

The CHALLENGE *of Complexity*

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Scenario-building in the product design process

THINKING IS A COMPLEX PROCESS. THEORETICIANS HAVE MADE COUNTLESS ATTEMPTS IN PAST DECADES TO SIMULATE OR QUANTIFY HUMAN COGNITION, OFTEN TO END UP WITH ADDED COMPLEXITY BROUGHT INTO SUCH EFFORTS.

Considering the needs of the consumer or user is one of the most important and complex parts of the product design process. Its complexity comes from the requirement to view 'need' in its broadest sense, including the physical, social, psychological and economical needs of the user. Ergonomics, market research and related human sciences provide tools and methods for designers to consider user needs. However, it is often claimed by designers that although they rarely use such tools and methods, they do cope with complexity, doing their upmost by employing their own methods. A study conducted by the author in the course of her Ph.D. study[1] in England and Wales revealed that designers most favorably used scenario-building as a spontaneous and informal method in considering needs of the user in the design process.

Most design projects involve scenarios, however these scenarios are neither apparent in the final product nor in their presentation. Similar to other formal or informal methods, scenarios are seldom documented during the design process. In the face of recent legislative and organizational pressures and the consequent changing nature of the design process, however, documentation and formalization of thought processes within the design process will become crucial in the near future.

One of these pressures is Product Liability legislation, which has made designers far

more responsible in relation to accidents. According to the EC Directive of 1985[ii], any buyer or user will be able to claim compensation for damage or injury caused by a 'defective product', without having to prove that the manufacturer or designer were negligent. The directive renders the consideration of 'foreseeable misuse' very important. Therefore, a designer must consider the characteristics of both the product including its physical environment and its users, including any person who may have any type of contact with the product, even if, in certain circumstances, personal factors appear to be more dominant to cause an accident.

An important organizational pressure is the growing need to align designers' and managers' perspectives. According to David Walker, designers and managers are like two different tribes who have grown up in different parts of a jungle. As stated by Walker, the miscommunication between the two has its roots in their different aims, different educations and different styles of thought. In their thinking styles, managers appear to be serial, linear, analytic and problem oriented, whereas designers are more holistic, lateral, synthesis-oriented and solution-led.[iii] On one hand, managers are frightened by creativity and they do not want to take the risks that accompany the inherent uncertainty of the design process. On the other hand, designers do not like to justify their thoughts by any formal method or device, because they do not want to be interrupted in their creative process. The result is a demand to externalize designers' thoughts by certain methods which will be compatible with managers' thinking styles and which can accommodate uncertainties.

Another important pressure is Quality Assurance standards, particularly ISO 9001.[iv] Quality standards brought into prominence the issue of standardizing design practice. In order to meet the given requirements for Quality Assurance, all decision procedures need to be systematically planned and recorded. Such procedures require full reflection on the needs of the user.

This paper offers scenario-building as a methodology to externalize designers' thoughts and to navigate through the complexity of design and the product development process in organizations. Scenario-building is commonly used in business forecasting as a powerful tool to cope with problems which involve uncertainties. It is also used in Human Computer Interface (HCI) studies in order to simulate and envisage possible interactions between users and technologically complex products. Such a method promises to also be effective in future product design practices, since it utilizes the designers' most effective: the imagination.

1.0 THEORETICAL BACKGROUND

The roots of scenario-building as a thinking style and method can be sought in two different areas: cognitive psychology, which studies how the human brain works, reasons, represents information and solves problems, and future studies, particularly in business management, which studies methods that could be used to discover alternative futures for an organization and its tasks.

1.1 SCENARIOS AS COGNITIVE MODELS: SCHEMATA, SCRIPTS, SCENES AND EVENTS

According to Piaget, in order to adapt to their environments, all organisms build a model of the world in their minds. This model is built up by the individual's experiences. Such experiences take the form of frameworks which are called schemata.[v] In cognitive psychology, schemata are generally viewed as active models of our environment, which continuously change as new experiences are added. Piaget suggests that the first schema that an infant develops is its body schema. According to Rumelhart, among several approaches to schemata theory, schemata can be viewed as plays containing information about characters, settings and scripts for appropriate sequences of action.[vi]

In cognitive psychology, scripts and scenes are viewed as types of schemata. Schank and Abelson define script as a spatially-temporally organized body of knowledge that defines actors, actions and objects likely to be present in a given situation.[vii] As established by developmental psychology, young children prefer to represent their knowledge related to categorization of objects in the form of scripts. According to Fivush, a baby as young as 13 months spontaneously acts out appropriate actions with realistic event props.[viii] Scenes represent places, the rooms, streets and buildings in which our daily routines take place.[ix] Scripts and scenes are mental models which represent our knowledge of everyday life and are included in any thought process.

Scenario-building can be considered as thinking through events. Such events involve characters, actions, settings, objects, scenes,

etc. Designing involves scenario-based thinking in which the central theme is an object that, in the end, leads to a product. In various stages of the design process certain characters may dominate the scenario, for example the 'end user' or 'targeted consumer group' (usually based on the designer's own body schema), in a setting which is the physical and social context of the design object.

1.2 SCENARIO-BUILDING METHOD IN BUSINESS FORECASTING

The first definition of scenario-building as a forecasting method was made by Kahn and Weiner: "Scenarios are hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision points."[x] Herman Kahn at the Rand Corporation was the first to systematically use such a method for future forecasting. His studies were generally based on macro-level, futuristic scenarios, which dealt with major global changes in the social, economic and political systems of the future world.

Scenario-building later brought insight to business forecasting. It is commonly used as a forecasting method in strategic planning. Although it is mainly used as a qualitative method, some quantitative applications of it also exist. In comparison to Kahn's scenarios, scenarios in business are more focused on the aspects of the environment that directly affect relevant products and markets.[xi] They are mainly used with a holistic approach. In design, scenario-building is also focused as it is in business; however, it does not possess a holistic nature, since factors affecting design such as safety, cost, human factors, environment, etc. are so diverse, and most of them take their information input from different disciplines. Therefore there is always more than one scenario governing the design of a product. The nature of the method as used in design is closer to the definition made by Mendell for "mental scenarios": "any collection of ideas about the future: images of the past, present and future, theories, frameworks, numbers and graphs, phrases, etc."[xii]

2.0 SCENARIO-BUILDING AS A MODELING ACTIVITY IN THE DESIGN PROCESS

In the design process scenario-building can be viewed as a type of modeling method. As designers build physical product models in the form of mock-ups, prototypes or drawings, they build models of its user, the way it will be used, and the context in which it will be placed. A scenario in relation to a design product can be thought of as a model of cross-sections of time from the life of a yet-to-be-designed product, in which that product is purchased, used, stored, etc. in its physical and social environment.

In 1991 a field study was devised as part of the author's Ph.D. study to investigate the user models employed by a population of 55 design practitioners working in England and Wales. In this study, three major approaches to model the user were identified:

1) Empirical models are the user models which the designer builds upon the information he has retrieved from related human sciences such as ergonomics, market research, product semantics, etc.

2) Experimental models are the user models which are built upon the results of experiments, observations, panels, protocols, etc., which explore user-product interaction. Ideally, such experiments are done with representative users, however, the designer may also use himself as a subject to experiment with his design. He considers himself as the user and acts out the use process. This is called self-modeling.

3) Scenario-based models are the user models in which the user and the use process are finally characterized as a creative process by combining the information adopted from both empirical and experimental models.

The results of the investigation indicated that almost all of the design practitioners employed scenario-based models. Their attitudes toward the usefulness of such models were positive, whereas empirical and experimental models were employed to a lesser extent. Approximately 50% of designers explicity employed such models. However, designers also very often used self-modeling. In this respect, the actors or the actresses of the scenarios they built were the designers themselves.[xiii]

Similar to Piaget's 'schemata', designers' scenarios are dynamic models of events and environments which are in relation to the product envisaged. They change with the additional data from experimental and empirical models and with the added experiences which make up the designer's own self-model (body and mental schemata).

During the interviews it was widely believed by the designers that scenario-building was the core activity in the design process. It was done instinctively as part of a practitioner's

design thought processes. Usually the designer would put himself in the user's situation and write a short story about how his design would be used. Although it was widely employed as a thought-based procedure, it was evident in a few cases that scenario-building was sometimes carried as far as simulation, e.g. in user trials or in product testing.

Scenarios are built spontaneously and automatically and, most of the time, unconsciously. Unlike the scenarios that are used as a forecasting method, designers' scenarios are not well structured, complete, macro-level scenarios. They are usually in the form of fragments which take place in the cross-sections of a whole product life cycle, which starts from design and ends at disposal of the product. As stated by Mandler, event and scene schemata are hierarchically organized. Designers' scenarios also have a hierarchical structure, where smaller scenes and events are embedded within larger ones.[xiv]

In design, scenarios are not always predictive or futuristic. In order to make predictions about the future, one needs to establish historical and contemporary perspectives concerning the same subject matter. Here such historical and contemporary accounts are referred to as retrospective scenarios , and predictive and futuristic narratives are referred to as prospective scenarios. For example, in product design some typical retrospective scenarios are operational scenarios, which are about how a certain type of machine typically works, etc.

3.0 SCENARIOS IN RELATION TO PRODUCT LIFE CYCLE

As is postulated in numerous studies concerning the design process, a product is assumed to go through a cycle consisting of such stages as design, production, marketing, retailing, purchase, use and disposal, etc. Each of these stages provides information feedback to the design process, finally leading to a similar product going through the same cycle. Within this cycle, when the design process is examined, it consists of several activities including problem identification and formulation, research and analysis, concept development, product development and product testing (Figure1).

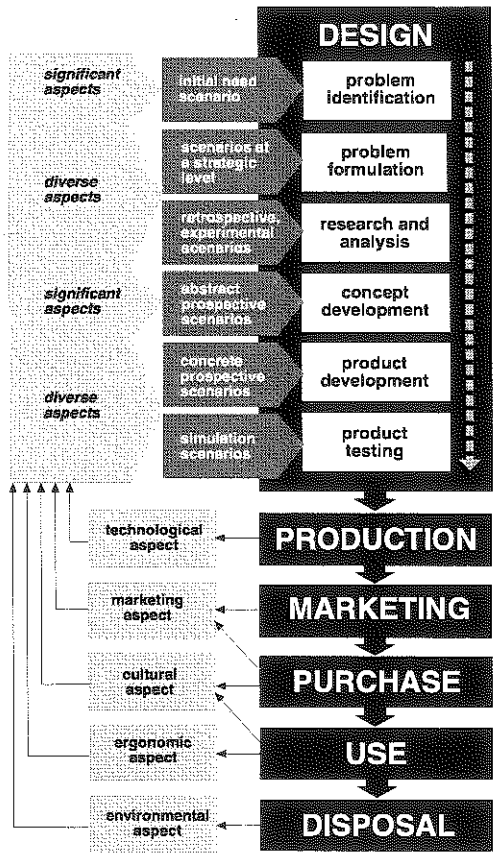


Figure 1.

As argued for many years by theorists and practitioners, this is not a linear process. There are interactions and overlaps between these activities, however, the order of such activities in the figure implies a progression flowing from top to bottom.

Scenario-building activity differs in its nature, depending on the activity in the design process to which it is employed. During the first two activities, problem identification and problem formulation, the scenarios are usually built at a managerial level. In the problem identification phase the scenario is built on an identified societal need to be satisfied. Identification of such a need might be based on the entrepreneur's, marketer's or the designer's own everyday life experience or observations. In the problem formulation phase scenarios are usually built as part of the business strategy, where the design brief is established.

Research and analytical activity usually interacts with other activities and stages throughout the design process. At the preliminary stages of the design process, where the initial needs governing the design brief are researched and analyzed, scenarios are built retrospectively, based on existing knowledge and events. When research and analysis is done in the latter stages of the design process, in relation to emerging design ideas, scenarios might be used in testing the design idea with representative characters and in a representative context.

At the concept development phase, where the basic design idea is formed, scenarios are usually built prospectively, at an abstract level, and focus on the main aspect of the design matter that will address the initial, specified need. When at the product development phase, the design idea evolves to become a real product prospective scenarios has to become more concrete and more holistic in their nature. Diverse aspects of the design problem other than the ones which govern the response to initial need also have to be considered. At the product testing phase, when the design idea is embodied in a prototype or a product, prior scenarios can be tested on a working simulation.

4.0 SCENARIOS IN RELATION TO DIFFERENT ASPECTS OF PRODUCT DESIGN

Disciplines such as ergonomics, HCI (Human Computer Interaction), market research, sociology, product semantics and engineering, which provide input to the design process, offer different frameworks to use scenarios in the design process. Characteristics of existing methods of scenario-building which take their feedback from the aspects of such disciplines will be discussed below.

4.1 USAGE SCENARIOS: ERGONOMIC ASPECT

a) Operational scenarios

Operational scenarios can be both retrospective, e.g. how an ordinary washing machine works, and prospective, e.g. how the interface of a yet-to-be-designed washing machine will work.

b) Event scenarios

Event scenarios consider the product in its everyday usage environment and take into account every possible desired or undesired event that can feasible occur in relation to it. Event scenarios include considering every possible kind of user (e.g. third party users, bystanders, people with special needs, etc.) who could interact with the product, and every possible kind of usage behavior (e.g. secondary usage, misuse, abuse, etc.) in relation to the product. Event scenarios may be retrospective, for example typical accident scenarios [xv] derived from existing accident data, or they may be prospective and totally imaginary, in the form of story-boards created by the designer. They can also be prospective while still using existing data about past events in a systematic manner, for example creating hypothetical events by combining typical patterns of actions with existing external forces in relation to the usage of a product.[xvi] Such scenarios help the designer to foresee potential accidents and similar undesired events which might be caused by his product.

c) Cognitive/semantic models

Particularly in the case of complex electronic interfaces, where the user has to combine a series of actions with functions of the product to accomplish a task, the designer has to build certain scenarios to anticipate the different ways in which people might access those functions. This usually follows a formal or an informal 'task analysis process', where the user's tasks, goals and activities, and the product's functions related to those tasks, are identified and subsequently prioritized or systematically linked to each other in the design. They are particularly used when defining very complicated activities, and in anticipating the

potential interaction of the product with its future user. Such analyses can be based on the information gathered after observing users in their real use contexts.[xvii] this helps to identify compatibility between the user's perceptions and the product's attributes.

4.2 RITUALISTIC SCENARIOS: CULTURAL ASPECT

A ritualistic scenario can also be both retrospective and prospective. A retrospective glance at a ritual for design purposes would explore and analyse how norms, values and habits are formed in a society in relation to the usage of products. A prospective ritualistic scenario, on the other hand, would create a new ritual in relation to the changing values and attitudes within a society.

4.3 PSYCHOGRAPHIC SCENARIOS: MARKETING ASPECT

Psychographic scenarios are formed in the tradition of consumer profiling or lifestyle profiling studies for market research purposes, which are employed as an integral part of the 'Market Segmentation' process. It consists of describing the personality and lifestyle of the consumer in terms of stereotypes. Assumptions are usually based on empirical data, researching the activities, interests and opinions of the consumers, in order to label their personality behavioural characteristics.

4.4 TECHNOLOGICAL SCENARIOS

a) Process scenarios

A process scenario of a product involves the process sequence in the production of a product related to the design subject. Depending on the design brief, it may provide a powerful insight to the design concept.

b) Futuristic scenarios

Futuristic scenarios within a technological context take a prospective approach to future developments related to the technology of product or process.

4.5 ENVIRONMENTAL SCENARIOS

Scenarios within the scope of environmental aspects of the design process may be built at a more macro and strategic level: input may include environmental contamination and the destruction of natural resources. Such scenarios analyze the whole life cycle of a product within an ecological system and aim to determine the scenario most favorable to the environment.

5.0 FORMALIZING SCENARIO-BUILDING AS A DESIGN TOOL

As identified earlier, scenarios differ in their nature according to that part of the design process in which they are employed and depending on the disciplines by which they are guided. The common characteristic of all such scenarios is that they involve certain elements: characters, settings, actions, events, etc. Nearly all design projects involve scenarios, however, most of them are limited since they involve only one character, the same sequence of events in a single setting: i.e. the typical end user using the product in the required way in anticipated social and environmental conditions. The following procedures offer scenario-building as an effective methodology with the design process, to broaden the spectrum of design ideas and to make them communicable.

5.1 BUILDING HOLISTIC SCENARIOS RATHER THAN FRAGMENTS

Designers' scenarios are usually in the form of fragments, considering each significant factor affecting the design problem. Usually in such fragments, a single description of an event, a character or a situation is involved. In order to make scenarios communicable, a more holistic scenario should be built like a narrative, involving descriptions of main and sub-characters, physical and social contexts, actions, events, relationships with other objects, etc.

5.2 INTEGRATING EXPERIMENTAL AND EMPIRICAL MODELS TO SCENARIO BASED PLANNING

Scenarios in a holistic sense can be employed throughout all stages of the design process, where empirical information is analyzed within retrospective scenarios. Experiments with users or opinion tests are employed as part of such scenarios. Prompted by such analyses, the scenario is then completed with a prospective look towards new design solutions offered for the future.

5.3 EXTERNALIZING DESIGNERS' SCENARIOS

Some conventional methods for representing scenarios are story texts, flowcharts, snapshots, storyboards, reports, etc. Various media tools can be used to present them, including sketches, photographs, videos, computer simulations etc. Designers' most powerful tool is to be able to visualize imaginary contexts: in an organizational environment, a visually presented scenario can best convey the thought procedures behind a design idea.

5.4 DIVERSIFYING CHARACTERS

Characters define actors and actresses in a scenario, and refer to the consumer, user or any stakeholder of a yet-to-be-designed product. There is wide-spread opinion that designers' scenarios, which are mainly based on their self-models, renders the design process an individual response, which as such cannot be considered justifiable or reliable. A powerful design scenario should aim to characterize representative users from real life including possible atypical users who may have any type of contact with the product.

5.5 DIVERSIFYING SETTINGS

A setting refers to the physical and social context in a scenario. A robust design idea requires visualization in a variety of possible usage environments, social contexts, dynamic and diverce situations.

5.6 DIVERSIFYING ACTIONS AND EVENTS

Events form the story of a scenario. Actions are elements of events performed by characters. Events in a scenario may illustrate the possible occurrences related to the usage, purchase, life cycle or evolution of a product. One can list countless occurrences in relation to a design idea. Design scenarios may aim to select the most critical probabilities regarding the future everyday life of a product. A commonly used method for this is to imagine a best- and worst-case scenario. The ultimate aim of this method is to develop strategies for surviving the worst case, and exploiting the best case scenario.

5.7 TESTING THE DESIGN PRODUCT WITH OTHER DESIGNERS' SCENARIOS

A design scenario can be tested by presenting it with different scenarios to design teams other than the product's actual design team.

5.8 ENABLING MANAGERS AND DESIGNERS TO COLLABORATE IN BUILDING SCENARIOS IN THE PRELIMINARY STAGES OF THE DESIGN PROCESS

Decisions concerning the problem identification and problem formulation activities of the design process are usually taken at a managerial level in organizations. In-house designers or outside consultants are usually involved in the process after these two activities are completed. The designers' contribution to such stages, however, is crucial since they can bring insight from their own point of view to identifying of a need and formulating strategies to respond to it with a design product. Scenarios are effective tools in building a communication links between designers and managers in order to accomplish this.

6.0 ADVANTAGES IN ORDER OF SCENARIO-BUILDING

The advantages of scenario methodology in the design process, when employed in such a broadened spectrum, can be listed as follows:

1) A scenario may cover many aspects of a design problem that cannot be covered by statistical analyses based on observations and measurements from real life, or by experiments. Such research and analysis methods can only produce retrospective results from existing events, situations and contexts, whereas in a scenario-based analysis, the investigator can imagine a broad range of events with many alternative design ideas. Furthermore, some events, such as accidents involving users, cannot be staged experimentally. Therefore scenarios are prospective and they can call attention to a larger range of possibilities.

2) Scenarios can consider many kinds of user and many circumstances of usage which can be excluded in empirical or experimental modeling.

3) Scenarios enable designers to consider the design product through the dynamism of time, involving aspects from the past, present and future and to integrate various dynamic notions with the product such as actions and events.

4) Scenario-building offers an implicit, qualitative method to deal with uncertainties. Scenarios possess a flexibility to encourage other creative thinking methods such as brain storming, lateral thinking, synectics, etc.

5) Scenarios are built on a highly rich and extensive knowledge base covering all the social, psychological, environmental and physical experiences that a person can possess throughout his life and which cannot be created in a computer.

6) Scenario methodology offers a powerful tool to eliminate the difficulty of utilizing everyday life knowledge which is richer, besides being highly unstructured and complex, in comparison to empirical knowledge, which is more structured and factual.

7) In scenarios, several events and several different aspects of a design problem (ergonomic, technological, marketing, environmen-

tal, etc.) can be collective considered.

8) Scenario-building is a heuristic method. Scenarios can illustrate certain principles and questions, sometimes in an oversimplified fashion. In many cases, such principles and questions might be ignored or lost if the references are taken only from a complex and controversial real world.[xviii]

9) Scenarios have a high educational and communicative value, since they can be intentionally dramatic and literary in style.[xix]

7. CONCLUSION

Scenario-building is a cognitive process, which is consistently practiced by everyone from a very young age. For this reason, it is a very effective idea and knowledge representation tool, as well as a good learning and communication's tool. In the design process, scenario-building is commonly employed naturally and spontaneously in an unsystematic way. In this paper it is emphasized that if their communication qualities are enhanced and their spectrum is broadened, scenarios can be utilized as a robust methodology. Scenarios are proposed to be formalized to the extent that they can restructure and broaden designers' thoughts making them explicit to outsiders, rather than dictating or constraining the sequences of the design process.

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