

A Method for User Centering Systematic Product Development Aimed at Industrial Design Students

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Abstract

Instead of limiting the introduction and stimulus for new concept creation to lists of specifications, industrial design students seem to prefer to be encouraged by ideas in context. A new method that specifically tackles human activity to foster the creation of user centered concepts of new products was developed and is presented in this article. This approach supports to push the limits of creativity to get passed existing concepts. This article stresses important aspects of established literature about the process of developing products, highlighting how the requirements of the specification are encouraged as a first step in creating new concepts. The theory about activity, developed by Leontiev and Vygotsky, can fundamentally be used to the benefit of many examples of human activity. Systematic design procedures are also used in the method presented to evaluate and improve the initial concept drafts and guide their development.

Key words

study of human activity, design theory, science of design; industrial design, person-artifact interaction

Introduction

This contribution springs from the author's research experience, involving activity theory, but also from teaching experience, in what concerns product development methods to both engineering and industrial design students. Design studies portray a strong component of visual Arts, but, especially in what concerns Industrial Design, a technological component must be strongly emphasised in education to achieve a 'well rounded' graduate. These two streams need to be balanced, in order to promote adequate education. This problem may be traced back to an issue Michl (2002) tackled when most eloquently stating that "the notion of design is still grafted on to a romantic notion of creativity *ex nihilo* rather than to a problem-oriented concept of creativity". Dealing with this dichotomy in industrial design education necessitates bringing together 'hard' engineering design approaches to design with 'soft' creativity stimulation approaches, in line with Campbell et al., (2003) futuristic view on the, so called, 'hybrid' designer (an industrial designer who is able to perform some of the engineering design tasks).

In what concerns industrial design activities, developments relating to awareness of people's experience prove that

design and user research methods are evolving (2003). As a result of the aforementioned concerns and in line with these trends, a method based on activity theory, a theory founded by Leontiev that was based on Vygotsky's cultural-historical psychology, is used in class to explore contexts of use and thus generate innovative product concepts. The generated concepts often stand in manifest radical rupture with existing solutions.

A set of aims has guided the formulation of this paper. On the one hand, it is intended in this paper to explain the educational context that fostered the development of the concept generation method. On the other, the paper seeks to present both the product development process and activity theory and their proposed convergence for the purpose of concept generation. The following sections provide the elements from product development theory and from activity theory that form the building blocks for the method, or approach, depending on the perspective, that is presented in the last part of the paper.

Specification of requirements

This section provides an overview of some of the most important theories and methods of product development, and that make up the basis for teaching in this field. Product development is part of any company's industrial innovation process (Roozenburg and Eekels 1995). Industrial innovation includes all activities preceding the launch of a new product into the marketplace, such as basic and applied research, design and development, market research, production, distribution and sales. Product development encompasses two major phases: product planning and strict development (Roozenburg and Eekels 1995). During product planning the company willing to place new products in the market identifies in explicit terms what it wants to achieve (in a requirements list specification). With this in mind, the idea finding commences, yielding the generation of one or more promising ideas for a new product. During the strict development phase, the plans for product, production and sales are developed.

Pahl and Beitz (1988, 1996) developed another well accepted method of product development, consisting of four phases: product planning and task clarification; conceptual design; embodiment design, and detail design. Under the label Design for X, a wide collection of specific design guidelines are also contemplated. Each design

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guideline addresses a particular issue that is caused by, or affects, the characteristics of a product. Pahl and Beitz (1996) consider several design for X, or design for properties, examples, such as design for aesthetics, design against corrosion damage, design to cost, design for ergonomics, design for minimum risk, and, design to standards.

In line with Pahl and Beitz, Hubka and Eder (1992), systematically examine the basic goals, general principles, and methods of engineering science and specify product development phases and respective outcomes as follows: elaborate and clarify the assigned task (output – the design specification); establish the function structure (output – the function structure); establish the organ structure (output – the concept); establish the component structure (output – the layout); and, establish component structure in more detailed level (output – representation and description of technical system).

Within the engineering design methodology mentioned, Hubka and Eder (1992) and Pahl and Beitz (1996), the main apparent objective of product design is to meet functional requirements. It hence dedicates only but marginal attention to the user. The theories of these authors mostly focus on the technical functions and structure of the product and omit the product's relation to the user. Some of the theories, as is the case for Pahl and Beitz (1996), provide limited guidance on how and where in the design process some of the user aspects should be dealt with (for example, identifying and understanding user needs).

One of the challenges in trying to achieve a balance between technical and artistic inputs into product development education of industrial design students, is being able to introduce the technical systems design view presented in this section, and intertwine with another (rather more user/person centered) approach. In an engineering school that teaches Industrial Design students, it becomes apparent that rather than mostly using verbal requirement lists as inputs for new concept generation, these students seem to prefer to be creatively stimulated with ideas in context. Activity theory is being used as a basis to achieve this end. The following section pursues the presentation of fundamental aspects of activity theory, and provides elements that enable to develop a perspective for the study of activity-person interactions, or the study of use.

Activity theory

Under the light of a framework derived from activity theory, any task, or activity, can be broken down into

actions, which are further subdivided into operations. In a design context, using these categories can provide the designer not only with an understanding of the steps necessary for a person to carry out tasks, but also with the motive and goals of the person's actions.

The objectives and motives of any human activity, the social and material or physical perceptions, and the needs of the human determine the activity and its structure (Hydén 1981). The means for carrying out an activity include techniques and skills, procedures, artifacts, where language and tools such as products can be included. Activity theory can be used to inform product development efforts, through the study of use. This is presented in this section, following the general outline of the development of activity theory, in the following subsection.

Evolution of activity theory

In this subsection, an overview of the path of activity theory, from Vygotsky's early conception, through Leontiev's contribution, reaching today's form is proposed. Activity theory first appeared and was developed in the Soviet Union. The foundations of this theory include the philosophical ideas of Hegel and Kant, as well as the theory, developed by Marx and Engels, of dialectical materialism. The theory had evolved from the work of Vygotsky, as he had initially formulated a new method of studying thought and consciousness. Vygotsky had been working on this theory at a time when the prevalent dominant psychological theories were based on reflexology (stimulus-response based school that at a later stage was developed into behaviourism) and psychoanalysis (Mappin 2000). By reducing all psychological phenomena to a series of stimulus-response chains, reflexology attempted to eliminate consciousness.

The mentalist tradition, according to Vygotsky (1981), confined itself to a vicious circle in which states of consciousness were comprehended through the use of the concept of consciousness. This consisted of the major objection Vygotsky pointed out towards the mentalist tradition. Vygotsky claimed that if consciousness were to be taken as a subject of study, then the explanatory principle had to be sought within a different layer of reality. Socially meaningful activity might play this role, serving as a generator of consciousness, was what Vygotsky suggested. The suggestion that individual consciousness is built from the outside through relations with others was Vygotsky's first step towards the concretisation of this principle. Human higher mental functions ought to be viewed as products of mediated activity, according to Vygotsky. The role of mediator is played by psychological tools and by means of interpersonal communication.

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Vygotsky's first ideas about how consciousness was mediated were formulated after he had appropriated a few Marxist ideas about how tools (or instruments) mediate the work activity. Vygotsky then extended those ideas to encompass the manner through which psychological tools get to mediate thought.

Work was, for Marx and Engels, the basic form of human activity (Wertsch 1981). Their analysis emphasised that not only did humans transform nature in their carrying out of work activity, but they were also themselves continuously and repeatedly changed in the process. The level of work activity at a particular stage in history was seen as a direct reflection of the tools that were available at that time. Therefore, new kinds of instruments would always be necessary to carry out the perpetually changing new forms of work activity. The reciprocal implication of the afore-mentioned dialectical considerations is that each new level of tool or instrument development leads to the rise of yet another generation of a form or manner of conceptualising and acting on the world.

One of the main cornerstones of Vygotsky's psychological constructs was the resemblance between Marx's notion of how the tool or instrument mediates overt human work activity and the semiotic notion of how human social processes and thinking can be mediated, and are in fact often mediated, by sign systems. In both cases the point is that instruments are not only used by humans to change the world, but these instruments also come to transform and regulate humans in this process of changing the world around them (Wertsch 1981).

According to Vygotsky (1981), psychological tools are artificial formations. By their nature they are social, not

organic or individual. They are directed towards the mastery, or management, of behavioural processes, in a comparable way to the way by which technical means are directed towards the management of processes of nature. Verbal communication, systems for counting, mnemonic techniques, algebraic symbol systems, works of art, writing, schemes, diagrams, maps, mechanical drawings, and all sorts of conventional signs can serve as examples of psychological tools and of their compound systems (Mappin 2000).

Each psychological tool alters the entire flow and structure of mental functions as long as it is included in the process of behaviour. A tool with a psychological nature does this by determining the structure of a new instrumental act, in the same way that a technical tool alters the process of a natural adaptation by determining the form of work operations.

Artificial, or instrumental, functions and forms of behaviour ought to be recognised along with natural acts and processes of behaviour. The latter first emerged in the process of evolution, and were developed into special mechanisms that are common to humans and advanced animals. The former (artificial functions and forms) are a later acquisition of humans. These are the product of historical development and are a form of behaviour unique to humans (Vygotsky 1981: 137).

The mediation by psychological tools, at the time, a new method of thinking about consciousness, was then termed the instrumental method. Vygotsky's initial formulation of an instrumental act is shown in Figure 1. A stimulus was thought to be able to play the role of an object towards which an act of behaviour was directed, according to

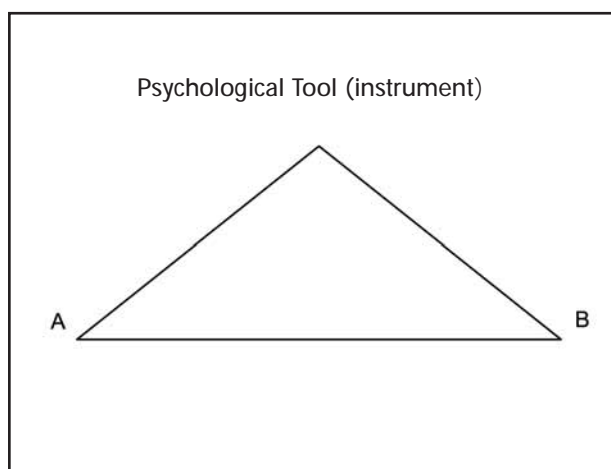


Figure 1. Initial formulation of an instrumental act, according to Vygotsky's early proposal

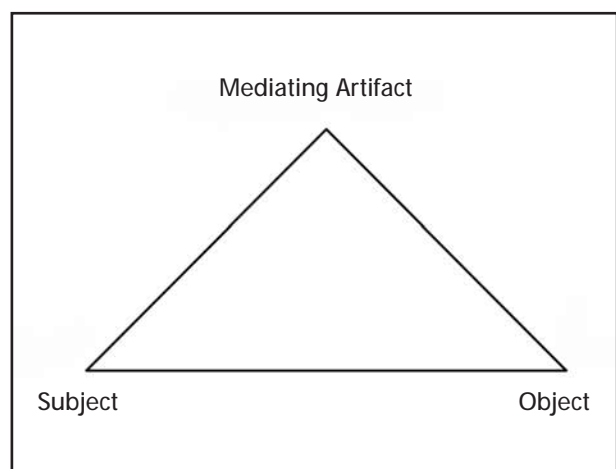


Figure 2. First generation of activity theory psychologist's view of the mediating artifact

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Vygotsky. However, in this act, the tool could also play the role of the means by which human beings directed internal psychological operations to solve a problem. In Vygotsky's instrumental method, although the link between A and B was the direct associative connection (from stimulus, leading to response), both the stimulus and the tool could be considered as stimuli affecting the ultimate response.

In the instrumental act, a new intermediate link, the psychological tool, which becomes the structural center (the feature that functionally determines all the processes that form the instrumental act), is inserted between the object and the psychological operation toward which it is directed. Any behavioural act then becomes an intellectual operation (Vygotsky 1981: 139). However, to many of the psychologists working on the development of activity theory, this formulation was still too close to behaviourism (Mappin 2000). They took Vygotsky's idea of artifact-mediated and object-oriented action and reformulated it to take the form depicted in Figure 2.

According to the conception depicted in Figure 2, which is representative of the view shared by the first generation of activity theory psychologists, an activity is composed of a subject and an object, mediated by a tool. A subject is a person or a group that is engaged in an activity. An object (in the sense of "objective") is held by the subject and motivates activity, giving a specific direction to the latter. The mediation can occur through the use of many different types of tools, material tools as well as mental tools, including culture, ways of thinking and language.

In activity theory, the unit of analysis is an activity, which is opposed to the approach pursued by cognitive psychology, focusing on the study of the individual as a separate entity. In activity theory, context is not considered as an outer container or as a shell inside of which people would behave in certain ways (Nardi 1996). Rather, people consciously and deliberately generate context (activities) in part through their own objects (or objectives). Context is both internal to people, involving specific objects and goals, and, at the same time, it is external to people, involving artifacts, other people, and specific settings (Nardi 1996). The crucial point from this perspective is that in activity theory, external and internal perspectives are fused, or unified.

Collective activity would become the turning point marking the onset of a second generation in the development of activity theory. The unit of analysis in Vygotsky's early work was object-oriented action mediated by cultural tools and signs. There was no recognition of the part played by

other human beings and social relations in the triangular model of action. Leontiev extended the theory by adding several features based on the need to separate individual action from collective activity (Mappin 2000). The distinction between activity, action and operation was added to delineate an individual's behaviour from the collective activity system.

The following extract from Leontiev's own writings (1978) vividly characterises the essence of collective activity: "a beater, for example, taking part in a primeval collective hunt, was stimulated by a need for food or, perhaps, a need for clothing, which the skin of the dead animal would meet for him. At what, however, was his activity directly aimed? It may have been directed, for example, at frightening a herd of animals and sending them toward other hunters, hiding in an ambush. That, properly speaking, is what should be the result of the activity of this man. And the activity of this individual member of the hunt ends with that. The rest is completed by the other members. This result, i.e. the frightening of game, etc., understandably does not in itself, and may not, lead to satisfaction of the beater's need for food, or the skin of the animal. What the processes of his activity were directed to did not, consequently, coincide with what stimulated them, i.e., did not coincide with a motive of his activity; the two are divided from one another in this instance. Processes, the object and motive of which do not coincide with one another, we shall call "actions". We can say, for example, that the beater's activity is part of hunting, and the frightening of the game his action" (Leontiev 1978: 210).

The beater is engaged in actions that result in the opposite of what he is immediately seeking (food for survival). Instead of shortening the distance to the quarry, he is pushing the game away. This makes sense only if he knows that someone is waiting to achieve his goal (consciously shared with others) at the other end. The sense of his action was not in the action itself but in his relation to other members of the group (Mappin 2000).

The emergence of action as a co-ordinated part of social activity performed by an individual must be accompanied by shared meaning of the action that is reflected consciously by the actor. Therefore, the necessary, conscious division of work in human society is the most obvious indicator of the individual human's societal nature. The individual is truly human only in society. Indeed, a still stronger conclusion can be argued: that human individuality itself is achievable only in society (Mappin 2000). It is apparent from the description above that more than one action can be used to achieve a goal, both

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the beaters and the hunters in the activity system above are carrying out actions which will result in a successful hunt. But their actions are different.

The third hierarchical level which Leontiev added to the theory of activity was the level of operations, which are performed automatically. As Leontiev states, when learning to shift gears in a standard automobile:

"initially every operation, such as shifting gears, is formed as an action subordinated specifically to this goal and has its own conscious orienting basis. Subsequently this action is included in another action, such as that of changing the speed of the automobile. At this point, shifting gears becomes one of the methods for carrying out this action, that is, it becomes an operation necessary for performing the action. It is no longer carried out as a special goal-directed process. The driver does not distinguish its goal. So far as the driver's conscious processes are concerned, it is as if shifting gears under normal circumstances does not exist. He/she is doing something else: he/she is driving the automobile from place to place, driving up steep inclines and across level expanses, bringing it to a stop in certain places. Indeed, we know that this operation can "drop out" of the driver's activity entirely and can be performed automatically" (Leontiev 1978: 64).

As a result of the need to consider the shared meaning of activity, the initial theory was reconfigured by the addition of rules, community and the division of work and was renamed the activity system. An activity system is a way of visualising the total configuration of an activity. This is the current hierarchical conception of activity that may be diagrammed as depicted in Figure 3. There is an inherent correspondence between activity and motives, action and goals, and operation and instrumental conditions.

According to Mappin (2000), in this model of an activity system, the subject refers to the individual or group whose point of view is taken in the analysis of the activity. The

object (or objective) is the target of the activity within the system. Instruments refer to internal or external mediating artifacts which help to achieve the outcomes of the activity. The community is comprised of one or more people who share the objective with the subject. Rules regulate actions and interactions within the activity system. The division of work discusses how tasks are divided horizontally between community members as well as referring to any vertical division of power and status. A general outline of the development of activity theory was just enunciated. Its essence is based on the premise that transforming the objective into an outcome motivates the existence of an activity. The following subsection shows how activity theory can be used to inform product development efforts, through the study of use, focusing in particular on the seminal work developed by Karlsson (1996).

The study of use informed by activity theory

In an effort to transfer the benefits of the insight provided by the powerful tools devised for the study of collective activity, to studies of usability, Karlsson (1996) developed a framework to study 'use', i.e., the relation between human and artifact. This framework establishes a transposition of the broken-down structure of activity theory to the person-activity interaction level, mediated by an artifact (product or system). The focus is on the individual and his/her relation to the objective and the mediating artifact. The framework is intended to provide a basis for the discussion, description and evaluation of different approaches to the design of the user-artifact relation. In this framework, the unit of analysis is the use activity, and she adopts a holistic approach that includes a system view of user-task-goal-artifact and environment. In this approach aspects such as product features and operations are studied, but the key point is that they must be related to the overall level of analysis. The framework is composed of five factors, each of which is represented in three different levels of analysis. In this view of the user-artifact relation, the purpose of employing an artifact (product) is to make use of its functions in order to achieve a goal. However, the actual benefit acquired from 'use' is dependent upon the properties of the artifact and the properties of the user, as well as other local conditions, such as the environment where the activity takes place (Karlsson 1996).

Use implies a goal (use for what?), an instrument (use what?), a person (use by whom?) and an environment and context (used where?) (Karlsson 1996). To this set of four short questions, a fifth may be added concerning the activity per se: 'use how?' which expresses the mode of interaction between user and artifact. This is quite relevant,

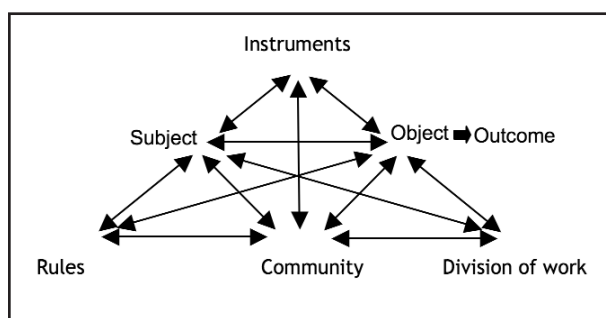


Figure 3. Activity system as a way of visualising the total configuration of an activity.

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as a dimension, since it is central to activity and hence, if consciously considered, may raise interest in aspects of use quality. Use quality may be considered as including characteristics such as user friendliness or beauty. The developments proposed in the following section have greatly benefited from the seminal work developed by Karlsson (1996).

Activity based concept generation

This section presents the fundamental results of the present paper, in the form of a method for stimulating new concept generation, that takes ideas in context, structured according to activity theory, as an initiating stage for the generation of new product concepts. The approach that is central to this contribution is bounded by the larger process of design, where it gives a contribution at the stage of concept generation. The bounding process of design that is considered is in line with the report of Lewis and Bonollo (2002). These authors performed an

experimental investigation to unveil the design skills most influential to professional success, in order to have design education adequately train student in those skills. Given the nature of the examples provided and the literature sources considered, it is fair to assume that Lewis and Bonollo's concerns were in line with the ones motivating this paper: valuing engineering design approaches in industrial design education and seeking to make these compatible. In order to structure their research, Lewis and Bonollo (2002) harnessed a five stage operational process of design, based on selected literature of their choice (Hales 1991). This process is comprised of five sub-ordinate processes. These are: task clarification, concept generation, evaluation and refinement, detailed design of preferred concept and communication of results. Table 1 provides an overview of this process with the description of the nature and the outcomes expected from each sub-ordinate process of the operational model of the design process.

Subordinate process	Nature of process	Output from process
1. Task clarification	A set of tasks including negotiating a design brief with the client, setting objectives, planning and scheduling subsequent tasks, preparing time and cost estimates	Design brief, including design specification, project plan with time line and cost estimates
2. Concept generation	A set of creative tasks aimed at generating a wide range of concepts as potential solutions to the design problem specified in the brief	A folio of concept sketches, supported by simple models or mock ups, providing a visual representation of design ideas
3. Evaluation and refinement	A set of analytical tasks in which the concepts in (2) are evaluated and reduced to a small number of refined solutions, usually only one or two candidate solutions	A folio of refined concept sketches, supported by models and technical information as required and illustrating the preferred concepts
4. Detailed design of preferred concept	A set of tasks aimed at developing and validating the preferred concept, including layout drawings, dimensional specifications, selection of materials, finishes, indicative tolerances	A folio of layout and detailed component drawings, supported by a technical report giving preliminary manufacturing information
5. Communication of results	A set of tasks whereby the concept detailed in (4) is communicated to the client via appropriate two- and three-dimensional media and written report	A folio of presentation drawings, including technical drawings from (4) and supported by a refined three dimensional model and/or prototype

Table 1. Operational Model of the Design Process (Lewis and Bonollo 2002, Hales 1991)

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The proposed new concept generation approach is based on the adaptation of an ergonomic design approach structured by activity theory, established by Coelho and Dahlman (2006). The approach was developed for use in the classroom, in the author's Product Design course within the second year of the undergraduate program in Industrial Design, and takes as a point of departure human activity, in order to search for new product concepts. It is meant to be considered in the concept generation stage of the design process, once all the task clarification steps have been carried out. Figure 4, depicting the Project X assignment, is an example given in class as a starting point for the generation of new concepts by industrial design students in the present approach proposed for new concept generation.

The description given above is an example intended to trigger students to apply this way of starting concept generation in their particular assigned projects. The approach is then based on searching for visual (sketched) answers to the question "how can this human activity be enhanced, supported or enabled by an artifact?". This process is based on considering the goals, instruments, and person and context information, structured according

to activity theory, besides establishing a 'tout court' requirements list specification which is then abstracted to reveal the fundamental problem (Pahl and Beitz 1988). The approach is believed to hold the potential to trigger the generation of concepts beyond existing solutions, and pushing the envelope of creativity beyond the mere upgrade from existing concepts.

It is arguable that the nature of human activity will change according to the nature of the artifact that supports it. Hence, when generating alternative concepts, based on the consideration and exposure to the activity analysis, concepts and human activity are in flux with each other and modification of one may bring upon changes on the other. Figure 5 depicts in graphical form the decomposition of the aspects of the task clarification subordinate process of the design process that are relevant as inputs for the concept generation activity based approach. A schematic diagram is shown on Figure 6 depicting the rationale underlying the execution of the technique, in the stage of concept generation. Since task clarification plays an important role in providing inputs for the activity analysis, this process stage is also schematically depicted (Figure 5). While it is acknowledged that these

<i>Project X</i>	
<i>Product:</i>	<i>device Y (tele-ski)</i>
<i>Task to be performed:</i>	<i>support human activity climbing uphill in preparation for downhill.</i>
<i>Client: (imaginary)</i>	<i>- electromechanical equipment supplier for winter sports resorts.</i>
<i>Client goals:</i>	<i>- offer safety in access, transportation and descent; - portray an avant-garde image to winter sports resorts.</i>
<i>Client base:</i>	<i>Iberian Peninsula.</i>
<i>Existing equipment:</i>	<i>tele-chair, transporting rod; lateral transporting rope; conveyor belt.</i>
<i>Human activity (user goals):</i>	<i>- gain altitude to restart descent; - socialise; - physically relax; - enjoy the landscape.</i>
<i>Environment and context:</i>	<i>- dichotomy novice/expert; - use of rucksacks; - protection against wind gusts; - profitability of equipment off season.</i>

Figure 4. Example of a starting point for the generation of new concepts by industrial design students, using the approach proposed for new concept generation

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stages of the process of design encompass a set of actions that go beyond the scope of the illustrations, the aim in their making was to focus on the contours of the proposed approach. Evaluation and refinement follow the concept generation sub-ordinate process, but since no significant modifications are made to established methods, there is no illustration provided of stage 3 of the operational design process and further beyond.

Several steps need to be carried out to perform task clarification, the output of which includes a design specification, an implementation plan and cost estimates (as depicted in Table 1). Getting to these results involves a series of actions, that include task clarification itself but also exposing the goals of the client (assuming the design is being commissioned by a client), as well as context information. Within the exploration of the task that is to be performed by the design, emphasis on human activity is sought, making the human activity, user goals, and the environment where the activity might take place explicit. The context of use is also characterised. This information would otherwise be available anyway as a result of the use of checklists to build up the requirements list, but it is important to have it explicit and categorised.

Within the concept generation stage, abstraction of the fundamental problem from the design specification may benefit considerably by keeping the "main problem" within the light of the activity framework. In rather complex tasks, for instance those dealing with machinery or automated equipment, functional analysis is a fit process for technical systems and establishing solution principles. In this education scenario, functional analysis of the task to be performed is also introduced, albeit it is less useful for radical new concept development of simple concepts. Many projects that are developed in class concern unsophisticated devices, such as furniture, or simple appliances, with a common theme being directly supporting human activity. Brainstorming is quite useful as an explorative tool in the concept generation phase, and it is used in conjunction with abstraction, functional analysis and activity analysis to support, or nurture, the creative process.

It is acknowledged that goal establishing and analysis is not foreign to setting requirements when creating product specifications (Roozenburg and Eekels 1995 - provide a thorough categorization of goals, objectives and requirements). These goals are essentially geared at

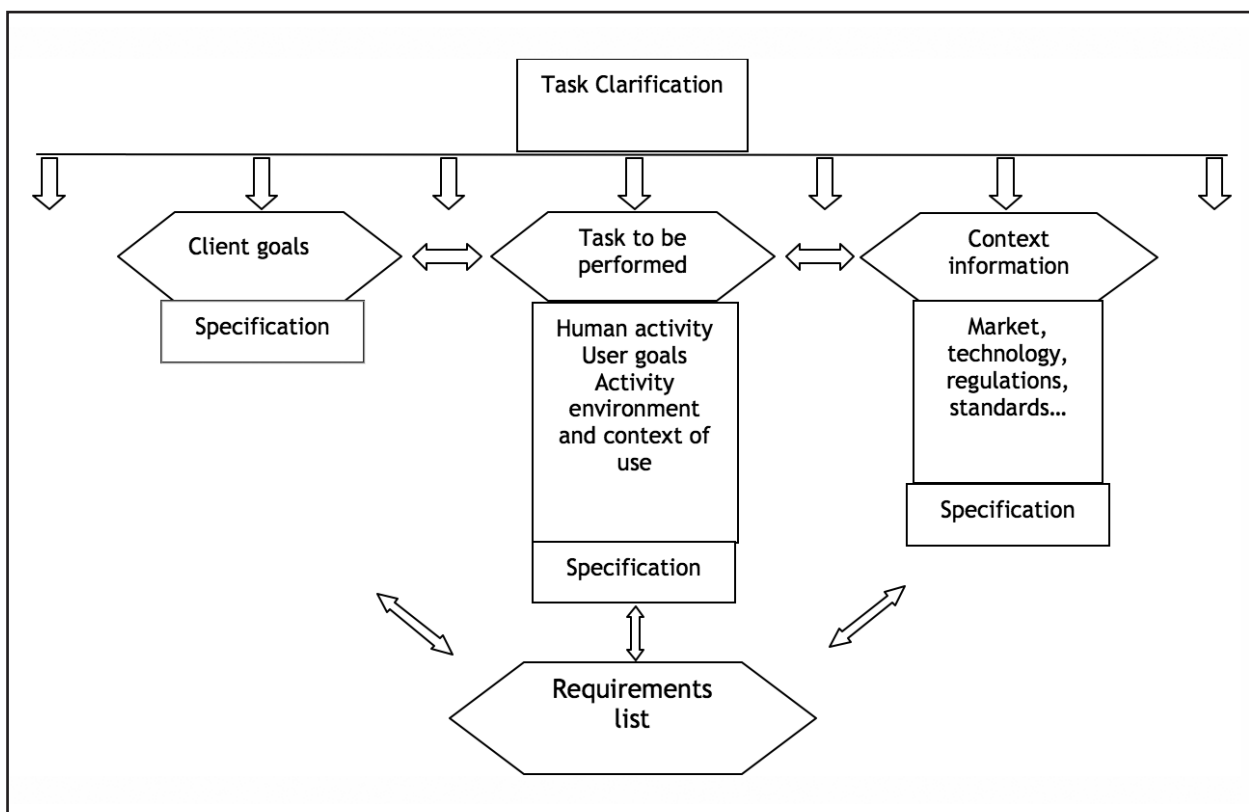


Figure 5. Partial depiction of the task clarification stage of the design process, focusing on the elements that are needed to support concept generation using the activity based approach proposed

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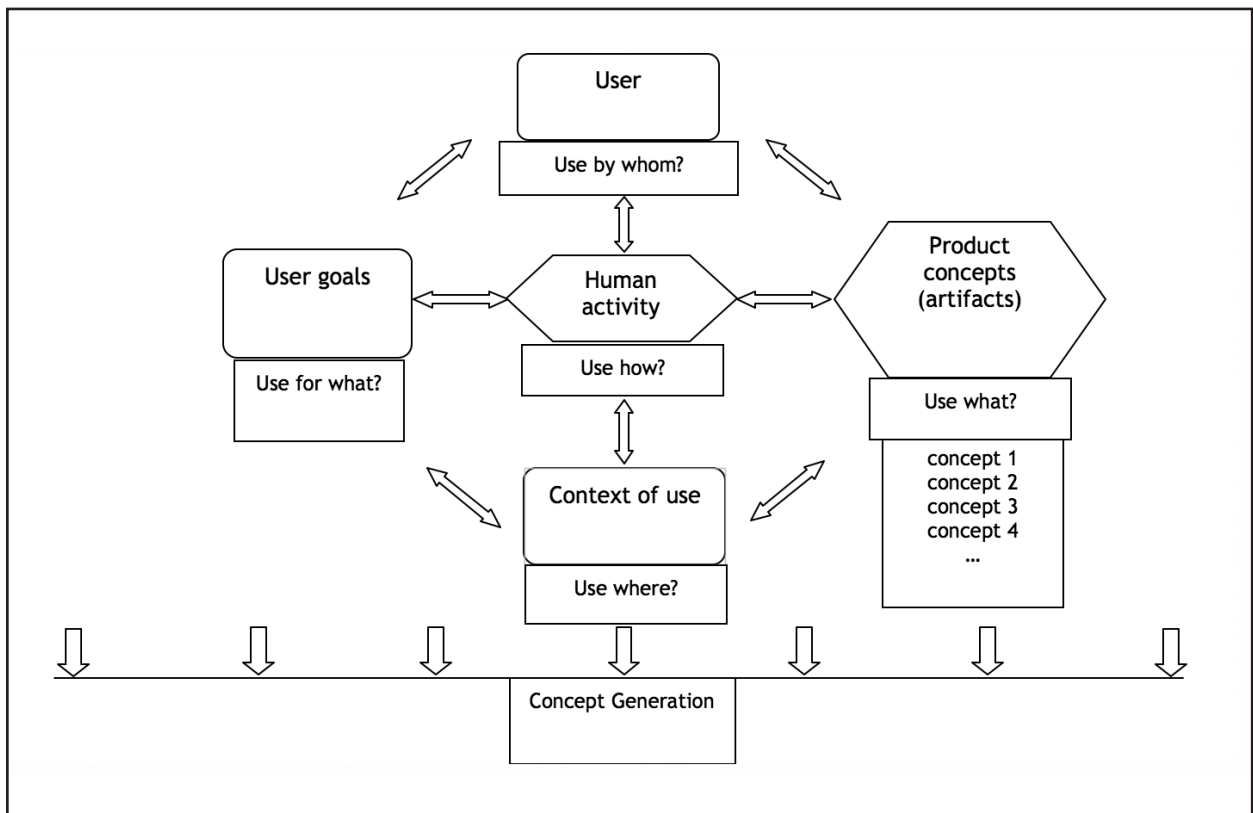


Figure 6. Activity analysis depicted as a way of triggering new concept generation. The activity is at the centre of this analysis, and the use relation is characterised at every step. Providing answers to the question “how can this human activity be enhanced, supported or enabled by an artifact?” aims at the generation of multiple concepts

product properties. However, focusing on human activity goals to trigger concept generation, particularly is something which is deemed additional and enriching to the aforementioned approach to goal analysis.

The approach proposed is also based on systematic design procedures to evaluate and improve the initial concepts and guide their further development (Ulrich and Eppinger 2004). These systematic design procedures include, for instance, evaluation of alternative concepts according to multiple dimensions and selection of the fittest solutions for further development. It does not however explicitly establish links and relationships between design variables, performance specifications and user needs, and, or, utility function, as is suggested by Ulrich and Eppinger (2004), given the clash of this action with a focus beyond the requirements list, which is one of the main drivers in the approach proposed. The suggested links and relationships could also be somewhat deterrent from radical new concept generation, which is sought by the use of the proposed approach.

Figure 7 depicts a selection of results attained by industrial design (undergraduate) students, using the approach proposed for new concept generation, considering the design brief presented in Figure 4 as Project X.

Conclusion

In this paper, a method for initiation of new concept generation was presented that is based on considering human activity goals and instruments, as well as person and context information, structured according to activity theory, rather than only establishing a “tout court” requirements list specification followed by abstraction of the main problem. It is aimed at combining a technical approach with a creativity stimulation approach, which is based on considering and visualising the activity in context. “How can this human activity be enhanced, supported or enabled by an artifact?” is the core question. The method is based on searching for answers to this question, once the activity has been characterised and analysed using the activity framework. It thus entails the potential to trigger the generation of concepts beyond existing solutions. This trigger also aims at pushing the envelope of creativity

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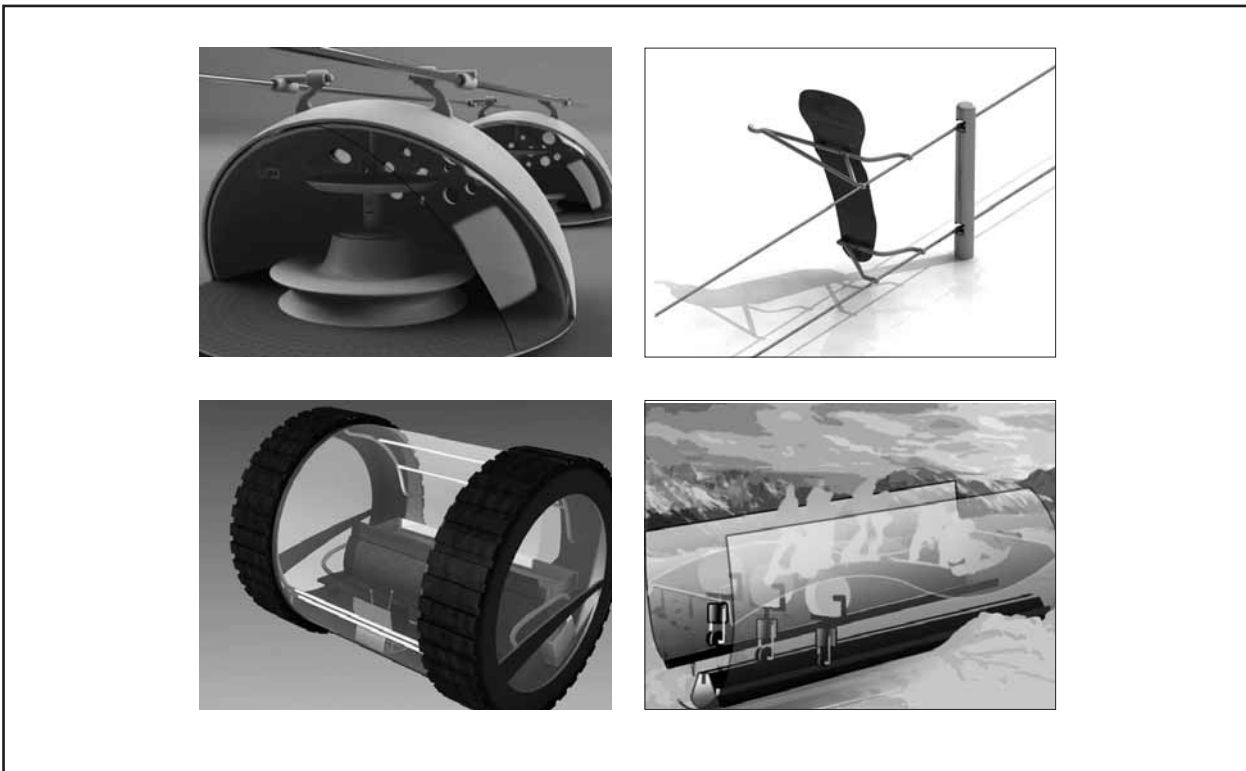


Figure 7. Examples of results attained by industrial design (undergraduate) students, using the approach proposed for new concept generation, considering the assignment presented as Project X

beyond the mere upgrade of existing concepts. Afterwards, systematic procedures are used to evaluate and improve the initial concepts and guide their development.

Activity theory is a powerful framework that can be applied in many domains, to foster meaningful and efficient solutions to problems in several fields of human action. As an example, knowledge based engineering could benefit from the insight given by an activity theory based framework. From yet a different perspective, while concept generation is aided by activity theory in the present paper, an activity theory based framework is also suggested as a means of enabling structuring to support the identification of underlying concepts across collections of works of art, artifacts, or architectural sites. As a final example for yet another suggested application domain for an activity theory developed framework, the field of distance learning using Information and Communication Tools is emphasised. Distance education changes the way by which work is carried out in the sector of education.

Activity theory may have an important role to play in the field of distance learning with ICT, improving its effectiveness by means of the analysis of the structure of user goals, instrumental conditions and operations.

References:

Campbell, R.I., (2003), Hague, R.J., Sener, B., Wormald, P. W. The potential for the Bespoke industrial Designer. *The Design Journal*, Vol.3, No. 6, pp.24-34.

Coelho, D. A., Dahlman, S., (2006), Ergonomic Design Structured through Activity Theory. In Fischer, Xavier; Coutellier, Daniel (Eds.), *'Research in Interactive Design'* – Vol. 2, Paris: Springer Verlag.

Hales, C., (1991), *Analysis of the Engineering Design Process in an Industrial Context*, Eastleigh, UK: Gants Hill Publications.

Hubka, V., Eder, W.E., (1992), *Einführung in die Konstruktionswissenschaft*. Berlin: Springer Verlag.

Hydén, L.-C., (1981), *Psylogi och materialism: Introduktion till den materialistiska psykologin*, Stockholm: Prisma.

Karlsson, I. C. M., (1996), *User Requirements Elicitation – A framework for the study between user and artefact*. Doctoral Dissertation. Dept of Consumer Technology, Chalmers University of Technology, Gothenburg.

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Lewis, W. P., Bonollo, E., (2002), An analysis of professional skills in design: implications for education and Research. *Design Studies* No.23, pp. 385-406.

Leontiev, A. N. (1978), *Activity, consciousness and personality*, Englewood Cliffs, NJ: Prentice-Hall.

Mappin, D. A., (2000), Advanced Instructional Design - Diving Deeper, Course Syllabus - Edpy 597 -University of Alberta, Canada
(<http://www.quasar.ualberta.ca/edpy597mappin/module15.html>).

Michl, J., (2002), On seeing design as redesign – an exploration of a neglected problem in design education. *Scandinavian Journal of Design History* No.12, pp. 7-23.

Nardi, B., (1996), *Context and Consciousness: Activity theory and human-computer interaction*, Cambridge, MA: MIT Press.

Pahl, G., Beitz, W., (1988), *Engineering Design - a systematic approach*, London: the Design Council / Springer Verlag.

Pahl, G., Beitz, W., (1996), *Engineering Design - a systematic approach*, 2nd edition, London: Springer.

Roozenburg, N. F. M., Eekels, J., (1995), *Product Design: Fundamentals and Methods*, Chichester: John Wiley & Sons.

Suri, J. F., (2003), The Experience Evolution: Developments in Design Practice. *The Design Journal* Vol.2, No.6, pp.39-48.

Ulrich, K.T., Eppinger, S.T., (2004), *Product Design and Development*, international edition, McGraw-Hill.

Vygotsky, L., (1981), The instrumental method in psychology. In J. Wertsch (Ed.), *The concept of activity in Soviet psychology*, Armonk, NY: Sharpe.

Wertsch, J., (1981), (Ed.) *The concept of activity in Soviet psychology*. Armonk, NY: Sharpe, pp 134-135.