18] distinguishes itself from the others because of its non-sequential structure. It is organised around 3 key parts: the engine (leadership, culture and business strategy), controllable activity elements (opportunity identification, opportunity analysis, idea generation and enrichment, idea selection and concept definition) through which the flow of ideas circulates and iterates and external influencing factors that affect the entire innovation process. The two linear flows models present a formal structure comparable to the NPD ones (see 2.2.). One is prescriptive and describes actions for NCD as well as NPD and commercialisation stages [4] whereas the other one is descriptive and based on survey results [14]. By looking at the 3 models, the major activity of the creation process is the ideation and concept generation, which has also been further studied and described [2].

The above-mentioned processes mainly focus on assembled product development and are not particularly adapted to innovations in domain of services and interactions that are key-elements of the user experience [19]. On figure 2, we observe that only one model overlaps the NCD-NPD junction. This transition, represented by a gate by Cooper, is a difficult step and depends on different parameters such as the engine of the NCD and influencing factors [18].

2.4. NCD tools

The above-mentioned models describe the flows of the NCD process. They contain tools, which will now be further developed. Abductive, inductive and deductive reasoning can be used in these design thinking tools [8]. The three approaches have complementary roles for the creation, designing and innovation activities. Abductive reasoning is the main feature of creative thinking [24]. Its aim is to find working methods and/or artefacts leading to defined aspired values (design brief) through the iteration of proposals and evaluations [8]. The designers' knowledge is very important for abductive reasoning, as it represents the origin of their proposals. The scope of induction and deductive is more tangible and objective since observable facts replace the aspired values. Induction is used because of its ability to discover working principles (or logics) with observations and measurements. The outcome can be, for instance, logics between sensory perception (e.g. shapes, colours) and emotions [11]. Deduction then permits to validate the findings. The process of scientific discovery and justification can be pictured by the combination of inductive and abductive reasoning [6].

Understand the environment of the project is the first step towards an optimal NCD flow [16]. Tools can be user-oriented, literature oriented or context oriented through trend analysis, field observation or benchmark. Then comes the concept building activity of the NCD that can be characterised by a succession of two kinds of steps: divergent that corresponds to the creation of alternatives and convergent that is about evaluation and selection [5]. These iterations combined with the overall decrease of the quantity of ideas permits to narrow down and refine the ideas starting from the biggest possible amount [20]. Interaction with networks, within or outside the company, enhances also the quality of these ideas [1]. Within 3 steps mentioned (understand, create and evaluate) at least 2 categories of methodologies can be distinguished. They both combine the three reasoning approaches but use them in different proportions:

- The first category is orientated towards abductive reasoning. Its tools lead to propositions based on experience and subjective observations. The category includes understanding tools (e.g. IDEO methods cards "learn", "look" and "ask"), creation tools (brainstorming, synectics procedures, prototyping, scenarios, role-playing [16][25]) and evaluation tools (e.g. evaluation by an expert committee).
- The second category uses inductive reasoning as key input and contains tools based on kansei methodologies. Initially, they were only used for the evaluation step [23] but now they bring objective sets of logics and create concepts to the three steps [25][12]. These outputs are made possible through deduction from observation of participants, physiological measurements and/or questionnaires. For example, kansei tools permit to get to understand users through a sensory and emotional identity territory related to a design brief [11] or to create artefacts leading to creativity logics in relation to the designers' different cultures [12].

3. Research question & hypotheses

From what we could see in the state of the art, the NCD literature is lately expanding and models and tools are now available. Nevertheless they do not integrate explicitly the use of kansei approaches. As they have been tested in such conditions during past projects but not summarised nor formalised in a model yet. The present paper will answer the following research question. How to formulate a NCD model integrating explicitly kansei approaches?

The sub-questions are the coming after ones. How to visualise the past NCD projects and analyse their flows? What does the kansei approaches bring to the existing processes and tools?

H1: The existing Kansei Design NCD process flow can be formalised and optimised.

H2: The NCD can take advantage of abductive but also inductive reasoning in its methodologies.

4. Analyse of past projects

4.1. Introduction

As multiple case studies approach is more likely to yield an accurate and generally applicable theory than a single-case study [7], we decided to analyse 13 pasts NCD studies done in the past 5 years within the KD division. We centred our focus on the different tools used, some of the characteristics of the methodology and of the outputs. The aim is to inventory the capabilities, the strengths and weaknesses of the process and to formalize a framework that, as mentioned in the state of the art, will help to smoothen the process flow. On table 1, 13 pasts NCD projects (P) held over the past 5 years are summarised in terms of tools, methodologies and outputs. The data were gathered through interviews with project managers and analysis of reports. The original table includes more details and description but cannot be displayed for confidentiality reasons.

Table 1: Past projects analysis (Used, Partially Used, Not Used)

	Tools								Flow			Outputs					
	UU – Understand Users	UL - Understand Literature	UC - Understand, Context	CA - Create, Abductive	CI - Create, Inductive	EE- Evaluate, Experts	EC - Evaluate, Conscious	EU - Evaluation, Unconscious	FI – Flow, Iteration	FE – Flow, External	FC – Flow, Cross-divisional	OS – Outputs, Strategy or logic	OC – Outputs, Concept	OP – Outputs, Prototype	ON - Outputs re-used in the NCD	OD - Output used in development	OT - Output tools re-used
P1	■	■	■	■	■	■			▒	■	■	■	■	■	▒	■	■
P2		■	■	■		■			■		▒	▒	■		▒	■	
P3			■	■			■			▒		■					■
P4	▒	■	■	■	■		■		■			■			▒	▒	■
P5	▒	■	■		■		■	■		▒	▒	■			▒	■	▒
P6	▒	■	■	■	■		■		■	▒	▒	■	■	■	■	▒	■
P7	■	■	■	■		■			■	■	▒		■	■	■		■
P8	▒	■	■	■	■	■	■		■		▒	■	■		▒		
P9	■		■	■		■				■			■		■		▒
P10	■	■	■	■		■			■	■			■	■	■		■
P11	■	■	■	■	■		■				▒	■			■		■
P12		▒	■	■		■	■		■	■		■	■	■	■	■	
P13	■	▒	■	■		■			■	■		▒	■	▒	■		

4.2. Categories descriptions

On table 1, the observations about the processes were ranked according to 3 categories: the tools used, the description of the flow of the project and characteristics of the project's outputs. The tools are divided into the "understand", "create" and "evaluate" sub-categories.

The "understand" tools can either focus on the potential future users through direct contact through observation, questions (such as kansei engineering approaches) or "try it yourself" tools (UU). Understanding the scope of a project can also be done by literature research (UL) and context researches encompassing trend analysis, changes in the regulations, benchmark or technology research (UC). As described in the state of the art, the generation tools can be either abductive focused (CA) or inductive focused (CI). The CA tools identified in the processes include brainstorming, bodystorming, sketches, multisensory design and scenario building. The CI tools are much more specific to KD. As example we will present the "Kansei Lab" tool. It compares for a specific brief the creation process and design of the participants that use as input previously studied multi-sensory stimuli from a common database. The outputs of CI tools are therefore not only design proposals but also stimuli association logics.

This database permits to analyse more in detail the influence of participants' persona information [11]. The evaluation tools used can be classified in 3 categories. The first is an evaluation by an expert panel having knowledge and experience in the investigated field (EE). The two others are focus groups-based tools that were deepened using kansei engineering approach for measurement of values and emotions. They capture either conscious data using forms and software (EC) or unconscious data through physiological measurements (EU).
In order to get information about the flow of the projects, we marked on table 1 if the process was iterative (FI), if it involved cross-divisional activities (FC) or contributions from external entities (FE). Concerning the outputs, we noted their nature: strategies or logics (OS), concepts (OC) or concepts integrated in prototypes (OP). We also noted down if the outputs were re-used in another NCD project (ON), in a development project (OD) and if the tools created were re-used (OT).

4.3. Learning from the past projects and the literature

By looking at the tools used in the projects, the first element that we can notice is the intensive use of kansei approaches. They are bringing new insights to understand users (UU), new creativity sources (CI) without being restrictive [12] and alternative evaluation methods (EC, EU). Kansei approaches are always used in addition to abductive design methods and more classical understanding tools. They only can replace evaluations by experts. This shows the great complementarity of the abductive approaches (described in the state of the art) and kansei tools for the creation of IP. It adds also the latter mentioned tools in the scope of design thinking as they contribute to encourage the practices, cognitive approaches and specific mind-set (see also section 2.1.). The lack of projects using unconscious measurements is due to the complexity and length of the analysis part. Nevertheless these tools bring more precise information and might be a good way to get more insights in the future. During the interviews, a positive feedback was given to the process flows containing iteration, internal and external collaborations. They are in fact major feature elements of NCD
[1][16]. They provide to the divergent-convergent structure more qualitative inputs and an idea refinement process. They should also be promoted in the future. As explained in the introduction, the IP created includes concepts but also logics and strategies. The framework will therefore have to adapt to different context and promote the new role of design thinking in the corporation. In order to increase the transfer to development specific care should also be given to the communication of the potential innovations. Only few hints about the crucial step are present in the literature as processes often end or begin at this junction (Figure 2). This is also due to the innovation culture that is specific to each corporation [18]. Among the 13 projects only few prototypes were created. Tangible representations of the IP created helped to communicate the ideas. This is especially true in a multicultural environment [12]. In the model, communication and awareness-raising activities should therefore be emphasised, as they are a must for the take over of the creations in the NPD process.

5. Towards a model

In order to optimise the flow of ideas we took the party to formulate a NCD framework. First of all, this formalisation will permit to centre the team's activity on the creation process and not on the creation of the process itself [5]. Some other improvements are also possible by analysing the weaknesses we identified in the past projects and the hints we could get from the literature. The framework represents the flow of intellectual property (IP) creation and the innovation processes using four steps: "find the ideas scope", "organise ideas", "conceptualise ideas" and "integrate ideas" (Figure 4). The two first steps aim to understand and cartography a specific area. They cover the difficult steps that aim to find valid ideas to investigate, to create of a brief and to document the field explored. The third step describes the actual

creation of IP through iteration of creation and evaluation phases (abductive and inductive). The IP created can be concepts representing functions, values, emotions through artefacts and scenarios and also strategies presenting a larger picture of concepts in a context, the global organisation and the interactions that occurs. Finally, the forth step represents the process of innovation described by Gero [13]: the uptake of the IP created in the designing development process. It represents the transition between the NCD and the NPD processes.

These steps are all defined by their aim, the tools they use and the outputs they involve. For each step, iterations occur in a divergent-convergent flow. The iterations in the process flow continue in each step until the outputs provided get the approval from the project's managing committee. The different outputs created should logically be re-used in the later project's steps but, as shown on figure 4, the know-how and knowledge created is also meant to serve for other projects. The know-how includes specific abductive tools (such as the Mood-boxes [11]) or kansei methodologies (such as the kansei lab [11]). The knowledge is about facts and logics that govern interactions between artefacts such as for instance the differences observed in perception and creativity between Japanese and European [12]. Concerning the hypotheses, H1 is validated because the model is now formulated (Figure 4). The methodologies used in it cover abductive and inductive reasoning which also validates H2.

After having been formalised, the platform also has been used. It was first tested on four of the past projects, in order to identify if it covers all the activities. It also pointed out how these processes could have been improved. The platform is now used in new NCD projects for real scale tests and refinements. Future publications will analyse these activities.

Process flow	**FIND THE IDEAS SCOPE**	**ORGANISE IDEAS**	**CONCEPTUALISE IDEAS**	**INTEGRATE IDEAS**
Aim	- Understand a field - Be a trend setter - Find inspiration	- Refine understanding and explain - Define the playground for the next stages	- Create intellectual property - Test, analyse and refine ideas	- Transfer intellectual property into innovation
Tools created and used	- Fair & shows analysis (UU,UC) - Field research (UU, UC) - Design research & management literature networking & analysis (UL)	- Political, economical, environmental, social and technology research (UC, UL) - Kansei studies (UU) - Benchmark (UC) - Collaborations (FE, FC)	- Abductive and inductive creation tools (CA, CI) - Inductive evaluation tools (EC, EU) - Expert evaluation committee (EE) - Collaborations (FE, FC)	- Communication tools - Prototyping (OP) - Transfer methodologies - Training - Collaborations (FC)
Outputs for the project	- Trend reports - Defined problematic/scope	- Brief (including user, literature and context information)	- Concepts (OC) - Strategies (OP)	- Communication friendly material about concepts & strategies - Knowledge about development possibilities (technologies, process)
Increase of the know-how: New tools tested, refinement of the existing ones (OT)				
Increase knowledge about "logics": users (e.g. sensory perception, personal characteristics), context (e.g. trends, evolutions) and literature (ON, OD)				

Figure 4: NCD ideas flow platform

6. Conclusion

The paper presents a new approach towards NCD. After defining key vocabulary of the field we discussed models from the literature and the process flows from 13 past studies in order to propose the first version of a NCD platform. It integrates classical NCD tools and more specific kansei approaches in a formalised and optimised framework. The platform structures the KD activities during the NCD process and gives a new playground to the design team. It also has the advantage to facilitate the planning and the follow-up of new projects for which new frameworks had previously been created each time. As KD's field of activity is relatively wide, it might even be used in other business environments.

By formalising a framework, this paper also opens future researches activities. As the platform will be used as basis for new NCD projects, it will allow us to refine it and better define the flow, tools and outputs. It also gives a macro-view and a frame to our future research on methodologies and strategies composed of abductive and inductive reasoning.

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