DESIGNING SHIP AVIATION FACILITIES BY CAD

BY

G.C.A'COURT
(DGA(N) Ship Facilities Drawing Office)

ABSTRACT

The Computer Aided Design (CAD) system in the DGA(N) Ship Facilities Drawing Office is used for designing flight deck, hangar and aviation workshop layouts. The system and its operation are described, together with its advantages and examples of its work.

Introduction

During the past five years increasing use has been made of Computer Aided Design (CAD) systems. Whilst private industry has taken the lead in this field, MOD(N) is now following this trend. The Directorate General Aircraft (Navy) Ship Facilities Drawing Office (in H.M.S. *Daedalus*), which is responsible for providing guidance drawings for all Aviation requirements in Royal Navy ships and Royal Fleet Auxilaries, is now the proud owner of a fully networked CAD system.

Background

Like every other section, whether service or civilian manned, the Ship Facilities Drawing Office (SFDO) has been 'rationalized', or in plain language has suffered from staff cuts. Naturally these have not been accompanied by a compensating reduction in workload; quite the contrary. SFDO has recently been and still is involved with several major projects, namely Auxiliary Oiler Replenishment (AOR), Aviation Training Ship (ATS), Aviation Support Ship (ASS), Type 23 frigate (H.M.S. *Norfolk*), the normal updates for existing

ships in the Fleet, and the design of dedicated on-board equipment stowages required to support the Anglo-Italian helicopter the EH 101. Given this scenario, it was decided to enlist the services of the ADP section of the Naval Air Technical Evaluation Centre (NATEC), which is also based at H.M.S. *Daedalus* at Lee-on-the-Solent, to investigate CAD systems and propose an installation which was most suitable to the type of work undertaken by the office and, more important, to enable it to remain an effective unit notwithstanding the reduced manning levels. After a relatively short time a comprehensive study report was produced by the ADP section and the people controlling the financial aspects selected a company called KGB Micros to supply and install the equipment. This was successfully undertaken during early December 1986 and, contrary to expectations, I can confirm that we are not wired direct to the Politburo.

System

It was realized, at an early stage of the system selection process, that a CAD system with 6 workstations requires secure and effective mechanisms for controlling access to data. Local Area Networks (LAN) are well known for their ability to interconnect Personal Computers, allowing data files and devices to be shared. A Network Interface Card is fitted into each personal computer and these are then interconnected via cables. The cables and interface cards together form the Network Hardware. Its function is to provide a fast and reliable medium for the transfer of information from one computer to another. The crucial component in any LAN is the Network Operating System. This software program controls all access to the shared resources. The success of this multi-user CAD network is largely due to the quality of the network operating system, which in this case is Netware from Novell.

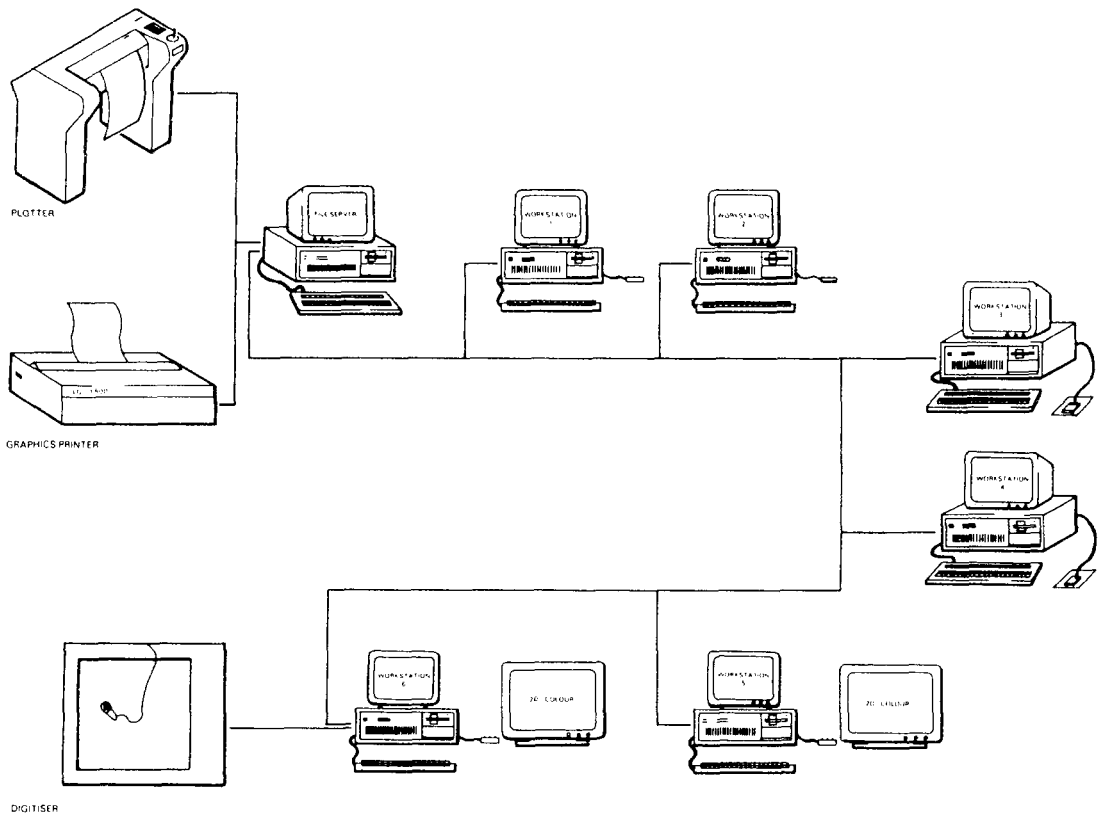

FIG. 1—COMPUTER AIDED DESIGN (CAD) SYSTEM

A simple network system is made up of two types of component, the file server and workstation. Netware places all shared resources on to the file server. FIG. 1 illustrates the SFDO configuration.

The File Server

The file server is a standard IBM personal computer. It does not, however, use the standard operating system, PC DOS. Instead, it runs under the control of Netware. Netware functions by processing requests for resources which are received on the network interface and responding with the appropriate replies. Usually a file server operates in a 'dedicated' mode, that is it runs only under the control of Netware and does not share the computer with PC DOS. The screen and keyboard therefore do not appear as a PC DOS terminal. Instead they are used as the 'server console'. This allows an operator to examine and control network operations. For example, he can find which files are being accessed by a workstation, disable a workstation, broadcast a message to all users, and reschedule jobs which are in the printer spool queues.

FIG. 2—OPERATING ONE OF THE WORKSTATIONS, WITH A COLOUR MONITOR TO THE RIGHT

The Workstation

This also is a standard IBM personal computer (FIG. 2). It requires a Network Interface Card to access the shared resources on the file server. To the user it behaves as if it were a perfectly ordinary personal computer. Access to the network is achieved by running a program called the Netware Shell. This provides a logical connection to the file server via the network hardware and use of the remote disk drives and printers on the server.

How Netware Works

A file server broadcasts a message on the network every few seconds to announce its existence and identify itself. When the Netware Shell Program is loaded, it listens for such an announcement and responds by requesting a connection to the server. The server hears this request and provides the connection. Initially this connection provides only one simple function—a logical drive, F, which contains two utility programs, SLIST and LOGIN.

SLIST gives the user details of the servers on the Network, and LOGIN gives access to additional functions which have been configured for an individual user. LOGIN asks for a username and a password.

The LOGIN program automatically sets up the workstation environment to suit the requirements of the individual user.

Data Access and Security

The file server contains one or more physical disk drives. Each physical disk can be divided into logical volumes of fixed size. Each volume contains a 'DOS-like' tree-structured directory of files. There is no restriction on the size of individual files or directories; they may be as large as the volume on which they reside.

As well as containing files, the server also possesses a set of 'entities' which control the operation of the server. The most visible of these entities are the 'users'. These are created by the system supervisor. Access to data is controlled by giving each user a set of privileges, which are granted to the user by the supervisor. The user description contains a list of directories to which that user has been granted access. There are eight distinct access rights:

Create files
Delete files
Modify file name/flags
Open existing files
Parental rights (creation of sub-directories)
Read from files
Search for files
Write to files

Each individual file in a directory possesses two flags which control access. A file may be set to be read/write or read only. A file may be set to be shareable or non-shareable.

Netware can also restrict a user to login only on selected terminals and at fixed daily time intervals. A terminal can be automatically disabled and an alarm set following several unsuccessful attempts at logging in.

Together, these features allow a great deal of flexibility in the design of the structure of a file system. There is a menu-driven supervisor's utility SYSCON which ensures that creation and maintenance of usernames and directories is a straightforward task. This does not necessarily make the design of a directory/user structure simple. This depends on the work that will be done on the network. It must be emphasized that forethought and planning are important to the production of a safe and reliable system.

The Ethernet Interface

Netware supports dozens of different types of Network Interface Cards. In particular, choice is made on the basis of cost, speed, reliability, workstation location and personal prejudice. For the DGA(N) CAD Network, Ethernet was chosen as a fast, cost-effective method of connecting a limited number of terminals (<20) over a restricted distance (<200 metres). A single thin

coaxial cable interconnects all the computers. The cable is terminated at each end to eliminate signal reflections. Each computer then views the cable as an 'all-pervading medium' through which it can communicate with any other computer. The cable is shared amongst many computers by use of a Carrier Sense Collision Avoidance protocol. The Ethernet card listens to the cable to check that it is not being used. It then transmits a packet of data, and also listens to the cable to check that its tranmission has not been corrupted by a simultaneous transmission from another source. If it detects such a collision then it waits a random time before retransmitting. The above protocol and the format of the data packet have been defined by the International Standads Organisation. Ethernet cards which implement this standard are available from several manufacturers.

Using AUTOCAD on the Network

AUTOCAD is a professional 3D drafting program which is designed for use on a stand-alone personal computer. It may, however, readily be installed on to a Novell Network to provide a multiple workstation system. This is achieved by subdividing the program and data files into several appropriate subdirectories as follows:

(a) *AUTOCAD Programs* are stored in a CADPROG directory. Each CAD user is given read access to these files, but only the supervisor is allowed to modify them. This ensures that only one version of Autocad is in use, and prevents the accidental deletion or modification of the programs. The files are set to be shareable, so that several users can run Autocad at the same time.

(b) *Standard Symbols and Drawings* are stored in a LIBRARY directory. CAD users have read access, and there is also a Library Manager who has unrestricted access to this directory. This imposes control over the updating of standard drawings.

(c) *User Drawings*. Several names have to be allocated for CAD use. When these users 'login' they are automatically given access to the shared CADPROG and LIBRARY files. Each user is also given a private directory. This is the user's work area. All files that are currently the responsibility of this individual area are stored in this directory. Only the user and the supervisor have unrestricted access to these files. The Library Manager has read access allowing him to transfer a completed drawing into the library.

(d) *Configuration Files*. Autocad supports a wide range of screens, digitisers, plotters and printers. The DGA(N) CAD system uses a mixture of monochrome and colour workstations. When AUTOCAD is loaded it must recognize the type of hardware on which it is running. This is achieved by storing the configuration files on a local workstation disk and instructing AUTOCAD to search for the hardware configuration data on this drive.

Printer and Plotter Management

A plotter (HP7585) and printer (EPSON LQ1500) are attached to the file server. These may be accessed by any CAD user via the Netware spooling facilities.

The commands required to spool a drawing to the plotter or printer have been incorporated into the AUTOCAD menu system. To produce a drawing on the plotter the user need only select the appropriate option from the menu. The system then produces a temporary plot file and then transfers it from the workstation to the file server. As several sizes of paper are available (A0-A4) the plotter is loaded manually with the required size of paper at the

start of each plot. At the end of each plot the plotter is placed off-line to indicate that another sheet of paper must be loaded. Several plots may be queued on to the spooler from each workstation, and this queue may be monitored and controlled via the file server console. FIG. 3 shows the plotter in operation.

Plotting to the graphics printer is done in a similar way. The printer is loaded with continuous stationery, and therefore prints consecutive jobs automatically. Netware separates them with a 'banner page' which identifies the originating user and the date/time of the job.

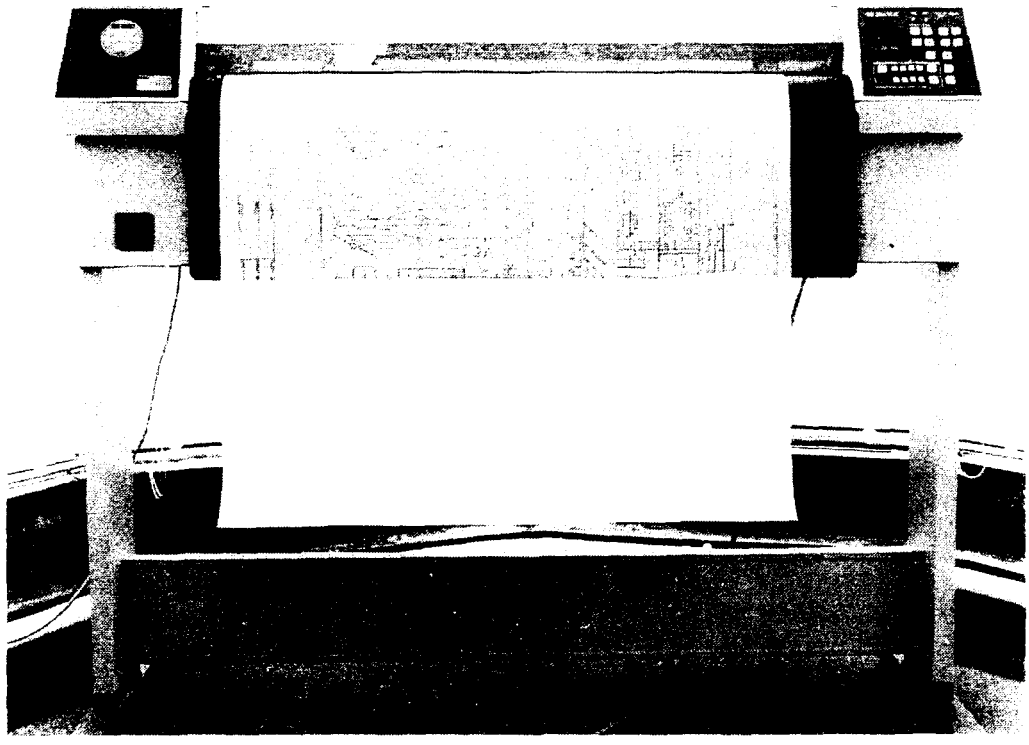

FIG. 3—THE AO SIZE PLOTTER IN USE

The Digitiser

A digitiser capable of accommodating up to A0 size paper is available to convert existing hand-drafted drawings into the system for final copying on to floppy disk. The digitiser is linked to a workstation which in turn is connected to a 20-inch colour monitor. This configuration has proved highly successful when digitising complex drawings with different line types. Each line type can be given a different colour thus assisting the operator to identify specific areas more readily. FIG. 4 shows the digitiser, together with a workstation and colour monitor.

File Backup

Each drawing file is copied on three separate floppy disks, which are distributed to widely separate locations. This procedure follows previously established practice for data backup via floppy disk media and guards against the accidental loss of an individual drawing file.

A daily and weekly bulk file backup is also performed on to a 60Mb (megabytes) capacity tape and operates at a speed of 2Mb per minute. As this backup requires access to all files it must be performed by someone with supervisor privilege. It is usually performed when there is no other work being undertaken on the network, to ensure that non-shareable files are also backed up.

The tape cartridge provides an additional/alternative file security mechanism. It also provides a quick method for recreating the system in the event of total data loss on the file server.

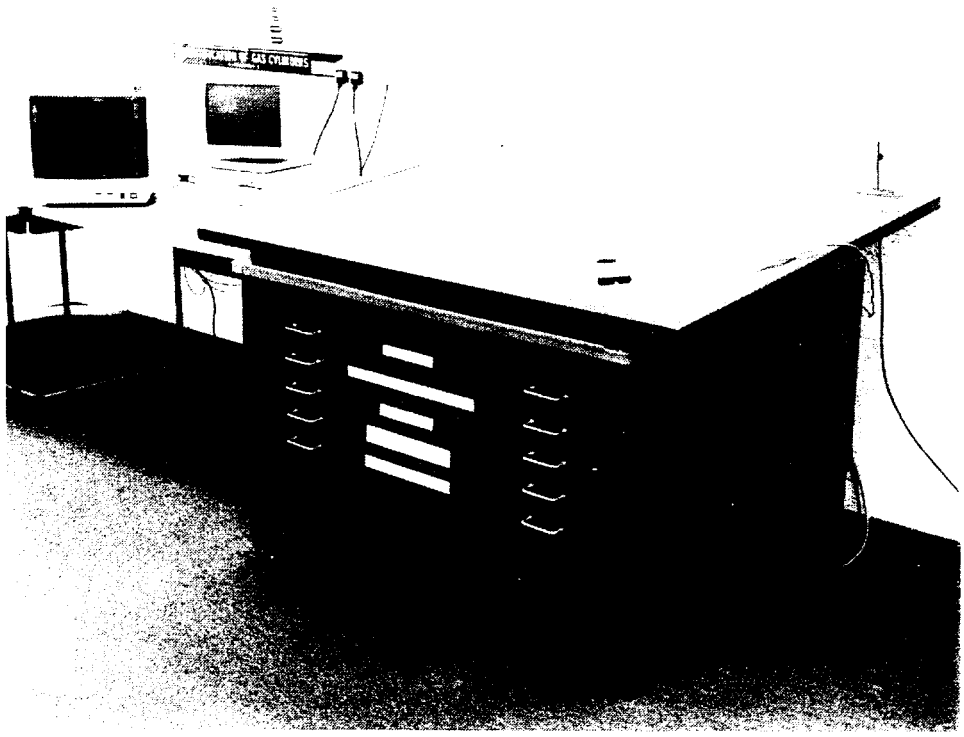

FIG. 4—THE DIGITISER, WITH A WORKSTATION TO ITS LEFT AND A COLOUR MONITOR (EXTREME LEFT)

System Reliability and Availability

The workstation and file server computers are IBM PC ATs. It is estimated that each computer will suffer a failure once in every two years. The loss of a single workstation on a six station network does not have a severe effect on system availability. At worst, if the system has become fully utilized one user would have to wait for available time on one of the other workstations until the faulty station is repaired. Assuming a repair time of two days, the loss of workstation time is less than 1%.

The loss of the file server will, however, have a highly disruptive effect. Although it is possible to use each workstation in stand-alone mode, such operation would reduce productivity by an order of magnitude. Repair of the file server is classed as an urgent task and should be accomplished within one day, or two days if there has been a total loss of data on the file server.

Thus we can expect system availability to be better than 98%. If an even higher level of availability is required then a second file server must be attached to the network, so that work can be transferred instantly from the faulty server to the spare server.

System Expansion

Because the system is built up of 'industry standard' modules it may be readily expanded to provide additional workstations, more storage capacity and more output devices.

The theoretical limitations of the Network are:

128 workstations per file server

2 Gigabytes of storage per server. If additional capacity is required then multiple servers may be installed.

The physical extent of the network is limited by the performance of the cabling systems. A network may be extended over several kilometres by the use of appropriate (but expensive) transmission media. Networks may be transparently interconnected by the use of Network Bridges allowing a mixture of cabling systems to be used.

The current workstations have a processing performance of approximately 1 MIPS (million instructions per second). If a higher processing speed is required then a faster workstation may be attached. The current limit on compatible workstations is 3 MIPS. In five years time a speed of at least 10 MIPS should be available.

User Interface

To 'login' to the system a user simply types his password into the workstation and the LOGIN program automatically does the rest. The user now has a number of choices available; he can for example ask for ACAD or WORDSTAR programs to be loaded. Another important feature of the system is the flexibility of being able to transfer work to any of the other workstations simply by ending the job, 'logging out' from one and 'logging in' to any other.

Use of the System

As the title of this article indicates, the system is used to design aviation facilities. The size and complexity of the task depends on the class of ship. A large vessel such as the AOR would, in addition to requiring guidance for the flight deck and hangar layout, involve some 20 other aviation workshops and offices. At the other end of the scale, a frigate size ship such as the Type 23 has five aviation compartments including the flight deck and hangar complex.

The other area where the system is being used with great success is the design of dedicated on-board aircraft equipment stowages and specialist avionic and mechanical servicing benches. A selection of work taken from current projects is shown in FIGS. 5, 6 and 7.

System Management

The whole system is configured in such a way that a traditional hand draughtsman can, without any computer knowledge, carry out all the normal day to day management functions in a relatively short time. Each activity has its own file so it is simply a case of loading the appropriate program and typing in the correct commands.

Benefits

The benefits of the system are continually being evolved but basically they fall into three areas.

Firstly the AUTOCAD drawing software package is configured in such a manner that the list of commands gives the operator the ability to make unlimited alterations during development of a drawing in order to create the

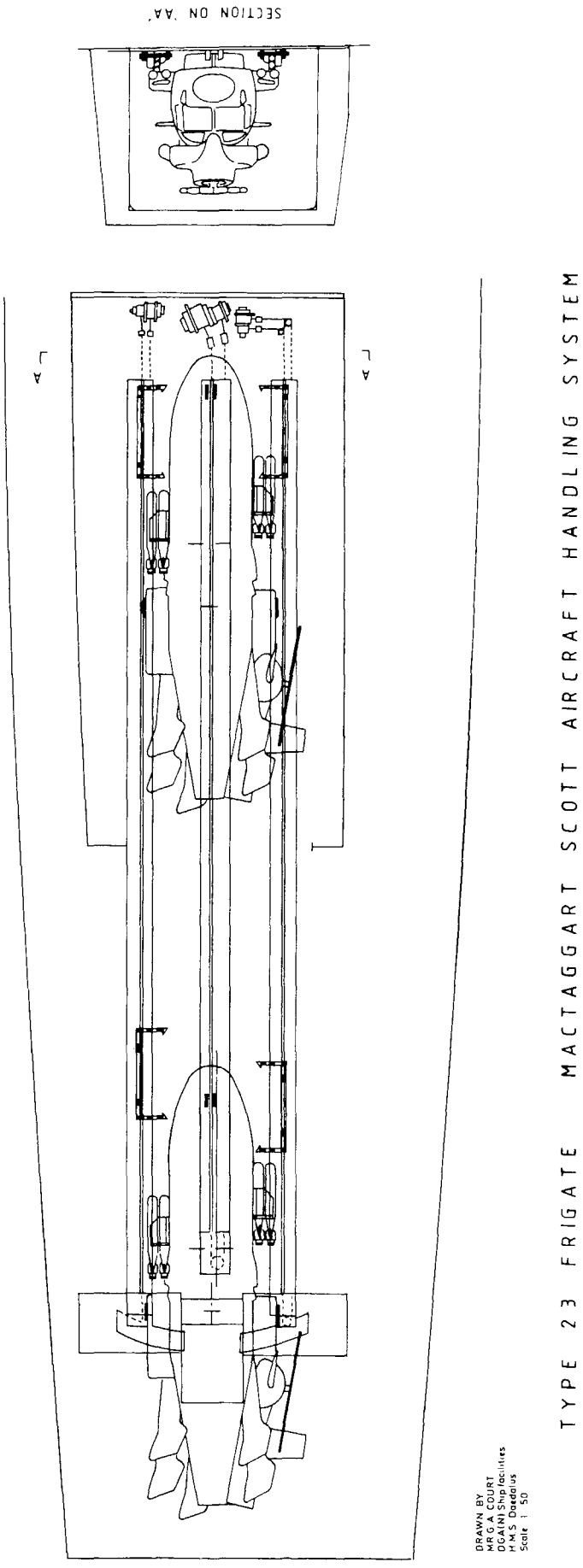

FIG. 5—TYPICAL CAD OUTPUT: AN AIRCRAFT HANDLING SYSTEM

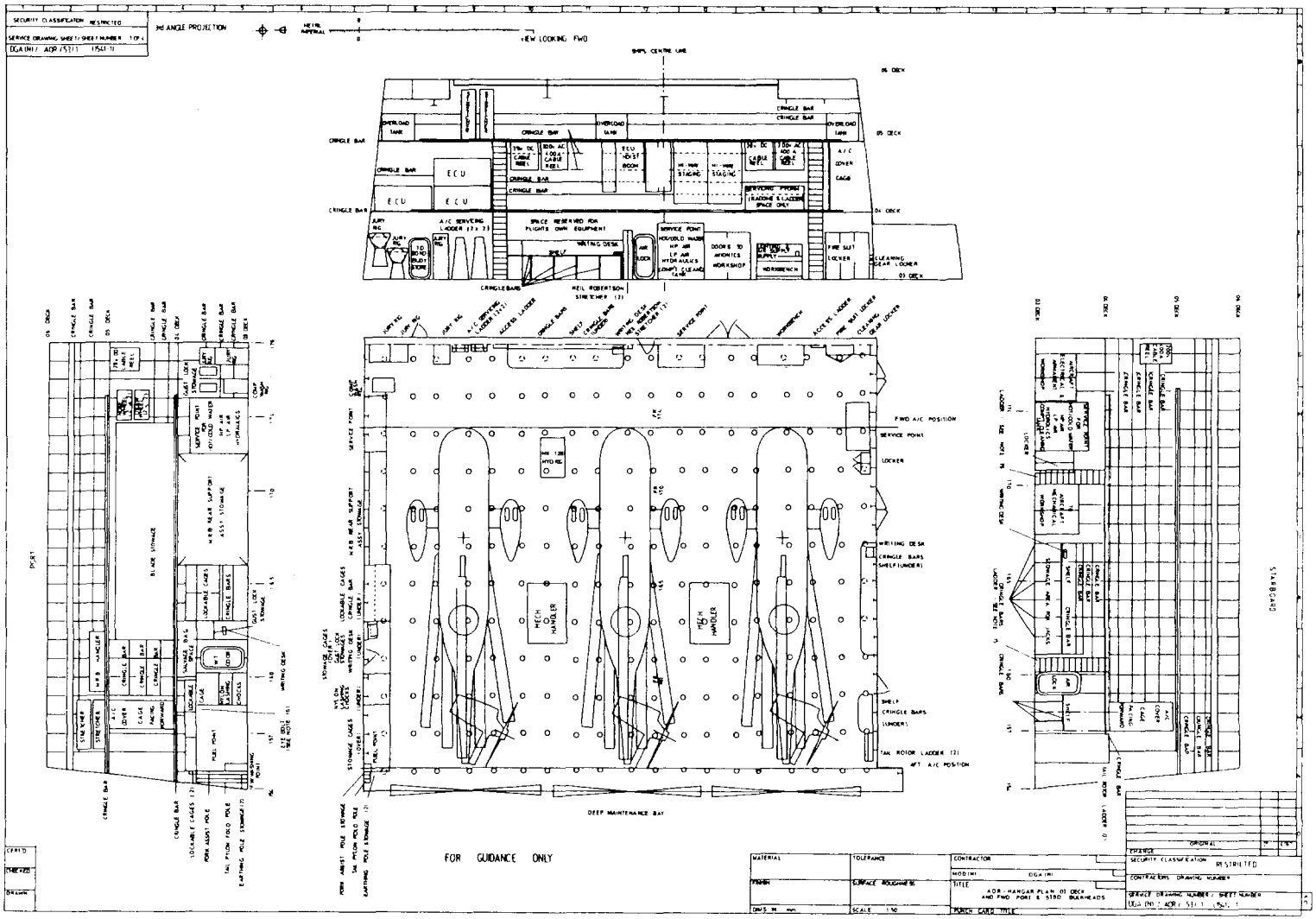

FIG. 6—TYPICAL CAD OUTPUT: THE AOR HANGAR

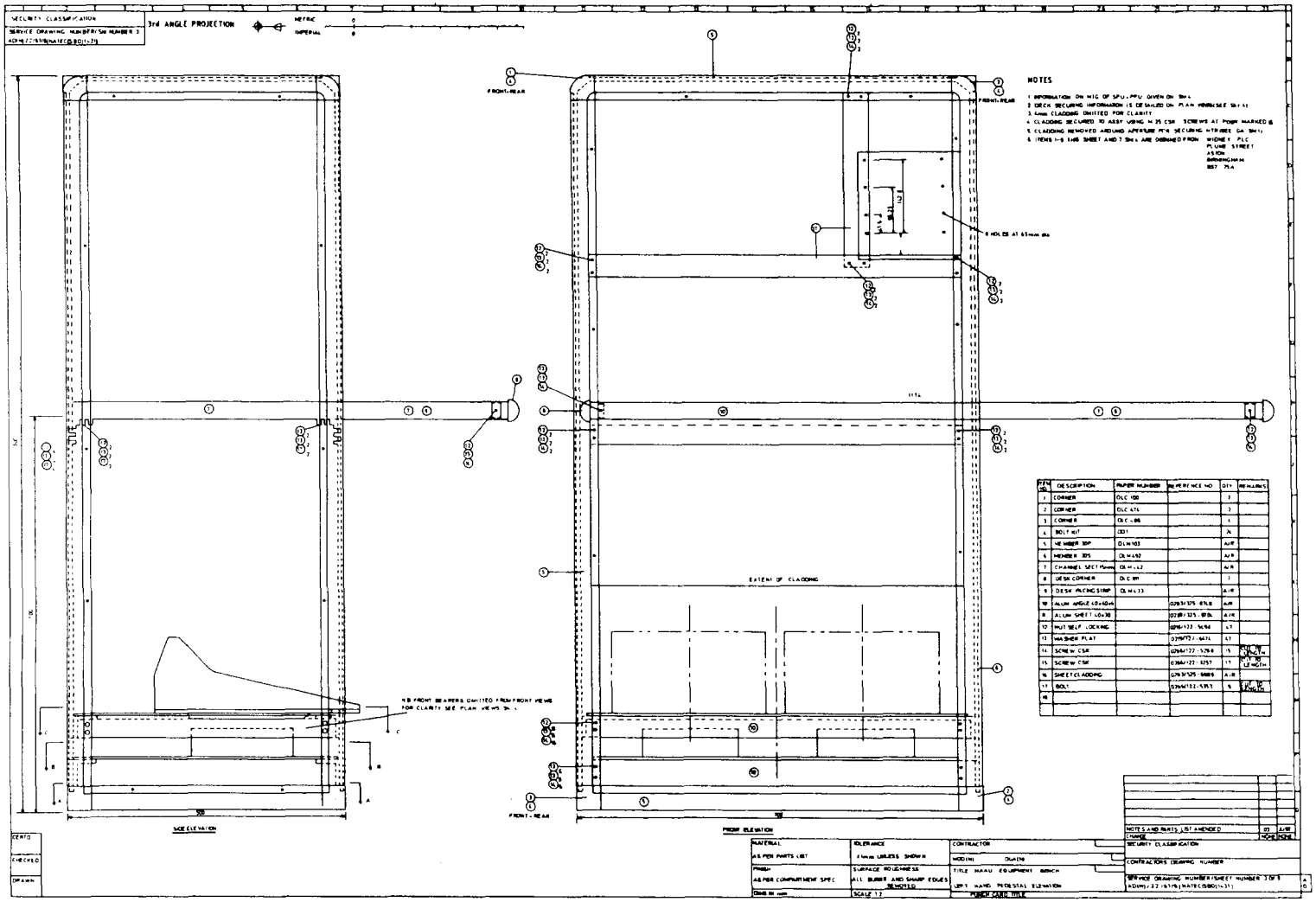

FIG. 7—TYPICAL CAD OUTPUT: HELICOPTER ACOUSTIC ANALYSIS UNIT EQUIPMENT BENCH

optimum design. An example of this flexibility can be appreciated during the build up of a hangar layout and in particular the positioning of an aircraft. Imagine using hand draughting techniques and spending a couple of hours drawing in an aircraft profile only to find that it subsequently has to be moved to port by 150mm. Rubbing out would normally be followed by an equally frustrating redraw. Using AUTOCAD this operation is reduced to about 10 seconds; by simply calling up the appropriate command and feeding in the new parameters, the change is carried out automatically.

Secondly, as a library is built up of the most commonly used items such as aircraft profiles, dedicated equipment stowages and specialist radar benches, they can be stored in part of the memory bank and called up and positioned in a new drawing, thus eliminating the need to redraw them each time they are required. These benefits have, in a very short time, demonstrated the value of the system. Already savings in time of up to 25% and 75% respectively are being made when creating new and updating/modifying existing drawings produced using the CAD system, in comparison with conventional hand draughting techniques.

The last and ironically the most important benefit gained from the system is the fact that it gives people with limited hand draughting skills the ability to produce detailed drawings in a relatively short time. This is especially important given the fact that SFDO is predominently staffed by service personnel and the last time they were in a drawing office environment was during their artificer training. Experience gained to date has shown that after 10 days of intensive tuition a CPO AEA will have acquired a sufficient understanding of AUTOCAD and the main keyboard functions to enable him to produce simple drawings. With further practice he can, well within 30 days, achieve a drawing standard such that the work can be sent to other MOD agencies and/or private industry.

Conclusion

It would be very easy to praise the system to such an extent as to create a 'halo' image but the finished product speaks for itself. The drawings are clean, precise and with a consistently high quality line and text definition. When this is coupled to the benefits previously described it can be appreciated that the system enables the draughtsman to produce a truly professional job every time, in less time, and with less manpower.

Acknowledgments

My sincere thanks go to Commander B. J. Smith R.N., Officer-in-Charge NATEC, for his personal interest and help during the entire project and also for allowing us to use the services of his ADP section. Without both, I am sure the CAD system would still only be a pipe dream and not a reality.

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