

Real-world effectiveness of Ergonomic methods

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Abstract

The way ahead with the practical development and application of Ergonomic methods is through a better anticipation and appreciation of changes to system effectiveness and human work that will be incurred through the introduction of new technologies to the workplace. These improvements will involve an improved awareness by the system of the working context and environment. The argued future is with improvements in the handling and use of knowledge by systems. The development of suitable Ergonomics methods, or the careful adaptation of existing methods, should accompany any technological revolution. Moreover, future methods are needed that are specifically developed to be applicable to the real time study of work considering both work context and the amalgamation of results from the use of many diverse methods throughout the design and development life cycle of a system. Part of this process will be a necessary complementation of both quantitative and qualitative methods and guidelines. Another focus should be on creating improved Ergonomics participation within multidisciplinary system design and development environments throughout the system's life cycle. Only through this avenue can Ergonomics show a consistent and valued contribution to quality design and its development. In parallel to such a contribution will be an acceptance by other engineering disciplines, managers, and customers that such an application of Ergonomics is cost effective.

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1. Introduction

1.1. Historical Ergonomics effectiveness

As early as 1939 Sir Fredrick Bartlett was making human centred contributions to the design of air and land systems alongside other contributors such as Norman Mackworth, K.J.W Craik, Margaret Vince, and W.E.Hick. However, Ergonomics is a relatively new branch of science that only celebrated its 50th anniversary in 1999 and is supported by research carried out in many other scientific areas, such as engineering, physiology and psychology. As a discipline it originated in World War II, when it was realised that scientists were designing new systems without fully considering the people who would be using them and the context of system operation. It gradually became clear that systems and products would have to be designed considering human and environmental issues if they are to be used safely and be fit for their purpose.

As well as considering the historical benefits accrued to the application of Ergonomics to systems, this paper

will consider the insidious influences of new technologies with relation to systems design and related work. The benefits of Ergonomics as assisting the best compromise within a system design and development life cycle will be argued. Some examples of areas where Ergonomic principles have been successfully applied, or need to be applied to improve system efficiency or safety, are:

- The design of overhead crane cabins was improved to allow the crane operator ease of access to the crane controls. This alleviated the amount of damages caused by the crane operation and the cost of implementation was estimated to be repaid within six weeks (Beevis and Slade, 1970).
- Improvements by a major computer company to the efficiency of its sign-up procedure for a security application, this resulting in an equation of the costs of the improvement within the first half day of its operation (Nielson, 1993).
- Measures to improve safety and productivity in the South African forestry industry, devised by Ergonomists, were estimated to result in savings to the industry of four million USA Dollars annually (Hendrick, 1998).

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- “A new threat to the operation of the £650m air traffic control centre at Swanwick, in Hampshire, emerged last night when some of the controllers wearing glasses complained that they could not see vital information on their screens. But the controllers were warning that certain pieces of information were obscured on the computer screens, a concern that yesterday led to hurried meetings between officials of the controllers’ union, Prospect, the health and safety executive, and NATS, the partially privatised air traffic control service. Iain Findlay, the union’s aviation officer, said that they had reached agreement with NATS that the ergonomic design problems of the equipment would be examined. This would be done ‘in the light of the operational experiences of our members and the effect on their health and safety’”. (The Guardian, January 24, 2002).

It should be noted that the application of Ergonomics to the above projects, or the projected application, was retrospective in that improvements were made or suggested post the introduction of systems and their associated work practices. It is hard to estimate the actual safety, political, or monetary costs or savings in these cases, as there is no baseline set of costs available for comparison. However, it is a general systems engineering rule of thumb that changes to an engineered system made late in development will cost several orders of magnitude more than if they had been incorporated in the system design or its early stages of development. Further that if a system design does not promote safety of operation it is not effective. It is also a certainty that a system can be reliable but have little utility but cannot have utility without reliability.

In comparison to the above, it is worth mentioning that many engineering paradigms, such as the many that exist in systems engineering or that with Integrated Logistic Support (ILS), provide a regime to the processes of engineering a system. However, there is a scarcity of evidence as to how cost effective any particular regime is with relation to other methods of managing and conducting the engineering of a system. It is easier to criticise work retrospectively than to proactively approach the promotion of the effectiveness of a system from the onset of system design and throughout its life cycle.

The actual cost effectiveness of the application of Ergonomics in real money terms will vary tremendously depending on the quality of application, the form of the system and the adopted design regime. Thus, effectiveness of Ergonomic application will be argued here with relation to improvements possible to system quality covering its fit to specified requirements, its reliability, its safety, its utility, and ease of use,—encompassed by the term ‘Fitness for Purpose’. Arguably there is a need

to specify a system’s Fitness for Purpose criteria from the onset of design, these as goals on which to base system acceptance into operation. In addition, some achievable areas of improvement to Ergonomic methods will be presented with relation to their use in the real world. The paper will conclude with considerations on the future developments of systems under architectures built specifically for the use and handling of knowledge—another challenge to the wide remit of the discipline of Ergonomics.

2. Influences of technology

Increasingly over the last decade, the complexity of digital electronic and communication systems has burgeoned, and has often included a wide geographical distribution of multiple users using the system for diverse purposes. This burgeoning complexity means that traditional principles, though still applicable and often ignored (Norman, 1990), have less positive impact on the quality of design and the cost effectiveness of the application of Ergonomics than other less physical influences on design such as related to cognition.

It is argued that the work involved in the operation of complex computer based avionics systems is becoming predominately thinking based. For example, work still involves system control, such as aircraft flight direction. However, flight direction is still provided by the aircrew but the majority of the associated flight control effort is now provided by engineered aircraft systems such as Flight Management Systems (FMS).

Ergonomics as a discipline is currently failing to adequately address the problems associated with the influence of new technologies on the design work related to new and advanced systems. Many other disciplines are facing similar problems [In 1998 a survey by the Standish Group (Standish Group, 1998) showed that in the United Kingdom 53% of investigated major software projects failed (The Computer Bulletin, July 1998)]. Internationally, the figures have shown a worse picture indicating only a 16% success rate in major digital electronics based projects, these accompanied by large cost and time over runs (Scientific American, 1994). The same report indicated that 45% of designed system functions were never used raising the question of how do you effectively influence the design of such a system through Ergonomics?

If technology is used as a driver of change to systems design supported primarily by arguments of increased reliability and decreased life cycle costs, and omitting other arguments supporting the efficacy of its adoption, it is likely that design will be performed with inappropriate foci. Thus it is likely to include a poor address to important facets of design such as its Fitness for Purpose. Technology should be an enabler for

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