Ergonomic and design approach to create a new product

Ergonomic and Design Approach to create a New Product[1]

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Abstract: Entangling lines (cables or tubes) causes work flow hindrances and risks at a lot of work places. Particularly in operation room and intensive care facilities were the patient is connected with numerous devices and machines and most of them has an own connection to an electrical power source. A new product – The Cable Bone - was developed to facilitate cable handling. This presentation will focus on the non-linear design process and will discuss the applied methods. Those were work process analysis, user interviews, design specification, analytic-systematic design methods, creative confrontation (synectics) design methods, prototyping and trials at the work places. The analytic-systematic design process result was a solution of integration of cables but did not reach user's acceptance. Creative confrontation results reached acceptance in one of two solutions to order and fix the cables.
Keywords: Product Innovation, Creative Confrontation Method, Synectics.

1. Introduction

Cables (lines, tubes) particularly those connected to mobile technical equipment are causing work flow hindrances and risks at work places. Work flow hindrances are caused because of entanglement of different cables (the spaghetti syndrome) and/or because of too long cables. Time is needed to order the cables or to find ad hoc improvisations for shortening or ranging the cables. Risks are caused because too long cables and/or entangled cables are lying at the ground floor and leading to the danger of stumbling. Beside of this any disorder has a potential to confuse cables or to provoke uncertainty and lack of overview in the work process.

Particularly in hospital's facilities an high amount of electronic devices are installed every time in a new conglomeration to fulfil the need of information about the patient's vital status and to provide therapy. A work system analysis in operating room work processes was the author's context to think about a tool to help the physicians and nurses when connecting each time a certain set of machinery to the patient. Both ergonomic methods (i.e. work analysis, user involvement and usability testing) and industrial design methods (i.e. conceptual design process, analytic-systematic methods, creative confrontation methods) were applied.

2. Methods

- Work process analysis in an university hospital operating room facility using observations, paper & pencil notes, photography and video analysis.
- User interviews, 18 participants, semi-structured, topics of: work place layout, equipment, procedures related to lines (cables, tubes), team work.
- Design specification, analytic-systematic methods, creative confrontation methods, discussion of ideas together with two focus groups of users (2 and 3 persons).
- Iterative loop of decision making, prototyping, trials and optimisation of the solution at the work places together with the focus groups.

[1] Held, J. (2003) Ergonomic and Design Approach to create a New Product. In: Tagungsband der 49. Jahrestagung der Gesellschaft für Arbeitswissenschaft, München, ISBN 3-935089-68-6, S. 159-162.

3. Results

The work analysis showed problematic cable handling caused by inconsistent and incompatible work place layout and missing tools for fixing, guiding, ordering cables and entanglement of cables. In a work process critical to its duration (de-connection and re-connection for the transport of the patient between preparation room and operating room) three different cable-attaching procedures were found in use.

Interviewed users mentioned entanglement and knotting of cables as most important cause of procedure problems, particularly stumbling, unintentional de-connection, destruction of plugs and time delays.

The program of demands showed design specification in demands of physical appearances (7 criteria), construction and material (5), cleaning aspects (3), aspects of standardisation (1), requirements according to work procedures (12), aspects of replacing and recycling (2).

Analytic-systematic methods showed solutions of devices to fix, guide, code, separate and configure, extend or stretch cables. Morphology charts (Swiss scientist Fritz Zwicky propagate this method 1967, see citations and applications in: Roozenburg and Eekels 1991, p.201ff. or Pahl and Beitz 1997, p.203ff) were used to structure them (figure 1) among the parameters of “storing cables”, “guiding the cables”, “fixing the cables”, “coding the cables”, “separate the cables”, “extend or stretch the cables”.

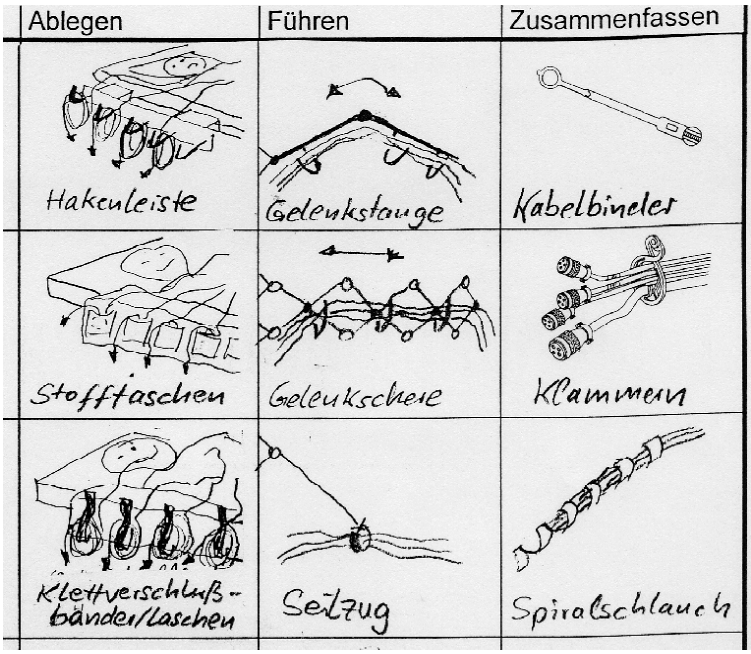

Figure 1: *Extract from the morphological chart (some solutions shown here for: store cables, guide cables, fix cables). This chart technique was used to find parameters and components of solutions. And it was used as a tool for the synthesis of solutions.*

Ratings of solutions out of the analytic-systematic method were done using nine criteria: liability to technical standards, level of changing current work situation, influence on existing hospital equipment, costs, implement-able in the short-term, amount of actions for attaching, complexity of the construction, possibilities for reparation, amount of connections. The rating results in a solution #1 for configuring the most used cables in one single hose using sealed break out cable legs (figure 2).

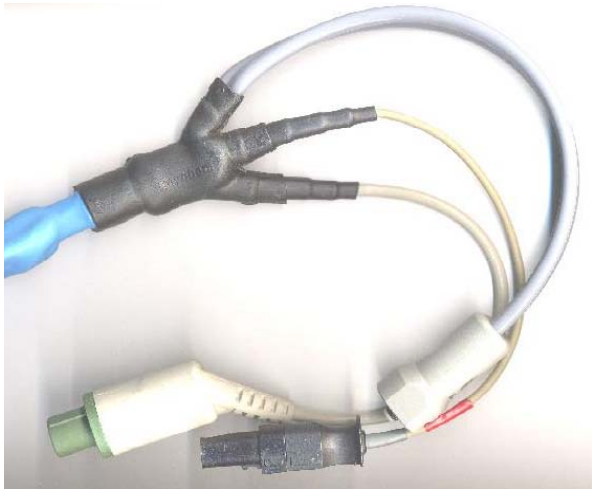

Figure 2: *Prototype of the solution #1 to configuring the cables in hose using sealed break out cable legs. Focus is the support of the daily procedures of de-connect and re-connect the patient's lines during a time-critical transport of several meters between two rooms in an operating room facility.*

Prototyping of solution #1 showed feasibility but trials and user discussions showed their uncertainty in acceptance, their hindrances to change all of their cable equipment and the effect of intensify their wish to continue working with single cables instead of integrate them.

This lead the project again to a phase of idea search. Now creative confrontation methods were used, particularly thinking in analogies comparable to the method of "synectics" (Pahl and Beitz 1997, p.109ff., Roozenberg and Eekels 1991, p.189ff.). One first solution found by analogy and form similarity in relation to an artist's palette of paints (figure 3).

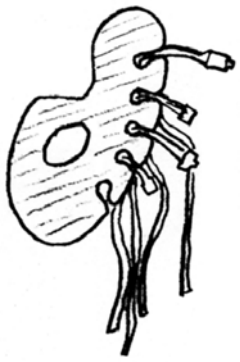

Figure 3: *The solution #2 is a "cable palette" in analogy to an artist's palette of paints. Prototyping and testing in the work procedure didn't satisfied the users need of storing and/or shortening the cables.*

Thus a cable palette to facilitate ordering of cables and handling of de-connection and re-connection procedures was tested but not accepted by the users because cables could not shorten and cables could not stored with the device.

A second round of idea search showed new analogies and metaphors and lead to the solution #3 which finally was accepted by the focus group (figure 4).

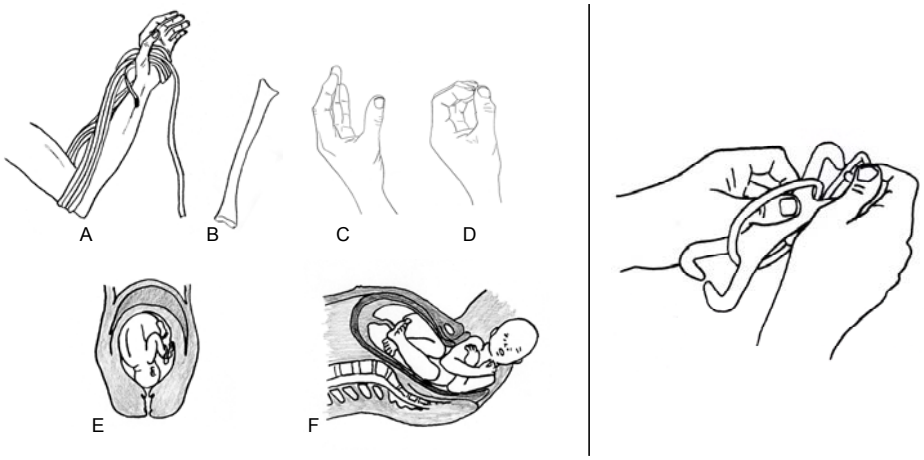

Figure 4: *Analogies, form similarities and thinking in metaphors used for solution #3. A cable or line is often ordered by winding it with the help of elbow and palm of the hand (A). This reminds at one of the bone which is in-between (B). When winding or unwinding a cable the fingers are open to allow access (C) but when holding or storing the cable the fingers are closed (D). The very first "cable"-entangling problem in human's life can occur during birth. The risk is the entanglement of the umbilical cord. Both images (E) and (F) can seen in form analogy to a form which first holds together and "store" the baby and the cord (E) then open and setting baby and cord free (F). At the right side the finally realised solution (mod. déposé / pat.pend.) to order, wind or shorten any cable or line is presented. This solution was accepted by the focus group, is realised and up to now (February'03) approx.600 items are in use. Due to the used analogies and metaphors the name of the product was given to: "The Cable Bone".*

4. Discussion

Difficulties were found in this project in following the program of demands. The appliance of ergonomic methods, i.e. work procedure and user requirement analysis was a major impact for this program of demands but as the first solutions arrived in the user's hand, some demands must corrected in their rating of importance. This is seems to be a measurement problem and early prototyping can not solve it, but can help for better management of the trade-offs.

Obviously the creative confrontation methods (thinking in analogies – synectics) played the major role in the presented project. This seems in accordance of findings (Goel cited in Helander 1997, p.9) that most design decisions based not on logical reasons. But the author will not miss the work spent for the systematic methods. They provide a structure of the problem. It was not used in the synectics method but this is an advantage. It means that analytical-systematic methods can "stow" away problem structures to set capacity and room free for creativity work. Last point of discussion is about the used composition of ergonomics and industrial-design methods. In this project they fitted well together. But due to their logical structure analytical methods in ergonomics seems easier to adopt as creative confrontation methods. Thus the designer will not think about the need of help from the ergonomist.

5. References

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