INTRODUCTION

The year 1994-95 proved to be a landmark year in the development of the Centre. Not only did its computing environment register a steady enhancement during the year but also its scientific activities. This report briefly presents the significant developments for the general scientific-technological reader.

The year began with the commissioning of the CONVEX C3820 after extensive testing. It was thrown open to scientific users on a round-the-clock basis. The computer site was not only newly completed in January 94, but it is located in a building which was designed to serve as a laboratory for medicinal plants! It is not surprising that the teething troubles associated with power and environmental problems took a fair amount of effort, ingenuity and time. The degree of success achieved by the staff of C-MMACS can only be gauged by the utilisation of 9,000 CPU hours of this galium-arsenide technology based vector-parallel supercomputer in the first year of its operation. The level of utilisation is indicative of the big boost this contemporary system has given to simulation activities in several disciplines, especially where the real-world problems of present day relevance demand fairly complex, usually nonlinear, mathematical models and compute-intensive simulations. But simulations of this type also need considerable facilities for visualisation in order to set up problems efficiently and also to analyse the results. Installation of four high performance workstations, linked with the supercomputer by a fibre optic link, served precisely this purpose. Furthermore, transmission of large data files, searching of remote data bases, and transfer of public domain software have become such essential components of contemporary scientific research that networking is inescapable. Development of extensive data links and INTERNET connectivity has made this Centre a truly world-class high-performance computing environment, that serves not only R & D laboratories but also academia and industries in India.

The Latur earthquake and the attendant tragic loss of life triggered intense scientific discussions into possibilities of measuring extremely slow earth movements and modelling the accumulation rate of crustal strain in south India as a basic approach to inferring earthquake risk in the region. The South Indian Strain Measuring Experiment (SISME) was conceived and executed jointly with scientists of several institutions, notably, the University of Colorado, the Indian Institute of Science, and the Survey of India, Bangalore Circle. This experiment is remarkable in several ways. First, it has provided in a very short time valuable information on the average crustal strain rate in south India, and the first directly measured velocity of the Indian plate towards Tibet. Second, it has used technology based on Global Position System (GPS) in a very sophisticated way to attain levels of accuracy that could not be attained in India earlier and that is likely to be a model of many future activi-

ties based on GPS technology. Third, it is an outstanding success in international scientific collaboration based on low cost, high speed of execution, young staff, excellent leadership, and, last but not the least, the spirit of cooperation.

The research activities of the Centre, which include both inhouse as well as collaborative activities, are reported in the next five chapters. The grouping of these activities is suggestive of their relevance. It can be seen that the number of organisations with which the Centre interacts is rather large, and the spectrum of activities very broad. Diverse problems are posed to the Centre by various CSIR labs and other institutions and compact multi-disciplinary teams are set up to address these problems. These features highlight the objectives of the Centre, which were laid down in 1988 as follows:

"The objectives of the Centre will include the following:

1. To develop expertise, excellence and facilities for undertaking major mathematical modelling and simulation problems and to take up research in major modelling and simulation problems in identified areas primarily of relevance to CSIR (including new software development) by itself and in collaboration with other CSIR Laboratories.

2. To promote mathematical modelling and computer simulation across the spectrum of activities of CSIR Laboratories by all available means including organisation of workshops, training programmes, seminars, brainstorming sessions etc.

3. To strengthen existing units in CSIR laboratories and Hqrs. working on mathematical modelling and allied activities and to coordinate their work"

The pursuit of such broad spectrum of research activities calls for developing generic expertise at the Centre in areas like nonlinear modelling, optimisation, system modelling, inverse problems, scientific computing etc. and combining it judiciously with discipline-specific expertise available in other institutions.

The chapter on modelling for resources describes inter alia how a model of primary production, that is, the production of phytoplankton in the upper ocean explains the role of nutrient-recycling by bacteria. The marine ecosystem model, which is being tested and refined for conditions in the Arabian Sea, has the potential of being developed as a tool to give us insight into potential zones of living marine resources, and exchange of carbon across the atmosphere-ocean interface.

The next chapter on modelling for climate variability reports several important developments. To mention a few, significant insight has been obtained in modelling the role of moist feedback in tropical circulation, particularly, in the evolution of organised disturbances and the effect of land-ocean contrast. A promising hybrid prediction system based partly on neural network and partly on nonlinear dynamical system, which is designed for applications in atmospheric sciences, is also described. Considerable progress has occured in developing modelling capability for large scale ocean circulation, which has implications on climate variability, living marine resources and navigation. Simulation using a contemporary model has given insight into seasonal variation of ocean currents and upwelling.

The chapter on modelling for hazard quantification describes, in addition to SISME, the discovery of scale-selective intensification of disturbances into tropical cyclones. This work has potential applications in operational weather forecasting.

The chapter on modelling for design contains interesting contributions on thermosolutal convection and particulate flows. A phenomenon of biplume has been observed in numerical simulations for the first time. It basically shows that, when the effects of temperature and concentration are opposite, there are conditions when heated and therefore lighter fluid ascends and denser fluid with higher solute concentration descends. The novel feature is that both take place at the same time. A theoretical model developed for dispersion of solid particles in fluid phases has been successful in capturing trends in many diverse experiments.

The chapter on miscellaneous modelling areas reports progress in several problems. Most notable is a new methodology of conformational sampling that has been developed by scientists of the Indian Institute of Chemical Technology and the Centre. Its application to a cyclic peptide, which is a member of crown ether family, has succeeded in revealing all low-energy conformations that have been observed in experiments.

External cash flow (ECF) is a good indicator of the relevance of an R & D Centre. CSIR has specified in a general way a target in relation to the resources provided by it to each of its units. It is a pleasure to report that ECF during the year was Rs.99.454 lakhs in comparison with the CSIR support of Rs. 94.291 lakhs. Thus the Centre has for the third time achieved higher ECF than CSIR support in its short span of existance.

This year's annual report of C-MMACS is the first to be brought out independently of the annual report of NAL. Earlier, the practice was to report the progress of C-MMACS activities as a part of the annual report of NAL. C-MMACS annual reports for 1992-93 and 1993-94 were essentially compilations of parts of the NAL report. Consequently, the present arrangement has provided greater freedom in choosing a more appropriate format and making the report a coherent document. Another aspect of the present report is that composing, editing and proof reading have been carried out by C-MMACS staff.

I would like to thank Ms. M.K. Sharada, Ms. Sridevi Jade, Dr. P. Goswami, Dr. R.N. Singh and Prof. V.K. Gaur for their help in compiling and editing the report, Dr. M.S. Phanikumar and Ms. Stella Alexander for composing it using LaTeX and PostScript, Dr. S. Bhogle for numerous suggestions on editing and publishing this report, and Mr. M.B. Ananda and Mr. S.T. Anandhan in getting the report published in a short time.

K.S.Yajnik
Head, C-MMACS