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CRITICAL HUMAN FACTOR ISSUES IN QUALITY INSPECTION TASKS
العوامل الانسانية الحرجة في فحص جودة المشغولات

By

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ملخص البحث: يتناول هذا البحث موضوع ضبط الجودة من وجهة نظر العوامل الانسانية ويقدم العوامل الانسانية التي يجب أن تؤخذ في الاعتبار عند تصميم محطات أو مراكز فحص الجودة حتي تعزز من انتاجية العامل في عملية الفحص، وقد تم عرض النقاط الخاصة بتخطيط وتصميم محطات فحص الجودة. هذا وان عدم الأخذ بعين الاعتبار لامكانيات ونواحي القصور للانسان عند تصميم محطات ومراكز فحص الجودة سيؤدي الي قبول مشغولات رديئة ورفض مشغولات جيدة وقد يكون هناك ما هو أكثر من هذا، الا وهو تعرض العامل للحوادث والضجر والكلل وما الي ذلك

Abstract

This paper looks at the quality control task from human factors standpoint. It presents critical human factor issues which if considered can greatly enhance the productivity of the inspector. Various planning issues pertaining to the quality inspection workstation design are also outlined. Since humanbeing plays a vital role in an inspection task and assuming that most workplaces are designed with task in mind rather than the human, therefore, the capabilities and limitations of the human if not incorporated into the design could lead to the acceptance of poor items and rejection of good ones. Possibility of physical injuries fatigue and boredom etc. will also be prevalent in these workplaces.

Introduction

Inspection and test departments have the responsibility to appraise the quality of purchased and manufactured items and to report the results. The reports are used by other departments to take corrective action when needed. One of the major problem with the inspection activity is the tendency to view the inspector as a person who has the total responsibility of the potential error. This attitude can lead to an ineffective inspection activity and deterioration of quality for the product. Various planning issues pertaining to the quality inspector job assignments and supervision are critical in any workplace design. Also, more importantly the human factor variable, which is often neglected by the industry should be explicitly described.

Human factors engineering which focuses on the human interaction with any system or component and looks at the design based on human capabilities and limitations

addresses the issue of inspection tasks in a very comprehensive fashion. The decision making in inspection tasks can be viewed as a case of signal detectability. Signal in this case can be viewed as the defect and the ability to detect this depends on several human factor variables including, illumination, workplace layout, inspector's sensory mechanism, inspectors vision, body size of the inspector with respect to the workplace etc. Since the decision making cannot be any better than the informational input, one of the more important ways to aid the inspector is to optimize the visual task. Sometimes the simple positioning of lights or a viewing angle can enhance a particular job. Colored lights have also proved to be helpful in color matching inspection.

In dealing with the human error, selection and training of the inspector is a prime concern, also the design of equipment, procedures and environments can improve the performance of people.

Human Factors Engineering

Human factors or ergonomics aims at looking at things from human angle. This may include the physical and psychological understanding of the human as these traits are applied in designing any system which has human as its integral part. If these issues are incorporated in the design than the likelihood of achieving a safe, healthy, efficient and comfortable workplace is very likely. The following sections describes the designing of quality control workstation to achieve maximum human performance.

Ergonomic Workstation Design

A workstation lacking in proper consideration of humans physical and psychological characteristics usually end up being non-productive, inefficient and unhealthy. The workstation should be able to accommodate at least 90% of the population of users (Bailey 1982, Singleton 1972) in relevant body dimensions. Usually the designs for shorter people would include such situations as reach, strength, or any limiting value, whereas, the larger or taller people should be incorporated in the designs such as doorways, door heights or any situation in which the performance may be affected by the increased height or length of an individual or different body members. The user should be both physically and mentally satisfied with the work being done at the station and this could only be achieved if the design has user in mind. The most critical issues in the workspace design itself include the reach or clearance and the positioning of the user with respect to various features of the workplace. These issues calls for the proper height of the work area, good static and dynamic fit with respect to the user population (to include 90%) i.e. both the body's non-moving and moving positions be satisfied. The static position would involve the actual anthropometric or body measurement of the user in a non-moving position, whereas, the dynamic or functional position requires that there is no interference between the body members and the workplace when they are moving or in motion. Appropriate tolerances can then be included in the physical dimensions of the workplace.

The body posture plays an important role in the overall comfort of any workstation, often extended reaches, body bending etc. results in muscle fatigue and potential musculo-skeletal injuries causing safety hazards. Much of this problem is caused as a result of poor seating. The seat design should incorporate various segments of the population, this can be achieved by adjustable seating. Inclined seating should be used whenever the work to be performed require bending postures. Also a standing position should always be evaluated against the seating position for a particular application, this could also be assessed based on the frequency of standing and sitting.

Quality inspection tasks requires extensive decision making from the inspectors, even though the decisions are generally simple but they have to make a number of decisions. As the inspector looks at every part, he or she has to decide if the required specifications are met and should the part be accepted or rejected. There is good chance that the inspector may forget to look for a particular specification especially if the choices are many. This would result in the acceptance of defective items (Type I Error) or rejection of non-defective items (Type II Error). If both of these errors are reduced than the inspection performance will improve, this will result in increased productivity, customer satisfaction, cost savings and better health and safety of inspector.

Several researchers (Drury 74, Nelson and Barany 69, Wallack and Adams 69, Bloomfield 75) have addressed the issue of human factor relevance to quality inspection tasks. Ballon and Pazer (1982) have addressed the costs associated with type I error in the inspection tasks. However, most of these researchers agree on some major issues which can influence the proper performance of the quality inspector. Time variable for inspection is a crucial variable since the inspection jobs are normally either paced or unpaced. In a paced line, the inspector has to detect several types of defects in a certain period of time resulting in both type I & II errors especially if the line is not properly paced or the defects are too many or the workplace is not designed properly. A human system can only perform at a certain speed which depends on individuals maximum physical and mental capacity. Unpaced tasks may be non-productive or may cause unhealthy postures etc., therefore, a well designed workplace incorporating both the human abilities and limitations can improve the inspector's performance several folds.

Improper lighting can make objects appear different, the light should preserve the color of objects especially for inspection type tasks, therefore the optimum amount of light falling on the work area or the workpiece is important in defect detectability, this light depends on light location, intensity, surface texture etc, also due to more energy cost consciousness the tendency to limit the illumination in factories can have serious effects on the inspection quality.

The inspector's vision is probably the most important factor in his/her ability to detect a defect, the visual acuity varies between individuals and can be measured to categorize the inspector's ability to detect a defect.

A posture at the workplace that forces a person to take a poor posture because of improper table or chair heights, adjustments etc. can affect the performance as the long term effects of these postures can cause static muscle loading which results in excessive fatigue and hence increased errors and slower reaction times.

CASE STUDY

The above concepts were utilized in analyzing a real life industrial situation for a glass/tumbler inspection workstation at a local factory in the city. The existing workplace is described in figure 1 and the needed human factor considerations in the redesign of the existing workplace are outlined in figure 2 and described as follows:

Present Layout (Figure 1)

The operator or inspector is seated on a stool, extends the body to get the inspection piece or glass and looks for relevant defects such as cracks, bubbles etc. and places the defectives in a bin, whereas the good ones are packed in a box.

It can be seen in figure 1 that the operator has to extend the body in order to get the workpiece, putting excessive static loading on the musculo-skeletal system. This loading can easily result in fatigue injuries etc. The feet of the inspector are hanging on the stool causing excessive pressure on the tissues inside of the thighs. This condition may cause swelling and tissue damage for extended periods of seating. The unnecessary holding postures for glass can cause muscle fatigue and cumulative trauma disorders, such as carpal tunnel syndrome etc. Improper location or low intensity lighting in the present set up can cause eye strain.

Improved Design (Figure 2)

The improved design takes into account the relevant human factor variables. It can be seen from figure 2 that an adjustable chair is provided to accommodate varying sitting heights, a backrest is provided to reduce strain on both lower and upper back. Extended body reach is reduced by providing a conveyor closer to the body and a gravity chute is introduced to minimize holding postures. This chute carries the defective part to the defective part conveyor. Proper illumination or lighting with good location would help reduce eye strain and improve the productivity. Guardrail is provided to reduce the accidental dropping of the glasses on the ground. Footrests both at the conveyor and the chair would give more freedom for foot comfort.

It is evident from figure 2 that the use of human factor design principles can aid the workplace designer to improve the health and safety of the worker which transforms into efficiency and improved productivity.

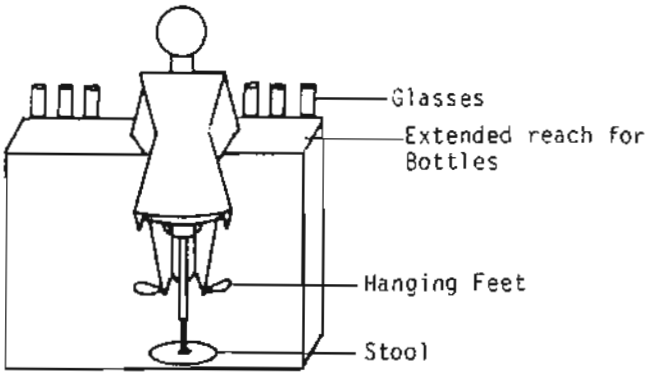

Fig.1. Existing Design of a Glass/Tumbler workplace inspection.

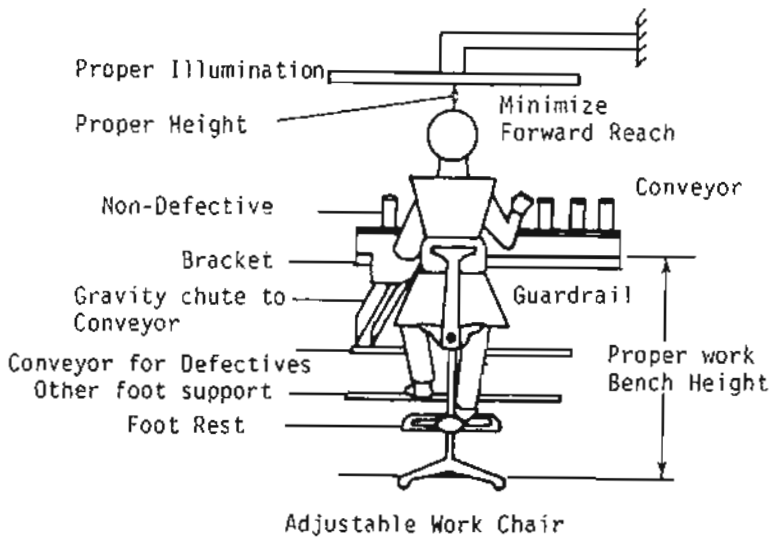

Fig. 2. Improved Design with Human Factor Considerations.

REFERENCES

[1] Bailey, R.W., "Human Performance Engineering", Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1982.

[2] Ballon, D.P., and Pazer H.L., "The Impact of Inspector Fallibility on the Inspection Process in Serial Production Systems." The Institute of Management Science, April 1982.

[3] Bloomfield J.R., "Studies on Visual Research" In C.G. Drury and J.G. Fox (Eds.) Human Reliability in Quality Control. London Taylor & Francis Ltd., 31-44, 1975.

[4] Drury C.G., "The Effect of Speed of Working on Industrial Inspection Accuracy", Applied Ergonomics, 4, 2-7, 1974.

[5] Nelson J.B. and Barany J.W., "A Dynamic Visual Recognition Test", American Institute of Industrial Engineers Transactions, 1, 327-332, 1969.

[6] Singleton, W.T., "Introduction to Ergonomics", Geneva, World Health Organization, 1972.

[7] Wallack, P.M. & Adams S.K., "The Utility of Signal Detection Theory in the Analysis of Industrial Inspector Accuracy". American Institute of Industrial Engineers Transactions, 1(1), 33-44, 1969.