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ERGONOMIC ANALYSIS IN GLASS MAKING INDUSTRY WITH THE APPLICATION OF ARTIFICIAL INTELLIGENCE TECHNIQUES

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Abstract:—Ergonomic analysis is an important part of the design and evaluation of products, jobs, tools, machines and environments for safe, comfortable and effective human functioning. The Artificial Intelligence Techniques like Neural Network is to estimate the occupational health hazards (OHH) of glass making workers for different job combinations.OHH of a job typically depends on factors like working hours (WH), duration of rest breaks (RB), and working hours between two rest breaks (WHBTRB).The Earnings of the glass making workers is calculated as per the jobs specified to them. In particular eight types of jobs, usually done by glass making workers, are considered. Each job has its specific earnings. Usually high earning jobs are very tedious to perform. Workers performing such jobs suffer from severe stresses and other health problems. Both low back pain (LBP) and neck pain (NP) are major occupational health problems. Some jobs are not that much tough or severe in nature but these are not that well-paid. In general workers prefer high earning jobs, which in turn create considerable health problems to them. Combining jobs is found to be a way of reducing OHH and yet maintaining the good earnings. One severe job (firing-work) is combined with the rest of three jobs sequentially resulting in three job combination.

Keywords:—Ergonomics, Human Factors and Work Place Design, Glass Manufacturing, Small Scale Industry, ANN.

I. INTRODUCTION

In glass manufacturing industries, studies have been conducted and there has been a general indicating that working in glass industries may lead towards many occupational health hazards. Managing such hazards in an optimum manner for workers of 'OKAY Glass Industry' is a challenging job. These workers are subjected to high heat stress owing to high temperature of kiln. To address the issue, the American conference of government industry hygienists (ACGIH) and the National institute for Occupational safety and health (NIOSH) have set guidelines for a safe thermal environment. Current guidelines defines working environment that cause either a decrease in body core temperature below 6°C (cold stress) or an increase above 38°C (heat stress) as potentially hazardous (ACGIH, 2004). The molten mixture prepared with the above method is glass. Molten glass is then taken out from the furnace with the help of iron pipes. The glass worker then blows air through their mouth from the other end of pipe and the molten glass, which is on the second end of the pipe, blows like balloon. Before this blown glass cools, it is quickly placed in the dyes of desired size and shape.

Fig- 1 Carrying the molten glass

Fig- 2 Giving the rectangular shape for the coloring in the glass

In the glassware industry the temp goes up to 30000C. High temperature and harmful vapors in glassware manufacturing causes health disorders to workers, such as Heat Stroke, T.B., Dehydration, Heat crams, Heat rashes.

Fig 3 - Giving the spiral shape

Fig 4 – Working condition of worker

II. FUNDAMENTAL ASPECTS

2.1 Health Problems

Excessive exposure to a hot work environment can bring about a variety of heat-induced disorders.

2.1.1 Heat Stroke

Heat stroke is the most serious of health problems associated with working in hot environments. It occurs when the body's temperature regulatory system fails and sweating becomes inadequate.

2.1.2. Heat Exhaustion

Heat exhaustion includes several clinical disorders having symptoms which may resemble the early symptoms of heat stroke. Heat exhaustion is caused by the loss of large amounts of fluid by sweating, sometimes with excessive loss of salt.

2.1.3. Fainting

A worker who is not accustomed to hot environments and who stands erect and immobile in the heat may faint. With enlarged blood vessels in the skin and in the lower part of the body due to the body's attempts to control internal temperature, blood may pool there rather than return to the heart to be pumped to the brain.

2.1.4 Heat Cramps

Heat cramps are painful spasms of the muscles that occur among those who sweat profusely in heat, drink large quantities of water, but do not adequately replace the body's salt loss.

2.1.5 Heat Rashes

Heat rash, also known as prickly heat, is likely to occur in hot, humid environments where sweat is not easily removed from the surface of the skin by evaporation and the skin remains wet most of the time. The sweat ducts become plugged, and a skin rash soon appears.

There exists a plethora of literature in the area of occupational health with respect to workers suffering from disorders/NCDs. Solomonow (2004) evaluated the role of lingaments as a source of neuromusculoskeletal disorders resulting from exposure to occupational activities. Creep, tension-relaxation, hysteresis, sensitivity to strain rate and strain/load frequency were shown to result not only in mechanical functional degradation but also in the development of sensory-motor disorders with short- and long-term implication on function and disability. Foglemana and Lewisb (2002) identified risk factors associated with the self-reported musculoskeletal discomfort in a population of video display terminal (VDT) operators.

A cross-sectional epidemiologic study was carried out by Piedrahita et al. (2004) to explore the relationship between musculoskeletal symptoms and cold exposure in a large meat processing company in Colombia. Heus et al. (2004) tested the effects of three level of inspiratory resistance on maximal voluntary performance.

Dahlberg et al. (2004) compared the work technique and self-reported musculoskeletal symptoms between men and women performing the same type of work tasks within a metal industry. Lipscomb et al. (2004) studied musculoskeletal symptoms among commercial fishers in North Carolina. Whysall et al. (2004) investigated the extent to which process, barriers and outcomes are accommodated by current ergonomics consultancy practices.

III. ARTIFICIAL NEURAL NETWORK

Generalizing the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions created back propagation. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by you. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities.

Neuron Model (tansig, logsig, purelin)An elementary neuron with R inputs is shown below. Each input is weighted with an appropriate w. The sum of the weighted inputs and the bias forms the input to the transfer function f. Neurons may use any differentiable transfer function f to generate their output.

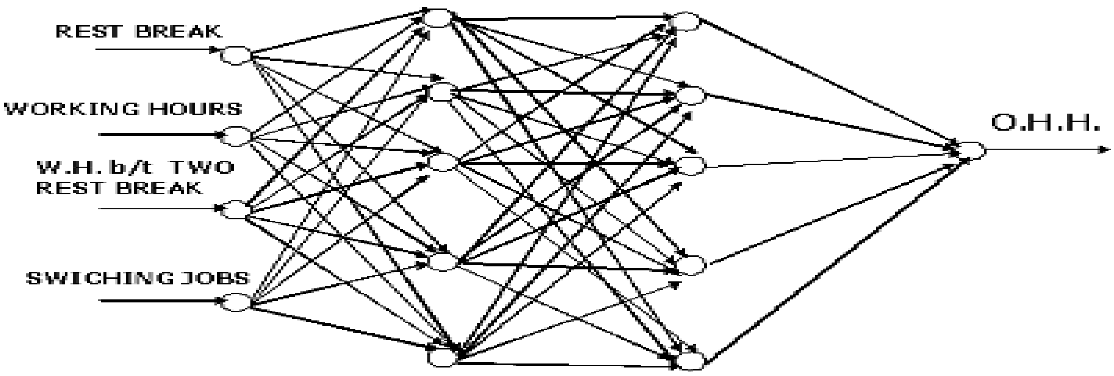

Fig4.2—Modeling of A.N.N with problem

IV. GENETIC ALGORITHMS

Genetic algorithms (GA) are global search techniques, based on the operations observed in natural selection and genetics. They operate on a population of current approximations- the individuals- initially drawn at random, from which improvement is sought. Individuals are encoded as strings (chromosomes) constructed over some particular alphabet, e.g., the binary alphabet (0.1 >, so that chromosomes values are uniquely mapped onto the decision variable domain. Once the decision variable domain representation of the current population is calculated, individual performance is assumed according to the objective function which characterizes the problem to be solved It is also possible to use the variable parameters directly~ to represent the chromosomes in the GA solution

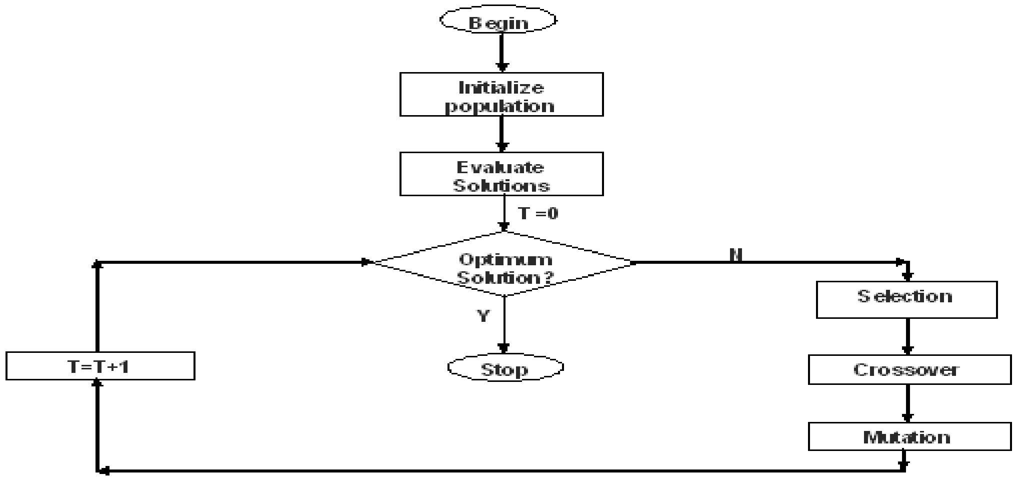

Fig5.1- Working Mechanism of GAs

V. DATA ANALYSIS

Basically we can divide the work of the bangle formation in the following four jobs.

1. Making Gundhi
2. Tarwala job (firing work)
3. Bangles Rolling
4. Finishing

Out of these jobs the Tarwala job is complex one. So result of that a person which doing the job of Tarwala will face more problems (as far as the health is concern) as compared to the person which doing the other jobs. But at the same time a person doing the job of Tarwala can earn more money as compared to a person doing the other jobs.

5.1 Working parameters

Here we assume that a worker will do two types of jobs in a day. Out of these two jobs one job will Tarwala job and second can be any one out of rest available three jobs.
Rest breaks matrices in minutes = [0 10 15 20 25 30] for each type of job.
WHBTCB matrices in hours = [0 1 2 3].
Working hours in a day (combined hours of two jobs) = Between 10 hours to 16 hours.

EARNING-
Average earning of a worker of type 'Making Gundhi' 60 Rs. /hours

Average earning of a worker of type ‘Tarwala job’ 90 Rs. /hours
Average earning of a worker of type ‘Bangles Rolling’ 70 Rs. /hours
Average earning of a worker of type ‘Finishing’ 50 Rs. /hours

OCCUPATIONAL HEALTH HAZARD SCALE -
Here we take the range of O.H.H from 0 to 12 with the assumption of that when the value of O.H.H is 0 i.e. Negligible, and when the value of O.H.H is 12 i.e. Extremely high.

DATA SET FOR (TARWALA JOB+ MAKING GUNDHI)

WH_1	RB_1	$WHBTCB_1$	WH_2	RB_2	$WHBTCB_2$	O.H.H	EARNING IN Rs.
10	15	2	1	0	0	10	960
10	30	2	0	0	0	9	900
9	10	1	2	0	0	9	930
8	20	2	3	15	2	8	900
7	20	1	4	15	2	8	870

Table 1

DATA SET FOR (TARWALA JOB+ BANGLES ROLLING)

WH_1	RB_1	$WHBTCB_1$	WH_2	RB_2	$WHBTCB_2$	O.H.H	EARNING IN Rs.
10	15	2	1	0	0	12	970
10	30	2	0	0	0	10	900
9	10	1	2	0	0	11	950
8	20	2	3	15	2	9	930
7	20	1	4	15	2	9	910

Table 2

DATA SET FOR (TARWALA JOB+ FINISHING)

WH_1	RB_1	$WHBTCB_1$	WH_2	RB_2	$WHBTCB_2$	O.H.H	EARNING IN Rs.
11	15	2	2	0	0	12	1090
10	30	2	2	0	0	10	1000
9	10	1	3	0	0	11	960
8	20	2	4	15	2	9	920
8	20	1	5	15	2	9	970

Table 3

5.2 Result of Data training
According to the linear regression analysis the Result of Data-set training are as follows—

a. Result of Training of Tarwala Job+ Bangles Rolling

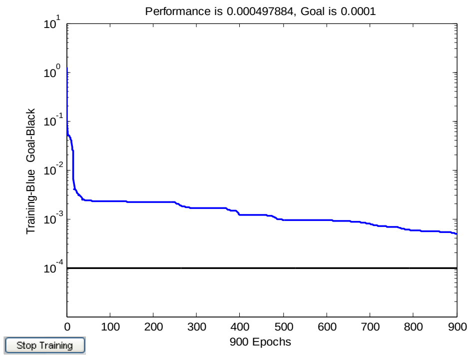

Fig1.-Training of Data

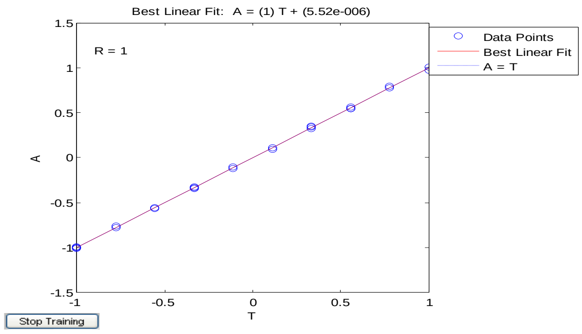

Fig2.-Final Training result

m = 0.9998, b = 5.5208e-006, r = 0.9999

b. Result of Training of Tarwala Job+ Making Gundhi

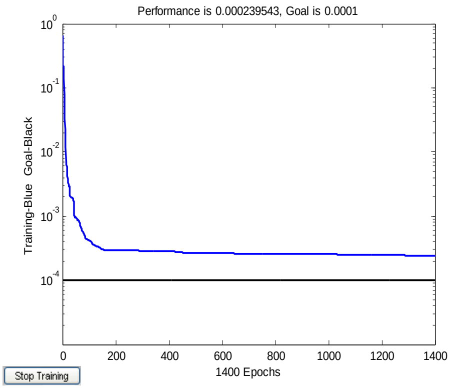

Fig3.-Training of Data

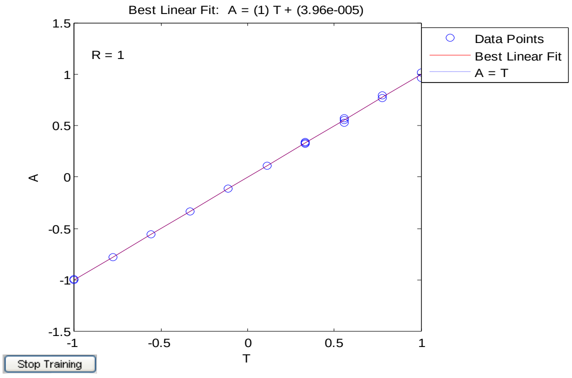

Fig4.-Final Training result

m = 0.9998 ,b = 3.9581e-005 ,r = 0.9999

c. Result of Training of Tarwala Job+ Finishing

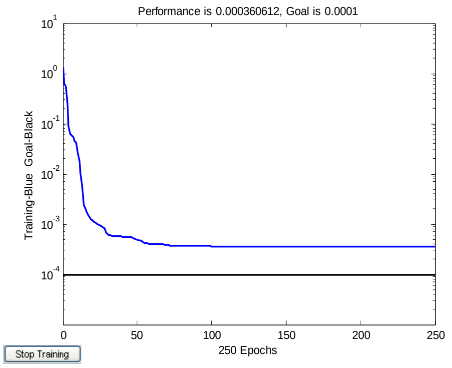

Fig5.-Training of Data

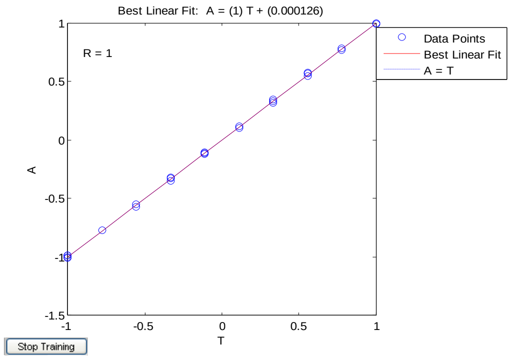

Fig6.-Final Training result

m= 0.9998 ,b = 1.2616e-004 ,r = 0.9999

VI. RESULTS

According to the job combination the results are as follows—

a. Result of Tarwala Job+ Bangles Rolling

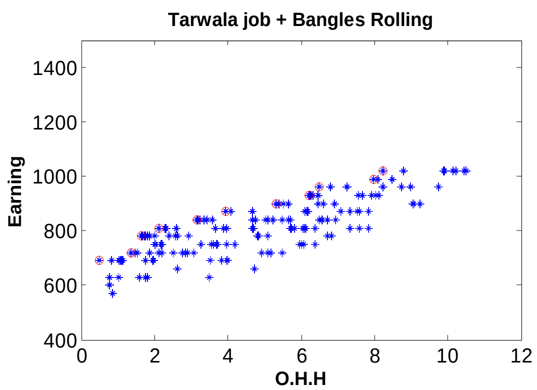

Fig 1.—Initial Population

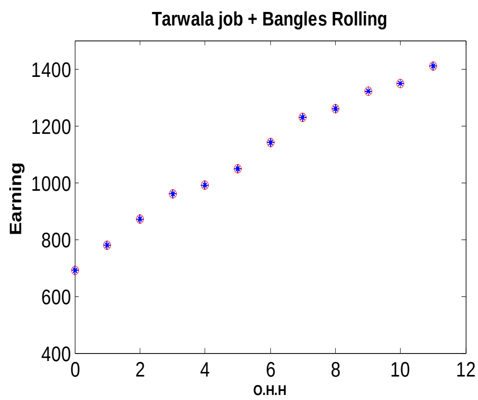

Fig 2.-- OHH and Earning

b. Result of Tarwala Job+Making Gundhi

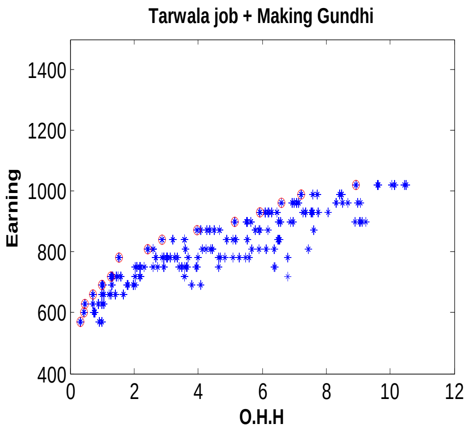

Fig 3.—Initial Population

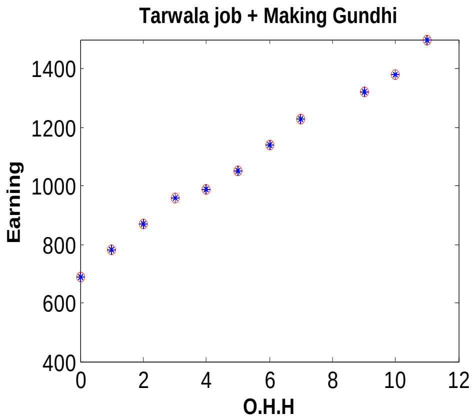

Fig 4.-- OHH and Earning

c. Result of Tarwala Job+Finishing

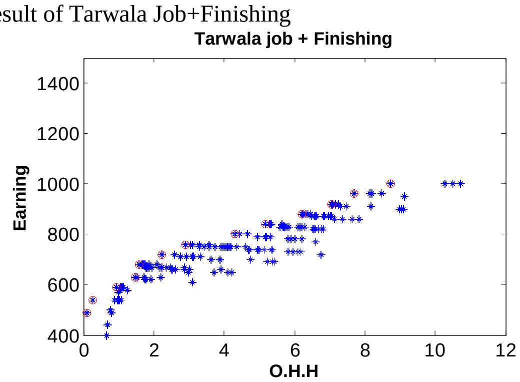

Fig 5.—Initial Population

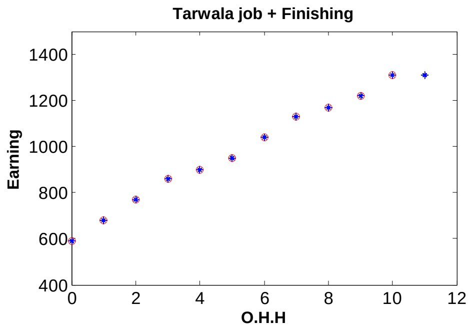

Fig 6.-- OHH and Earning

VII. CONCLUSION

Worker should use glasses for safety his eyes from excessive heat. Workplace change is not possible without considering job training, technical skills and vocational education. Switching over alternate jobs with in the organization can also reduces the O.H.H of the workers and earning of worker will reduce so every worker will not agree with these changes. Health and hygiene can not be achieved without an investment in safe and healthy behaviour among the workers, factory owners and others. With these curves it is clear that we are getting some points which shows that if worker follows these scheduling he will get maximum earning with minimum occupation health hazard. O.H.H of the worker can be reduced by providing rest breaks between their sessions, but if we increase rest break then total duration decreases and earning of worker will reduce so every worker will not agree with these changes. Switching over alternate jobs with in the organization can also reduces the O.H.H of the workers and earning of worker will reduce so every worker will not agree with these changes.

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