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Design of systems for productivity and well being

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ABSTRACT

It has always been an ambition within the ergonomic profession to ensure that design or redesign of production systems consider both productivity and employee well being, but there are many approaches to how to achieve this. This paper identifies the basic issues to be addressed in light of some research activities at DTU, especially by persons responsible for facilitating design processes. Four main issues must be addressed: (1) determining the limits and scope of the system to be designed; (2) identifying stakeholders related to the system and their role in the system design; (3) handling the process' different types of knowledge; and (4) emphasizing that performance management systems, key performance indicators (KPIs), and leadership are also part of the system design and must be given attention. With the examples presented, we argue that knowledge does exist to help system design facilitators address these basic issues.

1. Introduction

How can we ensure that the design and redesign of technology, production and service systems consider the human characteristics of the people who use and operate these systems? For years, this question has preoccupied ergonomists and human factor specialists who aim to move from fixing systems to designing systems. The underlying arguments to support such a shift in focus are that (1) in the early design phase, there are more options for alternative work configurations that can be considered; (2) the costs are only marginal, since changes in plans are minor compared to changes in the physical manifestation of the plans; and (3) such a shift would have a significant positive effect on the overall effectiveness of the system.

The traditional answer to the question raised above assumes that system design is fundamentally guided by specifications in the form of a set of criteria that the final system has to meet. Thus, the strategy is to formulate criteria for human factors and add these to the general set of criteria guiding the design process (Singleton, 1974). This line of thinking, which is pursued in many handbooks, recommends ergonomic criteria to be used in the context of system design. The impact of this strategy on production system design practice appears to be limited, judging from anecdotal evidence regarding facilities and systems, which continue to be designed with limited consideration for the people who work or interact with these systems.

Therefore, the discussion continues with regard to how to integrate ergonomic and human factors in the design of production and service systems. One position argues that ergonomists must change their focus from guidebooks and legislative requirements towards enterprise strategies (Jensen, 2001; Dul and Neumann, 2005). Consequently, issues related to working conditions must be formulated within the discourse of company strategy, and the activities decided upon must relate to both the formal and the emergent strategic activities in the enterprise (Mintzberg, 1998). This also implies developing the role of ergonomist or human factors specialist from an actor who primarily delivers authoritative knowledge about person–machine interfaces into a politically reflexive actor who becomes involved in development of the enterprise (Broberg and Hermund, 2004). Recently, within the ergonomic field, the notion of 'Participatory Design' has been promoted as an approach to secure optimization of both the economic and ergonomic aspects of work (Vink et al., 2008; Broberg, 2010).

This paper presents a system-based approach to the design and redesign of production systems to promote productivity and well being, based on participatory design. The concept of 'production system' used here is an umbrella term for all purposeful systems designed to transform inputs into outputs that fulfil society's needs. Consequently, the concept covers not only industrial production systems but also service systems and health care systems, as well as production systems working with immaterial inputs and outputs, such as consultancy, teaching and research.

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[1] The description of this case is based on an interview conducted by the authors with Professor Jesper Larsen. The case has not been published in the present form, but the algorithm developed is described in Rasmussen et al. (2012).

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We have observed that it is common, when designing or redesigning a production system for productivity and well being, to establish a forum involving important interest groups. This forum discusses, evaluates and decides how to design or redesign the production process in order to ensure production systems that function well from a sustainable perspective, i.e. economic, environmental and social sustainability. Many different tools and procedures for facilitating activities in these forums have been developed and tested (e.g. Beyer and Holtzblatt, 1998; Kensing and Blomberg, 1998). But there is more to designing systems than just procedures to follow and tools to apply. The basic circumstances for the design process have to be taken into consideration in order to predict potential risks and hopefully deal with them in time. This paper presents a fundamental conceptual framework to be used by systems designers when initiating a design or redesign process.

2. Definition of a system

Within the present framework, we define a system basically as a transformation process, which transforms input to output for the benefit of society as a whole. Hence, we apply a teleological understanding of systems and an approach to system thinking that is characterized by Jackson (2000) as "system thinking for problem-solving". The output can be material (a product) or immaterial (delivery of a service). The inputs are typically a combination of material and non-material (knowledge) objects. The transformation is accomplished through a joint effort by many different entities. The definition and conceptualization of entities are derived from the problems to be addressed. Technology, facilities, formal and informal organizations (structures, procedures and processes), workers (qualifications, competencies, attitudes and values), and (layers of) managers can be mentioned as examples of entities typically used in such a problem-solving process.

3. Basic conditions in a systems design approach

In designing or redesigning a system, some basic conditions have to be given special attention. These concern:

(1) Boundaries and scope of the system – a narrow definition will hamper redesign.
(2) Participants in the design and redesign process – inclusion of stakeholders facilitates the process as compared to a shareholder approach.
(3) The character of knowledge – attention is given to the different types of knowledge related to the design process, avoiding the temptation of reductionism and simplicity.
(4) Performance management, leadership and key performance indicators (KPIs) are also important design issues to be considered when the aim is to improve both productivity and well being.

These basic conditions may not be formulated explicitly when specifying the design task, but the people responsible for facilitating the design activities make decisions on these issues – either deliberately or unconsciously. This paper is based on the assumption that deliberate decisions are to be preferred, as they allow discussion and mutual clarification of these basic conditions.

4. Determining the system: boundaries and scope

When designing a system, the designer decides on the boundaries of the system to be designed. In determining the boundaries, the designer decides on the environment for the system, which is thus not included in the design process. These decisions also open for identification of the entities comprising the system: some of these entities are perceived as circumstances not open to redesign; some are seen as outcomes – i.e. entities closely related to the system's key performance indicators; and some are seen as entities to be manipulated in the design process.

Westgaard and Winkel (2011) give an illustrative example of this basic decision in relation to understanding occupational musculoskeletal and mental health. Based on a systematic literature study, they find:

> "Most ergonomic intervention studies are designed to observe the effects of reduction in relevant risk factors impacting the individual worker, while this literature typically ignores the potential health consequences of measures to improve competitiveness and productivity" (ibid. p. 262).

This implies, first, that most designers of intervention studies (which can be seen as an activity focused on redesign of a work system) define their redesign of the system as comprising two entities: 'the individual' and 'relevant risk factors'. In defining these relevant risk factors, some aspects of the system are defined as being manipulated in the intervention (for example, weight and shape of burdens and additional tools to use when lifting), while other aspects might be left out (for example, the individual's physical strength) and specific techniques developed to reduce the task's burdens. The last part of the quotation opens for an alternative definition of the system. Here, the individual is seen as a part of the production system, together with the means for ensuring productivity. This implies that the central entities now shift to such issues as the technological level in the production flow, the work design, and the formal and informal systems of incentives applied in order to secure the system's output.

An important factor in determining the boundaries of the system is the scope of the system to be designed. Scope refers to the size, number and variety of activities in the system. The scope of the system determines to what extent it is possible to change the system radically. A small system consisting of a machine for stamping holes in a plate only allows simple improvements in productivity and well being, just because there are only so many ways a stamping machine can be redesigned. In contrast, a complete process in which stamping holes is only a small part allows for significant redesign, e.g. merging hole stamping with a related activity that improves flow and enriches the job.

The designer must be aware of the scope and boundaries of the system so as not to focus on a system that is too narrow in scope to allow redesign, thus leading to sub-optimization. The system must be continually reconsidered and consequently renegotiated as the design process evolves. Essentially, the designer must be ready not just to embrace redesign of the product but also of additional services.

It is evident that the definition of the boundaries of the system to be designed has a key role in determining the basic configuration of the system, seen from the designer's point of view. This is further supported by identifying the stakeholders that are relevant for the system's performance and thereby for the system design.

5. The stakeholders and their role

According to the Oxford Dictionary, a stakeholder is "a person with an interest or concern in something, especially business". Within business studies, the distinction between a 'shareholder' and a 'stakeholder' approach is often debated (Sundaram and Inkpen, 2004). A shareholder approach focuses on one group of stakeholders, the shareholders, and the goal is to maximize shareholder value. This often implies that the short-term economic result is the main criteria in decision making. A stakeholder