Ergonomics: the emerging science in the Indian scenario

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Abstract

Since time immemorable, man has been using ergon omics to make life more comfortable, whether the "hunter-gatherer" sharpens his tools for hunting and protection or the caveman using flint stones to light the first fire. One of the earliest civilizations in the world, India has been a torch bearer in research in ergonomics for alleviating human factor issues in day to day life; however such practices were not documented, as oppose to Western countries.

Although people gradually realized the importance of ergonomics in various facets of their lives, lack of education, unorganized industrial and health sector, a slowly developing economy and absence of Government induced laws posed hindrance for the growth of the science of ergonomics in India. Importing advanced technology without adapting it to the environmental, physical, mental and sociocultural needs of the Indian workforce has not been fully realistic. In an urge to bring about technological advancement faster, often the characteristics and preferences of human operators are ignored and cause failure in technology transfer by alienating the workforce and achieve little in improving the living and working conditions of the local people.

Sixty years after independence, there is more awareness amongst the masses and research in ergonomics has struck its roots not only in industrial sectors but in health, consumer products of daily needs, in the defence and agricultural sectors as well. However, lack of categorized data base of the population anthropometry still poses a major problem in product and facilities development. There is an acute need for in depth research in physical, physiological and psychological aspects of the Indian population which exhibits enormous diversity amongst ethnic groups.

Ergonomics, as a useful tool for evaluating the indigenous technology and products as well as the imported ones and their implementation, can contribute to the safe and productive application of technology. In doing so India needs to emphasize on the availability of knowledge base of it's own in the form of standards, recommendations, procedures, etc. concerning working conditions, occupational health and safety. Since many factors influencing the nature, extent and diversity of problems are specific to India (e.g. climate, people, method of work, facilities, infrastructures of technology, finance, etc.) it is necessary to incorporate research into agricultural, industrial, defence and domestic issues. Extensive efforts in this regard are being carried out in different parts of the country which now need to be unified for streamlining the recommendations and forming the ergonomic guidelines for particular population undertaking a particular occupation. A shared vision and programme for applying ergonomic concepts for an overall development of Indian society as a whole is the need of the day and each Indian is required to play his own part efficiently in this endeavour.

Keywords: Ergonomics, Developing country, India

Introduction

Ergonomics is the scientific study of people at work, aiming to reduce stress, eliminate injuries and work related maladies, enhancing performance and the general sense of wellbeing. This is achieved by designing tasks, workspaces, workstations, equipment along with different controls, displays and other physical attributes to be compatible with physical capabilities of operators. This ensures conservation of the mental and physical wellness of individuals over longer duration of exposure to their work environment.

The importance of ergonomics lies in the fact that with the use of ergonomically-designed devices, we can minimise stress-related issues. Worldwide, ergonomics or human factors issues are becoming increasingly important in designing any product, procedures and the environment in which the user or the operator functions. The importance of human factors is most noted when it is absent, rather than when the systems function properly and are in tune with each other. The interest in the knowledge of ergonomics and human factors has always been inspired following disasters or calamities, when lacunae in safety measures are mostly understood. Ergonomics in India is not new but it's progress and use in the development process is quite slow.

A. Background: Industrial Revolution and Indian Economy

Historians regard Industrial Revolution, which began in United Kingdom between 1750 and 1850 A.D., as the most important event in the history of mankind since the domestication of animals and plants. It lead to the emergence of the modern capitalist economy. India provided the ingredients needed for Britain's Industrial Revolution: the capital, raw materials and market for finished goods. While helping to accelerate Industrial Revolution in Britain, India's economy was devastated. Though in the period 1860-1913, the performance of the Indian economy compared quite favourably with that of Italy, Japan and Russia, it remained stagnant both in the inter- and post-World War II periods. With one of the lowest per capita incomes in the world, Indian economy is yet to revive from the deleterious effects of the long lasting colonial rule.

B. How Economic Status Influences Ergonomic Practices

Industrial development has been accepted globally as an important driving force for economic growth and development of a nation as a whole. Today's industrialized countries have all actively supported and protected their industries through specific policies and institutions and developed strategies to develop a sound industrial and technological base enabling modernization of a nation. As an aftermath of colonial rule, a devastated economy was inherited by Independent India, extreme poverty of rural population being the basic limiting factor for the growth of dynamic industries.

Some economists regard the current divide between the developed and developing world as largely a phenomenon of the 20th century (Moray 1995). Industrially developing countries (IDC) have larger populations, the higher levels of poverty, poor health, illiteracy and the greatest need for improvement in working conditions. Developing countries have not yet achieved a significant degree of industrialization relative to their populations and have a medium to low standard of living. There is a strong correlation between low income and high population growth Sustainable progress can be achieved when ergonomists tackle Developing World problems from a Developing World perspective, keeping in view the macro approaches of the multidisciplinary nature of the field with realization that "Good ergonomics is

good economy". One needs to define the steps that can close the gap between working conditions in affluent and deprived nations, like India, China, Egypt, Iraq, Mexico, Peru, etc.

India made considerable economic progress since independence. Diversification and expansion are noticeable mostly in industries and agriculture where new technologies have been incorporated and large investments have been made. India's stringent import policies have aided manifolds development and proliferation of local industries. This small-scale industries (SSI) sector plays a vital role in the growth of the country by contributing about 40% of the gross industrial value added in the Indian economy. However, the industrialization or imported technology absorption did n't consider Indian workers as it's most important component.

C. How Ergonomics can intervene

The primary aim of ergonomics is to integrate knowledge derived from many sciences and optimize the functioning of a system by adapting it to human capacities and needs. Ergonomic approach is not limited to any particular industry or application and it involves everything which involves man. All well designed work systems, sports and leisure, health and safety systems should imbibe ergonomics principles. Successful completion of any job is influenced by each person's capabilities (physical and mental), the job demand (physical and mental) and the condition (physical and organizational environment) under which the person is carrying out the job. Thus ergonomics attempts to enhance the effectiveness with which work and other human activities are carried out and to maintain or enhance certain desirable human values in the process, e.g., health, safety, satisfaction etc. In this way ergonomics strives to enhance and preserve human health and satisfaction and optimize the human performance in a system perspective.

It is important to recognize that ergonomics and human factors developments in IDCs, e.g., India cannot go in hand with the developments in developed countries. In IDCs ergonomics is an essential means of assuring the efficient use of the labor force, e.g., SSI sector of India and can help to make best use of technological resources through optimizing the application of existing and the new or transferred technology to the benefit of the local user population and the operating environment. Many current problems in IDCs, such as high rate of accident and injuries, low productivity and work quality, can be improved through ergonomic input. In a country like India, ergonomics should be employed to bring about sumptuous improvement in working conditions of the SSI and unorganized sector where labour force is yet to be treated as precious resource for growth.

D. Ergonomics in Indian Scenario

Ergonomics in India as subject in the field of research was first introduced in the Physiology department of the Presidency College, Calcutta (Kolkata), around 1955. Extensive studies on energy metabolism of rickshaw pullers and body surface areas of Indian adults, etc. were carried out here. In academic field pioneering work was done by Physiology department of Central Labour Institute, Mumbai, Work Physiology and Ergonomics division of Central Mining Research Institute, Dhanbad and in the field of research and development (R&D) on Indian Armed Forces at Defence Institute of Physiology and Allied Sciences (DIPAS), Delhi (Sen 1984, Wisner 1985, Van Cott 1985, Ganguly 2009).

Indian Society of Ergonomics (ISE) was established in January 1987. It's present strength is about 400 members comprising researchers, medical

practitioners, physiotherapists, agricultural engineers, Health and Safety Executives, etc.

Since factors influencing the nature, extent and diversity of problems are specific to India (e.g. climate, people, method of work, facilities, infrastructures of technology, finance, etc.) it is necessary to incorporate ergonomic research into agricultural, industrial, defence and domestic issues. Extensive efforts in this regard are being carried out in different parts of the country which now need to be unified for streamlining the recommendations and forming the ergonomic guidelines for particular population undertaking a particular occupation. During past five decades ergonomics research in India has focused on areas like physical work capacities and work stresses of different occupations, diverse anthropometry of Indian people, load carrying, biomechanics, simulation and human modeling, improvement of working conditions in adverse environments (hot, hot humid, cold, high and very high altitudes, etc.), agricultural operations (tea cultivation, terrain cultivation, tool design, process redesign), reducing drudgery of women (household activities, agricultural operations), product design and electronics and information technology (IT) sectors. Some important recent researches applying ergonomics are discussed in this article.

1. Ergonomics in Education

Ergonomics in Education system was incorporated in 1971 at Department of Physiology, University of Calcutta, Kolkata where postgraduate degree was started in Work Physiology and Ergonomics. The subject was introduced later in various Technology Institutes such as IIT Bombay, Delhi, Guwahati and Kanpur, National Institute of Design (NID), Ahmedabad, National Institute of Industrial Engineering (NITIE), Mumbai etc. Considering the vast population strength these centres provide very few trained ergonomist to the country.

2 Ergonomics in Agriculture

All India Coordinated Research Project (AICRP) on Home Science / Family Resource Management was started in 1980 to investigate the resources available for different socio-economic segments of families, especially farm families. The approaches used were socio-economic surveys, laboratory and field studies under different action program for implementation based on different themes. First theme (1980-1989) was Fuel and Energy Management; Second theme (1992-1996) was Functional Kitchen Reorganization while third theme (1997-2002) was Farm Women's Physical Drudgery. In India, about 70% of the total female working force is involved in agricultural operations. About 60% of agricultural operations like transplanting, weeding, harvesting, storage of grains are handled exclusively by women while they share the work with men in other operations. In spite of technological advancement in agriculture, the jobs attended by women remain more or less same and characterized by low productivity and drudgery. The newly introduced technologies are either gender-neutral or gender-biased for men. Women have quite different technological needs due to different anthropometric characteristics and types of work that they do. Recently, some tools and technologies have been developed for women in various agricultural operations which would increase the work efficiency of the farm women and reduce their drudgery in agricultural activities (Gandhi S., 2009). Necessary steps are being taken to equip farm women with the appropriate technologies to enable them to do their work efficiently and became equal partners in agricultural production.

An attempt was made to examine the involvement of men and women in various farm operations in paddy cultivation in different villages in India during the year 2008-2009 (Singh et al. 2009). The study revealed that the transplanting, hand weeding, harvesting and threshing were the major operations performed predominantly by the women in cultivation of direct seeding of paddy Women also played a role in many other farm activities including application of manure, fertilizers and irrigation, but were excluded from activities which required operation of machinery in the operations like tillage, seeding by drum seeder, weeding and harvesting. It is necessary to develop/promote suitable women friendly equipment so as to take care of their job opportunities.

The AICRP on Ergonomics and Safety in Agriculture under Indian Council of Agricultural Research (ICAR) started in 1996 with Central Institute of Agricultural Engineering, Bhopal being the nodal point. With introduction of modern techniques and reduction of agriculture workforce, various farm operations are getting more and more mechanized. Very often these tractors and machines cause either fatal or non-fatal injuries. For planning farm safety programme, a survey was carried out during the period 2004-2007 in seven most important agricultural states in India, namely Tamil Nadu, Orissa, Madhya Pradesh, Punjab, Rajasthan, Arunchal Pradesh and West Bengal (Gite et al. 2009). It was found that out of the total accidents in agriculture sector, about 30.5% were due to farm machines, 34.2% were due to hand tools and 35.3% were due to other sources like snakebites, fall in well, environmental causes, etc. In the farm machinery category the highest number of accidents were due to tractors and tractor operated implements (31%) followed by animal drawn equipment (22%), threshers (14%), electric motor/pump set (12%), chaff cutters (9%), power tillers (6%) and sprayers (4%). Of these farm machinery accidents, 5.6% accidents were fatal in nature whereas the remaining 94.4% were non-fatal. These data are being used to prepare package of farm safety measures to be recommended for large scale adoption in various states. The package of farm safety measures recommended includes engineering interventions, enforcement measure and educational aspects.

Agriculture in India employs about 242 million workers, approximately 52% of the working population, who are exposed to chemical hazards continuously. Pesticides are beneficial in terms of controlling crop damages due to insects, pests and diseases but equally dangerous to human health. However, in India, protective measures and safety guidelines are almost non-existent in agriculture. According to a survey conducted on agricultural accidents occurred during 2004-2005 in nine districts of Madhya Pradesh (Agarwaal et al. 2009), it was found that accident incident rate while spraying was reported as 45/100,000 workers per year. Apart from this, flow of dangerous chemicals in operator's blood through skin contract and breathing go unnoticed. The long term exposure or repeated exposure leads to many chronic diseases, which often are not realized by operators. Though the use of personal protective equipment (PPE) is recommended for spraying operation, it has been seen that operators often do not wear proper clothes, shoes and other PPE while performing the spraying operation, mostly due to high degree of discomfort. Respiratory masks suitable for chemical safety were rated highly discomfortable due to weight experienced on the face and breathing resistance. Perspiration was found to be the major cause of discomfort for hand gloves. Eye protectors made of transparent plastics were found to be more comfortable and having better visibility as compared to eye

protector made of opaque hard plastic frame with glass ocular. The design refinements are needed to reduce weight experienced by operator in respirator and for better absorption of sweat in hand gloves.

3 Ergonomics in Industry and Manufacturing

In early sixties the Industrial Physiology Division of Central Labour Institute, Mumbai and the Work Physiology and Ergonomics Division, Central Mining Research Institute, Dhanbad evaluated the work loads of steel workers, soap makers, forging, glass workers, mine rescue work, etc. They designed standard methodology for categorizing the heaviness of job and 'Acceptable workload' for Industrial workers was defined. The extensive ethnic variability in Anthropometry of Indian population was recognized. The exposure to chemical and other occupational hazards were gradually defined with strict regulations under industrial laws for organized Industry and Manufacturing sector.

In a recent study the use of PPE in the small and medium scale (SME) units of casting and forging of northern India were explored. About 572 male workers of casting and forging units were assessed for the quantitative and qualitative parameters relating to occupational safety and ergonomics practices in different processes. This study revealed that approximately 78% of the workers did not use the PPEs to their full advantages and were directly exposed to high noise, temperature and dust and many more problems. Occupational safety and ergonomics practices were almost missing in most of the processes. Majority of the workers reported musculoskeletal disorders; noise induced hearing loss and general health problems. The study showed that, occupational health and safety practices were being ignored in these SMEs and it was recommended that occupational health and safety practices be implemented and maintained through strict legislation and provision of penalising the defaulter.

Similar studies carried out in different parts of India revealed an association between musculoskeletal disorders (MSD) and work related physical factors (e.g., long exposure duration, repetitiveness, force level, awkward postures, etc.). Most of the tasks in the unorganized sector may be identified as prone to work related MSDs. Construction workers showed high incidences of low back pain and discomfort (41.2%), followed by those of wrist and hand (26.5%). About 23.5% remained incapacitated due to lower back problems and 35.3% attributed this to their work (Chakraborty et al. 2009).

It was recommended that, training for safe lifting and handling of materials, proper work-rest schedule, modifications of some working procedures and use of some ergonomically designed equipments may reduce the postural stresses and improve the quality of work done and the health status of construction labourers working in unorganized sectors.

4 Ergonomics for Consumers

In today's world, the objective of design is not just meeting functional utility of the product but also demands total trustworthiness and pleasure value. It has to satisfy the human factors aspects, apart from being functional, reliable, aesthetic and economic. In various IITs at Delhi, Mumbai, Kanpur, Kharagpur, Guwahati the ergonomic designing of consumer products are being carried out. Other Technical Institutes and Universities in various part of the country have also started this venture with young students putting their ideas in designing of products. Designs for daily life consumer goods have impact on user's physical and socio-cultural behaviour in the context of everyday issues of attachment, comfort, personalisation and

productivity. When consumer understands that a particular product is giving him better economic and health benefits he gets motivated to use it. Similarly, when industries find new ergonomic interventions may benefit them by increasing productivity and reducing accidents and absenteeism, they try to incorporate those design modifications or procure those equipment. Although there is a humble beginning, the impact is quite slow and small considering the large and rapidly proliferating consumer markets in India. Designing of consumer goods are mostly based on individual choices of the manufacturer and without any scientific base.

5 Ergonomics for Accident and Safety

Accidents are instantaneous events with undesirable consequences that may be fatal or non-fatal. Such incidents may take place on the road, at our homes or at the workplaces. So in order to contain accidents situations need to be studied under different scenarios and suitable interventions need to be employed. Strict adherence to traffic rules may reduce accidents on roads. Other types of accidents may be those occurring during agricultural operations, different industries and manufacturing units, radioactive material or other hazardous chemical exposure, etc. All these aspects are being dealt by undertaking studies of the operations being carried out in such premises, finding out common causes of these accidents and finally applying ergonomic interventions, procedure modifications and using personal protective equipments to eliminate/reduce the rates of accidents. Such research activities are undertaken by Industries, Universities, Technology Institutes and other government and non-government organizations.

6 Ergonomics for Health Sector

Ergonomic studies have been conducted on dentists, clinical physicians, surgeons and nurses globally to evaluate their physical load and compatibility to the tools and facilities they use. Such studies have shown great potential in using ergonomic principles to reduce their stress level and improving the comfort and performance (Haslam 2002). Aiming towards understanding the human factor aspects in the work practices of Nursing Officers of Indian Armed Forces, a detailed study was undertaken to evaluate their workload, work organization and lifestyle as a whole (Majumdar et al. 2002). It was found that the nurses spent about one-third of their total daily work duration for patient care activities. Their physical workload was found to be moderate, but they had to work in awkward postures, e.g., back bent, back bent and twisted, etc. not only during patient care but even during administrative and housekeeping activities. Ergonomic interventions like designing adequate manoeuvres to transfer and lift patients, elimination of unnecessary activities and redesigning the work procedures, providing adequate rest pauses might prevent the early onset of musculoskeletal disorders, as reported by these nurses.

In another study, the compatibility of the existing workstation, including the chair and table of women employees in research institutes from different parts of India were evaluated with respect to the individuals using a particular workstation. Results show that 75% of women were using workstations that did not compliment their physical characteristics. It was concluded that continued use of such workstation facilities would, on long run, result in postural discomfort leading to work related musculoskeletal disorders (Majumdar et al. 2011).

7 Ergonomics in Defence

In 1962, Defence Institute of Physiology and Allied Sciences (DIPAS)

was established to study the physical performance of Indian soldiers at extreme environments (hot, cold, altitudes, etc.) in terms of thermal comfort, nutrition and load carriage. Some of the recent researches on different ergonomics and human factors issues carried out by this Institute is discussed below.

a) Load Carriage by soldiers

A detailed study on Indian infantry soldiers was undertaken to evaluate the biomechanical and physiological stresses during load carriage operations and recommending the optimum and maximum load for carriage in Indian army. Ten soldiers were subjected to unload and nineteen load carriage operations. Biomechanical evaluation included spatial, temporal and kinematic and kinetic parameters while physiological parameters measured were heart rate (HR), oxygen consumption (VO_2), carbon dioxide output (VCO_2),minute ventilation (VE) and maximum aerobic capacity (VO_2 max).

Forward tilt angle for both sides of the body were found to increase significantly for all backpack conditions (Majumdar et al. 2010). The vertical and anteroposterior components of ground reaction forces steadily increased with increase in load magnitude. Percentage increase in HR and VO_2 were found to be significant in higher load magnitudes as compared to walking without load. It was observed that soldiers adjusted their speed of march from 3.27 kmh^{-1} at 0% inclination with NL to 1.12 kmh^{-1} at 15% inclination with maximum load condition to keep their physiological responses under control without any indication of fatigue. It could be concluded from this study that combinations of load carriage involving existing backpack was strenuous with increased biomechanical and physiological stresses. This could be due to inadequate design properties of the backpack involving its size, shape, scaffolding and the belts (Pal et al. 2009). Presently ergonomic evaluation and standardization of load carriage are being carried out under different environmental conditions like, sea level, hot humid and hot dry desserts, jungle, high and extremely high altitudes.

b) Maximum aerobic performance at high altitude

The human body functions best at sea level and with increasing altitudes certain physical and cognitive coping maladjustments begin to appear, risk being directly related to the altitude. The human body adapts to high altitude (HA) through immediate and long-term acclimatization, posing important issues for soldiers deployed at these altitudes. Rapid deployment of unacclimatized soldiers to high mountainous environments may cause debilitating effects on operational capabilities which may manifest in their physiological and cognitive performance. It was evaluated in two different ethnic populations of soldiers when they were inducted from sea level to HA.

The sea level studies were conducted at Defence Institute of Physiology and Allied Sciences (DIPAS), Delhi, India for Indian soldiers (n=20) and Bishkek, Kyrgyzstan for Kyrgyz soldiers (n=10). Both populations underwent physiological and cognitive monitoring to evaluate performance alterations at Toya Ashu at 3200m altitude. At HA, the data on both populations were collected after 3, 7, 14 and 21 days of induction. The parameters measured were physiological (maximum aerobic capacity (VO_2max), heart rate (HR), hear rate variability (HRV), forced vital capacity, forced expiratory volume, peak expiratory flow, maximum voluntary ventilation, cerebral blood volume, alveolar oxygen saturation and body composition analysis) and cognitive (simple and choice reaction times, spatial span, pattern recognition and spatial working memory, motor screening test,

paired associated learning) performances. Maximum aerobic capacities at sea level of both the populations were comparable, but it deteriorated more in Indian soldiers with induction at HA and recovery was slower. The overall physical performance of Kyrgyz soldiers at HA was better whereas Indian soldiers demonstrated better cognitive performance. Salient findings of other parameters did not show much difference among both the populations.

c) Ergonomic Evaluation of Workstations

The world today requires new products with user friendly interfaces to be designed and manufactured in short time frame that should impose minimal physical and mental strain to the user.

With the advent of proactive ergonomic design techniques, different computer aided design (CAD) software have been developed that allow designing a product digitally and evaluating the same using digital humans for understanding design artefacts. Digital human models (DHM) have the advantage of allowing the designer to explore the potential advantages and disadvantages of different design configuration without requiring the construction of expensive physical mock-ups used in the past.

A number of DHM have been developed at DIPAS, Delhi based on various ethnic populations of Indian Armed Forces using human modelling and simulation software in virtual reality environment. Digital prototypes of a number of systems and facilities used by Indian defence personnel have been ergonomically evaluated by this technique at DIPAS. Specific recommendations for design improvement have been given to the laboratories involved in developing these workstations. This technique enables the designer to provide optimum human fit and compatibility of the operator with given workstation and working environment.

d) Designing of Functional Clothing

It is known that clothing protects against anything that might injure the human body. Apart from carrying out above function, 'Functional clothing' enables the user to carry out certain specific tasks more effectively. For example, soldiers rely on suitable clothing for protection against adversities and threats such as cold weather, ballistic projectiles, radiation, chemicals, and biological agents. Such clothing may be body-armour systems, nuclear-biological-chemical war-suits, space suits, etc.

It was required for Indian Army that an indigenous bullet proof jacket (BPJ) be developed, with strict adherence to the given surface area and weight of BPJ, to help Indian soldiers during insurgencies or low intensity conflicts. At the Ergonomics laboratory of DIPAS, UniGraphics design software was used to design a BPJ as per the upper human body shape and size. Due to specific requirement of fabrication and retaining the ballistic properties of the material various modifications such as removal of any concavity, interference between soft armour plate (SAP) and hard armour plate (HAP), etc. of the BPJ were made at different stages of its design. Once the BPJ assembly including SAP, HAP, neck, collar, shoulder and groin guards was modelled, it was put on the DHM and all kinematic manoeuvres were performed virtually to carry out ergonomic analysis of physical fit to the soldier under different operational conditions before the users' trial.

The BPJ developed in this process has digitally taken care of most of the bottlenecks that soldiers would have encountered in real life, thus resulting in a digital prototype which will be eventually translated into a physical prototype with maximum human comfort and fit, enhancing

performance and sustainability of soldiers in low intensity war situations or insurgencies manifolds.

Figure 1. Different views of indigenously designed Bullet Proof

8. Ergonomics in Government Regulations and Standards

One of the most important lacuna faced by ergonomist in implementing the human factors aspect at work is the lack of appropriate standards for Indian population and government rules and regulations. There are hardly any government rules for unorganized sectors. The Factories Act is very old. The modified version (Model rules of Factories Act 1984) has given minimum importance to ergonomists in improving the health and safety of the workers in India.

Conclusion

Ergonomics, as a useful tool for evaluating the indigenous technology and products as well as the imported ones and their implementation, can contribute to the safe and productive application of technology. Being one of the most important and advanced IDCs, import of technologies, rather than developing all techniques from scratch, is more desirable, for saving time, money and effort. However, blind applicability of technologies developed elsewhere is not feasible for Indians under any circumstances. While importing technologies India needs to emphasize on the availability of knowledge base of it's own in the form of standards, recommendations, procedures, etc. concerning working conditions, occupational health and safety. Since many factors influencing the nature, extent and diversity of problems are specific to India (e.g. climate, people, method of work, facilities, infrastructures of technology, finance, etc.) it is necessary to incorporate research into agricultural, industrial, defence and domestic issues. Extensive efforts in this regard are being carried out in different parts of the country which now need to be unified for streamlining the recommendations and forming the ergonomic guidelines for particular population undertaking a particular occupation. Some work has been started in similar lines and extensive work is yet to be done. A shared vision and programme for applying ergonomic concepts for an overall development of Indian society as a whole is the need of the day and each Indian is required to play his own part efficiently in this endeavour.

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