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# Efficiency and resilience in product design by using morphological charts

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## Abstract

The paper presents the possibilities and results of using either brainstorming or morphological charts for the development of new products in the field of smart furniture. In order to ensure the best possible match between product characteristics and customer requirements and to shorten development time in terms of resilience, an application of morphological charts is presented. The process started with potential customer polling. The obtained data was centralized and processed as shown into morphological matrices and the results were validated within conceptual design experiments. Similarly, a pure brainstorming based incremental design solution is presented, as well as a combined approach, integrating both methods. Analyzed by several professionals in furniture design, the models resulted from the experiments show the potential of each method with respect to market targeted by a start-up furniture company.

## 1. Introduction and set-up

In the paper [1], the authors conducted a study upon the concept and definition of smart furniture, arguing the need to base new product development in this field on the requirements expressed or inferred by the customers. In a conclusion to their work, the authors of [1] propose a statement which summarizes the modern approaches in the field and will also serve as basis of thought for the current undertaking, which is meant to improve the appeal of

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smart furniture in terms if usefulness and aspect: "Smart furniture is the furniture which brings added value, functionality, comfort and elegance to fit every personalized requirement issued by the user".

The morphological analysis, also known as the morphological chart or box, is "a general method for structuring and investigating the total set of relationships contained in multi-dimensional, usually non-quantifiable, problem complexes" [2]. It was first proposed by Fritz Zwicky, a Swiss astronomer. According to [3], the use of morphological charts in generating conceptual designs is characterized by efficiency (i.e. large number of designs with limited data and under time constraints) and the ability to produce early results. The morphological chart consists of a table layout, which couples together the desired product functions (left-hand side) with the possible solutions for each of them (right-hand side), list in as much detail as possible its technical future characteristics/specifications [3].

Brainstorming is a classical method to elicit creativity in a group or theme setting, and it is very often encountered in design, advertising, architecture and so on. The practice is also incorporated as part of many problem solving processes. One might say, that this method is also the "workhorse" in new product development, based on its sheer volume of usage.

Given this context, the authors of this paper set out to experiment the efficiency of morphological charts in new product development in the field of smart furniture production. This endeavor matches similar scientific preoccupations focused on the results produced by morphological analysis in such fields as: architecture/interior design [4], automotive components [5], management sciences [6] or education [7].

To achieve the above stated goal, there were formed three teams of three designers each, having as task to design a new product, each using different approaches. For a better analysis on the effectiveness of morphological charts in producing the desired results in term of user satisfaction, the following arrangement has been implemented in an experiment meant to study the results than can be achieved in producing a smart desk that incorporates advanced IT&C devices and gadgets within a classical furniture piece framework.

Table 1 Teams organization

| Team number | Team 1 | Team 2 | Team 3 |
|---|---|---|---|
| Development method | Morphological charts | Brainstorming sessions | Morphological charts built after brainstorming sessions |
| Requirements | Customer | Design team | Customer and design team |

## 2. Experiment and Results

In the scientific literature there are algorithms or methods that use morphological charts, in particular for prioritizing the functions listed, resulting in a final product with a maximum score, the best product. In this paper the morphological charts are thus designed that, by combining the functions listed in the table there are generated different concepts not with different scores but with different use - for example the manager desk will have all the features incorporated, and the programmer desk will have only the job-specific functions. In their vision the authors consider that an important characteristic for smart furniture is multi-functionality.

The following section describes the results from a case study conducted by the authors within the project: "Research for the development and implementation into production of innovative furniture", contract no. 12 P01 001 13 C3, beneficiary Smart Furniture SRL Cluj-Napoca, partner Technical University of Cluj-Napoca.

For the first team, in a preliminary stage a number of over 20 people were interviewed, who were asked to specify their requirements for their ideal office desk. The information has been gathered by researchers with economic background, but it is recommended to be done by personnel from marketing department. This data was processed and centralized by design and technology engineers, to form a morphological chart. By combining the functions and the modules new products with different properties are generated; this stage requires the involvement of production staff.

For smart office desk the morphological chart is shown in Table 2 and some conceptual models resulting from combining functions from chart are shown in Figures 1 and 2. The combination of orange labeled cells is assembled