ENGINEERING AND PRODUCT DESIGN EDUCATION CONFERENCE
7-8 SEPTEMBER 2006, SALZBURG UNIVERSITY OF APPLIED SCIENCES, SALZBURG, AUSTRIA

NEW REPRESENTATION TECHNIQUES FOR DESIGNING IN A SYSTEMIC PERSPECTIVE

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ABSTRACT

Industrial production is challenged to generate highly individualized solutions, which should adequate global production to local systemic conditions. This represents a paradigm shift both for industrial organization and for designers, who will need new tools to analyse and design the system, but also to communicate the system to a wider audience.

This paper will emphasise the relevance of those issues in the design activity and outline the main methodological problems to be addressed. The authors will then offer a contribution in this area by providing an overview of different methods and tools used in previous projects and from teaching activities.

Keywords: systemic solutions, representation techniques methods and tools

1. BACKGROUND

Industrial production is required to respond to a more and more complex demand, especially in western countries, where markets are saturated, but social patterns and lifestyles are still changing rapidly, mainly due to population ageing and immigration. Companies are addressing this change with a progressive segmentation of their offering: the early models of consumer segmentation are less and less efficient in those markets, indeed such a social context would require a very fine market segmentation , up to the level of *individual segments*, which capture individual values and need in local contexts. The solutions companies should provide must address global changes and, at the same time be adapted to individual contexts of use. Companies are therefore forced to work on both global and individual level. They need to design products for a globalised market, but, at the same time, complement their offering with a higher number of individual and local services. This is possible by creating a network of connections with other companies, sometimes even competitors, to generate local solutions.

This represents a paradigm shift in industrial production, which will deeply affect the designers' activity. In the new paradigm, the production of material products will become less and less relevant in business strategies, whereas the design of solutions including both material (products) and immaterial elements (services) will be the main task for industrial companies and for designers. In the new paradigm, solutions are being proposed, which aggregate different actors, institutions, suppliers, service providers and final users, to cooperate in a *co-production* process [1, 2].

The solutions to be developed in the new paradigm need an adequate planning that creates the conditions for their *industrialisation*[1]. The production of such solutions should be planned according to formalised procedures that identify the various system components and show how to aggregate them in a meaningful systemic way. The new

[1] In this paper the term *industrialisation*, related to the new solutions, is not used to refer to large scale production, it rather indicates the use of the industrial logic (based on formalised description of activities, subdivision of roles and economy of scale) to plan the new solutions. The quantitative and social dimension of the new solutions cannot, in fact be compared with traditional industrial processes.

paradigm shift suggests that designers redefine their methodological approach and find an adequate *operative paradigm*[2] for the new context.
The research for an operative paradigm involves several disciplinary aspects of the design activity: from the analysis of the systemic context generated by the new demand to the design of product-service systems (PSS). Those aspects have been analysed in several research works [4-6] and will represent the background of this paper, which will instead focus on the issue of representation and communication of such solutions. .

1.1. Communication and representation techniques: why are they so critical?

Local systemic solutions are only possible by means of a solid cooperation between companies and local actors. Designing such solutions is a new challenge, as it broadens the number of players the designers should talk to. The most traditional view of the design activity is based on a direct relationship between designers and industrial companies. This view could not hold for a long time in the new paradigm, because it ignores the role of final users. In the development of highly individualised or localized solution, the users are meant to play and active role. Norman [1, 7] considers final users as *co-producers*[3].
New representation tools are needed for designers to communicate the new systemic solutions to a broader audience of actors. The clarity of those tools is critical: likewise engineers and technical people in the production departments, all the other actors, including customers must understand what their role is in the system, what they are expected to do. If communication is not effective, there will be no final solution.
Designers have good communication tools to manage the material part of their solution, but they are not necessarily able to represent the immaterial parts (i.e. interaction, events, sequences of actions) which must be effectively communicated. The new representation techniques will need to include both technical representations and more *colloquial* methods, to talk with customers/co-producers, who are not supposed to spend too much time in understanding what to do to get what they want.
Finally, representation and communication techniques play a critical role also in the earliest phases of the design and development process. In this phase, the immaterial elements of the project need to be captured and framed in logical schemes, diagrams and storyboards that explain their relevance and help defining the actors that will to co-produce the solution.

2. MAPPING NEW REPRESENTATION TECHNIQUES

The new representation and communication techniques will be used to provide several kinds of information to different kinds of people. According to the characteristics and the aim of communication, some tools can be defined, which represent the new territory of communication tools for designers. Different tools can help designers communicating from the early phases of analysis of the context to the last design and development phases. In particular they would address the following questions:

- **Who are designers communicating with?** Different actors talks different languages and, therefore different communication techniques.
- **What is the content of the communication?** An overall description of the system or a detailed description of products, events and infrastructures?

[2] Arbnor and Bjerke [3] define an *operative paradigm* as a set of methodics and methodical procedures borrowed by different disciplinary contexts and opportunely adapted for operating in a specific problem area.
[3] Norman suggest that if one focuess on the real offering of IKEA, “the home furnished according to one’s individual preferences” it becomes clear that IKEA only provides part of this offering, the other part being provided by the user him/herself, who designs his/her own ideal home (helped by the IKEA catalogue), collects and transports the furniture and assembles them at his/her place.

- **What is the level of definition in the representation?** The earliest concepts and the final solutions require different communication tools.

The following paragraphs and illustrations will provide indications on some of the tools used in the analytical and design/development phases in previous research projects and teaching activities[4].

2.1. Analytical phase

Actor Network mapping

Actor network mapping gives an overall picture of the network of actors and components in the system. The focus is on roles, grouping and relations. The grouping aspect of the technique is used to organise the actors by their function. Depending on the actor in the centre, this technique emphasises the roles of the other actors in relation to central actor. By focusing on a service's clients, for instance, the map visualises supporting actors and components from service providers. This would constitute a user perspective on the system, but not necessarily be a user oriented representation. Furthermore the Actor network map can be used as a mean to delegate main functions to actors. The designer can sketch different maps, using both new and existing service and components providers.

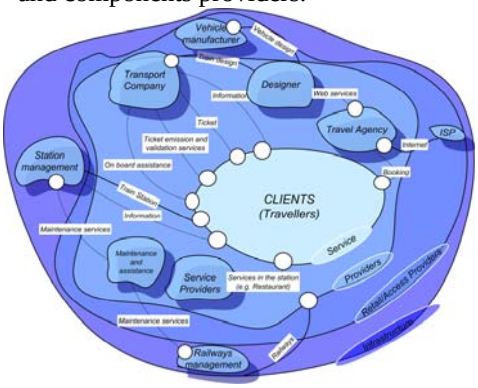

Figure 1 The actor network map as used by in a students' project for a car-sharing system [9]

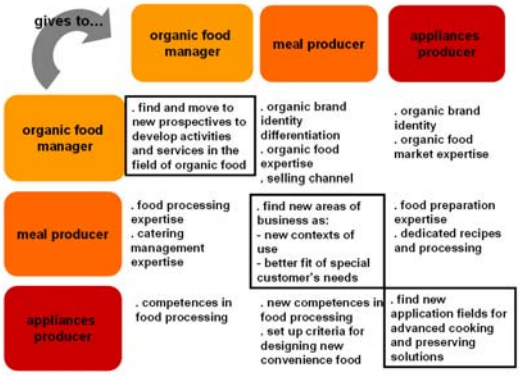

Figure 2 the Motivation Matrix lists actors expectations when cooperating with each other (source[4])

Motivation matrix

The motivation matrix, introduced in the HiCS project as a tool to coordinate roles and expectations from different actors, is a technique that visualises the functional relation between all the actors participating in a production system. This builds an understanding for *why* the various actors should participate or contribute to the system which is a fundamental step in deciding and organising their role and input. Filling up the cells in the motivation matrix forces the designer to actively reflect upon each actor's relation to the whole system and its single actors. This representation technique is therefore heavily depending on the text filled in to the matrix. The textual orientation therefore requires careful reading to extract the information from the map. The Motivation Matrix is mainly targeted at internal use and the perspective is primarily technical due to the construction point of view: the reason why each actor should be part of the system.

[4] The following sections will report methods and tools developed within the teaching activity of the school of Architecture and Design at Aalborg University [6], and other research project including *Telecentra*[8], *HiCS*[4] and SusHouse. The economy of this paper does not allow for an extensive description of the techniques. The bibliographical references, though, provide more information on each of those tools.

Design Orienting Scenarios (DOS) and Storytelling

Design Oriented Scenarios has been introduced in a SusHouse project [10] as a tool to figure out possible futures that can provide concrete indications about design actions in the present. Within teaching activities DOS, which do not contain detailed design indications, have been used as the basis for generating more detailed stories about time, interactions and events seen from the use point of view. The format contains both drawings and text, but the balance can vary from text book style supported by pictures to a storyboard supported with few lines of text. The main idea of this representation technique is to understand and communicate existing or potential situations. In the analytical phase storytelling can be used to understand possible ways of performing the service or action that is to be designed or redesigned. The story brings the events alive and visually expresses key problems, interaction issues and emotional factors in relation to existing systems.

2.2. Design and development phases

IDEF0

IDEF0 is a method to represent a sequential view of a system through examining an event and unfolding it into sequences of sub events. This allows for the organisation of tasks by inputs, outputs, controls and mechanisms for each task to be performed. This technical representation technique is a way for the designer to understand and construct the system. The use of the technique depends on viewpoints and the purposes, and therefore each representation requires a stated viewpoint and clear idea of the task to be performed by the system. The representation format is standard and rule based as well as flow oriented and directional, which makes it easy to read once the rules are understood. IDEF0 is widely used by the students to gain overview and understanding of the main tasks performed by the system.

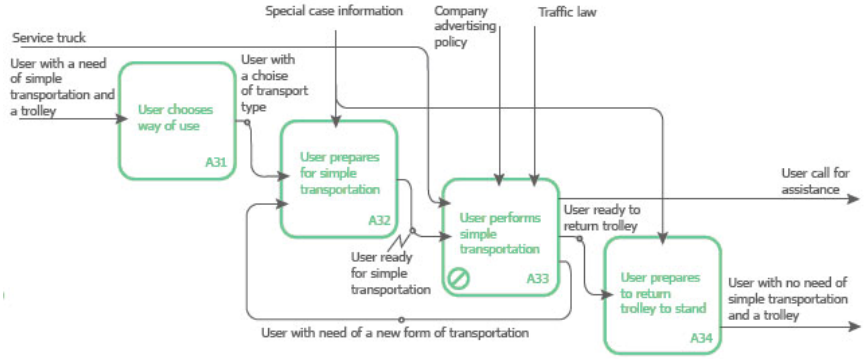

Figure 3 IDEF0, as used in a students' project on a shared bicycle trailer service. The service is described as a "production system" in which the customer is co-producer [11]

System Platform

The system platform representation is widely used to illustrate an overview of the actors and material or information flows in a system. The platform contains information of grouping of actors, components and flow of material and immaterial content between them. The platform representation explains how a whole system works and illustrates flows of money, information and material between the actors in the system. It can be used to demonstrate logic grouping of services, actors and components in order to clarify main aspects of the system.

The functional aspects include how and where the consumer interacts with the system. The constructional aspects focus on how service providers are grouped and how the material and money flows are organised. This representation technique does not use a fixed format, and thus icons and layout are variables that give the designer the possibility to emphasise certain aspects of the system. This kind of representation can have a more *colloquial* language, when used to represent the system to final customers or actors which are not familiar with other *technical* tools, such as IDEF0.

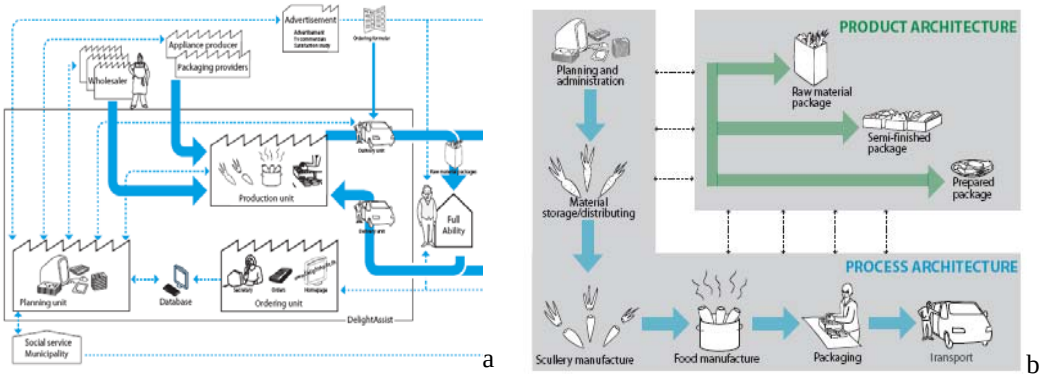

Figure 4 In this project for a food system for elderly people the students used the platform representation to organise actors and flows, both inside and outside the system (a). From this representation the student synthesized a system architecture (b)[12]

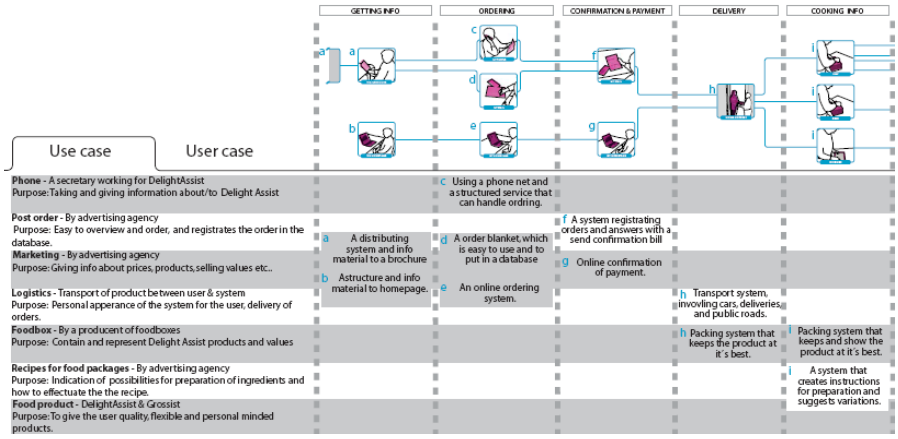

Figure 5 Use case for a food delivery system for elderly people. The step by step description of the events is outlined in the upper part of the graphic. The lower part describes the system behavior for each event. [12]

Use cases

Visual use cases are used to represent important time and interaction related aspects. Use cases visualize actions in a service step by step, allowing for a deeper understanding of the system in its details. The user is the main actor in most use cases; each step of his/her action involves the use of tools, components and procedures in the system. When representing all those aspects a use case provides synthesized information on the system behavior for each specific use condition.

The representation style can include boxes in various shapes to indicate action type for each step; the sequence from top to bottom or left to right emphasises the time aspect sometimes providing time indication for each step. Use cases can be illustrated with a *technical* style (with text in boxes) or with a combination of drawing and flow charts, for a more *colloquial* and user oriented communication.

3. CONCLUSIONS

When extending the designers' competences from products to system, the designer needs to acquire new tools to analyse the context, to design new solution and to communicate to a wider audience of *co-producers*. The issue of representation is particularly critical, because of the substantial role played by new actors, including final users. Design schools are therefore required to teach new representation languages that put design students in the conditions of talking all the actors and to work as professional competences that can mediate between different communication instances. In this sense designers are working as *platform organizers*, thus providing the basic communication tools to facilitate and support the design of systemic solutions. Some of the methods described in this paper are already part of design curricula in some European schools. However further work is needed to integrate teaching, research and practice for a more complete development of a toolbox for the future system designers.

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