

Honeywell

**LOS ANGELES
DEVELOPMENT
CENTER**

**LADC 1978
ANNUAL REPORT**

LARGE INFORMATION SYSTEMS DIVISION

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Introduction

This is the second "annual report" covering activities at Honeywell's Los Angeles Development Center, which was created in July, 1976 to provide hardware and software support and development engineering for Xerox computer users. The central effort is, of course, development of CP-6, a large-scale multi-use operating system, and associated processors patterned after the successful CP-V system. Now nearing completion, CP-6 will be released to customers in 1979. Support of Xerox computer users has also required substantial updates of CP-V software and a large effort to design and build Honeywell add-ons to Xerox hardware. Distribution of Xerox software and a documentation function, which employs a staff of writers for CP-6 user documentation as well as a computer center of more than 12 machines to support development and maintenance activities are also centered at LADC.

This report is divided into eighteen sections, each covering a major activity.

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Summary

While 1976 and 1977 were years of architecture and tool building, in 1978 the greater part of the code for the CP-6 system and its language processors was written. During 1979 this code will be tested at both LADC and at the initial customer test sites.

This was also the year that CP-6 came alive, moving from being just barely capable of time-sharing early in the year to the

first efforts at running CP-6 in a "production" environment late in the year. Between these two milestones were a successful demonstration of the system before an audience of 200 at the Toronto meeting of the Users' Group, EXCHANGE, and the first use of the system as a development vehicle by compiler writers at LADC during the summer.

PL-6 continued to prove itself as the development language for CP-6. It now appears that 85-90 percent or more of CP-6 code will be in PL-6, as compared to our earlier estimates of 80 percent. The software factory on CP-V, especially the L66 simulator/debugger, still heavily used, is a second major contributor to the high productivity at LADC.

The Computer Center continued to grow and change in response to project needs. No change is without impact, since each bit of down-time on any of the machines or in maintenance of air conditioning, power, or other support services irrecoverably takes away development or checkout time from the date of first CP-6 shipment.

Staffing continued to be a problem in 1978 reflecting the competitive Los Angeles employment situation. For similar reasons, attrition among LADC programmers ran higher than expected. On the bright side, we were quite successful in hiring experienced graduates from schools having both excellent computer science curricula and CP-V installations. Training costs for these people are low and their productivity very high. Their efforts have significantly enhanced CP-6 success.

A fair fraction of our effort was carried out via subcontracts to outside software vendors. This technique has worked but requires constant and considerable management attention.

In 1978 substantial efforts were also made in hardware and software support of our current customers. Releases of CP-V and of several of the compilers were made as the windup effort on these products. Hardware efforts sustained customer needs with the completion of the magnetic tape program and significant deliveries of memory, disk, and other hardware. New hardware development continued or was initiated in selected areas of customer need. Initial releases of CP-6 conversion aids were made to CP-V customers.

Plans were initiated with home office FED, Manufacturing, Marketing, and responsible field personnel to establish specifics for 1979 installations of CP-6.

While LADC takes great pride in meeting the major milestones of 1978, our shortfall in staffing has left major problems in second release planning and first release testing that must be faced in 1979.

Organization

Early in the year we welcomed a Marketing software support group that took up permanent residence at LADC. Their charter calls for support in special sales situations and assistance to the CP-V C&F team in screening of difficulty reports. They were diverted for the better part of the year to complete the software for the L6-based front-end processor (FEP) for CP-V, for which Marketing had previously contracted. With the release of CP-V F00, support for the FEP was incorporated into the standard product.

In March, we consolidated our organization by combining the Real-Time and Communications and the Commercial Systems Sub-Sections, which brought the responsibility for communications, transaction processing, and data base systems under a single manager. We believe this to be a sensible organization, one which will facilitate our development of a competitive TP offering. At the same time, this reorganization placed the responsibility for all Phoenix subcontracts under a single LADC manager. As 1978 progressed, this aspect of the change seemed to have been a significant factor in bringing these subcontracts on track.

On July 1, the hardware group at LADC was transferred to Phoenix Hardware Engineering under Ron Brookman, a change which aligned the group more closely with other hardware design groups in LISD. Reflecting back at year end, it is not clear that the anticipated benefits expected from this move have been realized.

As the year drew to a close, we prepared for the transfer of the LADC Computer Center to Jack Spease's Phoenix Computer Center (PCC) organization. The center, air conditioning, the changing equipment complement, the communications facilities and the field engineering support, together, represented one of the big problem areas in 1978. We have entered 1979 with an optimistic view that those problems that remain in the LADC Computer Center would be resolved by incorporation into PCC. Jerry McCaughey will be the new manager of our center.

CP-6 Host Operating System Software

The Host Operating System for CP-6 was in the development phase throughout 1978. At each integration stage (when unit tested code is combined), more user services were added to produce a system in July with which the language, commercial and data base processor projects could begin checkout on the Level 66. Availability of this system in July was the first major goal for 1978, defined early in the project as a must in order for LADC to achieve a mid-1979 first customer installation. The second major goal for 1978 was to begin CP-6 in-house production test in November. In fact this date was beaten by one month, with production test beginning on October 2, 1978 for four hours per day. The third major goal for the year was to have code complete by October. This one was missed; the coding completion date has now been delayed to sometime in early second quarter 1979. Other highly visible mileposts for 1978 were as follows:

Work continued from late 1977 into January 1978 to complete the initial phase of the integration of the Level 6 Front-End Processor with the CP-6 Host Operating System. At month end, three time-sharing terminal users ran concurrently using a PCL-like utility test program to build, copy and test files. The first version of the Processor Standards and Conversions specification, was also issued during January. This document that outlines the CP-6 Data Control Block usage, Common Command Language usage, Computer Conventions and Compiler Options for all of CP-6.

Shortly after the H-level integration in early February, the first phase of XDELTA, the executive debugger, became available. This greatly enhanced the debugging facilities for the operating system programmers. Boot time initialization of MPC firmware was included for the first time. The CP-V based software factory L66 Simulator/Debugger was modified to support hexadecimal floating-point format in anticipation of corresponding Level 66 hardware modifications.

The system table builder and initializer (TIGR) was available by the beginning of the second quarter. This boot time process replaces the complex SYSGEN process of CP-V. The new I/O system for CP-6 completed checkout in April, and the test and diagnostic interface specification for work to proceed on the on-line diagnostic package for CP-6 was agreed to with Phoenix Maintainability Engineering.

In May the first draft version of the Host Operating System test plan was produced, the first working version of which was distributed to the programming staff in September. This test

plan defines the types and classes of tests to be produced, the standards and techniques to be followed, and documentation to be produced. A set of test tools was defined for test case library maintenance and test execution.

The I-system integration occurred in early May. This system had sufficient user-visible capability to be used in a demonstration at the Toronto meeting of the Xerox Users' Group EXCHANGE on May 24, three months earlier than planned.

The K-level of system integration brought together enough of the CP-6 user interface to begin live checkout of compilers and other software processors on CP-6. The first version of "User Stuff," an internal user's and operator's guide for CP-6, was issued. The K system was used by the Phoenix Maintainability Engineering people to begin testing the test and diagnostic interface.

By mid-year it became clear that the code completion date of October could not be achieved. The operations and system manager functions of the system were only in the most rudimentary form; much effort would be required to have them completed by the end of the first quarter 1979. System resource management also required significant effort beyond the end of 1978.

The LINKer and the user version of the debugger, DELTA, became available in September. This version of CP-6 (M-level) was judged to have sufficient capability and stability to begin production test on October 2, 1978, one month earlier than planned. Phoenix Maintainability Engineering carried an M-level CP-6 system to Phoenix at the beginning of October. After several hardware and configuration problems were solved, CP-6 testing in Phoenix made good progress. A prototype hexadecimal floating point hardware unit was installed in one LADC L66 system in November.

By the end of 1978, the CP-6 Host Operating System had reached a source line count of over 233,000 lines, 93 percent of which are PL-6, with the remainder in assembly language. In addition, more than 75,000 source lines have been written for development and test tools. We continue to be enthusiastic about PL-6; it is widely applicable and contributes to rapid checkout.

1978 was a tough year in that five well trained and capable systems programmers resigned. The added difficulties in attracting well qualified applicants to Los Angeles led to operating under headcount for the entire year, and the year ended three programmers below budget in the Host Operating System area.

A major impact on the productivity of the entire CP-6 project throughout the year has been poor availability of the CP-V systems in the computer center, caused by air conditioning outages, hardware failures, overload on the production systems, F00 release CP-V software testing, fewer operations personnel than needed, and more change in the computer center than could be properly managed.

CP-6 Communications Software

Like 1977, 1978 was a very busy and productive year for the Real-Time and Communications (RT&C) organization. The year was spent entirely on the Release 1 FEP for CP-6. Major accomplishments that occurred through the seven integrations in 1978 include:

- o Completion of most of the asynchronous terminal handler.
- o Completion of L6 XDELTA, the executive debugger.
- o Completion of HASP Remote Batch Terminal support.
- o Completion of L6ANLZ, the on-line L6 debugger,
- o Completion of most FEP resident support processes.

One of the most impressive aspects of 1978 was the productivity rate of the RT&C programming staff. Not only was a great deal of code written, but checkout time was minimal and regression errors few. At the end of 1978, there was a total of 56,000 lines of code in the FEP, 35,000 lines of code in the software factory for the FEP, and 5000 lines of code by RT&C programmers in Host-resident FEP interface programs. That amounts to 96,000 total lines of code in by the RT&C group. Half of that amount was done in 1978 at a rate of almost 1000 lines of code per person per integration (approximately every six weeks). This is a testimonial both to the level of competence of the staff and to the FEP Software Factory. Without the right tools, the job would have been impossible on the current schedule. The current software factory, residing on CP-V, consists of a high level implementation language, SIL6; a linker; a simulator; an L6-resident DELTA-like debugger; an L66-resident FEP DELTA-like debugger; a processor for creating bootable tapes; a dump analysis program; and various utilities.

Especially careful coordination was required in the development of Communication software in parallel with Host software development. They are closely linked because both host and front-end are part of an architectural whole and thus lock-step

development must occur for CP-6 system success. It was achieved in 1978.

CP-6 Language Processors

The year 1978 was marked by significant accomplishment in the Language Processor area. Coding was completed on both the APL and BASIC processors, with substantial checkout performed using the L66 Simulator. A significant milestone was reached in July when a small kernel of the BASIC compiler became operational on CP-6. This represented the first LADC compiler that successfully executed on the L66. The FORTRAN-77 and TEXT projects are making good progress, and a substantial amount of code has been written, although neither has reached the code-completion stage as of year-end. However, progress continued by debugging on the L66 Simulator and on CP-6 itself.

The APL project was the first to reach code-completion stage. To date, all checkout has been performed on the L66 Simulator, which has been more productive than checkout on the evolving CP-6 system due to the stability of the Simulator. The modular design of the APL interpreter lent itself to this approach. Final system checkout, however, will be performed on CP-6 beginning in February, 1979.

The BASIC project differed from the others in that an extremely detailed design document (2000 pages) was produced prior to the start of coding. The effectiveness of this approach was proven when 10,000 lines of code (excluding comments) were produced during the first month of coding by the three-person team. This effort was further rewarded when one member of the team left the company and the new-hire replacement was able to quickly come up to speed, virtually without missing a step. Checkout has proceeded rapidly, and a substantial portion of the compiler is now operational on CP-6.

The FORTRAN project is now making excellent progress. After a long period of recruiting difficulties, we resorted to hiring three contractors to work on-site with us through project completion. At year-end we have completed coding of 72 percent of the compiler. The Front-End is nearly complete, which has enabled us to demonstrate the syntax- and semantics-checking capability of the compiler. During 1978 a Level 66 code generator was produced for CP-V FORTRAN. This effort was the key to the successful transport of the PL-6 compiler to CP-6 in November. A substantial part of this effort will be carried forward to the CP-6 FORTRAN code generator.

The TEXT project is also making excellent progress. The Multics COMPOSE processor is being adapted for CP-6 TEXT, since its capabilities are superior to those of CP-V TEXT. The COMPOSE modules, written in PL/I, have been modified to interface to CP-6. At year-end, checkout of these modules is proceeding at the more rapid pace with the availability of major portions of the PL/I compiler on CP-6.

During 1978, the PL-6 compiler matured considerably in terms of stability and performance. Three performance-improvement releases were completed, each one generating more efficient object code than the previous version. The first version of PL-6 developed in 1977 was produced without attention to object code efficiency, since its early availability was much more critical in enabling our programmers to compile their programs. The current version of PL-6 generates object programs that are 50 percent smaller than those produced by the 1977 compiler, with corresponding improvement in execution speed. Each release of PL-6 has been of remarkably high quality. The stability of PL-6 during the last year and a half has been a key factor in the excellent progress of the entire CP-6 project.

CP-6 Commercial Software

Commercial Systems is designing and developing RPGII, IDP and Transaction Processing. It is also responsible for the LADC adaptation of I-D-S/II to CP-6 and for integrating the Phoenix Software Engineering products, GMAP6 Assembler, COBOL 74, Sort/Merge, and PL/I.

CP-6 SORT/MERGE is being provided by Phoenix Software Engineering with tests and test drivers produced at LADC. This project is somewhat behind the original schedule due to problems of distance, turn-around delays, interruptions attributable to remote-site operations, and to some extent the instability of the early CP-6 system integrations. By year-end, however, the MERGE coding was complete, as was all of the SORT coding except for tape collation. The SORT/MERGE Reference Manual has been reviewed and updated. Newly assigned personnel have successfully run test cases against MERGE in stand-alone and LINK mode.

PL/I for CP-6 is used only to support PL/I code contained in the COBOL, IDS/II and TEXT products. During 1978, the developers used the software factory, under CP-V, to adapt PL/I to the CP-6 environment. They successfully built and tested a run-time library and a cross-compiler and used the latter to produce a CP-6-resident compiler. Towards the end of 1978, the PL/I-resident compiler succeeded in compiling several test programs that were linked and successfully executed on CP-6.

While additional effort remains, this was a major step, necessary for establishing COBOL, IDS/II, and TEXT as resident processors on CP-6.

The COBOL-74 project involves rehosting the current GCOS product. The first stage, COBOL-74 as a cross-compiler under GCOS, has successfully compiled several COBOL programs and produced object units for execution on CP-6. Agreement was reached early in the year to defer support of a sharable compiler and hexadecimal floating point until second release. During the year, LA and Phoenix management changes related to this project had a positive impact on schedule stability. By the end of 1978, a Navy Audit-Test Program successfully moved through these steps and executed under CP-6. Much work remains, but good progress appears to be on-going.

The CP-V to CP-6 COBOL Conversion Program was completed in 1978. The additional need for converting data base management calls into direct COBOL-74 language statements was identified. This had been overlooked in the initial COBOL conversion contracting, but late in 1978 the work scope was defined and a contract let for the work.

Phoenix Software Engineering programmers first produced modifications to the GMAP assembler to interface it to CP-6 as a cross-assembler in the second quarter of 1978. These object units have been successfully converted to CP-6 form by a utility called TOAD, linked and run on CP-6. Phoenix Software Engineering has also provided the modules to make GMAP6 a resident processor on CP-6. With the aid of some LADC macros, which define CP-6 for this assembler, GMAP6 was installed as a CP-6-resident processor in December.

IDP was the CP-V interactive data base query processor and report generator. The CP-6 version is being expanded to include CP-V MANAGE functionality, i.e., the query of sequential data files and report formatting. It has been defined by LADC in an EPS-1, and its design has been documented in an EPS-2. Coding is in progress and approximately 50 percent complete.

Work on MANAGE Conversion tools has been progressing on schedule. The design for the MANAGE Source Conversion program has been written and submitted for design review. The MANAGE Dictionary conversion program has been coded and is in test.

I-D-S/II for CP-6 is being produced by LADC from the DB4.0 release of the standard GCOS offering. The data base control system is being tested in the Alternate Shared Library (a separate and unique virtual memory segment) with all new system

interfaces, new buffer management, and run time subschema loading. NSA security keeps a user isolated from the data base control system, buffers, and context. CP-6 security keeps the user from referencing any I-D-S/II data base without using the protection mechanisms built into the data base control system. The subschema translator has been tested on CP-6 using the GCOS PL/I cross-compiler for CP-6 and the CP-6 PL/I run time library with new PL-6 system-dependent routines. The subschema translator represents 20 percent of the translator PL/I modules. Recoding of the basic utility package in PL-6 has begun. The I-D-S/II development represents a CP-6 project that improves upon the equivalent Xerox EDMS product offering and has some improvements over the GCOS version. EDMS data base reorganization and EDMS to I-D-S/II data base conversion is 50 percent completed under a contract with Carleton University. The I-D-S/II project continues to be one of the most difficult and complex of the rehosting efforts.

LADC completed system test for the RPG-II compiler developed by Toshiba and designed to run under GCOS. During 1978 this product was delivered for release as an RPQ under GCOS after testing at LADC. The compiler, currently being used on version 4J, is scheduled to be released under GCOS 4JS in early January 1979.

In retrospect, 1978 was a difficult and busy year. We were successful in attracting a number of new college graduates who have been doing an excellent job. We were still not able to get to our staffing goal and had to reassign people to high priority projects to keep the schedules in balance. A great deal of progress was made with the Phoenix language projects for CP-6 as a result of new management, which has succeeded in putting these projects back on track. As a result, we have worked well together and a mutual appreciation and respect has developed, producing a positive and productive working relationship.

CP-6 Conversion

First deliveries were made during 1978 in accordance with CP-6's extensive plan for conversion aids for users. In May the CP-6 Conversion Guide was issued to all interested customers and Honeywell personnel. This document, which contains descriptions of the differences between CP-V and CP-6 products and how-to-use-it information on the conversion programs, was updated once in 1978 and now contains sixteen documents.

In November the CP-V-based software factory for CP-6 was released to users protected by a proprietary software license. It contains PL-6, the LINKer, and a simulator/debugger for L66 to enable an early start on conversion efforts by users. Also

released in November was the first conversion aid program, LMMON, which provides a record of execution times for all modules executed at an installation.

CP-6 Testing

In July, the LADC Test Group was moved into the RT&C group in order to provide a closer association between developers and testers. The LADC Test Group is responsible for performance and configuration testing and stability testing, as well as the external load generator used for simulating CP-6 time-sharing users.

The second half of 1978 was spent getting the various hardware and software tools in place, with the majority of testing scheduled to begin in early 1979. The preparation work involves not only test definitions but also establishment of the physical links within the LADC computer center to support both asynchronous and synchronous loads to be applied to CP-6.

A draft version of a detailed test plan for CP-6 was produced in the fourth quarter and issued to a limited internal distribution.

CP-6 Documentation

During 1978, 13 people (including technical writers and document production personnel) were added to the staff to provide the capability to write and produce the large set of user manuals required for the CP-6 software system. Initial output from the group included update packages to ten CP-V manuals to reflect the F00 and ANS FORTRAN software releases, the CP-6 Concepts and Facilities Manual, and five draft versions of CP-6 Language Reference Manuals. Work on the CP-6 Operating System Reference Manuals is well under way, with a target for release of an initial set of manuals to support the initial test sites and a full set of manuals to support the general release in late 1979.

CP-V Software Sustaining

Support for COBOL, RPG, SORT, transaction processing, data base management, and query processors was aimed at stabilizing the error backlog for these products. Manpower for maintenance and support was budgeted at one person per month. During 1978 a maintenance release was made for CP-V COBOL. A significant effort was expended in field support of customers experiencing difficulties in transaction processing.

All 16-bit RBM support has been turned over to Field Engineering Large System Product Support. CP-R maintenance is still

performed at LADC, although minimal manpower is being expended due to the CP-6 priority.

Maintenance releases of APL (Version D05) and Extended FORTRAN IV (Version F02) were completed during the year. Considerable effort was expended in stabilizing the CP-V ANS FORTRAN compiler, which culminated in the B08 release in October. This release closed 145 SIDR's since the B07 release and has been installed at about 15 customer sites where it is working productively.

Early 1978 was a period of high activity with the installation of many CP-V E01 systems. Over this period of time Field Engineering commented that this release was one of the best CP-V releases ever. The final (according to current plan) release of CP-V (F00) was completed in October. This release included support for MPC 600 series tape drives, large memory and dual CPU Sigma 6/7s, logging of single-bit MOS memory errors, magnetic tape error recovery improvements, Edit and PCL enhancements, Sigma 5 speed-ups, and SPILL/FILL; over 400 SIDRs were closed with code in this release. With the turnover of CP-V F00 to the Software Library in September 1978, another step in the phase-down of CP-V support by LADC was achieved. The backlog of difficulty and improvement SIDRs was reviewed and many were closed "not to be fixed". Also, according to the phase-down policy, incoming SIDRs are reviewed immediately with critical ones being closed promptly and the remainder closed by explanation or deferral to CP-6. Plans are to turn over screening responsibility for SIDRs to Marketing and Field Engineering in early 1979.

CP-6 Hardware

CP-6 requires a random access memory that allows expansion to 16 million words and provides memory content retention in the event of input power failure. In March, 1978 a 4-million-word memory of M128 16 pin - 16K bits per chip was installed at LADC in standard Level 66 cabinets. In October, 1978, two 4-million-word systems were brought up on the two LADC Level 66 systems. These 4-million-word memory systems were installed in free-standing double-bay memory cabinets with two System Control Units and associated power systems including battery backup and have been performing satisfactorily since then.

New unit record MPC firmware was defined for implementation for the CP-6 project. The need for this unique firmware relates to size and performance of the CP-6 Host Operating System code. After overcoming resource limitations in the Controller Design unit in Hardware Engineering, good progress was made on this project in the second half of 1978. With excellent cooperation

on both sides, the initial version of new printer firmware is expected in mid-January, 1979 and the total package should be completed by the end of the first quarter 1979. This firmware will be released on the standard L66 firmware tape.

CP-6 requires hexadecimal floating point hardware in order to be competitive and ease conversion problems from CP-V. Currently, the Level 66 hardware provides binary exponents which give floating point numbers ranging up to $10 + 38$. The new hexadecimal range is $10 + 138$. Once under way, this project progressed very smoothly in Hardware Engineering with hardware installed at LADC in October 1978, ahead of the committed schedule. Only two problems were encountered, and these were fixed very quickly.

NSA virtual memory and security options have been installed on LADC L66 machines throughout 1978. Our experience has been generally good; several problems have been identified and fixed with the help of Phoenix Engineering. Several remaining critical hardware problems require resolution by Phoenix Engineering prior to first customer ship in June, 1979. However, this could be a potential problem area for the project in 1979.

CP-V Hardware Development

During 1978 the Xerox Product Line (XPL) group at LADC successfully introduced several important products and made the transition to factory production for several other products which had been introduced late in 1977. During 1978 XPL concentrated its development resources on Sigma MOS Memory, Sigma 6/7 Extended Addressing and Dual Processing, and MPC Tape Subsystem. In addition, the group initiated development of Sigma 4MW MOS Memory for Comshare and Sigma Console Substitution.

Other activities during the year included MPC Disk Subsystem throughput enhancement, support of Sigma 9 New-Build for Comshare, Diagnostic Programming System Library Releases, and Continuation and Fix (C&F) for the Xerox Sigma and 500 Series Computer Product Lines.

In December 1977 the first Sigma MOS Memory was installed at Xerox in Rochester. The memory unit was tested and shipped to the customer from LADC. Despite the fact that it contained many boards of a development level quality, the 256KW memory unit has functioned trouble-free (making it difficult to convince the customer to upgrade to production level quality), all during 1978. Two additional memory units were tested at LADC: one has been installed on the LADC Computer Center dual Sigma 7 configuration, while the other has been retained for C&F activity.

During the early part of 1978 the coordinated efforts of XPL and Advanced Product Manufacturing (APM) enabled the introduction of the Sigma MOS Memory to the factory with a minimum of difficulty and permitted volume shipments during the balance of 1978. Until development and release of the board test vectors were completed, LADC supported factory board testing. Although logistically very complicated, the successful board testing effort at LADC enabled the factory to sustain early shipment schedules. The Sigma MOS Memory made the transition from APM to full factory production status during the second quarter of 1978. By December 1978 approximately 36 memory units with an installed value exceeding \$6.0M were delivered (equally between Sigma 9 and Sigma 6 systems). A substantial order backlog exists as we enter 1979. Customer acceptance of the Sigma MOS Memory has been extremely good. Aside from providing substantially more memory and performance to the users, reliability has been extremely good.

The MOS Memory diagnostic completed test and was released during the first quarter of 1978. CP-V developed and tested the MOS Memory error logging routine and included it on the F00 release in the 3Q78. An interim error logging routine, MERCI, developed by FED Large Systems Software Support, was utilized by CP-V E01.

During the first quarter extensive hardware/software development testing occurred on the Sigma 6/7 Extended Addressing enhancement and on the Sigma 6/7 Dual Processor in the LADC Data Center. The dual Sigma 7 configuration entered into a production mode during March with predicted performance improvements. A new Sigma memory map diagnostic was developed, tested and released during the second quarter of 1978. Hardware changes to the Sigma 6/7 CPU, MIOP and SIOP were documented and released. Through the efforts of Product Support with LADC-XPL assistance, the first field installation was successfully completed in June, 1978. By establishing field installation teams, a very complex system modification has been installed in the field with minimum perturbation to the customer's operation. Approximately 15 Sigma 6/7 systems have been modified (usually in less time than a long weekend), including installation of Sigma MOS Memory, other system upgrades, and the software operating system.

The third quarter of 1978 saw the first installation of the Xerox MPC Tape Subsystem. Through the XPL-developed MPC Adapter, the facility to attach Honeywell Tape MPC's and the ATS tape drives to Sigma and 500 Series systems was established. Originally planned for the first quarter of 1978, the program was deferred due to the availability of the new ATS drives, and a change of scope which added the requirement of being able to boot CP-V from the MPC Tape Subsystem. Although the MPC Tape Subsystem utilizes the same MPC Adapter boards developed for the MPC Disk Subsystem,

a new backpanel design was required to incorporate it. A new magnetic tape subsystem diagnostic, which incorporates Honeywell ITR's and MDR's as well as a variety of functional exercisers and utilities, was designed, tested and released. An extensive test program was carried out to insure tape compatibility among the ATS drives and the several varieties of Xerox drives. Extensive CP-V tape I/O handlers' changes were developed, tested, and subjected to a full production environment. The changes are included in CP-V F00, released the third quarter of 1978. By the end of 1978, approximately 10 magnetic tape subsystems were shipped from the factory. Installation has gone smoothly, no field problems have occurred, and customer acceptance is very high.

In September Honeywell and Comshare signed a contract which calls for Honeywell to new-build 24 Sigma 9 CPU's and 5 Sigma 4MW MOS Memory Units with deliveries committed beginning in the third quarter of 1979 and extending through 1981. The contract value exceeds \$14M with options for Comshare to purchase additional CPU's and memories.

The new-build Sigma 9 CPU's, manufactured in Phoenix, and will utilize the original Xerox Technology. XPL's participation in the Sigma 9 new-build consists of technical program management providing the factory with engineering support and direction, selection of alternate components, document coordination and system verification. The existing Sigma 9 power subsystem will be replaced in the first quarter of 1980 with a Honeywell-designed equivalent by Phoenix Power Supply Engineering with direction from XPL.

A design project was started in September 1978 at LADC to develop a 4MW MOS Memory for the Comshare contract. It is based on the Sigma MOS Memory but includes substantial redesign of memory control boards, backpanels, and the use of the M128 MOS Storage Board. Logic design has been completed and a pilot unit has been delivered to LADC, with tests planned in January 1979. Modification of the Memory Diagnostic is required, but no requirement exists for software as Comshare will provide their own operating system, Commander II. However, as part of an overall test strategy by LADC it is planned to test the 4MW MOS Memory and new-build Sigma 9 configuration using CP-V to test 512KW of memory using the standard CP-V Exercisers. In addition a modified CP-V System, which will have recovery and any other necessary modules patched, will be sysgened for as much memory as CP-V design limits allow (indications are that 4MW are possible, although 2MW may be the limit).

During the fourth quarter of 1978, a project was initiated at XPL-LADC to provide a console substitution for Sigma systems that will permit the present hardwired teletype KSR device to be replaced with a HIS or DIABLO HYTYPE device. The design effort consists of modifying the present Xerox 7012 KSR controller by adding several newly designed Sigma T-series type modules. The change will be field-installable and preserves compatibility with the present KSR. Delivery is planned during the second quarter of 1979.

During the first quarter of 1978, a design change was introduced into the MPC Adapter-Disk that removed the requirement for a dedicated Sigma 9 MIOP for an unbuffered MPC Disk Subsystem operation. The design enhancement was made in order to permit Marketing greater latitude in managing the limited supply of Sigma 9 MIOP's.

A major release of the Diagnostic Programming System Library, DPSL-B00, occurred during the second quarter of 1978. This release incorporated the MPC Disk Diagnostic, including provisions for on-line VOLINIT as well as the MOS Memory Diagnostic. At the end of 4Q78 a DPSL-B01 prerelease occurred. This version incorporates the MPC magnetic tape diagnostic, the new Sigma map diagnostic, facility for DPSL Boot from the MPC Tape, as well as several improvements to existing diagnostics.

Throughout the year XPL provided C & F support to the XPL. This activity, which frequently goes unnoticed, provided timely solutions to many problems encountered in the field as well as in the factory. In order to continue our support during 1979 it has been agreed to renew our present agreement with Xerox to continue engineering service support for design automation. An especially large activity occurred in association with MOS Memory installation at Motorola and BSCTE in Chicago. Not only was a large field installation required, but a special Sigma 9 system was configured at LADC for 2 months to identify and fix several elusive hardware and software timing problems.

The success of LADC-XPL during 1978 has been greatly attributed to the excellent support and cooperation of many LISD (Phoenix) organizations, including is in order to the Xerox Program Office, Technology Engineering, Power Supply Engineering, Mechanical Design, Design and Documentation, Drafting, EDA, PAE, APM, and Manufacturing Product Support.

Computer Center

1978 was a year of extensive growth and change in the LADC Computer Center, as we built the Xerox and Honeywell Systems, the

communications equipment, the Computer Center Facilities, and the Operations and Field Engineering staff.

Early in the year we expanded the Sigma 7 system to a dual processor, 256K MOS memory configuration, with an MPC disk subsystem. This system was put into 24-hour service for production exposure of the new hardware elements, while providing computing resources for the CP-6 Software Factory and for development and testing of the new MPC/Tape hardware and the CP-V F00 software release. The 560 system was expanded again, first with an MPC/Tape subsystem, then with additional LCMM memory modules to provide the required CP-6 Software Factory capacity. The Sigma 9 system went through a sequence of configuration increases to support a wide variety of development and field support requirements, including Level 6 FECP exposure. The Sigma 9 which had been on loan from Xerox was returned in December. The 530 system was also expanded to fill a role as on-line remote output station for the Software Factory systems.

The configurations of our two Level 66 systems grew to the size required for CP-6 testing. System A is now operating with dual processors in NSA mode, with the hexadecimal floating point option, with an 8-million-word MOS memory, with dual IOM's, dual disk controllers, and a full complement of the new magnetic tape units. We are now installing the third Level 66 system to provide the additional computing resources required for final Release 1 development and system testing and for the start-up of Release 2 work.

During 1978 three Level 6 systems were added to the Computer Center, and the initial two systems were upgraded. There are now five model 43 systems, each with a necessary set of peripheral equipment and communications options. Four of these are operating on-line with the Level 66 systems using the special L6-L66 coupler units.

Our Communications Facilities have increased substantially during 1978, as we added terminals, leased lines, and dial-in lines for access to the Computer Center, patch panel capacity, and associated internal data lines for access to the various computer systems. The transition from dial-up to leased hardwire lines for terminal access to the Computer Center was completed early in the year. With the continually increasing usage experienced throughout 1978, the projected one-year cost saving was \$200K. The system now has about 1000 asynchronous low-speed lines and is still growing to provide the many access paths for development work as well as system testing. We are now installing the modems, lines, and switching capability for more extensive testing of the synchronous communications capability of CP-6.

In 1978 we completed a large number of projects to improve and expand the Computer Center facilities to support the hardware and communications growth described above. The most significant improvements were the increase in air conditioning capacity and the addition of standby air conditioning equipment. With these facilities projects out of the way, we anticipate fewer interferences with CP-6 development work in 1979.

The Computer Center Support Staff also increased during 1978, with five additions to operations and six to Field Engineering. A series of changes at year-end transferred computer operating responsibility to the Phoenix Computer Center organization and designated LADC as a separate Field Engineering district. These moves should result in improved CP-6 support in 1979.

LADC Interfaces

As a necessary part of the CP-6 development task, LADC must coordinate its activities internally with many other areas in Honeywell (especially within LISD) and must also interface externally with current and future customers. A Step II IPR review was held in May 1978 prior to price announcements for the first CP-6 models, and dialogs continued throughout the year with manufacturing people concerned with test of CP-6 hardware, with education people concerned with CP-6 course development, with FED people concerned with CP-6 maintenance strategies, and with marketing people concerned with CP-6 release content and sales. In addition, LADC people made a number of presentations to potential CP-6 customers in support of field sales.

For customers, LADC also provided a 4-hour presentation and CP-6 demonstration at the Toronto EXCHANGE meeting in May. During 1978 four meetings were held with the CP-6 Technical Committee of EXCHANGE, at which many of the CP-6 plans were reviewed and presented for critique. Especially important were the reviews of conversion aid plans.

Manpower

The LADC population on January 1, 1978 was 118 permanent, full-time employees (including 8 hardware engineers), with eight additional contract personnel. Recruitment efforts were active in 1978, and as a result of college, newspaper and technical journal, agency, and employee-referral recruiting programs, our 1978 year-end headcount was 147, including 15 contract personnel. This total excludes Hardware Engineering which transferred to Design Engineering in June. As in the past, colleges and universities with a Computer Science curriculum and a CP-V computer system were our best source of new people.

In spite of the growth in 1978, we fell short of our forecasted manpower goal. Our attrition rate was 18 percent in 1978. While some of the attrition was forced, LADC felt the pressures of the very aggressive recruiting marketplace for systems programmers in Los Angeles, where average attrition rates are much higher than we experienced. Budget revisions, restraints on personnel requisitions, and approval authority revisions that resulted in a slower than expected offer approval cycle were other factors that caused us to miss our staffing target.

A major recruiting effort is planned for the first half of 1979.

Facilities

In March of 1978, LADC leased an additional 9800 square feet of office space, which improved the work environment for everyone. The enlarged facility provides office space for the documentation group, software control group, hardware development and support staff, field engineering, and a large conference room.

During the last quarter of 1978, negotiations were begun for a long-term lease (January 1, 1979 through August 31, 1983) for the second floor office area and computer center facility at LADC. We will probably complete lease negotiations by late January of 1979.

Financial Report

LADC spending in 1978 was \$5.8M gross (\$5.7 net), which compares to a 1978 plan of \$6.6M and \$6.5M, respectively. The major variances were \$0.6M in compensation and benefits (due to an underrun in staffing), \$0.2M in subcontracts (underruns in ANS FORTRAN staffing, EDMS Conversion - only one phase of a two-phase project completed, and CP-6 documentation).

Conclusion

1978 has been a year of detailed design, implementation and test. Many of the architectural concepts were finally put in place early in the year and the overall system design was completed.

In May, 1978 at the EXCHANGE Users' Group Meeting in Toronto, CP-6 was demonstrated and was officially announced and priced as a product to which the Honeywell Corporation was externally committed. We in LADC then recognized that our commitment became more binding, and our ability to alter external manifestations of this system virtually disappeared.

June 1979, the target ship date for the first customer test systems, has been imprinted in everyone's mind. Focus and attention to this goal has been an overriding consideration in all LADC activities.

During the year many diversions came our way that could easily have changed our focus and taken us off track. Convergence was one such issue. We do not believe the issue of convergence should be dismissed casually since it touches on many critical points that need to be fully assessed. We do believe, however, that it is necessary to minimize the impact of such activities on our short-term commitments, particularly now that these commitments have been announced externally. For a while in the first half of 1978 it appeared as if the distractions arising from these issues would have a serious impact on our schedule commitments. This fortunately no longer is the case.

During 1978 as our organization grew we continued the emphasis on youth, bringing on board many young professionals from the CP-V user community and others with one to two years' experience. Working along with our senior people, bringing with them tremendous enthusiasm and eagerness to learn, an energy capacity that seemed endless, and an appetite for work that seemed insatiable, these young people have made a major positive impact on the CP-6 project.

As 1978 drew to a close, we would have to conclude that subcontracting within the organization can work, as our Phoenix language processors subcontractors did come on track during the year. There is still much yet to be worked out in terms of long-range support, the maintenance of these products, and keeping them in step with one another, but it does appear that some synergy has come from this. One lesson to be learned, however, is that we must be careful in overestimating the benefits which may accrue through rehosting efforts. Our operating system environments are very different. These differences and the orientation of the people at each development site have been the source of many problems which require detailed and constant attention and commitment by management on both sides (thus the expenditure of additional resources) to achieve success.

The impact of not meeting our staffing goals for the year not only had an impact on our ability to complete Release 1 on schedule with the exhaustive testing originally planned, but has also caused a delay in starting Release 2. The original plan called for some Release 2 planning activities to begin in the last quarter of 1978, and this did not take place.

Our Computer Center represented the source of lost productivity several times during the course of the year. As new equipment arrived, equipment was swapped, reconfigurations, communications changes, and facilities changes occurred (air conditioning in particular). This resulted in low equipment uptime and frequent unplanned interruptions. These problems were exacerbated by an understaffed FED support team at the start of the year and the overhead in time of having the new engineers hired and trained. The dedication and long hours of the senior FED staff members were clearly the significant factors in providing LADC as much productive time as was obtained.

Level 6's within the Computer Center have been the source of many problems due to sparing, configuration control, and lack of in-depth FED expertise. These experiences with L6 have proved the need for some special treatment for in-house development organizations that are depending on Level 6 hardware and are sensitive to the need to incorporate the latest engineering changes. An uptime of 99 percent or greater is required both for the CP-6 development machines and also for the CP-6 systems used by customers. As 1978 came to a close we had called M&TO's attention to these L6 problems; they now seem to be receiving the proper level of attention.

We take pride in the success of 1978 in meeting our major coding milestones which culminated in a ready-for-demo system, but temper that pride with the knowledge that not all schedules were met (most importantly in planning for Releases 2 and 3, but also in significant areas of coding and testing). In 1978 we learned a great deal about the process of successfully bringing the work of others in to the CP-6 product; different organizations in Honeywell can successfully work together but there must be, we have found, a significant management coordination effort. Young computer scientists recruited from CP-V schools strengthened LADC greatly during 1978; unfortunately we were unable to attract them in sufficient numbers to meet our staffing goals. The decision to code CP-6 in the high-level language PL-6 continued to prove its merit, as did our substantial efforts in software factory tools and symbolic debuggers for CP-6. Additional tools for performance and functional regression testing will, we are sure, prove their worth in 1979. The year 1979 will hold even more challenges than did 1978 as we complete the testing and installation of CP-6 at the several initial customer sites. In 1979, it will be imperative that we keep the "focus" we had in 1978. A well defined set of product requirements aimed at a specific market and a highly visible schedule have provided this clear focus and been pervasive in all our activities. We know we can expect high productivity, in this kind of environment. We need that, to succeed!

