THE MANAGEMENT OF END USER COMPUTING
A RESEARCH PERSPECTIVE

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CISR WP #100
Sloan WP # 1410-83

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ABSTRACT

Based on interviews with 200 end users and 50 information systems managers concerned with end user computing, end users can be classified into six distinct types. Each of them needs differentiated education, support and control from the Information Systems function. End users exist primarily in staff functions. They develop and use a wide spectrum of computing applications ranging from "operational systems" of the type usually developed by information systems professionals to complex analytical programs. To support a large number of their applications a new computing environment, "the third environment" (in addition to the traditional COBOL and timesharing environments) must be developed by Information Systems (I/S) management. Close attention must also be paid by I/S management to the need to involve "functional support personnel" (end users in each functional area who spend most of their time programming and aiding other end users) in the I/S end user management process. An end user strategy is needed in each organization. In addition, users cite increasing needs for support from I/S management. Finally, a new type of "control" process is necessary if end user computing is to be well managed.

Today, interest in end user computing (EUC) is booming. While most information systems departments are still heavily involved in paperwork processing, there are a host of signs which suggest that this traditional focus will soon become a junior partner to user-developed and operated computing. End user oriented languages are increasingly plentiful and ever-better. Improved man-machine interfaces are being developed [15,16]. Users are becoming more aggressive and more knowledgeable [3,8]. Formerly the sole province of scientists and engineers, end user computing is spreading throughout the entire organization. It is at the point where in some companies, EUC now utilizes 40-50 percent of the computing resource [11]. This has led to increased attention to appropriate organizational forms to support this growing phenomenon [4,7,13].

Yet, despite all this activity, "end user computing" is still poorly understood. There has been a mass of exhortative literature and occasional single-case-based discussion of end user computing. But there has been a paucity of conscientious research into who the users are, what they are doing, what their needs are, and - most significantly - how to manage this new phenomenon.

In order to shed more light on the above questions, we interviewed 200 end users and 50 members of information systems staffs having the responsibility for supporting end user computing in seven major organizations. The companies involved were three Fortune 50 manufacturing companies, two major insurance companies, and two sizable Canadian companies. Users interviewed were all making use of "time sharing" of one sort or another. We have just begun a parallel study of personal computer users in ten major corporations.

METHOD

The interviews, which were confidential, began with an open-ended discussion of each participant's computing activities. The approach was aimed at surfacing key issues with regard to end user computing as perceived by the users themselves. The interview was guided by a structured questionnaire. Ultimately, after allowing the user to discuss all issues and aspects of EUC he or she believed important, each user was asked to comment on each of the questionnaire items upon which he had not touched. Quantitative data was not gathered in the early interviews, but as the issues became clear, such data was obtained from 140 of the users representing 271 different applications. Analysis of this data is noted below.

In each company interviewees were selected at random from a list of users designated by the company as "heavy and/or frequent users of time sharing". It was felt that this procedure would provide a diverse unbiased sample of the population of most interest - the major users. This, we believe, it did. However, our sample is not representative in its proportions of the entire end user community. We will return to a discussion of the evident, and interesting, results of this method of user selection.

FINDINGS

In this paper, we present both the findings, which were the facts observed during the study, and our conclusions, which are our interpretations of the findings. The findings of the research can be grouped into four major areas. These are the significant growth evident in end user computing, the nature of the user population, attributes of the applications being performed, and the managerial processes being employed with regard to end user computing. Each of these will be discussed in turn.

Growth

In each of the companies observed, end user computing was growing at a rate of approximately 50-90% per year. This was measured by either actual allocation of computer hardware power or external time sharing budgets. The highest measured growth rate observed in the study companies was 89%. Later discussion with a significantly larger sample of companies suggests strongly that these figures generalize well. At the same time, traditional data processing, oriented toward processing the paperwork of the company, is growing at a far smaller rate. On the average, in both our sample companies and others, this growth rate appears to be only 5-15%. These widely divergent growth rates have led some observers, such as Robert I. Benjamin at Xerox, to predict that by 1990, end user computing will absorb 75% of the corporate computer resource [2].

Users were asked to note the factors underlying their growing utilization of end user computing. Four major clusters of reasons dominated their replies. The first of these is "a vastly increased awareness" of the potentials of EUC. A new generation of users has arrived which understands EUC and views it as a means of facilitating decision-making and improving productivity. Most of these employees are recent graduates who have had experience with an end user language in college. At the same time, more senior personnel have been introduced to EUC by colleagues who have made use of EUC's capabilities. A second route to top management awareness is through managerial journals such as Business Week and Fortune, which have been increasingly informing their readers both of the potentials of EUC and of the software products available. Finally, users noted, hardware and software salesmen are making calls directly on them in their "end user" departments.

A second set of user-perceived reasons for the high growth rate of end user computing centered around recent improvements in "technical" capabilities which make end user computing increasingly more feasible and less costly. Vast improvements have been made in end user software [3,7,14].

Today's languages, while not quite "user friendly", certainly are significantly easier to use than those available even three to four years ago. Decreasing hardware costs have made feasible the use of "cycle-eating" interpretive languages and relational databases. Users also refer to the increasing availability of both internal and externally-purchasable databases, providing automated access to information previously unavailable or which would have had to be painstakingly entered by hand.

The third set of reasons for the increase in EUC concerns the more difficult "business conditions" which prevail today. These conditions have intensified the need in all organizations for more effective analysis, planning, and control. High interest rates, inflation, and world-wide competitive pressures have made it increasingly important for both staff and line managers to have access to more, and often more detailed, information within a greatly decreased time frame.

Finally, and noted by almost all users, their needs cannot be satisfied through the traditional information systems organization. For a significant portion of their new applications, users find the tools, methods, and processes adhered to by the information systems organization as entirely inappropriate. Even for those applications where proven I/S methods would be appropriate, however, users have turned to available end user languages since the waiting period to get the application up and running through the I/S department - most often two to three years - is seen as intolerable.

The End Users

Clearly, if one is attempting to understand end user computing, it is important to know who the users are, where they are located, and what they do. In this section, we develop a classification of end users and their location within the organizations we studied. The tasks that are being carried out by these users through EUC will then be noted in the next major section of this paper entitled "the applications".

Who are the users?

The literature provides three recent classifications on end users. The simplest available categorization is that provided by the CODASYL end user facilities committee [5]. Their three part breakdown includes "indirect" end users who use computers through other people (e.g. an airline passenger requesting a seat through his travel agent), "intermediate" end users who specify business information requirements for reports they ultimately receive, (e.g. marketing personnel), and "direct" end users who actually use terminals. It is only the last category that is of interest in this study.

Two recent authors further break down the "direct" category. McLean [8] classifies users into:

- o DP professionals (who write code for others)
- o DP amateurs (non-I/S personnel who write code for their own use), and
- o non-DP trained users (who use code written by others in the course of their work, but know nothing about programming)

Martin [7] also divides "direct" users into three classes, but they are somewhat different. His classes are:

- o users who use but do not create applications (bank tellers, clerks, airline agents), and
- o users who both use and create applications. This latter category is divided into:
  - o non-programming users (who employ simple application generators), and
  - o programming end users (who employ BASIC, APL, etc.).

In the companies we studied, we observed a finer-grained and, we believe, more useful classification of end users. Six distinct classes of end users who differed significantly from each other in computer skills, method of computer use, application focus, education and training requirements, support needed, and other variables, emerged. Although all utilized

end user languages or the products of these languages, each user class is distinctly different from the others. They are:

- Non-Programming End Users whose only access to computer-stored data is through software provided by others. They neither program nor use report generators. Access to computerized data is through a limited, menu-driven environment or a strictly-followed set of procedures.

- Command Level Users who have a need to access data on their own terms. They perform simple inquiries often with a few simple calculations such as summation, and generate unique reports for their own purposes. They understand the available database(s) and are able to specify, access, and manipulate information most often utilizing report generators and/or a limited set of commands from languages such as FOCUS, RAMIS-II, or EXPRESS. Their approach to the computer is similar to that of an engineer to a slide rule in days past. They are willing to learn just enough about the data- base and the software to assist the performance of their day-to- day jobs in functions such as personnel, accounting, or market research.

- End User Programmers who utilize both command and procedural languages directly for their own personal information needs. They develop their own applications, some of which are used by other end users. This latter use is an incidental by-product of what is essentially analytic programming performed on a "personal basis" by quantitatively-oriented actuaries, planners, financial analysts and engineers.

- Functional Support Personnel who are sophisticated programmers supporting other end users within their particular functional areas. These are individuals who, by virtue of their prowess in end user languages, have become informal centers of systems design and programming expertise within their functional areas. They exist today as "small pockets of programmers" in each functional organization of the companies we studied. They provide the majority of the code for the users in their functions. In spite of the large percentage of their time that these individuals spend coding (several estimated over 80%), they do not view themselves as programmers or DP professionals. Rather, they are market researchers, financial analysts, and so forth, whose primary current task is providing tools and processes to get at and analyze data.

- End User Computing Support Personnel who are most often located in a central support organization such as an "Information Center". Their exact roles differ from company to company. Most, however, are reasonably fluent in end user languages and,

in addition to aiding end users, also develop either application or "support" software.

- o DP Programmers who are similar to the traditional COBOL shop programmers except that they program in end user languages. Some corporations have developed a central pool of these programmers to provide service to end user departments wishing to hire "contract programmers", to avoid high consultant/ programmer fees, and to build a larger base of knowledge of end-user-language computing within the corporation.

The distribution of the end users whom we interviewed is shown in Exhibit 1. This distribution is not representative of the entire user population in the companies we studied, but reflects the bias inherent in our selection of users who were the "major users of the computing resource". It is our belief, from discussion and observation in the companies studied, that with respect to the entire end user population our first two classes of users are seriously underrepresented in our sample, perhaps by an order of magnitude. (Upon reflection, however, we would not change our selection process. It led us to the most involved user population - and the one most capable of shedding light on the area.)

EXHIBIT 1

Distribution of End Users Interviewed

User Class	No.	%
Non-Programming End User	13	9
Command Level End User	22	16
End User Programmers	30	21
Functional Support Personnel	53	38
End User Computing Support Personnel	7	5
Data Processing Programmers	15	11
	140	100

For managerial purposes, our user classification has four major messages to which we will return in our "conclusions" section. These are:

- End users are a diverse set. There is no single stereotyped "end user" with a single defined set of characteristics. We have defined at least six major types - there may be more.

- Diversity in the end user population, and what they do, leads to a need for multiple software tools in the end user environment. Some sophisticated users need bit-level, procedural (e.g. BASIC, APL) languages to carry out their functions. For others, text-processors, report generators and simple command-level languages will suffice. Since no single end user language can meet the range of function needed by these different users, a broad menu of end user tools must be supplied.

- Diversity in the end user population also surfaces an evident need for strongly differentiated education, training, and support for the quite different classes of users. Non-programming users desire only well-written instructions sets. "Command-level" users want brief, limited training and education targetted to their particular specific interests. The more sophisticated "end user programmers" need in-depth understanding of the one or two software products most relevant to the particular function they perform. Finally, the functional support personnel members and professional DP people desire and need more extensive training in a wider variety of software products. In all the companies studied, education, training and support seem targetted at only a single segment of the end user population, most often the most sophisticated. In our study, this was a major source of user discontent.

- Finally, most signficantly, the classification highlights the existence and importance of functional support personnel. These

people are not only the key utilizers of end user computing, but they are a source of significant opportunity and of potential problems for the I/S function. We return to this in the "conclusions" section.

User location

Exhibit 2 shows the location, by function and role, of the users interviewed. The most significant point here is that 81% of the users interviewed were in major definable staff groups in their corporations. This is natural. Staff personnel, almost by definition in most major organizations, are those responsible for the gathering, manipulation, analysis, and reporting of information.

It is clear that staff groups represent major "clumps" of end user computing activity. This is an important finding. It provides a positive response to the remarks of many interviewed I/S managers best expressed by one who, despairing of his ability to bring end user computing under control, noted that "end user computing is spread all over the company like grains of sand. I don't know how I can possibly plan for it, support it or manage it, I can't get my hands around it." Our data, which generalizes both through the seven companies studied and others with whom we have discussed this issue, suggests that with a limited number of fact-finding missions into the major staff groups in his organization, this manager could gain a significant insight into the bulk of the end user computing taking place in his organization. It appears that the 80/20 rule, once again, has validity.

The Applications

Of significant interest were the types of applications being performed by end users. Exhibits 3-12 record various aspects of these applications. Some 271 applications were discussed, on the average of about two per user, which was the design objective. Some users were involved with only one application. Up to four applications apiece were discussed with a few users.

EXHIBIT 2

User Functional Location

	No	%	Cum. %
Staff			
Corporate Strategy, Planning Forcasting	16	11.4	11.4
Marketing - Research	8	5.7	17.1
Marketing - Planning	9	6.4	23.5
Finance - Accounting	10	7.2	30.7
Finance - Planning/Analysis	7	5.0	35.7
Purchasing, Scheduling, Distribution	9	6.4	42.1
Human Resources/Personnel/Industrial Relations	9	6.4	48.5
Actuarial	5	3.6	52.1
Operations Research	5	3.6	55.7
Engineering	12	8.6	64.3
I/S - Developer/Support/User	20	14.3	78.6
Other - Special Projects, Legal	3	2.1	80.7
Line:			
Management	3	2.1	82.8
Marketing/Sales	9	6.4	89.2
Manufacturing	5	3.6	92.8
Claims/Rating	6	4.3	97.1
Other	4	2.9	100.0
	140	100.0	

Exhibit 3 shows one classification of interest, the primary focus of the application. It shows a highly diverse range of systems which ran the gamut from traditional "paperwork processing" to the provision of complex analytical assistance. As shown, about 10% of the systems were "operational" paperwork processing systems such as inventory systems or commission-check producing systems which might alternatively have been coded in COBOL. Most were programmed in an end user language to "get them up quickly". Another 39 systems primarily served as "automated back ends" of COBOL type

systems. In most cases, these involved information databases taken from production systems (often with additional data keyed in) which turned out reports regularly or on demand. We will return to this class of system again during the discussion of Exhibit 9.

One fifth of the applications provided software to merely extract particular data items from a database or to do simple command-level manipulation of items in the database. Not surprisingly, however, one-half of the applications supported more complex analysis of data. Included in these systems were financial pro-forma analysis, engineering calculations, operations research, optimization models, and simulations. Although the analytic techniques and software were complex (and usually developed by functional support personnel), many of these systems could be operated by a relatively naive user through the insertion of a few parameters - often in a menu-oriented way.

EXHIBIT 3

Applications (by Primary Purpose)

Purpose		No.	%
(1)	Operational systems	24	9
(2)	Report generation	39	14
(3)	Inquiry/simple analysis	58	21
(4)	Complex analysis	135	50
(5)	Miscellaneous	15	6
		271	100

A second cut at understanding the applications used by end users is the "scope" of the system. Exhibit 4 indicates that less than a third of the systems were "personal" in nature, being operated by a single person to carry out one of his or her tasks. More than half of the systems concern

applications relevant to the operations of an entire department, with 17% of the system being multidepartmental (most often multifunctional) in scope. In general, the scope of the data utilized followed quite precisely the functional scope of the system. The breadth of impact of these systems was surprising to us and to the management of the companies which we studied. We, and they, had expected a much larger proportion of single person systems. To the contrary, we found in each company a large, and growing, number of very large information databases where moment to moment access was absolutely necessary for the efficient functioning of major staff departments or combinations of departments. The users were adamant in stressing the importance of these systems and the information systems management implications of them - to which we return in the "Conclusions" section.

EXHIBIT 4

System Scope

Scope	No	%
Multi-Departmental	45	17
Single Departmental	141	52
Personal	85	31
	271	100

Exhibit 5 shows the primary source of the data used for each application. In about a fifth of the systems, data came from two or more of these sources, but Exhibit 5 shows only the primary source. The importance of the paperwork-processing "production" systems as a data generator for end user analysis is clearly evident. One hundred and ninety of the 271 applications rely on such data as their primary input. Interestingly, and very significantly, this data is transmitted directly from the production files in only slightly more than half of these cases. For the other 92 systems, the data is laboriously keyed in from previously prepared reports. This

emphatically indicates a "data extraction gap" -- an area in which end users feel strongly that I/S is "dropping the ball". Unable to get the data directly, and needing it, users are resorting to keying it in themselves. The exhibit also illustrates the minimal interdependence from one end user system to another and a relatively limited use today of "externally purchased" data.

EXHIBIT 5

Primary Source of Data

Primary Source	No.	%
Extract from Production Files	98	36
Keyed in from Reports	92	34
Generated by User and Keyed In	45	17
Process Control	10	4
Extract from Other End User Systems	9	3
From Purchased Database	6	2
Other (time clock, log punch, etc.)	11	4
	271	100

Exhibits 6 and 7 illustrate patterns that are not at all surprising. Although the figures cannot be taken too precisely, it does appear to us both quantitatively and qualitatively from user comments that the bulk of systems being used by end users are being developed for them by local "functional support" personnel. Behaviorally, it makes extreme sense that users would tend to rely on people within their own function who speak their own language and with whom communication of their system needs is relatively straightforward. Certainly, this was stressed to us by users at all levels. The overwhelming primary use of these systems by non-programmers is also not surprising. A significant number of departmental and multi-departmental databases (discussed above) exist today which can be accessed on a menu-basis by accounting, marketing, financial, and other staff personnel.

EXHIBIT 6

Developers of the Application

	No.	%
Non-Programming End User	0	0
Command Level End User	34	13
End User Programmers	60	22
Functional Support Personnel	131	48
End User Computing Support Personnel	9	3
Data Processing Programmer	27	10
Outside Consultant	10	4
	271	100

EXHIBIT 7

Users of the Application

	No.	%
Non-Programming End User	150	55
Command Level End User	46	17
End User Programmers	57	21
Functional Support Personnel	13	5
End User Programming Support Personnel	2	1
Data Processing Programmers	3	1
	271	100

When the data in Exhibits 6 and 7 are cast into a matrix (Exhibit 8) showing "who develops systems for whose use", an expected pattern emerges. In the lower right quadrant of the matrix we see a few systems developed by functional support personnel and I/S professionals for their own use, but the bulk of the systems developed by them are for non-pro- gramming users. Almost all the systems developed by end user programmers are for their own

use. (From further analysis of the available data, we learned that seventy-five percent of the applications developed by this developer class are complex analytic programs. The remainder are divided almost equally between simple inquiry systems and report generating pro- grams.) Command level "amateur" programmers, as expected, develop appli- cation programs only for themselves. Almost all of these are sets of commands to access the database through a QBE entry, an ADRS routine, or other report generation or simply inquiry routine.

EXHIBIT 8

Developer-User Matrix

Developer	NP	CL E/U	EUP	FSP	E/U CSP	DP Prog	TOTAL
Non-Programming E/U	-	-	-	-	-	-	-
Command Level E/U	-	34	-	-	-	-	34
E/U Programmer	2	2	56	-	-	-	60
Func. Supp. Pers.	112	6	1	12	-	-	131
E/U Comp. Sup. Pers.	6	-	-	1	2	-	9
DP Programmer	21	3	-	-	-	3	27
Consultant	9	1	-	-	-	-	10
TOTAL:	150	46	57	13	2	3	271

One of the greatest advantages of creating and controlling a program for oneself is to be able to run it whenever it is useful rather than being bound by formal scheduled "run" procedures. Exhibit 9 illustrates that end users take advantage of this. Fully two-thirds of the applications are run only "as needed". Still, a significant portion of the applications are used on a regular weekly or monthly basis. As might be expected, these "regular"

systems have a heavy population from the "operational" or "report generation" systems classified in Exhibit 3.

EXHIBIT 9

Frequency of Use

Frequency	No.	%
Daily	16	6
Weekly	34	12
Monthly	27	10
As Needed	178	66
One-Shot	16	6
	271	100

Only 15% of the systems, as seen in Exhibit 10, utilize graphics. The most interesting finding, however, with regard to graphics is shown by Exhibit 11. Graphics systems use by the two least professional sections of the user population average only 10%. On the other hand, systems developed for use by the four more professional segments show almost three times the frequency of graphics use. Since these systems, in almost all cases, are developed by each of these user classes for their own use, the perceived value of graphics by these user-developers is clear.

EXHIBIT 10

Use of Graphics

Graphics	No.	%
Yes	42	15
No	229	85
	271	100

EXHIBIT 11

Graphics User by User Category

Graphics \ User Class	NP	CL E/U	EUP	FSP	I/S EU	Trad. I/S	TOTAL
Yes	17 (11%)	4 (9%)	16 (28%)	4 (31%)	0 (0)	1 (33%)	42
No	133	42	41	9	2	2	229
TOTAL	150	46	57	13	2	3	

Management of End User Computing

A fourth level of facts we sought was data on the organization structure and processes used to manage end user computing. Two different structures were apparent. These can be termed "traditional time-sharing management" and "centralized end user computing support".

Five of the seven organizations, including the three largest, were still primarily treating the surge in end user computing as just an extension of in-house "time-sharing". Management practices put in place a decade earlier to support and control a then limited amount of "time-sharing" were still in effect. As a result, users were essentially given a hardware resource, one or a few available software languages, and (sometimes) basic education classes on the most prominent software languages. In general, the information systems personnel managing these resources saw their major task

as keeping the systems running and staying ahead, where possible, of the users and their demands for more capacity. A secondary task in several companies was the attempt to bring more expensive external time-sharing onto the in-house facility. The three largest companies all had multiple time-sharing hardware in diverse geographic sites with little coordination evident to us or the users in their software offerings or data extraction procedures. In all cases, users felt there was "no one in charge" and felt significantly frustrated at their inability to locate data they knew was stored somewhere in the corporation's files or to get extracts of that data once located.

The two other organizations did provide support to end users desiring it, but in both cases, this came only from a centralized group at corporate headquarters. In one case this was called an "Information Center". In the other, it was designated a "Decision Support Group". Both support groups were charged to find and bring up good software tools and to educate users in the use of these tools. In one of these companies, an "end user language programming group" had been set up in the traditional Information Systems organization to assist users wishing to contract out programming in end user languages.

In general, this latter, support oriented, approach to end user computing produced, in our study, a more satisfied user population. Still, the centralized nature of the organization in both cases was troublesome to many end users. In both of these companies, we found users relying more heavily on the informal "functional support" personnel within their functions than on the central end user group. In both companies, some users had rebelled against one or more of the corporation's "standard" software languages being supported by the centralized end user computing group. They had chosen instead to use similar, but different, software which their functional support people felt to be more appropriate. As user populations grow in size, solely centralized approaches of any form appear inadequate.

What we did not see

Perhaps more significant than the structures and processes we saw with regard to end user computing were those that we did not see. Among the most important missing processes were:

o A strategy for end user computing. Whereas all of these companies have well-documented strategic long-range plans for the "COBOL-shop", there was, with one outstanding exception, little evidence of any strategic thinking with regard to end user computing and the resource mix, tools, processes and structures which will be necessary for it over the next several years.

o Development of end user computing priorities. Whereas most of the companies were very proactive with regard to developing priorities for paperwork processing applications (through the use of BSP or similar planning devices), end user computing was essentially in a "reactive" mode. No attempt had been made in any company to help users zero in on those end user systems which might most significantly affect the profitability or productivity of their organizations in the future.

o Policy recommendations for top management. There was an awareness in each organization that the information systems policies developed for the paperwork processing eras of information systems would most probably not be appropriate in the end user era. However, only in one case had significant thought been given to recommending a new policy set for top management concurrence.

o Control methods. It was recognized in each company that the Information Systems department could not control the use of the end user computing resource. Most probably, because of this attitude, control policies for end user computing were mostly ignored. Those that existed were oriented around the decades-old, cost-benefit-oriented procedures which had been developed to manage and control an entirely different type of computer usage.

In short, the Information Systems management attitude toward end user computing in most of the companies was on the order of "this is the business of the users. We will give them the hardware, some software tools and perhaps some centralized support and let them do their thing. We really do not have the time to develop new procedures and policies. Even if we did, it's not clear that we are the appropriate people to do so."

CONCLUSIONS

It is impossible to talk to 250 people, both users and managers in the end user area, without coming away with some strong personal conclusions concerning the management of end user computing. Many of these are backed up by the data discussed in the previous section. Some, however, are based on a qualitative feel which is compounded through many hours of discussion. Our fourteen conclusions group into three major areas - end user strategy, support of end users by the Information Systems organization, and control of end user computing.

Strategy

With regard to the end user computing arena, we reached six conclusions concerning strategy. They are:

1. There should be an end user strategy. Little attention has been paid to the development of a strategy for end user computing either in the organizations we studied or in the perhaps two dozen organizations with which we have discussed these findings since the study. Most of these same organizations have extensive information systems strategic plans dealing with conventional paperwork-oriented data processing. Yet, when it comes to end user computing, they have, at best, put an information center or a "DSS group" in place with a relatively small budget and a cursory plan. If one believes (1) that end user computing will reach 50-75% of the MIPS in almost every corporation in the next several years, (2) that end user oriented

"information databases" have increasingly become an integral part of the working environment of major corporate staffs, and (3) that rapid change in the tools and techniques available in this area require guidance - then the lack of a strategy, and a clear long-range plan, in this area is a serious mistake for the I/S function.

2. The marketplace for end user computing can be defined. As noted earlier, the usual statement one hears from an information systems manager when it is suggested that there should be a strategy in the end user computing area is "I can't develop a strategy in such a nebulous area. Conventional paperwork processing is centered in a few areas and a few systems and can be well defined. To the contrary, end user computing is 'everywhere'". Our data would suggest, however, that by far the bulk of the end user computing is generated by a few major staff groups (marketing, finance, quality assurance, personnel, etc.) in each organization. In defining the marketplace, it is clear that significant help can be gained by contacting a small and well defined set of functional support personnel in each staff group.

3. There is a need to proactively help end users develop application priorities. To date, end user applications have been developed as the need has been perceived by each end user. To the contrary, for paperwork processing systems, I/S has helped users through the utilization of planning processes, such as BSP, to zero in on those applications which are of high priority. Experience to date suggests that application planning processes, such as the Critical Success Factors method can be utilized in the same manner as BSP in the end user environment to direct attention to"high payoff" end user applications [6,10]. Much more effective use can be made of the financial and human resources currently expended on end user computing.

4. Emphasis should be placed on a strategy aimed at developing and managing the "third environment". Two thirds of the applications we saw involved large departmental or multi-department information databases. This multi-user, shared database environment is a vast, growing, and clearly significantly important part of the data processing scene. By far the majority

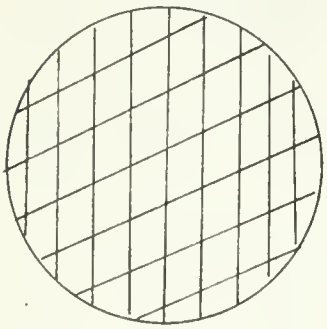
of the purchasing, personnel, financial, and market research staff systems we saw are of this type. Increasingly too, corporations are developing executive databases which involve multi-department bases [12].

As Exhibit 12 shows, I/S in the past has supported two computing "environments", a COBOL environment and a time-sharing environment. These have supplied vastly different facilities. In the COBOL environment, I/S

EXHIBIT 12

The Third Environment

I. COBOL ENVIRONMENT



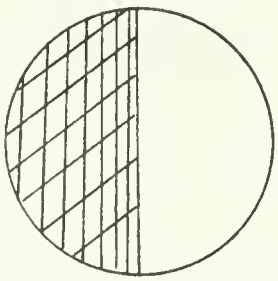
I/S Dominated

I/S Programs
I/S Operates

I/S Provides:

Data mgt.
Privacy
Security
Restart, recovery
"Uptime" contact
etc.

III. THIRD "SHARED" ENVIRONMENT



Shared Responsibility

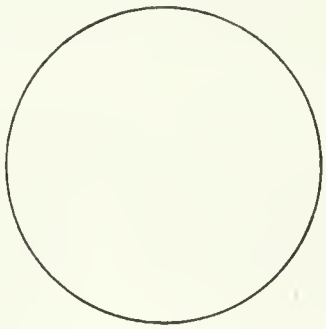
I/S Provides:

Hardware
Languages
Data mgt.
Privacy
Security
Restart, recovery
etc.

But Users:

Program
May enter some data
Operate
Have responsibility for systems

II. TIME-SHARING ENVIRONMENT



User Dominated

I/S Provides Only:

Hardware
Languages
Users Program
Users enter data
Users operate
Users have responsibility for systems

has taken total charge. It has provided a well-managed process in which it develops and programs the systems, operates them, and ensures that they are documented, well-controlled and secure. The traditional timesharing environment, to the contrary, is only marginally served by I/S. I/S provides hardware and one or more languages. The user does the rest.

A "third" or shared environment is now necessary to effectively manage the growing number of departmental and multi-departmental end user systems. As exhibit 12 notes, this environment demands that I/S perform its "house- keeping" functions, such as data management, privacy, security, maintaining uptime, and so forth, while the users take responsibility for developing and operating their programs. Two of the companies in our study have recently placed major attention on this shared environment, having discovered that the majority of their key end user systems demand this environment.

5. There is a need for new corporate policies. It is clear that policies toward information systems which worked in the days of paperwork-processing, must be revised in an end user era. These policies must fit with the end user strategy. New justification policies are required for systems which enhance analysis but do not replace clerical personnel. New pricing policies are required in an era when distributing the "cost" of computer cycles is less important than providing signals to users as the relative desirability of using internal versus external timesharing, large machines versus personal computers, and "standard" software offerings versus user-unique systems. Several other new corporate I/S policies in areas such as education and computer budgeting are also needed in the end user area.

6. The strategy should be promulgated. End users today in many corporations are confused about the actions being taken by the information systems organization with regard to end user computing. They strongly (in many cases vehemently) desire to know exactly what support and what future direction they can expect from information systems management. This knowledge is necessary so that they can make informed decisions on the increasing number of computing alternatives available to them.

Support

The second area with which information systems management must be concerned is that of supporting the end users. Although there are a multitude of areas which deserve attention in the support process, we believe through our data and our discussion with end users that four actions are most necessary. These are:

7. The development of a "distributed" organization structure for support. At the present time, most formal end user support structures are either located in a "time-sharing" office or an "information center". By their nature, these are today primarily "centralized" organization structures located in offices often near the hardware. Quite often the personnel are "product specialists" each knowing a different language or software package. End users plead for two major things. The first of these is for a "focal point" person to whom they can go with all of their requests for assistance no matter which software language or product they are using. The second is that this "focal point" be as "local" as possible. In fact, for most major departments, the "functional support" personnel are serving exactly this function. Yet, they are unrecognized by the formal I/S organization structure. If recognized as a resource and worked into the formal I/S end user support structure, probably through the lightest of matrix operations, the functional support personnel could be of significant assistance to the I/S organization in carrying out its strategic approach in end user computing. They would also become of increased use to end users through improved, routine contacts with new systems, languages, and procedures being introduced by the information systems function. In short, a "distributed" end user support organization could be developed to make more optimal use of both the technical expertise of the central I/S people and the functional area knowledge of the functional support personnel. Allen's research, which shows the importance of localness, is very relevant here [1].

8. The provision of a wide spectrum of products. Today there is no "all-singing, all-dancing" software product which an end user can use to

effectively perform calculations, develop spread sheets, do text processing, and so forth within the structure of a single software language or architecture. Each of these (despite recent efforts to combine them in some packages) still essentially is a specialized task. As a result, the end user computing establishment should offer a spectrum of at least a half dozen different types of available software. Otherwise, as was quite clearly occurring in many of the organizations we studied, users will stretch the available end user software products to do jobs in a manner far less efficient than could be done with the appropriate software.

9. The development of an incredibly large education program. This, today, is a critical area. Different types of education are necessary for the end user era. The first is the need to educate information systems personnel as to the capabilities and uses of end user software. At the present time, according to an informal survey we have made, less than 10% of the more than 500 information systems people responding feel that they have adequate knowledge of even one end user language. This leaves these information systems analysts in a very weak position when it comes to comprehending the end user world. At the simplest level, they are unable to recommend to user managers which methodologies (COBOL-based, or end user language-based) they should be following for any particular system need.

Second, there is also a need for in-depth education in end user languages and capabilities for the more "professional" end user programmers - our types 3 to 6. Third, there is a need for brief, "how-to", example-based education for the non-programming and command level end users who desire to know only as much of an end user language or user system as they need to perform a few tasks of importance to them. Fourth, there is a need to educate line management and key staff managers at all levels in the basics of end user computing so that they can more effectively judge which systems they would like to have their people develop at what probable cost. As we will note below, information systems management cannot control all end user computing. The most effective control is to have functional management knowledgeable in the basics of end user computing. Finally, there is a need to educate top line management - or at the very least the steering committee

members - as to the tools, techniques and potential impacts of the end user computing era, so that the need for effective policies (discussed in point six above) can be understood.

This education load, it is true, is overwhelming. Certainly, the education of top mangement is the first priority. After that, each company must decide on the most effective allocation of a hopefully-expanded education budget.

10. The development of effective "data migration" procedures. A major complaint of many of the end users we interviewed was their inability to either locate where data was stored in the corporation, or, once located, have the data extracted and forwarded to them. As noted in our findings above, many of the end users solved this problem by rekeying data which they obtained in the form of hard copy reports from production systems. Obviously, this is a waste of corporate resources. Not only is there the time and energy involved in rekeying, but there is also significant potential for data errors in manual processes. It is very evident that existing approaches to extracting and migrating data for end users have not been given enough attention, either by computer vendors or, in most cases, by information systems management.

Control

In addition to the need for a strategy for end user computing and significant steps to support end user computing, there is also an evident need for well defined control processes for each organization in the end user area. Many line and I/S managements are concerned that end user costs are rising too fast and are "out-of-control". They are concerned that little attention is being given to justification of these systems, that amateurish development processes are not well managed, and that they are approaching Nolan's third stage in the end user area. [9] We saw several aspects of this. A control policy adapted to the special circumstances of the end user area is needed. The most important of the steps to be taken with regard to control we believe are:

11. The need to flag "critical" applications. As noted earlier, 29 of the applications which we studied were operational in nature. Some of these feed other operational paperwork processing systems in the COBOL-domain. The failure of any of these systems to run would, therefore, significantly impair the ability of each of the corporations to function efficiently on a day-to-day basis. In almost all cases, the necessary documentation and/or controls usually developed by I/S professionals for operational systems were lacking in the end user developed systems. In each organization there should be a "control" process which identifies and highlights these systems for consideration of careful documentation, the incorporation of necessary edit and control features, and inspection by the corporation's auditors.

12. A need to exercise control primarily through line management - not information systems personnel. It is impossible for information systems personnel to be totally in touch with all of end user computing. Further, the valuation process for these systems is highly subjective. Only functional managers can perform this valuation. It is, therefore, necessary for line management to implement and monitor justification and control procedures for those systems being developed and used by their subordinates. (See point #9 "education", above.)

13. A need for I/S expert involvement in the control process. Line management, however, cannot do it all. For large systems, at least, we believe there is a necessary procedure to ensure that professional information systems personnel assist line management in deciding whether the systems should be developed in an end user mode, which software should be used, whether the system is essentially a time-sharing environment or "third environment" system, and so forth. There is a clear role for a professional information systems consulting group to aide line management in this process.

14. The provision of I/S "environmental control" through incentives. One area in which the information systems organization can exert some "control" is in the development of the "environment" for end user

computing. Standards for end user hardware and software should be developed and incentives (in terms of price and support processes should be offered) to motivate end users to adopt the organization standard relational database, word processing software, and so forth. The advantages of an I/S-managed environment are in allowing I/S professionals to better understand the software that is developed, to support users in questions they may have concerning the use of a limited set of software, and to keep critical systems running when the user or developer leaves the company. In one of the companies studied, several such incentives were being offered by I/S. For example, standard user software packages were being made available to end users at no cost. A predominantly standard environment was being created.

Conclusion

Developing the appropriate strategy, support processes, and control processes for end user computing is almost a staggeringly large job today. The trends towards end user computing, however, are irreversible. There is little doubt in our minds that end user computing will be the dominant segment of information systems in most large companies by the end of this decade. It requires significant managerial attention.

REFERENCES

1. Allen, T. J. Managing The Flow of Technology. MIT Press, Cambridge, 1977.

2. Benjamin, R. I. Information technology in the 1990's: a long range planning scenario. MIS Quarterly 6, 2 (June 1982) 11-31.

3. Canning, R. G. 'Programming' by end users. EDP Analyzer 19, 5 (May 1981).

4. Canning, R. G. Supporting end user programming. EDP Analyzer 19, 6 (June 1981).

5. Codasyl End User Facilities Committee Status Report, North Holland Publishing Company, Information and Management Two (1979) 137-163.

6. Davis, G. B. Strategies for information requirements determination. IBM Systems Journal 21, 1 (1982) 4-30.

7. Martin, J. Application Development Without Programmers. Prentice Hall, Inc., Englewood Cliffs, New Jersey (1982) 102-106.

8. McLean, E. R. End users as application developers. Proceedings of the Guide/Share Application Development Symposium. (October 1974) 50.

9. Nolan, R. and Gibson, C. F. Managing the four stages of EDP growth. Harvard Business Review (January/February 1974) 76-88.

10. Rockart, J. F. Chief executives define their own data needs. Harvard Business Review (March/April 1979) 81-93.

11. Rockart, J. F. and Flannery, L. S. The management of end user computing. Proceedings of the Second Conference on Information Systems, Boston, MA (December 1981) 351-364.

12. Rockart, J. F. and Treacy, M. E. The CEO goes on-line. Harvard Business Review (January/February 1982) 82-88.

13. Rosenberger, R. B. The productivity impact of an information center on application development. Guide 53 Proceedings, Dallas, Texas (November 1981).

14. Sisson, R. L. Solution systems and MIS. Proceedings of the Twelfth Annual SMIS Conference, Philadelphia, PA. (September 1980).

15. Sondheimer, N. K. and Relles, N. Human factors and user assistance in interactive computing systems: an introduction. IEEE Transactions on Systems, Man and Cybernetics SMC-12, 2, (March-April 1982) 102-7.

16. Yavelberg, I. S. Human performance engineering considerations for very large computer-based systems: the end user. The Bell System Technical Journal 61, 5, (May/June 1982) 765-97.