



Virtual Ergonomics: Research and Application in India

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'Ergonomics (or Human Factors)' is the scientific discipline dealing with study of interactions among the elements of a system comprised of humans, work accessories/ tools/ machines and their surrounding environments [1]. It also focuses on various factors (environmental, psycho-physiological, socio-economic and so on) which influence these interactions; to improve the performance, efficiency and productivity of the entire system (known as man-machine-environment system) along with enhancing safety and reducing the chance of error and accidents. Appropriate application of the knowledge/ principles and techniques of ergonomics makes any 'Design' successful in order to change existing scenario of the human working environment into a preferred one [2]. Prof. R. N. Sen, the pioneer ergonomist in India explained ergonomics as the 'science, technology & art of man at work' [3]. Ergonomics is not a new subject in India. This discipline was introduced in India in 1945 with the establishment of Industrial Health and Advisory Committee by Indian Research Fund Association (presently known as ICMR: Indian Council of Medical Research). Although research in the field of exercise physiology, ergonomics and occupational health was started in this country a few decades ago (the late 1950s), the first academic course on ergonomics and work physiology was started in 1971 at the University of Calcutta [1,4]. Now ergonomics is well-known discipline in India with academic courses (UG, PG and Doctoral level) in colleges and universities along with the establishment of research and development facilities in academic, research and industrial organizations. Down the line from its inception, numerous studies have been reported and research papers have been published by Indian researchers on physical (real-life) ergonomics evaluation of product and/or workstation design along with consideration of occupational health and safety but introduction of research and education pertaining to virtual ergonomics (VE) is getting momentum in recent years only [5]. VE which is highly relevant to applied ergonomics in the design of objects/products can be defined as the ergonomics analysis performed in virtual environment or CAD software platform. Various digital human modeling (DHM) software are commercially available all over the world for the VE evaluation of man-machine interface in CAD environment. Among numerous DHM software; Jack, RAMSIS, Delmia Human, SAMMIE, SANTOSH etc. are very popular. The VE have added advantages over traditional ergonomic evaluation process which involves real humans and hardware prototypes [5]. The proactive ergonomic evaluation which is offered by VE allows the user to evaluate their products/ workstations at the very beginning of product development process (conceptualization phase), even before

the actual mock-ups and/or prototypes are built [6]. Thus, it helps the product designers to check the human compatibility of their intended product before its origin, by providing the customized human model (manikin) of any variation of anthropometric/ biomechanical data, somatotypes, age, sex and race/ nationality etc. In contrast to the traditional ergonomic evaluation process, VE is profitable as repeated trials and thereby design modifications are possible without incurring additional raw material, cost, manpower and time [7,8]. Moreover, VE evaluation using DHM software has the potential to be used in the analysis of inaccessible and hazardous workplace environments where traditional ergonomic evaluation process is either risky or not at all feasible [9]. Owing to the benefits of VE, developed countries are widely using this technology for manifold applications and receiving the returns. The use of this technology is still in nascent stage in India [5,10]. This sub-discipline has emerged in India in the early 2000s. Ergonomics Laboratory of Defence Institute of Physiology and Allied Sciences (DIPAS) under Defence Research and Development Organization (DRDO), Govt. of India, started VE for design and evaluation of military workstations (vehicles, air cockpits, command posts etc.) in 2004. Gradually research and design applications using VE began to be practised in numerous academic institutions, research organizations and industries. Academic institutions which are presently involved in VE, include Center for Product Design and Management (CPDM), IISc, Bangalore; Indian Institute of Technology (IIT) Guwahati, Guwahati; M.S. Ramaiah School of Advanced Studies, Bangalore; Dept. of Human Engineering & Human Factors, IAM, Bangalore; National Institute of Technology (NIT) Silchar; National Institute of Technology and Industrial Engineering (NITIE), Mumbai; PSG College of Technology (PSGCT), Coimbatore; National Institute of Technology (NIT) Jalandhar; PEC University of Technology, Chandigarh; VIT, Vellore to name a few. Amongst the notable research organizations currently involved in VE are Defense Institute of Physiology and Allied Sciences (DIPAS, DRDO), Delhi, Automotive Research Association of India (ARAI, Pune), Hindustan Aeronautics Limited (HAL), Bangalore and Aeronautical Development Agency (ADA), Bangalore. Automotive and product based industries are also utilizing VE in their design process to make their plant and the manufactured products more human-centric. Mahindra and Mahindra Ltd., Chennai; TATA Motors, Pune; JSW ISPAT Steel Ltd., Raigad; L&T Engineering Services, Bangalore; TATA Autocomp Systems Ltd. - Technical Center, Pune; Maruti Suzuki India Limited (MSIL), Gurgaon; 3Ds technologies, Chennai etc. are few such industries. First, publication related to VE appeared in Indian Journal of Aerospace Medicine in 2005 by Pinto and Tanja [11]. Over the course of time, the number of Indian researchers and academicians interested in VE has been increased gradually. Publications pertaining to application and research on virtual ergonomics techniques started to be visible in national and international journals and conference proceedings [5]. Though the number (32 papers) of reported studies on the application of virtual ergonomics techniques by Indian researchers is quite good, there is less number (11 papers) of research publications (published from India) which contribute in construction/development of digital manikin or its body parts for software development. From the literature, it is observed that Indian researchers have also published review articles (13 papers) on various aspects of VE during last few years.

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While all over the world researchers, educators and engineers are enjoying advantages of VE evaluation techniques by using various computer-aided ergonomics (CAE) and digital human modeling (DHM) software [12,13], the scenario of adopting these VE technologies in India is yet to take a constructive shape due to various factors. The factors which hinder the wide adoption of the VE technologies include lack of awareness about benefits offered by VE evaluation techniques; lack of expertise and contextual knowledge of CAD/CAE and Ergonomics among researchers; huge initial investments or expenditure towards infrastructure development and human resource training for these technologies; problems of file transfer from CAD to DHM software or vice versa; not very realistic or robot-like appearance of digital manikins; difference in results from software to software; and lack of trained human resources for providing training by software sellers/ suppliers, etc. [5,12]. To utilize the expedient VE techniques in India, this sub-domain of applied ergonomics is needed to be popularized. Awareness among researchers, scientists, engineers, designers and entrepreneurs could be achieved through organizing seminars, conferences, workshops etc. There is the need for collaboration among various industries, academic institutions and government/private organizations under one umbrella to promote VE in India. Due to high cost, many times it is difficult for academic institutions and small-scale industries to invest for VE in terms of software procurement, infrastructure development, training and hiring trained manpower. Hence, there is the requirement of initially subsidizing DHM software by the Government to make it more economical and accessible. Research initiatives for the development of user-friendly DHM software and creating manikins more realistic with the incorporation of manikins representing Indian anthropometric dimensions are also needed for its wide adoption in India [5,12]. Indian organizations including research centers, product development organizations and academic institutes need to put more impetus to overcome the shortcomings and pace up with the global trends in VE.

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