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DEMYSTIFYING ENGINEERING: IMPLICATIONS FOR PRACTICING ERGONOMISTS

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ABSTRACT

Acknowledging the social, political, and constraint-driven nature of design, practicing ergonomists may increase their effectiveness by actively using organization and stakeholder characteristics to their advantage. Engineers are a stakeholder group with significant influence over the design and management of work systems and therefore are key participants in almost all design processes. By gaining a better understanding of the competing demands placed on practicing engineers, the organizational factors influencing engineering work, and the way health and safety issues are viewed from an engineer's perspective, ergonomists could improve their effectiveness when initiating change in the workplace. Though this information is scarce within existing literature, relevant information has been gathered and is summarized in this paper. An interview study now underway, 'Work System Design: A Study of Professional Practice among Ergonomists and Engineers,' will examine these issues in a Canadian context to support more effective human factors collaboration in the future.

Keywords: engineering, human factors, work system design

DÉMYSTIFIER L'INGÉNIERIE : IMPLICATIONS POUR LES ERGONOMES PRATICIENS

Par la reconnaissance de la nature sociale, politique et orientée-contraintes de la conception, les ergonomes praticiens peuvent accroître leur efficacité en se servant activement des caractéristiques des organisations et des intervenants à leur avantage. Les ingénieurs sont un groupe d'intervenants ayant une influence importante sur la conception et la gestion des régimes de travail et, par conséquent, sont des participants clés dans presque tous les processus de conception. En parvenant à une meilleure compréhension des demandes concurrentielles imposées aux ergonomes praticiens, des facteurs organisationnels qui influencent le travail d'ingénierie et de la façon dont les questions de santé et de sécurité sont considérées du point de vue d'un ingénieur, les ergonomes pourraient améliorer leur efficacité lorsqu'ils entreprennent des modifications du lieu de travail. Bien que ces renseignements soient rares dans la documentation existante, des informations pertinentes ont été recueillies et sont résumées dans cet communication. Une étude par entrevue est actuellement en cours (Conception du régime de travail : une étude de la pratique professionnelle chez les ergonomes et les ingénieurs) et cette étude portera sur ces questions dans un contexte canadien en vue de favoriser une collaboration en lien avec les facteurs humains plus efficace dans le futur.

Mots clés : ingénierie, facteurs humains, conception du régime de travail

INTRODUCTION

Engineers have been identified as one of the groups with a significant influence on the success of human factors application in the early phases of design and are key to successful human factors uptake in design processes (Perrow, 1983). This paper examines available information on the relationships, knowledge, and attitudes of engineers that may be relevant in improving the effectiveness of interdisciplinary human factors collaboration and introduce a new research agenda in the field of human factors engineering.

HUMAN FACTORS AND DESIGN

Human factors is an area of study primarily concerned with the application of theory through design (IEA Council, 2000) and the need to apply human factors in early design stages is seen as an important strategy for the prevention of work-related ill health (Ontario Ministry of Labour, 2005). Therefore, it is valuable to consider the nature of design within the organizations in which ergonomists work.

Even in technical fields such as engineering, design is frequently described as a social, negotiated process between individuals who interpret the world through vastly differing mental models, philosophies and values (Broberg & Hermund, 2004; Bucciarelli, 1988, 2002). In addition, the influence of culture, from both within and outside the organization, is widely acknowledged to influence design decisions. The challenges presented by attempting to change a culture in order achieve different design results have also been documented (Broberg & Hermund, 2004; Perrow, 1983).

In reaction to this interpretation of design, it has been suggested ergonomists must embrace the role of 'change agent' in order to maximize their effectiveness (Broberg & Hermund, 2004; Launis et al, 1996). This idea is supported by the observation that ergonomists working in the 'change agent' role can support application and improve adoption of HF related regulations by design engineers (Jensen, 2001; Wulff, 1999a). But in order to succeed in this role, ergonomists must learn to navigate organizations and appeal to the priorities of designers of all disciplines and levels of seniority (Broberg & Hermund, 2004; Buciarelli, 1988; Burns & Vicente, 2000).

It is in this way that engineering knowledge becomes relevant to the practicing ergonomist. By gaining further insight into the goals of engineers and the constraints placed on their work, ergonomists may be able to navigate organizations more easily.

ENGINEERING PRACTICE: EXISTING LITERATURE

In order to investigate the current roles and responsibilities of engineers involved in work system design and their implications for practicing ergonomists, literature was reviewed across multiple disciplines. Professionals with extensive experience in human factors, industrial engineering and sociology were consulted in this endeavour. The following points were identified as relevant to human factors practitioners.

Work System Design and Engineering

- Workplace design is likely to be overlooked or poorly managed within organizations and there appears to be a lack of recognition of "workplace design" as a specific process or activity. (Launis et al, 1996)

- Due to the lack of recognition of work system design as an independent area of interest, it is not the responsibility of any particular person or department; rather, it is the result of a series of design decisions made by various players and affected by policies at a wide level of organizational levels. Consequently, responsibility for human factors is also distributed among these parties. (Neumann & Winkel, 2006)
- Engineers lack clearly defined responsibility for the impact of their work once implemented. If a design can be implemented with no short-term problems, the designer may never know about the long-term implications of their work or take part in solution building should problems – in productivity, quality or user wellbeing – arise. (Broberg, 2007; Perrow, 1983).
- Likely due to this lack of long-term responsibility for design projects, engineers generally reported a lack of awareness of their impact on the work environment of others. (Broberg, 2007; Launis et al, 1996)

Group Characteristics and Attitudes

- Engineers are a widely varied professional group, both within and between disciplines, differing by level of experience, role in the organization (Darr, 2000), and the surrounding culture (Adams, 2007; Lynn, 2002). The attitudes and working styles of engineers in different contexts may be very different.
- Organizational culture influences decision making, even on the most technical engineering design projects (Jensen 2001; Launis et al, 1996; Newberry, 2007; Perrow, 1983).
- Views of a given technology depend on an engineer's discipline. Intimate knowledge of a technology prevents them from relating to it in the same way as the general public. As a result, engineers may be less likely to anticipate the effects of their designs on users (Newberry 2007).
- When faced with an unfamiliar technology engineers are likely to see it from a novice perspective, yet are more likely to view it as understandable compared to other non-experts (Newberry, 2007). Therefore, they may be more open to learning new approaches than other professional groups.
- Between disciplines (e.g. mechanical, chemical, civil, etc.) engineers display differing attitudes toward work environment and human factors (Broberg, 2007).
- A generally positive attitude toward the inclusion and improvement of human factors was reported when surveying engineers (Broberg, 2007; Kim et al, 2007).

Working Conditions of Engineers

- Time pressure and high workload are frequently reported work conditions for engineers (Wulff et al, 2000; Wulff et al, 1999b). One study indicated that this affects designers' work to the degree that they may be open to using human factors tools in their work under the condition that workload did not increase as a result (Kim et al, 2007).
- Engineers often work as part of multidisciplinary teams and interface with stakeholders across organizational boundaries (Buciarelli, 1988; 2002). However, these teams may experience conflict between members with a primarily technical focus and those with a more social focus (Kilker, 1999).
- Engineers have a high degree of accountability in event of a lawsuit or accident. They often use documentation as a way of avoiding liability (Wulff et al, 2000).
- Engineering projects are characterized by many constraints, including technical, cultural, social, and financial. All act to limit the possible design solutions available and create complex problems that cannot be solved optimally (Burns & Vicente

2000). In these cases personal and organizational values will strongly influence the nature of the solution (Coles & Norman, 1995).

- Due to the strong influence of organizational attitudes and values, training alone is not enough to change the behaviour of engineers. For new knowledge to be applied the context of work must change as well (Broberg, 2007).

RESEARCH IMPLICATIONS

Despite the information presented in this paper, very little is actually known about the daily work and practice of professional engineers worldwide. There has been no recent, comprehensive study of the skills, methods and practices used by engineers on a day-to-day basis (Trevelyan & Tilli, 2007). One potential explanation for this gap in the literature is Abbott's (1988) observation that traditional sociological research into professions has focused less on what professionals actually do as opposed to how they are organized to do it. As a result much of the content and context of day-to-day work is missing from the literature.

Our review of available literature showed that existing studies on engineering often focus on the context of engineering work rather than the people performing it or what that work actually entails on a day-to-day basis. In addition, they are written from the perspective of researchers outside the engineering profession. Finally, despite the noted influence of culture on the way engineering is practiced, none of the studies reviewed was done in Canada.

As a result, a study on the day-to-day work of Canadian engineers appears to be pertinent and useful from both an engineering and human factors perspective.

A HUMAN FACTORS ENGINEERING STUDY

The project 'Work System Design: A Study of Professional Practices among Ergonomists and Engineers' is an ongoing study by the Human Factors Engineering Lab at Ryerson University. It examines the roles and practices of Canadian industrial engineers and ergonomists in the design of safer, more productive workplaces. This project aims to uncover information on the day-to-day work of industrial engineers as well as the unique constraints and demands placed on upon them when working on work system design related projects. This paper introduces the engineering phase of the project, which consists of a series of semi-structured interviews with industrial engineers in Ontario whose work impacts work system design.

Industrial engineers were chosen for this study as, like ergonomists, they are interested in the efficiency, effectiveness, sustainability and safety the work systems they design and improve. In addition, all industrial engineers receive some training in human factors as a degree requirement and thus are well positioned to provide information on the topic of interest.

This study will address the following questions:

- How do engineers involved in workplace design actually do their work?
- How are work system design decisions made?
- How are human factors and health and safety issues perceived and valued within engineering departments?
- What is the engineer's role within their organization? Do they play multiple roles?
- Is there common ground between engineers and ergonomists? Do they have similar goals (i.e. a highly efficient, humanly sustainable work system)?

- Do engineers have particular strengths that can help achieve human factors goals?
- How can human factors technologies better support engineers?

CONCLUSION

By gaining a better understanding of the competing demands placed on industrial engineers, the organizational factors influencing engineering work, and the way health and safety issues are viewed from an engineer's perspective, ergonomists could improve the effectiveness of their collaborations when initiating change in the workplace.

The review presented in this paper suggests engineers could be a willing and helpful partner for ergonomists – under the right conditions. For example, given the heavy workload of engineers it is important that human factors is not perceived as something that will add to their list of constraints or increase their workload. Organizational factors would likely have a large effect on this perception. If managers and customers support this type of work, engineers will be more likely to receive recognition, funding and time to pursue projects on the basis of human factors improvement. Moreover, it is important to note that while the engineer in question may be responsible for the design of a system component, they may ultimately have little mandate and no control over the work environment in the long-term and be unable to enforce policies even if they support them. The interview study 'Work System Design: A Study of Professional Practice among Ergonomists and Engineers' will provide further insight into the conditions necessary for successful integration of human factors into engineering design.

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BACKGROUND

Work System Design Project

Examining the 'Engineering-Ergo' gap from the perspective of each profession:
- Understand current practices
- Identify opportunities to improve integration

Interview Phases:
1. Swedish ergonomists (Laring et al, 2007)
2. Canadian ergonomists
3. Canadian industrial engineers

BACKGROND

- Multi-disciplinary
  - Engineers
  - Ergonomists
  - Sociologist
  - Etc...

BACKGROUND – ENGINEERING PHASE

- Engineers: key stakeholder in design
- Insights into engineering may help ergonomists navigate organizations and anticipate the impact of decisions
- Therefore, relevant to the practicing ergonomist

OBJECTIVES

- Document first phase of the engineering interviews:
  - Exploring existing literature
  - Determining gaps in knowledge
- Disseminate findings in a way that is meaningful for ergonomists

RESULTS

- Far less existing research than expected
- Almost none done by engineers about engineering

RESULTS

BACKGROUND
OBJECTIVES
RESULTS
IMPLICATIONS
CONCLUSIONS

- Insight into three main areas:
  1. Attitudes and characteristics
  2. Daily work
  3. Organizational factors

ATTITUDES AND CHARACTERSITSICS

BACKGROUND
OBJECTIVES
RESULTS
IMPLICATIONS
CONCLUSIONS

- Engineers are diverse
- Technical, systems-based perspective (vs. social, individual-based perspective)
- Engineers report they are open to improving ergonomics

DAILY WORK

BACKGROUND
OBJECTIVES
RESULTS
IMPLICATIONS
CONCLUSIONS

- Engineers are under pressure (deadlines!)
- Engineers are accountable (legal liability!)
- Engineers lack feedback about the long-term effects of their work (MSDs!)

ORGANIZATIONAL FACTORS

BACKGROUND
OBJECTIVES
RESULTS
IMPLICATIONS
CONCLUSIONS

- Projects have numerous, diverse stakeholders
- "Workplace design" is not managed
- Distributed responsibility for ergonomics
- Training alone is insufficient to change behaviour

IMPLICATIONS - ERGONOMISTS

BACKGROUND
OBJECTIVES
RESULTS
IMPLICATIONS
CONCLUSIONS

- Engineers can be receptive partners in ergonomics
- There are real organizational and professional barriers that must be addressed for this to occur

IMPLICATIONS – RESEARCH (me!)

BACKGROUND
OBJECTIVES
RESULTS
IMPLICATIONS
CONCLUSIONS

- ***"If we knew what we were doing, it wouldn't be called research, would it?"***
  - Albert Einstein
- The needs/requirements of engineers are not known
- A study of the day-to-day work of Canadian engineers appears to be pertinent and useful before changes can be made

CONCLUSIONS

OVERVIEW
BACKGROUND
OBJECTIVES
METHODS
RESULTS
IMPLICATIONS
CONCLUSIONS

- A study of the day-to-day work of Canadian engineers is necessary!
- Approach ergonomic change *ergonomically* to improve the integration of ergonomics, particularly in early design stages

THANK-YOU!

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