THE OPERATIONAL USE OF WORKSTATIONS IN THE CENTRAL FORECAST OFFICE OF THE UKMO

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1. INTRODUCTION

Computer workstation systems initially provided welcome local power and flexibility to researchers and developers, but it soon became apparent that there was a place for them too in meteorological operations. That is not to say that the days of the number-crunching mainframe are limited, rather that the sensible sharing of tasks as appropriate across more than one type of computer platform can produce benefits for users, customers and managers.

Back in the 60's the operational forecast offices were typified by enormous volumes of paper. Yards of teleprinter-produced observational data landed regularly with a thud beside those tasked with the hand plotting of synoptic and upper-air charts, and tephigrams. After hand analysis by the forecaster a further batch of tailored charts or messages were produced on paper for duplication and dissemination to local customers. It was quite an occasion when the first satellite imagery arrived on wetfax - but yet more paper!

By the mid-70's mainframe computers were performing regional Numerical Weather Predictions (NWP) for operational use and, as the models improved and computing power increased, these were joined in the 80's by global weather predictions. The mainframe was also the platform used to plot observed data on flat-bed plotters and to tailor and deliver the NWP diagnostic output to the forecaster. Most of this ended up on paper though the advent of graphics via an interactive terminal attached to the mainframe did go some way towards providing the forecaster with on-demand meteorological information at the workbench.

By the end of the 80's it was recognised at the UK Met.Office (UKMO) that concerted action was required to provide a new system to rationalise up to twenty years of operational legacy code running on a variety of ageing hardware platforms. The forecaster required something better than the hotchpotch of fairly inflexible display facilities available at that time, and those supporting the systems required a break from the tender loving care given to code written long before standards were imposed and to equipment for which the maintenance costs were becoming evermore expensive. The pressure was on to improve the quality, consistency and timeliness of forecast products. The HORACE Project was born.

2. THE HORACE PROJECT

The HORACE Project was initiated in 1991 to provide the Principle Forecast Offices (PFOs) of the UKMO with a computer-based visualisation and production system to satisfy the operational requirements well into the 21st Century. The project has been run using formal project management methods to aid the specification of requirements, the identification of the technical solution, the procurement and installation of hardware, and the development of the software.

The system is required to be easy to use, to speedily and flexibly display every type of meteorological information, to provide tools to aid the decision making process and to include robust facilities for the production and dissemination of meteorologically consistent value-added products. In addition it needs to be expandable to meet projected data volumes, upgradeable to meet ever more demanding User Requirements, and portable to run on different hardware platforms.

3. THE HORACE SYSTEM

The hardware for the system was chosen following a competitive tendering process and is based on Hewlett-Packard file-servers and workstations at each site. In CFO there are three HP 9000/897 file-servers with mirrored pairs of external disks, and 18 HP 735 workstations. Three HP DesignJet plotters are used for the hardcopy synoptic charts, and three LaserJet A4 printers for other printed output. Communications are provided to the CFO system by direct Ethernet links to the UKMO TROPICS message-switching system which is used for the reception of data from the GTS and for the world-wide dissemination of output products. NWP data from the mainframe is received directly on another Ethernet link, while communications between the file-servers and each workstation are via a FDDI network.

4. CURRENT SITUATION

HORACE systems are now running operationally in the Central Forecast Office (CFO) at Bracknell, at the HQ of RAF Strike Command (HQSTC), and at the HQ of the Royal Navy Fleet Weather and Oceanographic Centre (FWOC). A full development system is running at Bracknell.

These systems currently provide A0 plotting of hard-copy synoptic charts to replace the mainframe-based flat-bed plotters, the display of every type of observation in a variety of alphanumeric and graphical formats, text data such as warnings and station details, NWP picturefiles and non-animated imagery. It is possible to calculate standard information such as site-specific night minima, and to create and disseminate textual products. A chart digitisation and dissemination facility has recently been added.

The database holds observations, text, imagery and NWP data covering the globe. The displays can access and zoom-in on any map area.

5. DEVELOPMENT PROCESS

The most vital requirement for any development programme is to provide the users with the system and applications to perform the tasks required - which is not necessarily the same as what they or the developers think they require. In the very early stages of planning the forecasters had virtually no experience of any sort of windows environment, let alone the potential power and flexibility of a workstation, so their original requirement looked almost identical to their existing mainframe facilities - but transposed to a workstation. This has changed significantly as development has progressed and as those involved have gained experience, now there is a constant stream of new ideas with the danger that users may lose this enthusiasm if they have to wait their turn for implementation.

The user requirement was only the very first step. Experience has shown that the more feedback gained from the user during the process of prototyping and development , the more satisfaction will be gained from the delivered product, and ensuing change requests will be minimal. It is not always possible to obtain sufficient time from the shift-working forecasters for specification and assessment , or even agreement between them as to the best way to provide a certain facility. In an ideal situation an operational forecaster should work permanently with the project team during critical periods of development.

The HORACE development took advantage of the availability of formal design methodologies and a CASE tool, Software through Pictures, to design the basics of the system from scratch. It was originally envisaged that a commercial database would be used and that much of the legacy software could be ported from other platforms, 'tidied up', and implemented fairly speedily. This proved impossible. Two commercial database systems were tried and despite assurances to the contrary could not provide the retrieval response times required by the users. In addition much of the FORTRAN legacy software proved to be poorly designed and documented, non-portable and inefficient to run.

In some ways it was gratifying to see how programming skills had improved over the intervening years, but it did mean inevitable delays to the project while an in-house database and new applications code were written. It also bolstered the intention that this time round standards would be enforced to produce well-designed, maintainable, well-documented and efficient programs. The C language and Xlib calls are the preferred choice where possible for new programs, with FORTRAN being used where necessary to interface with GKS.

As the development programme has expanded (and with such a comprehensive database and flexible system the opportunities appear to be boundless) it has now been recognised that a software configuration management system is required to impose rigor on the development process, and one is in the process of being procured.

6. OPERATIONAL CONSIDERATIONS

6.1 General

There are requirements placed on every operational computer system over and above those required for researchers and developers. These focus attention on such matters as resilience, security, backup, and support for the systems themselves, together with formal change-management and release-management processes to maintain the continual integrity of the software. The operational user, who may well be a relative novice in computer matters, requires a user-friendly interface and formal training in how to obtain the best from the system when performing the day-to-day tasks.

These basic requirements have evolved through years of mainframe usage, and the experience gained there has been of use in implementing the first operational workstation systems at UKMO. The management of the project were very conscious that from the forecaster's perspective the HORACE system placed all their eggs in one basket, that if the whole system was down there was a risk that they would have no access at all to information or to time-critical production facilities.

6.2 Hardware

Much emphasis was placed on duplicating critical hardware in CFO. There are two primary file-servers, with a third spare which switches-in automatically should either of the others fail; mirrored disks; two communications hubs with either able to support all the workstations albeit with reduced performance; duplicated communications channels and networks. The advice available from the hardware vendors can be invaluable for identifying likely problem areas - as long as their proposed solution is affordable. In the end it comes down to assessing the risk and making provision accordingly. Even if there are few failures there will always be occasions when the system will need to be taken down for systems enhancements so these require careful planning with the forecast office operations manager, and in critical weather situations may need to be rescheduled.

6.3 Alternate locations

It is intended to provide the ability for CFO to access the development system file-server, database and workstations in an emergency. All the software is available at every site and the logon procedure identifies the site by default and configures in the local preferences. An override option enables the user to choose, say, the CFO set-up even if the workstation is physically located elsewhere. It is already possible for users at one site to send locally produced charts across the network to the printers at another site in an emergency, and eventually it is planned to provide an operational site remote from Bracknell for use if the whole facility is unavailable.

6.4 Monitoring and Support

It is most important that all aspects of an operational system are monitored on a regular basis. Monitoring should cover hardware, software (system and applications), communications, networks, file-systems and even users! Some tasks can be automated while others require the eagle eye of someone who knows the system well to identify activities which are out of the ordinary. First-call support for the system outside normal working hours is provided by members of the shift-working IT operations section who can handle some of the requirements but who will call on further HORACE expertise if required. The provision of expert 24-hour support is currently being evaluated.

6.5 Security

The security of any UNIX system is always open to question. Advantage is taken of all the facilities built into the system but in the absence of some more robust security measures it is advisable to isolate the system from all possibility of outside interference if at all feasible.

6.7 Change Control

There is always a risk associated with making a change to the hardware, systems or applications software so a formal process has been implemented to manage both release control and change control. All changes are preceded by comprehensive tests to ensure that the change works as planned and a change in one area does not adversely impact another. New releases are planned for implementation every four months with urgent bug-fixes or time-critical changes being installed incrementally as required. Once released every effort is made to implement the changes at all the user sites as speedily as possible as the maintenance of more than one operational version is an expensive overhead on resources.

6.8 The Graphical User Interface

The Graphical User Interface (GUI) is the visible face of HORACE to the user so much care has been taken to design an intuitive display which of itself requires little user training. It is important that layout and selection processes are consistent across the whole system so all new GUIs are created in OSF-MOTIF using X-Designer, while the original GKS GUIs are planned for replacement as soon as the bulk of priority development is complete. It is a constant challenge to minimise the number of mouse-clicks required to perform any one task! As the GUI is the *two-way* interface between the forecaster and the application it is also very important that it conveys status and help information to the user. Consistency in error-trapping resulting in plain-language informative text is vital if the user is not to be left wondering what on earth is going on!

6.9 Training

The requirement for initial user training varies with the individual concerned, for some it has been necessary to provide the most basic introduction to working with an interactive screen, keyboard and mouse. All users have required some help in navigating around the visualisation facilities and full training and familiarisation in the use of production facilities. Now as each new type of facility is introduced it is important to assess and supply the appropriate level of training required by the users. When more complex production facilities involving a significant amount of graphical editing and field modification are available it is expected that they will require a fairly lengthy period of familiarisation before being introduced operationally.

7. FUTURE PLANS

It is already necessary to be considering enhancements to some of the hardware procured in 1992 as workstation memory and disk space is at a premium for some of the more resource-hungry graphical applications. A small number of HP C110 workstations will shortly be procured to replace the early 720s used on the project, and to enable development of the twin-monitor display system eventually planned for the majority of operational seats.

There is already a lengthy software development programme for HORACE lasting well into 1998 but new requirements are being added all the time. Some of the basic requirements are yet to be met, with priority being given to further NWP and imagery visualisation. Greater emphasis will now be placed on the semi-automation of tasks in CFO by providing the tools, techniques and facilities to streamline selected tasks. There is an increasing requirement for editable 'first-guess' products, and the development of on-screen analysis of scattered data is nearing completion. A new strategy for the overlaying/animating/zooming of every type of meteorological information is underway to take advantage of the new hardware and software facilities. 3-D displays are in prospect.

8. CONCLUSION

Technology changes all the time and this years innovation is soon overtaken and sometimes forgotten but the operational meteorological community cannot afford to be constantly upgrading computer systems and rewriting software. The advent of the computer workstation is providing the opportunity to flexibly scale both hardware and software to what is affordable, while at the same time providing an exciting new medium for the benefit of the users and ultimately the customers.

Technology is defined as 'The application of practical science'. It is an eminently practical task to provide the tools to enable the forecaster to produce an improved service and product. The HORACE workstation system is an ideal platform to deliver this requirement.