HONEYWELL

Large Information Systems Division

Los Angeles Development Center

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LADC 1977 Annual Report

Introduction

1977 was the first full year in Honeywell for the Los Angeles Development Center, which was formed in July of 1976 to develop migration products for Xerox computer users. While LADC is a part of the Software Engineering organization in LISD, it is also somewhat of an anomaly: it not only serves the software needs of the Xerox base, but also includes some compiler development for use in GCOS, Hardware Engineering and miscellaneous software services, together with software distribution, computer center operations, and field support. Like the Cambridge Laboratory, it is remote and in many ways self-sufficient.

The migration products being built at LADC were originally presented in the Xerox Business Plan (Project Phoenix/Xerox Liberator) in the spring of 1976, which was updated in September 1976. A revision to the business plan is at this writing being prepared for release in the first quarter of 1978. Nevertheless, the general direction presented to management early in 1976 remains the same; the major thrust of migration is still the development of the CP-6 operating system, a systems software conversion effort of a scope and magnitude never before undertaken in our industry.

Because of the unique nature of our project, organization and orientation, we have chosen to present a formal review of 1977 for interested parties within HIS The body of this report comprises a Summary section at the beginning which reviews the entire year at a macro-level, followed by more detailed reports of the areas listed below:

- Project Management
- Software Factory
- PL-6, The System Implementation Language
- CP-6, Host Operating System
- Real Time and Communications
- Language Processors
- Commercial Software Systems
- The LADC Computer Center
- Current Products Software Support
- Hardware Engineering
- Manpower
- Facilities
- Financial Report

Summary

This past year has been filled with many successes and relatively few disappointments. CP-6 successfully made the transition from the architecture to the design phase; sub-contracts to Phoenix and Billerica for various elements were agreed upon, and work commenced in virtually all these areas.

A basic set of programming and documentation standards and procedures was established early in 1977. A Design Review Board, chaired by one member of the senior staff, was created to review all designs produced by LADC. (Needless to say, 1977 was a very busy year for the board.)

In late 1976 it was decided to use our existing Xerox equipment and CP-V operating system for the CP-6 software factory. The first version of the implementation language (PL-6), the principal tool in the CP-6 software factory, was running on CP-V by mid-year, generating CP-6/L66 object units. The host software factory was enhanced with a L66 assembler, linker, debugger, L66 simulator, and a transportation program to bootstrap programs onto the L66. Parallel tools for the L6 were built and installed on CP-V in the third and fourth quarters. The software librarians in our Control Group began to participate in the software development process.

Our Computer Center expanded during the year; two L66 NSA systems and two L6s were installed for CP-6 development and test. The existing Xerox computers were enhanced with the newly developed Honeywell add-ons. Most computing equipment in the center is now (or will soon be) available for on-line use 24 hours a day. A major cost reduction program to eliminate expensive dial-up lines involved installing hardwired lines from the office area to a switch panel in our computer center.

The host system development made excellent progress through seven system integrations on the L66. Each successive integration included new modules to shape the emerging CP-6 host system. By year-end the scheduler, service decoder, memory management, major parts of file management, and the editor had all been successfully demonstrated. Early in December, the delivery and installation of the L6-L66 coupler prototype enabled us to check out the host and front-end interface software.

In the language processor area, the design of the new BASIC was completed and CP-V designs for APL, FORTRAN 77, RPG II and IDP (the data base query language) were updated for CP-6. Agreement was reached with Phoenix Software Engineering on the adaptation of the TOSHIBA NSA-GMAP assembler to CP-6, COBOL 74 from GCOS III and the development of a new SORT modeled after the GCOS version. After causing some concern, a revised plan and schedule for interfacing to CP-6 the PL/I implementation language, needed for I-D-S/II and COBOL 74, was negotiated between Phoenix and Los Angeles. Because of understaffing, LADC efforts for I-D-S/II interface to CP-6 proceeded more slowly than planned; additional manpower is planned to augment this project's staff. TEXT (the CP-V on-line document creation and editing subsystem) was redesigned to correspond with the Multics offerings in an attempt to consolidate user visible interfaces.

Plans for T&D support from Phoenix were derailed by the Engineering reorganization; as of the end of the year, a feasible revised plan had not yet been agreed to.

We met with EXCHANGE, the Xerox User Group, in February and October. Honeywell's commitment to CP-6 and the other migration products was reaffirmed in February; the October meeting was highlighted by a noticeably more satisfied customer base and a CP-6 tutorial that attracted a standing-room-only audience.

Early in 1977, a detailed project plan for CP-6 was prepared. Four revisions to the plan were published, each successively more detailed. The contents for first, second and third releases were renegotiated with Marketing early in the year as follows:

First Release -	Multi-batch, time sharing, remote batch (including IBM HASP, 2780/3780 support).
Second Release -	Real time, transaction processing, remote terminal concentration.
Third Release -	Remaining functions, performance enhancements.

Support for the 66/85, required as the ultimate migration vehicle for the larger Sigma 9 users, was moved to the third release. This requirement has been questioned by Engineering management and is under review. It is now being treated as an unfunded item in the PFS. Modifications to the 66/85 program (elimination of IOP) have made this a much smaller effort for CP-6.

The CP-6 PFS was agreed to late in the year after several months of negotiation. A list was formulated of unfunded hardware and software items which are considered requirements by Marketing, but which are outside the original Engineering plan. Inclusion of these items will be negotiated in early 1978 after considering their impact on the business plan.

A draft version of a Concepts and Facilities Manual for CP-6 was published internally as a general functional description of the entire system. The first external version of this document should be available for distribution at the May 1978 EXCHANGE meeting.

In September, a Step 1 IPR and Concept Design Review were conducted simultaneously in Los Angeles. The reviews were considered successful at LADC, though a number of unacceptable and high risk items were identified. Most notable among the concerns were the following: lack of a defined plan for converging CP-6 with the Honeywell mainstream, unclear program management not integrated with other LISD programs, dependence on PL/I software efforts in Phoenix, the ambitious schedule and the achievability of the performance goals. Action plans for reducing the risks thus identified are in preparation for submission to management in the first quarter of 1978.

The schedule for first customer ship was delayed one quarter to reflect the impact of a number of problems, including the slower-than-plan manpower build-up, the later-than-hoped-for deliveries of the L6-L66 coupler and PL/I (implementation language), the unplanned efforts required for the L6 and L66 software factories, and the greater-than-anticipated field support requirements. This new schedule was not communicated to users in October, but will be discussed with them at the May 1978 EXCHANGE meeting.

In the Hardware Engineering area, the Sigma 5 virtual memory option (Map) and the MPC disk adapter developments were available for the end of third quarter shipment to users as announced. First customer shipments were actually made in October. Eleven MPC subsystems and six Sigma 5 Maps were shipped from Phoenix in 1977. The MOS Memory Program, which involved attaching the 66/85 memory cabinet to Xerox Sigma systems along with a battery support system, newly designed in Phoenix, was delayed from a third quarter 1977 announced availability. The first unit built in Los Angeles was shipped from Phoenix to a customer the last week of the year. The Sigma 6 extended addressing and dual options were also delayed due to their dependence on the memory. The first unit is planned for shipment in 1Q78, a delay from the original October 1977 target.

In spite of all of the focus on the new hardware and software products, a significant amount of effort was expended on behalf of the current product line. The last of the software enhancements committed by Xerox Corporation to users of CP-V and CP-R operating systems were delivered in 1977. In the case of CP-V, the E01 release delivered in October (scheduled for September) contained many of the functions originally planned for 1978 delivery. CP-R E00 was delivered on schedule in the second quarter. Support for the 50MB disks on Xerox 16-bit computers, announced in February 1977, was delivered on time in August. Validation of the large-capacity core memory for the Xerox 560 was accomplished in our Hardware Engineering subsection. Maintenance releases for several language processors were also completed. Even with all these efforts, the backlog of software difficulty reports rose in 1977, reflecting not only the intended reduction in maintenance activities but also a more-aggressive-than-anticipated user base.

Our progress in 1977 is impressive by any measure, though some problems remain to be resolved early in 1978. The year 1978 will be demanding on all of us involved in this program. We continue to enjoy excellent credibility with the Xerox customer base. Our objectives are to continue the on-time, high-quality performance we have delivered so far and to work toward bringing ourselves and our products into the Honeywell mainstream.

Project Management

LADC management spelled out detailed organization objectives for 1977 and communicated them to all employees. Each subsection manager also has a unique set of agreed-upon objectives to work toward during the year. The organization structure itself remained fairly stable (except for the CP-6 architecture team, which dispersed to the various design implementation teams after completing the system architecture).

A detailed CP-6 project plan serves as the basis for measuring accomplishments against commitments. Management periodically reviews progress, and problems of a general nature are discussed in LADC project review meetings. The individual plans have specific "internal" commitments tracked by the individual subsection managers. The major milestones for the entire project, which represent our external commitments, are collected in one section in the plan.

LADC uses the standard LISD reporting mechanism--weekly Significant Events and Monthly Status Report--to keep management informed of progress and problems. Particularly in the last quarter of 1977, we have also become increasingly involved with Program Management, Business Planning and Product Planning personnel as these LISD organizations have come up to speed on CP-6 and related projects.

Technical information, standards and procedures are transmitted to all LADC programmers through the CP-6 Architecture File. This keeps all employees informed of the technical details of the products as well as the techniques used in building them. For a broader view three all-employee communications forums were held during the year to review the state-of-the-project, as well as the status of the Xerox base, other activities within HIS, and competitive activities. Xerox Product Marketing people participated in each session, covering the market and business-related items.

One of LADC management's key objectives has been to bring more discipline to the software development process. In 1977 we established various control mechanisms and a number of standards for all software people in six major areas as discussed below: user interfaces, program identification, system integration, documentation, test library and design review.

A single type of service call with one parameter list and one error return has been established as the way one obtains system services in CP-6. A standard system-wide calling sequence has been defined. The entire CP-6 system will present a unified face to all, providing system level services which interpret file identifications, parse command lines, report errors, supply HELP, apply alter or update lines to source files, and compute mathematical results.

For identification purposes, the CP-6 system has been divided into functional areas which are subdivided into functional code groups, each consisting of one or more program modules. Within this hierarchy, unique alphabetic identifiers have been selected to identify source and object unit files, program labels, data error codes, and technical documentation.

A formal control procedure has been established to manage our source and object files as the system evolves. The CP-6 software librarians maintain and control these files in one place. At each system integration point, the librarian recompiles all modules, creates a new system, and runs all regression tests. The December integration required three working days (7 CPU hours) to integrate, recompile and verify all the modules and create a system tape. The majority of this work was performed by one librarian (a member of the Control Group) supervised by one system programmer. By the end of 1978 we expect the process to require considerably more time, but all the necessary controls will still be available to minimize errors.

For CP-6 documentation, standard procedures have been defined for format, type and content of commentary to be included in all program source modules. Tools have been developed to extract this commentary, which will provide various levels of maintenance documentation.

In 1978, our plan includes the development of a fairly extensive test library, which will be subject to the same controls as the systems software.

A dual design review process at LADC ensures consistently high quality in design. First, all specifications are issued informally to the entire technical staff (as well as select personnel in Phoenix); each staff member is expected to comment on areas that affect or are affected by his own work. Next is a formal peer group review (review teams consist of a permanent core of three senior staff members, augmented by personnel appropriate to the given subject matter). Review teams are formed early in order that the members may follow and contribute opinions to the design work as it progresses, thus avoiding significant surprises when the initial specification is issued. More than 50 designs were reviewed in 1977.

In addition, designs which have impact on the users are reviewed with the EXCHANGE CP-6 Technical Committee, a group elected by the users who have non-disclosure agreements with Honeywell.

Software Factory

The software factory is the vehicle for the construction, debugging, integration, preliminary test, and export to L6 and L66 target systems. It was needed because the schedule imposed on the project required a productivity increase of 50 to 100 percent over that achieved during the development of CP-V. Early analysis indicated that this increase could be achieved by means of a high level System Programming Language (SPL) for 85 percent of developed software, and that life cycle costs for software enhancement would improve considerably if an SPL were the major development tool. From the perspective of management, the CP-6 software factory was needed to help control access to modules as they progressed from the debugging to integration and later phases.

After an analysis of several operating systems, we concluded that CP-V was the proper choice because it was available in LADC, was known to our personnel (no "learning curve" costs), and was ideally suited to on-line program development. Results to date indicate that this was the correct choice: almost every element of the factory was available on or ahead of schedule, and all CP-6 milestones on L6 and L66 have been met. Furthermore, a major criteria for the factory--that it be movable from CP-V to CP-6--has been solved by implementing factory software in transportable languages: FORTRAN and PL-6, our SPL.

The software factories for both L6 and L66 consist of (1) primary tools, described below, and (2) secondary tools (mainly utilities useful to any program development process) not described here. The tools most interesting to management and project leaders (e.g., how many source lines in a module, how many non-commentary, how many non-declaration, how many changes from last report, etc.) have not all as yet been constructed.

The primary tools consist of language compilers (PL-6 and Assembler), linkers for combining the object units produced by the compilers, and L6 and L66 simulator/debuggers for running and testing the run units produced by the linkers. In the case of the L66 simulator, some CP-6 monitor services are also included to allow debugging of operating system elements (e.g., parts of the CP-6 FORTRAN or APL compilers) that rely on monitor services (e.g., for input/output). System builds for L6 or L66 are accomplished via factory elements which combine the run unit output from the linkers into bootable tapes for the respective machines. Part of the total software factory debuggers and dump programs for the target machines is included on the bootable tapes.

It is difficult to assess comparatively the accomplishments to date, i.e., whether a different approach would have been better. We know that all software developed to date for both L6 and L66 has been on schedule; more importantly, every technical person involved in developing the software thus far produced is convinced that the schedules could not have been met without the software factory tools we have made available.

PL-6, the System Implementation Language

When the CP-6 program began in 1976, we recognized that the program's ambitious schedule and the high productivity required made urgent the need for a system implementation language. Though we did not have the lūxury of designing a new language, we fortuitously discovered the PL-H compiler developed in CEO-Boston for the Level 6 software factory, which appeared to be a reasonable base for the CP-6 SPL. We also borrowed freely from the code generator built at S&RC in Minneapolis for the Control Fortran project.

The development of PL-6 began in late 1976. Through some extraordinary efforts the first version, a complete system generating EIS and NSA code for the Level 66 and a debug schema for use with the CP-6 debugger, was available for development personnel' use in early July 1977. This was a delay from the original April 30th target, but this was mitigated somewhat by the early availability of, first, a systax checking version of the Compiler in early May and, then, a semantics checking version in June. A Preprocessor, for PL-6, provided important features such as %INCLUDE (merging of source records from other files), %MAC (macro definition), and %SUB (string substitution).

As of the end of 1977 nearly 100,000 lines of PL-6 code had been generated. Much of this code has been through the compiler several times in the course of debugging.

PL-6 development continues, with current efforts aimed at improving the efficiency of the code generator. Our goal is ambitious; we are targeting for an overall code improvement of 50 percent by July 1978. At the start of the year, we are making good progress and are optimistic about meeting this goal.

CP-6 Host Operating System

CP-6 made the transition from the architecture phase to the detailed design and implementation phase early in 1977. Early in the year, the first version of the CP-6 work plan identified the staging of the 1977 system integrations and the content of the system at each integration point. It was later updated to reflect initial progress against the plan and system integrations required to achieve the first release in 1979. Some highly visible milestones for 1977 were planned as follows:

1.	Level 66 with NSA at LADC	February	1977
2.	Begin CP-6 checkout on Level 66 (GMAP code only)	March	1977
3.	PL-6 compiler available	April	1977
4.	Begin checkout of PL-6 modules on Level 66	July	1977

5. Install Level 6/Level 66 coupler September 1977

6. Begin checkout of CP-6 command processor in time-sharing mode December 1977

All but two of the major 1977 milestones for the host system were met.

Achieving 1977 and 1978 objectives required the implementation of a very ambitious hiring plan for the Operating System subsection, which called for increasing the number of programmers from 21 on January 1, 1977 to 33 by year-end. The actual year-end level achieved was 28.

By the beginning of 1977, significant progress had already been made in the overall internal design of the CP-6 host operating system. More than 200 architecture documents were produced during the year and more than 50 design specifications were reviewed by the designated design review teams. The design review process is working quite well. The Basic Structure and Control specification established the guidelines on how CP-6 would use the Level 66 NSA hardware. An initial bootstrap system began checkout on schedule and formed the nucleus of the A-system build making use of the newly installed NSA hardware. All areas of the CP-6 host system were in design and implementation early in the year, except for the I/O system and device handlers, which started late due to a lack of resources.

Two critical scheduling problems involving delays of the PL-6 compiler and the L6-L66 coupler came to light during February. While both of these problems caused extensive replanning, we were able to maintain our December integration schedule. Time-sharing functions were provided in 1977 by means of a second system console. Although the PL-6 compiler did not become available until July, the syntax-checking portion of the compiler was made available for programmer use in March.

An assembler running on CP-V to assemble GMAP code was needed. The fact that the GMAP assembler ran outside the software factory caused logistics and handling problems. One of our new senior designers spent three months learning the L66 by designing and implementing a new assembler on CP-V, which now significantly improves turnaround time to programmers.

The CP-6 A-System provided a firm foundation for testing the software factory tools to be used for building CP-6 system tapes. Significant amounts of PL-6 code (for language and service processors) existed that could not begin testing on L66 until the second quarter of 1978. In order to provide an early test vehicle for this code, a three-part CP-6/L66 simulator running on CP-V was defined: a Level 66 instruction simulator, a CP-6 DELTA-like debugger, and a CP-6 NSA environment simulator. This product has served the language and service processor implementers in their initial module testing and allowed many file management and central system components to be module-tested.

The C-System build and integration was completed in July, a major milestone comprising several "firsts":

- The first PL-6 code was compiled and linked on the CP-V software factory.

- The first CP-6 system tape was built by the CP-V software factory.

- The first piece of the CP-6 kernel, including Memory Management and the Service Request Decoder, was loaded and tested on Level 66.

The D-System build during August was a stabilization period for the initial central system code running on the Level 66. Two significant observations about the project were made at this time. First, the PL-6 compiler proved to be extremely solid in spite of the very short development schedule; the few problems encountered were minor and very quickly fixed. In using PL-6 very few programming errors of the type common to assembly language programming were encountered. Problems found most frequently related to the implementation of the CP-6 algorithms rather than clerical errors in usage of hardware registers, etc. Second, rapid isolation of problems was afforded by the Level 66 NSA hardware during checkout, which proved a very valuable tool, even though we were at first exposed to a number of NSA hardware problems. Solutions to several of these existed in Phoenix, but had not been installed on our machine.

The basic CP-6 coding productivity assumptions, usage of NSA hardware and usage of a higher-level implementation language successfully passed the first major test. By year-end all significant NSA problems had been resolved.

In September, parallel development and checkout was well under way. Discussions with the Maintenance Engineering staff in Phoenix made good progress in the definition and schedule for the integration of on-line diagnostics (TOLTS) into CP-6. In November, the Hardware Engineering reorganization in LISD dispersed to different projects the staff that had been assigned to provide on-line Test and Diagnostic support for CP-6. As of the end of 1977, a new team is being formed in the L66 project and it appears that efforts for CP-6 support will be less than originally planned resulting in elongated schedules. If we cannot resolve this issue it will present a major first release exposure for the CP-6 project.

By December the testing of the H-System, containing the first stage of interactive user support, had begun; it is now making good progress toward its planned integration date of February 1978. Work also began in December on a detailed test plan of the CP-6 host operating system that will identify the types of tests to be performed on the CP-6 system prior to first release and the testing techniques to be used.

During 1977, the final CP-6 Project Plan identified the schedule and resources required to achieve the first release by June 1979. At year-end, over 50,000 lines of PL-6 and assembly language code were running on the Level 66 machines at LADC. This is a good start, but much remains to be done.

Unfortunately shortfalls do exist. Our system debugger (DELTA) effort has turned out to be much larger than planned; while it is currently under control, it is late. Our inability to staff to our year-end targets has caused a slower start than anticipated in test tools and documentation. The necessity to share computer resources with hardware development and to serve as a test site for new hardware has reduced the computer time available and thus adversely impacted our Software activities.

During late 1977 we began to address a number of these shortfalls, which must be resolved early in 1978. Of primary importance is the recruiting problem; this will require support from Phoenix as well as LADC efforts.

Some of the significant milestones we are looking ahead to in 1978 are:

Interactive user support	February	1978
Batch user support	June	1978
Multiple CPU system	June	1978
CP-6 demonstration	August	1978
In-house production usage begins	November	1978

Real Time and Communications

1977 was a very busy and productive year for the Real Time and Communications organization. Most of 1977 effort was directed toward communications, since real time is not scheduled until the second CP-6 release. About half of the staff was devoted to the first release and the remainder to the architecture for the future. Several attempts were made during the year to redirect CP-6 communications. Fortunately, we have been able to resolve these questions without sacrificing our first release schedule. We have now spent several man-weeks investigating a management suggestion aimed at connecting CP-6 closely to Billerica XNP efforts; Billerica, Phoenix and LADC personnel have been studying the feasibility, costs and schedule for such a marriage. Resolution of the question is expected in January or February.

"805 Time Sharing" is the name given to the first phase of a three-phase development for the CP-6 L6 FEP program whose major purpose is to supply sufficient time-sharing terminal capability to support the testing of CP-6 processors (such as DELTA, the command processor, EDIT and others) in a "system environment". This effort, which started in mid-year, has been on schedule in spite of some serious handicaps.

- o The first release software factory was built, including an implementation language for the L6 (SIL-6), an implementation language for the MLCP (CIL-6), an L6 simulator under CP-V, an L6 debugger, an MLCP debugger and a Program Transportation System. This set of tools allows us to build L6 programs on a CP-V system, create an L6 bootable tape and load, execute and debug the programs on an L6. The tools have proved valuable in meeting demanding schedules, and have significantly enhanced our productivity. Although all of the factory work has been excellent, of particular note is the SIL-6 effort, a crash project launched in very short order when it became clear the Control Fortran project at S&RC would not yield a timely implementation language for LADC use. Like virtually all other efforts for the L6 software factory, this was not originally planned for CP-6.

- o The first L6-L66 coupler was delivered, installed and checked out at LADC in December. The installation team from Billerica is to be commended for an excellent installation/checkout job. (Trying to manage a project 3,000 miles away required some very close management attention.) We are scheduled to receive four more pilot (wire-wrapped) boards in the first half of 1978, and will switch to multi-wire boards in the second half.

- After clearly establishing the requirement for an on-line test capability for communications and some confusion as to who had implementation responsibility, we were finally able to obtain a commitment from Phoenix T&D to provide a COLTS capability for first release of CP-6. While the commitment to produce is still intact, this piece of the project has suffered as a consequence of the Hardware Engineering reorganization, previously described in the CP-6 Host section. Failure to resolve the outstanding issues early in 1978 will have a similar impact.

The architecture activity for second release began in August. The team is on schedule toward its goal of having an overall design available in the second quarter of 1978. The second release is the base system on which real-time processing and transaction forms processing will be built; it will also support all the terminals that were supported under CP-V and will incorporate HDLC and VIP handlers from GCOS 6.

The major objectives of 1978 are to complete the first release development of the FEP in order to begin full system test with the host in October, and (in parallel) to complete the design for the second release by the third quarter. In addition, we would like to begin an L6 code generator for PL-6 so that we may replace SIL-6 for the second release and use an implementation language common to host and front-ends. A request is pending to fund this as an Advanced Technology Project.

Language Processors

Development of the CP-6 language processors is progressing with excellent, demonstrable results. The 1977 objectives were to complete the APL, BASIC, FORTRAN 77, and TEXT designs, and to begin the coding phase of each. Except for the TEXT project (described in more detail below), all these goals were met.

Designs of the APL and FORTRAN 77 processors are substantially complete; they were derived from their proven CP-V counterparts, modified as necessary to interface to the CP-6 operating system and the L66 NSA hardware environment. Both projects are now in the coding phase, with a total of 13,000 lines of PL-6 code written. A portion of this code has already been checked out using the L66 simulator on the CP-V software factory. Successful results from this effort have heightened our confidence in the code we have produced.

The BASIC compiler is based on a new design in order to produce a competitive product that is much more useful than either GCOS or CP-V BASIC. A preliminary design specification of 700 typed pages completed in mid-year is now undergoing detailed design elaboration. Many of the proven software development techniques, such as top-down design and structured programming, are being applied to this project for significant future payoff. We are deliberately devoting more than the usual amount of time to the design phase in order to shorten coding and checkout. Some nominal coding has been completed. The general utility routines, consisting of 800 lines of PL-6 code, have been written and partially checked out on the L66 Simulator. The coding phase will proceed rapidly once the detailed design is completed in early 1978.

A common run-time library is being developed for the APL, BASIC, and FORTRAN 77 processors, where substantial commonality exists in the mathematical run-time routines. The benefits of this effort are to promote uniformity across the entire system, and to eliminate redundant development effort, thereby reducing development and life-cycle maintenance costs. The library routines being used are those adapted from GCOS PL/I.

The progress on developing the TEXT processor, the on-line document creation and editing system, was less than planned due to a strategy change in midstream. While the original strategy was to reimplement the CP-V TEXT processor, concerns expressed by LSEO management over a lack of compatibility among GCOS, Multics, and CP-6 TEXT handling systems led to the decision to replace CP-6 TEXT with a new system derived from the Multics text handling system. The benefits of this strategy change are (1) it is the beginning of an effort to unify Honeywell's various text handling systems, and (2) the impact of this mid-course correction would be minimized, since the Multics system is written in PL/I. (it is estimated that nearly 50 percent of this code can be adapted with relatively little change for CP-6.) Because of this change and the loss of a key individual, this project is trailing the others; nevertheless, significant progress has been made. A specification of the Text Formatter has been written and distributed for review. We have in our possession a tape of the source modules of the Multics text handling system and we are compiling them on PL/I to determine what changes are needed to adapt them for CP-6.

Overall, we are pleased with our progress to date. Detailed work plans are in use, spelling out all the major milestones as well as the specific tasks and expected completion dates for every member of each project team. Our decision to use PL-6 as the higher-level implementation language has been fruitful. While the initial transition required some adjustment, our programmers are becoming more and more proficient with the language, thus achieving greater productivity. Coding and checkout are proceeding much more rapidly than if we coded in assembler language. We looked at the past year's accomplishments with a sense of satisfaction; we look forward to the coming year with a great deal of enthusiasm.

Commercial Software Systems

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

Late in 1977 we agreed to qualify a Toshiba version of RPG as an interim GCOS product for delivery in mid-1978. Ultimately we are committed to a single RPG product for the L66 line; the selection will be made later in 1978.

RPG II has been functionally defined by LADC in an EPS-1 (consistent with the HIS RPG Unification Standard) and its design documented in an EPS-2. Coding of the compiler portion of the product is substantially complete, and we are well into the run-time development. Due to budgetary restrictions, only one person has been allocated to this project. The development activity has proceeded adequately, but no work has been done yet on planning or testing for quality assurance.

IDP was the CP-V interactive query processor and report generator. The CP-6 version is being expanded to include CP-V MANAGE-like functionality and has been defined by LADC in an EPS-1; its design has been documented in an EPS-2. Coding is scheduled to begin in January 1978.

GMAP6 is the assembler to be produced by Phoenix to meet LADC functional requirements. After detailed analysis of a proposed new meta-assembler, it was decided to rely upon a Toshiba implementation for the ACOS/NSA environment. Modifications have been documented and an initial version installed under GCOS at LADC in December 1977. This version contains a substantial number of CP-6 enhancements and the ACOS form of assembled object unit which will be converted to CP-6 form by a utility provided by LADC. Additional versions planned for 1978 provide first a full GCOS to CP-6 cross assembler with debug schema, then a native CP-6 version. To supplement GMAP6, LADC has produced CP-6 system service macros. These macros, for use by assembly language programmers, parallel the service calls used in PL-6.

COBOL 74 for CP-6 is to be produced by Phoenix, based upon the standard GCOS offering. Some functional modifications were specified by LADC. Substantial difficulties were encountered during 1977 in scheduling enough resources due to previous Phoenix commitments and incomplete information on CP-6 calling sequences and language conventions. Because of geographical separation, the compiler developers were not able to work in parallel with CP-6 designers. Indeed, a CP-6 orientation seminar for Phoenix personnel was conducted in mid-1977 at Los Angeles. A special documentation effort at LADC will provide much of the missing information. The nature of the work to be done here is known and documented but must be carefully coordinated with the availability of PL/I and CP-6 testing in 1978.

CP-6 Sort/Merge is to be jointly produced with Phoenix to meet LADC functional requirements; it will serve as the base for a GCOS66 product. LADC has defined the CP-6 user interface and Phoenix has substantially completed the design of the processor. A timing benchmark was produced on CP-V by LADC in anticipation of CP-6 time trials in 1978. Planned LADC work on Merge development and quality assurance testing have been set back by the resignation of the assigned individual. The Phoenix piece of the project is also understaffed.

I-D-S/II for CP-6 is to be produced by LADC from the standard GCOS offering. It will be interfaced to CP-6 differently than EDMS was to CP-V, and thus new design is required. By mid-year we completed our definition of I-D-S/II as the first system resident of the Alternate Shared Library and learned a great deal about CP-6 security and data base privacy in an NSA environment. The documentation of changes required in the GCOS version is essentially complete and coding will start in early 1978. This project is one of the most difficult ones we have undertaken.

PL/I for CP-6 is to be produced in Phoenix from the standard GCOS offering but is not planned for distribution to customers. It is the implementation language for key portions of COBOL 74 and I-D-S/II and is to be used at LADC for support of those CP-6 products. GCOS to CP-6 cross compilers, special run time libraries and eventually a native CP-6 compiler will be produced prior to final qualification of CP-6 I-D-S/II and COBOL 74. Some difficulties were encountered in obtaining a firm commitment of resources to support this effort. Management visibility was raised on this issue at the September CDR and, by year-end, a plan consistent with LADC requirements was in place.

In retrospect, 1977 was a difficult year. We were able to bring the CP-6 Commercial Processors from preliminary concepts to specified systems with known appearance and place in the system. We have established lines of communication with Phoenix development people, but more teamwork is still needed. Recruiting efforts, which fell below plan in 1977, adversely impacting many of these projects, must be bolstered early in 1978 in order to ensure these programs are on track.

The LADC Computer Center

1977 was a year of change in the Computer Operations at LADC. 1978 will see accelerated growth and change to reach the computer, communications, and service capability required to support the intensive software development activity leading to first release.

In 1977, the 560 system served as the primary software factory for CP-6 development as well as the base for development and exposure of CP-V software releases and fixes. The system was expanded for dual processor operation and with communication capability for 65 users. An IRBT system was added for checkout of CP-V features as well as printer capacity close to programmers offices. Initial (LCMM) high density memory boards were installed for checkout. As part of the hardware enhancement program, a dual MPC disc subsystem was added for system integration and software checkout.

In 1977 the Sigma 6 system served as a hands-on development system for CP-V software releases and patch verification. In late 1977, the system was relocated; a major expansion project incorporated a 256K MOS memory, a second processor, and an MPC disc subsystem. In early 1978, additional communications capability will be added to this system, and it will be converted to production time-sharing mode as a second software factory system for CP-6 development.

Two 66/80 systems were installed in 1977 to provide hands-on systems for initial CP-6 software development. They also provide GCOS time-sharing service for those developers working on the Phoenix-related parts of CP-6. In late 1977, plans were established for a major expansion of both systems to provide the full configuration and capability required for CP-6 checkout and performance testing. One of the systems will grow to a dual processor, dual IOM configuration with an 8-million-word memory. The communication subsystem will include Datanet equipment for GCOS operation to 250 lines and Level 6 equipment as front-end processors for CP-6 operation. The second system will continue to provide a vehicle for CP-6 development work and GCOS time sharing and will also become a load generator for CP-6 performance testing.

Two Level 6 systems were installed in 1977 to support the development of CP-6 communication and real-time software. The initial hardware coupler unit was checked out to allow on-line use of the Level 6 as a front-end processor for CP-6. Three more Level 6 systems will be added in 1978 and the existing systems will be upgraded to Model 43 and expanded to full configuration.

The increase in the number of terminals at LADC, which was significant in 1977, will continue to match the growth in the programming staff and the increase in system usage through early 1978. Concurrently, the data communication systems changed and expanded. Initially, terminals were connected to the computer via the dial-up telephone system using acoustic couplers and modems. In 1977, we converted to hardwired leased lines to reduce operating costs and improve the quality of service. A patch panel was installed to provide the required switching flexibility. This system will expand significantly in 1978 to connect the several machines for performance load testing of CP-6 to a maximum of 250 users.

One of the major problems in 1977 was many service outages because the Computer Center air conditioning system and electrical system were not adequate to handle the computer equipment installed. The situation has been and is being improved so that air conditioning will no long be a deterrent to the development work.

The service area had several basic problems in 1977. The Operations and Field Engineering staff was not adequate to satisfy the heavy demand for night and weekend computer service. Also, the accelerated, high priority hardware enhancement programs disrupted computer operation. In early 1978, the Operations staff and the Field Engineering staff will be augmented to provide full three-shift, seven-day coverage, and training programs will be increased to enable the staff to adequately cover the wide variety of hardware and software systems at LADC.

Current Product Software Support

The Xerox product line supported by LADC includes 32-bit mainframes (Sigma 5-9 and 550, 560) and 16-bit systems (Sigma 2, 3 and 530) and all associated peripherals. Software responsibilities include the Real-Time Batch Monitor (RBM) for 16-bit systems, CP-R virtual memory system for 32-bit real time and CP-V multi-use, virtual memory system along with all the associated language processor, utility and application programs.

E00, the fifth major release of CP-V, was made in November 1976, providing support for Xerox 560 multi-processing as well as a number of User Group requests. By early January, this release had stabilized in the field at the initial release sites. More than 500 customer Software Improvement and Difficulty Reports (SIDRs) were answered in this release.

In January, development began on modifications to CP-V multi-processing to permit slave CPUs to execute monitor services for certain high usage service requests. While this capability was planned for the F00 release in 1978, very good progress was made during early 1977 and it was included in the E01 release. In addition, the E01 release contained Honeywell MPC support for 200 megabyte disks, Sigma 5 virtual memory support, multi-account private packs, and more than 400 SIDR fixes. Five pre-releases of E01 were made in September.

LADC personnel participated in the first two installations at University of Toronto Library and Dalhousie University. The release was completed by the end of October, but general distribution to the field was delayed by Marketing until December in order to resolve a pricing issue. (Non-contract customers will now be charged for this and subsequent new releases.)

Adequate field support of CP-V has been adversely affected by the higher priority of CP-6 efforts. A software support group did not exist at LADC in 1977. By the end of the year an LADC-resident CP-V Field Support Group defined by Marketing had been announced at the Fall Exchange meeting. Staffing will begin in early 1978.

Dual Sigma 6 with Extended Addressing (to 256K words) support is planned for availability along with the hardware shipment in the first quarter of 1978. The F00 release, planned for September 1978, will include MPC tape support, error logging for correctable memory errors and approximately 300 SIDR closures. F00 is the last planned functional enhancement to CP-V.

After ten man-years of effort, CP-V ANS FORTRAN, a new compiler designed for compatibility with the proposed FORTRAN 77 standard, was released to the field in December 1976. The product was further enhanced in April by an interactive debug facility (FDP). Support of the new product continued throughout the year, with software corrections made available to customers monthly via the Software Support Tape (SST). Version B07 was released in December 1977 (a substantially improved and stabilized product containing corrections to a number of software errors). Maintenance releases of APL and BASIC were also made during the year.

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 1977, maintenance releases were made for 530 RPG, CP-V COBOL, SORT, EDMS, and Interactive Data Base Processor. Significant effort was also expended in field support of customers experiencing difficulties in Transaction Processing. On-site LADC support was required to Steven F. Austin University, Westchester State College, and University of Tulsa. Results for 1977 were on plan: the SIDR backlog in the commercial products area was kept exactly flat.

The E00 release of CP-R was released to the field in April 1977, on schedule. Aside from SIDR corrections the major system enhancements included an increase in system area available for user programs, blocked tape I/O, multi-reel save tapes, dismountable user areas, and rollin/rollout.

Beyond the normal maintenance efforts the major activity associated with RBM-16 was the release of an update package that provided support for 50MB disks which previously had been restricted to the 32-bit product line. This package was released to the field in August 1977, on schedule. RBM is a stabilized product now supported by FED.

Hardware Engineering

Hardware Engineering at LADC is responsible for the design and development of new hardware products and for sustaining engineering support of Xerox computer systems.

The group was formed in October 1976 with the transfer from Xerox of ten engineers most familiar with Xerox computer systems. The group has been responsible for the following programs:

- Sigma MPC Adapter for Disk and Tape Systems
- Sigma MOS Memory
- Sigma 5 Memory Map
- Sigma 6/7 Extended Addressing and Dual Processor
- Large Capacity Core Memory (LCMM) for Xerox 550/560 systems

During 1977, almost all of LADC's Hardware Engineering resources were devoted to these programs. In the fourth quarter the Disk MPC Subsystem, Sigma MOS Memory, Sigma 5 Memory Map and LCMM Memory were shipped to customers. The first customer shipment of the Sigma 6/7 Extended Addressing (with MOS Memory), Sigma 6/7 Dual Processor, and tape MPC Subsystem is planned for early 1978.

The Sigma MPC Adapter interfaces Honeywell disk and tape subsystems and the Xerox 32-bit computers. The MPC Adapter design electrically interfaces the Xerox IOP via the Sigma IO interface to the Honeywell MPC via the PSI interface, and is identical for both tape and Disk MPCs. Modifications to the Disk MPC firmware were made by Engineering in Phoenix, while CP-V software changes were made by LADC.

The MPC Adapter design was implemented using three (instead of the four as originally estimated) standard Honeywell universal wirewrap boards. It is installed in available space within the disk or tape MPC. The design goal of field retrofittability to a standard Honeywell MPC was achieved, requiring only recabling from Sigma to the Level 66 System.

An MPC-Disk subsystem diagnostic was designed and released. Written in 32-Bit I/O Utility language, the diagnostic program permits testing of the MPC, MPC Adapter and disk drives. The program incorporates existing Honeywell ITRs and MDRs for testing the MPC and Disk drives; new tests, unique to the MPC Adapter, are included in the package, as well as the facility to initialize disk packs. A similar diagnostic package for the tape MPC subsystem is planned during the first half of 1978.

First shipment to a customer occurred in October from Manufacturing; by year-end a total of 11 MPC Disk subsystems were shipped, including some dual access systems. Installation and field problems have been minimal.

Limited LADC resources have delayed test vectors on two of the MPC boards. However, LADC is supporting the factory by testing boards at LADC.

A design change is in preparation to relieve the configuration restriction requiring a dedicated MIOP on Sigma 9 for unbuffered MPC operation. With this change, Marketing will be better able to manage the limited supply of Sigma 9 MIOPs.

Unit test of the tape MPC subsystem commenced during late 1977, but the bulk of the work will occur during 1978. Although the adapter design is identical for the disk and tape and no firmware changes are contemplated, a T & D package, and CP-V I/O handler must be built, and testing must be done with the new CPI drives. To relieve the requirement that Xerox systems must retain at least one Sigma tape drive and controller (for system boot), LADC has agreed to incorporate system boot capability within the Tape MPC-Adapter.

The tape program is behind schedule due to CPI drive availability, added requirement for system boot capability, and personnel limitations. Original ship plan was for First Quarter 1978 but is now planned for the second quarter.

The Sigma MOS Memory program provides for attachment of Honeywell MOS memories to Sigma computers. It includes the design of a multi-access port matrix, memory control logic, and battery support subsystem. Design is based on the 66/85 MOS Memory cabinet and utilizes either M16 or (early in 1978) M32 MOS Memory storage boards and standard memory buckets. Phoenix Engineering developed a battery support subsystem for power interruption ride-through. The port matrix and memory control logic were implemented with six board types using the standard Honeywell universal wirewrap boards. A diagnostic program has also been developed for fault isolation and for functional verification. Initial test of the memory revealed serious noise problems, but a redesign effort with some outstanding Phoenix help eliminated them on a very short recovery schedule.

A first customer shipment from LADC to a Sigma 9 site occurred in December; a second shipment from LADC to a Sigma 6 site is planned for late in the first quarter of 1978. Until all board test deck vectors are released, LADC will support factory shipments of MOS memories by testing boards at LADC. Manufacturing plans to ship approximately ten units during the first quarter.

MOS Memory performance on Sigma 9 did not achieve planned design goals. (Sigma 6 performance is as planned.) Redesign effort (affecting one board type) is expected to correct the performance problem. The change will be cut into Manufacturing during First Quarter 1978, and earlier shipments will be retrofitted in the field.

The Sigma 5 Memory Map program provides for design and development of a map option similar to the Sigma 7 Virtual Memory Map. The hardware design consists of a one-high Sigma backpanel, several T-series modules and a Honeywell designed 4x6" wirewrap board. Installation of the map on Sigma 5 requires a substantial CPU wiring change. Although initial availability of the map was planned only for CP-R, CP-V checkout went smoothly and we were able to better its availability by six months. Phoenix Manufacturing has been shipping one map option every two weeks during the fourth quarter of 1977.

The Sigma 6/7 Extended Addressing provides facility for Sigma 6/7s to address up to 256K words, up from the prior 128K limit. New hardware design was minimal, since the Sigma 5 Map chassis design was applicable to Sigma 6/7. However, to provide for the additional address bit, substantial wiring changes are required for the Sigma 6/7 CPU, multiplexor and selector IOPs. Extended Addressing testing is now proceeding along, having been delayed by the memory program.

Sigma 6/7 Dual Processor testing is concurrent with Extended Addressing. A small CPU wiring change is required to implement this capability.

The LCMM program provides for a vendor-purchased double density core memory module to permit memory expansion on Xerox 550/560 systems. LADC incorporated wiring changes into the 550/560 memory units, tested and successfully qualified the LCMM module. Factory shipments are now in process.

LADC Hardware Engineering is responsible for the sustaining engineering on the Xerox computer product line. However, due to limited available resources and with FED's understanding, activity was held to a minimum during 1977. 1978 will require dedication of resources to this important task.

The hardware programs at LADC during 1977 depended heavily on support services from Phoenix; the support we received was exceptional. Also, LADC has successfully bridged the learning curve to the Honeywell technology and the Phoenix way of doing things. We have established good working relationships with Engineering, Manufacturing, PAE and FED.

Manpower

LADC population at the time of the transition to Honeywell was 66. Staff build-up was rapid, and we began 1977 with a total staff of 96. A substantial part of the growth was the result of former Xerox employees returning. Through college, newspaper, agency, and employee-referral recruitment efforts, we grew to an employment level of 119 at year-end, and in addition we had retained the services of 9 contractors.

In spite of this growth, we have fallen short of our forecasted manpower goal. Four budget revisions during 1977 had an adverse impact on recruiting efforts, and some candidates were lost as a result of a relatively slow offer approval cycle. Our assumptions for attrition were considerably off the mark. Eleven applied and seven unapplied people left Honeywell in 1977, which considerably enlarged our recruitment task.

Our business plan and schedule commitments require an increased staff, and a major recruiting and hiring effort is planned for the first half of 1978. Every attempt will be made to make up the lost time.

LADC met its Affirmative Action Program goals for 1977. An equally aggressive set of goals will be established for the coming year.

Facilities

With the LADC population increasing by nearly one-fourth, we found our facilities inadequate and detrimental to employee motivation productivity. Offices became crowded and noisy. Programming productivity was also adversely affected by the shortage of terminals. Meeting facilities at LADC (one 10-person conference room) proved to be totally inadequate.

During the last quarter of 1977, negotiations were in process between Phoenix facility planners, the Los Angeles site building managers, and LADC administration to acquire additional office space. It is anticipated that LADC will complete negotiations for expanded facilities early in 1978.

Financial Report

LADC spending in 1977 was $4.7M gross ($4.4M net). The budget underrun was $300,000. The two major variances were $150,000, not expended on manpower due to the shortfall in recruiting, and we underran our EDA support from Xerox ($50,000).

On the negative side, additional effort was expended for MOS Memory problems; much of this effort (approximately $100,000) was charged back to the Marketing organization.

Conclusion

With 1977 in the books our attention is focused on the many difficult challenges in 1978. By year-end, we hope to be demonstrating CP-6 for Xerox users. Continued cooperation and support from our subcontractors in Phoenix is essential. We are depending heavily on them. We are also relying on the stability of our project plan which has enabled us thus far to track so close to our original schedule. We remain enthusiastic and optimistic about CP-6 and confident in more than fulfilling management's expectations for this project.