Consistent Ergonomics – A Precondition for Optimal Clinical Working Systems

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Introduction

Medical electrical equipment used in High Dependency Environments (HDEs) such as Operation Rooms (ORs) and Intensive Care Units (ICUs) should support the staff in performing the patient treatment with high quality. Industry has to prove the usability of their products, which has also become the objective of a new IEC standardization [1]. Usability takes two factors into account: the intended use of a product and the user. System ergonomics offers knowledge and methods to support usability engineering in industry in general. But within the design of medical equipment also additional aspects have to be considered to meet the complexity of clinical working systems.

Situation & Problems

The task "patient treatment in HDEs" consists of many sub-tasks which are processed on a *case layer* in different structures (e.g. treatment of a poly-traumatized patient in the Emergency Room, OR and ICU) and on a *workplace layer* in parallel (e.g. ventilation, cardio-vascular monitoring). For almost all sub-tasks medical devices are produced by a lot of highly specialized companies. These devices are designed according to patho-/physiological needs (e.g. oxygenation in lung insufficiency) and availability of technology. Each device has its own user interface claiming good ergonomic design (*device layer*). Comparing different groups of medical devices (e.g. infusion pumps, ventilators and monitoring systems) it is obvious that good ergonomic design (usability) can be achieved by quite different concepts for Human-Machine-Interaction (HMI). All the devices used in the treatment of one patient are setting up workplaces which have to be controlled by clinical staff as an entity. On this *workplace layer* the ergonomic design is very poor: Devices (including their display and control panels) are scattered all over the workplace. Vital parameters are hidden among unimportant details. Five and more different concepts for HMI are not seldom. Human errors are pre-programmed. Considering the entire *case layer* the situation is even worse.

Goal

We need a top-down concept for a consistent ergonomic design on all system layers: From medical cases to clinical workplaces and specific technological devices.

Concept

We are using the Task-Process-Task-Model (TaPTa) to analyse complex working systems in an hierarchical and recursive way [2]. A task is separated into sub-tasks according to the process planning. The question "HOW do we complete a task?" leads us to more detailed processes and sub-tasks (lower system layers). The question "WHY are we doing things?" leads us to more aggregated tasks (higher system layers). We propose to link ergonomic aspects to the TaPTa-Model and its layers. Thus we can define ergonomic guidelines for different system layers:

For the case layer: Guidelines for the patient treatment and the organizational design of ORs and ICUs (e.g. ground-plans, necessary staff structure, functions of workplaces, logistics etc.).

For the workplace layer: Guidelines for the workplace design including its equipment, structure, overall HMI, surrounding (e.g. light, colours, climate, noise) etc. [3].

For the device layer: Guidelines for specific devices including their functions, HMI, physical design, service, training etc.

On all system layers ergonomics considers the task (defined by the patient's treatment), the processes to complete the task, the usage of technical structures and the required staff (users). The question "HOW do we realize the ergonomic guidelines?" leads us to more detailed system layers. The question "WHY do we need a display, device, workplace or OR" leads us to higher system layers with more extended (but also general) rules for an ergonomic design.

References

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[3] Friesdorf, W; Schwilk, B; Haehnel, J; Fett, P & Wiedeck, H (1990): Ergonomics applied to an intensive care work-place. Intensive Care World 7(4): 192-198