2. LITERATURE REVIEW

2.1 Review on Ergonomic Design of 'Man-Machine' Systems

From the review of International design activity which is limited to Japan and the U.S.A (Munehira Akita, 1991), it is clear that design is of increasing importance as an integral part of modern ergonomics, whether micro or macro. The word design is prevalent among human factors engineering texts and is widely used when considering almost every problem. For example, one might cite the following:

i) the design of visual displays for ease and speed of integration,
ii) the design of knobs, control handles and pedals to match human performance,
iii) the design of visual and auditory equipment and communication system to ensure accurate communication,
iv) the design of visual display terminals and human computer interface systems to fit the user's physiological and cognitive functions,
v) the design of homes, public and commercial buildings, cities and their environment to secure satisfactory life, welfare and prosperity,
vi) the design of transport systems for safe and convenient movement, and,
vii) the design for human-machine system organisations for simple and effective management

Thus any product/machine/equipment, no matter what it is, whatever its function, must be evaluated in terms of maximising the interaction between the product/machine/equipment and user to make product/machine/equipment appropriate for human use. Generally speaking ergonomics seeks to design elements from simple tools to the work environment itself, that are best matched in terms of the capabilities and limitations of human performances. The human activities involved in the operation will be analysed and assessed by the designer through task analysis but he or she will also draw on data obtained from experimentation with a potential user. Product specification should be matched to user equipment (Jan Kaczmarek, 1979).

In Japan almost all products including modern high-tech products such as cameras, audio-visual equipment, automobiles, personal computers are designed
ergonomically. The Japan Industrial Design Promotion Organisation (JIDPO) awards "Good Design" for products with G-Marks, considering all aspects of design including ergonomics (Munchira Akita, 1991).

The products that ergonomists have helped in the design and development cover an enormous range (A. Chapanis, 1995) such as tooth brushes, hammers, chairs, dental equipment, telephones, keyboards, copiers, computer work stations, automobiles, tractors, aircraft, military weapons systems, nuclear power plants, off shore oil drilling platforms, air traffic control systems and space vehicles.

Ergonomics capability in product design and development has been established through a study of six organisations in Newzeland (Carol Slappendel, 1994). The products covered were petrol pumps access control equipment and point of sale systems. Leyland DAF and the University of Nottingham (Haslegrave and Holmes, 1994) have collaborated in establishing an ergonomics team to support the truck design and development process in the company. This project was structured to promote integration of ergonomics and engineering considerations within the technical design process for the design of a sleeper cab, in-cab communication for long-distance drivers, layout of the passenger space in a minibus.

Ergonomics is changing because its theories are evolving, but most importantly because its areas of application are changing and forcing the theories. Manufacturing is one area where the change is particularly noticeable with new technologies redefining operator's roles (Drury, 1991). This redefinition has strong implications for ergonomics both in what techniques and theories we develop and in how we choose to apply them within the manufacturing context.

Ergonomic design of computer hardware has been discussed with details of adjustment ranges for "VDT Work Station Heights" by Kroemer (1993). Selection criteria of ergonomically designed tools have been discussed with specific guidelines by Roberta Carson (1993). Ergonomics has been given high priority at Lockheed Fort Worth Company. An ergonomic work environment enhances productivity, improves employee satisfaction and prevents injury. The Lockheed Fort Worth Company's ergonomics effort is an example of one approach that has generated positive results by applying ergonomic principles to improve work environment (Pipnich et al., 1993).
Ergonomics and the global problems of the twenty-first century is discussed by Neville Mora (1995). Such problems will be a major ecological and social problems including population pressure, pollution, water shortage and urbanisation etc. The study of human behaviour is essential to solve these problems.

In designing a workstation, computer-aided human modelling programs (Das and Sengupta, 1995) can be used advantageously to analyse human-fit to the work station components. The analysis is performed within a three-dimensional computer graphic environment.

2.2 Ergonomics and Anthropometry in India

Little work has been done on anthropometry in India (Dutta and Neena Naik, 1979). There are a few anthropometric studies conducted in India for various purposes. One of the earliest reports on some anthropometric measurements of Indian workers in relation to sitting arrangements was by Saha (1973). The data was obtained from a Radio Manufacturing factory in Bombay. The Central Labour Institute (CLI), Bombay has been mainly concerned with research in this area and the majority of the Indian studies reportedly have been published from this Institute. An anthropometric survey for agricultural machinery design was published by Gite and Jadav (1989). Now-a-days, the Industrial Design Centre, Indian Institute of Technology, Bombay is also actively engaged in anthropometric studies (Ray, 1990, 1995). The National Institute of Design (NID), Ahmedabad is emphasising the importance of ergonomics while designing man-machine systems.

Anthropometry of south Indian industrial workmen was published by Uppugonduri (1992). This study was conducted on south Indian male workers in the electronics industry in Hyderabad, Andhra Pradesh.

2.3 Direction for Research

The methodology of ergonomics is based on the systems approach. Accordingly, ergonomics can draw upon methods employed in other disciplines involved with qualitatively new problems related to the man-machine system.
The ergonomic approach to the study and optimisation of activity has specifics of its own. In methodological terms, this is expressed in the following principal provisions: First, ergonomic design of work calls for the use of both experimental and a prior design methods. Second, the use of generalised indices of work, its pace, strain and comfort presupposes procedures for obtaining integral criteria from a system of particular indicators. Third, ergonomic research and assessment should always be systems-relevant and this can be effectuated only on condition that different methods reflecting man-machine relationships are employed simultaneously. Hence a definite strategy for selecting appropriate methods with respect to concrete ergonomic objectives is a must.

Ergonomics research methods may be arbitrarily divided into two groups: analytical (or descriptive) and experimental. For effective ergonomic research both should be combined whereby these methods compliment and enrich one another (V. Zinchenko et al., 1989).

"Tyre-Changer" is an equipment employed for demounting and mounting of tire from and/or on to the wheel disc of light motor vehicle(s). The research is directed first to design a Low Cost Manual Tyre Changer (LCMTC) by the application of modern design techniques including Value Engineering. Then experimentation has been carried out to improve the operational or functional efficiency of the equipment. Finally, an anthropometric study has been conducted to get relevant anthropometric data of the users (persons) for human integrated design of the Low Cost Manual Tyre-changer (LCMTC).