ENGINEERING STANDARDS DEVELOPMENT AND ERGONOMICS – A LITERATURE PERSPECTIVE WITH SPECIAL FOCUS ON WAREHOUSING

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Abstract
A labor standard is a unit of time required to accomplish a work task. Engineered Labor Standards are used to measure and control the time required to perform a particular task or group of tasks. They are most commonly used in manufacturing operations; however, labor standards are also used in a variety of activities, including warehousing operations.

Several factors can contribute to the inconsistencies that are so common to Engineering Standard development. There may be several sources of error in standard development, but the most serious of these is in the allocation of ratings and allowances. An inexperienced rater can easily underrate or overrate a task. On the other hand, inadequate allowances can result in serious health and safety issues for the operation.

Ergonomics mainly focuses on minimizing the risk of injury, illnesses, accidents and errors by addressing the interface issues relevant to humans, equipment, tools and systems. Proper Ergonomic interventions do help in minimizing the risk of injury and errors without compromising productivity. Ergonomists from a non-engineering background can often be puzzled by the intricacies in the standard development process. On the other hand, the lack of understanding of ergonomic realities on the part of Industrial Engineers or other standard developers can create health and safety problems in the workplace. This lack of communication between the two often cause confusion among Employers, Unions and Workers.

Warehouse workers are very commonly exposed to repetitive lifting, carrying, pushing and pulling tasks requiring excessive bending and twisting. These exposures put these workers at increased risk of injuries due to excessive fatigue and cumulative trauma. On top of the problems, which may be pre-existing in a workplace, an inconsistent engineered standard could place these workers at additional risk due to an increased pace of work, resulting in anincrease in job demands. In addition, under these conditions, a number of workers will not meet the existing performance standards without risking their health and safety. This paper will focus on the literature review on the subject with an aim to highlight the gaps in the Engineering Standards development process in relation to Ergonomics issues.

Keywords: Engineered Standards, Ergonomics, Warehousing

Engineered standards (ES) are developed using recognized principles of industrial engineering and work measurement. The standards developed define the time necessary for a qualified worker, working at a pace ordinarily used, under capable supervision, and experiencing normal fatigue and delays, to do a defined amount of work of specified quality when following the prescribed method. A labor standard is a unit of time required to accomplish a work task. Engineered Labor Standards are used to measure and control the time required to perform a particular task or group of tasks. They are most commonly used in manufacturing operations, however labor standards are also used in a vast variety of activities including warehousing operations.

Warehouse Studies

Warehouse workers are very commonly exposed to repetitive lifting, carrying, pushing and pulling tasks requiring excessive bending and twisting. These exposures put these workers at increased risk of injuries due to excessive fatigue and cumulative trauma. On top of these problems which may be pre-existing in a workplace, an inconsistent engineered standard could put these workers at additional risk due to an increased pace of work, resulting in increase in job demands. (7) reported that warehouse workers account for nearly 10 back claims for worker's compensation per 100 workers during a given year in the US. (14) reported that the job of grocery selector has a high level of risk for low back pain. This conclusion was based on a study of two warehouses using several different established ergonomic assessment methods. According to findings based on 1991 NIOSH lifting equation, the job of grocery selector will be unacceptable for nearly all healthy workers. Five other methods produced similar findings.

(1) reported the results of the OSHA 200 logs for the 67 order selectors in grocery warehouses between 1987 and 1991. The average annual rate of back injuries was 31% (range 28%-39%) and on average back injuries among selectors accounted for about 60% of all lost workdays in the grocery warehouse. (4) emphasized that in doing 'work measurement' we are not measuring work but we are measuring time which does not represent the mechanical or physiological aspect of work. According to (4), a fatigue allowance should be given if the energy requirement of the job over 8 hour period exceeds 5 Kcal/min or 4.7Kcal for 510 minutes. Although according to (4), 5Kcal work is considered to be very heavy and is rare in U.S. industry. In the same study (4) the authors concluded that the average energy expenditure rates were well above 5 Kcal/min in three of the grocery warehouses studied (criterion used in the study of three grocery warehouses for 8-hour work period).

In a Health Hazard Evaluation study at a Grocery Warehouse by (11). It was reported that out of 38 full-time grocery order selectors, 50% reported atleast one injury in the last 12 months and 18% of full-time selectors reported atleast one back injury in the previous year. In the second evaluation, these percentages were 63% and 47% respectively of full-time workers at the first warehouse, 70% reported significant backpain in the previous year (47% at the second warehouse)

In performing a physiological evaluation of time standards for warehouse operations as set by traditional work measurement techniques, (4) reported that without providing additional fatigue allowances, significant number of workers will not meet the existing performance standards. (4) studied order selectors in three warehouses. It was found that the mean heart rate was significantly greater than 110-beats/min criterion. Also, 40% of the workers failed to meet the 100% time performance level. The mean energy expenditure and heart rate were well in excess of acceptable limits. In one of the warehouses 65% of the workers failed to meet the 100% time performance index mean energy expenditure was 8.4 Kcal/min

(Recommended=5 Kcal/min), the mean heart rate was 133 b/min (Recommended =110 b/min)

Health Effects
The three primary causes of fatigue include physical, psychological and environmental (9). Health effects related to fatigue factors and engineered standards have been explored in the literature.

In looking at computerized work performance monitoring systems, (9) states that "The 1987 AFL-CIO convention adopted the following resolution on computerized monitoring: "electronic surveillance invades workers' privacy, erodes their sense of dignity, and frustrates their efforts to do high quality work, by placing a single-minded emphasis on speed and other purely quantitative measurements. Numerous studies have shown that monitoring creates high levels of workplace stress that result in a variety of adverse health conditions. Stress-related diseases, such as heart disease, high blood pressure, and digestive ailments, are increasingly reported among workers who are subjected to electronic monitoring."

Further, NIOSH's Health Hazard Evaluation's (11) (12) of specific grocery warehouses concludes that order selectors and order assembler's respectively have an elevated risk for musculoskeletal disorders, including low back pain because of the combination of adverse job factors all contributing to fatigue such as heat stress, a high metabolic load, and the workers' ability to regulate their work rate because of the work requirements. The authors believe that the existing performance standards encourage and contribute to excessive levels of exertion.

Examples of the kinds of musculoskeletal statistics related to grocery warehouse workers include (9) reporting that" One study has shown that warehousemen averaged nearly 10 claims for workers' compensation per 100 workers during a given year". The National Association of Grocery Warehouses list back sprains and strains accounting "for 30% of all injuries in grocery warehouses; further, one third experiencing at least one recordable injury per year." (10) examined how well the allowance worksheets methodology measures fatigue with regard to grocery warehouse order selectors and found that inter-rater reliability in the use of allowance sheets is a very serious problem. (2) argues that "fatigue allowances are purely for fatigue and are unrelated to any considerations made with respect to personal and unavoidable allowances. He further recommends that fatigue allowances should also be used in conjunction with personal and unavoidable delay allowances."

Environmental
In considering fatigue allowances, environmental issues such as temperature, air supply, humidity, noise level and lighting issues need to be addressed which are not considered in all engineered standards systems.

(16) suggests that better lighting increase productivity, recognizing that there is no one best solution to a lighting problem. Each warehouse is different. Cleaning existing lighting and fixtures, attention to floors to bolster lighting, painting walls and ceilings a light color while keeping them clean and *low brightness* (a bright lamp placed low or mounted on a low ceiling) directs light on a vertical lane a benefit for lift truck operators who are continuously looking into the brightness of lights. Avoidance of "hot spots" where you have a high level of light that temporarily blinds a worker and dark holes that force employees to constantly adjust to new light conditions are also key considerations. (3) suggests a three-step approach to lighting: good, cost-effective warehouse lighting, lighting system design criteria, and

equipment selection and maintenance of the lighting system. While (2) and (5) have listed relaxation allowances for many environmental issues, these are not shared by all engineered standards systems and their respective weights vary. Environmental issues with respect to engineered standards need to be further developed in terms of research and their application in engineered standards.

In summary, there are many issues not fully captured in all engineered standard systems which contribute to fatigue such as temperature (heat stress, cold), vibration, air supply, ventilation, fumes, dust, dirt, wet, humidity, noise level, lighting in addition to personal and unavoidable allowances. Additionally, gender differences need to be allowed for in all areas.

DISCUSSION

There is a delicate relationship between Engineered Standards and Ergonomics. It is very similar to a clash between Socio-Technical approaches of work design and Taylorist principles. Ergonomics mainly focuses on minimizing the risk of injury, illnesses, accidents and errors by addressing the interface issues relevant to humans, equipment, tools and systems. Proper Ergonomic interventions do help in minimizing the risk of injury and errors without compromising productivity. A Professional Ergonomist should address the productivity and efficiency issue and aim to incorporate that aspect in the analysis. In the same way an industrial engineer should incorporate the safety and ergonomics issues in developing time standards without compromising productivity and efficiency. A middle ground approach would be ideal i.e. developing Engineered Standards with human factor consideration. A more proactive approach is needed where the standard developer should look at the issues that are relevant to their facilities and try to critically look at the existing standards in the light of ergonomic and safety considerations.

The standard time developer (often an industrial engineer) needs to be well trained in rating various movements and workers when developing normal times using time study. The fatigue allowance issue is very crucial and often proves to be a reason for friction between employers and unions. A carefully developed fatigue allowance is the key. There are prescribed methods (5) (13) (2) (15) to develop fatigue allowances. Each of these methods has their own deficiencies. A detailed account of each of these four methods can be found in (8). Ergonomist from non-engineering background can often be puzzled by the intricacies in the standard development process. On the other hand the lack of understanding of ergonomic realities on the part of Industrial Engineers or other standard developers can create other problems. This lack of communication between the two often causes confusion among Employers, Unions and Workers. Therefore, it is of utmost importance that Industrial Engineers are involved in Health and Safety Committees and Ergonomist are involved in the Engineering Standards development process i.e., if the Industrial Engineer is not fully trained in Ergonomics.

Standards cannot be set and forgotten. Process improvement is one of the central elements of an effective Work Measurement System. As methods improve, the associated labor standards must be updated. Standards changes will effect the estimating value of all the data based on those standards. The data used to develop standards should be current and representative of current methods, facilities, and working conditions. The differences between the standard hours and actual hours should be explained as according to Professor Lund in (6) "Any work standards developed from these standardized methods, conditions and procedures, are only valid as long as there are no significant changes in the underlying methods, conditions or procedures. In other words, if warehouse layout changes, if the

location of a single product changes, if any procedures or methods change, the underlying standard documentation needs to be changed and the work standards updated."

Engineering Standards Implementation-Human Factor Focus

- Management should consult with employees on risks associated with introduction of engineering standards.
- An ergonomic risk assessment should be carried out prior to the implementation of engineering standards.
- A thorough ergonomic assessment should be carried-out by a functional "Ergonomics Committee (EC) working independently or under a Health and Safety Committee.

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