Application of a Simulation-Based Software Tool for the Prospective Design of IT Work Places

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Abstract The following article presents an approach on the extension of WorkDesigner—a simulation-based software tool for the strain-based staffing in industrial manufacturing—for the prospective design of IT work places. After a short introduction of WorkDesigner, the common economical and technical need for the individual design of IT work places is described in the following chapters. Here the current mega trend Digital Transformation takes center stage. Chapter 4 presents additional parameters for the adaption of WorkDesigner to the drafted "digital" needs. Finally, the results and the future developments are discussed.

Keywords Workdesigner · IT work place · Prospective design · Digital transformation · Internet of things · Industry 4.0

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1 Introduction

Digital Transformation, Internet of Things or Industry 4.0 are all representative terms for a new reality: the global crosslinking between humans, products and services as well as resources. This crosslinking has the potential to release enormous power of innovation. Here the information technology takes center stage and will be the enterprises' key to success and competitiveness. A high level of flexibility and speed of the IT is demanded for the long-term assurance of profitability and competitiveness. Common IT approaches can not sufficiently guide the processes of the digital transformation. A change of the IT paradigm is needed to enable application- and user-specific work modes (cf. [1]).

In 1995 Landauer [2] already argued that efficient and ergonomic software design can increase the productivity of IT-based work by about 700 %.

In this context a field study by System Concepts LTD. System Concepts LTD [3] identified three primary reasons for the respectively low performance of IT software solutions: confusing dialog elements (12 %), inconsistent design of graphic user interfaces (25 %), work processes mismatched to dialog sequences (60 %) and others (3 %) (see also [4, p. 1077]).

To assess and improve innovative IT software solutions and IT work places with regard to productivity and workload, WorkDesigner, a simulation-based software tool for the strain-based staffing and design of work processes, is proposed to adapt to the current "digital" need for action.

WorkDesigner is based on the approach established by Feller and Müller [5] using an age- and stress-based simulation model for the development and assessment of work systems for employees in industrial manufacturing; Fig. 1 shows some impressions of WorkDesigner.

It is important to note that in this approach employees and work places are the main parameters. Based on the specific age, sex and an absolute term for the individual's ability the employee's physical ability level and the corresponding work ability level is determined for every discrete simulation step. Every work place is defined by five parameters (stress factors rated from excellent to deficient): lighting, climate, noise, work posture and work intensity. Considering age-related changes in the employees' abilities, all stress factors are individually weighted for every interaction between an employee and a work place. Based on the formulas provided by Feller and Müller [5] the overall stress is calculated for every work process, which leads at the end to the determination of the employee's utilization of his or her work abilit. (cf. [6]).

In the following chapters the common economical and technical need for action is described as well as an approach on the extension of WorkDesigner for the prospective design of IT work places is drafted.

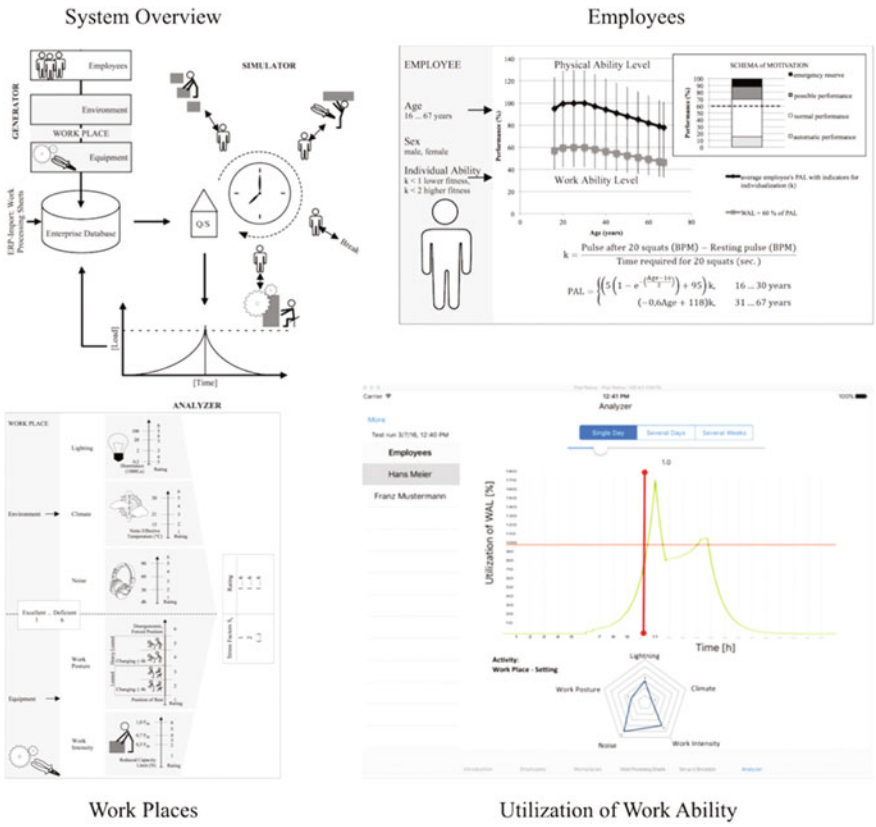

Fig. 1 Impressions of WorkDesigner (cf. [5])

2 The Role of IT in the Context of Digital Transformation

The Digital Transformation has become the ultimate challenge for almost all industries. It's leading to significant changes within the company with impact on the operational structure, strategic positioning and the organization. The use of technology to radically improve performance, enhance the customer engagement and create new digital business models is the overall task and a substantial challenge for the IT organization.

In the past the IT departments focused mainly on supporting the business by offering the needed technical capabilities for highly optimized processes. Running a stable and reliable infrastructure and offering adequate services were the primary focus. A sufficient business and IT alignment was the goal.

This has changed radically through the Digital Transformation. Suddenly the digital services are a substantial part of the offering. The requests towards the IT are no longer coming from the internal organization, but from the external market and

the customer itself. Not stability but agility and speed are the critical capabilities of today. To perform this tremendous mind shift is the major challenge of today's IT departments.

To be directly involved in the product design, the development process and the digital service offering is a new situation for the IT department and causes sustainable discomfort.

Through the enormous pressure the most IT departments do not see the great chances they have been given by moving into the strategic center of the core business. The shift from product orientated business models towards service focused business models will make the IT a substantial part of the value chain itself.

The integration of digital services will not only have a tremendous impact on the IT department but on almost all areas of a company. The number and the complexity of IT workplaces will grow dramatically in the next years, and at the same time the flexibility of the workplace infrastructure will change as well. Flexible and mobile workplace concepts within the company and outside must be supported. The integration of smartphones and tablets will take place and will have a tremendous impact.

A seamless IT infrastructure, optimized towards the needs of the operational procedures will be substantial for the overall success of a company. New ways how to increase the efficiency of IT workplaces is a task most industries haven't tackled yet. Through the Digital Transformation and the new role the IT will take in the near future, the ergonomic aspects of IT workplaces will become a critical success factor for companies.

3 Common Approaches for the Design of IT Work Places

Many different influences impair the achievement of great software. Some programs are more compelling to increase or decrease the user efficiency than others. The quality of software should not only be selected by the visual appeal of the graphical user interface but more influenced by the quality of the programming of the core object model.

As shown in Fig. 2 visual design affects the user experience by about 10 % which is by way of comparison, three times less than the interaction of techniques and design. The most important influence is the object model with about 60 %, which contains the task model and the consideration of significant user groups.

There are principles of software development placed in norms like ISO 9241 which the subject matter is the Ergonomics of human-system interaction, including dialog principles (cf. [8]), guidance on software individualization (cf. [9]), principles for the presentation of information (cf. [10]) and many more. There is also a standard about the forms (cf. [11]) as well as the norm for the software ergonomic design principles and framework for multimedia user interfaces (cf. [12]).

The general purpose is to recommend how the software structure be realized. It can be comprehended that parts of the ISO 9241 as well as elaborations (cf. [13]),

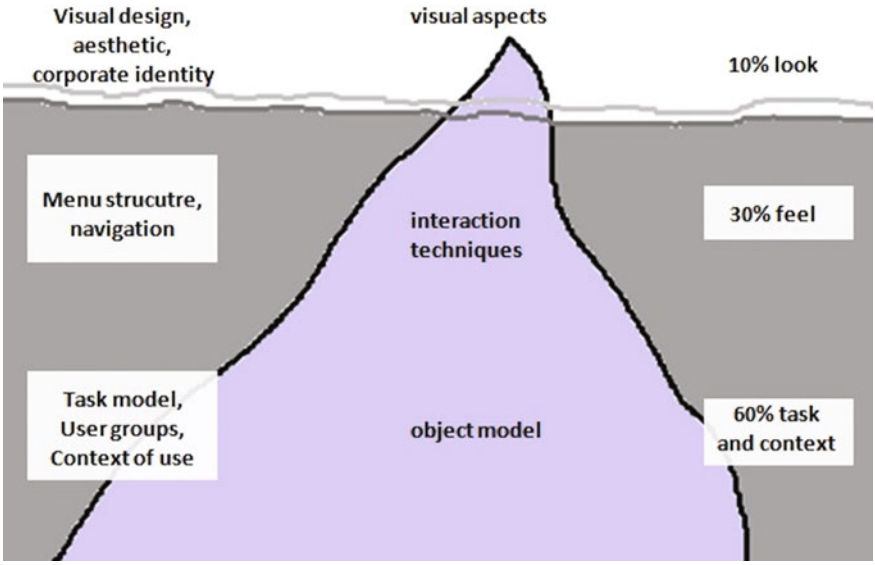

Fig. 2 Hidden influences of usage quality (cf. [7])

which are mostly based on the ISO 9241, are aiming to accomplish the following characteristics: adequacy of tasks, self-description capability, expectation compliance, learnability, controllability, fault tolerance, and customizability.

According to the ISO 9241, the software should maintain the specifications of each part to reach this characteristic. There are some known basic approaches such as grouping similar information to receive clarity (cf. [10], Chap. 6.3.4). But it is quite surprising these standards should be considered as the publication date is more than ten years since its original publication. This is an inherent problem of the ISO 9241. Most parts are just too old for the extremely fast rising and especially changing information technology sector.

The flow of the user dialog today is an example, which is not comparable to the entire principles of 2006 (cf. [8]). There is no sense to use outdated specifications that do not fit with the features of today's information technology. Especially when considering the entire domain of connected devices.

Furthermore, there is a considerable number of specifications that in some cases concern an overstated level of detail, as well as most specifications, are still not entirely regulated. Fortunately, there are no regulations that dictate how to design a Button (cf. [11], Chap. 5.4.8).

A significant problem is the neglecting of user groups. Different knowledge of users can affect the software-usability and acceptability in a strong way. A well developed user-adaptable software program can generate a high efficiency because it is providing the user new skills and knowledge in an optimal way. Only fundamental characteristics can be inferred from the literature.

Today, great software design means not only to accommodate user skills; it also means the adjustment to lifestyle. This implies self-adaption to the software via exterior influences. A nice example of the difference between the dialog principles is Google Glass. Depending on the location and view, Google Glass displays necessary information through an augmented reality interface.

To achieve optimal usage, the software would be required to adapt to any hardware device. There is not one correct way and always best software design; the designer needs to differentiate the product to reach the optimum level of characteristics and general acceptance in any and all situations.

4 Extension of the Simulation-Based Software Tool WorkDesigner for the Design of IT Work Places

As it has been shown in the previous chapters, the impact of IT is increasing. More and more workplaces are turning into mobile offices, which enables employees to work from anywhere. As result of this, their ergonomic requirements are changing as well. Accordingly, the simulation-based software tool WorkDesigner is proposed to be adapted. Based on the considerations of the previous chapters, the following part gives an approach on how the software should be expanded.

To evaluate software regarding its impact on the users' stress level, there are a huge number of different parameters. Most of the common simulation systems are lost in the detail. For companies which want a quick result this is not practical. So additional parameters therefore have to be evaluated quickly, either in a subjective or an objective way.

4.1 User Index

As discussed in Chap. 3, a big mistake in the DIN norm is disregarding the user, because how effective software is depends heavily on him. So as Florin [14] said, the user has to be recorded accurately. The software WorkDesigner already records the user in a sufficient but limited (physical) way. To get more details the user description has to be expanded. An example how this could look like is given in Fig. 3.

The parameters for age and gender are already used in WorkDesigner and now added to this are nationality, area of expertise and a few questions about the personal behavior with software. While the questions about behavior works as an indicator for the experience and attainments with software, the "area of expertise" gives an idea of the affinity to technology. One point often neglected in DIN is "nationality". So the fact that different cultures have different ways of reading and writing are included in this point. With an appropriate rating the user description

Fig. 3 User description

generates a "user index" with which the learning curve and stress level of the user can be derived.

4.2 Software

Just as important as the user is the software itself. A highly qualified user can not gain his full potential without having the right software available to him. So it is important to find parameters which allow a professional and also personal way of evaluation. Figure 4 shows some parameters which meet these requirements.

All of these could be evaluated quickly on a scale of one to six. According to Florin [14], who explained that usability and design have to be clearly divided, the four parameters are split into these two categories.

Setup The first impression of software. This contains the optic and presentation for the user. Are objects arranged in a proper way? Do I have all important tools on the first page? These are just a few questions which give a personal impression of the Software and represent a subjective way to evaluate this point. To evaluate the software more objectively, the DIN EN ISO 9241-12 should be used. The DIN gives a huge number of criteria as to how objects have to be arranged and how much information should be given. In addition to that, the knowledge about human nature, as for example Florin [14] explained it, can be important.

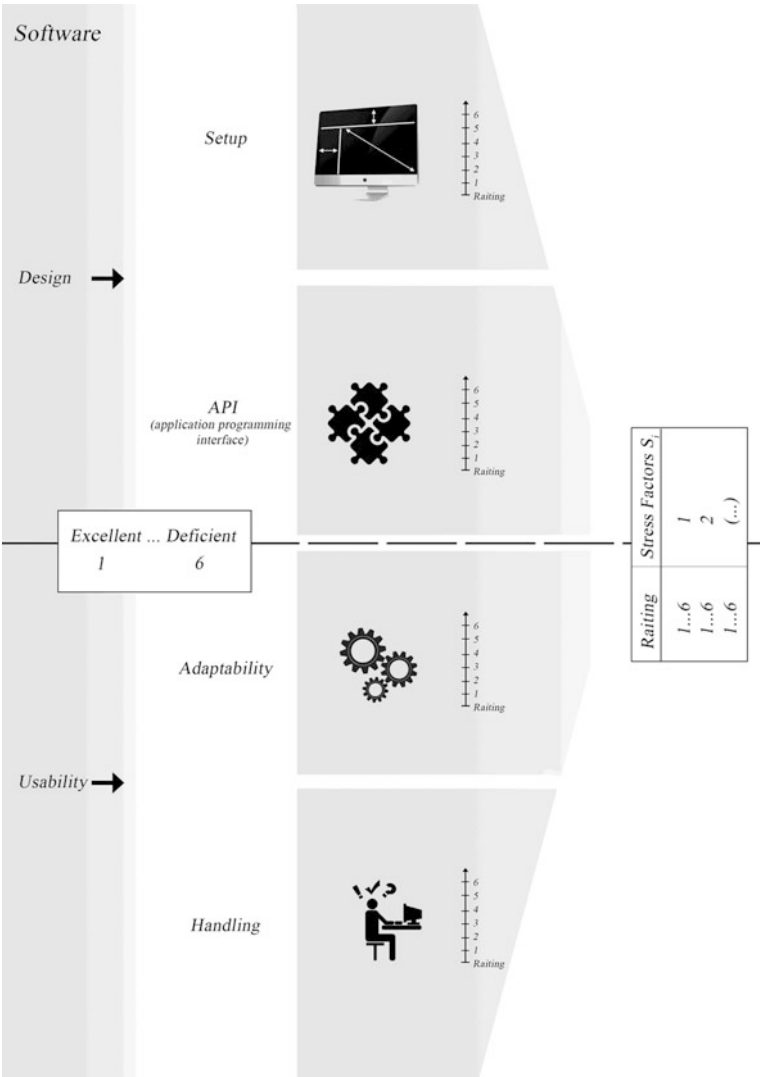

Fig. 4 Software parameters

API (Application programming interface) Apart from the Setup one important aspect of Software is the possibility of sharing data with other programs. This connection is the API. Most workplaces are working with more than one type of Software, so it is important to have good a connection between all programs. How well this works and if all programs are involved is a good way to evaluate this point. Also the possibility to share between different operating systems, like iOS and Windows, has to be in focus. In contrast to Setup it is difficult to evaluate the

API in an objective way. How many and which Software should be supported is very personal and can't be a fixed number.

Adaptability The first parameter which deals with usability. In 1995 Landauer [2] already described that with the right software, you could raise your productivity to nearly 700 percent. In addition to Landauer [2] the System Concepts LTD. Reference [3] figured out that the important part of software working well is the matching between software dialog and work processes. It is therefore important that you can fit the software to your personal requirements. How many different changes can you do? Can you change the design and can you create own software add-ons? These questions could help to evaluate the software more objectively.

Handling As Reiterer and Geyer [15] describe, usability transforms more and more into the user experience so it is important to take a look at this. So the last suggested parameter is handling which describes the user experience and feelings while working with software. Experiences like: How fast can I work with the software? How much help did I get and also how consistent are the different parts of the software? All of this creates the impression of the work and has an influence on the level of stress. The DIN EN ISO 9241-10 gives a few more additional points.

In combination with the user index, the software parameters give a good interpretation for the level of stress. It is a quick way to evaluate software but includes all important aspects of the software ergonomic.

5 Discussion

In the context of Digital Transformation flexible and mobile work place concepts are highly demanded likewise by employees (user experience—the employee as IT's customer) and enterprises (to raise productivity and maintain competitiveness). Here the IT takes center stage and will be the key to economical success.

As described the common approaches for the design of IT work places are not sufficiently adjusted to the individual user's needs, the requirements of the Digital Transformation and the current mobile technologies. So the application of a simulation-based software tool for the assessment and prospective development of IT work systems is proposed. For this purpose, an approach on the extension of the software solution WorkDesigner with additional user/employee parameters as well as software parameters respectively complimentary work place parameters is introduced in Chap. 4.

It has to be mentioned that the presented work is still in progress. The next development steps are the sufficient and quantitative definition of the introduced parameters, the software integration and the validation in a field study.

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