Human Factor Engineering Term Paper

California State University-Dominguez Hills
QAS515 Human Factor Engineering
Term Paper

For

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HFE Term Paper on Intel Module Repair (IMR)

Introduction

Intel Module Repair (IMR) has 10 technicians who repair manufacturing system and sub-systems. Systems and sub systems repairs are mechanical, hydraulic, electrical and computerized; some units consist of all types. Modules repaired weight range from 2-800lb. Some modules produce voltages as high as 800KV, and RF generators that deliver up to 20KW. Repairs require disassembly of units in which some of them have more than 100 screws and bolts each. Technicians work in two shifts, front end and back end of week. Both shift are 12 hours each and start at 6:00AM and end at 6:00PM. Technicians take two coffee brakes and a lunch break. 25% of work need a clean room environment therefore, technician may use IMR small clean room while most of the time they go to work in the factory clean room; the factory is a clean room. Technicians vary in weight, height, age and gender. Ages are between 25 years of age to 50 years of age; possible variation is about ± 15%. Weight is between 135lb and 220lb; possible variation is about ± 15%. Height is between 5’2” and 6’0”; possible variation is about ± 15%. Work team is gender blind.

Work area contains three RF stations that handle high power. Each technician has a workbench that is equipped with power, Oil Free Air (OFA), three shelves; two to the front and right and one to the front left. All parts of the desk are electronically adjustable; desk and shelves. Adjustment allows any size technician to use this type of desk and reach any part on the desk. Repaired systems and sub systems are loaded on fixed height carts. Each technician has a toolbox and a tool cabinet equipped with all tools they need. Technicians are encouraged to request any type of tool they feel it might make their job easier. IMR is a part of Intel Corporation. Intel Corporation considers Safety as number one value and takes it seriously. Intel Corporation is considered one of the best corporations to work for. IMR management and employees live by Intel's culture.

IMR lab work area has a small break room used for tea and water, and drinking fountain is provided in this room; no drinks or food is allowed to working area. Cafeteria is 1000 feet away from lab and technicians have to leave their building to reach the cafeteria. Two rest rooms are available for technician, and both are 100 feet away from lab. Technicians park their vehicles about 1200 feet away from their work area. Each technician has a telephone on the desk and emergency telephones are placed in the workplace. Technicians are trained on emergency evacuation and IMR has two of its technicians are members of the Factory Emergency Response Team (ERT).

Lab is painted off-white flat color paint. Lightening consists of four rows of florescent lights, each row has eight lightning fixtures, each lighting fixture contains two florescent units and each fixture is covered with a sheet that removes direct flares. All light are 12 feet high. Benches are equipped with a spotlight and magnifying light fixtures.

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Technicians occasionally complain form rest and shoulder pains, stiffness of the neck, leg pain, numbness in the figures and low back pain and stiffness. Symptoms and complaints are not constant rather very far from one another. Symptoms are of a light nature and short in duration. Technicians take no time or little time off work due to the above symptoms.

After reviewing the complaints and the description of the symptoms I felt that these signs are of an accumulative nature. In this steady I will try to define the nature of the problem if we have one and find a solution that would avoid long term physical injuries.

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Review of the literature

Work-related Musculoskeletal disorders (WSD), such as low back pain, tendonitis, hand-arm vibration syndrome and carpal tunnel syndrome, account for a most of the work-related illness in the United States. Many studies have examined workplace factors and their relationship to MSD. The majority of studies involved working groups with a combination of interacting work factors.

There is evidence for a causal relationship between highly repetitive work and neck and neck/shoulder. Most of the studies defined repetitive work for the neck as work activities, which involve continuous hand and/ or arm movements that affect the neck and shoulder musculature and generate loads on the neck/shoulder area; fewer studies examined relationships based on actual repetitive neck movements. Also, there is ample evidence for forceful exertion and the occurrence of neck MSDs in the literature. Reports show that working groups with high levels of static contraction, prolonged static loads, or extreme working postures involving the neck/shoulder muscles are at increased risk for neck/shoulder MSDs.

Neck MSDs is defined by symptoms occurring in the neck, or by using the combination of symptoms and physical examination findings. Rate of tension neck syndrome among workers in the U.S was reported to be 4.9% from interview data and 1.4% when case definitions included physical exam findings (Hagberg.1995). The percent of work-related MSD cases defined by physical examination findings to those defined solely by symptoms has ranged from approximately 50% (Silverstein et al. 1987); repetition of the neck/shoulder region, address the cyclical work activities involving repetitive neck movements and/or repeated arm or shoulder motions that generate work loads to the neck/shoulder muscle area. A series of articles by Kilbom et al. (986) Kilbom and Persson (987) indicated that electronic workers in highly repetitive tasks with static postural loads to the neck and shoulder areas were followed over a 3-year period.

Three separate physical exams were carried out at yearly intervals, the first one initially assessing tenderness on palpation and pain or restriction with active and passive movements. Ergonomic assessments occurred at the outset of the study and included video analysis of postures and movements of the head, shoulder, and upper arm. The evaluation recorded work-cycle time and number of cycles per hour; time at rest for the arm, shoulder, and head; total number of rest periods; and average and total duration per work cycle and hour. The investigators performed step-wise logistic regression with deterioration of disorders or remaining healthy in the different locations as the two dependent variables. Age, muscle strength, job satisfaction, and high productivity were included in the analyses of these studies.

Other studies that focused on working groups with a combination of repetitive and forceful work used health outcomes from symptom surveys and self-reported workplace exposure and compared symptomatic workers neck MSD cases to symptomatic workers in the same workforce found significant differences in neck/shoulder MSDs between groups involved in repetitive upper limb operations and office workers. They found workers involved in repetitive activity had about10% to 30% maximum voluntary contraction of the trapezes muscle. They concluded that habitual neck or shoulder muscle fatigue is caused by repetitive tasks that result in localized tenderness and may be a precursor to chronic MSDs (Hagberg.1995).

Studies outside the epidemiologic literature give supported evidence that repetitive work is related to neck/shoulder disorders. Other studies found that the neck injuries among fork-lift truck drivers were caused by repetitive, extreme head rotations needed for the operation of fork lift trucks and introduced the side ways sitting driver forklift (Stevens, S. S 1960)

Epicondylitis is an injury to the muscles and tendons on the outside of the elbow that results from overuse or repetitive stress. The narrowing of the muscle bellies of the forearm as they merge into the tendons creates highly focused stress where they insert into the bone of the elbow. Moore and Garg carried out a medical records review using an epicondylitis (case definition based on symptoms and physical examination and a semi-quantitative ergonomic assessment of 32 jobs at a meatpacking plant. The authors used their “Strain Index” to categorize jobs as hazardous or safe, based on a number of factors: observation, video analysis, and judgments based on force, repetition, posture, and grasp. Force was defined as percent of maximal strength by comparing the reported weight of the pertinent object with estimated average maximal strength of the worker for different types of pinches and grasps, then categorized into five levels. Levels were derived from population-based data stratified according to age, gender, and hand dominance. Repetition was recorded as cycle-time and exertions per minute.

The exposure assessment in this study gave more weight to the factor of “force” than to repetition. Workers’ work histories, demographics, and pre-existing morbidity data were not collected on each participant.. Analyses were based on full time work for jobs, not individual workers. It has been found that a significant relationship between hazardous jobs of which force was a major component, and upper extremity MSDs of which epicondylitis was an important component. The results found a significant cause for a case of epicondylitis to occur in a hazardous job (Moore and Garg, 1994).

Basic medical description of Carpal Tunnel Syndrome (CTS) is a fibro-osseous tunnel on the palmer surface of the carpal bones that transmits a number of tendons and the median nerve from the forearm into the hand. In the wrist there is a sheath of tough connective tissue, which envelops and protects one nerve (median nerve) and tendons, which attach your muscles to the wrist and hand bones. The carpal tunnel is the space between this sheath (above) and the bones (below) making up the wrist and hand (carpal bones). The term 'carpal tunnel' is also used quite commonly to refer to 'carpal tunnel syndrome’, which is a condition where the median nerve is pinched within the tunnel and causes pain and/or numbness of the wrist/hand, typically as a result of repetitive motion such as painting

There is positive evidence of a positive association between highly repetitive works alone or in combination with other factors and CTS based on currently available epidemiological data. In recent years, the literature relating occupational factors to the development of CTS has been extensively reviewed. Most of these reviews reach a similar conclusion—work factors are one of the important causes of CTS. One review found the evidence more equivocal, but stated that the epidemiological studies revealed a fairly consistent pattern of observations regarding the spectrum and relative frequency of CTS among other Musculoskeletal disorders (MSDs) among jobs believed to be hazardous (Moore and Garg, 1994).

One of the most plausible ways that repetitive hand activities may be associated with CTS is thorough causing a substantial increase in the pressure in the carpal tunnel. In turn, this can initiate a process, which results in either reversible or irreversible damage to the median nerve (Rempel 1994). The increase in pressure of sufficient duration and intensity may reduce the flow of blood in the epineuria venules. If prolonged, this reduction in flow will affect the flow in the capillary circulation, resulting in greater vascular permeability (Rempel 1994).

The work determinants of pressure in the carpal tunnel are wrist posture and load on the tendons in the carpal tunnel. The normal resting pressure in the carpal tunnel with the wrist in a neutral posture is about 5 millimeters of mercury (mmHg), and for example, typing with the wrist in 45degrees of extension can result in an acute pressure of 60 mmHg. Substantial load on the fingertip with the wrist in a neutral posture can increase the pressure to 50 mmHg. A parabolic relationship between wrist posture and pressure in the carpal tunnel has been found. Laboratory studies of normal subjects, elevated carpal tunnel pressures quickly return to normal once the repetitive activity stops; patients with CTS take a long time for the pressure to return to their baseline values. One of the supporting observations for this model is that at surgery for CTS, edema and vascular sclerosis are common (Rempel, 1994). Based on the epidemiological studies, especially those with quantitative evaluation of the risk factors, the evidence is clear that exposure to a combination of job factors studied (repetition, force, posture, etc.) increases the risk for CTS. This is consistent with the evidence that is found in the biomechanical, physiologic, and psychosocial literature (Moore and Garg.1994).

Hand-arm vibration is the transfer of vibration from a tool or work piece to a worker’s hands and arms. The level of hand-arm vibration is determined by measuring the acceleration of the tool or object grasped by the worker. Hand-Arm Vibration Syndrome (HAVS) is a disease that involves circulatory disturbances, sensory and motor disturbances and musculoskeletal disturbances. While it has been known since the beginning of the 20th century that vibration effects the hands and arms, it was not until 1983 that scientists agreed on a definition of HAVS that includes the circulatory, nervous and Musculoskeletal systems.

Symptoms of HAVS include bluish discoloration (cyanosis) of the skin of fingers and hands. Whitening (blanching) of fingertips after cold or damp exposure. Numbness, with or without tingling happens, before, during after blanching. Attacks, more common in winter, but eventually may occur year around. Palms of the hands are rarely affected.

Sense of touch and pain perception reduced, sometimes forever. Decreased grip strength, and inability to sustain muscle power. If symptoms of HAVS are ignored the tingling and numbness in the fingers, and loss of grip strength can cause problems with using objects, and they may slip hands. There can be serious interference with work, home activities and hobbies. Some activities (especially in the cold) for those who suffer HVAS should be avoided to prevent the vessel spasms, which cause pain.

In general, there is strong evidence of a positive association between high level exposure to hand-arm vibration (HAV) and vascular symptoms of hand-arm vibration syndrome (HAVS). Studies of workers with high levels of exposures such as forestry workers, stone drillers, stonecutters or carvers, shipyard workers, or workers using air-powered tools show such workers were typically exposed to HAV acceleration levels of 5 to 36 m/sý. Also, There is evidence that an increase in symptom severity is associated with increased exposure. A group of 570 quarry drillers and stone carvers, along with machine operators who were not exposed to hand-transmitted vibration were examined. HAVS was assessed by physician interview, and sensor neural symptoms were staged and graded. Exposure to vibrating tools was assessed by interview and linked to vibration measurements obtained from assessment of a sample of tools. Prevalence of HAVS was 30.2% in the exposed and 4.3% in the unexposed groups. Symptoms increased with lifetime vibration dose (Andersson, 1979).

Low-Back Pain (LBP) is common in the general population: lifetime prevalence has been estimated at nearly 70% for industrialized countries; sciatic conditions may occur in one quarter of those experiencing back problems (Andersson,1977). Studies of workers' compensation data suggest that LBP represents a significant portion of cases in working populations. Data from a national insurer indicate that back claims account for 16% of all workers' compensation claims and 33% of total claims costs (Snook 1982; Webster and Snook 1994b). Studies have demonstrated that back disorder rates vary substantially by industry, occupation, and by job within given industries or facilities (Andersson, 1979). Heavy physical work has been defined as work that requires high energy or high measure of physical strength. Some biomechanical studies interpret heavy work as jobs that impose large compressive forces on the spine (Andersson, 1979).

Conclusion

In comparing facts about the type of work IMR technician are involved in, their work environment, complaints and symptoms and what has been discussed in the literature, it can be concluded that they are subject to long term exposure to MSD, CTS, LBP and some low levels of HVAS. The majority of complaints show that the effects are minimal at this time, and that a corrective action would eliminate long-term effects. There is strong evidence showing relationship between studies in the literature and IMR complaints. Therefore, a detailed and comprehensive evaluation and corrective action is recommended at the earliest time.

Recommendations

In order to address this issue and achieve high-level success, I recommend the following:

1. **Exercise.** It has been suggested that exercise can be an effective part of an ergonomic program designed to address work-related musculoskeletal disorders.. However, the effectiveness of on-the-job exercise programs may not be very effective, therefore encouraging specific exercise in the company gymnasium can be effective in strengthen hands, arms, neck, shoulders and lower extremities of workers.

   An exercise program will benefit employees by:

   - Improve circulation, increasing blood flow through the stressed area
   - Reduce fatigue
   - Increase muscle strength and endurance
   - Improve flexibility
   - Maintain or improve muscle balance
   - Reduce stress

   Tips on designing an exercise program

   - **Make the program positive for everyone.** A voluntary program is more likely to be accepted by employees that mandatory.
   - **Provide complete information**. Be sure employees really understand the purpose of the program and know how to perform the exercises properly.
   - **Keep the exercise regime short.** Frequency and duration are interdependent and influenced by job function.
   - **Keep the exercise regime simple.** Select exercises that can easily be done at the intended location

2. **Workload evaluation.** Evaluate all repaired systems and sub systems as follows:
   - **Weight.** Evaluate system and sub system according to weight. Light, which is a one-man lift, medium as a two-man left, and high for system and sub system that exceed a two-man lift. Such evaluations can be defined by weight limits. A grade of 1 to 10 can be established. A grade of 1-3 for light, 4-6 for medium and 6-10 for high. The lowest grade is 1, and a grad of 10 is the highest.
   - **Repetitive work**. Evaluate repaired system and sub system according repetitive work requirement. Light for systems and sub systems that require minimal repetitive work, medium for systems and sub systems that require a higher level repetitive work, and high for system and sub system that require excessive repetitive work. A grade of 1 to 10 can be

established. A grade of 1-3 for light, 4-6 for medium and 6-10 for high. The lowest grade is 1, and a grad of 10 is the highest.

- **Force.** Evaluate repaired system and sub system according to force needed to complete the work. Light for systems and sub systems that require minimal force, medium for systems and sub systems that require a higher-level force, and high for system and sub system that require excessive force. A grade of 1 to 10 can be established. A grade of 1-3 for light, 4-6 for medium and 6-10 for high. The lowest grade is 1, and a grad of 10 is the highest.
- **Frequency.** Evaluate repaired system and sub system according to force needed to complete the work. A grade of 1 to 10 can be established. A grade of one is the lowest and a grad of 10 is the highest.

4. Replace all fixed height carts by adjustable carts to eliminate effects of pending and reaching that may cause LBP.

5. Seek consultation of an ergonomest and a medical person to construct a rotation schedules that allows for equal division of work among all employees and prevent exposing any one worker into excessive and unnecessary repetitive work, force and heavy weigh that may lead to long term injuries. A workload evaluation should be part of the ergo and medical analysis and program.

The following table is a suggested module of evaluation:

Suggested Evaluation System

Name of	Weight			Force			Repetition			Frequency			Total
Module	L	M	H	L	M	H	L	M	H	L	M	H	Grad
25-B RF Generator			9	2					9			10	200
ADH TxZ Lid		5				10			10			10	250
RF Match	1			1			6					10	70
Upper Bellws	1			1			1					1	3

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- ✓ Total Grade = (W + F + R) * F
- ✓ Maximum Grade = 300
- ✓ Minimum Grade = 3
- ✓ Maximum grade is given to modules that are high is weight, need high level of force, require high level of repetitive work and it is repaired more frequently than other modules.
- ✓ Minimum grade is given to modules that are low in weight, need low level of force, require low level of repetitive work and it is not repaired frequently.

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14. http://assist.daps.dla.mil/quicksearch/