ERGONOMIC INVESTIGATION AND THEIR EFFECT ON PRODUCTIVITY OF MICRO, SMALL & MEDIUM INDUSTRY OF JHARKHAND STATE

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ABSTRACT

The goal of ergonomics is to reduce work related musculoskeletal disorders by adapting the work to fit the person, instead of forcing the person to adapt to the work. Ergonomics is concerned with the design of systems in which people carry out work. There is historical tendency to seek technical means of improving system performance and to blame accidents and break down on “human error”. But the detailed analysis of accidents and near accidents has revealed that human error is almost never the sole cause of poor system performance. The purpose of ergonomics is to enable a work system to function better by improving the interactions between the human component and the other component. This paper depicts a study of ergonomic investigation about the working culture in the micro, small and medium scale industries in Jharkhand and their effect on the net productivity.

Keywords: Ergo, Ergonomics, Jharkhand, Forging, Productivity, Industries in Jharkhand, Human Effort.

1.1 INTRODUCTION

Musculoskeletal discomforts were recognized as having an occupational related etiology as early as the beginning of the 18th century. In 1713 Bernardini Ramazzini, the father of occupational medicine, in his treaties De Morbis Artificum Diatriba (“Diseases of
Workers” as translated by Wright, 1940) documented that MSD disorders were associated with workplace factors regarding bakers, Ramazzini noted, “Now and again, I have noticed with swelled hands, and painful to; in fact the hands of all such workers become much thickened by the constant pressure of kneading the dough” (Wright 1940). Of sedentary workers, ‘Ramazzini observed, “men and women who sit while they work at their jobs, become bent, hump backed and hold their heads like people looking for something on the ground; this is to effect of their sedentary life and the bent posture as they sit …” (Wright 1940).

Objective of the Study

* To assess/evaluate musculoskeletal discomforts among workers.
* To evaluate the effect of MSD’s on productivity.
* To find out remedial measures.

![Diagram of Ergonomics disciplines](image)

**Fig.1:** Aims of Discipline-Ergonomics

2.1 DISCUSSION

There are several more or less established doctrines that characterize the human factors profession and that together distinguish it from other applied field:

- Commitment to the idea that things, machines, etc. are built to serve humans and must be designed always with the user in mind.
- Recognition of individual differences in human capabilities and limitations and an appreciation for their design implications.
- Conviction that the design of things, procedures etc. influences human behavior and well-being.
- Emphasis on empirical data and evaluation in the design process.
- Reliance on the scientific method and the use of objective data to test hypotheses and generate basic data about human behavior.
Commitment to a systems orientations and a recognition that things, procedures environments, and people do not exist in isolation.

2.2 A HISTORY OF HUMAN FACTORS
To understand human factors, it is important to know from where the discipline came. It is not possible, however, to present more than just a brief overview of the major human factors developments. We have chosen to concentrate on developments in India, major work has been done in the United States but several sources trace the history in other countries.

2.3 MOVEMENT MECHANISM OF BODY
The skeletal and muscular systems of the human body form the movement mechanism and perform other functions that are of tremendous importance for maintaining life. The skeletal system provides the mechanical levers whose movements are accomplished by contraction of the muscle. Because of its importance in understanding the subject of back injuries, a special emphasis is placed on describing the structure of the spinal column and potential back injuries due to manual work.

APPLICATION AND DISCUSSION
The very broad overview of the skeletal system is not meant to be a substitute for a course in basic anatomy. The agronomist is urged to refer to an anatomy text (or a functional anatomy text such as those used by physical therapist, kinesiologists or occupational physicians). The objective of this chapter is not to lead agronomists to believe that they are experts in anatomy, but rather to provide a basis for them to discuss anatomical issue with ergonomics team members trained in anatomy. There are many excellent references available, which do not typically focus on ergonomics, but they can be very helpful in understanding human anatomy.

FUNCTIONAL CHARACTERISTICS OF MUSCLE TISSUES
Muscles tissues have the following five distinctive characteristics:

- Conductivity: ability to transmit impulses;
- Irritability: ability to respond to a stimulus;
- Extensibility: ability to be stretched;
- Elasticity: ability to return to their original length when stretched force is removed;
- Contractility: ability to contract or shorten;

TYPES OF MUSCLE CONTRACTIONS
There are several different types of muscles contraction, with the more common types of contractions listed below:

- Isometric (Static) contraction occurs during a prolonged state of contraction, in which the muscle remains at the same length and performs "no physical work" but tension within the muscle increases.
- Sotonic (dynamic) contraction occurs when the muscle shortens and performs work, but the tension within the muscle remains the same.
• Lsokinetic (dynamic) contraction occurs when the muscle (or external load) moves at a constant velocity.
• Lsoinertial (dynamic contraction involves the movements of a constant load (free weights).
• Fibrillation is an abnormal of the cardiac muscle without producing an effective movement. Fibrillation is typically the result of asynchronous firing of cardiac muscle fibers.
• Convulsion is an abnormal or uncoordinated smooth contraction of a group of muscle.

SKELETAL MUSCLES AND THEIR FUNCTIONS
Muscles are attached to bones by tendons. A tendon is a band of tough, inelastic fibrous tissue whose only function is to transmit the forces generated by the muscle to the bone to which it is attached. Each tendon is attached to an origin bone and an insertion bone. Generally, the insertion bone moves when the muscle contracts.

To identify the muscle’s function, physiologists have classified the skeletal muscles into prime mover, antagonists, and synergists:

• Prime Mover – muscle or muscles whose contraction is the primary agent in producing a desired movement.
• Antagonists – muscle that relax or contract to slow the action of a prime mover.
• Synergists – muscles that contract at the same time as the prime mover. By eliminating undesirable movements of a joint or holding a part steady, the synergist muscle assists the prime mover in producing a more effective movement.

The biceps brachii in the upper arm serves as a prime mover in flexing elbow joint and as an antagonist to the triceps brachii or gravity to slow the extension of the elbow.

2.6 FACTOR’S AFFECTING HUMAN PERFORMANCE
Since some degree of muscular activity is required in all kind of work, even in most intellectual occupations, and in all expression of life, work physiology is of interest not only to those concerned with manual labor. Furthermore, some of the factors affecting the energy – yielding processes are not merely physiology in nature, but include a variety of both psychological and clinical aspects, including the Workers State of health and motivation, in addition to the nature of the work itself and the environment in which the work is being done. In certain types of industry, toxic agents in the air at the place of work are not only of interest to the toxicologist, but to the physiologist as well, since the uptake, and therefore the noxious effect to the toxic agents, is dependent upon pulmonary ventilation and other physiological parameters. This is yet another reason for a closer collaboration between the work physiologist and other occupational health specialists.

• Service function: As already pointed out, the ability to perform physical work basically depends on the ability of the muscle cell to transform chemically – bound energy in the food which we ingest, into mechanical energy. This in turn depends on the capacity of the service functions that deliver fuel and oxygen to the working muscle fiber.
State of health: Physical performance may indeed be affected by the individual’s state of health. This relationship, however, is by no means absolute or clear cut.

Sex: Basically speaking, there are few jobs, which cannot be equally well performed by females as males, except in cases where heavy lifting or very heavy physical work loads are involved. As a matter of fact, experience has shown that women may, in many cases, be superior to men, especially in jobs requiring accuracy, patience, alertness an perseverance.

Age: Maximal oxygen uptake, heart rate, stroke volume, pulmonary ventilation, and muscle and muscle strength decreases significantly with old age.

Nutritional state: In carefully controlled lab., Studies varied nutritional states in terms of caloric and protein, taken over a ten days period has an appreciable effect on physical performance at room temperature however, a combination of nutritional deficiency and cold stress and destroying effects on performance.

**PSYCHIC FACTORS**

Attitude: Obviously, a person’s attitude to work in general, and to his job in particular effects performance. While this may have changed with changing trends in the industrialized parts of the works, these attitudes may still persists in more primitive societies.

Motivation: Motivation plays a major role in all kinds o human pursuits. This aspect of our state of mind is closely associate with an awareness of a personal role in the working team or in the job.

Sleep deprivation: Sleep deprivation, when severe i.e. extending over more two – to three days, may cause marked deterioration of mental performance

Stress: Stress, which one is able to cope, acts simulation, arousing one’s mental alertness and intellectual activity up to a point.

Fatigue: Subjective feeling of fatigue usually occurs at the end of an 8 hour work day when average work lord exceeds 32 to 40 percent of individuals maximal work capacity, depending on whether or not the work is more or less continuous

Small or large muscle group: The smaller the muscle mass involved in handling a certain lord, the greater the stress on each individual muscle fiber. The heart rate is also higher in arm work then in legwork, especially in prolonged work.

Work rhythm: Automation and many working device which saves, modern technology has contributed greatly to elimination of much heavy physical work.

Continuous work: With increasing rate of work, there is linear increase in oxygen uptake. Up to the point when the oxygen uptake levels further increase in workload is not accompanied y a further increase in oxygen uptake.

Intermittent work: A psychological steady state works situation I rarely attend in industrial work because ordinary muscular is very seldom maintained at a steady rate for long period.

Static Versus Dynamic work: Man is made to work dynamically, changing between work and rest, between muscle contraction and relaxation in more or less rhythmic fashion.
Literature Survey: Scenario of the Casting and Forging Industry in India and Jharkhand State

The Indian Institute of Foundrymen (IIFM) represents the foundry industry and has more than 3700 members. The foundries support automobile, machine building, sanitary goods, households’ goods, and related industries. Forty percent of the outputs of the foundries are for the automobile sector. As per Jharkhand state scenario, as of March 2007, the number of small scale industries existing in Jharkhand was 1,63,220 out of which 28,468 were registered units and remaining 1,34,752 were un-registered units provided employment to more than 1,00,000 persons in registered units and more than 2,36,000 in un-registered units. India is globally ranked second in casting production, but our share of the global market is below 2 percent. The foundry industry has 4500 foundries in India producing around 7 million tons of castings; many of them are small or medium scale. The industry gives employment to more than 5 million people directly and three times that number indirectly. The Association of Indian forging industries (AIFI) represents the composition of the Indian forging industry and has been categorized into four sectors - large, medium, small and micro. As is the case the world over, a major portion of this industry is made up of small and medium units/enterprises (SMEs). About 200 organized and 1,000 unorganized forging units in the country are spread across Pune, Chennai, Delhi, Ludhiana and Jalandhar, Jharkhand (Singh et al., 2010, www.indiaprwire.com). The employer of small scale units are totally lagging behind in providing occupational health and safety to the workers (Singh et al., 2009). Therefore the manpower employed in small scale casting and forging units are more exposed to occupational noise, heat stress, musculoskeletal strain and dust. The major occupational diseases of concern in these units are silicosis, musculoskeletal injuries, pneumoconiosis, chronic obstructive lung diseases, and NIHL. There are short falls of data regarding the working condition and health problems of the workers working in small and medium scale casting in India (Singh et al., 2008, Singh et al., 2009). Work-related health problems should be studied thoroughly for formulating ergonomic measures to increase the standard of living while working in these industries. The major occupational diseases of concern in India are silicosis, musculoskeletal injuries, pneumoconiosis, chronic obstructive lung diseases, and NIHL (Habibullah et al., 2004). A cross-sectional study carried out in Malaysia, assessed the compliance to a Hearing Conservation Programme (HCP) launched by the Malaysian Government, results revealed that percentage of industries complying with the norms of HCP need to be improved in order to prevent the hearing problems amongst workers (Ibrahim et al., 2006). Another study evaluating the noise exposure level of industrial workers in five selected processing and manufacturing firms in Ilorin, reported that the majority of machines produced noise which exceeded occupational safety and health administration (OSHA) recommendations (Oyedepo et al., 2009.). A study conducted in Japan reported Ergonomics SA, 2010, 22(1) ISSN Number: 10-10-2278 38 that working hours of workers were significantly associated with their fatigue and reduced concentration. High levels of instrumental support and positive reframing were significantly associated with low levels of negative emotions, fatigue, and reduced concentration/activity levels (Otsuka et al., 2009). High levels of self-blame, denial, substance use, venting, self-distraction, religion, and behavioral disengagement were significantly associated with high levels of negative emotions, fatigue, and concentration/activity levels (Otsuka et al., 2009). This study suggested that improving coping skills such as using instrumental support or positive reframing may reduce the adverse health effects of long working hours (Otsuka et al., 2009). Hyesook et al., 2002 reported that the Korean government has started providing financial subsidy programs for Occupational Health Services (OHSs) in small scale enterprises (SSEs)
from the occupational injury prevention fund. To identify the health care status in SSEs in Korea, authors surveyed 5,080 factories, which had participated in the government-funded subsidy program in 1997 (Hyesook et al., 2002). The overall morbidity of the workers in these SSEs was higher than the national average for both general and occupational diseases. The study recommended that it is desirable for this program to be continued in Korea, in addition, the same program may be a good model for rapidly developing countries. Another study reported that workers in informal small-scale industries (SSI) in developing countries involved in welding, spray painting, woodwork and metalwork are exposed to various hazards with consequent risk to health and high levels of exposure to multiple health hazards and that use of protective equipment is poor (Rongo et al., 2004). The same study revealed that workers and employers were both aware of occupational and environmental health hazards, but absence of a clear policy on the informal sector and the lack of permanent workplaces did not encourage investment in occupational health and safety (Rongo et al., 2004). The whole literature reveals that developing countries like India lag far behind in implementing occupational health and safety programs in their industries. As far as Indian SMEs are concerned, very few studies on occupational health and safety issues are available, especially in the casting and forging industry. The present study has been undertaken to reveal occupational health and safety practices in SMEs and addresses some important issues such as; what is the status of health and safety practices in casting and forging SMEs, what is the level of use of PPEs, what is the level of occupational exposure to hazards conditions.

3.1 METHOD

The present cross-sectional study included randomly selected 160 collar male workers engaged in casting and forging SME, three from each type; i.e. in total 10 units, located in Giridih, Dhanbad & Jamshedpur areas of the Jharkhand state of India (Table 4). The workers were performing different jobs in various sections like moulding; molten metal pouring, grinding, forging, punching, blanking, welding, gas cutting, electroplating and painting etc. (see Table-. 1 to 4 for more details). Around 95% of these workers were performing their jobs manually except a few material handling.

3.2 QUESTIONNAIRE STUDY

Based on OSHA guidelines comprehensive questionnaire was formulated to assess the information regarding various hazards like noise, high temperatures and dusts/fumes associated with the SME’s. The questionnaire included demographic descriptors, the nature of job/process, exposure (in years) to the hazardous conditions like noise, temperature, dust/fumes/gasses, and chemicals, working hours, shifts and over times, personal information of the worker regarding work posture, physical load, reaction to noise, temperature and dust, sleep disturbances, water intake, diseases, alcohol tobacco consumption, use of PPEs, work time injuries, auditory, visual and overall health and job satisfaction. Observations were taken regarding the use of PPEs at the shop floor and the responses of the workers regarding the same issues were asked in the questionnaire. The questionnaire was pretested on a few subjects to know the trend in the quality of life of the workers and then a standard questionnaire was constructed and applied to the full sample. A brief discussion about questionnaire and study model, were held at different companies under investigation as most of the workers s were illiterate or less educated.
3.3 NOISE POLLUTION ASSESSMENT

Noise Pollution assessments were done based on the noise pollution(Regulations and Control)Rules 2000, India and OSHA norms for hearing conservation were incorporated including an exchange rate of 5dB (A), criterion level at 90dB (A), criterion time of 8 hours, threshold level = 80dB (A), upper limit = 140dB (A) and with F/S response rate. The measurements of sound pressure will be done to determine a weighted (Leq) sound pressure level. The sound pressure will be recorded for 10 minutes each time on each work station and one long term recording for 8 hrs was done. At each section sound pressure will be recorded at least 8 to 10 times at different locations where the movement of the workers is most frequent.

3.4 STRESS ASSESSMENT DEVELOPED BY HEAT

The ambient temperature and heat exposure was measured using an IR-Thermometer. A long term (8 hours) recording was done in each section followed by a short term recording for 10 minutes each. The ambient temperature was recorded for 10 minutes each time on each work station and one long term recording for 8 hours was done. At each section temperature was recorded at least 10 times at different locations where the movement of the workers was most frequent.

2.7 DATA COLLECTION

Ambient Air Quality standards in respect of Noise

<table>
<thead>
<tr>
<th>Area Code</th>
<th>Category of Area/Zone</th>
<th>Limits in dB(A) Leq*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day Time</td>
</tr>
<tr>
<td>(I) A</td>
<td>Industrial area</td>
<td>75</td>
</tr>
<tr>
<td>(II) B</td>
<td>Commercial area</td>
<td>65</td>
</tr>
<tr>
<td>(III) C</td>
<td>Residential area</td>
<td>55</td>
</tr>
<tr>
<td>(IV) D</td>
<td>Silence Zone</td>
<td>50</td>
</tr>
</tbody>
</table>

The data were expressed as mean ± standard error. The descriptive statistics for the male samples and mean and standard error of mean were calculated.

Demographic data

The demographic features based on recorded/collected data have been represented in the Tables 1 to 2, 3 and in Figures1 (A), (B). The age distribution of the workers has been tabulated in the table 1.

<table>
<thead>
<tr>
<th>Table 1: The age distribution of the workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
</tbody>
</table>
It is seen from the table that most of the workers (~19%) are of the age group of 30 to 32 years. With the increase in age the number of workers steadily decreases. The physical parameters of the workers showing the weight (Kg) and the height (meters) of the workers are presented in Figure 1 (A) and (B) respectively.

**Figure 1(A):** % of workers Vs Weight in Kgs

**Figure 1(B):** Height (meters) of the workers

### Table: 2 Level of Education vs. Frequency

<table>
<thead>
<tr>
<th>Education</th>
<th>Uneducated 152</th>
<th>Primary 172</th>
<th>Middle 142</th>
<th>Metric 96</th>
<th>Senior Secondary 39</th>
<th>&gt;Senior Secondary 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (%)</td>
<td>(2.73%)</td>
<td>(28.23%)</td>
<td>(22.66%)</td>
<td>(16.78%)</td>
<td>(8.03%)</td>
<td>(3.07%)</td>
</tr>
</tbody>
</table>

**Table 3: Marital status and exposure in years of the workers**

<table>
<thead>
<tr>
<th>Different working Environments (Years)</th>
<th>Marital Status</th>
<th>High Noise N (%)</th>
<th>High Temperature N (%)</th>
<th>High Dust/Fumes N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 yr.</td>
<td>MARRIED</td>
<td>20(12.50)</td>
<td>13(9.24)</td>
<td>15(9.01)</td>
</tr>
<tr>
<td></td>
<td>UNMARRIED</td>
<td>27(16.93)</td>
<td>31(19.14)</td>
<td>32(19.09)</td>
</tr>
<tr>
<td>4-6 yr.</td>
<td>MARRIED</td>
<td>32(20.55)</td>
<td>35(21.21)</td>
<td>35(21.68)</td>
</tr>
<tr>
<td></td>
<td>UNMARRIED</td>
<td>7(5.05)</td>
<td>9(5.06)</td>
<td>9(6.01)</td>
</tr>
<tr>
<td>7-9 yr.</td>
<td>MARRIED</td>
<td>26(15.36)</td>
<td>31(19.23)</td>
<td>29(18.41)</td>
</tr>
<tr>
<td></td>
<td>UNMARRIED</td>
<td>6(3.52)</td>
<td>3(1.97)</td>
<td>2(0.95)</td>
</tr>
<tr>
<td>10-13yr.</td>
<td>MARRIED</td>
<td>27(16.56)</td>
<td>24(15.12)</td>
<td>25(15.32)</td>
</tr>
<tr>
<td></td>
<td>UNMARRIED</td>
<td>12(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>≥ 14 yr.</td>
<td>MARRIED</td>
<td>17(10.03)</td>
<td>14(9.01)</td>
<td>13(9.03)</td>
</tr>
<tr>
<td></td>
<td>UNMARRIED</td>
<td>0(0)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Total</td>
<td>MARRIED</td>
<td>120 M (74%)</td>
<td>120 M (74.41%)</td>
<td>118 M (74.25%)</td>
</tr>
<tr>
<td></td>
<td>UNMARRIED</td>
<td>54 U (26%)</td>
<td>41 U (25.59%)</td>
<td>42 U (25.75%)</td>
</tr>
</tbody>
</table>
From table 2, it is evident that most of the workers either have primary education (28.23 %) or are uneducated (2.73 %). Thus they are unaware of the safe working practice within the industry and also they have no such formal training.

It can be observed from Table 3, that the majority of the subjects were married (74.25%). The data also shows that married workers were working for more years than the unmarried ones and thus they have prolonged exposure to hazards like high noise, high temperature, high dust, and awkward postures in these firms. So, they are more prone to have NIHL, respiratory symptoms and MSDs for prolonged working in such industries.

### Table 4: Frequency of workers interviewed in each section of SMEs, N (%)

<table>
<thead>
<tr>
<th>Total No. of Units- 10</th>
<th>Casting Units</th>
<th>Forging Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers interviewed in Working Sections</td>
<td>Total N(%)</td>
<td>Small Scale 3</td>
</tr>
<tr>
<td>Moulding/Casting</td>
<td>28(18.03)</td>
<td>67(4.05)</td>
</tr>
<tr>
<td>Gas Cutting/Welding</td>
<td>11 (6.04)</td>
<td>4 (1.77)</td>
</tr>
<tr>
<td>Blank cut/Trimming/Punching</td>
<td>15 (9.79)</td>
<td>NA</td>
</tr>
<tr>
<td>Drop Forging</td>
<td>23 (14.68)</td>
<td>NA</td>
</tr>
<tr>
<td>Broaching/machining</td>
<td>14 (8.92)</td>
<td>35 (22.03)</td>
</tr>
<tr>
<td>Grinding</td>
<td>6 (4.02)</td>
<td>NA</td>
</tr>
<tr>
<td>Barreling</td>
<td>11 (6.04)</td>
<td>2 (1.07)</td>
</tr>
<tr>
<td>Quality Check Inspection</td>
<td>14 (8.92)</td>
<td>320</td>
</tr>
<tr>
<td>Nickel Plating/Painting</td>
<td>9 (5.59)</td>
<td>1 (0.87)</td>
</tr>
<tr>
<td>Tool room/maintenance</td>
<td>150 (100)</td>
<td>1 (0.70)</td>
</tr>
<tr>
<td>Total workers interviewed</td>
<td>46.87*</td>
<td>30 (9.44)</td>
</tr>
<tr>
<td>Total Employees in firms</td>
<td>30</td>
<td>40.00</td>
</tr>
<tr>
<td>Percent Response rate (%)</td>
<td><em>(150/320</em>100=46.87)</td>
<td>122</td>
</tr>
</tbody>
</table>

Occupational exposures health hazards such as noise, temperature and dust have been investigated amongst the workers and have been tabulated in Table 5.
Table 5: Worker’s occupational exposure to noise, temperature and dust N (%)  

<table>
<thead>
<tr>
<th>Exposures</th>
<th>Total</th>
<th>1-4 yr</th>
<th>5-9 yr</th>
<th>10-14 yr</th>
<th>15-19 yr</th>
<th>≥ 20 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Noise</td>
<td>150</td>
<td>43.6(28.62)</td>
<td>51.4(28.87)</td>
<td>29.6(18.03)</td>
<td>27.6(17.08)</td>
<td>146.6(9.09)</td>
</tr>
<tr>
<td>High Temperature</td>
<td>150</td>
<td>41.9(26.23)</td>
<td>45.6(28.67)</td>
<td>33.6(20.98)</td>
<td>23.5(14.68)</td>
<td>141.0(9.74)</td>
</tr>
<tr>
<td>High Dust/Fumes</td>
<td>150</td>
<td>44.8(27.97)</td>
<td>43.2(27.62)</td>
<td>30.2(18.88)</td>
<td>27.8(15.88)</td>
<td>149.8(9.64)</td>
</tr>
</tbody>
</table>

As workers have to accept the exposure to high noise levels during their job. The majority of workers who reported noise annoyance have ≤ 5 years of work exposure. Concurrent to the increased adaptability workers also undergo NIHL which is also one major factor that workers experience less noise annoyance. The temperature near the worker’s place of work and at 5 to 10 feet away from the head differed by 0.5 to 1.5 degree at the cupola furnace, induction furnace and oil fired furnace and 0.5 to 1.0 degree at the drop forge section. The inside (inside the shop under the roof) index has been measured in various sections of these plants. The temperature level at various sections like drop hammer, grinding and barreling sections was found to be > 29.5 degree for medium work and > 28.5 degree for heavy work within permissible limits.

CONCLUSION

Here, we can arrive at a conclusion that the Ergonomics Process model presented is a highly transferable process that can be adapted for use by organizations in industries. If the agency or organization does not have a designated Ergonomics Manager, then it would certainly be appropriate for a Risk Manager or Safety Officer to oversee the process. It would also be appropriate to have an Ergonomics Sub-Committee or Task Force develop and manage the process. This would require express roles and responsibilities to be defined to facilitate a team approach. Whether it is a single individual or a team approach accountable to the process, successful outcomes can only be achieved when management is fully committed from a financial and organizational leadership perspective. Management must be involved and committed to the success of the process as part of a top down approach. Perhaps most crucial though is the involvement of employees from the beginning of the process through training and self-assessment. Employees are required to attend training to learn skills and methods to self-identify and self-correct ergonomic issues in their work area as able. If they are unable to correct on their own or are experiencing issues with their workstation, have symptoms associated with work or a safety concern, then a request is made by the employee and signed by the supervisor entering them into the ergonomics process. A self-assessment is provided by email or online for their completion, which then launches the ergonomics process flow. Employees are engaged throughout the entire process along with their supervisors (and managers) as a result. This approach to Ergonomics Process design and implementation notes that the more involved management and employees are in a participatory approach, the more robust the financial benefits will be. In addition, the more real the actual cost figures provided, the more accurate the financial analysis is for the employer further demonstrating that the investment is well worth the outcomes achieved. Establishing an Ergonomics process based on the theories and principles described is a commitment to drive change in the organization via a powerful business process, ergonomics. Those that choose to implement an EP will experience significant improvement in employee health and safety demonstrating continuous returns for years to come.
REFERENCES


