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A METHOD FOR SYSTEMATIC FUTURE PRODUCT CONCEPT GENERATION

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Abstract

A systematic future product concept generation approach where design, technology development and market foresight aspects are combined is a potentially useful tool for companies when they prepare for future changes. This methodology has been developed, applied and evaluated in a national research project by three universities in Finland. The respective specialities of the research units are product development, industrial design and corporate foresight oriented futures research. The main issue was to evaluate plausible scenario based future product concepts and their visualisations as tools in company long range planning potentially creating additional value on product development management level. By exploring alternative future scenarios and creating possible product concepts on basis of their requirements or presented opportunities, it is possible to enhance company agility and ability to handle changes. Several methods for futures research and concept development separately and as such are available. However, since so far the combination of these two disciplines are scarce, the project was found to present a novel and interesting practical approach.

Keywords: product concept development, scenario creation, scenario planning, concept visualisation, corporate foresight, long range planning

1. Introduction

Companies face continuous pressure to bring new products on the market faster than before. Consequently product development cycles are becoming ever shorter. True breakthrough products have to be innovatively developed, attractively designed and they have to apply latest and in many cases best available technology. To be a success, a new product has to be technologically and economically feasible, it has to fulfil the needs of the customer and meet the requirements (e.g. safety and environmental) placed by society. This is a demanding task since the operational environment including markets, society and technology is constantly changing. Therefore a significant number of new-product development efforts are becoming outdated and subsequently abandoned even before their results reach the markets. These difficulties are often consequences of companies not having been able to foresee changes and their speed affecting their activities [10]. Product concept generation is a potential tool closely associated with product development management and resource allocation. Product concepts usually refer to product drafts which are however not directly used for production and market introduction but more as a platform to investigate opportunities and thus to function as a decision making basis. Product concepts typically include information about the product's function, target group, the technology to be used, structure etc. [20, 6, 4]. Some of the product concepts are developed further into production ready versions, some including typical future product concepts can be intended to be used otherwise in the company future product development efforts e.g. on a longer time scale.

2. Visioning Concept Development

2.1 The TUTTI-project

The idea of further developing and testing a systematic future product concept generation approach where industrial design, technology development and market foresight aspects are combined was conceived based on earlier cooperation by the research units. Individual methods and tools as such are available and had been applied and developed in many projects and case studies. A holistic approach combining the three domains had so far not been tested. A notable industrial interest for conceptualisation working method development could also be identified. Thus to develop, apply and evaluate this kind of methodology a national research project called TUTTI - Systematic Product Concept Generation Initiative – was initiated and carried out in cooperation by three universities in Finland (2002-2004). The participating research units were the coordinator Helsinki University of Technology (Machine Design), Helsinki University of Industrial Arts (Industrial Design) and Åbo Akademi University (Institute for Advanced Management Systems Research). The respective specialities of the research units are product development, industrial design and corporate foresight oriented futures research. Funding was provided from the MASINA national technology program by the national technology agency TEKES. A management group with industrial representatives was invited to monitor the project.

The main issue in the TUTTI-project was to evaluate whether it is possible to systematically create plausible scenario based future product concepts and their visualisations to be used as tools in long range planning in companies. Traditionally the scenario method has been used mainly independently in futures research as a tool for strategic planning and decision making [19]. Scenarios are also linked to new or breakthrough product development [e.g. 13] but the combination of scenario method application and concept creation is a novel approach in this field and the project was found interesting addressing this practical combination. Presenting concrete and detailed future oriented product concepts for management level consideration could create additional value [14]. By exploring alternative future scenarios and creating actual possible product concepts on basis of their requirements or the opportunities they present, it is possible to enhance company agility and ability to handle changes in the future. In the project a method was developed, tested and evaluated using examples from a specially selected set of case products and product groups these being; short distance urban transportation systems, everyday domestic technology, recreation and entertainment related technology, wood processing technology and distributed energy production and storage technology. The method trial application successfully resulted in 18 product concept descriptions and visualisations. These examples illustrate what types of results can be expected when implementing the approach in practice. The project also highlighted method properties, practical challenges together with needs and possibilities for further development.

2.2 Concept Development – Independent projects vs. activities within the product development process

Traditionally the beginning of the product development process has included a concept development phase [20] in which the product principal properties are defined and the product is given a first initial shape. Concept development as a comprehensive tool in product development can however offer much more possibilities than what is commonly known and presented in literature. Basically concept development initiatives can be divided into two groups: 1) concept development in separate independent concept development projects or initiatives and 2) concept development within (and as phase of) the product development

process, figure 1. Furthermore both of these groups include several types of concept development activities depending on the aims, objectives and phase of the project. [5, 16]

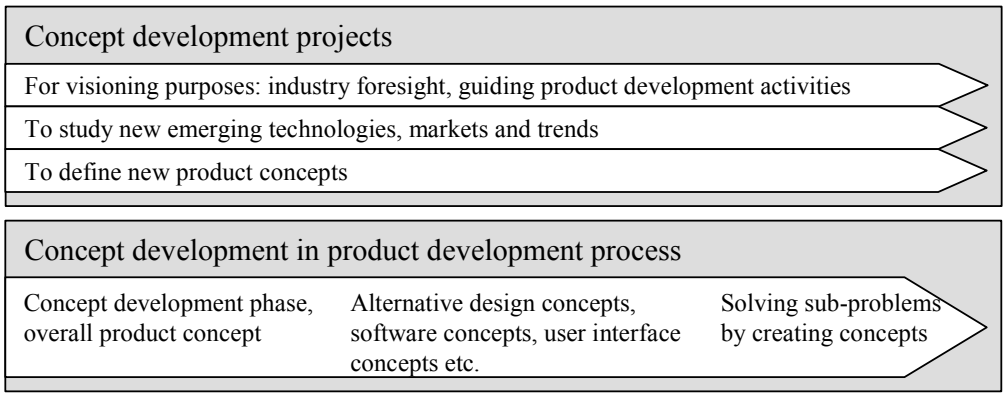


Figure 1. Typical scopes of concept development activities

It may be beneficial to generate product concepts prior to actual product development projects in separate concept development projects. These may have different focuses. It is e.g. possible to create product concepts for visioning purposes as described in this paper; visioning concepts can be used in industry foresight or as tools for guiding product development activities. Additionally there may occur a need to study new emerging technologies and markets which can also be done by creating product concepts. Or alternatively prior to a product development project new product concept applications can be defined and tested in separate concept development projects.

It is notable that the eventual product development project itself also contains a concept development phase where it is possible to decompose the proposed concept and create new, alternative concept variants. In addition to the concept development phase, where the overall product concept is created, there may be conceptualisation activities where alternative design concepts, software concepts and user interface concepts etc. are developed by specialised professionals respectively. There are usually also several sub-problems to be encountered on the way, which may require concept development type actions in order to produce alternative solutions in problematic situations. Conceptualisation projects are typically fast and relatively cheap and require fairly modest resources. It can be recommended that this kind of predefining concept development could be continuous when as such it can provide a permanent source of new product ideas. If further evaluation proves that a concept presents business potential, it is then possible to start an actual product development project with it.

2.3 Visioning Concept Development Characteristics

The driving force behind visioning and emerging concept development is that companies must prepare for changes in technologies and markets. New, emerging technologies facilitate new business and new competitors appear in the market. Companies should make sure that there will not be gaps between product generations and there are no unpleasant surprises waiting in the future. [9] Visioning concept development activities are a tool for this. Future product concepts can e.g. be used in positioning and profiling future company business activities, the company future can be discussed through visions of its future products. Future product concepts are not unfounded presentations of imaginary future products, but visions tightly linked to descriptions of possible conditions in the future e.g. scenarios and technology roadmaps. Scenarios describing conditions of the operational environment (e.g. the market

area) are quite widely used to support company strategic planning, but they have typically not included detailed visions of the actual (physical) products.

Because the future can however not be exactly foreseen, in practice the company will have to prepare itself for different kinds of futures by conceptualising different kinds of products respectively. Possible shift - evident in many branches - from producer of just physical products into total service provider with several immaterial elements included in the product is to be taken into account. Whether the concepts developed are realistic in practice should be made sure by technology development surveys and roadmaps. The product concept developed can be presented as different kinds of visualisations for which digital technologies provide ever growing possibilities. It is to be stressed however that future product concept considerations should not concentrate on efforts to anticipate the physical appearance of the product only. Scenarios and concepts should be updated so that they match current reality and information available. It is also notable that a strong actor may be in a position where it is possible to promote and support general development in a direction (into a scenario) most favourable from his subjective perspective. Companies' own actions most strongly affect the realisation of alternative future scenarios. A need for a more systematic product concept generation approach and methodology can be identified.

Strategic planning in a company is future-oriented work. Scenario planning is a method for imagining and describing possible futures. In scenario planning companies may include several types of issues [18]. One of those issues is how these alternative futures relate to the future products of the company. The future product concepts are created for alternative future worlds where forthcoming technologies are assumed available and e.g. social, political, economical as well as environmental circumstances are assumed to may have changed from present situation (not all parameters necessarily however). Visioning concept development is thus not tied to proven or even existing technologies and production methods of the company. Even the existing business base should be questioned in scenario creation. Driving forces for future product concepts can be found in technology roadmaps [e.g. 15] and future scenarios [7]. The intent of visioning concept development is thus to visualize possible new products in several alternative scenarios. This work is not necessarily aiming just at radical innovations [e.g. 21, 10] but is naturally dependant on the general strategy of the company also. In addition to supporting decision making visioning concept development increases innovativeness amongst the employees and it also brings the R&D and management levels closer to each other. These concepts additionally bring up new ideas that can be used in forthcoming products in the nearer future also. The visualisations are often usable marketing material as such. Companies, which introduce futuristic product concepts, send a message that they are leading the development.

3. Future Product Concept Generation – a Method

Conventional future concept creation -processes in companies usually produce visualized material for internal and marketing purposes. However, these processes are typically run more as design exercises than strategic planning and decision-making supporting efforts. The concept creation and evaluation tasks are carried out intuitively rather than systematically. The comprehensive approach including initial futures studies and technology foresight has been a less applied method. The method now presented here should however be seen more as a supporting process than an exact tool for concept creation. Typical method application projects include workshops and by multidisciplinary development teams. The method as such is not supported by any specific software nor does it utilize mathematical algorithms or exact

calculations. In addition the method does not aspire to be conclusive nor an automatically result yielding mechanism – it is an attempt to ease the concept creation process and to support communication in this field. The method can be divided into two main steps (figure 2): A) *Futures description* and B) *Conceptualisation*. Step A can subsequently be divided into two sub-steps: I) *Identification of change factors* including four phases 1 - 4 and II) *Scenario creation* including three phases 5 -7. Step B *Conceptualisation* can be divided into three sub-steps: III) *Identification of product needs* including the phases 8 and 9, IV) *Generation of future product concepts* including the phases 10 – 13 and V) *Timing of R&D –activities and operations* which is done internally and independently by the actor i.e. typically the company.

Futures description		**Conceptualisation**		
Identification of change factors	*Scenario creation*	*Identification of product needs*	*Generation of future product concepts*	*Timing of R&D – activities and operations*
1) Definition of time-span, actor perspective and industry branch viewpoints, 2) Collection of information and material, 3) Definition of the main characteristics of the scenarios and 4) Utilisation of the futures table method	5) Clarification of the actor perspective and selection of the most relevant drivers, 6) Futures table method application, creation of scenario paths and storylines and 7) Creation of the final scenarios	8) Futures table expansion onto the theme level and 9) Creation of theme level scenarios	10) Idea generation, 11) Concept draft generation, evaluation and selection, 12) Design concept generation and technology and market analysis and 13) Creation of future product concept application	Actor/company actions

Figure 2. The method main steps, substeps and individual phases

3.1 Futures Description incl. Identification of Change Factors and Scenario Creation (main step A)

1) Definition of time-span, actor perspective and industry branch viewpoints; Before starting conceptual design it is important to specify in which business the company is now involved and in which business it may be active in the future - also the definition of the time span for the scenarios needs to be made i.e. choice of how far into future the scenarios will be extended. It is critical to understand the core competence of the enterprise: it may e.g. look like the company is an elevator manufacturer but as a matter of fact it may be involved in short distance mobility –business instead. In the Tutti-project the individual company or 'actor' was represented by five selected application fields ('themes') identified as potential.

2) Collection of information and material – scenario and technology studies, In this phase the main trends affecting the development of the operational environment should be investigated by studying existing scenarios. For example some well known general and global scenarios have been made by Shell, CIA and WBCSD:n (World Business Council for Sustainable Development). Different scenarios have different emphasis so it is advisable to study a wide selection. Technology foresights, technology roadmaps, existing technology studies, scientific publications and newspapers, patents etc. are material for the technology study. Is also important to follow what happens in military and space research and development because after some years those technologies are usually available for civil purposes too. The price of these technologies will also go down. It is advantageous for the development team if e.g. one team member makes a technology prestudy or survey in which case he or she can act as a technology advisor through the process. The key technologies to be applied in future products

should be defined – the focus in collecting data is naturally on technologies that affect directly or indirectly the development of future product concepts. Technology roadmaps are especially useful material for concept development because they aim to present expected development in chronological order. A technology roadmap illustrates the assumed availability, development, and application of technologies from the present into the future. Mapping is extended somewhat to the past also to show the development until today and to get a logical dynamic continuum. The result is a "map" which illustrates how the selected technologies develop, how they can be used, and when. The time dimension, i.e. when to invest and when results and profits will be realised, is important. A technology roadmap is typically presented as a visual map. Also existing examples from research laboratories, universities etc. are worth investigating because open minded implementation of technologies in other contexts than for which they were originally developed may breed new innovations.

3) Definition of the main characteristics of the scenarios; In the beginning of the futures research process, the relevant futures information for the actor is mapped as extensively as possible. Information collection can consist of application of several systematic methods like expert consultations, surveys, interviews, trend analysis and collection of forecasts and historical data, but should also include collecting 'quiet' latent knowledge and information within the organisation. Systematic methods can ease the collection of this tacit knowledge also. The driving forces and change factors in the operating environment to be considered are mapped e.g. by the so called PESTE-analysis (as applied in the Tutti-project). In PESTE-analysis the driving forces are divided into Political, Economical, Social, Technological and Environmental types. The aim of the PESTE-analysis is to collect all the probable driving forces, signs of change and weak signals. [15] Combining results of PESTE-method application with existing scenarios it is then possible to outline the characteristics of case specific scenarios. At this point it is already possible to make short descriptions of the main points of the eventual scenarios – the final number of the scenarios may however still change later because e.g. of combinations.

4) Utilisation of the futures table method; Futures tables (similar to Field Anomaly Realization FAR method [17]) can be used in information processing or in structuring alternative futures development stage descriptions. Relevant variables and their alternative values are presented in the futures table typically by listing important parameters onto rows and different potential states of these factors into columns. In the listing the PESTE-classification may be used and the tables may also include several different monitoring levels e.g. global, block, state/national and branch levels.

5) Clarification of the actor perspective and the selection of the most relevant drivers; Alternative future developments are processed further into logical future scenarios from the actor perspective – the driving forces dominant characteristics are following through the whole scenario path placed into the futures table.

6) Futures table method application, creation of scenario paths and storylines; The so called future path - specific for an individual scenario to be created - is then identified by selecting possible scenario specific parameter values moving systematically down through the whole table. The selection is made so that the scenario specific storyline forms a logical internal continuum. At the end one alternative futures path corresponds to one alternative future operational environment development scenario. Depending on selected parameter number and their possible states the size of table might respectively be considerably large and there might thus be a very large number of alternative future paths – to their nature either desired or undesired. The most interesting states of the future as presented by the futures table are then selected for further analysis. The futures table application method can thus be used to find

essential development drivers, to identify and evaluate different combinations of the states of factors or to build and to illustrate scenarios (as was done in the Tutti-project).

7) Creation of final scenarios; The future paths can be converted e.g. to textual presentations in which the scenarios are then described. The scenario presentations should be internally consistent, plausible and logical descriptions of the potential future including all the essential PESTE factors. Scenarios describe alternative developments from present day towards the future (time range varies but is typically 10 – 20 years). Scenarios are a way to summarise and document the results of the futures research efforts carried out. The results can be based on quantitative or qualitative methods. The actual world of tomorrow is not a fixed steady state but a cross-section of several possible developments at certain moment. The key function of the scenarios is to explore essential alternative operational environments of the companies.

3.2 Conceptualisation incl. Identification of Product Needs, Generation of Future Product Concepts and Timing of R&D Activities (main step B)

8) Futures table expansion onto the theme level; A type of expansion of the future table is important and may be needed when aiming at visioning future product concept development. Expansion in this context means that one or more additional levels have to be included in the futures table. Compared with the PESTE factor levels these levels can be called theme or product levels. In this paper the term 'theme level' is used. A futures table expansion is created by listing future factors that effect the supply and demand of certain types of products. This means that there are parameters that describe consumers' behaviour, values, their living conditions, environment, preferences etc. Theme level scenario characteristics may then be included in the operational environment presentations created earlier. Also in this sub-phase it is important to keep the scenario storylines internally logical.

9) Creation of theme level scenarios; these scenarios are also short textual presentations describing states of the selected parameters and eventually act as basis for product concept development because theme level scenarios with a business related emphasis give ideas for new product concepts.

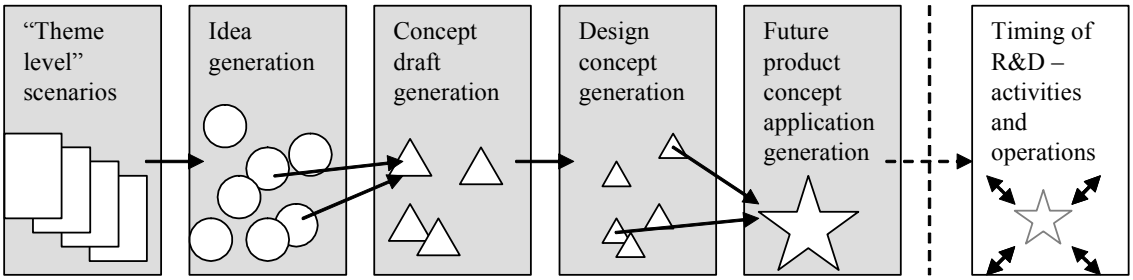


Figure 3. Phases of conceptualisation (method main step B)

10) Idea generation: Idea generation is done in team sessions by using different alternative methods e.g. brainstorming. Technology expertise support has to be provided because the multidisciplinary nature of visioning concept development. Technology roadmaps that are made from the actor's (company) point of view are needed when designing future oriented products because the existing know-how directly available is usually insufficient. Theme level scenarios and global scenarios play a central role in idea generation. Differences in the scenarios for which the product ideas have been generated have to be identifiable and visible in the generated product ideas.

11) Concept draft generation, evaluation and selection: Abstract ideas become concept drafts when they are given a first iteration of a physical form and some kind of functional and technological description to support them. Usually several ideas may be needed to produce one decent concept draft. Good concept drafts are usually born when a multidisciplinary development team discusses the individual ideas and evaluates and develops them simultaneously. Concept drafts should always contain some visual and textual information about the product, user and the use context.

For further selection concept ranking, grouping, rejection and combination is needed because idea sessions typically produce large amounts of concept drafts. There are several concept selection methods available e.g. Concept Scoring and Concept Screening [20]. In many cases external decision making, product championing, intuition and multivoting may be used. These practices mean that the concepts are presented to some external authorities for selection e.g. an expert or otherwise selected and influential person chooses the concepts for further development. The concept may also be chosen by development team consensus or by team vote. [20]. In the Tutti-project voting was used as main concept selection method.

12) Design concept generation and technology and market analysis: After selection for further development a set of actual design concepts is then created. Different basic constructions, forms and functions are studied. One single concept draft may require very large numbers of sketches before evolving into an actual design concept. Different selection and evaluation processes are used in this phase too. During the design concept generation concept specified technology studies and market potential estimations should also be carried out. This to make future product concepts more concrete and fact supported for eventual final product development decision making.

13) Creation of future product concept applications: Final designs are created and the concepts are presented by visualisations, mock-ups, miniatures, animations, textual material etc. The final appearance of concepts depends on several factors. Concepts made for strategic purposes need to contain sufficiently information about the idea of the concept and there must be an understanding of the bigger picture too (other products, environment, people etc. around the concept) but the outer appearance is not necessarily very important because of the long time frame. On the other hand if there are some marketing or advertising i.e. publicity ambitions behind the future product concept development, surely the design has a much more significant role. The way to present the concepts is critical – what kind of impression is wanted, which features are locked and which may change?

The last phase (sub-step V) in the method is to implement the results – to evaluate what kind of strategy is needed and how the goal (future products in future markets) can be reached. In this paper (and in the Tutti-project) the timing of individual actions is not analysed.

4. Scenario Examples

4.1 Global level scenarios

Discussed here are scenarios on two levels, global and theme levels (see method description especially steps 6 and 8). It is impossible to define only one exact possible future. The economic, technological, and social systems involved are complex. The aim of scenario creation is to identify several alternative futures as plausible and extensively as possible. The usefulness of the scenarios is not measured according to the accuracy of individual scenarios. It is the scope of scenarios which matters, i.e. how well the scenario set enables us to map the

alternative futures [9]. In the long-run, there are more options and not any of them is automatically the most probable.

The result of the method *phase one: Futures description* is a set of scenarios. In the Tutti-project the scenario examples used were created mainly from the local technology industry's point of view. Basically scenario building drivers could originate from a) outside of the industry, i.e. they are change factors arising from the operational environment, which then have significant influence on industry or b) inside of the industry, i.e. they are internal change factors, which have significant influence on the overall development of the outside world. Furthermore, the Tutti-project scenarios were constructed bearing in mind the technological, market and societal dimensions of the development. The final scenarios illustrate coherent development in all of these dimensions. The six final scenario examples of the Tutti-project were (in no specific order):

New emerging markets scenario: In this society driven scenario, the focus of global economy, markets, economic growth and volume shifts to Asia. Although global integration continues, there are several new players in the global economy. China is on its way to become the largest economy in the world [2, 1]. In this scenario Asian business practices may come to dominate. This scenario from an European point of view highlights the challenges created by new emerging markets with their cultural characteristics and related consumer habits and values.

Business as usual, tightening competition scenario: In this society driven scenario there may be growing tensions between the economic blocks. USA is still the only superpower, but the focus of global economy may be gradually shifting to Asia. Traditional business practices and consumer behaviour patterns continue to dominate. This "business as usual" scenario extrapolates many of the present trends into the future and illustrates a world of plenty but with ever tightening competition and increasing efficiency and profit requirements.

Europe centered scenario; In this society driven scenario European countries gain more influence on forums like in the UN and in international organizations. Russia and the EU may integrate more closely which may provide considerable resources of oil, gas and raw materials for the European industry. In addition, the EU improves its positions in technology and science. Basically, this scenario describes the new bloom of Europe and its consequences on the global economy.

Epidemic & sabotage scenario: In this society driven scenario global development is characterized by discontinuities one after another (local and global conflicts, terrorism, environmental disasters, epidemics). The epidemics can also be something totally different than currently discussed diseases. The development in this scenario is marked by growing uncommunicativeness, restrictions and insecurity. This scenario highlights possible future threats which could jeopardize an overall positive development of the global economy.

Changing values scenario: In this market driven scenario consumer values change dramatically. The main issue is the consumers' transformation into 'citizens' and power shift from multinational corporations to non-governmental organizations. Consequently local brands may prevail over global ones. This scenario may lead to so called "No logo" – development or even to extremely alternative ecologically oriented movements. This scenario illustrates the rise of the post-modern anti-materialistic values which prioritise cultural and environmental issues over economic ones. This kind of development could also lead to unexpected consequences in the economic system [3].

Bio technology boom scenario: In this technology driven scenario revolutionary development in biotechnology changes the world. Biotechnology supplements or even substitutes other technologies. Consequently, several new technologies emerge. In this scenario biotechnology

applications also achieve full consumer approval. The scenario describes the world where a full scale technological revolution is taking place. Consequences on society, markets and other technologies would undoubtedly be significant.

In addition, there were also four other scenarios considered in the Tutti-project process, which were however rejected after evaluation. These scenarios were Russia-centered scenario where Russia together with the other Baltic Sea region and Eastern European countries would form a new vital and dominant market area, a locally oriented and limited scenario, in which competitiveness of Finnish industry would decline considerably, Small Scale Technology scenario, illustrating a new technological paradigm and Africa-centered scenario, which was evaluated to include several uncertainties and problems difficult to approach [8, 12].

4.2 Theme level scenarios

Theme level scenarios are more detailed, projecting the effects of global scenarios within a more narrowly defined context and as such are the practical basis for actual concept design. The potential and immediate design drivers are identified in theme-level scenario work. Here it may be advisable to focus more on how and why and in which circumstances products will be used rather than on what some certain product exactly will be like. The theme level consideration in a way crystallizes the focus of the business and the 'nature' of the products. The Tutti-project selected themes have been presented earlier in the text. PESTE-categorisation can be used on theme level also as on other futures table levels. Political circumstances, role and support of society, roles of companies and individuals, degree of class division, individual resources and assets, personal life styles and surroundings, attitudes, technology development speed, possible theme associated boom technologies, materials, environmental questions etc. should be considered as parameters in theme level scenarios.

5. Future Product Concepts

5.1 Concept Examples

One of the main findings was that there are several possibilities to approach the product concepts regarding to changes in technology and company market orientation. The idea is that it is a) possible to maintain either the core technology or familiar business and try to explore new possibilities in some other field e.g. to stick to ones own core technology and aim for new markets by new applications or b) to stay in the traditional markets but search for new technological opportunities or c) change both the markets and the technology. As an examples the Tutti-project considered "Short distance mobility in all scenarios" where the technology platforms vary but the business remains, and "Robotics applications in all scenarios" where the technology platform remain but the markets (customer needs) may change. Principal positioning of these example approaches groups is illustrated in figure 4. Note that a Two-by-two concept positioning matrix is situated on the top surface of the cube. The vertical dimension of the cube represents time. Concepts developed today are eventually positioned in the two-by-two matrix at a certain time (e.g. the year 2020, the Tutti-project reference). The dashed paths inside the cube illustrate the strategic reference direction i.e. the focus of concept development and the curvy path illustrates the possible road of the company to its future state – in this case it would eventually be active in a new business utilising new technology. Thus by implementing the method described it is possible to try to predict the company position beforehand.

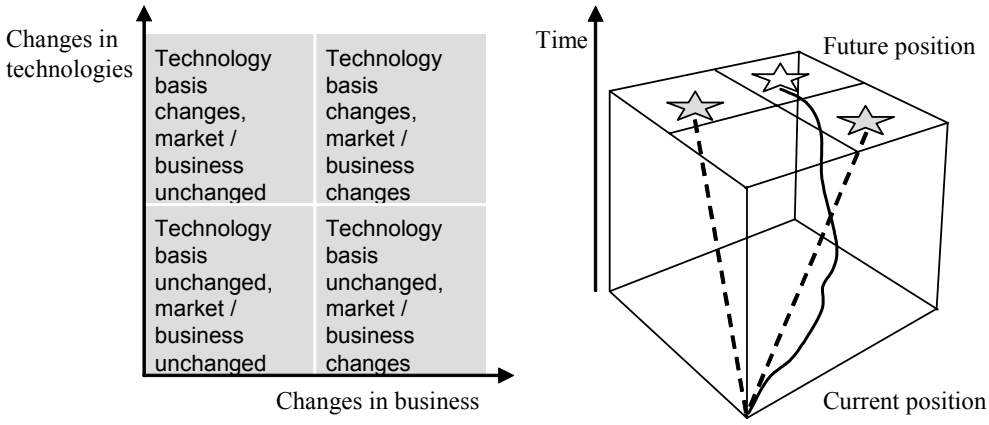


Figure 4. A Two-by-two product concept positioning matrix and its use with time related development paths

As examples of method application results and visualised future product concepts in the Tutti-project there are next presented four concepts derived from theme level scenarios: "Step-in-Car" and "Mall Mule" representing the "short distance mobility" -group and "Fly-Tron" and "Automated Textile Machine" representing the "robotics"-group. "Step-in-Car" and "Mall Mule" are created based on same business knowledge. Both are based on "Short distance mobility" theme but the technology platforms differ from each others. "Step-in-Car" is developed for the Sabotage-scenario and "Mall Mule" for the Business as usual scenario. Creating design drivers for 'short distance mobility' within the Sabotage-scenario included questions like what aspects would affect how people would get from a place to another in an insecure urban environment, what kinds of vehicles would/could exist, what product properties would the users expect, what types of dangers should be considered etc. In this case the design drivers eventually included e.g.: fear, selfishness, uncommunicativeness, readiness to compromise on e.g. environmental issues for the sake of safety and overall and constant safety awareness. "Fly-Tron" and "Automated Textile Machine" on the other hand are based on same technology platform – robotics – but they are targeted for different kinds of markets. "Fly-Tron" is for the Sabotage-scenario and "Automated Textile Machine" for the Changing values –scenario.

Step in car – a two passenger light vehicle for urban traffic fulfils the need of safe transportation in urban environments for the middle class by offering a safe transportation alternative for pedestrians. It enables short distance travelling without the need to step outside. The step-in-car also replaces some of the car usage. The step-in-car protects its users from possible outside threats in the street environment such as pollution, noise and violence. In addition to the actual protection, the step-in-car also offers the feeling of safety, privacy and integrity to outdoor movement. The achieving of the high level of safety in the step-in-car requires the use of highly developed materials in the frame construction. The step-in-car has to be able to use several alternative fuel sources, in order not to subject for problems in fuel distribution. The air inside the car should be filtrated to suit breathing etc. No revolutionary technology is, however, needed for this concept.

Mall Mule – an automatic person transport system for use in department stores and malls enables customers to move easily in large malls. The Mall Mule will handle transportation inside the malls as well as between the parking facilities and the mall. With the help of a multimedia connection it enables services tailored to suit the customer profile (advertisements, notifications, product-presentations, payment methods etc.). The Mall Mule also enables department stores and malls to control and guide the flow of customers. The concept consists of an automatic transportation system for persons, passage-control and an

enclosed service-function system. The Mall Mule is based on a guided vehicle-technology that is superior to the present. The cart in the system constantly monitors its environment, with the help of cameras and other sensors, and moves smartly, controlled by the system. The storage of the cars is handled by specific storage towers, where the cars are stored at top of each other. At the same time they are charged while waiting for the next user. There already exists guided vehicles with similar technology as the Mall Mule.

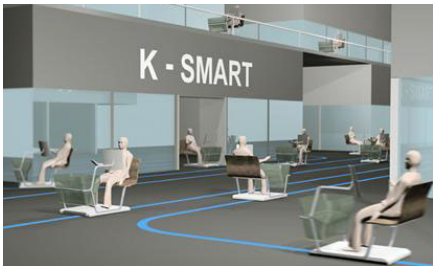
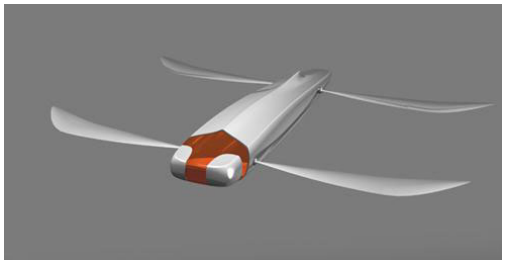


Figure 5. The 'Step-in car' concept derived from the Epidemic & sabotage scenario and the Mall mule' concept derived from the Business as usual scenario

Fly-Tron – an insect like sensor equipped surveillance gadget prerequisites technical implementation and development of energy storage techniques, lighter more sensitive and less energy consuming cameras and sensors and bringing these technologies to the market. Further development of contour recognizing systems and other systems enabling autonomous movement are also needed. No actual technology-revolutions are however needed to enable this concept either. The concept responds to increasing personal safety and environmental surveillance needs rising in the Sabotage-scenario. The Fly-Tron replaces other gadgets and security- and guard-services. Indoors, such as at home or at a hotel, the Fly-Tron ensures a certain safe environment by autonomously overseeing the quality of the air, the safeness of the space and integrity of property, the medical condition of the owner etc. The Fly-Tron interacts with other similar robots and its own docking bay, where it recharges when needed.

Automated Textile Machine – an automatic manufacturing unit for clothes operated at 'clothing cafeterias' responds to brand-adversity and prioritizing of local production in the Changing values scenario. The Automated Textile Machine is a miniature factory, which in addition to the manufacturing machinery includes a customer interface and a three-dimensional scanner, with which the machine records the customer's personal measurements. The ordering of clothes does not necessarily demand scanning, because an updateable personal profile can be registered into the system. The customer is able to produce a pleasing garment by choosing and combining alternatives from different designers' catalogues or by creating the model for the cloth personally. The garment is then produced automatically.



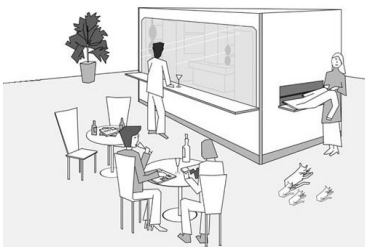


Figure 6. The 'Fly-Tron' concept derived from the Epidemic & sabotage scenario and the 'Automated textile machine' derived from the Changing values scenario

5.2 Product vs. System Oriented Development

In the creation of the concept examples it was noticed that the deeper the focus was on concept development the more factors had to be taken into consideration – the role of an individual product as a part of a system is less important if we consider longer time scales. As an example it is difficult to conceptualise e.g. a trash can for the future without thinking about the way how people live and produce their waste in e.g. fifteen years and what kind of recycling systems will be available then. Today's bin would respectively however be relatively easy to re-design because the system in which it is part is known. We are also familiar with the current limitations in business, manufacturing technologies etc.

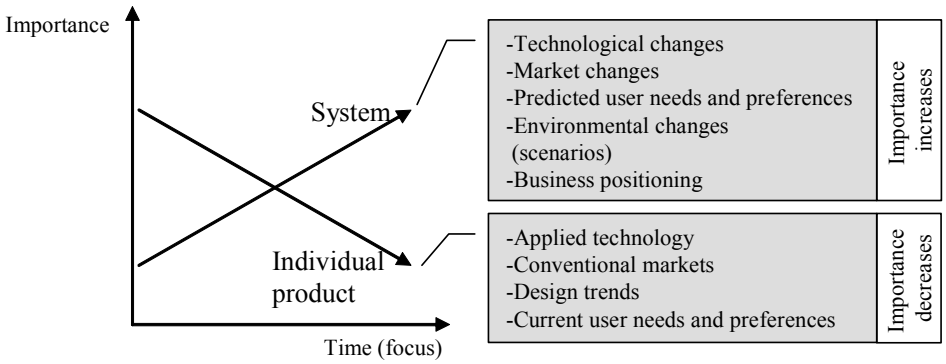


Figure 7. Characteristics of product vs. system oriented concept development

If we develop a product or a product concept for the near future we know our markets and there are certain ways to apply existing technologies. It is also possible to collect information about the users and e.g. the role of design and product image is important. But if the focus is further away in the future today's know-how may not be sufficient. It is important to find out how technologies and markets probably change, what are the surroundings and predict the future user needs. There must be methods available and applied as the one described in this paper for the future data "collection". The knowledge of conventional technologies and markets lose the importance and e.g. the outer appearance of the products may have no real significance in visioning concept development (when used as a support of industry foresight). We have to submit the visioning concepts created in the Tutti-project for criticism because at least some of the concepts seem to represent better the category "emerging concept development" than "visioning concept development". Some concepts are visualizations of individual products which contain new or emerging technology and which have a strong but not holistic link to the system around. In the idea generation phase there were several topics - like recycling and public transportation systems - that forced to think wider than only product oriented. The design team was in many cases not able to reach a clear conclusion whether the results - visioning product concepts - could be regarded as more than product centered visualizations. In retrospect this observation is obvious.

6. Discussion

The method presented should not be viewed as a computer aided tool for concept creation. It is more a kind of framework tool for systematic scenario based future product concept generation work. It defines the main steps, phases and principal tools but also leaves room for case by case modifications and further development. Taking into consideration the often qualitative nature of the data processed when applying the method it is not ideally suited as

basis for a computerized tool. For individual more narrowly defined method associated steps e.g. concept evaluation there have however been developed many types of software applications. Perhaps the main feature of the method is offering a systematic tool when looking for product development strategy alternatives in a rapidly changing world. It should be noted that as such the method application may yield e.g. also ethically clearly questionable product concepts if some design drivers are allowed to dominate without limitations. Scenarios may show potential for extreme type products with undesirable health and environmental effects, safety risks, risk for social segregation, risks for conflicts etc. Ethical evaluation of the product concepts should always be included in the method application by the user because as such the method treats all futures and concepts without preference. Methodologically the approach developed and applied in the project clearly presents strengths, but it also has some notable shortcomings. A suggestive SWOT analysis is here presented in figure 8 to summarise the main features.

Strengths - multidisciplinary approach - visionary approach - strategic dimensions - communicative values - bringing management and R&D together	Weaknesses - lack of "common language" and terminology - collection of basic and background information time consuming and costly (need of automation and links to BI systems)
Opportunities - several possibilities for further development and refinement - commercial utilisation in real industrial cases	Threats - process may be considered too strenuous by companies - results considered too futuristic or unrealistic, fast application difficult

Figure 8. Conceptualising method suggestive SWOT analysis

7. Conclusions

The main results of the TUTTI research project as presented in this paper are: 1) A description and evaluation of a methodological future product concept generation process and associated tools, 2) examples of case product concept descriptions and visualisations resulting from the method application on selected products and product groups and 3) Initial evaluation of the approach's usability as product development management decision making tool. A notable finding was that regardless the basic type of product concept the process as such seemed to fit the same general format in most cases. A notable byproduct was also the clarification of several topic (concept development) related definitions and the associated vocabulary. The multidisciplinary research group carried out a systematic process of creating alternative 'world' scenarios and developing future product concepts. The methodology was evaluated and further developed in the process. As a conclusion the method was found applicable and to yield interesting results and as such proved a suitable basis for further application and development. Dealing with future the method by nature however contains numerous uncertainties and difficulties which have to be carefully taken into consideration when applying it. Practical applications also require more narrow focus the more detailed results are expected. The utilisation possibilities of the method as a decision making tool require further investigation. The initial response from companies however has been positive and further cooperation is expected.

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