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**COMPUTER AIDED ENGINEERING/
COMPUTER AIDED DESIGN AT NWRI**

by

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ABSTRACT

The application of low-cost personal computers as the basis for CAE/CAD work stations at NWRI is briefly reviewed, and the configuration of the existing equipment described. Justification is presented for expansion of the system by the addition of four work stations in ENSRVS, rather than procurement of a PC-AT as originally planned.

RESUME

On passe brièvement en revue l'utilisation de micro-ordinateurs peu coûteux comme éléments de base des postes de travail pour la CAO et on décrit la configuration de l'équipement actuel. On explique en outre les raisons pour lesquelles on a décidé d'agrandir le système au moyen de quatre postes de travail dans les Services de l'ingénierie plutôt que d'acquérir un PC-AT tel qu'il était prévu initialement.

MANAGEMENT PERSPECTIVE

Computer-aided design, designing and drawing with the aid of a computer, has many potential applications in the design and development of sampling and measurement systems to support NWRI research programs. Among these are block diagrams, flow charts, design calculation, printed circuit board/electronic design, and mechanical drafting.

The rapid development of the microcomputer with high resolution graphics capability and the parallel development of a wide range of software packages now places significant CAD power in the personal computer. At the same time, the cost of this equipment has dropped significantly.

This report reviews the application of this technology in ENSRVS and MANTEC Sections of Hydraulics Division. It provides the rationale for choosing to expand the number of personal computer based work stations for use in the design support role. The use of these tools reduces the need for people to be employed in routine support tasks such as drafting and tabulating of data, and frees them to make a more creative and productive contribution to the work of the Institute.

T. Milne Dick
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PERSPECTIVE-GESTION

Le conception assistée par ordinateur, c'est-à-dire l'utilisation de l'ordinateur pour faciliter les travaux de conception et l'exécution des plans et des graphiques, peut être mise à profit de multiples façons dans la conception et la mise au point de systèmes de mesure et d'échantillonnage destinés aux programmes de recherche de l'INRE. A titre indicatif, mentionnons les schémas fonctionnels, les diagrammes d'acheminement, les calculs de conception, la conception des plaquettes et des circuits électroniques et le dessin automatique.

Le perfectionnement rapide des capacités graphiques à haute résolution offertes par les micro-ordinateurs et la mise au point simultanée d'une vaste palette de logiciels d'application ont considérablement rehaussé le niveau d'autonomie du micro-ordinateur en matière de CAO. Le coût de ce matériel a aussi chuté.

Dans le présent rapport, on examine l'application de ces techniques dans la Section des services d'ingénierie et dans celle de la fabrication et de la conception technique de la Division de l'hydraulique. On explique les raisons pour lesquelles il semble justifié d'augmenter le nombre de postes de travail dotés de micro-ordinateurs, destinés aux travaux de conception. Ces nouveaux instruments de travail permettent de libérer le personnel normalement affecté à des tâches routinières telles que l'exécution des dessins et la compilation des données pour leur permettre de contribuer de façon plus créatrice et productive aux objectifs de l'Institut.

Le chef,

T. Milne Dick

Division de l'hydraulique

1.0 INTRODUCTION

The application of Computer Aided Engineering and Computer Aided Design (CAE/CAD) technology in the Engineering Services and Manufacturing and Technical Development Sections of Hydraulics Division was initiated in FY 1984/85.

A study team comprising F. Roy, J. Dolanjski, R. Desrosiers and S. Beal was set up. A preliminary report to the Division Chief, Hydraulics Division, was made 29 November 1983, with the proposal to establish two electronic design work stations in 1984/85, and make equipment selections for mechanical layout and design drafting work stations in 1985/86.

The purpose of this report is to document the progress made and experience gained to date and to propose plans for further expansion of the CAE/CAD system now operating.

2.0 INITIAL SYSTEM CONFIGURATION

CAE/CAD technology has potential for increasing the productivity and creativity of individual designers and engineers by:

- transferring routine copy, search, and listing tasks to a machine;
- automating or at least simplifying the manual design entry, documentation, and analysis methods typically employed;
- managing the increasingly complex data base that the design accumulates;
- applying program automation and design process abstraction to simplify specialized tasks such as circuit layout, mechanical layout, supporting calculation and analysis.

To fully exploit these potentials, the automation of engineering and design require the creation of an integrated system of tools that provide designers and engineers with a computing environment

suitable to individual work habits, and which promotes communication between study team members.

Three categories of system configuration were considered in this application.

- a) Mainframe systems in which the work station comprises a terminal with time sharing access to a central mainframe computer. This would use the existing NWRI Cyber as the basis for CAE/CAD.
- b) Turn-key systems in which the processor, peripherals, and software are designed as a specialized work station. An example of this approach is the PRIME Computer.
- c) Individual stand alone personal computer based work stations, with specialized CAE/CAD software packages, peripheral hardware such as digitizers, plotters, and a cursor control mouse, and with future potential for local area networking.

Major concerns influencing the selection of our system configuration were:

- benefit to cost ratio;
- industry support to the selected system;
- potential of hardware for other than strictly CAE/CAD applications;
- maintenance of an inhouse standard compatible with other Divisions if possible.

The decision taken was to base our CAE/CAD system on the IBM PC personal computer. The reasons for this were:

- benefit to cost: the greatest benefit to our operation is in the function of electronic design, the generation and drawing of electronic circuits, circuit boards, and listing of electronic parts. The next benefit is in the generation and drawing of mechanical parts. These functions required only a two-dimensional

modelling capability which could be satisfied by program packages such as Auto CAD and DASH 1 available for the PC. The cost of choosing a mainframe based system, or a turnkey system was at least two orders larger than the PC based system. The low complexity and volume of our requirements did not justify this higher cost;

- industry support: the IBM PC has created a highly competitive and innovative software market place which produces a wide range of CAE/CAD software. These programs are increasingly user friendly and adaptive to general design needs. Software for mainframe and turnkey systems are generally produced by or sponsored by the system manufacturer only, and tend to be specialized and less adaptive to general needs;
- availability: the MANTEC Section had on inventory two IBM PC computers which provided a starting base for two work stations. CAE/CAD work was initiated in a short time by the purchase of the required software, and memory expansion for these units;
- inhouse standard: it was decided that the IBM PC should be adopted as the inhouse standard for low cost personal computer work stations, based on low initial cost, and the large independent software industry associated with this model of personal computer.

3.0 ENSRVS AND MANTEC CAE/CAD WORK STATIONS

By the end of FY 1984/85, two formal CAE/CAD work stations had been established, one in ENSRVS and one in MANTEC.

The ENSRVS station comprises:

IBM PC with 512 k Bytes RAM	HI-PAD Digitizer
Hercules Colour Graphics Adapter	DASH 1 Card and Cursor Mouse
Monochrome Monitor	PC Mouse
Colour Monitor	Houston Instruments D Size Plotter

This work station is located in Room R129 and is available to staff of ENSRVS, MANTEC, and SHORES Sections of Hydraulics Division. It is used for electrical and mechanical layout, drafting, analysis of data bases, and generation of reports and manuals. Software available includes AutoCAD 1, DASH 1, GENII (optics design), LOTUS 123, dBase II, Wordstar, and others.

The MANTEC station is similar, with additional capabilities given by a 5 M Byte hard disk added to the PC. This station also has a Gtek EPROM programmer. This station is located in Room R144A and is used almost exclusively for electronic design and microprocessor program development.

4.0 EXPERIENCE TO DATE

The practicality of using low-cost personal computers for design and engineering support functions becomes more evident as the designers and engineers gain experience in their use in a variety of tasks. With constant use, the designer develops the same functional relationship with the computer as previously developed between the designer and the support draftsman or clerical assistant. As this working relationship develops it becomes frustrated by having only the one work station for several users. It has become clear that effective and significant productivity gains can be achieved only by providing each active designer or engineer with a personal work station. This realization has resulted in a change in the plan for further expansion of this system.

Originally, it was perceived that the mechanical design work station would require a higher capacity computer with greater speed and memory than the IBM-PC. The new IBM-AT was considered to offer the required capability.

Operating experience with the PC and AutoCAD has shown this system to be adequate for the complexity of mechanical design tasks normally required. Rather than a higher capacity computer, what is

required is more work stations to increase design access to the power available from the software.

5.0 FUTURE DIRECTION

On review, better productivity gains will result from increasing the availability of CAD/CAE work stations rather than increasing the capacity and complexity of the existing work stations.

To accomplish this, it is proposed that four additional work stations be procured in ENSRVS Section, to be placed in each engineer's keeping. Each station will consist of:

IBM-PC including 2 diskette drive, 256 K RAM	\$2,700.00
Hercules Graphics Card	500.00
Quadram Quadboard II with 256 K RAM	595.00
Disk Controller	N/C
8087 Co-processor	250.00
IBM Monochrome Monitor	350.00
Epson FX-80 Printer with cable	725.00
PC Mouse	250.00
DOS Ver 3.1	90.00
Accessories and Delivery	135.00
	<u>\$5,595.00</u>

Existing peripherals for irregular functions such as full size plotting of drawings, digitizing from existing drawings, electronic circuit design will be held in stores for common user access as required. These consist of:

Houston Instrument Plotter
Hi Pad Digitizer
Dash 1 Card and Cursor Control
Colour Monitor and Adapter Card
Colour Plotter
Telephone Modem

As future experience dictates, this inventory may be increased as required to adjust limitations in the system.

Further future consideration will be given to Local Area Network capability. However, present communication needs are adequately met by having a standard work station configuration, with data base material on easily shared copy diskettes.

6.0 CONCLUSION AND RECOMMENDATION

Experience with the two initial personal computer based work stations in ENSRVS and MANTEC has shown that productivity of designers and engineers is increased with the aid of these tools.

The original plan for system expansion by increasing the capacity of the work station through replacing the IBM PC with a PC-AT has been demonstrated to be unnecessary. The standard PC with 512 K RAM and a Math Co-processor chip is able to meet existing needs for speed and memory.

Instead, it is clear from our experience that further investment in the system should be directed towards increasing the number of work stations. To this end, it is recommended that four PC's be purchased from funds allocated under Study 350 for CAE/CAD system development in FY 85/86.