digital INTEROFFICE MEMORANDUM

DATE: January 24, 1968

SUBJECT: Large Modules for the PDP-X, Model 2

TO: Operations Committee

FROM: Roger Cady
Don White
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cc: D. Knoll
E. deCastro

The purpose of this memo is to acquaint the members of the Operations Committee with the reasons behind the decision to partially implement the PDP-X, Model 2 in large boards. We would appreciate any suggestions that will help guarantee the success of this effort.

Many discussions have taken place concerning the physical-packaging concept of the PDP-X; whether it should be built of large or small modules. This question has been received again; therefore, we feel there are several points that have not been brought up that require clarification.

One of the biggest objections to large module construction is that it adds another "newness" to an already new machine. Our contention is that large modules are not really that new, if looked at in the proper prospective. Discussions with Ed deCastro and review of the logic structure to date, are quite revealing. It is anticipated that the PDP-X processor would require about twenty (20) large modules with a break-down as follows:

Board	Quantity	Description	Comments	Type
1	2	Major Register		A
2	2	Fast solid-state memory		A
3	1	TTY in/out	½ size board	B
4	1	Paper Tape in/out	½ size board	B
5	1	Control Memory	same, regardless of module size on rest of machine	C
6	1	Control Memory S. A. & Buffer		A
7	1	API		E
8	1	Fast Memory Address Selector		A
9	1	Rope Memory Address Selector		A
10	1	IR, I/O Buffer Register		A
11	1	Memory Control		A
12	1	I/O Control		E
13	1	Memory Bus Drivers	May be same as 14	A
14	1	I/O Bus Drivers	May be same as 13	A
15	1	Timing		E
16	1	Indicator Register, Key filters, etc.		D
17	1	?		?
18	1	?		?

Type classification is the important thing on this list it reveals the problems of using this type construction. All boards of Type A are well organized logic structure that can be tested on existing test equipment by means of adapters and by testing in sections. These boards represent those areas of the processor least likely to change; thus, reducing scrap and ECO risks significantly.

Type B boards represent nothing more difficult than that which is used on the 8I. The only difference is that both in and out will be one board.

Type C is the control memory. It will be the same size regardless of the rest of the machine.

Types D and E represent the most difficult areas of the machine and those most likely to change. These modules represent a testing problem which can be met only with a large module tester capable of 144 pin-testing and diagnostic routines. Also, they represent a small percentage of the total processor and thereby can be built from small and medium sized modules (single and double size). This would place more logical points accessible to present test equipment, and more interconnection logic on the wired backboard.

When the subject, the large vs small module is approached, with the above in mind, it is evident, risks are much smaller than the first overall look may indicate. Manufacturing capability for large modules may be questioned, this indeed, is an important area.

At present, FLIP CHIP boards are manufactured four-high; essentially the same size as the proposed large module. Plans are being made to build 8I boards with plated-through holes the same way. The line widths and spacing are no more critical on the proposed, than on the 8I. In fact, improved layout techniques will make them more producible. Thus, if commitments to produce 8I boards are met, X boards can be produced.

Cost reduction is one of the key reasons for using large boards (about $1,000/system). It has been argued that this savings will be wiped out if the use of large boards makes the machine a few weeks late. Loss of Profit Before Tax that occurs if the X is in fact late (assuming that the Model 2 dies in 1972, regardless of when deliveries start), has been calculated. Result, it would require that deliveries start six-months late (due to large boards) before the large boards savings is wiped out for this computer.

Personnel committed to building, testing and programming the large-board approach, have flatly stated that it will be done on time.

Based upon the above information, plans to build the A, B, and C Types as large boards are in process. The D and E Types will be constructed on conventional boards. The 144 pin module tester will be implemented, as originally scheduled by the X project, to provide high speed - low cost testing of the large modules. However, the capability of testing these modules with existing testers will still exist as an alternate.

How much programing

oh

Win Hindle

COMPANY CONFIDENTIAL

PDP-X

MARKETING PLAN

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PART I:

GENERAL MARKETING APPROACH AND FIRST IMPLEMENTATION

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1. Breakaway from sophisticated users
2. More end user packages
3. With OEM approaching 50% why such high mktg cost

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*

8 January 1968

TABLE OF CONTENTS FOR PART I

0.0 INTRODUCTION

The development of the PDP-X is a major product line project to which a significant percentage of the corporation's resources have been pledged. Its goal is the creation of a product or series of products capable of generating thirty to fifty percent of the company's sales in the period of 1970-1973, as the company passes $100,000,000 in annual sales. It is the function of this marketing report to show how we expect to take the product our engineers are developing and use it to generate these sales.

But, the creation of a marketing plan for the PDP-X is a complex task, reflecting the following problems:

1. We anticipate that the PDP-X architecture will spawn more than one central processor design and perhaps as many as three or four. We do anticipate that these will all fall within the PDP-X concept, sharing commonality of I/O structure and upward compatibility of instruction set, but we expect their announcements to be spaced over several years and their relative contributions to sales to vary in time.

2. We expect the market for the PDP-X to be far more than the traditional market for small, real-time, on-line computers, and we are anticipating the need for the creation of a series of computer-based products (using the PDP-X) aimed at specific large markets not currently associated with computers. In this situtation, the PDP-X marketing plan must also encompass and reflect the individual marketing plans required for these markets for computer-based products.

3. We are fairly certain that the market, as we currently know it, will undergo radical changes in emphasis in the next five years, the period covered by this report. In that time, we expect to shift from our current customer mix that places a primary emphasis on end-user computer systems,

independent of application, with OEM sales a distant second and total applications packages (hardware <u>and</u> software) vanishingly small, to a market in which OEM customers may account for as much as fifty percent of sales, with total hardware/software packages (or computer-based products) providing most of the rest, and non-application-oriented hardware playing only a minor role.

4. Whereas previous products have experienced a two-to-three-year cycle, from introduction of the product to announcement of a true successor product, the PDP-X project is anticipated to span a four-to-five-year period, although at different times the primary emphasis may fall upon different processor models or applications.

In the light of the problems and assumptions listed above, it was deemed unwise, and perhaps impossible, to attempt a comprehensive and detailed marketing plan for all aspects of the product and its entire life span. Instead, this report has been designated PART I: GENERAL MARKETING APPROACH AND FIRST IMPLEMENTATION. In it we shall attempt the following tasks:

1. To define the total marketing task as we currently envision it, and to indicate, rather broadly, the approach we expect to follow throughout the project.

2. To detail as specifically as is now possible the marketing approach to be followed in promoting our first implementation of the PDP-X architecture, at least in its earlier years.

3. To indicate the time-tables to be attempted for the other major marketing efforts which should follow the marketing of our first model.

In future reports, we shall attempt to present and discuss:

1. Traditional marketing efforts to be applied to subsequent implementations of PDP-X architecture.

2. Applications-oriented marketing efforts, independent of processor model.

3. Definition, creation, and marketing of computer-based products, independent of processor model.

The probable topics of future reports as we now envision them are:

THE COMMUNICATIONS MARKET

THE RESEARCH MARKET

THE INDUSTRIAL MARKET

COMPUTATION AND TEACHING

PDP-X: IMPLEMENTATION OF MODEL I

Therefore, when studying this report, the reader is asked to bear in mind the dual purpose of this report -- to set the framework for the entire project and to present a marketing plan for the first implementation. He is asked to remember that some areas of the report, which may seem sketchy at this time, will be filled out by subsequent documents.

One further note is in order at this point. Because we are not in possession of sufficient data at this time, it is not yet possible to make accurate production cost estimates for our first implementation. As a result, no pricing section has been provided with this report; pricing therefore, will be the subject of a later short report. But several assumptions as to the general price range of the products were essential to the development of this report, and these assumptions are presented in Section 1.0 PRODUCT CONCEPT.

1.0 PRODUCT CONCEPT

As currently envisioned, the PDP-X project will produce a series of compatible computer systems, featuring upward-compatible central processors, a common I/O bus structure, and, probably, a range of memory speeds.

But to view the PDP-X family as merely another entry in the classical market for small, on-line, real-time computers is to severely and unnecessarily limit its market potential and product life. Instead, the PDP-X family should be considered in all of the following contexts:

1. As powerful, versatile, general-purpose computer systems for the OEM customers and end-users who have the interest and ability to generate the hardware and software needed for their applications.

2. As the heart of complete hardware/software packages for applications that require or justify dedicated computer systems.

3. As the heart of a series of computer-based products in which the presence of a computer is of little or no interest to the end-users.

4. As special-purpose controllers in which the read-only storage (ROS) is tailored to the specific application at hand, removing the PDP-X from the realm of general-purpose computers.

These concepts, and their implications, are discussed below and followed-up in the sections on Markets and Competition.

1.1 THE PDP-X AS A COMPUTER SYSTEM

The easiest concept of the PDP-X family to understand is that of a series of 16-bit word length computers. In this context, the PDP-X family has been designed to provide the most processing power consistent with the price range in which it will compete. Among its outstanding features will be:

1. Multiple general-purpose registers that can be employed as accumulators and/or index registers.

2. Several sets of general-purpose registers to provide simple and swift transformations from background program to program interrupt or priority interrupt level.

3. The ability to employ and intermix memories of varying speeds with the same processor.

4. The ability to tie several processors together to provide true multi-processor systems.

5. Upward compatibility among processors in the family and a common I/O bus structure for all models.

As presently planned, the PDP-X family will have at least two, and possibly three, processor models:

Model I will feature a minimum instruction set (comparable to the PDP-8); 4-32K memories; a simple, stand-alone software package, including USA Basic FORTRAN; two sets of in-memory general-purpose registers (background and program interrupt levels); an ADD time of four cycles; and a minimum price tag around $10,000.

Model II will offer an expanded instruction set (more powerful than the PDP-9); 4-64K memories; several central processor options including automatic priority interrupt, memory protection and relocation hardware; a monitor-based software package with USA FORTRAN IV and background/foreground capabilities; two to eight sets of hardware general-purpose registers (background, program interrupt, and, optionally, priortiy interrupt levels); an ADD time of two cycles; and a minimum price of $14,000 - $18,000.

Model III, if produced, would feature hardware floating-point arithmetic capabilities and time-sharing software.

Both Model I and Model II may be offered at more than one memory speed.

Development of hardware and software for Model II is currently underway, and this model will be brought to market first. Unless clearly specified to the contrary, all marketing plans discussed in this document are aimed primarily at the marketing of Model II.

Model II can be considered a direct replacement for the PDP-9, selling in virtually all of the markets, and for the same types of applications, as the PDP-9. In this respect, and by virtue of its lower prices, it should be able to capture the same type of customer and in larger quantities.

The PDP-9 is currently sold for a fairly wide range of applications -- on-line physics experiments, bio-medical research, film scanning, display terminals, industrial data acquisition and process control, hybrid and general-purpose computation, and communications -- but generally to the same type of customer. Whether end-user or OEM, the PDP-9 customer tends to be fairly self-sufficient, willing and able to develop his own software, knowledgeable in interfacing techniques, and generally advanced in his experience and use of computers. The PDP-X, Model II, with a lower price, a more powerful instruction set, a more convenient and compact size, and the same ease of interfacing as with the PDP-9, should appeal to this type of customer and should increase OEM sales.

1.2 PDP-X APPLICATIONS PACKAGES

But, with very few exceptions, the PDP-9 does not appeal to the less sophisticated customer who needs to buy a total hardware/software package for his application, because we have failed to identify and create enough of these total packages. Only in the case of the PDP-9 MULTIANALYZER for Pulse Height Analysis, have we begun to approach this concept, and there, too, we have not supplied all that the unsophisticated user feels he may need.

In this respect, we have much to learn from IBM, who of all of our competitiors, seems to best understand how to approach the unsophisticated market with confidence and ease. This we must learn, too, because the number of computer novices far outweighs the number of computer experts, and we must have a significant proportion of the former to make the PDP-X project a success.

So, in addition to supplying computer systems, we must be prepared to supply total applications packages -- hardware and software -- to solve a series of specific applications. Examples of these might be:

-- A patient-monitoring system

-- An industrial low-level data acquisition system

-- A mass spectrometry analysis system

-- A graphics terminal

To accomplish this, we must employ more product line applications specialists to study the applications markets and develop the necessary products.

1.3 COMPUTER-BASED PRODUCTS

Beyond the realm of applications packages lies the market for computer-based products -- products that accomplish one specific task and just incidentally contain a general-purpose computer (usually used in a special-purpose way). Examples of this type of computer usage are our own PDP-8 Typesetting System and Teradyne's Automatic Test System.

This market differs from the applications package market in several significant respects. In the applications package market, one is clearly selling a computer system which can and may be used as a general-purpose computer. In this case, processor power, availability of options, and software capabilities are important selling features. These are not important factors in selling computer-based products. Also, the customer purchasing an applications package is dedicated to the use of computers, even if he is a novice, and he wants to learn more, to extend his capabilities, to master the computer and his application. But the person purchasing a computer-based product may not care that it contains a digital computer, may never want to concern himself with details of how the computer operates and what more he can do with it.

Therefore, the marketing and sales approaches may be quite different for these two markets. But it is our belief that the potential market for computer-based products far outweighs all others. We intend to try to penetrate this market with Model II, using it to develop some products or to encourage OEM development of products, but we feel that the great gains in this market can be made by the Model I.

1.4 SPECIAL-PURPOSE CONTROLLERS

Some products and applications may not lend themselves to an approach that uses a true general-purpose computer. For these, we hope to be able to tailor the PDP-X to specific problems through the judicious use of read only storage (ROS).

1.5 SUMMARY: PRODUCT CONCEPT

The PDP-X project will lead to a family of 16-bit computers which will be used as the vehicles for:

1. General-purpose computer systems

2. Applications packages

3. Computer-based products

4. Special-purpose controllers

As the market progresses from (1) to (4), above, it:

1. Appeals to customers of less sophistication,

2. Cares less about general-purpose computing capabilities.

3. Needs less processor power.

4. Requires greater effort to identify and satisfy the application.

2.0 GOALS

The preliminary goals set forth in Tables 2-1 and 2-2 are derived from product line objectives for the time period, after PDP-9 contributions have been subtracted. These should be considered minimum goals; if detailed studies of the individual markets prove that these goals may be increased, this will be done at a later time.

But goals of dollars booked or shipped are not sufficient. Further goals for the PDP-X product line are:

1. Identification of those market areas which warrant in-depth support and applications engineering.

2. Development of marketing plans and products needed to capture significant percentages of those markets.

3. Creation of totally new market areas capable of absorbing significant numbers of computers in the next 5-10 years.

Table 2-1: PDP-X Shipments In Dollars And Units

Fiscal Year	1968	1969	1970	1971	1972	1973
Total Product Line Shipments (D)	$14.0	18.0	23.0	30.0	39.0	52.0
PDP-9 Shipments (D)	$14.0	17.4	11.4	4.0	4.0	----
PDP-X Shipments (D)	----	0.6	11.6	26.0	35.0	52.0
Average Price of PDP-X System	----	$15K(A)	45K(B)	45K(B)	35K(C)	35K(C)
Total Number of PDP-X Systems	----	40	260	600	1,000	1,500

Notes:

(A) $15K average system price assumes basic Model II systems only.
(B) $45K average system price assumes full Model II systems.
(C) $35K average system price assumes some Model I deliveries.
(D) Shipments are all X $1,000,000.

Table 2-2: PDP-X Bookings And Backlog In Dollars And Months of Production

Fiscal Year	1968	1969	1970	1971	1972	1973
PDP-X Bookings (A)	----	$2.8	20.0	30.0	40.0	50.0
PDP-X Shipments (A)	----	$0.6	11.6	26.0	35.0	52.0
PDP-X Backlog,$(A)	----	$2.2	10.6	14.6	19.6	17.6
PDP-X Backlog, Months of Production	----	6	5	5	4½	4

Notes:

(A) All dollar figures are X $1,000,000.

3.0 MARKETS

An easy definition of potential markets for the PDP-X includes:

1. All PDP-8 markets, plus
2. All PDP-9 markets, plus
3. Some selected PDP-10 markets, plus
4. Several new markets, hitherto untapped by DIGITAL.

Another way of stating it is to say that the PDP-X family can be marketed anywhere that 8-, 12-, 16-, 18-, or 24-bit computers are currently being sold or could reasonably be expected to be sold.

But, these are gross statements, providing very little insight into the nature or problems of the specific markets in which we hope to sell the PDP-X. As a result, in this section we hope to focus upon several aspects of the PDP-X market: the in-depth profile of the market in general and how it changes with anticipated volume of sales, the probable market strategies to be used, and the specific market segments in which we intend to capture the overwhelming majority of PDP-X orders.

3.1 MARKET PROFILE

In general, we are looking at the market for computers with on-line, real-time capabilities. Most of the sales are closely tied to one or more applications or areas of scientific or engineering interest. Until now, little or no attempt has been made to enter the business markets, and no plans currently exist to penetrate this field.

Within the areas of interest, at least 10-15 applications areas show promise for multiple computer sales. These will be discussed in Section 3.3 (below).

But all of these areas, indeed the entire market place, seem to exhibit the same general profile and characteristics. These seem worth identifying and studying, because our concept of the product (see Section 1.0) is closely related to the market profile.

A market -- or more rightly an application -- first seems to come to light in the early work of a few pioneers who purchase general-purpose computers and set them to work on specific tasks of interest to their profession or problem area. Largely unaided by the manufacturer, these pioneers often must supply their own special hardware and software. Examples of this type of pioneering are:

-- Dr. Busing's X-ray diffractometer system at Oak Ridge

-- The Mass General Hospital work in biomedical research

-- Bob O'Hagan's oceanographic data collection aboard the U.S.S. Evergreen for the U. S. Coast Guard

-- Dr. Bevington's early work in data collection and analysis of nuclear energy spectra at Stanford

But their work often generates considerable interest among their less daring ("if he can do it, so can I") or less capable ("but I don't understand and really don't have time to learn computers") colleagues. To handle this second level of customer, the manufacturer is called upon to supply a complete system - hardware and software - or applications package. The number of customers who will buy a complete package, as opposed to just a computer system, is often one to several orders of magnitude greater, but their lack of a common problem or agreement on the proper approach may frustrate the manufacturer who attempts one or more applications packages.

These two groups -- the applications pioneers and their less adventuresome colleagues -- comprise the obvious computer market; they are clearly in the market for computer systems. But beyond these groups are further markets for computers, among people who don't know that they need a computer, or couldn't care. These customers are interested in a product to accomplish one specific task or set of tasks. They are not interested in computers or are afraid of them, but they will purchase turn-key computer-based products as long as they do not have to commit themselves to personal involvement with the computer. And the less involvement required, the greater is the potential market.

Figure 3-1 illustrates our concept of the market profile.

3.2 MARKET STRATEGY

This market profile suggests the pattern of development for most applications markets. However, some market profiles may exhibit truncation, due to the lack of a sufficient number of pioneers, and may require the computer manufacturers to totally usurp the role of the pioneer. (Typesetting seems to be an example of this problem.) Others may have such a large population of pioneers and eager imitators that the market for computer-based products may seem a small part of the market for applications packages. (Physics appears to exhibit this behavior pattern.)

However, in general we feel this profile to be applicable and a guide to market development. We have used it as a basis for the development of our general market strategy.

3.2.1 GENERAL STRATEGY

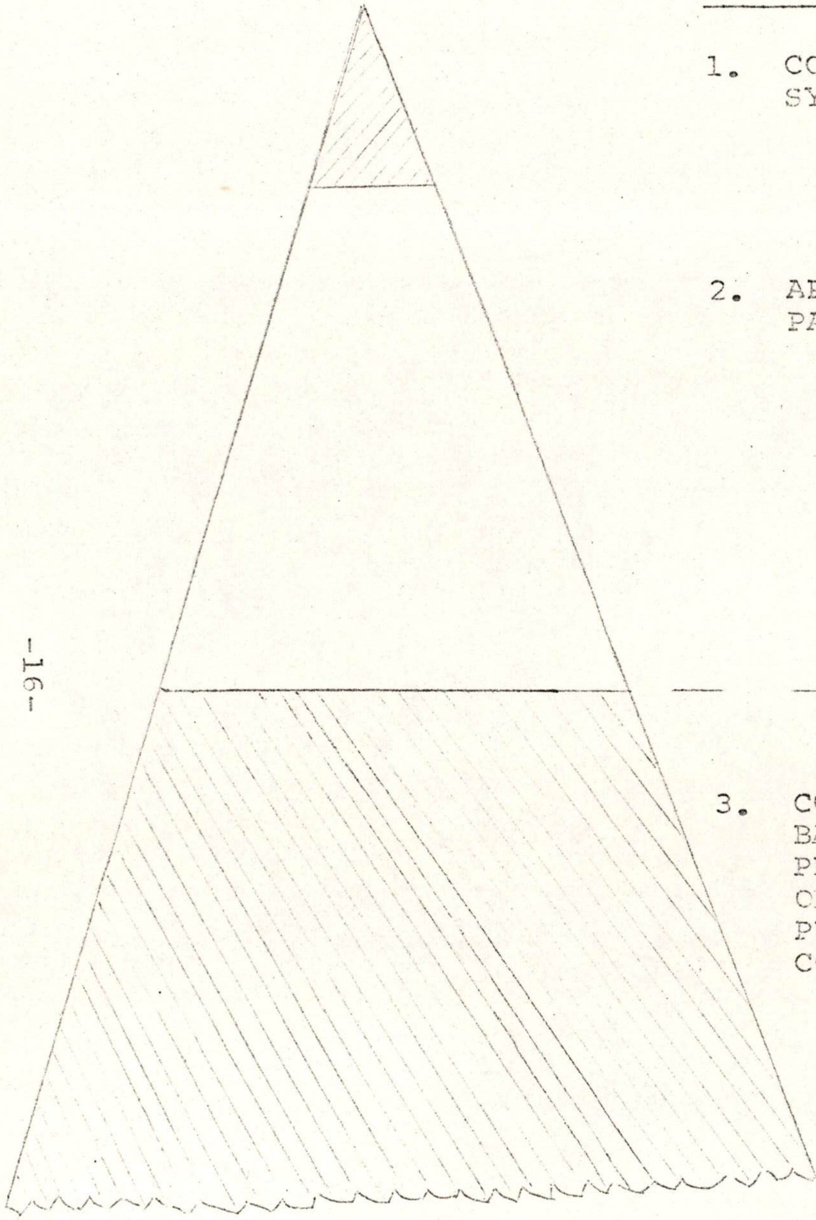
Our general PDP-X marketing strategy is as follows:

1. Group applications areas into major areas with common interests and sets of problems and assign to individuals or groups the overall responsibility for the development of applications within each area.

2. Identify those applications of sufficient market potential to warrant market development and determine the proper time schedule for this marketing effort.

3. Prepare a marketing plan for the effort to be expended in each applications area.

4. Assign market specialists or applications engineers to work with the applications pioneers in each field and to talk with potential customers for applications packages.



	CUSTOMER FOR	HIS OBJECTIVE	HE WANTS TO BUY	Market
1.	COMPUTER SYSTEMS	TO DEVELOP NEW COMPUTER APPLICATION	BEST AND LEAST-EXPENSIVE HARDWARE, MOST VERSATILE AND FLEXIBLE SYSTEM SOFTWARE	
2.	APPLICATIONS PACKAGES	TO USE COMPUTER TO AID IN RESEARCH OR ENGINEERING TASK	PACKAGE (HARDWARE AND SOFTWARE) TO ACCOMPLISH IMMEDIATE TASK PLUS INSURANCE THAT MANUFACTURER CAN SUPPORT HIM a. IF HE IS IN DANGER OF FAILING b. HE OUTGROWS EXISTING PACKAGE	TRADITIONAL COMPUTER MARKETS ↑
3.	COMPUTER-BASED PRODUCTS OR SPECIAL-PURPOSE CONTROLLERS	TO SOLVE ONE SPECIFIC PROBLEM, WITH OR WITHOUT HELP OF COMPUTER, BUT WITHOUT PERSONAL INVOLVEMENT WITH COMPUTER	TURN-KEY SYSTEM THAT OPERATES WITHOUT PERSONAL INVOLVEMENT	↓ NEW MARKETS FOR COMPUTERS

FIGURE 3-1: PROFILE OF THE COMPUTER MARKET

5. Identify, design, and market one or more applications packages for each market. This process should take considerable time, involve reiteration and redevelopment, and must be done with an eye toward continual evolution and expansion of both the applications packages and the markets for them.

6. Interest OEM customers in the design and marketing of computer-based products with a large vertical market. These computer-based products should relate significantly to current products the OEM customer markets and should, if possible, fall into areas where DIGITAL does not have as much technical competence as the OEM customer does. In the absence of suitable OEM customers, or if they exhibit considerable reluctance, significant consideration should be given to the development of these computer-based products by DIGITAL, either as a "pump-priming" effort or as permanent additions to the product line.

7. Convince the applications area, through vertical advertising, literature, and trade show appearances, that DIGITAL understands the area and is interested in supplying a total solution to its problems.

It is recognized that this strategy takes time and people to develop. But not all markets are at the same stage of development, and not all applications areas must be tackled in parallel. Section 3.3 (below) discusses those applications areas that currently seem to hold the most potential.

3.2.2 EUROPEAN STRATEGY

We recognize that past marketing plans have failed, through ignorance and lack of foresight, to plan for the proper introduction and support of new products in our European markets. Currently, about 30% of our PDP-9 sales are accounted for by our European subsidiaries, in spite of a delay in introduction, little support, poor communications, and the challenge of "European" products. With adequate planning and support and with production in Europe, this percentage could be much higher, perhaps up to 50-60% of our current PDP-9 sales rate.

In an attempt to properly service the European market for the PDP-X, we will follow the same general strategy outlined above, but with added emphasis on European details. We have asked John Leng to loan us one (1) experienced and qualified field salesman or manager for six months, beginning in the Spring of 1968 and ending at PDP-X announcement time. We propose to work with him to develop and implement an all-Europe marketing plan for the PDP-X, encompassing introduction, training of salesmen, preparation of literature, placement of advertising, and development of applications. He would return to Europe in time to train the sales force and supervise the announcement of the product to the public, and would then remain our chief PDP-X contact in Europe. We would maintain close liaison with the European field sales force through him, but, he would continue to work for the regional manager, not PDP-X marketing.

We also feel quite strongly that the PDP-X must be produced in Europe, hopefully both in Britain and a Common Market country. The man we have requested for six months might also eventually move into more than a marketing role, planning for and supervising PDP-X production in Europe.

3.3 APPLICATIONS MARKETS

At present, computer applications of interest to the PDP-X family (and particularly to MODEL II) fall into one of four major areas:

COMMUNICATIONS, including
- Remote terminals
- Graphics and displays
- Message concentrators
- Store-and-forward switching systems

RESEARCH APPLICATIONS, including
- Physics
- Biomedicine
- Analytical instrumentation
- Environmental sciences

INDUSTRIAL APPLICATIONS, including
- Data acquisition and logging
- Process control
- Component testing
- Tool and instrument control

COMPUTATION AND TEACHING, including
- Computation and simulation
- Time-sharing
- Computer-aided instruction and problem-solving

We are currently selling PDP-8s, PDP-9s, or PDP-10s in all of these areas, with varying degrees of success. But, we feel that significant efforts are called for in all areas to insure the success of the PDP-X.

Detailed marketing plans must be created for each application area to be attacked. Table 3-2 shows estimated yearly bookings by area, and the following represents our current thinking and approach to each application:

3.3.1 COMMUNICATIONS

This area has been mentioned first because of its enormous importance to the PDP-X project in general and to most other applications areas.

If we can solve the problems of communication between PDP-Xs, or between a PDP-X and any other computer, regardless of distance, a spectacular amount of business -- in graphics terminals, remote data acquisition systems, satellite computers, message concentrators, etc. -- will be easy to obtain. If we fail to solve the communications problem early, we may seriously hamper the growth of the PDP-X.

Our plans for this market are:

1. Develop the slower, general-purpose devices needed for long-distance communication (data-phone interfaces, etc.) and incorporate them into the product line as standard production options as soon as possible.

2. Develop those higher-speed direct connections that the market demands (PDP-X/PDP-X, PDP-X/IBM 360, etc.) and will have high enough demand to warrant their introduction as standard production items.

3. Assemble the information needed to be able to quote high-speed connections to other computers, as special systems, to handle the low-volume market situations.

TABLE 3-2: ESTIMATED YEARLY BOOKINGS BY MAJOR APPLICATIONS AREAS

FISCAL YEAR	1968		1969		1970		1971		1972		1973	
	$	%	$	%	$	%	$	%	$	%	$	%
COMMUNICATIONS APPLICATIONS	-		0.2	7%	2.5	12.5%	5.0	17%	7.0	17%	9.0	18%
RESEARCH APPLICATIONS	-		2.0	70%	14.0	70%	18.0	60%	23.0	58%	28.0	56%
INDUSTRIAL APPLICATIONS	-		0.5	19%	3.0	15%	6.0	20%	8.0	20%	10.0	20%
COMPUTATION AND TEACHING	-		0.1	4%	0.5	2.5%	1.0	3%	2.0	5%	3.0	6%
TOTAL PDP-X BOOKINGS	-		2.8	100%	20.0	100%	30.0	100%	40.0	100%	50.0	100%
OEM BOOKINGS	-		0.8	28%	7.0	35%	12.0	40%	17.0	42%	23.0	46%

4. With the problem of communication with other computers under control, focus attention on the development of communications-oriented applications packages or products to be produced by DIGITAL. These should include:

   -- A message concentrator (like the Type 680 Data Communications System)

   -- A graphics terminal capable of supporting 4-8 independent display surfaces

   -- A remote inquiry terminal capable of handling many alphameric CRT inquiry stations

5. Ultimately develop, either at DIGITAL or through selected OEM customers, the capability of producting store-and-forward message switching systems. The OEM approach is far more preferable, but, if the market proves large enough and the OEM customers do not move to fill the need, we may have to develop this capability ourselves.

With these types of plans in mind, we have set the highest priority on obtaining an applications engineer who can develop the necessary products and become the nucleus of a PDP-X communications applications group.

3.3.2 RESEARCH APPLICATIONS

The research applications, particularly physics and biomedicine, are the areas in which we are best known and in which we are currently working. The PDP-9 scientific applications team, currently including Bill McNamara, Jim Pitts, and John Wyatt, will be expanded to handle the increased demands of the PDP-X.

The scientific or research applications areas provide the most fertile ground for applications pioneers, and they have already provided us with a good basis for the development of applications packages and computer-based products.

In physics, we intend to move away from our overwhelming dependence on pulse height analysis, leaving it, for the moment, as the sole province of the PDP-9. But we do intend to promote the use of the PDP-X for numerous other applications -- film scanning, instrument and reactor control, mass spectrometry, etc. -- and to identify and create applications packages to meet specific needs. Pulse height analysis will be a later application, after demand for the PDP-9 diminishes.

In biomedicine, we would like to create a series of computer-based products for laboratory and hospital use. A biomedical data acquisition system, combining the best features of the LINC-8 and conventional logging equipment, might provide one product. Systems for clinical chemistry, patient monitoring, and several areas of research, seem to have extensive markets. Biomedicine seems particularly ripe for the total package approach of computer-based products, but actual definition of these products must await a more extensive study of the biomedical field.

Analytical instrumentation is a fast-rising field, and has provided a significant OEM market for the PDP-8 family. Their approach, to date, has been to promote the concept of one computer (PDP-8 or PDP-8/S) per application (X-ray diffraction, gas chromatography, mass spectrometry, IR spectrometry, etc.) and to encourage the suppliers of analytical instrumentation to become OEM customers. With the PDP-9, we have begun to promote the idea of one computer to handle a laboratory full of analytical instruments on a shared-time basis, and we believe we will be able to sell one or two large systems of this type within a few months. If these pioneer installations prove successful, as we anticipate, then we will be in a strong position to pursue this market with the PDP-9, extending its life.

With the PDP-X, we intend to promote both types of markets -- one computer per application and one computer per laboratory. With smaller configurations of PDP-X, MODEL II, we will try to develop applications packages for analytical instrumentation and will use these packages to stimulate OEM customers to produce computer-based products. The availability of MODEL I will accelerate the development of this market, but we do not intend to wait for MODEL I to begin market development.

With larger versions of MODEL II (16-32K, bulk storage, etc.) we will try to develop a multi-application laboratory system, but only after we have achieved success with either the PDP-9 systems or the PDP-X single-applications system.

The environmental sciences -- astronomy, geology, oceanography, seismology, and the exploration of outer space -- can, in total, represent a sizable market for computers. But, although we have sold two or three PDP-9s for astronomy, several PDP-8s for oceanography, and several PDP-7s for seismology, no single area seems to provide the market depth for us to warrant full-time applications support. In astronomy and oceanography, there are serious doubts as to whether these fields will ever support the development of applications packages and computer-based products. In geology and seismology, SDS and EMR, to support their other interests in the field of oil exploration, have developed elaborate hardware/software systems for the analysis of seismic records. But these systems have been configured around 24-bit and 32-bit computers plus expensive high-speed multiplication units, and the data they handle would probably be awkward for 16-bit computers. We intend to follow the trends of these markets and continuously review our approach to them, but at this time we have no plans for a concerted marketing effort in any of them.

The space science market, on the other hand, has considerable depth and provides a good base of business to several of our competitors, including Honeywell (3C), SEL, and SDS. We have never been too successful in penetrating this market with the PDP-7 and PDP-9 and have been particularly hampered by our lack of reliability calculations, MIL SPEC documentation, and 19-inch rack mountable equipment. We intend to remedy all of these defects with the PDP-X and will try to achieve a serious degree of market acceptance. However, since the market in which we are interested is the systems house market, not the end-user market, our efforts will be limited to marketing, selling, and proposal support rather than applications engineering or product development.

3.3.3 INDUSTRIAL APPLICATIONS

As opposed to the research fields where DIGITAL has a high degree of market acceptance, in the industrial markets we are still largely unknown. But our recent advertising, the publication of the Industrial Handbook, and the development of K Series modules and digital data acquisition systems provide us with the means for establishing and promoting an identity within the market.

Several key applications areas are of interest to the PDP-X product line. The MODEL II should provide an excellent vehicle for the establishment of our own line of data acquisition systems. The entire PDP-X family should be of interest to the process control field. Industrial testing of components and systems, and automatic control of tools and instruments, are both beginning to show promise as future computer markets for all PDP-X models.

Our approach to the industrial markets will be fairly simple, since we feel that we are still operating in this area in the face of a great amount of uncertainty about both the size and profitability of the total market and our role in it. We expect to hire a senior applications engineer or market specialist to supervise our overall effort in the industrial markets. He will be expected to:

1. Plan, with the Data Acquisition Systems Group (Clark Crocker and Dick Sorenson), the development and marketing of a series of data acquisition systems built, initially, around MODEL II and, eventually, MODEL I.

2. Promote the OEM sales of the PDP-X for process control applications, striving to land and hold several key accounts in both the U. S. and Europe. He will probably have to turn to the Systems Programming Group for a special monitor system geared to meet the needs of this market. Non-OEM sales in this field will probably remain negligible.

3. Investigate and monitor the fields of industrial testing and instrument and tool control. If the potential seems to justify it, he can:

    a. Advertise and otherwise promote our capabilities in these fields.

    b. Hire applications engineers to develop applications packages or computer-based products for the most promising applications.

c. Provide support to OEM customers attempting to develop these fields.

Obviously, our success in the industrial market depends very heavily upon finding the right person to develop it, and we are currently concentrating upon this task. When we have found him, and he has had the opportunity to study the problems, our complete marketing plan for the industrial market will be the subject of a separate report.

3.3.4 COMPUTATION AND TEACHING

The applications in this area include:

General-purpose computation and simulation

Hybrid computation and simulation

Time-sharing

Teaching the use of computers as an aid to problem-solving

Computer-aided instruction

Although somewhat different, they have been combined into one general topic because they all require heavy software support and a thorough knowledge of programming.

Because they are so different, each application may require a separate and different market approach. Because we have had so little experience in these fields, and because we will be forced to battle IBM head-on in many of them, we must proceed with caution, and it is quite possible that we will forego participation in several areas.

As a minimum, however, we would like to accomplish the following:

1. Establish the reputation of the PDP-X as a partner in small hybrid systems. To do this, we must provide a hybrid software package, including a JOSS-like language and a hybrid operations interpreter. This will help us produce OEM sales of the PDP-X. In addition,

if the market seems sufficient, we can provide one or more standard hardware linkages to popular analog computers. We will be testing this market before-hand with the PDP-9, although without software, to try to determine its depth.

2. Penetrate the market for computer-aided instruction, either directly or through OEM customers, with a series of computer-based products. Since cost is such an important factor in the education field, we will probably need the MODEL I for successful penetration of the market, but prototype development can begin with MODEL II.

3. Promote the direct sale of both MODEL I and MODEL II to secondary schools, junior colleges, and colleges as a vehicle for instruction in the use of computers in problem-solving and general computation.

The other fields are much more problematical at this time. General-purpose scientific and engineering computation, although offering a vast potential market, implies head-to-head competition with IBM and requires the ability to supply card I/O, line printers, and software applications packages. Without the necessary peripherals, we will probably forego this field; with them we may try to make inroads into IBM's domination of the market.

Time-sharing, too, may be dependent upon the availability of hardware, in this case MODEL III. If we decide to build MODEL III, it will be because of the potential field for smaller time-shared systems, but it is certainly too soon to make this type of decision. A time-sharing system built around larger versions of MODEL II is a possibility, too, but it will have to await the completion of the software for smaller versions of MODEL II.

4.0 COMPETITION

Because of the markets we intend to seek for the PDP-X, we are faced with two types of competition: competition from other computer manufacturers, and competition from non-computer-based systems and products. The competition picture will be further clouded by the fact that, increasingly, we will come into competition with our own customers or potential customers.

4.1 COMPETITION FROM COMPUTER MANUFACTURERS

We expect competition for one or more models of the PDP-X from every manufacturer of 8-, 12-, 16-, 18-, and 24-bit computers, as well as our own PDP-8 family, PDP-9, and LINC-I. Table 4-1 summarizes the current competition, by word length. But for Model II, most of the competition will come from the 16-bit word length computers, and in that field the chief competitors will probably be:

IBM 1800 and 1130 (or their successors)

Honeywell (3C) DDP-516 and DDP-416

Hewlett-Packard 2116A and 2115A

Varian/DMI 620I

4.1.1 THE TWO-MARKET THEORY OF COMPETITION

In examining the competition for the PDP-X, we were puzzled by the often-conflicting demands of the marketplace. To account for this, and to aid in our understanding of the competition, we have developed a two-market theory which we have found to be helpful.

Although the competitors listed in Table 4-1 represent a broad range of capabilities and commitments to software, peripherals, and support, they tend to polarize into two groups: (1) compact central processors/systems controllers and (2) general-purpose computer systems.

Table 4-1: COMPUTER COMPETITION

8-Bit Word Length	12-Bit Word Length	16-Bit Word Length	18-Bit Word Length	24-Bit Word Length
INTERDATA	DEC PDP-8/S	CDC 1700	DEC PDP-9	EMR 6020*
Model 2	PDP-8			6040
Model 3	PDP-8I	EAI 640*	VARIAN/DMI	6050
Model 4	LINC-I		622I	6070
		EMR 6130*		
	SCC 650			GE/PAC 4000
		H-P 2115A		
		2116A		HONEYWELL
				(3C) DDP-124
		HONEYWELL		
		(3C) DDP-416		SCC 655
		DDP-516		660
				670
		IBM 1130		
		1800		SEL 840A
				840MP
		RAYTHEON		
		703IC		
		SDS SIGMA 2		
		SEL 810A		
		810B		
		VARIAN/DMI		
		620I		

* May no longer be in business

In the former group we have placed the PDP-8 family, the INTERDATA series, the HEWLETT-PACKARD computers, the HONEYWELL (3C) DDP-416, the VARIAN/DMI 620I and 622I, and the RAYTHEON 703IC. In general, this group is characterized by an OEM emphasis or OEM-like approach, with strong emphasis on low-price, compact size, ease of integration into a system (either the OEM customer's or the end-user's) and one application per dedicated processor. Less attention seems to be paid to software depth and power, availability of a full line of traditional computer peripherals, services, and support.

In the general-purpose computer market we have grouped the IBM computers, the DDP-516, the SDS Sigma 2, the CDC 1700, the SEL 810 series, the EAI and EMR computers, the PDP-9 and the 24-bit computers. This market is much more end-user oriented (though many do well in the OEM field), and tends to require extensive software, monitor systems, FORTRAN IV, a full range of data processing peripherals, field service, and customer support.

The PDP-9 has tried, not always successfully, to compete in both markets. The PDP-X Model II must compete in both, although eventually the Model I can assume some of the burden of the former field. This may put extraordinary demands upon both the software and marketing efforts of the Model II, to make it appear simultaneously as a true competitor in both markets.

The discussions that follow are intended to detail the type of competition provided by the major competitors in each of these markets: Varian/DMI and Hewlett-Packard in the central processor/system controller market and Honeywell (3C) and IBM in the computer systems market.

4.1.2 VARIAN/DMI

With their acquisition by Varian Associates, Data Machines Inc. (DMI) have achieved financial stability, marketing and sales support, and a built-in market, if they choose to develop it, for computer-based instrumentation for Varian's analytical devices.

Their 620I and 622I computers are attractively priced, as shown on the enclosed price list (Table 4-2). Their ability to offer a 4,096-word system has already cost us sales at Boeing, CERN, and in Canada. And LRL has done a price comparison between the 622I and the PDP-9 (both 8K) that shows them practically identical in price (LRL bought PDP-9s on the basis of our service organization and their experience with FLIP CHIP modules). Also in favor of the 620I are its compact size and its use of integrated circuits.

On the negative side are their small sales force, their almost total lack of field service, and the unproven reliability of their integrated circuit cards (large boards). But these may be overlooked by both the computer applications pioneer and the OEM customer, so Varian/DMI can and already is becoming not only a formidable competitor but, perhaps, an indication of the competition wave of the future.

4.1.3 HEWLETT-PACKARD

Although their approach is apt to be slightly different than Varian's, Hewlett-Packard provides an even more serious challenge to our marketing plans, with direct attacks both on the OEM markets and the markets for computer-based products. Already H-P is marketing low-level data acquisition systems and has exhibited systems for gas chromatography and biomedical research. They are also steady exhibitors at the Annual Physics Show and have just announced a non-computer PHA system; their next logical step would be a computer-based system similar to the PDP-9 MULTIANALYZER.

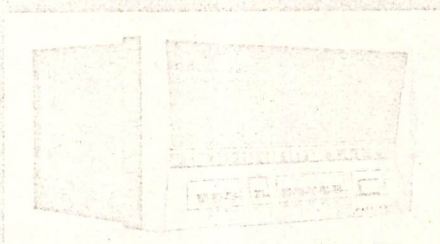
TABLE 4-2:

DATA 620/i SYSTEMS COMPUTER

PRICE SCHEDULE

MODEL NUMBER	DESCRIPTION	PRE-REQUISITES	PRICE
620/i-00	Systems Computer equipped with 4096 words (16 bit) core memory, console, Programmed Party Line I/O and power supply	None	$12,500
622/i-00	Systems Computer equipped with 4096 words (18 bit) core memory, console, Programmed Party Line I/O and power supply	None	$14,500
620/i-01	Memory expansion/peripheral controller chassis. Includes power supply and expansion capability for up to three 620/i-02's	620/i-00	$ 1,500
620/i-02	Memory increment, 4096 words by 16 bits (three per 620/i-01)	620/i-01	$ 6,000
622/i-02	Memory increment, 4096 words by 18 bits (three per 620/i-01)	622/i-01	$ 6,500
620/i-03	Memory parity option, 1st 4K (16 bit)	620/i-00	$ 2,000
620/i-04	Memory parity option per memory module (16 bit)	620/i-02 620/i-03	$ 1,200
620/i-05	Memory protect (16 bit or 18 bit computer)	620/i-00 622/i-00	$ 1,500
620/i-06	First TTY ASR 33 and adaptor	620/i-00	$ 1,400
620/i-07	First TTY KSR 35 and adaptor	620/i-00	$ 2,800
620/i-08	First TTY ASR 35 and adaptor	620/i-00	$ 3,800
620/i-10	Hardware multiply/divide and Extended Addressing	620/i-00	$ 2,500
620/i-11	I/O Party Line Neg. Logic	620/i-00	$ 1,000
620/i-12	Direct memory access and interrupt logic	620/i-00	$ 1,000
620/i-13	Real Time Clock	620/i-12	$ 1,000
620/i-14	Power failure/restart	620/i-12	$ 1,000
620/i-15	MICRO-EXEC Facility	620/i-00	$ 2,000
620/i-16	8 multilevel priority interrupts AC	620/i-12	$ 1,000

PRICES VALID ONLY IN U.S.A.—ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE



The prices for the 2115A and 2116A are extremely attractive (see Tables 4-3 and 4-4), and our competitive intelligence leads us to believe that H-P could cut central processor prices up to 20%, if they desired, without becoming unprofitable. Their system documentation is very complete and impressive, and their sales force is expanding rapidly, sometimes at our expense.

The biggest weakness in their strategy seems to be their approach to the use of the computers within their own company. All H-P computer-based products or applications packages are to be prepared by the H-P division interested in the system, not by the central computer group. If the gas chromatograph group wishes to develop a product using the H-P 2115A or 2116A, they must develop their own group of computer experts. This means that their own internal customers, who could represent considerable market potential, are in no stronger position than outside OEM customers and may be weaker, since they are forced to compete with the H-P computer group for programming and engineering talent. We can exploit this weakness, if we choose, by developing closer ties to our OEM customers, providing more engineering, programming, and marketing assistance, and promoting knowledge of their products (that use our computers) through our sales force.

But H-P will remain a strong competitor, and our overall PDP-X strategy will be:

1. To try to approximately equal their computer system prices, while offering more hardware power and more versatile software.

2. To offer selected applications packages or computer-based products (data acquisition systems, in particular) that strongly compete with their products, both in price and performance.

3. To develop a strong group of OEM customers who, in combination, can compete with H-P in any applications field they attack.

In summary, our strategy will be a direct challenge to H-P in <u>most</u> applications areas, plus developing several applications in which they are not involved.

TABLE 4-3: H-P 2115A PRICE LIST

ORDERING INFORMATION

HP 2115A COMPUTER (4096-word memory, 2752A Teleprinter included) $16,500

PROCESSOR OPTIONS

8192-Word Memory	Option M4*		5,000
Memory Parity Check. . . .	Option M2	(or field kit 12580A)	1,000
Extended Arithmetic Unit . .	Option M9	(or field kit 12579A)	3,000
Direct Memory Access . . .	Option M11	(or field kit 12578A)	3,000

**Memory expansion from 4K to 8K field-installable only on special order; consult factory.*

INPUT/OUTPUT OPTIONS

Order I/O options by option number ("K" number). Subseque t orders for interface kits *must* state system serial number so that proper software is furnished.

I/O OPTION	CAPABILITY	INTERFACE KIT	PERIPHERAL	OPTION NO.	PRICE	
					115v,60Hz	230v,50Hz
TELEPRINTER INPUT/OUTPUT	HP 2115A records on typewriter and punched tape, and inputs from keyboard and punched tape, at 10 characters/sec. (ASCII code)	12531B	HP 2752A Teleprinter (modified Teletype ASR-33)	K1	2,000	2,200
HEAVY-DUTY TELEPRINTER INPUT/OUTPUT	Similar to Option K1 above, except heavy-duty Teleprinter is furnished. Recommended where use exceeds 5 hrs/day or 30 hrs/week.	12531B	HP 2754A Teleprinter (modified Teletype ASR-35)	K2	4,600	Not Available
HIGH-SPEED PUNCHED TAPE INPUT	HP 2115A inputs from punched tape at 300 characters/sec. (ASCII code)	12532A	HP 2737A Punched Tape Reader (with accessory 12525A Tape Holder)	K3	2,100	2,200
HIGH-SPEED PUNCHED TAPE OUTPUT	HP 2115A records on punched tape at 120 characters/sec. (ASCII code)	12536A	HP 2753A Tape Punch	K5	4,100	4,150
INCREMENTAL MAGNETIC TAPE OUTPUT (1200 FT REELS)	HP 2115A records on IBM-compatible, 1/2 inch, 7 channel NRZI tape. Bit density 200 bpi. Recording speed 400 characters/sec. Reel capacity 1200 feet.	12537A	Kennedy 1406 Incremental Tape Transport	K6	6.250	6.400
INCREMENTAL MAGNETIC TAPE OUTPUT (2400 FT REELS)	Similar to Option K6 above, but reel capacity 2400 feet.	12537A	Kennedy 1506 Incremental Tape Transport	K7	7,500	7.650
LOW DENSITY MAGNETIC TAPE INPUT/OUTPUT	HP 2115A records on, and reads from, IBM-compatible 1/2 inch 7-channel NRZI tape. Bit desnity 200 bpi. Speed 30 ips.	12538A*	HP (H26) 2020A Magnetic Tape Unit	K8	12,500	12,700
DUAL DENSITY MAGNETIC TAPE INPUT/OUTPUT	Similar to Option K8 above, but HP 2115A records and reads at both 200 and 556 bpi.	12538A*	HP (H26) 2020B Magnetic Tape Unit	K9	15,000	15,200

• Following I/O Options K10 through K25 do not include the peripheral. *Use 2 I/O slots

TIME BASE GENERATOR	Generates real time intervals in decade steps from 100 μs to 1000 sec (derived from crystal oscillator). Used as source of timed interrupts for software clock.	12539A	None required	K10	1,000	1,000
DATA PHONE INTERFACE	Interfaces HP 2115A with Bell System Data Phone service	12540A	Bell System Data Set 103A	K11	1,000	Not Available
DIGITAL VOLTMETER DATA INPUT (HP 2401C)	HP 2115A accepts bcd (8421) data output from HP 2401C Integrating Digital Voltmeter	12541A	HP 2401C Integrating Digital Voltmeter (with mod. M21)	K12	750	750
DIGITAL VOLTMETER DATA INPUT (HP 3440A)	HP 2115A accepts bcd (8421) data output from HP 3440A Digital Voltmeter	12543A	HP 3440A Digital Voltmeter (with 8421 output)	K14	750	750
COUNTER/THERMOMETER DATA INPUT (8 DIGITS)	HP 2115A accepts bcd (8421) data output from 8-digit electronic counter and the quartz thermometer	12544A	HP 5245L Electronic Counter (with option 02). HP 2801A Quartz Thermometer (with mod. M6)	K15	750	750
DIGITAL VOLTMETER PROGRAM OUTPUT (HP 2401C)	Enables HP 2115A to select function, range, etc., of HP 2401C Integrating Digital Voltmeter	12533A	HP 2401C Integrating Digital Voltmeter (with mods. M21, 146)	K20	750	750
DIGITAL VOLTMETER PROGRAM OUTPUT (HP 2401C/2411A)	Same as Option K20 above, except HP 2411A Data Amplifier included	12550A	HP 2401C (M21, 146) Digital Voltmeter and HP 2411A DAta Amplifier	K21	750	750
CROSSBAR SCANNER PROGRAM OUTPUT (HP 2911)	Enables HP 2115A to select channel, settling delay, for HP 2911 Guarded Crossbar Scanner	12535A	HP 2911A Guarded Crossbar Switch and 2911B (M33) Scanner Control	K23	1,000	1,000
GENERAL PURPOSE DUPLEX REGISTER	Dual 16-bit flip-flop register. Permits bidirectional transfer of information between HP 2115A and external devices. (Accessory kit includes 48-pin mating connector.)	12554A	Determined by user	K24	750	750
RELAY OUTPUT REGISTER	Provides 16 form A contacts for operating external devices. (Accessory kit includes 48-pin mating connector.)	12551A	Determined by user	K25	600	600

TABLE 4-4: H-P 2116A PRICE LIST

HP-2116A COMPUTER .... $22,000.
(4096-word memory, no I/O options)

8192-Word Memory .... Option M4 (or field kit 12568A) .... $ 8,000.
(basic 4K + 4K additional)

Memory Parity Check .... Option M2 (or field kit 12569A) .... $ 1,000.

Memory Test .... Option M3 (or field kit 12570A) .... $ 420.

(Modifications M2, M3 may be field-installed without assistance from HP. Modification M4 may also be field-installed, but assistance of computer field service engineer recommended.)

HP-2116A INPUT/OUTPUT OPTIONS

◉ I/O options consist of interface kit (which includes software) and peripheral. I/O options K1 through K9 include peripheral; options K10 through K25 do not include peripheral. ◉ I/O options may be ordered by option number, either with original purchase of HP-2116A or subsequently. Later orders must state serial number of HP-2116A so that proper software is furnished. Computer field service assistance is recommended for installation of I/O options subsequent to original purchase of HP-2116A; consult computer sales engineer or factory for service charge involved. ◉ Auxiliary HP-2160A power supply may be needed when using most of the available I/O slots; consult computer sales engineer or factory.

I/O OPTION	CAPABILITY	I/O SLOTS USED	INTERFACE KIT	PERIPHERAL	OPTION NO.	PRICE $ 115v, 60Hz	PRICE $ 230v, 50 Hz
TELEPRINTER INPUT/OUTPUT	HP-2116A records on typewriter and punched tape, and inputs from keyboard and punched tape, at 10 characters/sec. (ASCII code)	2	12531A	HP-2752A Teleprinter (modified Teletype ASR-33)	K1	2,000	2,200
HEAVY-DUTY TELEPRINTER INPUT/OUTPUT	Similar to Option K1 above, except heavy-duty Teleprinter is furnished. Recommended where use exceeds 5 hrs/day or 30 hrs/week.	2	12531A	HP-2754A Teleprinter (modified Teletype ASR-35)	K2	4,600	Not Available
HIGH-SPEED PUNCHED TAPE INPUT	HP-2116A inputs from punched tape at 300 characters/sec. (ASCII code)	1	12532A	HP-2737A Punched Tape Reader (with accessory 12525A Tape Holder)	K3	2,100	2,200
HIGH-SPEED PUNCHED TAPE OUTPUT	HP-2116A records on punched tape at 120 characters/sec. (ASCII code)	1	12536A	HP-2753A Tape Punch	K5	4,100	4,150
INCREMENTAL MAGNETIC TAPE OUTPUT (1200 FT REELS)	HP-2116A records on IBM-compatible, 1/2 inch, 7 channel NRZI tape. Bit density 200 bpi. Recording speed 400 characters/sec. Reel capacity 1200 feet.	1	12537A	Kennedy 1406 Incremental Tape Transport	K6	6,250	6,400
INCREMENTAL MAGNETIC TAPE OUTPUT (2400 FT REELS)	Similar to Option K6 above, but reel capacity 2400 feet.	1	12537A	Kennedy 1506 Incremental Tape Transport	K7	7,500	7,650
LOW DENSITY MAGNETIC TAPE INPUT/OUTPUT	HP-2116A records on, and reads from, IBM-compatible 1/2 inch 7-channel NRZI tape. Bit density 200 bpi. Speed 30 ips.	2	12538A	HP (H26) 2020A Magnetic Tape Unit	K8	12,500	12,700
DUAL DENSITY MAGNETIC TAPE INPUT/OUTPUT	Similar to Option K8 above, but HP-2116A records and reads at both 200 and 556 bpi.	2	12538A	HP (H26) 2020B Magnetic Tape Unit	K9	15,000	15,200

◉ Following I/O Options K10 through K25 do not include the peripheral.

TIME BASE GENERATOR	Generates real time intervals in decade steps from 100 μs to 1000 sec (derived from crystal oscillator). Used as source of timed interrupts for software clock.	1	12539A	None required	K10	1,400	1,400
DATA PHONE INTERFACE	Interfaces HP-2116A with Bell System Data Phone service	1	12540A	Bell System Data Set 103A	K11	1,000	Not Available
DIGITAL VOLTMETER DATA INPUT (HP-2401C)	HP-2116A accepts bcd (8421) data output from HP-2401C Integrating Digital Voltmeter	1	12541A	HP-2401C Integrating Digital Voltmeter (with mod. M21)	K12	1,250	1,250
DIGITAL VOLTMETER DATA INPUT (HP-3440A)	HP-2116A accepts bcd (8421) data output from HP-3440A Digital Voltmeter	1	12543A	HP-3440A Digital Voltmeter (with 8421 output)	K14	1,250	1,250
COUNTER/THERMOMETER DATA INPUT (8 DIGITS)	HP-2116A accepts bcd (8421) data output from 8-digit electronic counter and the quartz thermometer	1	12544A	HP-5245L Electronic Counter (with option 02). HP-2801A Quartz Thermometer (with mod. M6)	K15	1,250	1,250
COUNTER DATA INPUT (7 DIGITS)	HP-2116A accepts bcd (8421) data output from 7-digit electronic counters	1	12545A	HP-5244L, 5275A Electronic Counters (with option 02).	K16	1,250	1,250
COUNTER DATA INPUT (6 DIGITS)	HP-2116A accepts bcd (8421) data output from 6-digit electronic counters	1	12546A	HP-5201L, 5202L, 5203L, 5232A, 5233L, 5532A, Counters (with option 02)	K17	1,250	1,250
COUNTER DATA INPUT (5 DIGITS)	HP-2116A accepts bcd (8421) data output from 5-digit electronic counters	1	12547A	HP-5212A, 5214L, 5233L, 5512A Counters (with option 02)	K18	1,250	1,250
COUNTER DATA INPUT (4 DIGITS)	HP-2116A accepts bcd (8421) data output from 4-digit electronic counters	1	12548A	HP-5211A/B Counters (with option 02)	K19	1,250	1,250
DIGITAL VOLTMETER PROGRAM OUTPUT (HP-2401C)	Enables HP-2116A to select function, range, etc., of HP-2401C Integrating Digital Voltmeter	1	12533A	HP-2401C Integrating Digital Voltmeter (with mods. M21, 146)	K20	1,000	1,000
DIGITAL VOLTMETER PROGRAM OUTPUT (HP-2401C/2411A)	Same as Option K20 above, except HP-2411A Data Amplifier included	1	12550A	HP-2401C (M21, 146) Digital Voltmeter and HP-2411A Data Amplifier	K21	1,000	1,000
CROSSBAR SCANNER PROGRAM OUTPUT (HP-2911)	Enables HP-2116A to select channel, settling delay, for HP-2911 Guarded Crossbar Scanner	1	12535A	HP-2911A Guarded Crossbar Switch and 2911B (M33) Scanner Control	K23	1,500	1,500
GENERAL PURPOSE REGISTER	16-bit flip-flop register. Permits bidirectional transfer of information between HP-2116A and external devices. (Accessory kit includes 48-pin mating connector.)	1	12549A	Determined by user	K24	950	950
RELAY OUTPUT REGISTER	Provides 16 form A contacts for operating external devices. (Accessory kit includes 48-pin mating connector.)	1	12551A	Determined by user	K25	600	600

1 JAN 67
18 AUG 67

4.1.4 HONEYWELL (3C)

Among the competitors providing total computer systems, Honeywell's 3C Division has the product with the greatest technical strength. The DDP-516 has an attractive base price ($23,800 for 4K); a full set of computer peripherals, including disks, drums, IBM-compatible magnetic tape, card readers, and line printers; a powerfull software package, approximately equivalent to that of the PDP-9; and the capability for 19-inch rack mounting.

Currently, a large proportion of their sales are to OEM customers - Gerber Scientific, Stromberg-Carlson, Radiation, Inc., Philips, to name a few - but their recent efforts, particularly in Europe, are aimed at greater penetration of the end-user scientific research markets. Biomedicine seems to be a prime target, and they are offering special prices and free programming support to capture several key scientific installations. Communications, too, is a market of extreme interest to the DDP-516. We can safely assume that 3C has studied all of our PDP-8 and PDP-9 markets and is currently working on plans to attack most of them.

But the DDP-516 (and the DDP-416, if it becomes real competition) can be beaten in several ways. First, the products have not proved as profitable as anticipated, and memory prices for the DDP-516 and CPU prices for the DDP-416 have been raised at least once. This means that a lower priced product, like the Model II PDP-X, can take away significant sales without fear of compensating 3C price reductions.

Second, 3C still does not have wide acceptance in the scientific research markets. Continual advertising and support work in this field, as we are planning, plus strong efforts to capture new applications markets before 3C realizes their potential, should keep us in good shape in these markets.

Third, their OEM success is based upon fairly large sales to a relatively few customers - most of whom we also courted, but lost through our own mistakes or inflexibility. We can work harder to keep them from acquiring major new OEM customers, and we can make a strong effort with the PDP-X to win over some of their large-volume accounts. Their OEM terms are not as good as ours, so they are vulnerable to a strong selling effort.

Finally, much of the European appeal of Honeywell is their claim to be producing computers in Europe. To combat this, and competition from true European products, we must plan to produce the PDP-X in at least one place in Europe.

4.1.5 IBM

Although the IBM 1800 is not truly competitive on either price or performance, and the IBM 1130 is not really a real-time computer, they or their successors must be considered strong competition for the PDP-X. In fact, in some areas of the U.S. (Mid-West, Texas), most PDP-9 competition comes from IBM.

The 1800 has sold widely for process control, inventory control, research applications, and scientific calculations. In spite of its comparatively high price and low performace, it has sold well because of:

1. Competitive leasing rates;
2. Relatively low-cost data processing peripherals (card I/O, line printer);
3. A low-cost bulk storage system;
4. A software system that has been sold well, making competitors toe up to it;
5. IBM's approach to each application market, where they are prepared to lose a fixed amount of money in order to achieve dominance in the market; and

6. IBM's approach to the market in general, where they play upon the customer's lack of confidence and fear of failure and sell the idea that IBM and all of its resources are behind him.

The IBM 1130 has sold spectacularly for scientific computation for small groups, departments, or businesses, and slightly for on-line, real-time applications. Its relatively low price, the availability of a number of special software applications packages, plus the reasons listed for the 1800 (above), make it virtually unchallenged in the field of small computers for scientific and engineering calculations.

Competing directly with IBM can be extremely difficult; unless we are prepared to sell at a lower price, lease, and supply all of the services, gratis, that IBM offers, such a course is bound to meet with only limited success. But IBM's marketing strategy does lend itself to competition in several significant ways, and these we are prepared to exploit.

First, IBM has not shown exceptional abilities in designing and producing state-of-the-art hardware, either CPUs or real-time peripherals. Thus, customers who are interested in hardware details can be sold the PDP-X instead of IBM by selling them on our specifications FIRST. In other words, we must reach the customer before he calls IBM and sell him on our capabilities and ways of solving problems.

Second, although IBM's software packages for the 1800 have received wide acceptance, they have some serious faults (response time, core requirements, etc.). We expect to be able to offer similar software with better specifications and to teach our salesmen how to sell against IBM.

Third, we must concentrate on developing applications in which we have a head start or obvious advantage over IBM and must ignore those into which IBM is pouring large amounts of resources. We should continue to push physics and biomedicine, develop communications and displays, and not try to test IBM directly in scientific computation and process control.

Fourth, IBM has made it clear that they are only interested in the end-user market and in selling computer systems. This means that we can and must develop both the OEM market and the markets for computer-based products. These sizable markets will probably remain fairly free of competition from IBM.

Fifth, if we can offer direct leasing sometime in the future in a limited number of cases, we can further challenge IBM.

In summary, although IBM is a formidable competitor in some areas, and probably blocks significant access to several others, their market strategy allows plenty of room for growth of the PDP-X.

4.1.6 OTHER COMPUTER COMPETITORS

Although none of the other competitors shown on Table 4-1 are currently considered major competition, several of them do have the potential to provide a serious challenge. In addition, although this table does not show any European-based competition, there are several signs that we may soon be facing a challenge in Europe from "home grown" products.

SDS, of course, has the resources to be a serious competitor, and the Sigma 2 can be an attractive system. Only SDS determination to concentrate on the Sigma 5 and Sigma 7, to the detriment of the Sigma 2, plus their problems in delivering software, prevent the Sigma 2 from being serious competition.

SEL, on the other hand, is concentrating on the 16-bit computer market with the 810A and 810B, and is growing at a rapid rate. By the time the PDP-X is announced, SEL may be a major U.S. competitor, particularly in on-line scientific applications and aerospace systems. Their entry into European markets may take some time.

CDC is currently marketing one of the oldest 16-bit computers in the field, the 1700. Coupled with their uncertain policies in the past, this tends to make the 1700 only sporatic competition. The key question with CDC is whether they are contemplating a replacement product; we currently have no intimation that they are.

The Raytheon 703IC cannot be considered as potential serious competition. Raytheon (formerly Packard-Bell) has not made a significant attack on the market since the PB250, and the literature and peripherals available for the 703 do not lead one to believe it is a major effort.

EAI and EMR are in such serious difficulties with the 640 and 6130, respectively, that each week brings new rumors of their demise. Neither has ever proved to be a significant competitor, but the death of the EAI 640 might re-open EAI as a market for our computers.

SCC, too, has never proved to be more than a casual irritant, causing one or two lost sales per year. Nothing in the foreseeable future can cause this situation to change, unless they both abandon their 12- and 24-bit computers for 16-bit ones and are acquired by a company with a strong sales and marketing force.

The rest of the 24-bit computers (GE/PAC 4000, DDP-124, EMR 6000 series, SEL 840 series) probably will not provide any competition for the PDP-X. By the time we develop the Model III, all of these should be obsolete. Currently, only the GE/PAC 4000 provides competition for the PDP-9, and only in the process control field where GE is seriously competing with the IBM 1800.

New entries in the field are always a possibility. RCA is rumored to be developing a 16-bit computer; English Electric-Leo-Marconi has announced a 16-bit system; and a French company seems interested in this market. But without strong international sales and marketing forces, these cannot be considered to be strong possibilities for competition for several years.

4.2 NON-COMPUTER COMPETITION

The development of computer-based products will bring us further in competition with non-computer products. Although each of these must be combatted with an individual plan, our overall approach to markets with non-computer competition will be to:

1. Establish an identity in the market through the judicious use of advertising and trade shows.

2. Train our supporting personnel and selected field salesmen in the details of the applications for which the computer-based products are intended.

3. Write, or have written, articles for technical journals which appeal to the applications markets and stress the advantages of computer-based systems. Make reprints of these articles available in quantity for use by salesmen.

4.3 THE CUSTOMER AS A COMPETITOR

If, as we hope, we are able to develop a high percentage of OEM business for the PDP-X, we will have to face up to a serious problem: competition from customers and potential customers.

For example, Adage, Inc., could become a customer for the PDP-X and include it in display terminals or data acquisition systems, both of which would be in competition with similar products we might choose to market. How can we sell Adage under these circumstances?

Although we currently do not have an answer to how to handle this problem, we are acutely aware of it and will try to seek an answer. Probably, this solution will result in a set of guide lines for our salesmen to use when confronted with the problem, plus an examination of each individual case by PDP-X marketing. Better solutions are urgently desired and are being studied.

4.4 DIGITAL AS A COMPETITOR

So far we have ignored what may be one of our largest sources of competition for the PDP-X - our own established products like the PDP-8, PDP-9, LINC-I, and PDP-10.

This competition will be strongest among the customers for computer systems, where the glamour and low price of a new product (PDP-X) will outweigh the longer delivery and lack of extensive applications packages. But it could be significant in the areas of applications packages and computer-based products, too, if we choose to develop

PDP-X applications and products that compete with existing ones for the PDP-8 or PDP-9.

We hope to defer, and perhaps eliminate, much of this intra-company competition by our choice of initial applications areas. With the exception of communications, which is vital to the total success of the PDP-X project, we intend to focus initially on those applications that either have not been attempted by our present products or are clearly handled much better by the PDP-X. Thus, for example, we will start early on analytical instrumentation packages, defer or ignore pulse height analysis and typesetting.

5.0 SCHEDULE AND PERSONNEL

Table 5-1 shows the schedule of major marketing events for the PDP-X for the next ten (10) quarters, starting with this marketing plan and ending with the announcement of MODEL I. Both events of general marketing interest and those pertaining to the four key marketing areas -- communications, research, industrial, and computation/teaching -- are shown.

This schedule reflects the following assumptions about personnel:

1. That the current PDP-9 support staff (3 people) will be retained and gradually phased over to PDP-X projects.

2. That the three (3) current openings in the group will be filled in this quarter, two of them hopefully by experts in communications and industrial applications.

3. That we will add approximately one (1) new applications engineer, applications programmer, or marketing man per quarter, beginning in the fourth quarter of Fiscal 1968.

The structure and duties of the PDP-X marketing group, as presently envisioned, are shown in Figure 5-2.

Table 5-1: SCHEDULE OF MAJOR EVENTS

QUARTER	GENERAL MARKETING	COMMUNICATIONS	RESEARCH	INDUSTRIAL	COMPUTATION/TEACHING
F'68,Q3	Submit marketing plan for PDP-X Model II Start PDP-X Sales Notebook Start PDP-X promotions plan Hire three (3) people -Communications expert -Industrial expert -General marketing man	Hire communications expert Start communications plan	Start research applications marketing plan	Hire industrial expert Start industrial marketing plan	
F'68,Q4	Start European expert (on loan) on European marketing plan Hire new business school graduate for general product line marketing Select key accounts for advance presentations Submit promotions plan	Submit communications marketing plan Start design of communications modules Start design of display systems	Submit research appl. marketing plan Start work on first application Select key OEM accounts for advance presentation	Submit industrial marketing plan Start design of first data acq. products Select key OEM accounts for advance presentations	Start marketing plan computation and teaching areas

Table 5-1: (continued)

QUARTER	GENERAL MARKETING	COMMUNICATIONS	RESEARCH	INDUSTRIAL	COMPUTATION/TEACHING
F'69,Q1	Make advance presentations to key accounts Finish sales notebooks Submit European marketing plan Place first advertisement Prepare training for field salesmen Prepare announcement mat'l. including brochure		Make advance presentations to key OEM Hire another research applications engineer Start work on second application	Make advance presentations to key OEM accounts	Submit marketing plan for computation and teaching Hire applications programmer for computation applications Start first applications packages
F'69,Q2	Train salesmen (October) Announce PDP-X, Model II (November) Show PDP-X at FJCC (December in S.F.)	Announce first communications modules -Dataphone Interface -PDP-X/PDP-X Link -PDP-X/IBM360 Link	Prepare PDP-X literature for Physics Show and Pittsburgh Conference on Analytical Chemistry	Hire second industrial market expert Start design of other products for industrial market	

Table 5-1: (continued)

QUARTER	GENERAL MARKETING	COMMUNICATIONS	RESEARCH	INDUSTRIAL	COMPUTATION/TEACHING
F'69,Q3	Prepare and publish support material Exhibit at Physics and Analytical Chem Meetings	Start design of message concentrator Hire second communications expert	Exhibit PDP-X at Physics and Analytical Chem Meetings Announce first applications package	Announce first data acq. products	Start development of market for computer-aided instruction Start second applications packages
F'69,Q4	Exhibit at SJCC and FASEB Start marketing plan for Model I Deliver first 40 Model IIs Hire another business school graduate for general marketing	Announce first display systems at SJCC	Exhibit at FASEB Announce second applications package		Announce first software applications packages
F'70,Q1	Submit Model I marketing plan	Announce message concentrator		Announce second set of products for industrial market	Announce second software applications packages

Table 5-1: (continued)

QUARTER	GENERAL MARKETING	COMMUNICATIONS	RESEARCH	INDUSTRIAL	COMPUTATION/TEACHING
F'70,Q2	Exhibit at FJCC Start production overseas(?)				
F'70,Q3	Prepare for announcement of Model I				
F'70,Q4	Announce Model I				

FIGURE 5-2: PROPOSED STRUCTURE
OF PDP-X MARKETING GROUP

- GROUP VICE PRESIDENT STAN OLSEN
  - PRODUCT LINE MANAGER J. A. JONES
    - MARKETING MANAGER D. B. COTTON — DUTIES: GROUP MANAGEMENT, LONG-RANGE PLANNING, REPRESENTATION OF PDP-X ON MARKETING COMMITTEE

	GENERAL PDP-X MARKETING GROUP- (NO MANAGER)	MGR. COMMU-NICATIONS APPLICATIONS (NEW HIRE)	MGR. RESEARCH APPLICATIONS W. G. McNAMARA	MGR. INDUS-TRIAL APPLI-CATIONS - (NEW HIRE)	COMPUTATION AND TEACHING APPLICATIONS (NO MANAGER)	EUROPEAN PDP-X MARKETING GROUP (MGR. FROM SALES)
	MKTING TRAINEES PLUS INTERFACING EXPERT AND SOFT-WARE SUPPORT PROGRAMMER	APPLICATIONS SPECIALIST FOR DISPLAY APPLICATIONS	APPLICATIONS SPECIALISTS IN PHYSICS, BIOMEDICINE, ANAL. INSTR.	ONE OR TWO APPLICATIONS SPECIALISTS	ONE TO THREE APPLICATIONS PROGRAMMERS WRITING SOFT-WARE PACKAGES	EUROPEAN FIELD APPLICATIONS SPECIALISTS
LIAISON WITH:	PROMOTIONS GROUP, TRADE SHOW GROUP, SALES ADMIN-ISTRATION	DISPLAY PRODUCTS GROUP	SPECIAL SYSTEMS, BIOMEDICAL APPLICATIONS GROUP	DATA ACQUISI-TION PRODUCTS GROUP, SPECIAL SYSTEMS	SYSTEMS PROGRAMMING	EUROPEAN TRADE SHOW GROUP, EUROPEAN APPLICATIONS PROGRAMMING GRP
DUTIES:	GENERAL PRODUCT LINE MARKETING, INCLUDING DEVELOP-MENT OF MARKETING PLANS, OEM SALES SUPPORT, AND SUPPORT OF OTHER GROUPS	DEVELOP COMMUNI-CATIONS MODULES, COMMUNI-CATIONS AND DISPLAY APPLICATIONS	DEVELOPMENT OF RESEARCH APPLI-CATIONS, WITH EMPHASIS ON PHYSICS, BIOMED-ICINE, AND ANALYTICAL INSTRUMENTATION	DEVELOPMENT OF ALL INDUS-TRIAL MARKETS, PARTICULARLY THROUGH OEM SALES	DEVELOPMENT OF SOFTWARE PACKAGES TO SUPPORT SALES FOR COMPUTAT-IONAL (NON-ON-LINE) APPLICATIONS	DETAILED NON-APPLICATIONS MARKETING IN EUROPE

wex

digital INTEROFFICE MEMORANDUM

DATE: December 28, 1967

SUBJECT: PDP-X Packaging

TO: John Jones
cc: Pete Kaufmann

FROM: Dave Knoll

Below are some of my thoughts and concerns which relate to risk and packaging on the X project. While most big board - little board discussions look at the situation at steady state, my thoughts will be directed at how we get there. I agree that we must at some time develop and use big board technology.

Current "X" plans are calling for new software, new hardware, new packaging concepts, new field service concepts, new testing concepts etc. - all on a very tight schedule. It seems that fewer "new" things we do, the less risk there is if not being able to do one of them. Shouldn't our strategy be to pick the one or two most important new things and do them well on the X? Certainly all of the new things mentioned above have to be and will be done eventually by DEC. Should they all be done on the first X version? I think that much of the answer lies in how costly it would be to have the schedule slip. What is the value of time?

In considering the current schedule, it seems to me that we have a very optimistic goal to shoot at if we are to ship in Jan - Mar 69. Of even more concern to me is our ability to have a clean, solid product by then and, therefore, be able to build up the production rate after the first shipments. Most of our talk seems to be about when we can ship the first X. To me, this is a rather insignificant milestone in the whole program. My concern is more with the quantity and the effect of changes and how they effect the buildup rate and cumulative shipments. Once the product is solid, the production rate can be increased rapidly.

To me it seems quite likely that the combination of 1) a limited amount of processor and option testing "in the laboratory" 2) the lengthy turnaround time for changes, and 3) trying to do 'too many' new things at once will add up to a six month slippage in the planned buildup rate. At the same time, I expect we will be scrapping a fair number of boards.

To put it differently, using large boards is quite analogous to using printed circuit back plane wiring in that it is a great cost saving technique so long as there aren't changes. Where changes occur, lead times and scrap costs mount.

The points above are my intuitive feelings. It is difficult to put a price tag on these factors. In the simplest case though, it has been proposed that time is worth 30K/day ($900,000/mo.) on the X project. It has also been estimated that big boards will save about 1K per machine or 60K/month at full value. To me we are, therefore, facing a gamble as follows:

Win:	save 12-18 months @ 60K/month	= $1,080,000
Lose:	lose 6 months @ 900K/month	= $5,400,000

Win means ship on the current schedule including buildup rate and lose means be six months behind. On these terms, this is a gamble I wouldn't take!

The cost of losing would be entirely different if the PDP-9 could be extended for six months. In this case the cost of time goes way down and the gamble changes. The schedule assumptions of shipping machines without having first tested all peripherals and to ship machines without full software packages means to me that there is felt to be an overriding necessity to get on the market fast. If this is true, then I suggest we build the machine from small boards, use existing testers, add printed circuit back panel wiring when the ECO's stop, and not worry about the $1000/unit extra cost. As soon as the product is proven to be solid and past all 'make work' ECO's, it should be repackaged in a program with only one unknown - large boards and their testing. The value of repackaging at this point would not be so much to save the $1000/unit as it would be to prove a new manufacturing technology - big boards for use in future versions of the X and other DEC products.

On the other hand, if the $1000/unit seems a large figure, then I suggest that time is not of such value and the first shipments of X's be planned for six months later after the unit and its options are clean and tested.

Dave

jb

	($,000)	FY '68	FY '69	FY '70	FY '71	FY '72(?)
8.	NOR	0	600	11,600	25,200	12,600
32.	G.M.	0	300	5,800	12,600	6,300
49.	Sales	70	670	2,000	2,400	1,300
59.	Eng.	629	1,100	700	500	400
60.	Admin.	50	220	850	1,500	800
70.	PBT	(749)	(1,690)	2,250	8,200	3,800
	Cumulative PBT	(749)	(2,439)	(189)	8,011	11,811

Pro Forma Income Statement
PDP-X FY 68-72
11-29-67
JAJ

digital INTEROFFICE MEMORANDUM

DATE: October 5, 1967

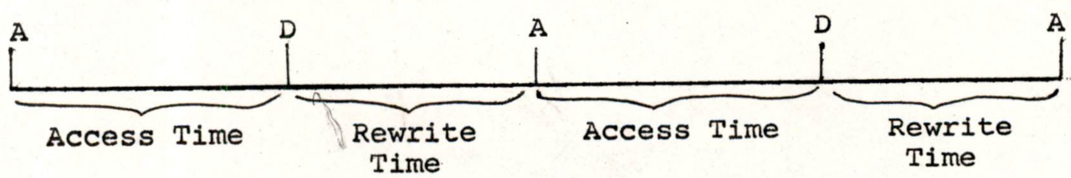
SUBJECT: PDP-X DESIGN APPROACH

TO: Operations Committee FROM: Ed de Castro

The design approach to many of the elements of the PDP-X system is now well defined. Several other areas, however, are still under consideration and alternative approaches are being pursued. The following discussion explains on an item by item basis the approach chosen and the reasons for that choice or the alternatives still open to consideration.

1. Memory System

A 3D, 3 wire, shared sense inhibit system has been chosen. The other alternatives available were a 3D, 4 wire system and 2½D system. The 4 wire approach was discarded simply because of cost. A stack to implement the system would cost about $400 (33%) more than the one chosen. The decision not to use 2½D was based both on the cost of the memory system and its influence on the cost of the processor. Although the costs of the 2½D and the 3D stacks are identical, the costs for driving electronics are quite different. The 2½D approach requires 152 switches as opposed to 48 for the 3D system. Likewise, 2½D requires 768 diodes as apposed to 512. The other source of economy is derived from the timing relationship between the processor and memory. The figure below shows two typical back to back memory cycles indicating the points in time of interest to a processor.



A = Address Ready D = Data Ready

A memory cycle is initiated by the processor when it transfers an address and a request for data to the memory. The processor then sits idle until the data becomes available from the memory. The elapsed time between these two events is called the memory access time and during this time the processor is not productively employed. As soon as the data is available it must utilize this information to calculate the next address for transmission to the memory. There is a fixed period of time during which this must be done in order that the memory may continue at full speed.

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Since this computation requires quite a bit of processor action the speed of the circuits required is determined by this time.

A 2½D memory characteristically has a long access time and a very short rewrite time. The 3D system has a short access time and a longer rewrite time. Thus slower and cheaper circuits may be used in the processor if a 3D memory is chosen.

2. Processor

The central processor will utilize a transfer bus organization for data paths and a read only memory for control. Circuits will be TTL, compatible with those currently being used in the PDP-8I. In some critical areas the high speed versions of these circuits will be used.

The read only memory approach appears to offer several advantages over the conventional method. It allows a better organized and lower cost system when the complexity is fairly high and it permits a single processing unit to perform several functions such as arithmetic operations and I/O device control.

The processor will operate asynchronously with memory, and thus memories of any speed less than 800 nsec can be used.

3. Input Output Bus

A byte oriented I/O bus will be used. This system allows the same I/O devices to be used on processors having word lengths which are multiples of 8 bits. Redundant I/O device design will thus be eliminated in the future. Electrically the bus will be a bi-directional differential current bus. This system allows the use of low cost twisted pair rather than coaxial cable. Motorola is currently developing integrated transmitters and receivers for this type of system. However, initial designs will probably use discrete components. Final specifications for this bus are awaiting recommendations from the large computer group.

4. I/O Device Controllers

Complex I/O device controllers such as tape controls, line printer controls and display processors will be implemented with standard processors. Appropriate programs stored in read only memory will perform the detailed device control functions. This scheme will allow us to build one processor in very high volume and avoid the need for production of specialized controllers.

5. Packaging

The details of the packaging scheme are as yet undecided. The very high percentage of the PDP-8I cost (35%) which is spent on packaging, indicates that some effort should be put in this area. We are presently experimenting with large boards capable of holding 80 integrated circuits. It appears that some other inter-connection method will be needed to supplement the etched board.

The entire system is planned to be compatible with E.I. A. standard 19" rack mounting. Thus making it more attractive to potential O.E.M. customers.

6. Control Memory

The control memory will be constructed from a linear transformer matrix similar to the PDP-9. We are currently conducting experiments to determine the best way to drive and sense a memory this large. We are also working with the vendor to obtain a core with better mechanical and magnetic characteristics. One promising drive scheme involves the use of standard integrated circuits as drivers and differential amplifiers for sensing.

7. Memory Bus

A restricted memory bus system will be used. This system allows two connections to each memory module. One part will be used by the arithmetic processor and the other will be shared by all other devices under the control of an arbiter. This concept allows for both fairly inexpensive memory controls and the realization of the limited multiprocessing capability inherent in this archetecture.

8. Test Techniques

These techniques are very strongly influenced by the packaging scheme that is finally adopted. If big boards are used we will concentrate our testing effort at the IC & subassembly levels. A multistation, computer driver, functional subassembly tester is envisioned as the best way to approach this problem. Final test is not expected to be very difficult.

9. System Speed

The substantial increases in memory speed that have occurred during the past several years have now made the processor as well as the memory an important determinant of system speed.

Several manufacturers have introduced systems with very fast memories and processors which can not keep up. This appears to be an uneconomical approach since equal performance could be obtained by using the same processor with a slower and cheaper memory. Processor cost in the range of interest is a very strong function of speed and thus we do not want to build a very fast processor which must wait for the memory. We have, therefore, concluded that a balanced system should be built.

There are two natural ranges of memory speeds which exhibit reasonable cost differences and therefore were chosen for consideration. These speeds are .75 - 1 µsec and 1.5 - 2.0 µsec. The table below shows the expected memory and processor costs to achieve these speeds. Costs do not include packaging or I/O equipment.

	Fast .75 - 1 µsec	Slow 1.5 - 2 µsec
MEMORY	2100	1500
PROCESSOR	2000	1400
TOTAL	4100	2900

Both alternatives appear attractive and there probably is a market for both versions. However, we do not feel that we can pursue both machines simultaneously and thus must select a single version for first introduction.

Ed

jeg

Hardware Registers + full instruction set

		SLOW MOD I	SLOW Mem MOD II	FAST Mem MOD II
1.	Without packaging & I/O (TTY)	$ 2300	$ 2900	$ 4100
2.	TTY	700	700	700
3.	present packaging (50% of item 1 + item 2)	1500	1900	2600
	Total	4500	5500	7400
	less TTY	-700	-700	-700
	Hi Cost Total	3800	4800	6700
6.	Saving if low cost package (50% of item 3)	-700	- 900	-1300
7.	Lo Cost Total	3100	3900	5400

Figure 1
Mfg. Costs

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		Mem Speed	Add Time	4K No I/O ~~Cost~~ Price	4K No I/O Mfg Cost *	Cost ** in one year
DMI	620I	1.8	3.6	12K	4	3.3
H.P.	2116A	1.6	3.2	22	7½	6.2
SDS	Sigma 2	.9	2.25	26	8½	7.0
CCC	516	.96	1.92	24	8	6.6
CCC	416	.96	1.92	17	6	5.0
SEL	810B	.79	1.58	~25	8½	7.0
EMR	6130/.9	.9	1.8	34	11	9.1
EMR	6130/.6	.6	1.2	?	?	?
SLOW MOD I		1.5	6.0			3.1
SLOW MOD II		1.5	3.0			3.9
FAST MOD II		.8	1.6			5.4

* 1/3 of 4K No I/O Cost

** 83% of *

Figure 2

Competitive Comparsions

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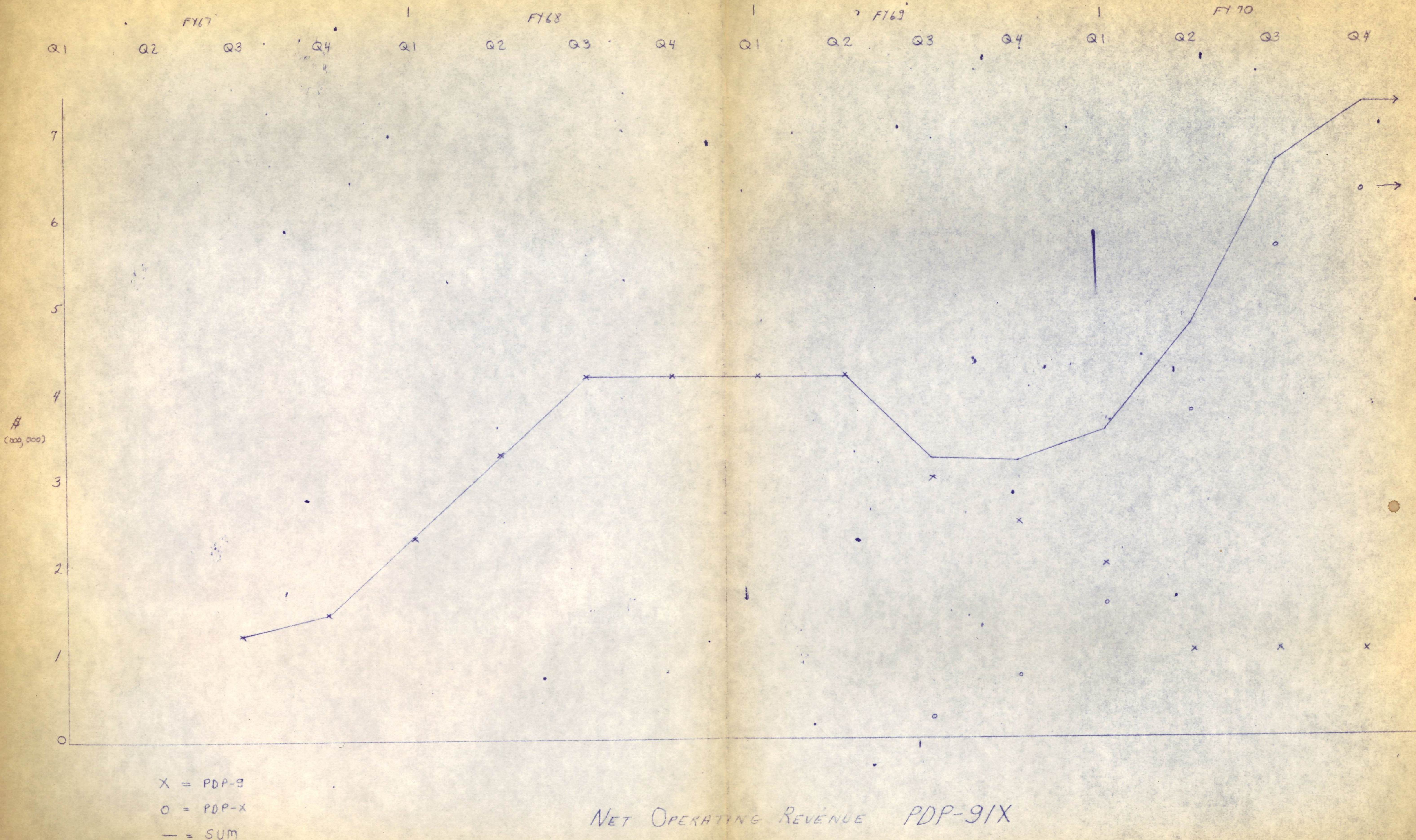
	(2) SLOW MOD I	SLOW MOD II	(1) FAST MOD II	
Memory with C. O.	6 mos 1E 1T	6 mos 1E 1T	8 mos 2E 1T	R Sogge P. Bingle? T.
Processor no C. O. used both as CP and I/O	10 mos 1E 1T (because a new man must learn architecture)	10 mos 2E 1T (because a new man must learn architecture)	8 mos 2E 1T	Burkhardt Brooke D Longaker
Processor C. O.	2 mos	2 mos 1E 1T	3 mos 1E 1T	
I/O	full set of controls needed	1E 1E	1E	B. Young
Circuits	.5E	.5E	1E	Sogge Lewis
Control Memory	-	.5E	.5E	
Same diagnostics	must do total software	✓	✓	
Same Sys. Software	must do total software	✓	✓	
Engineers Elapsed Time	6E 12 mos	6E 12 mos	7½E 11 mos	

Figure 3
Time Allowance

JAJ
10-13-67



NET OPERATING REVENUE PDP-9/X

7/20/67
J.A.J.

Win Hindle

28 July 1967

To: Members of the Executive Committee

From: J. A. Jones

Subject: PDP-X Proposal

On Monday, July 31st, Ed deCastro and I will make a proposal to the Executive Committee to begin work on a new small computer. The purpose of this presentation is to gain the Committee's approval to begin implementation of the proposed architecture.

The presentation will be in three parts:

1. Technical Considerations
2. Schedule Goals
3. Pro-Forma Income Statements FY 68-70.

Although approval is only being sought for the technical work, the other areas are being covered to show how this project fits into our overall product plan.

The enclosed memorandum and charts will be discussed at the meeting on Monday. They should provide useful back-up material.

We will be prepared to answer questions in any area that may assist the Committee in making a decision. Your comments and suggestions will be greatly appreciated.

digital INTEROFFICE MEMORANDUM

DATE: July 27, 1967

SUBJECT: TECHNICAL JUSTIFICATION FOR PDP-X

TO: Executive Committee FROM: Ed de Castro

PDP-X has grown out of experience with DEC's large and small computer lines, the design strives to achieve performance levels comparable to the largest machines through optional features added to a basically simple structure. In many ways PDP-X is a refinement of PDP-8, sharing the same basic word structure and basic instructions, but also including important design advances that will make it competitive with other products over the next several years. These features are:

1. More Modern Processor Design

a. Current DEC small computer designs are limited by their architecture to make very inefficient use of the available technology. For example, both the PDP-8I and the PDP-9 have all the necessary hardware to implement an index register, but their Op Code structure prohibits this. PDP-X architecture makes far better use of the available technology, yielding an improved price performance ratio; at least a factor of 3.

b. One of the more obvious problems with current small-machines designs has been their inefficient use of core memory, a system resource whose cost has been rising relative to the cost of the processor logic. Indeed, a major cost-reduction technique used in PDP-8/S design was the development of a far less expensive memory. PDP-X architecture makes more efficient use of available core memory through the introduction of a more powerful instruction set and an addressing structure that eliminates the (sometimes hidden) memory waste in sector addressing and single accumulator small-computer designs. The ability to directly address all of memory easily, when necessary, simplifies the task facing the programmer by eliminating the need for complex linking structures as found, for example, in the PDP-9. In addition, the more casual customer or application programmer can generate working programs far more quickly.

c. In the next few years, as large scale integration (LSI) becomes more readily available, later implementations of the new architecture can effectively take advantage of the "standard" LSI devices now being developed. Current computer products such as PDP-9 could be constructed around "custom-built" LSI but the economic advantages are only marginal.

d. The new architecture has many unimplemented operation codes. As LSI ROS becomes available, new instructions can be added without significantly effecting cost. The ROS approach to the control allows elimination of much of the "random" logic that is so difficult to package and test. This approach also allows use of the same processor for diverse functions, such as a dedicated IO device controller.

2. Wide Range of Possible Processor Performance

a. PDP-X basic configurations expand neatly over a far wider range than current products. Use of a read only storage (ROS) for Op Code expansion and special peripheral controllers permits increasing system capability at moderate cost. The addition of integrated, active memory arrays will speed interrupt processing as well as the more complex instructions. We can reasonably expect to offer 3 processors, all of which use the same architecture. These would replace the present PDP-8, PDP-9 and PDP-24.

b. Not only is the architecture implementable in several processor models whose price and performance span the entire small computer market, but it also includes a model sufficiently small and inexpensive to use as an (OEM) IO device controller.

c. The major reasons for the wide range of possible processor performance include:

1. Large, partially implemented, Op Code set

2. Variable number of interrupt levels with associated register sets

3. Use of main core memory to replace hardware registers

4. Facility for multi-user/multiprocessor configurations without drastic alterations to basic processor

5. Use of ROS to create dedicated IO or OEM controllers

3. Design Features For Real-Time and Multi-user Environment

Real-time usage has become an important factor in computer sales and applications; three very distinct usages stand out. The first is the dedicated on-line system where the cost of the device (e.g., a particle accelerator) interfaced to the computer far outweighs the later's cost. PDP-X hardware provides a better order code, extremely fast interrupt response time, higher speed core memory, and a faster IO system; in addition, the software package includes a set of highly optimized, re-entrant arithmetic and utility routines to allow this sort of real-time usage.

The second is used by an OEM who requires the smallest and simplest processor possible to imbed in his product. Such customers will use much of the same hardware used by DEC in dedicated IO controllers.

The third usage occurs where several real-time operations together occupy only a small fraction of the available processor time. Here the customer (DEC's traditional laboratory user) looks for a multi-user software system. PDP-X provides, as optional features, the hardware required to implement such software systems.

4. Processor Module Concept

a. All implementations of PDP-X use the same basic building blocks, eg., ROS, basic register section, basic memory, etc. The differences in models occur in the number of such building blocks used and the ROS programming. Processors with different architectures, i.e., PDP-8I/PDP-9I cannot share such major subassemblies.

b. As advanced engineering/manufacturing methods shrink the cost of computer arithmetic processors the cost of IO controllers grows relative to them. Today, one finds tape systems, displays, etc., almost as complex as the arithmetic processor and certainly more difficult to manufacture. To satisfy user demand for still more powerful IO command structures, including more flexible interfaces, higher bandwidth, and less main (arithmetic) processor interference, these controllers must grow even more complex.

The PDP-X approach may be termed the processor module concept. Here, the specialized IO controllers are replaced by small, general purpose processors dedicated to IO control. Much of the special purpose hardware normally found in the controllers is replaced by appropriate software and ROS programming. Devices which, by their complexity, lend themselves to this implementation include:

MAGtape
DECtape
Display
Multistation teletype control
Line printer control and buffer

5. Amenable To Modular Implementation

One of the most obvious, and perhaps expected, facts of digital system manufacture is that the labor cost and time of test rises as a square law rather than linearly with module count. Independent subassembly construction and testing seems to be one effective method of minimizing system manufacturing cost and in-process construction time. Indeed, even if test were a small fraction of system cost, the unavailability of properly skilled manpower strongly influences the production rate. As labor costs rise and component costs drop, the need for modular construction techniques increases. A PDP-X processor (memory, or major option) may easily be partitioned into a number of independent subassemblies which are small enough to be suitable for automated test equipment yet, which reduce the number and cost of interconnections. These subassemblies are considered repairable only at the subassembly construction level and, like most of todays modules, they are replaced, not repaired, by system test and maintenance personnel.

6. Integrated Option Design

All of the central processor features required for extended arithmetic functions, large core memory, and real-time and multi-user operation are an integral part of the PDP-X architecture. These features are standard or optional depending on the model purchased. A general format for peripheral command structure has also been formed; this structure eliminates the inconsistencies often found in input/output programming systems for machines such as PDP-9.

7. Standardized IO Bus

a. All connections between IO device control units and processors are through the standard IO Bus. This bus is used for all processor models and configurations to reduce redundant peripheral development. DC interlocked control signals are used to insure reliable operation over extremely long distances while still permitting arbitrarily fast devices to operate physically close to the processor.

IO Bus has more capability than is currently found on the PDP-9 class computer; it is used for all data transfers under program control, multiplexer channel control, and selector channel control. Connections between MAGtape and DECtape transports and their associated control processors are also through the IO Bus.

b. Since the bus is shared by all processors, peripherals need not be re-engineered every time a new program is announced.

Ed

jeg

($,000)	FY 1968					FY 1969				FY 1970			
	Q1	Q2	Q3	Q4	Orig Budget	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
8. NET OPERATING REVENUE								225	710	1550	3760	5650	6300 17,260
32. TOTAL GROSS MARGIN (50%)								112	355	775	1880	2825	3150
40. P. L. Marketing		10	20	30		30	50	55	60	70	80	80	80
41. & 42. Selling*						14	43	93	226	340	380	380	380
43. Advertising						20	10	10	20	20	20	20	20
44. Prom. Lit.				10		30	10	20	30	20	20	20	20
45. Mail & Trade Shows						20	10	10	20	15	15	15	15
49. TOTAL SELLING EXPENSE	0	10	20	40	70 (40)	114	123	188	356	485	535	535	535
55. Production Engineering	0	0	6	12		24	24	24	18	12	12	12	12
50. P. L. Engineering	36	54	63	66		78	78	78	70	70	60	60	60
51. P. L. Programming	6	24	48	66		72	72	72	72	48	24	24	24
52. Drafting	0	20	20	20		30	30	30	30	20	10	10	10
53. Mech. Engineering	0	3	8	17		25	25	25	25	17	8	8	8
54. Manuals	0	10	20	20		25	25	25	25	15	10	10	10
59. TOTAL ENGINEERING EXPENSE	42	111	185	211	549 (551)	254	254	254	240	229	134	134	134
60. ADMINISTRATIVE	4	12	22	25	63 (49)	37	38	55	95	149	255	349	382
70. PDP-X P.B.T.	(46)	(133)	(227)	(276)	682 (640)	(405)	(415)	(385)	(336) 1541	(88)	956	1807	2099 4774
PDP-9 P.B.T.	410	844	1292	1359	3905	1359	1359	900	700	500	300	300	300
Budget	707	1004	1057	1131	3899								
Product Line P.B.T.	364	711	1065	1083		954	944	515	364	412	1256	2107	2399

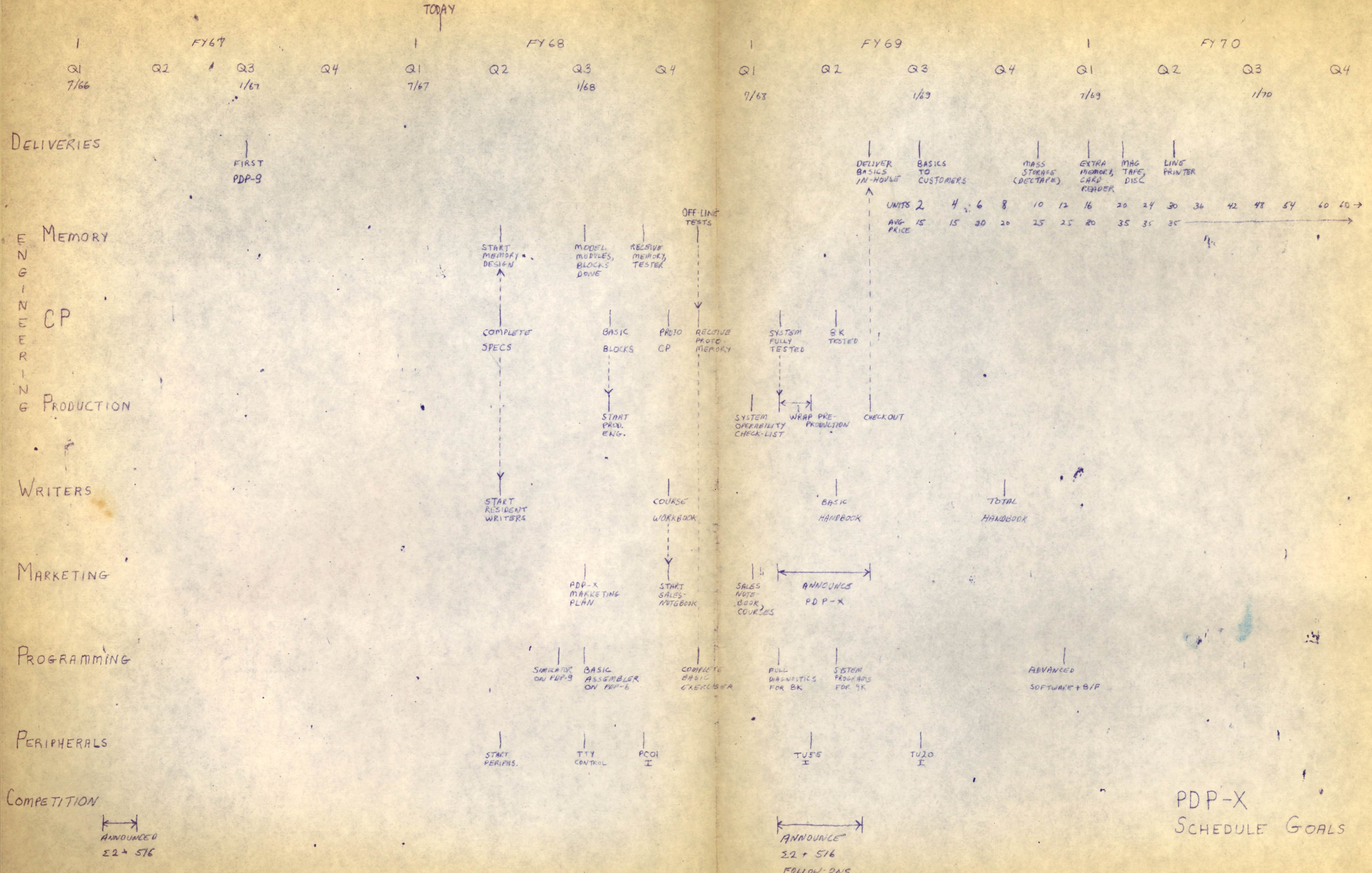
*Selling assumes: 1. bookings $600K/man/year

2. cost $ 36K/man/year

Pro Forma Income Statement

PDP-X FY 68-70

July 25, 1967



PDP-X
SCHEDULE GOALS

7/21/67

CONFIDENTIAL

C L I N I C A L   L A B - 1 2

MARKETING REPORT

September 1, 1971

Aaron Janowski

I. Introduction

II. Product/Market Definition--The Present

a. Product
b. Customers
c. Hardware
d. Software
e. Progress

III. The Future

a. Market Maturity
b. Market Share
c. Sales Development
d. Competition
e. Pricing
f. Hardware and Software Developments
g. Promotional Plans for Fiscal 1972
    1. Trade Shows
    2. Literature
    3. Public Relations
h. Customer Support

I. INTRODUCTION

Saturation of the market for Clinical Lab-12 cannot yet be seen. It is a burgeoning new market that is virtually untapped. Capturing a larger and more profitable market share will involve some level of diversification on the part of products being sold. I do not believe a greater market share can be accomplished by burdening Clinical Lab-12 more heavily above and beyond its present design concept. More terminals, more patients, more speed more platters, more of anything will not improve our market share because it will not talk to a wider market group presently capable of purchasing a computer system. Clearly, our path is to develop a second system having other kinds of capabilities suited to other types of locations within the laboratory world such that the potential customer can make a choice between a hospital oriented dedicated laboratory computer system with limited communications capability to one that is not dedicated, not hospital oriented, and heavily communications directed. Such a choice would virtually double our market potential and conceivably offer us realizable advantages over the competition.

We can characterize the next six to nine months by indicating that, although in the past we were deficient in software and in system capability, we are now in a position to completely document and support the system and therefore, are headed for a new phase of operations which is heavily marketing oriented. Our deficiencies now lie in customer support, literature, advertising, seminars, and publications. Consequently, our orientation for the next year will lean towards overcoming those deficiencies and placing the DEC Clinical Lab-12 system firmly within the grasp and the visibility of its buying public.

II. PRODUCT/MARKET DEFINITION--THE PRESENT

A. PRODUCT

Clinical Lab-12 systems now being marketed are solving various problems in the hospital laboratory environment effectively. The major benefits derived by the user include quality control, high throughput of test data, cumulative reporting of test results to the physicians on the wards, and, in general, to return the laboratory to its previous status as a high revenue and profit center for the hospital.

B. CUSTOMERS

Our Clinical Lab-12 system is oriented to the typical community hospital, which has enough lab equipment and does the volume of tests necessary to justify a computer. This is by far the largest segment of the market. Other market segments which also have good potential are commercial laboratories, research environments and multiphasic screening centers.

Of the 34 Clinical Lab-12 installations now in existence, 19 are full systems utilizing long-term patient files as the information base, and the rest are data acquisition systems tied to other processors. The last six months have seen a nearly total decline in the sale of acquisition systems alone, in favor of advanced configurations.

C. HARDWARE

The typical hardware configuration sold today is at the $175,000 level, consisting of a 12K PDP-12 with special A/D converters, interfacing hardware to analog recorders, 300 LPM line printer, card reader, six Teletypes, two RS08 disks and several digital input devices.

D. SOFTWARE

After its initial inception as System 4, primarily containing the on-line data acquisition portion of the total concept, the software went through several rewrites and many improvements evolving through Systems 5, 5.1, 5.2, 6.0 and now at 6.1.

System 6.1 software will have expanded communications capability, patient file size and new regulator functions for the laboratory and is considered the almost completed package needed to serve the market.

E. PROGRESS

Progress during the last year has been impressive. We have succeeded in:

1. Selling 1.68 million dollars.

2. Overcoming major software difficulties.

3. Negotiating needed field sales specialization.

4. Improving Maynard staff for sales support and preparation of literature.

5. Preparation of advertising and sales promotional materials to support sales and improve our image.

6. Coordinate programming and software support.

7. Improve product line communications with production, service, engineering and software support.

8. Hold regular reviews on software development priorities and customer commitments.

Our aims for the coming year will be to continue along the sales specialization route and lend a new direction to our efforts as a product line by stressing sales, sales promotion, advertising and public relations, and customer seminars while we continue to consolidate and conclude our software package.

III. THE FUTURE

A. MARKET MATURITY

Clinical laboratory computing systems have been around for five years, but out of the experimental stage for only two years. The market is out of its infancy and experiencing rapid growth. More systems were sold during the past six months (despite the economic downturn) than had been sold during the previous year.

The growth potential of Clinical Lab-12 will experience another major jump in Fiscal '72, as agreement among medical practitioners occurs that such systems are useful. General acceptance in medical products often occurs at the 200-installation level and has been demonstrated many times before in other well-known large ticket products. We expect the 200th installation to be made by DEC or one of its competitors during the spring of 1972.

B. MARKET SHARE

DEC's share of the clinical laboratory market should continue to be approximately 25 to 30 per cent of total contracts that are let. The amount of business will be dependent upon the level of success that our specialization program will experience. Our customers divide roughly in two. One half, computerniks in the clinical laboratory environment, enjoying programming expertise, and approximately half will be pathologists or clinical chemists having no programming talent at all on site.

Our bookings projection for Fiscal '72 is 24 systems with approximately 35 viable prospects having now been identified and contacted directly in the field. We look forward to booking 4.2 million dollars in Fiscal '72.

C. SALES DEVELOPMENT

As in the past, sales training will continue for all new DEC salesmen, especially the new specialists, with a week of marketing training to acquaint them with hospital products. During the week of July 26, a three-day sales meeting was held for hospital specialists so that all members of the group could meet each other and to bring everyone up to date.

Original budgeting plans indicate a requirement for 25 hospital product specialists, but based upon the budgeting direction from the Operations Committee, we're currently operating with a complement of men comparable to last year's business. That constitutes a total of 14 men who will be specialists in hospital products; RAD-8, Clinical Lab-12, and MUMPS.

D. COMPETITION

The competition breaks into two major categories: on one side is IBM with many 360 and 1800 systems. IBM presents a threat for the future as they continue to dominate the computer market and introduce System 7. Our major small machine competitors, DNA (Diversified Numeric Applications, Division of AVNET), BSL (Berkeley Scientific Laboratories, Division of TRACOR), and Spear (Division of Beckton-Dickinson Corp.), are continuing their attempts to penetrate wider markets by diversifying their basic product unsuccessfully.

The major competitor is still Spear. The reason that this company is strong has little to do with the technical characteristics of its operating system. The reason Spear is the major competitor has to do with its long-standing position in the marketplace and its ability to respond more quickly and efficiently to the demands of specific prospects. Spear has been in touch with the pathology marketplace far longer than DEC, DNA or BSL and the consequences of this are that they have established a good reputation with a wide base of contacts on which they draw.

Two recent meetings were held by the Spear Corporation, one in Clearwater, Alabama and the other in Carmel, California. These user-oriented seminars indicate that they are now beginning a new phase of marketing their products. I have no doubts that it will be successful. Pathologists have neither the time nor the inclination to read and absorb reams of technical information. Selling in this marketplace involves an inordinate amount of personal relationships. Our own experience has not been any different. Many of the recent orders we have closed have been those that we have been in touch with for a period of six to twelve months.

Selling against the competition will become more difficult than in the past as the marketplace matures. Those pathologists and clinical chemists who have purchased laboratory computers up until now have been essentially pioneers in their field and have conducted themselves accordingly. They have been able to justify putting up with inconvenience; have involved themselves in extensive personal training plans to understand computers, software, and the like; and have, by and large, supported systems that they owned despite drawbacks because of their pioneering spirit and their personal commitments to making computers in the lab work.

In the future, this will not be as true. Not only will pathologists demand more and better service, but will also want to relinquish more of the responsibility for managing, operating and making decisions regarding the direction of a computer installation. Consequently, selling will become less and less technical and more and more supportive in nature. The cost of marketing clinical laboratory computers will be highly disproportionate to the marketing costs of other products at DEC. This will include, in a dramatic way, differences in the marketing costs of MUMPS and RAD-8, which enjoy very different market positions.

It must be emphasized that all our planning for the future will include larger expenditures in advertising, literature and manpower in marketing to support customers rather than extensive expenditures in engineering, software development and the interfacing of new instrumentation to the present system.

The posture of the competition indicates clearly that transition is now in progress in all areas of clinical laboratory computers and it is necessary to consider the consequences of such transition in our own marketing plans, as follows:

1. Spear--converting from a tape-oriented system to a disk-oriented system. The product has not yet been seen in the field, but promises to present serious competition to us in the very near future. A new pharmacy package will be introduced in October.

2. DNA--has redesigned its system around an advanced Raytheon 703 central processor; completely repackaged its CPU in walnut paneled and smoked glass housing in order to be more visually appealing. Thirdly, it is about to present a miniaturized or stripped down version of its system for small laboratories as well as a very large package for private laboratory use that includes billing capability.

3. BSL--is abandoning its PDP-8 oriented version of the clinical laboratory system and now has gone to an advanced communications-oriented system for the private laboratory on a Tempo 16-bit computer. It is offering

a very small version to private laboratories in the $35,000 range. The success of each of these products is not yet in evidence because the products themselves have not yet been seen in the field.

Our attack on these competitors' movements will be described in the following paragraphs on pricing and hardware/software development.

E. PRICING

There will be a price increase for Clinical Lab-12. Rather than an across-the-board price increase for all components, our plans are to divide the system capability into four large categories that relate to the peripheral equipment that can be added to the system along with a new set of nomenclature. The Series 400 will be the LABCOM-4 basic system. The Series 410, 420, 430, and 440 will each be based upon a 1, 2, 3, and 4-disk platter add-ons and will have variations in software capability which will be priced accordingly.

The 410 system will be a 1-platter stripped down version of the advanced Clinical Lab-12 selling around $110,000 and at the other end of the spectrum will be the 440 system with extensive patient filing capabilities, statistical and calculation capability and a FOCAL[R] package under control of the monitor that will sell in the order of $250,000.

A detailed pricing plan is now being put together and will be available shortly. We expect to be able to discuss price increases and the new software capability that goes along with it at all of the shows we will attend beginning with AACC, the week of August 9. Prospects can evaluate their budgetary requirements beginning with an effective price increase as the law will permit.

It should be mentioned that the marketplace is relatively insensitive to price provided that certain capabilities are operating on the system. I estimate that Clinical Lab-12 is clearly in a position of superiority in relation to system capability and future upgradability, which is something that no other competitor can boast as well as demonstrate.

F. HARDWARE AND SOFTWARE DEVELOPMENTS

Software developments on Clinical Lab-12 continue along the lines agreed upon during our development conference in June (Norembega II).

The system is now approaching a totally well-defined and supportable configuration and we are progressing toward a level of documentation that will make it possible to train software support specialists to support systems in the field with a minimum of difficulty. Software written during the past six months has been extremely innovative and effective against the competition. The software plan for the next six to nine months should complete our overall Clinical Lab-12 package.

The capabilities of the system will be considerably expanded during this period to include a filing capacity for 2,000 patients, expanded terminal capability to 12, and the addition of certain features to communicate more efficiently with automated laboratory instruments. Serious thoughts are being given to the freezing of the Clinical Lab-12 software. Exceptions will be specific customer requirements at the time of an order and will be handled by product line programming rather than by the programming department. An important contribution to system flexibility will be the ability to use a special version of FOCAL under the Clinical Lab-12 monitor.

Thought is being given to an advanced Clinical Laboratory System concept on another processor. No formal planning has begun, but we have committed ourselves to concluding, packaging, documenting, supporting and completely debugging the present Clinical Lab-12 system so that it can be sold off the shelf with little additional support except from the field service and software support personnel. Conceptually, the new system <u>might</u> be designed on a PDP-11 to compete with System 7.

Hardware developments have not been a major part of Clinical Lab-12 and we continue to assume that kind of posture. Some thought has been given to planning a manual entry console specifically for use in the hematology laboratory, but our present position is that this device should not be available on the Clinical Lab-12 system but rather will be part of a new design.

Our present customers have raised no serious demands for further interfacing beyond what is already available. On occasion, one or two instruments are mentioned, but they do not seem to be a serious enough requirement such that it would stand in the pathway of closing an order, so we have delayed decisions and budgetary allocations to achieve those hardware developments until the picture is clearer.

Currently in progress are plans to interface the Data Products 132-column line printer provided with a new controller, the LA30 in a serial line fashion, and VT05s. As these three peripherals become more easily available, we will be able to determine to what extent further hardware design is necessary to make them operate smoothly with Clinical Lab-12 software.

G. PROMOTIONAL PLANS FOR FISCAL 1972

1. Trade Shows: We attended the American Association of Clinical Chemists in Seattle, week of August 9, and the American Hospital Association in Chicago, week of August 23. We will be attending the American Society of Clinical Pathologists in Boston in October and the American Society of Clinical Pathologists Interim Conference in February. In addition, two special meetings are planned which will have more of the quality of a regional seminar in association with some clinical pathology conference.

2. Literature: We have printed a new brochure, a new program code card, a spec sheet for Clinical Lab-12, installation flyers, and a host of other material to support our sales force. Direct mail campaigns will be geared around regional seminar activity. Our advertising campaign has only just begun. We have two ads, the "band aid" ad and the "runner" ad. Two more ads are planned, one aimed at the hospital administrator, and a second aimed at the clinical chemist, with a basic theme of quality control. All told, there will be four advertisements that will be placed primarily in vertical journals.

3. Public Relations: Activities will center around speaking engagements and papers written by our users. Some planning has already been carried out. We have been able to place one article by Dr. Pollycove in Lab Management magazine and are currently attempting to do the same with a paper given at a recent Buffalo conference by Dr. Goldblatt. We will proceed to encourage the presentation of papers and seminars with each of our users in the coming year on a much more intensive scale and a consulting contract has been put together by Phil Markell in the Legal Department in order to give us a more formal vehicle with which to communicate with our users and compensate them for their activities in our behalf.

H. CUSTOMER SUPPORT

The question of customer support is becoming an increasingly serious one in this marketplace. The recent survey by J. Lloyd Johnson, as commissioned by the College of American Pathologists, will reveal that, despite the fact that we have probably the superior small computer system in this marketplace, we have let the customer down in many ways in the kind of support we offer him. To begin with, in the training of the customer at the plant after the purchase of the system, continuing on in the field, and finally, in providing him with adequate literature of a technical and descriptive nature so that he can take full advantage of the very powerful software package that we have provided him.

We have been considering the possibility of hiring a senior medical technologist from the hospital environment to work with us in the marketing department for purposes of supporting customers before, during and after installation periods. It has been generally agreed upon by all concerned in the training process that the continuation of training customers by service personnel exclusively be discontinued. The technical details of the operating system and its peripherals are of secondary importance to the people who have purchased the Clinical Lab-12 system. They need to understand how to operate the system, how to integrate it into their laboratories and how to know enough about the operating scheme in order to be innovative and original in implementing their own particular interpretation of the software. Consequently, we're planning on converting a good deal of customer training from service orientation to a marketing and applications orientation in gradual stages.

The first step will be taken by Don Crowther as he analyzes all of our existing installations and discusses with our present users what their needs are in training their personnel. Some further thought then can be given to the appropriateness and timing of the hiring of an individual from the clinical laboratory world to train our customers.

Starting September 1, a user's newsletter will be published monthly to begin the process of forming a user's society for Clinical Lab-12.

digital **INTEROFFICE MEMORANDUM**

DATE: March 12, 1971

TO: Ted Johnson
cc: Win Hindle
Bill Segal

FROM: Aaron Janowski

DEPT: Biomedical Products

SUBJECT: CLINICAL LAB-12 SALES

Ted, a concise presentation of our problem as I see it.

What?

We are failing to meet our targeted goals because of a misapplication of the product to its market by salesmen not conversant in laboratory problems. We have a low profile in the hospital market and inadequate literature.

How Do We Know This?

1. The competition is closing orders where we are not competing, offering similar system capability.

2. Our own users indicate that salesmen who sold them the system did not understand their problems, and therefore did not leave confidence in what they were presenting.

Solutions:

1. Specialization
2. Training
3. Literature
4. System tailoring by programmers
5. Presentation of papers by our users at scientific meetings
6. Advertising

Time Frame for Results:

Six months from date of effective specialization.

jkp

digital INTEROFFICE MEMORANDUM

SUBJECT: COMPUTER PAC REVIEW COMMITTEE (CLINICAL LAB-12)

DATE: September 3, 1970

TO: Distribution

FROM: Ray Lindsay

DEPARTMENT: Biomedical

The first meeting of the Computer Pac Review Committee for the Clinical Lab-12 was held on September 1, 1970. Since this was the first meeting of this kind for the Clinical Lab-12, George Chaisson filled us in on some of the objectives for these meetings.

Since the committee itself, with the exception of Ray Lindsay, had not received any copies of the outline, we held a general discussion until we can get copies to each individual on the committee. There is another meeting planned for September 21, 1970 at which time we will go over the outline point by point. All of the individual notes from each person will be reviewed at that time in order to determine our strong and weak points and whether we have adequate documentation and programs.

Ray Lindsay recommended that a salesman (with active sales experience or preferably a salesman who is currently selling in the Northeast) should be on this committee. I think the committee is lacking a real live salesman and the benefits of his inputs. ?

The following general points were brought out at this initial meeting:

a. It is apparent that the way DEC operates is that a new application is always playing catch up ball, because an application is not considered seriously by all departments until they have machines going out the door. At that point in time it is a little late for people to worry about training, quality control, etc. It has been our experience that people do not think you are for real until the machine goes out the door. We tried unsuccessfully many times to get more cooperation before the fact rather than after the fact. Now it's just a matter of time to train the proper people. We are not in bad shape but we could have been in much better shape if we would have had the cooperation for training before the actual applications were out the door.

b. At first glance, it looks like the Clinical Lab-12 application has done many of the things that are suggested in the Computer Pac outline. The Clinical Lab-12 group has communicated actively with the software support specialists, field service and the sales force. I am sure there are areas that can be improved, but in general it is felt that we do have a good basis for an organization now.

The outline will be covered as much as possible in the next meeting and various points will be documented as to what we can do to improve our organization.

<u>Distribution</u>
George Chaisson ✓
Steve Duly
Don Crowther
Bob Payne
Maurice Tobin
Ken Stone
Bill Cummins
Brad Dewey
Ted Johnson
Win Hindle

jkp

digital INTEROFFICE MEMORANDUM

SUBJECT: Computer Pac Review Minutes - Clinilab-12

DATE: September 23, 1970

TO: Distribution List

FROM: William E. Cummins

DEPARTMENT: PDP-8 Family Field Service

1) The meeting was convened 21 September at 10:30 in Ray Lindsay's office. Bill Cummins was appointed committee chairman.

2) M. Tobin questioned one of the articles in the Computer Pac guidelines concerning hardware development schedule. He questioned whether there was an absolute requirement for formal schedules for hardware development required by the guidelines. Schedules are required and are available but they are not an absolute requirement of just these particular Computer Pac guidelines. Development schedules are a requirement for any new bookings and budgets.

3) A quick review was made of current bookings and budgets. Budgeted shipments for this quarter were to be approximately 576 thousand dollars. Actual shipments are about 300 thousand. Budgeted bookings were originally set at eleven machines for this quarter and later revised to seven. To this point, however, none have been booked.

A comment by Ray Lindsay indicates that he feels that last year's sale activity by the sales department was not up to budget, but since the budgets were not broken down such that sales reported time per product line, there was no way to verify his feeling; however, now sales time is accountable so sales must record and account for time spent working on each product line. It was Ray's feeling that through this new process of accounting for time through the budget that he would be able to verify and see the results of budgeted sales time.

It was the concensus that there were no problems with the Field Service budget (the warranty budget) for service of Clinilab. Don Crowther stated that at last there is one man assigned per regional staff in each region to support Clinilab.

Software Support budget - One software support man is now fully budgeted by the Clinilab Product Line Engineering group; however, the overall software support budget for Clinilab support is one man short of budget. The European manpower support is in good shape.

4) The following sentiments about Sales Software Support in Europe were made by Don Crowther, supported by Ray Lindsay... Although the European Support manpower is up to budget it was felt that the European staff is very short of people that are adequately trained to handle Clinilab Sales Support calls and Software Support and that this is due mainly to the lack of assignment of responsibility. Ray's comment was that he would suggest to J. Peterschmitt that one individual be assigned software support responsibility for Clinilab in Europe and that all other Software Support functions or activity be through him. It was also felt that Sales Support from Software Support is limited in several geographical areas and is thus hurting the sales effort since the Sales department is absolutely dependent upon Software Support for Clinilab sales. It was expressed that the main reason for this complaint was that unless a geographical area has Clinilab units, it is difficult to get Software Support committed to that area. Thus sales has a problem being able to call on software support manpower to assist in sales. It was felt that the Mid-Atlantic region and that the Central Region both have this problem.

Because of these sentiments, Ed Converse will prepare for the next meeting an outline of the capabilities and commitments of Software Support for Clinilab for both the European Region and the Mid-Atlantic and Central Regions in the States.

5) There was some concern expressed by Ray and Don over the Johnstown installation and in general all installations in terms of getting spares or having spares available for that system. Because of this problem, and a similar problem that could occur at any other site, Don has prepared a list of required spares and a spares kit to be submitted to Don Zereski for approval. Approximate cost of this kit would be three to four thousand dollars. Submission should be by 30 September and will be discussed by Don at the next meeting.

6) Another problem witnessed at Johnstown is the manner in which all persons involved with the Johnstown installation handled themselves with respect to the customer and DEC. It is Ray's feeling, and mine also, that all people within DEC who have any reason to come in contact with a customer should at some time have been through a company sponsored orientation course. The course should be designed to acquaint that individual with the customer's problems and how to maintain and conduct himself in front of the customer; i.e., a customer orientation class demonstrating or depicting the do's and don'ts of company/customer interface. It was felt that software support and the sales department do this to some degree but that Field Service does not; hence, it is recommended that Field Service adopt such a policy.

7) Ed Converse questioned if a system exerciser for Clinilab was available. Don Crowther replied that an exerciser does exist but has not been released. It has been written by Harold Long of Field Service. It has not been written or interfaced with diagnostic programming. Approximately two to four more weeks work on the exerciser will be required before it is submitted for use. Don will discuss this exerciser and its implementation schedule at the next meeting.

8) It is Don's feeling that the current method of distribution of tapes and the manner in which records of distributed tapes are maintained is not sufficient;and that there is a need to establish formal procedures within the Clinilab Product Line for the documentation and distribution of programs. Ray recognized this problem and has submitted a requisition for a man to do software maintenance and maintain a library or a system of documentation and support of distributed tapes. Several people are currently doing this job with no one man having the assigned responsibility. This subject should be brought up again at the next meeting.

9) The Clinilab acceptance procedure is being prepared and is scheduled for completion approximately 1 November.

10) It should be noted that sales was not represented at this meeting and therefore we had no comments concerning the support services from a sales viewpoint. These items will have to be covered by sales at the next meeting. A tentative date was scheduled for the next Clinilab meeting on 16 November, 10 AM in Ray's office. The agenda for the meeting will include:

   a. A discussion of the world wide software support commitment - Ed Converse

   b. A discussion of the system diagnostic and its implementation schedule - Don Crowther

   c. A discussion of support service problems from sales viewpoint - S. Duly

An unanimous request was made that someone from the programming department attend the next meeting so that tighter communications can be maintained over new Clinilab software development.

WEC:slm

DISTRIBUTION

* Ray Lindsay
* Bill Cummins
* Ed Converse
* Don Crowther
* M. Tobin
S. Duly
* Attendees

Ted Johnson
Nick Mazzarese
Ken Stone
George Chaisson

11-19

INTEROFFICE MEMORANDUM

SUBJECT Computer Fac Review
Minutes - Clinilab-12

DATE November 16, 1970

TO Distribution List

FROM Ed Converse

DEPARTMENT

1) The Clinilab status meeting was convened at 10:00 a.m. in Ray Lindsay's office. Present were Ray Lindsay, Don Crowther, Ken Ellson, Steve Duly and Ed Converse.

2) Ray Lindsay began by reviewing current bookings. Current bookings include a basic system in Sweden, an advanced system at the University of Toledo, and a system for an OEM in Detroit, Medical Data Systems. Espected bookings include the University of Arizona, and Beth Isreal Hospital in Boston. Also mentioned was a one-year lease to Albany Medical Center.

3) Ed Converse presented a status report of world wide software support capabilities for Clinilab. It was felt that the major weakness lies in the Central region where the hiring freeze has prohibited the hiring of a clinilab specialist.

4) Ray Lindsay introduced the topic of the use of software specialists in presales situations. It was concluded that the desirability of using software specialists in a pre-sales role depends completely on individual situations.

5) The Hot Line mailing list was gone over and additions and deletions were made.

6) Training is going on in each region for the Clinilab specialists.

7) A system exercise has been used in the field for a couple of weeks. It will be released through the Program Library. It uses the Clinilab 5.2 monitor. It should be released by the Library by November 25.

8) Disk problems seem to have settled down considerably.

9) There is still no one available to do software maintenance and maintain a library for a system of documentation and support of distributed tapes.

10) The Clinilab acceptance procedure is still being worked on. Lack of adequate machine time is hindering its progress. The estimated date of completion is mid December.

11) Europe: in support problems were then discussed. Ray feels there should be one person coordinating the effort of Clinilab sales and support in the European region. This subject will be discussed further in the next meeting.

12) A tentative date for the next meeting was set for December 28 at 10:00 in Ray Lindsay's office. Agenda for the meeting will include:

a) support service problems from a sales viewpoint - Steve Duly
b) European support problems - Ray Lindsay
c) project bookings - Ray Lindsay
d) step-by-step procedures for Clinilab installations - Don Crowther

Anyone having further items to be added to the agenda should contact Bill Cummins.

ELC/mn
Distribution:
Ray Lindsay
Bill Cummins
Ed Converse
Don Crowther
M. Tobin
S. Duly
Ted Johnson
Nick Mazzarese
Ken Stone
George Chaisson
Ken Ellson

Copies for: Bill Segal
Ray Lindsay
Dick Clayton
Ken Olsen
Gerry Moore
O.K

lci
LABORATORY COMPUTING, INC. • 4915 Monona Drive • Madison, Wisconsin 53716
(608) 222-5538

31 August 1970

Mr. Winston R. Hindle, Jr.
Digital Equipment Corporation
146 Main Street
Maynard, Massachusetts 01754

Dear Mr. Hindle:

I am writing this letter and delivering it to you in person to express appreciation for the help and cooperation which Digital Equipment Corporation has given our new company, Laboratory Computing, Inc., during the past year. Deferrment of payment on the PDP-12 computer system for LCI made it feasible for the founders of LCI to make an orderly transition from the University to the business world. On August 8, 1969 when I visited DEC to make the request for the computer, all of us were hoping that we would be able to make a full committment to our new company. Now, a year later, all of us are committed fully to the development of LCI and are looking forward to a strong and active business life. The founders of LCI are fully aware of how much DEC's assistance has meant to the development of LCI this past year. We extend our appreciation to you and all of the other members of DEC who have been so supportive of our activities. We are particularly grateful to Bill Segal, Dick Clayton, and Ray Lindsay, who have been so cooperative in this development.

For a while the declining business climate seemed to always be one step ahead of our requirements to get LCI on a firm basis. However, I am pleased to inform you that as of a few weeks ago LCI acquired a new partner, WARF Institute, Inc. (a corporation owned by the Wisconsin Alumni Research Foundation). This new-found strength further guarantees LCI will be able to live up to its committments in the clinical laboratory computer field.

I am convinced that the initial cooperation of our two organizations has led to the establishment of a viable business entity which will be mutually beneficial. Again, I want to express our appreciation for your assistance in its development.

Sincerely,

LABORATORY COMPUTING, INC.

G Phillip Hicks

G. Phillip Hicks, Ph. D.
President

GH:jd

Win

digital INTEROFFICE MEMORANDUM

CONFIDENTIAL

DATE: May 11, 1970

SUBJECT: XDS IN THE LABORATORY MARKET

CONFIDENTIAL

TO: Ray Lindsay

FROM: Aaron Janowski

cc: Bill Segal

DEPARTMENT:

Recent developments at XDS have come to my attention through former associates at Xerox.

1. Xerox planning groups are now evaluating the computer market place for clinical laboratory systems to be implemented by XDS.

2. A pilot program will begin July 1st on a concentrated software development effort. Supported by a $500,000 budget, it intends to utilize the Sigma3 for clinical laboratory applications.

3. Preliminary announcements of the system, and the intention of XDS to be in this marketplace, will be made at the Fall AACC meetings. Extensive use of marketing research questionaires will assess the marketability of the concepts being presented at this meeting.

4. The target price for the system is expected to be between $150,000 - $200,000.

5. Market strategy and planning as developed by Xerox for the clinical chemistry marketplace will be relied upon to target placements, prospects and to develop specialized distribution and support schemes for sales and service.

We are certain to see the designation of a cooperative development laboratory in the Los Angeles area as part of their operational plans. Although a number of possibilities exist, the only name actually mentioned in the course of discussion was the Cedars-Sinai Medical Center.

jkp

digital INTEROFFICE MEMORANDUM

DATE: February 23, 1970

SUBJECT: CLINICAL LABORATORY SUMMARY MARKETING PLAN

TO: Ted Johnson

CC: Win Hindle ✓
Bill Segal

FROM: Ray Lindsay

DEPARTMENT: Biomedical Marketing

I. Product Description

A. Applications

This product is oriented to solving the various problems encountered in a typical hospital laboratory. Some of the problems involved are quality control, data gathering, generating various worksheets for the technologists, and a summary print out of all tests run on a particular patient. One of the most important functions in which the computer can assist is in positive specimen identification.

This product can and may be extended to accomodate commercial labs, screening centers, and research institutions. We have at least one of our basic systems in each of the above mentioned envoronments, but are not actively supporting them such as we are in the hospital environment.

B. Terms of Sale

The average selling price of the basic system will probably be about $60 K. The average price for the advanced system will be approximately $120,000. These two typical prices do include extended warranty, which means that the system is now warrantied for one full year. The various normal discount policies which DEC has, apply also to the Clinical Lab system. Field Service installs the various special interfaces and trains the technicians in the laboratory. Software support specialists will eventually be trained to go to the installation and provide support.

C. Hardware Content

The hardware in the basic system is a PDP-12 with a Clinical Laboratory interface and a real time clock. The advanced system is the basic system plus another 4K memory, the RS08 disk with a half a million words, and a 300 line per minute printer. There will be various special interfaces, both analog and digital, built for the future use in the laboratory in order to keep up with the state of the art.

D. Software Content

The key software package for the basic system is the monitoring and the quality control checking of the Auto-Analyzer equipment. In the advanced system, that is also an important part, but more important is having a patient file and a means of reporting all the patients' results in a very pre-defined, concise way so that is is more meaningful to the physicians. One of the main software features of the Clinical Lab 12 system is the monitor which enables multiple users to be accessing various programs almost simultaneously.

II. Markets

A. Customer Types

Our Clinical Lab 12 system is oriented to the typical community hospital, which has enough lab equipment and does the volume of tests necessary to justify a computer. This is by far the largest segment of the market. Other market segments which also have good potential are commercial laboratories, research environments and multiphasic screening centers.

B. Market Maturity

Although people have been trying to solve the Clinical Laboratory application with computers for approximately five years now, the market still has to be considered in its infancy. There is no clinical lab system that we know of that is really doing the job as specified by various hospitals. Although we have gained some experience from our competitors' mistakes, we have still a great deal to learn.

C. Market Share

The market potential in the next two to five years is approximately $200 million dollars. Our present plans, for the next two and a half years, call for 14 million dollars in sales in this application.

D. Competition

Virtually every large computer manufacturer is now getting involved in this application. Our most serious competition at the present time is IBM, Spear Inc., BSL, DNA, and CDC.

III. Sales and Promotion Strategy

A. Promotional Program

See the attached scheduled release dates for the literature, brochures, etc. We have been running ads in three key magazines almost every month. We have had a direct mail campaign twice now, mostly to make the administrators of the hospitals aware that we are in the market and to help educate them to some degree. Education of people in the clinical lab is an essential to the success of this operation and a lot of our ads and mailers are oriented that way. Several field offices have held seminars for various hospitals.

B. Selling Strategy

1. Sales training -- There have been four classes held in Maynard for the salesmen. Upon return to the field, we have asked them to try and get some "hot" prospects which they can visit along with someone from Maynard. Other seminars have been held specifically for the salesmen in various offices.

2. Geographical emphasis -- The number of prospects which are apparent in each area is a direct measure as to how aggressive the salesman has been in pursuing this application. It is my belief that there is quite a bit of interest in every geographical area in the States.

3. Account emphasis -- Each end user who purchases the total support package will expect DEC to furnish hardware and software maintenance, and in addition be looking continually for new hardware, software or methods developed by DEC. Each user should have a monthly visit by Field Service and Software Support.

The OEM user will be supported according to the various options which he chooses to purchase from DEC. An OEM policy does exist detailing our policy pertaining to the Clinical Lab Application.

An important feature to all users will be our approach to providing interfaces to any new equipment introduced in the labs.

4. Organizational approach -- We are planning to have each region hire a specialist for the Clinical Lab application. To support these people, we want to have at least two software specialists in each region. Both will be available to assist the customer after installation and help the salesmen or the regional specialists in pre-sales work.

C. Software Support Program

There are a tremendous amount of programs which have to be written. These programs must be written so that they are easy to use by the laboratory technicians, and they must be also oriented so that additional programs may be added at a later date. This makes the programming very complex and it takes much longer to write each individual program. We are incorporating a System Build feature into the system in order to enter some of the customer's parameters or methods on site, either by using the scope and Teletype to answer questions, or an assembler such as dial. This is a matter of reassembling not reprogramming.

D. Other Support Requirements and Programs

As new equipment is introduced in the laboratory, we will have to respond and interface these various units to our system. There are many other programs which will have to be written in the future. These concern blood banking, surgical pathology, cytology, etc.

MARKETING PLAN SUMMARY

T. G. Johnson, 1/30/70.

	Quarterly										Total		
	FY70		FY71				FY72						
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	70	71	72
Bookings													
Units	4	12	13	14	16	17	17	17	17	17	16	60	68
$M	.4	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.6	1.8	1.7	5.7	6.4
Shipments													
Units	4	11	12	12	12	12	13	15	15	15	15	48	58
$M	.3	.9	1.2	1.2	1.2	1.2	1.3	1.4	1.4	1.4	1.2	4.8	5.5
Selling (including pre sales)													
* Men	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	16.0	32.0	32.0
$K	64	64	64	64	64	64	64	64	64	64	128	256	256
Av. bookings $K/man qtr.	200K	200	200	200	200	200	200	200	200	200	400	800	800
Post Software Support													
*Men	2	4	8.0	8.0	8.0	12.0	12	16	16	20	6	36	64
$K	16	32	64	64	64	96	96	128	128	160	48	288	512
Product Marketing													
Men	4	4	5	5	5	5	5	5	5	5	8	20	20
$K	28	28	41	43	43	43	43	43	43	43	56	170	172
Adv. & Promotion ($K)													
Promotional Literature	5	5	2	5	5	5	2	5	5	5	10	17	17
Space Ad.	4	4	2	2	2	2	2	2	2	2	8	8	8
Trade Shows	1	1	9	–	–	2	9	–	–	2	2	11	11
Other	–	–	–	3	3	1	–	3	3	1	–	7	7
Total Selling Expense ($K)													
$	168	168	248	248	248	280	283	312	312	344	336	1024	1251
~~New Products~~ = ENGINEERING													
Hardware	22	22	30	30	30	30	30	30	30	30	44	120	120
Software	18	18	36	36	36	36	36	36	36	36	36	144	144
New Shippings $K/man qtr. adjusted for trainees													

* Manpower figures include trainees

CLINICAL LAB PROMOTIONAL PROGRAM

	FY70		FY71				FY72			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Brochures Price Lists			Brochures X	Price List X		Modifications X				
Space Ads		EVERY MONTH IN 3 OF THE MOST READ MAGAZINES								
Trade Shows		Workshop Wisc. X	3				3			
Application Notes			X		X		X		X	
Flip Charts			X			Modifications X				X
Mailers		X		X		X		X		

digital INTEROFFICE MEMORANDUM

DATE: September 11, 1969

SUBJECT: CLINICAL LABORATORY OVERVIEW REPORT

TO: Operations Committee FROM: Ray Lindsay

In March, 1968, the Clinical Lab project received full support from DEC management to design and implement a Clinical Laboratory System, based on the University of Wisconsin's basic chemistry system and oriented to the typical community hospital. Although this was the primary goal, it was also realized that commercial laboratories (service centers), University Hospitals, Research Centers, and OEM's were prime markets also. Within the past year it has become very clear that the OEM market, for the Lab systems, is more advanced than we originally anticipated, and some of our efforts have been devoted to securing their business and giving them limited support.

OEM customers in the lab field want to provide a service to the commercial or hospital laboratories, set up multi-phasic screening centers, or integrate the lab system into a larger total hospital system. In addition, many of the larger pharmaceutical firms are purchasing smaller labs with the intent to automate them.

The various market segments and their sales potential are shown below. These figures are based on our average selling price, and immediate potential is within 2 to 5 years.

MARKET	HOSPITALS	COMM. LABS	RESEARCH	OEM'S (all market segments)
# of installations	7500	3000	1000	50
Immediate potential	1500	450	100	20
Immediate potential ($)	200 million	36 million	5 million	10 million

Bookings & Billings

If we refer to the marketing report submitted in September, 1968, we find that we are about at the stage of Q3 for 1969 which implies about a five to six month lag. Following is the picture for fiscal 1970, and programming commitments will not delay any of the indicated shipments.

FY 70	Q1	Q2	Q3	Q4	Totals
Projected bookings (as of 6-1-69)	588K	756K	1092K	1274K	3710K
Projected billings (as of 6-1-69)	200K	588K	960K	1248K	2996K
Actual shipments to date	85K				85K
Scheduled shipment of present firm P.O.'s	131K	608K	406K	225K	1370K

Additional firm purchase orders scheduled beyond fiscal '70 increase total backlog to 1580K.

FY 71	Q1	Q2	Q3	Q4	Totals
Projected bookings	1520K	1710K	1900K	2090K	7220K
Projected billings	1330K	1520K	1710K	1900K	6460K

As can be seen in the above chart, the 1971 picture is even brighter for bookings and billings, and a realization of profits of over 34%.

The Clinical Lab system is based around the LINC-8 computer with 8K memory, RS08 disk (½ million words), 300 LPM printer, 6 Teletypes, and a Clinical Lab interface, all working in a time-shared environment. After the LINC-8 system has been thoroughly checked in the laboratory environment (University of Wisconsin), which should be by December, 1969, the programs will be converted to the PDP-12 and will become Public Domain as agreed to by the University of Wisconsin and DEC. At this time the advanced system will be installed in a few locations (LINC-8) and the advanced system, based on the PDP-12, will be available about February, 1970. After this step is completed, a more powerful monitor will be developed to accommodate more peripheral equipment including a card reader, data phone, and various types of digital inputs.

The programming effort to date has produced a time-shared monitor, and almost a dozen user programs necessary for a successful Clinical Laboratory system. Although the RS08 disk situation has delayed the project by approximately six months, we have been able to make many programming refinements and have gained considerable insight into the application and market area in the interim.

The philosophy of the system is to provide a modular, expandable system with a feature which enables each hospital to tailor make its own system.

Since this market is really in its infancy, we have had to try and educate it in various ways. One of the more common means is to run various ads which dwell on important aspects of the system. We have also printed a brochure on both the Basic and Advanced Systems. The most important phase of this indoctrination, of course, is the education of the field salesmen. There have been four formal sessions held on the Clinical Lab system, which have been followed up by marketing support from Maynard. In addition, a few important shows, such as the Association of Clinical Chemists and American Association of Clinical Pathologists have been attended with working hardware and software over the past 1½ years. Many seminars have also been held in each region.

The DEC Field Service organization readily volunteered to support the Clinical Lab application. They are not only responsible for the installation of the system, but also train the lab personnel on-site in the use of the system and acquaint them with the various laboratory interfaces. Thus far, only Basic Systems have been installed. Since March, 1968 we have consulted with Field Service in every aspect of the system that concerns them and have had excellent cooperation. We anticipate that they will continue on this course when Advanced Systems are installed in the very near future. Field Service support and maintenance is absolutely imperative to the success of the Clinical Laboratory system. This is a critical application which will test DEC Field Service as never before. However, the potential of the market and its rewards will place DEC in an enviable position.

DEC's major competition in the Clinical Lab application are Spear, Inc., and Berkeley Scientific Laboratories in the small computer class, and IBM in the medium and large scale computers. Most of the other major manufacturers are trying to provide total hospital systems which include the Clinical Laboratories. Univac and NCR seem to have an interest in having DEC do the Clinical Application and interface

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to their larger systems. DEC's entrance into this field, and our system philosophy has definitely alarmed our major competitors and they are moving much faster and promising a lot more.

Our backlog of orders will really climb as soon as several of our Advanced Systems are installed and proven beyond a doubt to be a workable laboratory system.

Ray Lindsay

Ray Lindsay

djc

attachment

annotations *by Jon W. Mohr, Editor*

Clinical Labs As Big Business

In an era of activity characterized by size and efficiency, the clinical laboratory has often seemed an anachronism.

In the past ten years the laboratory has been hard pressed to grow apace with the proliferation of diagnostic procedures. To do so requires space, personnel and massive infusions of capital — all of which largely have been lacking. In too many cases, the clinical laboratory has lacked business resources, administrative acumen, and marketing vision. This collection of of factors has led to the brink of crisis and to the development of crash programs.

Automation is part of the answer. But the cost of automating prices this relief out of the range of all but the largest hospitals and those fortunate few who have become federal grantees or demonstration centers for instrument and computer manufacturers. Much of the slack is now being taken up by the independent clinical laboratory, and herein lies a tale of emerging big business.

The most dramatic recent move was that of Damon Engineering, Inc. of Needham Heights, Mass. Last spring, the firm acquired four clinical laboratories; on July 24 it picked up three additional clinical labs and a standards lab; and it has constructed a clinical laboratory at its Massachusetts headquarters. This brings the network of clinical facilities to eight in 12 locations.

And the parade of acquisitions and innovations is not at an end. Upjohn now owns two large clinical labs via acquisition, and another is on the waiting list for construction this fall. American Biomedical Corp. has announced plans to acquire Morrison Clinical Laboratory of Midland, Texas. Smith Kline and French is favorably impressed with its new acquisition, Leary Laboratory of Boston. We have even seen the beginning of franchising in the clinical laboratory field — a kind of medical Chicken Delight.

The advantages of such combines from a business point of view are obvious: Major sources of investment capital are immediately available; consolidation of services becomes eminently practical; automation emerges as a budgetary reality; centralized purchasing brings significant price breaks; management and personnel functions become more clearly defined; and for the parent company, a built-in proving ground exists for new instruments and supplies.

The ability to perform esoteric tests on a volume basis also makes it feasible for such labs to become safety valves for those hospitals who cannot profitably cope with the vast numbers of routine tests if they have to divert their attention to smatterings of "oddball" analyses. This last factor has altered the customer mix of some independent labs to the point where their executives have told us their sources of income are now split about 50-50 between private practitioners and hospital contracts.

The independent laboratories, however, are not the only ones being pressured into combination and/or cooperation. Pooled facilities are, as a matter of efficiency, profitability and convenience, becoming more and more of a reality among hospital laboratories. Some combines are generally recognized as exemplary, such as the Youngstown Hospitals Association Laboratories under the direction of Dr. Arthur Rappaport. Others, such as the laboratories serving hospitals affiliated with the University of Pittsburgh, are less than satisfied with their early attempts at cooperative automated ventures and are engaged in intensive redevelopment programs.

The Federal Government is also tacitly abetting this trend toward concert of action in its direction of research dollars toward automating clinical laboratories. The NIH has budgeted just over $2 million for contracts and research grants for automated clinical laboratories this year, and by 1974 the amount budgeted will grow to $13.5 million. Some of this research is already bearing fruit under the joint General Medical Sciences/Atomic Energy Commission program. However, automated clinical laboratories are today few and far between; they are expensive to purchase and program; and though laboratories will be forced into the posture of implementing more of them, only the largest laboratories, or groups of laboratories pooling their resources, will be able to buy and profitably operate them.

It would seem inappropriate to view these acquisitions and cooperative ventures as suspect. The old bugaboo about "bigness" — at once respected and damned — is not especially applicable to clinical labs at this time or in the foreseeable future. The reason: The laboratory is not seeking size for the sake of size; rather, size is being forced upon the lab as a means of meeting the challenges of better diagnosis and patient followup.

The price of innovation will continue to be high, but sound business practices, such as feasible cooperative ventures, is one way of keeping a leash on investment and operating costs. □

8 / DEC 10/20

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JUL 30 1985

INTEROFFICE MEMORANDUM

TO: STRATEGY COMMITTEE
MSSC

cc: Walter Manter

DATE: 25 JUL 85
FROM: Rose Ann Giordano
DEPT: Large Systems Marketing
EXT: 231-4049
LOC/MAIL STOP: MR02-2/C2

SUBJECT: SEE ATTACHED ARTICLE

Great article! An independent survey predicts we will keep 72% of the DEC 10/20 customers. We are pushing for 80% retention. This is the crucial year!

Users Of 36-Bit DECsystem Remain Loyal To Digital

Most will stay with the company's products when they replace their systems

In mid-1983, Digital Equipment Corp. called off production of Jupiter, the follow-on processor to its 36-bit DECsystem 10 and 20 family. The company also said it planned eventually to halt production of the 36-bit family. The moves affected an estimated 1,000 corporations worldwide.

Early this year, Compucom Inc., an Atlanta company specializing in the Digital 36-bit aftermarket, conducted a study in an effort to assess the impact of Digital's decisions on the domestic user base. Compucom wanted to determine whether it should continue pursuing a strong presence in this market segment, and it also thought that the DECsystem 10 and 20 community would want to know what other users were planning as a result of the 36-bit product-line moves. Was there sufficient interest for continued hardware and software support and development? How had the moves termination affected their loyalty to the vendor?

Compucom sent out questionnaires to more than 600 North American DECsystem 10 and 20 sites, asking, among other things, whether users had yet decided to replace the 36-bit machines, when, and with what. Would they stay with Digital, or would they—for fear of being let down again—take their 36-bit business elsewhere?

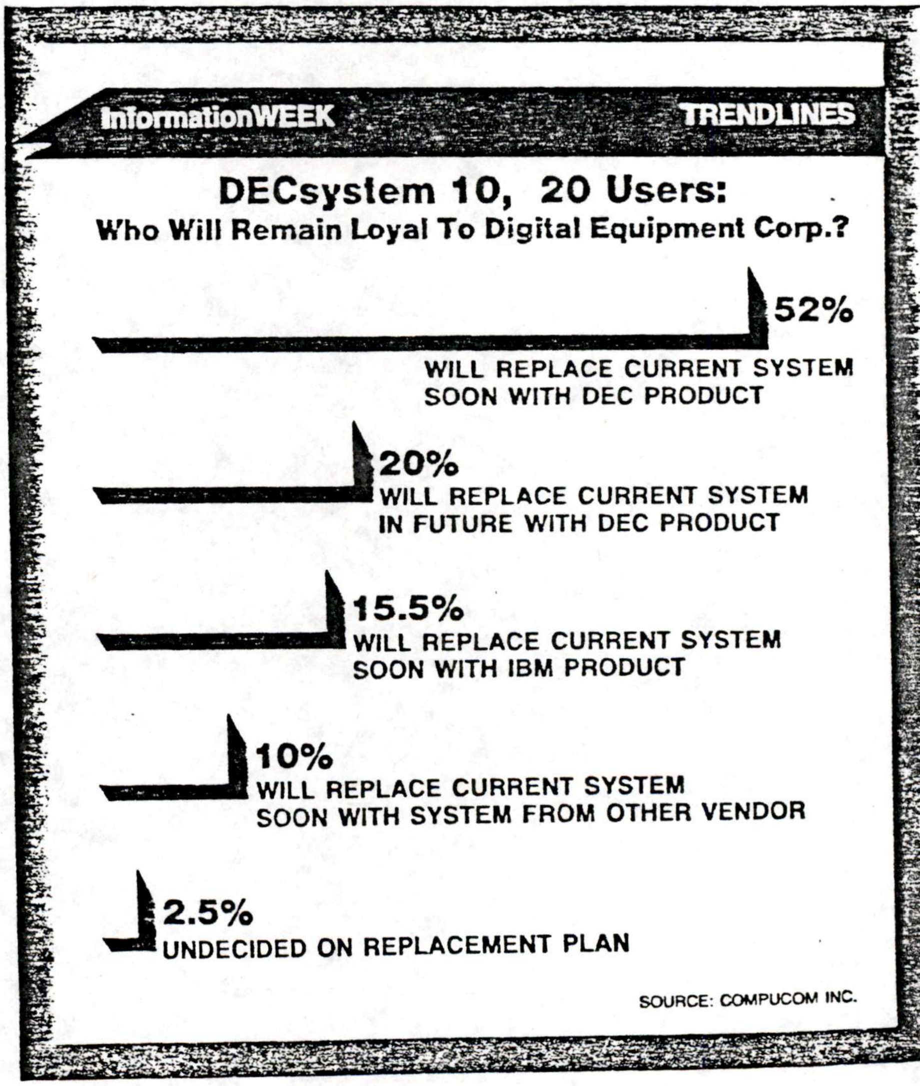
As of June 1, more than a third of the user sites had responded to the survey. Compucom based the following figures on data gathered from 201 questionnaires:

- Ninety-six of the respondents, or 48%, plan to replace their 36-bit systems at some point in the future. The remaining 52% have yet to make a decision.
- Among those committed to replacing their systems, 63% indicate they will stay with Digital and 32% plan to switch to IBM. About 5% say they will get their replacements from other vendors, such as Sperry Corp. and Hewlett-Packard Co.
- Of the 60 respondents indicating loyalty to Digital, 40 intend to replace their existing 36-bit systems within the next five years. Those opting to take their business to IBM and other vendors are going to be doing so within the next five years.
- Cited most often as the probable DECsystem replacement is the recently announced VAX 8600, Digital's new high-end 32-bit machine.

Also of note: Although Digital effectively halted the 36-bit product line, more than half the respondents said they are still developing software for it. Furthermore, since Digital has continued to develop peripherals for the 36-bit products, some of which are compatible with the VAX family, more than half the respondents say it will be easy to move from the DECsystems to the VAX family.

Overall, Compucom concludes that there is still a high degree of corporate commitment to Digital's 36-bit line. Millions of dollars worth of DECsystem 10 and 20 software has been developed, and more is probably forthcoming from both Digital and a number of third-party developers.

Some MIS directors who are seeking a replacement think that, although the VAX 8600 is sufficiently fast, the VMS operating system may not have the flexibility of the TOPS-10 and 20 operating systems. ■



DEC-10/20

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Interoffice Memo

TO: ANDY KNOWLES

cc: see "CC" DISTRIBUTION

DATE: SUN 2 JAN 1983 6:55 PM EST
FROM: GORDON BELL
DEPT: ENG STAFF
EXT: 223-2236
LOC/MAIL STOP: ML12-1/A51

MESSAGE ID: 5186654476

SUBJECT: QUESTIONS YOISE ON MY FULL HEARTED SUPPORT OF THE 10/20

In addition to learning from history, you raised other issues:

1. On VAX conversion, I agree, we're likely to lose a customer UNLESS we approach the problem the right way. (I have one case study, the University of Pittsburgh that looks to be a counter example!) Note that I have always agreed: left alone, 10/20 customers who don't know our full direction (including VAX) will switch to IBM unless we sell. Unfortunately, it requires carefuly selling and work to not lose.

2. Positioning 10's with VAX has to be done. I have a seperate memo on this that's coming around. It fundamentally says:
780 is faster than a KL on Cobol by 30%
780 is faster than a KL on DBMS
KL is faster on record I/O Cobol, unless data is sequental
KL is faster than a 780 by 20% on Fortran, unless double precision
KL can be a factor of 2 faster than a 780 on strictly integer problems until one plays with the VAX data structures
KL's will handle maybe 1.5 times the timesharing load of the same VAX configuration, but VAX with lots of memory may increase it

2A. I therefore make a 780 at about 2/3- 3/4 a KL, but a 782 should do more work than a KL. I believe a 780F (the 1.5 x 780) now in test should beat a KL on every benchmark and load, especially with lots of the new memory based on 64K chips. Furthermore, the cost of the system should be better by at least by a factor of 2.

2B. Future machines:
Jupiter at 2.3 x KL I hope on the first go around.
Venus should be >4 x 780, or about 3 x KL
Nautilus is too early to tell precisely, but because it's a dual processor from the ground up should do well on both cost and performance.

3. My business acumen. Since I simplistically rank product goodness as the key to all current and future business, I could understand why you believe I lack it, but believe you're wrong.

4. Smoke damage is costly, and it really hurts me to be accused of this. Here, I think we'd better have a talk about what you want me to do to change, because I sure don't want to do anything but help keep customers and build a follow-on 10/20. Communication is strictly amongst us, so I can't understand a cost. Would like to get input from this group too regarding my

behavior.

5. Heros... who they? It would be nice to be one or find one in here maybe next to the pony that we should soon discover somewhere near the Jupiter project.

As ever, I'm dedicated to preserving our customers and getting us a follow-on 10/20.

Gordon

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ROSE ANN GIORDANO	*WIN HINDLE	BILL JOHNSON
KEN OLSEN	JACK SHIELDS	JACK SMITH

DEC-10/20

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Interoffice Memo

TO: ANDY KNOWLES

cc: see "CC" DISTRIBUTION

DATE: SUN 2 JAN 1983 6:48 PM EST
FROM: GORDON BELL
DEPT: ENG STAFF
EXT: 223-2236
LOC/MAIL STOP: ML12-1/A51

MESSAGE ID: 5186654473

SUBJECT: SUPPORTING THE 10/20 BASED ON HISTORICAL (IBM/AMDAHL) CASE

Learning From History and Amdahl
As a fellow student of history, I know you'll be delighted to learn that Gene Amdahl is giving a talk on his pioneering computers including the 360 at the Museum on March 10 and 11. Please hold the dates. He's also going to spend time with the engineers working on large machines. In addition to being incredibly bright, pleasant and charming, he is an excellent lecturer and story teller. I'm looking forward to the visit.

As a student of history and computer biographer, what I remember is:

1. IBM had a mixed line of computers at the time of introducing the 360 (7040/7094, 7080, 1620, 1401, 1410, 7070 as shown on page 43 of Bell and Newell) crossing scientific and business computing.

2. Gene was on a post Stretch team to build a follow on scientific computer to the successful 7090.

3. B.O. Evans put together the 360 team with Amdahl, Brooks and Blaauw to make a new range of machines for both business and scientific use that would cover everything down to the small computers (the 1130 and 1800 were introduced as a result). SDS did the range bit first, but the control store technology permitted IBM to do a whopping range. Basically, the machine was designed right because they provided a 32-bit address field even though the use in the 360 was just awful!

4. There were pressures to continue every successful line that IBM had, but IBM bet it all not unlike the Fortune article stated.

5. Univac plugged along, evolving the 1103 (1108... 1190), and continued to sell YUKy military machines and evolve the Univac I (now the III), adding some other business and minis. Later they bought the Spectra series, but that's another story. The Univac Series has grown at about the same rate as the 10, with more in the field, and the users are relatively fanatical about it. They don't want Univac to ever stop making it.

6. GE/Honeywell evolved their warmed over 7090 (the 635). They also marketed the H200 that was perceived to be compatible with the 1401. It wasn't but it was marketed well and it got them in the door for a few years, but the machine wasn't really good enough to last even though Honeywell evolved it endlessly till its death. Honeywell's only real computer business is with the old 600 series. The Multics

version is owned by a few zealots, but the other users like the system, and are relatively fanatical about it. They want the series continued forever.

7. Meanwhile at IBM the memory management problem finally started being solved in 1972 with the 370 by providing a 24 bit VA, but because the basic 360 architecture was good enough, the design was capable of being evolved. The 32 bit VA was finally added, and everyone acknowledges the costly mistake.

8. Amdahl may tell the wonderful story of the poor management decision post Watson that forced him to found Amdahl Corp. to build large 360's. By now, he headed the San Jose Lab and had redirected a subsequent machine there to become a 360 and wanted to take it to market.

9. Amdahl Corp. started up to build a 360, IBM fixed the address problem (the 370), and virtually wiped the company out because he had designed the wrong machine (a 360). He took a couple of years for the redesign, but he found friends at Fujitsu who helped him out financially in return for rights to the gate array and packaging technology, the keys to fast computers.

10. Lots of companies build 370 compatible products because it basically does the job, and users regard it as a commodity and standard. This is also the situation in the microprocessor business today... but it's unclear that the semicomputer companies (Motorola and Inte)l make much at it.

11. The basic 360 was a classic design because it could be extended once in the form of the 370. It should be made in its current form for probably another 20 years. I expect it to have a major specialized grafting as IBM tries to build high speed for scientific processing either in the form of a new attached processor or extensions to the 370 along the lines that the Japanese introduced. Here, I'm anxious to talk with Gene about this.

12. The pre-360's designs at Univac and Honeywell were bad, and evolutionary designs haven't gotten any better. They grow the base a bit, but basically it's a replacement market.

13. I have a talk that brings in other examples, but the one recurring lesson (to me): A company that listens to its customer base too long will miss major markets and get wiped out of its current position if it simply follows evolution. There are NO exceptions except the 370 (and PDP-10). The could both be evolved because of good basic design.

Given this memory, here's what I get that's relevant to our situation:

1. The 360/370 are quite similar to PDP-11 and VAX; the PDP-10 is like the 7090 (even has the 36 bit word and fond memories). We used a compatibility mode to deal with the backward evolution. The range goals are different, since we are trying to have a range of sizes down to Personal computers when we finally achieve MicroVAX. Also, we want to use the two machines (the 11 and VAX) together over time to cover our range instead of being religious about having a single architecture. We are much more flexible in architecture to go after

different needs! Thus, we have a much more conservative and evoutionary view.

2. In both the 11 and VAX cases, we adopted a much more evolutionary view by first building a machine 11/20, followed by the 05-40-45, and the 780, followed by 730-750-790 asap. This means that we keep on building whatever we were building before too (the PDP-10 and PDP-8), with the exception of the PDP-15 (I'm still amazed at your ability to get it to stop) because it's too risky to stop because we might lose some piece of a market. Our attitudes about change aren't too different from Univac which is also very engineering oriented. The only difference was that we had a much better product base and were in an expanding rather than stable market segment.

3. One difference between us and IBM is that within IBM there seems to be a stronger seperation between business and engineering. I believe engineers running a company are more conservative. As such, IBM generally goes for the right solution (which I think is VAX based on product goodness) versus evolution where one bets on everything. We could never make a decision like the 360 knowingly. They have given up lines (the 1130/1800, System 7, 9, 34 etc.) when they have needed to or when they have a better alternative (System 38, Series 1, and PC).

4. Notice IBM always stop poor, deadend machines and replaces them with what should be the most competitive base product in that price band. They also try to minimize the band/market overlap even they often use some crazy segments (eg. the 8100 as a comm machine) instead of gp machines (the Series 1... which is finally cleaning up in this area) due to having many engineering groups.

Bottom Line (Based on History)
We will not stop a computer line until our customers tell us to... which is probably not a bad and too costly philosophy.

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Imaging Products #2 ~~WIN HINDLE~~

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DIGITAL EQUIPMENT CORPORATION

PROPOSAL FOR IMAGING PRODUCTS FOCUS GROUP

JACK MACKEEN
RICH KALIN

TABLE OF CONTENTS

SECTION I. -- INTRODUCTION

Image processing is not a new application for computers. It has been around for at least 20 years, but the costs have been too high for most commercial applications. This situation is rapidly changing and, as component costs decline, major market areas are being opened. Within just a few years, it should be economical to replace many of the micrographic, image storage and retrieval systems now in use with computer system equivalents. Over an extended period of time, it is expected that digital computer imaging will replace most of the present applications for photographic film. Just as VCR's have replaced home movie cameras, digital optical disks will someday replace film libraries.

The major markets for image processing in the 1990's are expected to be for Document Imaging Systems (DIS) and Picture Archive and Communication Systems (PACS). With DIS, paper source documents of all types, from ticket receipts to table-sized engineering drawings, are scanned by the computer and stored as bit-map files. Once on line, they can then be viewed on high resolution terminals, annotated, indexed, sent through networks, and printed out when needed. PACS are similar, except that the images are continuous tone, gray-scale photographs, and the primary end users are medical radiologists. Again, over time, the publishing, broadcasting, medical, environmental, and physics communities represent important markets for full-color imaging.

Most of the problems in building image systems have to do with the amount of data that must be dealt with. A full-page color photograph can require 25M bytes of storage. A facsimile encoded page of text may only need 50K bytes, but that is still 20 times the ASCII equivalent. Image data is big, and image systems push the limits of storage, network, and display technology. Optical disk jukeboxes, fiber optic networks, and 1100-line CRT's are all engineering efforts important to image processing. MicroVAX's and 256K-bit memory chips are essential components for building affordable systems.

Digital is well positioned to be a leader in this area. Our system, network, and storage architectures are well suited to the data-intensive needs of image processing. In discussions with both OEM and end user customers with requirements for image-capable systems, we find there is little being asked for that we are not already working on. However, with rapid advances in technology, the pressure from our customers is rapidly escalating the need to have a focused Corporate effort coordinating Digital's activities in imaging applications. A variety of marketing surveys provided by Digital end user groups indicate FY86-FY90 CAGR's ranging from 20% to 40%, depending on segment (application).

Rich Kalin

SECTION II. -- EXECUTIVE SUMMARY

This proposal:

1) Presents market sizing from end user market groups for imaging applications in their respective market segments.

2) Identifies product requirements and investments to support them.

3) Proposes the creation of a focus group as a way to foster success in the marketplace with appropriate goals and measurements.

4) Proposes use of the focus group as a new way to coordinate internal and external activities for given application spaces, with an expected result of lower overall costs to the company.

The market for imaging systems is estimated as approaching $5B this year. It is growing at nearly 30% per year and will reach $15B by 1990. Assuming a 25% market share for Digital of the computer systems related portion of the above numbers, the revenue opportunity for Digital through all channels rises from $530M in 1985 to $1800M in 1990. The majority of this is believed to represent incremental ? revenue opportunity.

Imaging is a horizontal application appropriate in various forms to all Digital marketplaces. In this sense, it is similar to office products and applications. An analysis of imaging applications and contact with customers indicates that many, if not most, market requirements can be satisfied by products Digital already has in development or advanced development. Examples are advanced networks, optical disks, and relational databases. Some developments would need to be accelerated; a few products should be added. These requirements are covered in the Redbook/Beige Book funding requests spelled out in the proposal. The FY86 requests total $18,862M, of which $9,722M will be covered within other engineering group budgets.

Implementation of this proposal represents a new way for Digital to focus on a market opportunity. By coordinating internal activities and drawing in requirements for both internal and external needs, a potential exists to reduce total engineering investments while getting early presence (directly and indirectly) in the market. Given that these activities are predominantly extensions of existing activities, the opportunity also exists to drive industry standards around Digital approaches to imaging solutions.

SECTION III. -- OPPORTUNITY/MARKET

OPPORTUNITY

It is a given that Digital is and will be in the imaging system business, both directly and indirectly. Digital strengths, including networks and distributed computing, along with man-machine interfaces (e.g., workstations), are the basis for most imaging applications.

The task is to carefully define the market segments to be approached and then organize to capitalize on the expected high growth rates in the imaging applications space.

The opportunity springs from the fact that this application space is in its infancy. No vendor has a dominant market position. Very few standards have been set. Initial deliveries of capability have come from small entrepreneurial system houses on a custom or project basis. Point products, such as optical disk filing stations, are beginning to appear from large companies, particularly the Japanese.

The opportunities for Digital are:

1. External

   a) To achieve market leadership as a developer/ deliverer of disciplined systems methodology for imaging applications based on extensions of present strengths in distributed systems.

   b) To set national/international standards for imaging applications which reflect Digital's architectures.

2. Internal

   a) To develop an all-channels marketing strategy up front. This is particularly appropriate given the infancy of the market.

   b) To coordinate development spending for both internal applications needs and product development for the market. This should realize potential savings of development/acquisition monies. Significant activities are already underway in various parts of the company, such as EDCS (Engineering Document Control System) in CAEM Engineering and an automated drawing control system in Manufacturing Applied Technology in Andover.

Successful internal and external exploitation of the opportunity will provide Digital a leadership imaging application position. Investment and focus in this space will enhance and reinforce basic strengths in storage, networking, workstations, and distributed systems.

THE MARKET

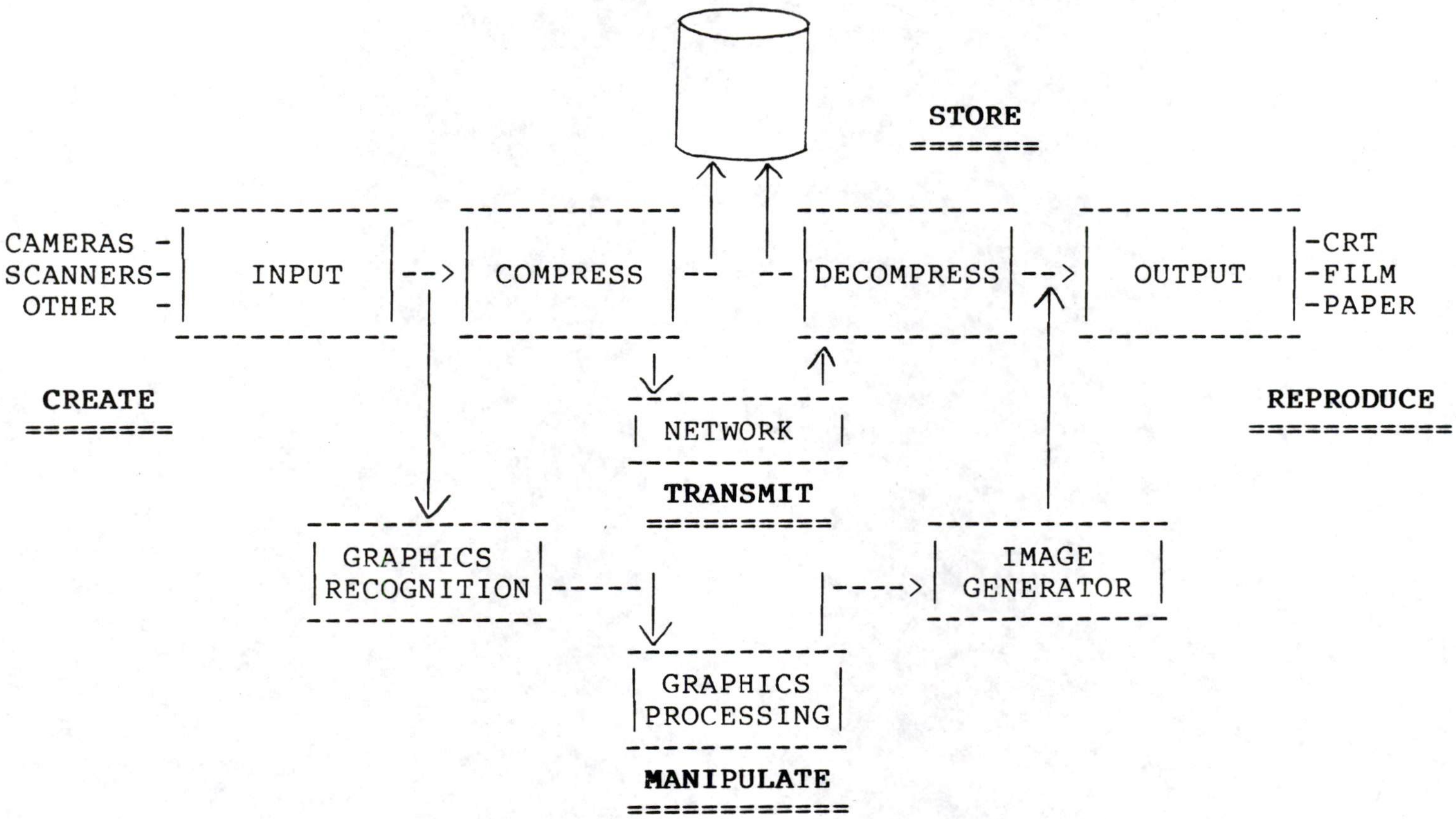
In 1985, the industrial/commercial market for imaging systems of all classes is estimated as approaching $5 Billion, including all components. Of this, the computer, image/document storage, and communications hardware and software was estimated at over $1 Billion. This content is expected to reach $5-7 Billion by 1990. It should be noted that industry reports and surveys differ significantly in size and growth rate estimates.

The current market appears to be dominated by medical, office, and scientific applications. By 1990, it is expected that medical and commercial records storage and retrieval will grow to be the largest application areas. The table below shows a market forecast by applications from 1985-1990. Additional detail is provided in Appendix VI-A.

WORLDWIDE NON-CONSUMER DOCUMENT/PICTURE IMAGING MARKETS

	ESTIMATED COMPUTER CONTENT %	1985	1990	CAGR
PHYSICS	25%	$ 250M	$ 475M	30%
ENVIRONMENTAL	25%	100M	385M	40%
MEDICAL	25%	1101M	4100M	30%
OFFICE	60%	2300M	6800M	20%
EARTH RESOURCES	30%	70M	300M	30%+
VTT PRIVATE	70%	210M	700M	27%
EDUCATIONAL/TRAINING	50%	124M	450M	30%
PUBLISHING	70%	100M	530M	40%
ENGINEERING/DRAFTING	60%	100M	750M	40%
MANUFACTURING	30%	100M	530M	40%
TOTAL		$ 4355M	$15520M	28%
ESTIMATED COMPUTER AND COMPUTER-RELATED CONTENT		$ 2125M	$ 7200M	
VALUE TO DIGITAL AT AN ASSUMED 25% MARKET SHARE		$ 530M	$ 1800M	

The following diagram is typical of the imaging systems applications being described by our customers regardless of application space. It is neither complete nor a representation of specific products. It is a convenient way to begin identifying the product set required for success in the applications listed on the previous page.



Satisfying applications requirements with all (or a majority) of these characteristics literally involves every engineering discipline Digital engages in. In addition, the applications fit into every marketplace pursued by Digital. Therefore, cross-functional coordination of engineering and marketing activities is key to success. This is the role of the proposed Image Products Focus Group.

SECTION IV. -- MISSION AND GOALS

MISSION

A. Coordinate all Corporate activities required for leadership in the market for computer-based imaging applications.

B. Be an imaging expertise center to provide strategic and tactical direction/guidance for marketing and engineering groups.

Define Products/Systems needed to succeed.

GOALS

A. STRATEGIC

1. Establish and gain approval for a Corporate strategy for image processing activities.

2. Evaluate appropriate strategic partnerships. Recommend these for approval to the appropriate body (i.e., MSSC/Strategy Committee). Manage relationship after established, if appropriate.

3. Recommend investment strategies in all forms (i.e., product development, buy-outs, joint arrangements, etc.) to fill identified and approved needs.

B. PRODUCT

1. From market requirements developed by SMU's, identify unique product requirements and propose product strategies for imaging applications.

2. Propose accelerated development activities as appropriate. Redirect product development only when supported by a specific business plan.

3. Provide product management/forecasting and other customer support as required in support of the plan.

C. MARKETING/SALES

1. Coordinate business plans and marketing activities so that messages and strategies are common and reinforcing across the company.

2. Provide imaging-specific sales aids, training tools and promotional materials. Coordinate other marketing communications activities with appropriate market groups.

3. Support specific customers on a project or program management basis as appropriate. Be a resource to all groups in support of their customers.

4. Coordinate activities focused on driving industry standards for imaging.

5. Collect revenue information in order to size overall market for imaging applications and Digital's presence in it.

<u>NON-GOALS</u>

A. Measurement as a P&L center.

B. Be a stand-alone business.

SECTION V. -- MEASUREMENT (WHAT IS GOODNESS)

1. Market share as measured by imaging applications installed (units or dollars or seats - done by application space, if possible).

2. Adoption by engineering and marketing/sales of proposed investments and programs (i.e., amount of dollars committed to the imaging space).

3. International adoption of Digital standards as industry/market standards (i.e., leadership in standards acceptance built around Digital architectures).

4. NOR dollars collected for counting purposes only.

5. Performance to business plan.

6. Being viewed as a company resource which delivers value.

7. Accuracy in overall sizing of application space.

SECTION VI. -- PROPOSED ORGANIZATIONAL STRUCTURE

It is proposed that the major functions of the focus group be engineering, marketing, and project management.

The major roles are cross-functional coordination in all disciplines due to the complex nature of the systems and services delivered. The overall number of people required should be able to be held constant once staffed as the primary thrust will be for projects and products which are already part of Digital's development efforts. The total number of people should be reasonably low, particularly after imaging product requirements (and sensitivities) begin to be embedded in on-going engineering plans.

The focus group should be a part of a marketing organization, with the engineering manager reporting also to the Vice President Distributed Systems Engineering and Marketing (Bill Johnson).

ORGANIZATIONAL PROPOSAL

The structure and staffing outlined below is believed representative of what a full-time, fully-staffed organization should be.

VICE PRESIDENT, OEM GROUP

FOCUS GROUP MANAGER

- - - - - - - - - - -IDENTIFIED REPRESENTATIVES FROM MARKET GROUPS

MARKETING

- o Market Requirements/Knowledge [2-3 People]
- o Coordination with Other Groups [2-3 People]
- o Product Requirements/Product Management/Forecasting [3-4 People]
- o Promotional/Sales Support/General Customer Support [2-4 People]

ENGINEERING* (Image Systems Program Office)

- o Technology Evaluation [2-3 People]
- o Technical Support [6-7 People]
- o Program Management and Internal Engineering Liaison [4-7 People]
- o Architecture [1 Person]
- o Administration [1 Person]
- o International Standards [2-3 People]

PROJECT MANAGEMENT (External)

- o Project Management [1-3 People]
- o Manage Specific Customer Projects/Major Relationships**

* Also reports to Vice President, Distributed Systems Engineering and Marketing (Bill Johnson)

** Will depend on the number of customer commitments requiring this level of resource; is currently two persons -- one for Kodak and one for Philips/Siemens

From the standpoint of common sense and today's budget realities, a "virtual" focus group with limited staffing is proposed for both marketing and engineering. In the "virtual" concept, each involved function (marketing, engineering, manufacturing, and service groups) would identify one or more fairly senior persons to be assigned responsibility for imaging activities within and on behalf of their organizations. These individuals would be empowered to speak for and commit their organizations. They would be expected to spend a minimum of 20% (up to 100%) of their time on imaging activities. They would remain within their organizations, but their goal sheets would reflect the imaging focus commitments.

This "virtual" group will create the forum for understanding and managing Digital's initial activities in imaging applications. Based on the understanding of customer, market, and product needs, funded positions will be established and full-time resources hired. However, the long-term success of the focus group is dependent on the marketing and field groups with customer responsibility retaining their participation in the focus group process via identified participants as resources.

To lead the "virtual" group, approval is requested to hire:

1. A focus group manager (Level 16-18).

2. Four marketing people responsible for coordinating with other groups to develop market and product requirements, as well as supporting customer situations with imaging-specific materials.

3. Project managers as required to support major customer liaisons with significant competitive information/technology issues. This is more crucial than usual due to the advanced nature of the technology involved and the complex systems disciplines. These could be direct hires or contracted via CSS/SWS. Project managers are in place now for Kodak and Siemens/Philips. Relationships contemplated which may require similar focus are 3M, Bell & Howell, GE, Xerox, and various European companies.

4. Items 1 and 2 above represent an investment required of $500K. Item 3 above is funded in the Image Systems Program Office.

Other staffing in place is the Image Systems Program Office managed by Rich Kalin in the Distributed Systems Engineering organization. This office corresponds to the engineering function as shown on the focus group organizational proposal. Current staffing is eleven people (9 exempt and 2 non-exempt). The bulk of the activities in this office are focused on working within the engineering community to define/implement/support image system technologies. In addition, the office is providing extensive technical support for Kodak/Philips/ Siemens.

SECTION VII. -- APPENDIX

A. IMAGING MARKET SIZE DETAIL

1. TECHNICAL GROUP -- Contact: Jack Bowie

A. Physics -- Contact: Mike Peterson

	1985	1990	CAGR
-- Astronomy } -- Astrophysical }	$250M	$975M	30%

Comment: Major focus/need is on scientific workstations. Requirement today is 1K x 1K x 8; future requirement is 2K x 2.5K (1990), color, with 8- to 16-bit planes. Applications should drive functionality-oriented technical workstations with requirements for imaging and animation.

B. Environmental -- Contact: Ellen Newlands

	1985	1990	CAGR
-- T.A.M.	$100M	$385M	40%

Comment: Digital's market share is currently estimated at 40%. Share drops if we provide only faster CPU and storage. Product needs to realize continuation of growth in market share are:

- -- Transfer Bandwidth of 25MB/SEC
- -- Optical Disk 1 Gigabyte/Side - Write Once
- -- 8 MIP VAX
- -- Cluster-Capable Array Processor
- -- Native Mode Graphics Software
- -- Display Capability 2K x 4K x 16
- -- User Interface for Graphics/Images
- -- Image Database/File Management Software

Applications:

- -- Oceanography
- -- Weather Forecasting and Research
- -- Earth Resources Analysis
- -- Forestry
- -- Marine Biology and Fisheries Management
- -- Ship Movement, Routing and Scheduling
- -- Air and Water Pollution
- -- Land Use Planning
- -- Oil Exploration

C. Medical -- Contact: Jack Bowie/Kerry Bensman

		1985	1990	CAGR
-- T.A.M.	{ Diagnostics	$ 41M	$ 100M	15%
	{ Imaging	$1060M	$4000M	30%
	Digital Share @ 30%	$ 318M	$1200M	

Comment: In order for Digital to realize a continued 30% share presence, the product set must be expanded with emphasis on higher-speed CPU's, very high-speed networks (100-250 MB/SEC), optical disk storage, high bandwidth storage architectures for both magnetic and optical disks, and high resolution workstations. CT and NMR unique workstations will continue to be built by the OEM's who supply such systems. Advanced database capabilities are required.

Unit shipments are split approximately 70% U.S. and 30% international. Medical-oriented revenue is expected to be 27% of all image processing in 1985, rising to 40% in 1990, according to one independent survey.

Customer Potential: Hospitals, Clinics, Medical OEM's

2. BOS -- Contact: Bill Stowe

A. Image Processing

1985	1990	CAGR
$2.3B	$6.8B	20%

Comment: The above figures from the Gartner Group are confirmed by an A.D. Little article, which notes that documents are increasing at a 20-22% CAGR. Each day U.S. businesses alone generate 600 million pages of computer output, 235 million photocopies, and 76 million letters. The total volume of stored information (400 billion documents) is doubling every four years.

There are four generic segments to the image segments of OIS:

-- Image Processing - Scan, Digitize, Transmit, Store
-- Computer-Assisted Retrieval
-- Facsimile
-- Video-Based

Customer Potential: IRS, Social Security Administration, Insurance Companies, Blue Cross, EDS/GM, National Labs, etc.

Recommendations: Immediate development of FAXmail, scanners (OCR), and compound document handling capabilities.

B. Videotext -- Contacts: Bob Camelio/Susan Szepan

Comment: Videotext applications based on the VTT terminal are a way to participate in cost-sensitive target applications. This may be the precursor to future needs delivered at low cost, and it is clearly at the opposite end of the spectrum from the high cost, high resolution, and functionality noted for most other devices for imaging applications described in this proposal.

Applications focus includes:

-- Point Of Sale (POS)
-- Public Access
-- Corporate Projects
-- Sales and Marketing
-- Shop Floor Information Systems
-- Office Automation
-- Training and Education
-- Imaging Databases

Private videotext systems are expected to represent $232 Million in revenues in 1986, growing to in excess of $700 Million by 1990 (study by LINK). To this can be added public access systems, estimated to number 1245 in the U.S. by 1990 with an average of 9 terminals each (Frost & Sullivan). Computer-controlled videodisc systems will add $1.5 Billion/year by 1990.

3. CAEM -- Contacts: Linda Moore/Bill Detweiler

	1985	1990	CAGR
-- Earth Resources	$ 70M	$300M	30%+

Comment: Within exploration applications, the following breakdown of expenditures is expected:

Seismic	29%
Interpretation/Modeling	39%
Mapping	12%
Other	20%

Product requirements are 1K x 1K terminal with 8-24 planes (60Hz non-interlaced) having >1MB/SEC DMA interface. System requirements are VAX-based with high-speed storage and networking. Cost per seat targets are expected to decline 30%/year from today's estimate of $250K.

4. OEM -- Contact: Eli Lipcon

Marketplace forecasts above include product and capabilities delivered via OEM's. Specific forecasts for imaging-related revenue from identified partnership relationships are:

	1986-1988	1989	1990
Kodak	$ 85M	$ 75M	$100M
Philips	$ 30M	$ 30M	$ 30M
Siemens	$115M	$ 50M	$ 60M
TOTAL	$230M	$155M	$190M

5. EDUCATION AND TRAINING -- Contact: Skip Atwater

1985	1990	cagr
$124M	$459M	30%

The numbers above reflect hardware, software, application, and courseware revenues.

Comment: Trends in training technologies are to integrate the natural image (video) with computer overlay (IVIS) and utilize as a stand-alone or networked learning station. The concept of training is moved away from "instruction" to intelligent access to information databases (AI). Market demand is for natural image development and delivery systems, authoring (information) systems, and packaged videodisc courseware. Market hardware requirements want low-cost PC-based entry systems, while high end wants "natural image terminal" products connected to a network.

Applications:

-- Stand-Alone Training Workstation
-- Natural Image Terminal
-- Factory Floor Visual Control Workstation
-- Maintenance Aiding System
-- Embedded Visual Diagnostic and Repair
-- AI Expert System
-- Intelligent Tutor to Visual Databases
-- Medical Training Systems

6. INTERNAL NEEDS AND OPPORTUNITIES

A. Customer Service Engineering (CSE) -- Contact: Brad Kennedy

CSE is working on a project to allow retrieval from a database of all the "Illustrated Parts Breakdown" documents. This will require an imaging terminal capable of high resolution, full-page displays. Brad has been working within Field Service to identify other applications. The first application identified is the need to integrate image capability into the existing "Sympton Information Database". A hardware need identified is to expand a compressed image file in real time.

B. Image Information Project -- Contact: Richard Browning, Manufacturing Applied Technology

This project is code-named "ERICA". It is focused on developing an electronic solution for the acquisition, storage, transfer, management, and distribution of engineering documentation. This documentation exists in two forms -- hard copy and CAD. Project ERICA will demonstrate a proposed solution on a small scale. The results of the demonstration will be evaluated, and a proposal for full-scale implementation will be made.

SECTION VII. -- APPENDIX B

DIGITAL'S CAPABILITIES

1. DIRECT

Digital has been involved in many facets of imaging for over 20 years. Some of the first display systems and graphics processing was done on early Digital computers.

Today, Digital capabilities in a product dimension include a wide range of computing power -- base band, broad band and high-speed computer interconnects; database and relational database software; color and monochrome bit-mapped displays; magnetic storage; and packaging suitable for a variety of environments.

Product or advanced development activities are underway on higher speed networks, optical disk storage, better graphics capabilities, and both higher resolution and lower cost displays. All of these have applicability in the imaging systems market.

Applications capabilities deliverable today range from Digital-developed electronic mail and word processing systems to a variety of network-oriented solutions delivered in conjunction with our software partners and OEM's. IVIS provides extensive video-based training/authoring capability into the educational field.

Additional applications/tools are under development, such as compound document editors and videotext terminals.

2. INDIRECT

The following list identifies OEM's delivering Digital-based systems with imaging capabilities of various types:

A. MEDICAL

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
Advanced Medical Systems, Inc.	Graphics General - Image Processing	Manufacture of Image Processing Systems	Medical, Scientific, Industrial
A.E.M. Technology, Inc.	Medical - Body Scanning/ Imaging	Three-Dimensional Image Reconstruction and Slicing to Replace Conventional X-Ray Technology	Medical, Diagnostic Radiology
Positron Corporation	Medical - Body Scanning/ Imaging - Tomography	Image Data Analysis, Process of Data and Storage of Data	Medical, Nuclear Medicine Physicians
Microtek	Converting and Archiving Radiogram Libraries and New Images to a Digital Computer Database		Hospital Radiology
EGG Ortec	Cat Scan/ Radiation Monitors		
CDA	NMR		
Siemens	Cat Scan		
Philips Electronic	X-Ray Q.C.		
Varian	Radiology		
Adac	Radiology		

A. MEDICAL (continued)

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
NCS	Radiology		
Diasonics	Diagnostic Imaging		
Kevek	X-Ray Spectrometry		

B. ENGINEERING/MANUFACTURING

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
Geoscan Services Company	Earth Resources - Seismic	Geophysical and Seismic Data Processing Display, Batch and Interactive	Geophysical/ Seismic Service Companies, Oil Companies
Megavision	Graphics General - Image Processing	Image Processing Hardware	R&D Labs Using Image Processing Research Labs
Pickering Research Corporation	Graphics General - Image Processing	Image Processing of Landsat Data and Photos that May Be Digitized	Non-Military Sector of Peoples Republic of China
Perceptics	Graphics General - Image Processing	Non-Destructive Testing of Parts and Assemblies by Implementation of Computer Topography Scanner for Defects	DOD and Their Primes
	***************	***************	***************
		Testing of Parts and Assemblies for the Trident II Missile	U.S. Government
	***************	***************	***************
	License Plate Recognition Systems		Custom Services, Government

B. ENGINEERING/MANUFACTURING (continued)

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
Scan-Optics, Inc.	Graphics General - Image Processing	High-Speed Document Reader and Key Data Edit System, High Volume Optical Character Recognition	Utilities, Financial Service Organizations
Ramtek Corporation	Graphics General - Image Processing	Support of Graphics Using Ramtek Graphic Display Products, Image Processing	U.S. Civilian Government Agencies and Military
Tameran, Inc.	Graphics General - Image Processing	Converts Graphic or Alpha Image From Host of CAD Systems to High Resolution Roll Microfilm or Fiche	CAD/CAM
Image Graphics, Inc.	Vector and Raster Graphic Systems		Aerospace, Scientific, and Engineering
Terra Mar	Image Processing		Geological
Cognex	Vision System Designed to Read, Verify and Assure Quality of Humanly-Readable Information in Industrial and Manufacturing		Industrial and Manufacturing
Comtrex, Inc.	Automated Visual Inspection Machinery of In-Process/Post-Process of Semiconductor Manufacturing		Microelectronics

B. ENGINEERING/MANUFACTURING (continued)

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
Lockheed Electric	Image Processing		
Systems Control	Process Control		
Moore Systems	Process Control		
Bailey Controls	Process Control		
Westinghouse	Process Control		
Simmons Precision	Process Control		
Bristol Babcock	Process Control		
SASC	Land Satellite Systems		
Itek	Optical Scanning		
Pacom	CAD/Process Control		
World Graphics	CAD/Flight Simulation		
Schlumberger	Well Monitors		

C. PRINTING/PUBLISHING/TEXT MANAGEMENT

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
Image Sciences	Integrated Electronic Forms Design and Publishing Systems		Fortune 500
Di-Sys, Ltd.	Videotext		Cable Television
Reuters	Text Management		

C. PRINTING/PUBLISHING/TEXT MANAGEMENT (continued)

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
CSI	Text Management		
Rockwell Graphics	Press Monitors		
Atex	Text Management		

D. BUSINESS/COMMERCIAL

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
Computer Entry Systems	Optical Character Recognition System - Remittance Processing		Bank, Department Store, C&P Tele. Wholesale/Retail
Xerox	Laser Print Systems		

E. GENERAL

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
Comtechnologys	Real-Time Image Processing Used for Quick-Look Analysis of Test Progress		Military R&D Military Contractors
International Imaging Systems	Image Processing		Industrial, Medical, and Earth Resources
American Signal	Flight Information Systems		
Genigraphics	Slides		
Johnson Controls	Process/ Security Systems		

E. GENERAL (continued)

COMPANY	APPLICATION	APPLICATION DESCRIPTION	INDUSTRY SERVED
GE Nuclear	Emergency Response Information Systems		
Perceptions	Image Analysis		
Printrak	Fingerprint Systems		

3. RELATED DEVELOPMENT ACTIVITIES

The list below identifies internal projects/products underway which are applicable to imaging applications. Some are advanced development, some are product development, some are in manufacturing, and a few are in product line engineering groups. The list is probably not complete and does not indicate that all of these projects are funded and committed. Its purpose it to show that a significant and widespread set of activities appropriate to imaging is underway in the company.

Required For Medical Imaging Market

1. FDDI - Fiber Distributed Data Interchange (John Adams)
2. Write Once Optical Disk (Linda Limos)
3. High-Speed Data Link (Marty Czekalski)
4. DECrad (Jack Bowie)
5. DECtouch - VT220/241 Touch Screens (Frank Gianattasio)

Other Projects Pertinent To Imaging

1. SARAH - Composite Document Editor (Bill Zimmer)
2. VTT - Video Text Terminal (Bob Camelio)
3. ACTOR - Imaging Terminal (Dave Upton)
4. PEGASUS - Multi-Purpose Workstation Terminal (Bill Greene)
5. Text Database - Advanced Development (George Berry)
6. CDROM - Read-Only Optical Disk (Ed Schmid)
7. MULE - Southwest Terminal Advanced Development (Tom Stockebrand)
8. NIGHTHAWK - Database Machine
9. Eastern Research Labs - Performance Issues (Greg Wallace)
10. Field Service Documentation Project - Using VS1 as Imaging System (Brad Kennedy)
11. Central Engineering Drawings Projects (Don Metzger)
12. Compression/Decompression Algorithms (Tom Stockebrand)
13. Print Server - PDP-11 Based (Frank Hassett)
14. DECfax - Facsimile Reproduction (Mark Sorensen)

15. Printers and Scanners (Tom Cyr - Hardware) (Jim Donneley - Software)

16. EDCS (Jack Conaway)

17. IVIS/IGT (GREMLIN) (Skip Atwater)

PRODUCT DEVELOPMENT

PROJECT/PRODUCT DESCRIPTION	CURR PHS	FRS DATE	LIFE NOR $B	LIFE EXP $M	FY EXPENSE $MILLIONS FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
SCANNER Provide input scanner for FAX and use with LN series printers FVS: T=9/85 IMAGE T=12/85 OCR Inventory at announcement = 0 MLP: T=$2995 IMAGE T=$6500 OCR Transfer cost: T=$1000 IMAGE T=$2000 OCR	0	Q2 FY86 IMAGE VERSION Q4 FY86 OCR VERSION	26M IMAGE VERSION 84.0 OCR VERSION	1.542 BOTH	.400	.800	.050	TBU	T. DUNDON
SCANNER FOLLOW ON (GRP 4) FVS: TBD MLP: TBD TC: TBD	PRE 0	TBD	TBD	TBD	-	-	.600	TBU	T. DUNDON
IMAGE PRINTER FVS: TBD MLP: TBD	PRE 0	TBD	TBD	TBD	-	-	1.000	TBU	D. SWEENEY
LN03+ Adding full bit map controller to the LN03 FVS: T=Q2 FY86 Announcement: Q2 FY86 Inventory at announcement = 400 units MLP: T=6500-7000 Transfer cost: T=1844 (note on funding - hardcopy will fund this if LEWS does not through PSI cost reduction)	PRE 0	Q3 FY86	TBD	1.000	-	.650	.350	HC OR LEWS	P. NELSON
VR400 FAMILY	0	TBD	N/A	2.481	.281	.829	1.400	TBU	JAMES
	0	TBD	N/A	2.200	0	.800	1.400		
Family of 4 CRT monitors (13V mono and color, 19V mono and color). High frequency, high resolution, flicker free. To be used as standard display for all mid to high end terminals and workstations High DEC value-added and uniqueness. First terminal application is ACTOR1. MLP $TBD Xfer cost $400-$2000 FVS: FY87T Announce: TBD Inv at Announce: TBD									

PRODUCT DEVELOPMENT

PROJECT/PRODUCT DESCRIPTION	CURR PHS	FRS DATE	LIFE NOR $B	LIFE EXP $M	FY EXPENSE $MILLIONS FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
ACTOR	0	TBD	TBD	TBD	.600	3.035	1.400	TBU	ELSBREE
				TBD	-	2.830	1.400		

A very high resolution image viewing station, optimized for document display. It allows a 8.5'x11' page to be shown at 100 dpi with 4 gray levels. Hardware assist for 90-degree rotation, zoom, and facsimile decompression. VT 220 emulation and NI interconnect.

Proposed costs are
shared with $2830K corporate.
MLP: $10,000
Transfer cost $3000T
FVS: FY87T
Announce: TBD
Inv at Announce: TBD

PRODUCT DEVELOPMENT

PROJECT/PRODUCT DESCRIPTION	CURR PHS	FRS DATE	LIFE NOR $B	LIFE EXP $M	FY EXPENSE $MILLIONS FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
PTOLEMY FAMILY	0	Q4 FY87T	TBD	6.8	.500	3.100	3.200	STORAGE SYS	K. SILLS

An optical disk subsystem, using 1-2GB write-once media, for the storage of digitized images. Key elements are a jukebox selector, allowing direct access to at least 50GB of on-line data, and heuristic software for managing drive usage and data caching. Program need is for a FDDI-server image archive.

MLP ext: $300K.
TC est: $75K. Project will also deliver single drive capability (> 1GB per side).
Single drive TC est $6K master; $9K slave.
MLP (T -Master): $25K. Includes development of Ptolemy drive interface.

PROJECT/PRODUCT DESCRIPTION	CURR PHS	FRS DATE	LIFE NOR $B	LIFE EXP $M	FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
HSDI				TBD	-	.920	1.700	STORAGE SYS	M. CZEKALSKI
				TBD	0	.700	2.000		

Implementation of an architecture and interface specification for supporting High Speed (up to 640 Mbps) Data transfer. Needed to support medical and document scanners, high-end workstations, array processors, and parallel transfer disk systems. Project will deliver a gate-array bus interface, a general purpose I/O board, and a HSDI/BI memory subsystem. OEM's will be encouraged to provide the other components required.

PRODUCT DEVELOPMENT

PROJECT/PRODUCT DESCRIPTION	CURR PHS	FRS DATE	LIFE NOR $B	LIFE EXP $M	FY EXPENSE $MILLIONS FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
NI2 CHIP EVALUATION A 100 Mbps bi-directional token ring based on the ANSI Fiber Distributed Data Interface (FDDI) standard. Distances to 50km. Possibly used for SI2 as well. Program need is for an Ethernet bridge adapter and DECnet controllers for BI and Qbus VAX's.		1/87		TBD	1.085	.190	0	NAC/DSG	K. AJGAONKAR
10/100 NI2 BRIDGE ACCELERATION A protocol transparent interconnect between a 10 Mbps NI and a 100 Mbps NI2. Allows NI2 to be configured as a backbone network, interconnecting Ethernets.		2/88	12.0	TBD	-	.198	1.956	NAC/DSG	P. CHOW
BI/NI2 ADAPTER A DECnet network controller for BI VAX's, optimized for very high network throughput (>50 Mbps). Needed for medical networks, high end file stores, and high speed data collection scanners.		3/88	32.4	TBD	-	0	1.548	NAC	K. AJGAONKAR
QBUS/NI2 ADAPTER A DECnet network controller allowing the direct connection of Qbus machines to NI2 token ring networks.		4/88	11.2	TBD	-	-	.733	NAC	K. AJGAONKAR

-

PRODUCT DEVELOPMENT

PROJECT/PRODUCT DESCRIPTION	CURR PHS	FRS DATE	LIFE NOR $B	LIFE EXP $M	FY EXPENSE $MILLIONS FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
IMAGE PHASE I Firmware and microVMS software to support the Datacube QVG-150 frame buffer. Needed to fill market and application development needs until ACTOR becomes available.	0	N/A	N/A	.728	.350	.410	-		
IMAGE SUPPORT To develop and demonstrate those parts (not committed) of the image system that need our particular expertise. The C-chip and the 3-port NEC memory chip are examples.	N/A	N/A	N/A	.100	-	.100	-		
VMS SUPPORT FOR THE WRITE-ONCE OPTICAL DISK Support for the Ptolemy library system under VMS, with file structures, indexing, and disk management suitably designed for the access characteristics of write-once media.				TBD	-	.500	-		
VMS SUPPORT FOR IMAGE PROCESSING Provide whatever modifications are necessary to allow VMS to efficiently transfer large data files between storage and NI2 network ports.				TBD	-	.500	-		
TOTAL					3.216	15.562	18.737		
LESS OTHER GROUP SUPPORT					2.866	9.722	13.937		
TOTAL IPG FUNDING					.350	5.840	4.800		

NON-PRODUCT DEVELOPMENT

PROJECT/PRODUCT DESCRIPTION	FY EXPENSE $MILLIONS FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
Non-Product Development:					
Kodak Program Program management and specialized technical support for Eastman Kodak's KIMS (Kodak Image Management System) development effort, an investment being made by us under contract to establish EK as a major OEM and maximize the use of DEC hardware and software in their systems. This consulting is in addition to services from SWS and CSS that the customer is paying for.	.490	1.550	1.190		
Philips Program Program management and consulting to establish Digital as the primary supplier of computer system and network components for future Philips distributed diagnostic imaging systems.	.098	.372	.510		
Siemens Program Program management and consulting to establish Digital as the primary supplier of computer system and network components for future Siemens distributed diagnostic imaging systems.	.098	.372	.510		
Systems Integration Prototype a Picture Archive and Communication System (PACS) using DEC and OEM components. Used to calibrate performance models, give demos, and identify system integration issues.	.232	.620	.850		
University Research Sponsor university research to further the state of the art of Imaging Technology, particularly in the areas of PACS, Medical Imaging and Machine Vision.	.050	.200	.300		

NON-PRODUCT DEVELOPMENT

PROJECT/PRODUCT DESCRIPTION	FY EXPENSE $MILLIONS FY85	FY86	FY87	EXTERNAL FUNDER	PROJECT OWNER
Base Product Marketing Understand the requirements for Imaging Systems by conducting limited user/application research, and customer requirements analysis. Qualify market data provided by OEM's. Provide materials and support for customer presentations.	.049	.186	.340		
Total Non-Product Development	1.017	3.300	3.700		
Product Development Total from Chart	3.216	15.562	18.737		
	------	------	------		
TOTAL (Product and Non-Product Development)	4.233	18.862	22.437		

SECTION VII. -- APPENDIX

D. COMPETITIVE ENVIRONMENT

-- Principal competition will be IBM, AT&T, and the Japanese. All vendors will attempt to enter the imaging applications space in some form. We are aware that Hewlett-Packard is committed to the imaging space and will have strengths because of their medical instrumentation division. Wang will focus on the commercial or business space. Several start-up/venture companies, such as Filenet, have delivered or proposed prototype or one-off versions of imaging systems.

-- AT&T has clearly targeted this space as a growth opportunity. They have approached Technicare and Atex, promising large amounts of investment in the imaging space. We are also aware, as a result of conversations with AT&T New Ventures, that there are imaging products being worked on within the Bell Laboratories.

-- Film and micro imagery companies, either by themselves or in partnership with computer vendors/systems houses, will enter the market. They view it as both an opportunity and a survival issue.

-- The Japanese are offering point products now, such as the Hitachi Optical Disk Filing System (see following page).

-- The list of market entrants is shown in the groupings below:

LIKELY JAPANESE IP SYSTEM VENDORS

Sony
Ricoh
Toshiba
Matsushita
NEC
Hitachi

LIKELY IP COMPUTER SYSTEM VENDORS

IBM
Wang
Hewlett-Packard
AT&T

CURRENT FILM SYSTEM VENDORS

Kodak
Bell & Howell
Minolta
3M
Fuji

MEDICAL IMAGING EQUIPMENT VENDORS

Philips
Siemens
Picker
Technicare
GE
Toshiba

IP VENTURE FIRMS

Filenet
Imagitex
Via Video
Datacopy
Scitex

OFFICE AUTOMATION

Optical Disk Filing System

To meet the ever-increasing need for efficient document handling, Hitachi has used its latest optical disk technology to develop a high-speed document storage system that is sophisticated in design yet simple and efficient in operation. The optical disk filing system can store the equivalent of 40 thousand letter-size documents on a single optical disk. With the addition of a 32-disk library unit, the system can store and retrieve more than 1.3 million pages of text and image data. This is equivalent to about 55 four-drawer filing cabinets full of data. In addition to creating an orderly and manageable filing system, this provides a tremendous space saving.

Operation of the system is simplicity itself. First, the system scans a document, displays it on a full-page high-resolution vertical screen and then stores it on an optical disk, using a semiconductor laser. This storage method guarantees outstanding accuracy and reliability.

Once filed, documents can be easily retrieved using the system's indexing capability. The user can then combine or edit documents, employing easy-to-read editing symbols (icons) and a positioning device (mouse).

Once retrieved and edited, documents can be printed out by a letter-quality laser beam printer, or transmitted anywhere in the world by built-in facsimile.

■ **Computer Sales & Service Division**
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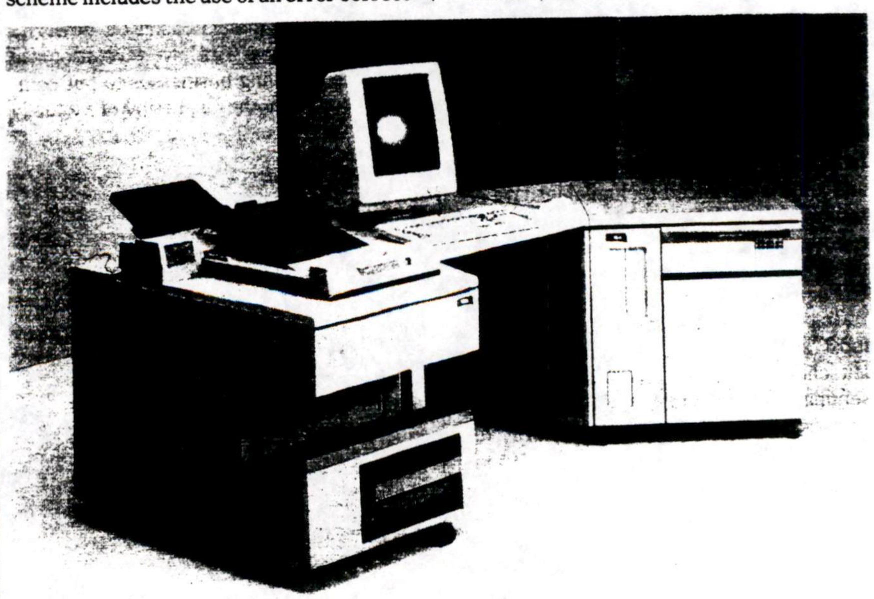
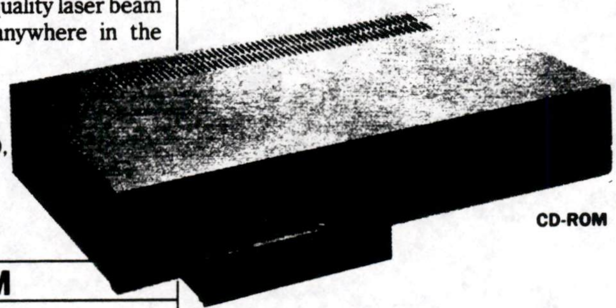


Hitachi's optical disk filing system



CD-ROM

CD-ROM

Compact optical discs (CDs) pioneered by Hitachi and others are taking the audio world by storm because of their sparkling fidelity, small size (about that of a 45-rpm record), and virtual indestructibility. But CDs could play an equally significant role in storing computer data. Because they have an immense storage capacity and can be mass-produced, they could serve as an inexpensive medium for the distribution of computer-readable text, graphics, and computer software.

Hitachi is leading the way in developing this exciting new technology. For example, we have devised a scheme for recording data on compact discs that is now in the process of becoming an international standard. The scheme includes the use of an error correcting code (ECC) to obtain the high reliability needed for use as a digital storage device for a computer.

With the Hitachi format, a compact disc can store as much as 550 megabytes of data—equivalent to about 6,000 graphical images, or about 300,000 pages of text. Storing that much information would require 500 to 1,000 of the floppy discs now used by personal computers.

Hitachi has also introduced an inexpensive system that enables virtually any computer (including most personal computers) to retrieve data from compact discs conforming to the standard format. Called the CD-ROM, the system can retrieve information from a disc in less than a second. It owes its low price to the use of a design similar to that of our existing consumer-oriented compact disc digital audio players.

Because they are an ideal media for distributing a large volume of data at an economical price, we see CD-ROMs opening up new markets in electronic publishing, personal data bases, personal computer software distribution, and graphics data bases for computer-aided design and engineering.

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