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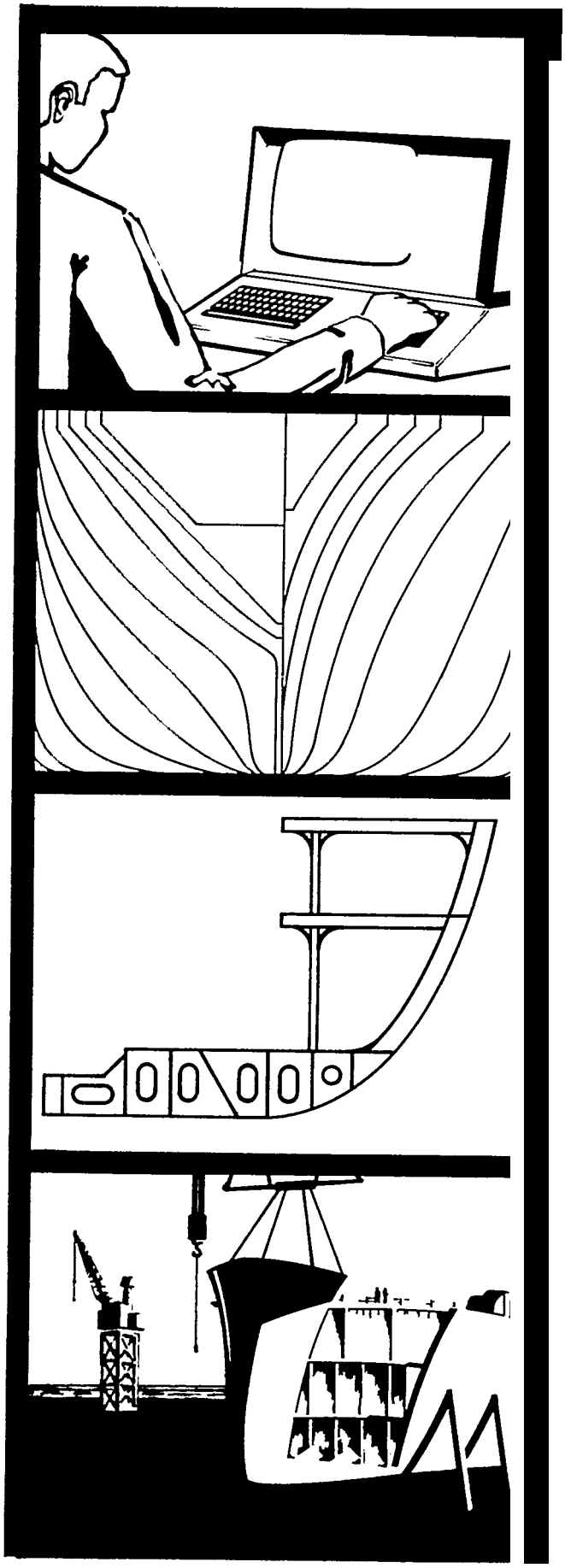

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AUTOKON ON A MINICOMPUTER

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Part I:

On November 12, 1977, Designers & Planners, Galveston office, accepted delivery of a Prime 400, computer. In mid-December the first of the Autokon-. 71 programs was successfully converted to the Prime. The entire conversion was completed by the end of February.

To understand why this took place, we need to look at our previous system, its capabilities and limitations, as well as answer the following questions:

(a) What will satisfy our future needs?

(b) By changing, what did we gain?

A study of our computer system and its possible replacement was undertaken about two years ago. At that time our computer equipment, had the following capabilities:

(a) Two Hewlett-Pacard.2100's .

(1) One was a 24K word machine with two''l.2 megaword disks and drives. This was used primarily to emu-. late a Univac 1004 for communication with our host computer (Univac 1108). Accessing the 1108 and our resident Autokon-71 programs our manuscripts were processed and the output was directed to the line printer and the plot data to the disk file.

(2) The second 2100 was a 12K word machine, which served as a director for our Gerber 1275 drafting system. With a communication interface between the two 2100's the plot data could be drawn on the 1275 tables directly from disk.

(b) Three peripheral devices

(1) 200 lines per minute line printer.

(2) Paper tape reader/punch

(3) 600 CPM card reader

The limitations were:

(a) The HP21OO system was not a multiuser system, making it a very expensive terminal.

(b) Program enhancements to the Autokon systems were limited, due to time sharing cost.

(c) Our system was a batch system, meaning that, after the parts programmer had coded a part, it then had to be key-punched, verified, sent to the host computer for processing, and the results returned to the programmer.

(d) Our in-house programming capabilities were limited to small or slow segmented programs running on a HP-21OO.

(e) We had outgrown the capacity and capabilities of the equipment, therefore a change was needed.

WHAT WOULD SATISFY OUR FUTURE NEEDS?

The state of the art in mini-computers had reached a point of affordability and sophistication which would allow us to process the Autokon programs with time comparable to our present host computer, along with increased versatility. After evaluating several vendors we chose the Prime 400.

WHAT DID WE GAIN?

(a) We have a totally dedicated 24 hour a day computer.

(b) We have multiprogramming capabilities. All of the NC programmers can run their programs concurrently with scientific and hull calculation programs.

(c) Our time-sharing costs have been eliminated.

(d) We can serv as a host computer to our other offices.

(e) Our further program development and existing program implementation is no longer-restricted by a computer cost factor.

(f) We have the benefits of an interactive system over batch. Card input is eliminated along with the hours of turnaround time.

PRESENT SYSTEM, AND OUR USAGE

Our present system configuration:

(a) Prime 400-CPU with 512K Bytes

(b) Magnetic Tape Unit - 9TRK, 800BPI, 45IPS

(c) High Speed Line Printer - 600 LPM

(d) Paper Tape Reader/Punch

(e) 300MB Disk Drive and Controller

(f) Card Reader - 300 CPM

(g) CRT's - 10 units

Each programmer has his own CRT and assigned work area (UFD) on the computer. The UFD is where the programmer will input his part manuscripts. After the manuscripts have been checked for correctness, they are then executed and the results-can either be spooled to the line printer or the CRT. All of this can be accomplished without the programmer having to move from his location. Once the programmer is satisfied with the results, the plot file which has been created is stored in a plot UFD and can be plotted on the Gerber 1275 Drafting System; When a plot file is determined to be correct a paper tape of the file is punched out and verified.

This method of operation permits uicker turnaround not only in manuscript preparation but in the time spent on the computer, and reduces needless punching of paper tape just to check the results.

We have been working with the converted Autokon-71 programs on the Prime 400 since the first of March under actual production. The past three months we have had two N/C lofting contracts being worked completely on the Prime. During this time we have made the following accessment of the system:

(a). Constant computer cost overhead maintained

(b) Turnaround time from initial start of job to completion reduced by 30%-40%

(c) Effectiveness of each programmer has increased significantly with the apparent total computer usage of the interactive system.

(d) Scheduling of computer related junctions is easier

(e) Storage of completed input and Databases can be placed on magnetic tape in lieu of boxes of cards

In general, the transition was smooth with the end results being better than we expected. We feel we have a streamlined efficient computer system, which is easy to use and maintain.

Part II: Description of the System Selection and Conversion Effort

Two years ago, when Designers and Planners began to look for an inhouse computer system to run the Autokon-71 package, a list of requirements was formulated. It included the following primary items:

(a) The ability to allow multiple personnel to simultaneously execute any of the Autokon modules such as ALKON or

FAIR using an interactive CRT rather than a remote card based batch system.

(b) Allow a collection of engineering software, previously run on a Hewlett-Packard 2100, also to be simultaneously executed. This included programs dealing with" various ship's functions such as damaged stability, hydrostatics calculations and propellor/shafting design.

(c) Provide the necessary software for effective interactive processing - namely:

(1)' A flexible and secure filing system.

(2) A quality source editor for the manipulation of programs and data files.

(3) A reasonably-easy to use command language allowing non-computer personnel to effectively converse with the system.

(d) Allow the conversion of the Autokon modules to proceed as smoothly as possible. This necessitates, among other things, a large address space, at least 32 bit integer hardware and FORTRAN as harmonious as possible to Univac's "FOR" compiler.

(e) Do the above with accuracy, speed and minimum cost.

A total of six large minicomputer systems were intensively examined. These included:

(a) Harris 210

(b) Hewlett-Packard 3000 Series II

(c) Interdata 8/32

(d) Modcomp IV

(e) PDP-11/70

(f) and the Prime 400

After a very careful evaluation and study, the Prime 400 minicomputer system was selected. Prime Computer, Inc. is a relatively new company that builds a family of general purpose computers ranging from the single user 100 to the 400 and 500 which are large scale systems designed primarily for multiprogrammed interactive processing. Being based on the MULTICS system developed at MIT, a combination of demand paging and segmentation provides virtual memory with an address space for each user or process of up to 512 million bytes (This is a SYSGEN parameter which, on our system, is set to 2^{21} bytes or slightly in excess of one million 16-bit words per user).

Several other salient aspects of the Prime 400 hardware are:

(a) Dual register sets, a 2000 byte fast access cache memory and interleaved error correcting memory provide basic processor speed.

(b) Stack architecture allowing efficient recursion, a hardware implementation of the Dijkstra “P” and “V” operators and a micro-code implemented prioritized process dispatcher leads to an efficient operating system.

(c) “Rings of Protection” which is a generalization of the usual two state system (Restricted or user mode -vs- non-restricted or OS mode) to a hierarchial n-state system. Code in state “i” has access to code in states greater than “i” but no access (except via the-procedure call) to code in states less than “i". This leads to a secure protection mechanism.

(d) Programs operate in an environment consisting of a stack segment containing all local variables and procedure back-linkages a linkage segment containing statically allocated data and an instruction or procedure segment which, for pure reentrant code, may be shared among concurrent users thus decreasing paging overhead.

These features, combined with good interactive software, especially the tree-structured file system, the FORTRAN compiler and the source editor dictated the selection of the prime system.

Approximately six man-months were required to convert the Autokon-71 package to execute on the Prime system. The changes may be roughly divided into two groups: Those which were essentially cosmetic in nature and reflect known compiler or system differences and those which were significant alterations due to such non-obvious factors as differences in word lengths, I/0 handling and the libraries.

Primary cosmetic changes to the Autokon-71 source included:

(a) Pure Ansi-FORTRAN subscripts were required and DATA statements could not contain embedded implied loops.

(b) Inline code is generated for logical functions “AND”, “OR” and “NOT”.Therefore, all references to-procedures “IAND”, “IOR” and “NOTQ” were changed.

(c) Various constants defined usually in DATA statements were expanded to their full precision (SQRT(2.0) was 0.707 etc.)

(d) The Univac ’octal (“O”) format did not exist on the Prime necessitating the changing of many formats to the “I”

type. These were later changed back after the octal capability was locally added to the formatter to aid the interpretation of AUTOBASE dumps.

(e) Numerous procedures assumed - 36 bit integers. These were changed to reflect the Prime 32 bit hardware.

(f) Various other compiler differences were noted: For example, the FORTRAN statement K=-10**4 results in a different value for K on the Prime than on the Univac.

Primary non-cosmetic changes made to the Autokon-71 package included:

(a) The I/0 procedures were, of course, completely rewritten. These included IORAN, GARBO and GARBI in FAIR, DRAW and LANSKI as well as QREAD, QWRIT and QWAIT in the AUTOBASE package.

(b) Various machine language procedures also were rewritten. These included QGTNT, IBITQ and several others.

(c) Several of the programs which assumed an absolute floating point upper bound greater than that provided by the Prime hardware were modified.

(d) Prime, unlike Univac, requires that the link-editor encounter the largest occurance of a FORTRAN common block first. Therefore, in each of the Autokon-71 programs, all common blocks were defined in the main program which is linked first.

(e) The Prime system software had to be slightly modified to allow floating point overflows, divide checks, etc. The standard action is for a program stop. The FAIR test

acceptance case alone generated overflows on the 36 bit Univac.

(f) On the Prime, data areas are placed differently relative to each other than on the Univac causing subscript errors that previously destroyed inactive data to manifest themselves. In this respect, LANSKI gave the most problems followed' closely by ALKON.

(g) Approximately 7-8 decimal digits of accuracy is available on the Univac (Single Precision) as compared to 6-7 on the Prime (32 -VS- 36 bits). In ALKON, where large numhers are manipulated, a significant number of errors appeared forcing the decision to run various parts of ALKON in double precision. This resulted in little additional overhead in this very I/0 bound program. With the exception of a minor altercation in LANSKI, no other significant problems concerning numerical accuracy have appeared.

(h) In order to generate paper tape results with the Prime system, a utility program was written to punch and verify tape in either the ESSI or in the word address format. Depending on the requirements of the target flame cutting machine, various character sets in even, odd or with no parity setting may be used.

Now that the entire Autokon-71 package is operational and stable, an effort is currently being made to maximize the overall throughput and speed of the system. With this set of programs, the primary emphasis is on reducing I/0 through the following techniques:

(a) In order to reduce paging, the relative placement of the procedures are being altered to reflect the calling patterns. In general, the higher the probability that when a subroutine calls another routine they both are in in the same physical page, the lower the overall paging time will be.

(b) The Prime FORTRAN compiler generates reentrant pure code which, in order to reduce paging, may be shared among different users. That is, rather than having several copies of a large frequently used module such as ALKON simultaneously in memory, it is possible to have only one copy of the pure component concurrently shared.

(c) With close to 2 Mbytes of virtual space available to each user, rather than initiating true I/0 to and from the disc, an attempt is being made to modify the AUTOBASE package in order to bring a significant percentage of the active database into the address space. It is hoped that the paging time will slightly increase while the I/0 time will show a significant decrease.

In summation, the conversion of this relatively large and complex software package from the Univac 1100 to the Prime system went remarkably smoothly considering the differences in compilers, libraries and the hardware.