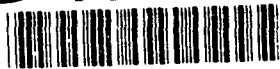


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THESIS

END-USER COMPUTING DEVELOPMENT STRATEGY
FOR THE REPUBLIC OF INDONESIA IN THE 90'S

by

Paulus Prananto

September, 1990

Thesis Advisor:
Co-Advisor:

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ABSTRACT

The policy on the development of defense and security for The Armed Forces of the Republic of Indonesia (ABRI) envisages the creation of a viable deterrent power through the effective use of all the components of ABRI as a relatively small but effective and efficient nucleus sustained by real national capabilities. It is therefore driving ABRI to realize better use of its resources.

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I. INTRODUCTION

A. BACKGROUND DISCUSSION

In 1984, The Armed Forces of the Republic of Indonesia (ABRI) created a new Office of Command and Control Center (PUSKODAL). This Office has set forth the information system architecture concept for ABRI that supports its double mission or dual function called 'dwi fungsi', under which ABRI is recognized as a defense and security force and also as a social-political force.

The increasing complexity of Information Technology in Data Processing, Telecommunication, and Office Automation; the potential decline in the average aptitude level of personnel entering ABRI; and the continuing restraints on defense spending will result in greater pressures on ABRI information system. It is therefore imperative that ABRI has to utilize information resources in the most efficient and cost-effective manner possible. The Commandant of PUSKODAL ABRI has identified the roles of End-User Computing, which is expected to produce applications more rapidly, responsively, and inexpensively than conventional Data Processing. Some of these roles have potential for significantly improving information system performance and reducing development costs.

It is quite possible that the architecture of future ABRI information systems will be different from those being utilized today.

This thesis will address EUC development strategy to match organization's goals, objectives, and strategies for ABRI in the 90's, looking at how ABRI should implement EUC technology among the Services, Staff, Agencies and Major Commands.

B. RESEARCH OBJECTIVES.

The primary objective of this thesis will be to provide ABRI with a strategic development plan for implementing End-User Computing given the current status of information systems available today and their present configuration. A secondary objective would be to present future trends in End-User Information Technology industry facing ABRI today.

C. THESIS SCOPE, LIMITATIONS AND ASSUMPTIONS

The main thrust of this thesis will be an examination of the various roles, functions, management and technical issues of End-User Computing technology available including an examination of ABRI requirements for the End-User Computing in the 90's. Future trends in End-User Information Technology will be examined, realizing that the information systems acquired today will be affected by the technological advances which will occur in the near future.

The scope of this thesis is not confined to any one specific organizational element of ABRI. Rather it attempts to consider the requirements for the organization as a whole. The mission and organizational structure of ABRI is assumed not to be changed drastically for the years 1990-2000.

D. METHODOLOGY

The methodology employed in this research effort was primarily an observational approach coupled with an extensive literature review of current books, periodicals, articles and journals, as well as ABRI directives, plans, and policy guidance. These research techniques were appropriate because they furnished ABRI requirements while identifying the available technologies and future trends.

E. ORGANIZATION OF THE THESIS.

The following is a breakdown of the various chapters included in this thesis :

Chapter II

This chapter provides the reader with the current framework or situation which the researcher faced. It discusses the overview of the ABRI Information System, the description of current status, the planned information systems, the expected evolution, some problems and issues in ABRI data processing developments, and the information system planning for the ABRI in the 90's.

Chapter III

This chapter reviews the conceptual definition of EUC, EUC technology, the principal users of EUC, EUC tools, EUC supports, and some issues in EUC management.

This chapter also analyzes the future EUC technology available which will have the most impact to ABRI in the 90's.

Chapter IV

This chapter provides a scenario of the EUC implementation for ABRI in the 90's, analyzes some scenario approaches to implement the EUC, and discusses the strategy which the researcher believes ABRI should employ in implementing EUC to match the organization's goals, objectives, and strategies in the 90's.

Chapter V

This chapter provides a summary of the researcher's conclusions and recommendations.

II. OVERVIEW OF THE ABRI INFORMATION SYSTEM

A. GENERAL

The environmental circumstances of any two organizations, albeit in the same function, may be entirely different and thus require substantially different approaches to the implementation of a common information system. It should therefore be borne in mind when examining what has worked well for a major command in The Armed Forces of the Republic of Indonesia (ABRI) organization, that those same approaches may not be entirely appropriate, or indeed, work well for other organizations. Some of the environmental factors which influence these considerations are :

1. Mission Priorities

There may be many more critical issues to be tackled within an organization before information system development. Structural re-organization, improvement of standing procedure, radical change of policies, changing the direction of the missions, etc., may rank above the introduction of major information system development activities. It is important to know *when* is the 'right' time to launch an information system project.

2. Management Awareness

In some organizations, the general awareness of senior and middle management is limited at best to a broad view, and at worst, to the belief that it is all a new fad which, if ignored, would go away. One has, therefore, to consider to what extent management needs to be educated and how best this can be achieved.

3. Fragmentation of Responsibility

Some major commands have different parts of the organization with responsibility for the various functions. Each major command has become or is becoming an integrated system for information handling. Large-scale computing applications may be the responsibility of the Finance Directorate, office services may be the responsibility of the Secretary or Administration Directorate, and organization and methods may be part of a small specialist Management Service Department. As a consequence of such fragmentation each component service may pursue separate strategies without necessarily interfacing effectively. Where this happens, the wider issues of 'Information System' will be lost or will not be achievable without radical and expensive change of direction.

4. User Involvement

It has become customary in most organizations for the end-users to play a leading role in co-operative development

of large scale computer system. In some organizations, however, systems may still be developed, keeping users at a defined distance. It is important to consider End-User Computing in that strong co-operative projects are undertaken with the end-user fully involved from the outset.

This chapter will present the current status of the ABRI information systems, analyze the current computing capacity, the planned information system, the expected evolution of information systems, some problems and issues in data processing, and information planning for the ABRI.

B. THE CURRENT STATUS

As in most organizations, the foundation for information technology in The Armed Forces of the Republic of Indonesia (ABRI) was the application of data processing using a mainframe computer in a centralized Data Processing Center with a major emphasis being placed upon batch processing.

The type of information system used by ABRI may be described as a hierarchy of 'free standing, but closely interfaced subsystems'. In other words, there would be a number of information systems, each oriented toward a specific area of management concern such as manpower, budgeting, supply, inventory, etc. Each subsystem can be put into effect and utilized independently of the other through appropriate links in a such way that requires attention to a great many details and inter-relationship in the design process and close

coordination with the organizational elements that utilize the information system. The practical advantages of this implementation strategies are :

1. Quicker and more reliable results, since any one or several of the subsystems can be designed and prototype tested without awaiting the development of the others.
2. Hardware flexibility, since a hierarchy of independent subsystem does not restrict ABRI to the choice of a specific computer that will handle the subsystems at all.

In mid-1975, a Master Plan for the development of ABRI Information System was approved by the Minister of Defense and Security/ABRI Commander-in-Chief. As initially conceived, the master plan included the ABRI information system architecture which was a building block of three dimensions. Each element of ABRI information system building block composed of the system applications, unit command/services, and type of data processing provided. There are nine major applications or subsystems in the ABRI information systems :

1. Manpower subsystem
2. Major asset management subsystem
3. Supply management subsystem
4. Finance and budget subsystem
5. Combat readiness subsystem
6. Defense industries subsystem
7. Facilities subsystem
8. Force planning subsystem

9. Mobilization subsystem

The unit command/service includes higher to lower units in the ABRI Headquarter, Army, Navy and Marine corps, Air Force, and State Police. Data processing activities maybe manual, mechanical, and automatic. The conceptual building block of a component of the ABRI information system is illustrated in Figure 2-1. In addition to these major information system architecture developments, there are two physical components of the ABRI Information System, whose scope of application extends across all the nine areas of management interests. These are Operation Research/System Analysis Office (ORSA) and Data Gathering and Processing Agency Office (PUSPULLAHTA).

ORSA has the function of meeting non routine in information requirements for management decisions which involve special analytical and computing facilities. PUSPULLAHTA is concerned with the acquisition, operation, and maintenance of relatively stable data bank information used for administrative and management support in planning, directing, organizing, and controlling activities.

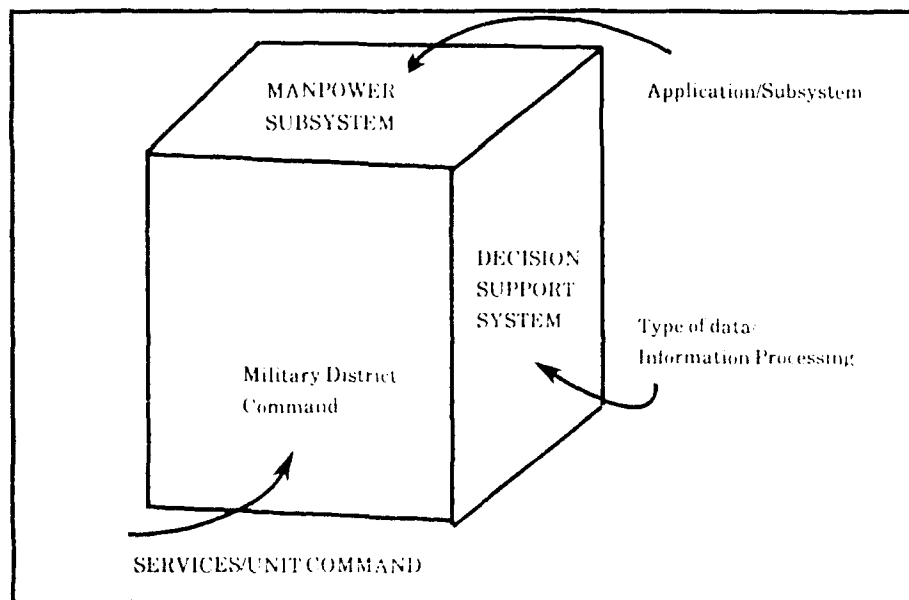


Figure 2-1: A component of the conceptual building block of the ABRI information system.

At present there are approximately 300 VDU terminals of one form or another in use under different mainframes, not including an estimated number of 700 personal computers. DOD/ABRI Headquarter uses Univac 1100/70 series, Honeywell Bull, and Harris Computer; Army has IBM 4031, IBM 370, Prime, and Wang Computer; Navy and Air Force work under Univac 90 series; and State Police has installed IBM 3030 and IBM 4031. Univac 1100/70 is an example of a typical mainframe configuration. It has 4 Megabyte (2 X 512 kilowords) main memory, dual central processing unit (CPU), 8 disk drives each 55 megabytes and 2 additional disk drives each 300 megabytes, 6 unit tape drives, 2 high speed printers and 1 card-reader. This hardware configuration has been installed since 1985 (see Figure 2-2).

There is an estimated number of 2000 active duty staff officers and civilians throughout the Data Processing Services and Regional Command Office, including managerial and professional staff. ABRI has, therefore, close to 1 in 7 of DP's office workers using a terminal. The majority of these terminals are not connected to the ABRI network. It is ABRI's firm intention to provide 'connectivity' for those which are currently stand-alone machines or have been connected to Local Area Network (LAN) networks. This link is possible to set up since ABRI already has special telecommunication channels using KOMSAT ABRI, a satellite communication system with Palapa B2.

The host operating system is EXEC-8. EXEC-8 is going to be interfaced with IBM VM/CMS. The data management system operates under DMS-1100, accompanied by supporting facilities such as DDL-1100, DML-1100, QLP-1100, and DML-1100. These standard development software programs run under EXEC-8.

The functions of each package of the data management system under DMS-1100 are :

- **DDL-1100** is the Data Definition Language used to define the database structure, including definition of fields, records, files, record relations/sets, access method, and data protection. The DDL-1100 also provides features to expose the schema and subschema being used in the database.

- **DML-1100** is the Data Management Language used to develop application programs. This software is embedded into two different high-level languages, ASCII-COBOL and ASCII-FORTRAN. DML-COBOL has become the standard ABRI programming language.

- **QLP-1100** is the Query Programming Language used to help the database users with no computer programming background to access the database. This QLP-1100, an unstructured user-friendly language, can be quickly learned by any user.

- **DMU-1100** is the Data Management Utility used to help users maintain the database, for example, to sort, dump, backup, recovery, rollback etc.

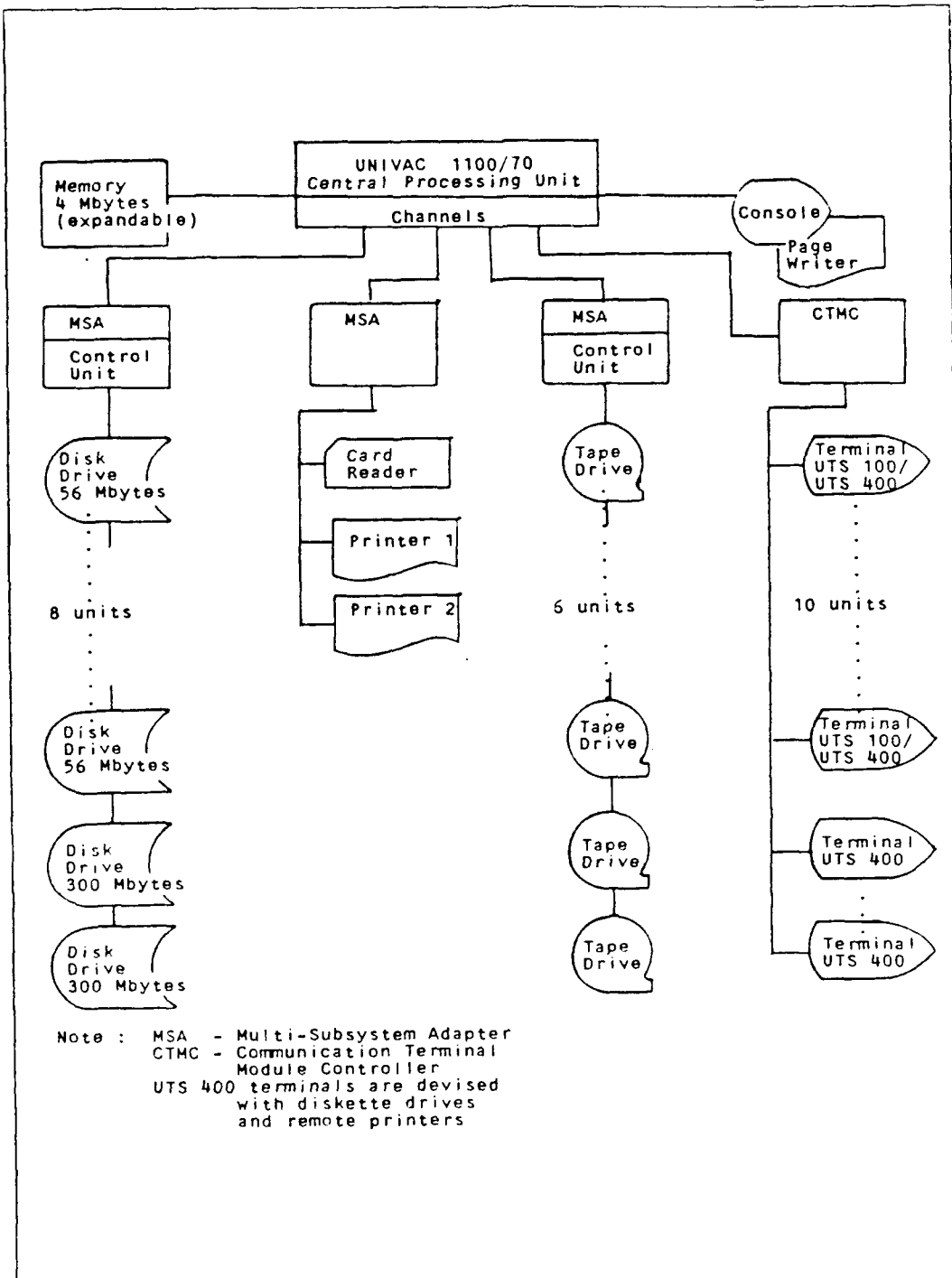


Figure 2-2: The hardware configuration of the Univac 1100/70

C. THE PLANNED INFORMATION SYSTEM

The planned ABRI information system concerns the importance of information resource management (IRM) through the organization. This is evidenced by the reorganization and consolidation of the IS/DP organizational elements involved in ABRI Headquarter, Services, and Major Commands. ABRI appears to be pursuing the informational goals in a systematic manner with controlled growth, coordinated acquisition policies, and expansion of education and training opportunities for personnel in this area. End-user computing technology is just one avenue for increasing the effectiveness of an organization's IRM. What are other related technologies, and how does ABRI stand with respect to these goals? The following planned information systems have been in the development stages in some services and major command units in the ABRI :

1. Mainframe-Microcomputer Interconnection

The objective is to be able to 'network' a range of services so that each level of the organization can access services from the mainframe using microcomputers. Doing so will reduce costs and improve operational effectiveness. ABRI tends to manage the delivery of microcomputers through three phases:

Phase I:

The first phase encompasses delivery through stand-alone (non-networked) systems, including personal computers, multi-user micro, interactive mainframes with remote terminals.

Phase II:

The second phase focuses on systems that are partially networked. Direct links between PCs, mainframes and LAN will provide services for desktop workstations, such as data access, backup, and security.

Phase III:

The third phase seeks to link PC's through common protocols by widely distributed systems. Appropriate computing and communications power will reside where it is required. PC's will perform the characteristics of the organization they serve i.e., hierarchical, functional divided, locally autonomous and adhering to a common set of standards.

2. Office Automation

ABRI has adopted office automation technology as a means to send communication between individuals without having face-to-face or telephone contact. Electronic mail is being promoted. The benefit of electronic mail is enabling a person to use the computer terminal directly for sending and reviewing incoming messages, thereby cutting down on actual paperwork and speeding up communication, and saving time in the process.

Another benefit might be a variation which would allow recorded voice messages to be dispersed by the computer, similar to what a telephone answering machine does for incoming calls. It would also allow the message to be sent to more than one destination which would save the originator the time consuming task of making many calls and waiting for busy signals.

The idea of messaging via electronic mail can be extended to computer conferences whereby the messages are sent

back and forth using an on line mode. This project would help ABRI to alleviate the expense to have personnel travel in order to attend conduct the conference.

Since some people find computer conferencing too impersonal and difficult to follow, the next extension of office automation for ABRI in the 90's maybe to utilize teleconferencing to transmit video signals. At the present time, ABRI has some systems capable of electronic mail type messaging, although remote systems for some major commands are not yet in place. Continued growth in this area can be expected given the rising costs of transporting personnel and the decreasing of computer and teleconferencing systems.

3. Distributed Processing

Fundamentally, distributed processing is an approach for making computer systems more amenable and responsive for use at any level in the organization. Instead of having one or two large central processing units, ABRI plans to add to the existing mainframes a series of linked mini-computers and/or microcomputers where terminals can be programmed to respond more quickly to the user's needs. Therefore, ABRI strives for compatibility and standardization in order to have systems capable of communicating between each other as soon as the cost of computer networking for distributed processing becomes affordable to ABRI.

4. Decision Support System (DSS)

ABRI will most likely be investing in DSS in the future, as these systems seem to fall nicely into the goals and objectives which ABRI has set for its Command, Control, and Communication Office (PUSKODAL).

DSS can make a proactive contribution to improve the speed and quality of senior and middle management decision-making, through provision of better information; information that is up-to-date, at the right time, and in the right format. The important characteristics of DSS is the ability to handle less 'structured' problems, formulate new ad hoc requests in response to results of previous query, support rather than replace managerial judgment, and improve decision-making effectiveness instead of efficiency. DSS can perform generic operations to extend along a single dimension, ranging from extremely data oriented to extremely model oriented. Some types of DSS classification (Sprague and Carlson, 1982) that relate to generic operations which have been planned by ABRI:

a. Suggestion Models

Perform mechanical work leading to a specific suggested decision for a fairly structured task. ABRI is going to apply this model to suggest some solutions in Logistic Support Modelling, for instance, supply support requirements in terms of quantity, quality, storage, volume, and weight in various scenarios by the ABRI Logistics Command.

b. Optimization Models

Provide guidelines for action by generating optimal solutions consistent with a series of constraints. ABRI Budget Planning System uses some parts of this model to determine and optimize which activities and projects are to be done and how much money can be allocated due to the constraints of the forthcoming fiscal years.

c. Representation Models

Estimate the consequences of action on the basis of models that are partially nondefinitional. These models allow managers to test a set of proposed decisions in a simulated environment. ABRI Construction Command plans to use this model to make the evaluation of some modification of the aircraft hangar for the Air Force.

d. Accounting Models

Calculate the consequences of planned actions on the basis of accounting definitions. While limited to the accounting function, these models do allow managers to estimate and project current budgets, reserves, and expenditures. These models will help ABRI perform 'what-if' analysis in financial management from the appropriations, program activities, and units' point of views.

e. Information Analysis Systems

Provide access to a series of database and small models that allow managers to perform a series of ad hoc

analyses for a wide range of uses. Generally, ABRI Personnel Center uses this model in selecting officers to be assigned or promoted into specific positions given some complex criteria like the job requirements, experiences, training, and some human behavior factors.

f. Data Analysis Systems

Allow the manipulation of data by means of operations tailored to the task. Managers pre-specify their needs for data aggregated in a variety of report forms.

g. File Drawer Systems

Allow immediate access to data items that provide specific bits of information managers may need to respond to individual queries.

ABRI has implemented categories for models of **Data Analysis System and File Drawer** in some management information systems (MIS) applications, such as Personnel Retrieval System to store and monitor personnel records and Disbursement Transaction System to record financial transactions since early 1989. The potential move to improve ABRI decision making system using accounting and representational models is probably in the immediate future. **Optimization and Suggestion models** will need extensive development before managers can routinely use them.

D. EXPECTED EVOLUTION OF ABRI INFORMATION SYSTEM

As an "emerging technology", the development of the information system in ABRI requires different management approaches at various points of its life cycle. The expected evolution of ABRI information system developments undertaken between 1975 and 2000 are well described by the four phases of information technology assimilation (Cash, McFarlan, McKenney, Vitale, 1988). These four phases are characterized as investment/project initiation, technology learning and adaptation, rationalization/management control, and maturity/widespread technology transfer.

1. 1975-1980 : Project initiation/Investment

This first phase was initiated by a decision to invest in a new (to the ABRI Headquarter level) information-processing technology. It involved the establishment of Data Gathering and Processing Agency Office (PUSPULLAHTA), installment of the UNIVAC-1106 (UNISYS) mainframe, development of data conversion program from manual to ADP technology, and was accompanied by a major program of education for management and a major recruitment program. From the outset, the conceptual design of ABRI information system was tailored for managing defense and security resources. It consisted of four subsystems :

1. Personnel information system (SISINFOPERS)
2. Material information system (SISINFOMAT)

3. Finance information system (SISINFOKU)
4. Combat strategy and tactics information system (STRATOPUR).

This project initiation was characterized by impreciseness in both costs and ultimate stream of benefits.

Retrospectively, the resulting systems often seem quite clumsy. Possible source of these problems might be vendor failure, lack of real management attention, lack of user involvement, or incompetent project management.

2. 1981 - 1985 : Technology Learning and Adaptation

The second phase involved an intensive program of new developments in both major DP applications to satisfy the initial requirements of the various functions, and systematic development of a series of interactive models. By the end of 1984, most of the fundamental building blocks of ABRI information system were in position and it was then appropriate to carry out a major review for forward strategy.

The new conceptual design for ABRI information system has been reviewed and now projected into three building blocks:

1. Administrative information system (SIMIN).
2. Operation environment information system (SILOF).
3. Office automation (SIOF).

As learning takes place, the actual benefits coming from the projects in this phase are also quite often different

from those anticipated. An observation on some major ADP applications shows that in none of them was the information system implemented as originally planned. In each case significant learning took place during implementation.

In 1985, the first developments of word processing were undertaken using personal computers (PCs). This system appeared to offer several distinct advantages at the time; the costs of the hardware and software were relatively inexpensive and the Univac 1106 mainframe did not support text processing widely. However, within one year of introducing the facility, certain inadequacies were identified. For instance, it was cumbersome for the average typist to handle text and the dot-matrix printer, which had poor print quality and operated at a very slow speed, was inappropriate. However, sufficient interest in word processing had been stimulated within ABRI, enough to warrant the introduction of a limited number of stand-alone microcomputers for straightforward typing activity.

3. 1986 - 1995 : Rationalization/Management Control

During the last four years, the major issues of information system strategies have continued to be featured in the educational efforts at all levels of managements, staff and professionals. Logical data analysis has been introduced, a database team has been set up, and a project for ABRI Data Dictionary has been established.

A significant increase in the number of new systems has also occurred. In this phase, ABRI has analyzed the various aspects of the project life cycle. Another important element in the development of ABRI information system has been the creation of the ABRI Information System Committee. The committee meets quarterly under the chairmanship of the Secretary of the Minister of Defence and Security and covers the full spectrum of the developments in this field, including war gaming models developed by Operational Research (ORSA), data processing, word processing, telecommunications, and long-range development projects. Representatives from each of the services (Army, Navy, Air Force, and State Police), major functions (Personnel, Operation, Logistics, etc.) and specialist groups maintain a coordinating role in key project areas. The objectives of the committee are to provide a clear direction for ABRI information system development programs in data processing, office automation, and telecommunication, and to ensure that the full spectrum of ABRI Information Technology is covered with equal attention. This committee also ensures that cross functional coordination exists and that priorities can be allocated on a regional basis for developments in each field. The chosen functional representatives are senior representatives of their departments having a detailed knowledge of the areas.

4. 1996 - 2000 : Maturity/Widespread Technology Transfer

The focus of this phase is the development and installation of controls for the new technology. This phase concerns with efficiency rather than effectiveness of technology. In this final phase, ABRI can be expected to be able to judge the appropriateness and feasibility of the new technology to their tasks than they were during the innovation phase. IS/DP managers typically will exhibit a "delegating" leadership style. Interpersonal involvement and task orientation are low. With operation procedures well understood and awareness high, the managers delegate responsibility to subordinates to be in complete charge.

E. PROBLEMS AND ISSUES IN DATA PROCESSING OF THE ABRI INFORMATION SYSTEMS

The main impact of computer applications on management in ABRI has been to automate structured tasks where the standard operating procedures, decision rules, and information flows can be reliably predefined, and by replacing clerical personnel, and indirectly affect management decision making through the aggregation of data in product reports and access to data. The primary impetus for an alternate to computer applications in ABRI management has been managerial frustration with computer technology in general, and with technical staff (computer system analysts, programmers, etc.)

in particular, a not uncommon reaction of many decision commanders. Essentially, the tools have not been matched to the managers' reality, so the computer remains only as indirect assistance, and often merely as a nuisance.

In general, ABRI information system is designed by technical professionals where managers play a passive role, at best. They have been consumers in an industry in which overselling has been all too common. Managers often have trouble in developing the computer resource in relation to their decision making needs. In short, the managers at ABRI have been passive, wary consumers, rather than initiators and innovators.

Poor planning, little knowledge, slack resources, single-minded vendors, lack of professionalism among information system development specialists, lack of proper methods and techniques, and lack of trained staff, have all contributed to this attitude. Some examples of common problems which caused the past failures of ABRI information system development are:

1. Applications are often out of date before they are delivered, they take far too long to develop, and they usually fail to meet the true needs of the end-users when they are installed. These are generally far too cumbersome and too expensive.
2. Desperate end-users can sometimes 'strike it lucky', and find that an approach selected without much care may yield dramatic improvements in simple cases. This can lead to false optimism, over selling of the approach, and is usually followed by doomed attempts to use the same approach on larger, inappropriate projects.

3. Buying more new technology without paying attention to the key prerequisites does not always seem to help as much as expected (Senn, 1987). When it does work, ABRI does not always know why. This problem lies behind many of the apparent failures of fourth generation language, where merely to purchase the software, or to permit its use by unprepared individuals on inappropriate applications, by no means guaranteed success.
4. The ongoing rapid rate of development in the hardware and software is also the reason why the development of properly interfaced subsystems has failed (Senn, 1986). This has meant that the professionalism of the discipline has been slower to develop than one would have wished. The computer specialists still had to invest a great deal of time in switching from one hardware and software system to another. Another effect of the rapid rate of development was that less time was spent on constructing new systems (improved performance), owing to the fact that so much time had to be spent on upgrading existing systems to take advantage of new technical possibilities.

In addition, ABRI Data Processing (DP) managers are now finding their early roles in information system development diminishing. The DP staff can not keep up with the rising demand for new application system. An application backlog of three to four years has been documented for many organizations. Today, ABRI DP managers face critical decisions in organizing information system development.

F. INFORMATION SYSTEMS PLANNING FOR ABRI

The importance of information which must be used effectively if its contribution is to be maximized before it depreciates, the importance of computers in information handling, and the complexity of the information technology environment suggests that an information system planning is

vital to success. ABRI has concurred that planning an information system to meet the organization's strategic plan is indeed a difficult task.

Alignment of the information system strategy with the organizational strategy is one of the central issues of information system planning in ABRI. Generally, organizations form strategic plans by looking at the current positions and determining where they want to be in the future. The Nolan stage model and McFarlan-McKenny strategic grid are probably the most appropriate frameworks for describing the current stage of the growth of the ABRI information system and for planning to move in a controlled way to the next stage. These models provide a detection of change as ABRI adopts information technology and develops organizational mechanisms to benefit from it. ABRI may also apply the three stage model of MIS planning (Bowman, Davis, and Wetherbe, 1983). This model provides a useful framework for describing the stages of information system planning, the order of the activities, and the alternative techniques and methodologies.

1. ABRI information planning environment in Nolan stage model

The stage model of computer growth originally proposed by Gibson and Nolan (1974), and later expanded by Nolan (1979), is the most-well known model that provides a useful

guideline for an organization, allowing it to see where it stands and where it may be headed in terms of computerization.

The model is a contingency theory which states : **IF** these features exists **THEN** the information system is in this stage (Davis and Olson, 1985). The basic theme of the model is that organization must go through each stage of growth before it can progress to the next one. The IS development typically undergoes six stages of growth towards an automated solution to information system planning. These six stages of growth are described below.

a. Stage 1 : Initiation

During this stage, the computer is first introduced into the organization. Although the participation of users is encouraged, their unfamiliarity with computers means that user involvement is minimal. The applications developed in this stage tend to serve the operational needs of the organization in areas such as accounting, payroll, and personnel administration. Little overall control of the computer systems is apparent.

b. Stage 2 : Contagion

Contagion sees the users becoming enthusiastic participants who begin to demand new applications. Consequently, there is a sharp rise in computer services expenditure. Management of computer services, although possibly centralized, is ineffective due to very little

overall or long range planning. Applications development is performed in isolation, with a consequent proliferation of incompatible and redundant data.

c. Stage 3 : Control

In stage 3, user demands for information are frustrated, while the ever-expanding budget and marginally increasing benefits of computer services draw the attention of upper management. Not surprisingly, budget expansion is either sharply reduced or held constant at this point. The focus is now on providing the IS function with the type of professional management found elsewhere in the business; planning and control systems are initiated, with chargeout systems forcing users to pay for their computer usage.

Emphasis is placed on documenting existing applications and moving them towards middle management, reducing focus on operational systems. As this restructuring takes place, however, the application backlog lengthens and maintenance costs soar.

d. Stage 4 : Integration

According to Nolan, a significant transition point in the organization's computer use is reached by this stage, that is, transition from management of the computer to management of the data resource. This shift, although hampered by data redundancies and inconsistencies, is reflected in attempts to integrate existing systems using data base technology.

e. Stage 5 : Data Administration

By stage 5, data base technology is in place and a corresponding data administration is being used to plan and control the organization's use of data. The emphasis is on common, integrated systems, with shared data among the various functions of the organization.

f. Stage 6 : Maturity

Very few organizations have reached this stage, but the attainment of maturity represents the true integration of computers with managerial processes. The information resource is meshed with the strategic planning of the organization, thus the applications reflect overall corporate policies.

Nolan proposed that an organization can determine which stage of maturity it falls into by observing four main characteristics. First, the application portfolio of information systems that are in use will change from functional, simple applications to more integrative organization-wide systems as the organization matures. Second, the DP department will shift from a centralized structure in a supporting role to a computer or data processing functioning as a data custodian for the entire organization. Third, as the organization matures, DP planning and control will shift from lax to formal. Finally, User awareness of DP will shift from reactive to participatory as the level of maturity increases.

Given the current status, the planned information system, and some problems and issues in ABRI information system above, an evaluation of each Nolan growth process can be conducted in order to place the ABRI information system in one of the Nolan's six stages. From a corporate or ABRI-wide viewpoint, the ABRI information system fits best in Stage II, The Contagion (Expansion) stage. This stage encourages proliferation of ABRI information system activities. It also encourages local programming efforts with little need for reporting these activities to higher headquarters. The existence of "user-oriented programmers" will confirm that many users look to solve their own data needs before looking to the major mainframe applications.

The ABRI information system planning strategy cannot be placed any higher in the matrix because the remaining stages involve a higher level of directions and control by ABRI headquarters. It must be noted that certain aspects of the growth processes do fall outside this stage. Any movement to the latter stages in this model would have to include more stringent control measures from ABRI headquarter.

2. ABRI information system planning environment in McFarlan-McKenney model

The strategic grid (McFarlan-McKenney, 1983) is a diagnostic model to understand the role of the information

system in an organization. The position in the grid explains the needed level of top management involvement and the relationship of information system plan and organizational plan.

The grid defines four types of information system planning situations, depending on the strategic impact of the existing information applications and the strategic impact of the planned information system. The grid can then be used to suggest the organization and management of information system planning. The four strategic grids are described below.

a. Strategy

Information system activities are critical to the current business strategy and to future strategic directions of the organization. Information system are part of new strategic directions.

b. Factory

Information system applications are vital to the successful functioning of well-defined, well-accepted activities. However, information systems are not part of future strategic operations.

c. Support

Information system applications are useful in supporting the activities of the organization, but are vital to critical operations and not included as part of future strategic directions.

d. Turnaround

This is a transition from "support" to "strategic". The organization has had support-type applications, but is now planning for applications vital to strategic success of the organization.

In order to place the ABRI information system planning strategy in one cell of the McFarlan-McKenney strategic grid, an evaluation of each characteristic must be conducted. It must be noted again that the perspective for this study is from the ABRI headquarter level and not from individual IS/DP departments.

Utilizing the same arguments used in the Nolan stage model, the strategy which best describes the current ABRI information system planning will be in the Turnaround-strategy grid. The strategic impact of planned information systems i.e., mainframe-microcomputer interconnection, office automation, distributed processing, and DSS to ABRI are high, but the strategic impact of existing operating information systems is low. Most of the current information system applications are in the supporting transaction processing level; the sharing of data between various IS/DP department is limited to local and regional areas, with involvement from little top management, and very little or no guidance from higher echelons.

Once the positioning of an organization with respect to planning is determined, ABRI should evaluate the

place of a technique in the flow of planning activities for developing an information system plan. The next section examines the three-stage model of information system planning (Bowman, Davis, and Wetherbe, 1983) that clarifies the generic planning stages, the order of the stages, and the alternative techniques and methodologies that apply (see Figure 2-3).

3. ABRI Information System Planning Environment in the Bowman-Davis-Wetherbe Model

The three-stage model of MIS planning (Bowman-Davis-Wetherbe, 1983) provides a framework for addressing critical issues and problem areas of MIS Planning. The three stages are strategic planning, information requirement analysis, and resource allocation. This model can aid in recognizing the nature of the planning problems and in selecting the appropriate stage of planning. For example, if the information system function is not responsive to the organization, the three-stage planning model indicates that a strategic alignment planning effort should precede organizational information requirement and resource allocation.

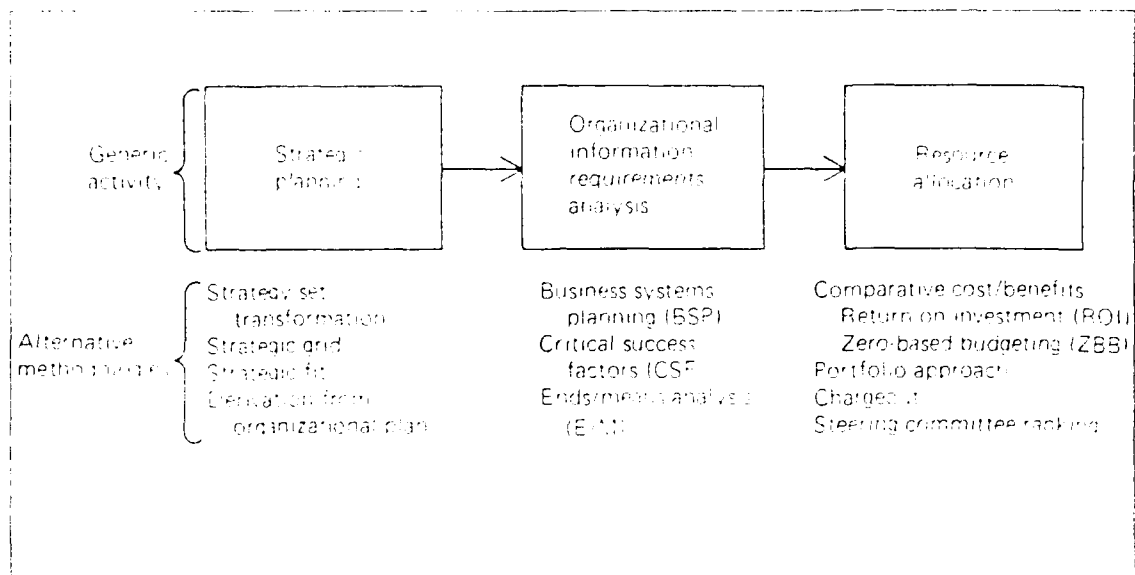


Figure 2-3 : The three-stage model of the information system planning process.

a. Strategic Planning Stage

During the strategic planning stage, it is critical to align MIS strategic planning with overall organizational planning. To accomplish this, the organization must:

- Assess organizational objectives and strategies
- Set MIS mission
- Assess environment
- Set MIS policies, objectives, and strategies

The output from this process should be an accurate perception of the strategic goals and directions of the organization, a new or revised MIS charter, an assessment of the state of the MIS function, and a statement of policies,

objectives, and strategies for the MIS effort. Some of the various planning methodologies used in this stage are Strategy Set Transformation (King, 1978), Strategic Grid (McFarlan-McKenney, 1983), and Strategic Fit with Organizational Culture (Watson, 1976).

b. Organizational Information Requirement Analysis Stage

Once goals and strategy have been delineated, the next stage is to obtain organizational information requirements. Information requirements are required for information system planning. It consists of three steps :

- Identify organizational subsystems/applications,
- Develop manager-subsystems/applications matrix to relate specific managers to organizational subsystems/applications,
- Define the information system architecture.

Some of the planning methodologies used in the stages are Business systems planning or BSP (IBM, 1983), Critical success factors or CSF (Rockart, 1970), Ends/Means Analysis (Zachman, 1977).

c. Resource Allocation Stage

Resource allocation consists of developing hardware, software, data communications, facilities, personnel, and financial plans needed to execute the master development plan defined in Stage II. This stage provides the framework for technology procurement, personnel planning, and

budgeting to provide appropriate service levels to users. The planning methodologies used in this stage are Zero-based budgeting (Wetherbe and Dickson, 1979), Chargeout (McLean, 1977), Portfolio approach (McFarlan, 1981), and Return on investment (ROI) techniques.

The three-stage planning model provides ABRI a considerable insight into information planning issues. This model should reduce confusion in selecting competing planning methodologies. For example, it can prevent ABRI from using a resource allocation methodology (e.g., Zero based budgeting) when a strategic planning methodology is appropriate.

III. END-USER COMPUTING

A. GENERAL

The increasing sophistication and power of intelligent terminals, microcomputers, and PCs, fourth-generation language (4GL) applications, and office automation were major factors in starting the trend toward End-User Computing (EUC) environment. Through such user-friendly tools, end-users can develop their own information systems, access data, create reports, perform their own data and information processing. Entire systems can be developed by end-users alone, without involvement by computer professionals such as computer system analysts or programmers.

End-user computing (EUC) is overtaking the traditional paper shuffling functions because progressive, knowledgeable users are utilizing user-friendly software and improved man-machine interfaces to perform these functions more efficiently and effectively. Once the domain of highly educated scientists and engineers, these tools and innovative end-users are now opening computing to the whole organization.

Today, development of EUC is booming. The trend of EUC development is away from the highly centralized system of the early 1970's and is expected to intensify over the next two

decades. Instead of being disenfranchised customers, end-users are now critical stakeholders (Evans, 1986).

This chapter provides the technological environment of EUC, reviews the conceptual definition of EUC, analyzes EUC architecture, end-user categories, EUC tools, EUC supports, and some areas of management issues in EUC development strategy.

B. TECHNOLOGICAL ENVIRONMENT OF END-USER COMPUTING

Before proceeding further, it is important to explore the evolving information technology trends that has the most impact on EUC. In the field of computing and communication, it is not surprising to see advances in technology that make the hardware, software, policies, and practices obsolete in just five or ten years. For example, computer architecture has progressed through five generations of machines in forty years from electrical accounting machine (EAM), to vacuum tubes, to transistors, to integrated, circuit (VLSI). The physical level is no exception either; 1K bit chips were used in the late 1960's, while today 1M bit chips are standard in most machines.

Similar growth has been experienced in the end-user computing technology. A study on EUC development predicted that total capacity of computing workload would grow by a factor of 12 from 1980 to 1990, while end-user computing would

grow by a factor of 40. By 1990, end-user computing will represent about 75 percent of the total computing workload (Benson, 1983).

Any strategy must take into consideration the impact of technology. Therefore, in order to get the maximum benefit from advances in end-user computing technology, any organization should propose a coordinated program, balancing the capabilities of proven equipment and techniques against the promise of advantages to be gained from new technology. The most promising technological advances which have the most impact on EUC are computer architecture, design, and storage, as well as input/output devices, software productivity, database management, data communication, and artificial intelligence.

1. Hardware Development

The EUC operational environment and its business applications will be affected by the advances in processing speeds and storage capacity projected for the immediate future. Faster computer speeds and increased capacities will allow more data to be absorbed, sorted, and tailored; thus alleviating the problem of information saturation. Data will be gathered, processed, and displayed in near real time and with a greater degree of accuracy and resolution. Graphs, displays, charts, and plots will also be enhanced. With greater computing power

the operational or battlefield commander can pose a greater number of strategic and tactical alternatives to command and control systems, have the systems project future scenarios, and better judge the outcome of critical war decisions.

In the business and management environment (e.g., personnel, material, finance, logistics, supply), data will be more timely, thus reducing the backlog of critical data. The greater capacity will allow 'just in time' inventories to be maintained. The ability to process data faster will facilitate the availability of data in both executive and support work space. And research and development efforts will be enhanced since greater processing speed and capacity will be utilized to more quickly resolve complex problems in defenses industry.

In recent years, computer architecture and design have benefited from the advances made in the semiconductor industry. Present research and development in computer technology are focused in two directions.

First, it is expected that additional semiconductor advances are imminent and forecasts improvements of from 3 to 5 times faster processing speeds and increased computing capacities. Second, the benefits from semiconductor enrichment have reached the point of diminishing returns and suggests that other approaches, such as the Reduced Instruction Set Computers (RISC), new computer interconnection schemes, and massive parallelism are better directions for the computer

industry to take. Whatever direction computer architecture and design successes take, advances in processing speed and more memory capacity will continue and will have a major impact on how ABRI information systems are developed.

There are three media commonly used for computer storage technologies: magnetic, semi conductor, and optical. Magnetic disks will continue to be the major large capacity storage medium in the near future, while magnetic tapes will decrease in usage. The most rapid advances are expected in the semiconductors as speed increases by an order of magnitude. Current optical storage technologies are either read only, or provide very slow write capabilities. Optical technology is experiencing significant growth and the use of Compact Disk Read Only Memory (CD-ROM) will probably become a reality for ABRI mass storage systems in the near future.

2. Input/Output Devices

Text and image scanners are evolving into practical devices and will receive emphasis as input media. As costs fall, laser printers which provide easy to use, high quality, and high speed production, will become a dominant output medium. Major advances in high resolution color displays, large screen displays, color printers, and increased availability will enhance EUC tools as decision aids.

3. Software Productivity

Technological innovation in the area of software productivity promises advantages to EUC both operationally and commercially (Freiser, 1987). Today, many systems fail, not due to hardware, but due to delays in software development, difficulties with integration of systems, and an inability to easily query data. Software productivity tools, providing reusable modules, will help these problems and save millions of dollar development costs (Evan, 1986). Software productivity enhancements are being affected by changes in three major areas: language, environments, and development methodologies. Fourth-generation languages will experience increased development and broaden usage.

Software development environments will provide a more natural interface with the users and will accommodate specific program development methodologies. Existing program development permits reuse of existing software, extensive use of data dictionaries, and automated aids for developing interactive queries, reports, and screens.

4. Database Management

A great deal of effort is underway to analyze and enhance the process of providing standard data interface between diverse systems. Data base management systems (DBMS), already in use, will increase adaptability and will be more easily accessed through modern fourth-generation language.

Today, the main factor which makes the off-loading of DBMS functions very desirable is due to user application requirements for larger database. Major advances underway include techniques and technology for implementing distributed data bases.

The database computer will become the predominant element for effective data management in many application systems, as its functionality increases and its interface to general purpose computer improves. Its main advantage is in freeing the host computer for processing rather than for data manipulation.

5. Data Communication

Under the continuous pressure of increasing data transfer requirements, development of national and international standards for data transmission and network protocols have been initiated. During the next decade we will experience major growth in local areas, metropolitan areas, wide areas, and long haul data communication supported by higher speeds and more interconnectivity.

A primary concern of data communication system is the current saturation of the communication media. This increased strain is forecast to continue for some time as a result of several factors.

The demand for tailored information is increasing particularly with respect to supply, logistics, and sustainability data. At the same time, advances in computer design provide an exponential increase in computing power and the resultant ability to transmit vast amounts of data. . .

6. Artificial Intelligence

Research is progressing in four major areas related to artificial intelligence expert system, natural language, vision, and robotics. With major initiatives in expert systems, EUC can expect real progress in near term. Expert systems will provide valuable decision aids in both tactical and business environment. Computer-aided instruction (CAI), computer-aided design and computer-aided manufacturing (CAD/CAM), computer-aided diagnostics, computer-aided health care, and tactical simulators will all benefit from research in expert system. This trend will escalate as expert systems are fielded to support EUC functions.

C. CONCEPTUAL DEFINITION OF END-USER COMPUTING

There has been a mass of literature on End-User Computing (EUC). Despite all these arguments, 'End-User Computing' is still poorly understood. EUC occurs when individuals develop their own computing applications independently of the existing data processing infrastructure i.e., bypassing MIS channels, system analysts and programmers (Euske and Dolk, 1986). EUC is

"the unstructured use of computers by someone who is not a professional in data processing to solve their business related problems." (Goldberg, 1986).

EUC has also been defined as the use of any size computing device by personnel who does not work in either DP or MIS departments, to do tasks such as word processing, spreadsheets, data base, report generation, and graphics. Other tasks performed by these clerical, management and operational people include data analysis, modeling, simulation, and interoffice communication (White, 1988).

For the purpose of this thesis, end-user computing is defined as the direct, hands-on use of computers by end-users with problems for which computer-based solutions are appropriate. This means that end-users will take action to determine the nature of the problem, select the appropriate computer-based tool, delineate the appropriate method of solution, and do the work to create the computer-based solution. More specifically, the end-user can be defined someone who does one of three things (Euske and Dolk, 1886):

- a. Buys information resources (i.e., hardware, software, data or associated information service),
- b. Sells or shares a resource (e.g., spreadsheet, database, or program that some individual has developed),
- c. Develops an information resource for self use (e.g., someone who develops a portfolio evaluation program for one's own particular investment purposes).

Clearly, if one is attempting to understand end-user computing(EUC), it is important to know about EUC's technology architecture. Equally important, is to know who the end-user are, how to classify them, where they are located, what they are doing, what their needs are, and most significantly, how to manage this new phenomenon.

D. END-USER COMPUTING TECHNOLOGY

One possible structure to overview the EUC technology is to locate processing power at a four-level hierarchy in an organization. These are desktop, work group, department, and corporation level.

1. Desktop level

At the desktop level there are personal computers and more-or-less intelligent terminals. There is no communication among them. End-users also see personal computers as private. That is, they can be used in a private place, for example, at home or in the privacy of one's office. The main applications running on the desktop are word processing, spreadsheets, and graphics. Since a major part of a manager's job involves monitoring work that is being performed by others, personal computing will include a number of aids for monitoring and scheduling, such as, electronic personal calendar, tickler files, milestone and status reporting tools, and other useful tools for planning and tracking projects. In the future, the

users of desktop computers can expect to see the processing power available for running new generation graphics-oriented interfaces on the desktop.

2. Work group level

End-user computing is appearing in work groups because it provides new ways to communicate. Generally, up to several people at the work group level share information, resources, and functionality via connection to a multi-user processor. Some useful applications are work group spread sheet, word processing, filing, database, and scheduling among individuals in the work group. Work group technologies are networked through a multi user operating system environment, such as Unix to department level system.

3. Department level

Currently, most personal computers access departmental facilities by emulating a terminal on the network, rather than as intelligence workstations. In addition to tools such as departmental meeting, project management, document distribution, and departmental application like financial planning and process management, there is a virtual work group information and functionality. That is, the end-users appear to be working on a work group file or spreadsheet, but in reality this file or spreadsheet is running on the departmental system. At the computer department level, a computer message

system and electronic bulletin board applications indicate that communication networks, such as SNA, DEC net, DDCMP and other communication protocols become increasingly important.

4. Corporation level

The main technologies of the corporation level are the corporate electronic messaging systems serving a regional, national and/or international population of over a thousand users and end-users enabling them to access appropriate corporate-level major MIS application systems.

Some capabilities external to the corporation have been designed into the architecture. For example, any end-users can access publicly available database such as Dow Jones and Newsnet through their personal computer.

Depending on the location of the public facility and end-users, communication networks such as Tymnet, Telenet, or Datapac may be used as part the corporate network facilities. Corporate mainframes, minicomputers and shared microcomputers generally serve a number of end-users for specific applications which department and work group data processing cannot provide.

E. PRINCIPAL USERS OF EUC

The simplest way to define users of EUC are individuals who are willing to use computer resources to get their job done. End-users come in all types and sizes : factory

supervisors, company directors, military officers, police officers. Regardless of position, end users can be identified by different points of view. End-users must be identified, because they have varying computer skills, methods of computer usage, focuses in applications, requirements for education, training and support.

Currently, the literature provides three recent classifications on end-users. Codasyl broke down end-user categories into three parts. They are 'indirect' end-users who use computers through other people. For example, an airline passenger requesting a seat through his travel agent; 'intermediate' end-users who specify business information requirements for reports they ultimately receive; and 'direct' end-users who actually use terminals. Martin and McLean broke down the 'direct' end-users category into three nearly identical classifications.

McLean's classes are : DP professionals who write code for others, DP amateurs who are non IS personnel who write code for their own use, and Non-DP trained users who use code written by others in the course of their work, but know nothing about programming.

A study of 200 end-users and 50 information system managers (Rockart and Flannery, 1983) observed a finer-grained and more useful classification of end-users. They distinguished six 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 which emerged. Although all utilized end-user languages or the products of these languages, each user class is distinctly different from the others. The principal users of EUC are categorized :

1. **Nonprogramming end-users** - whose only access to computer-store 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.
2. **Command level users** - have a need to access data on their own terms. They perform simple inquiries often with a few simple calculations and generate unique reports for their own purposes. They are willing to learn just enough about the software to assist the performance of their day-to-day jobs.
4. **End-user programmers** - utilize both user of query languages and user-friendly programming tools to solve own business problems. 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 analysts.
5. **Functional support specialists** - are sophisticated programmers supporting other end-users within their particular functional areas. They are individuals who, by virtue of their prowess in end-users languages, have become informal centers of system design and programming expertise within their functional areas. They provide the majority of the code for the users in their functions.
In spite of the large percentage of time that these individuals spend coding, they do not view themselves as programmers or DF 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.
5. **End-user support specialists** - are IS professionals dedicated to facilities that support end-user computing

activities. They 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 language and, in addition to aiding end-users, also develop either application or 'support' software.

6. **DP programmers** - 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 department wishing to hire 'contract programmers', to avoid high consultant and programmer fees.

DP programmers are the bridge for the end-users to build a large base of knowledge of end-user language computing within the company.

From a management view, it is clear that end-users are diverse. Diversity in end-user activities necessitates a variety of software tools. Diversities among end-users also necessitates strongly differentiated education, training, and support for the various classes of users.

F. END-USERS COMPUTING TOOLS : Fourth-generation language

Because of the possible diversity of the end-users needs within an organization (See Figure 3-1), multiple software tools may be employed. The end-users' level of sophistication will determine what type of software is sufficient to meet their requirements. More sophisticated end-users might want to use bit-level, procedural language (e.g., BASIC), whereas others might need text processing, spread sheets, report

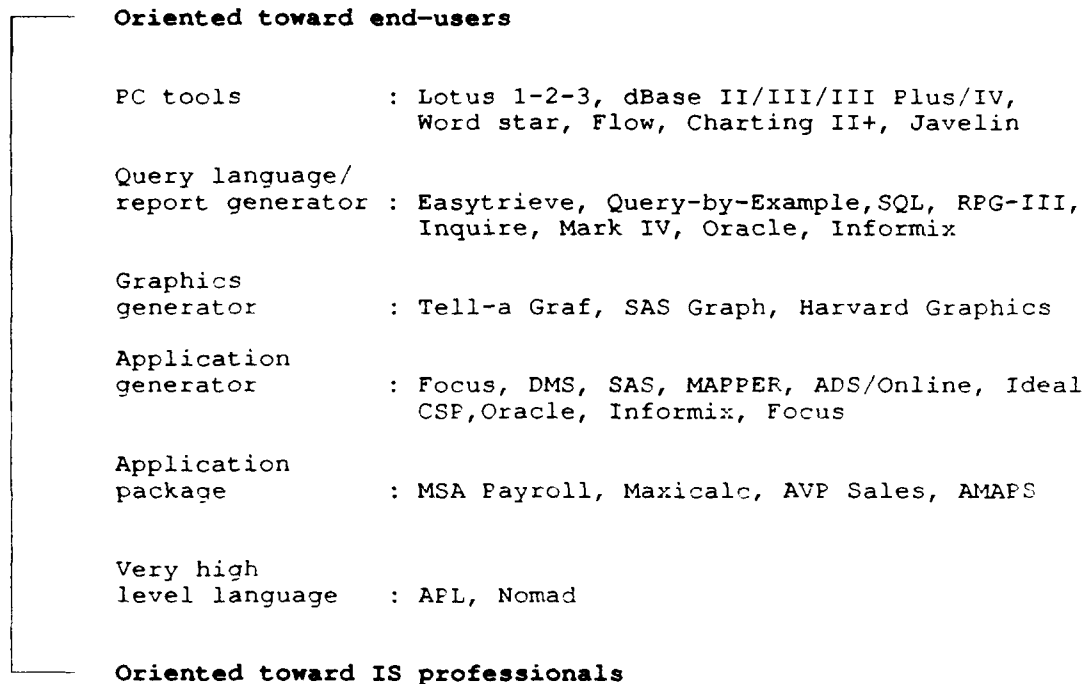
generators or simple command-level language to get their jobs accomplished.

There is no one language to support all the requirements simultaneously, so an organization must provide a broad selection of end-users tools to choose from. Figure 3-2 shows a spectrum of major categories of EUC tools with commercially available products in each category and to what level of user they are oriented.

Figure 3-1. Diverse Needs of End-Users (Frieser, 1987)

| Clerical Needs | Professional Needs | System Needs | Management Needs | Executive Needs |
|---------------------------|--|--|-----------------------------|----------------------------|
| Data Entry | Modeling | S/W Development | Complex Query | Query |
| Word Processing | Online design | S/W Testing | Model | Report |
| Simple Query | Problem Analysis | Prototyping | Report | Decision Support |
| Report Preparation | Statistics Document Creation & Review | Performance Recovery, S/W Installation | Decision Support | |

Figure 3-2. The spectrum of end-user computing tools (Laudon, 1988)



A common term for the end-users computing tools is fourth-generation languages (4GL). This term has been widely misused, and there is considerable confusion about what it actually means. An appropriate term for classifying languages, 4GL are designed to improve the efficiency of the development process.

In general, 4GL can provide order-of-magnitude productivity gains that obtain at least 10-to-1 increase in productivity over traditional methods (Laudon, 1988). They are less procedurally oriented than conventional languages, emphasizing what needs to be accomplished rather than how.

The less skilled programmers are the primary users of 4GL because 4GL often have features suitable for direct use by end-users so that some capabilities can be mastered with two days or less training. A principal strength of 4GL is the speed and ease with which they can create certain kinds of applications.

Fourth-generation languages for end-users applications have been developed for both mainframes and microcomputers. There are seven major categories of 4GL as software tools for end-users applications :

1. **Query language**

A high level language used to retrieve stored data. Usually interactive, on-line and capable of supporting requests for information that aren't predefined. They are often tied to database management systems. Available query language tools have different kinds of syntax and structure, some being more natural language than others.

They are facilities for creating customized reports. They extract data from files or databases and create reports in many formats. The more powerful report generators can manipulate data with complex calculations and logic before they are output. Some report generators are extensions of database or query languages. The more complex and powerful report generators may not be suitable for end-users without some assistance from professional data processing specialists.

3. Graphics languages

These languages retrieve data from files or databases and display them in graphic format. End-users can ask for data and specify how they are to be charted. Some graphics software can perform arithmetic or logical operations on data as well.

4. Application generators

They are made up of preprogrammed modules that generate whole applications. And end-users can specify what needs to be done and the application generator will create the appropriate code for input, validation, update, processing, and reporting. The most full function application generators consist of a comprehensive, integrated set of development tools : a database management system, data dictionary, query language, screen painter, graphics generator, report generator, decision support/modeling tools, security facilities, and a high-level programming language.

Most application generators contain "user exits" where custom-programmed routines can be inserted to allow customization. Some application generators are interactive, enabling end-users to define inputs, files, processing, and reports by responding to questions on-line.

5. Very high level programming languages

They are designed to perform coding with far fewer instructions than conventional language such as COBOL or FORTRAN. Programs and entire applications based on these

languages can thus be written in a much shorter period of time. Simple features of these languages can be employed by end-users.

In fact, these very high programming languages are designed primarily for data processing professionals as alternatives to conventional programming tools.

6. Application packages

These consist of prewritten application software that is marketed commercially. They are available for major business applications on mainframe, minicomputers, and microcomputers to perform accounting, budgeting, work scheduling etc. They may be tailored to an organization's unique requirements or turnkey systems can be installed without the help of data processing department.

7. PC tools

They consist of microcomputer products with capabilities similar to those of the mainframe tools. They include word processing software, graphics software, electronic spreadsheet software, application generators/database management systems, and programming languages such as BASIC and PASCAL.

G. EUC SUPPORT : The Information Center

1. Concept definition of the Information Center (IC)

One of the most interesting changes in organizational structure related to end-user computing technology is the

Information Center (IC). Other names for similar organizational units are Information Resource Center and Users' Service Center. This unit is not equal to the Data Processing Department which is being slowly replaced by new names like Information System Department.

"The information center is a place, a concept, a method of supporting end-users in achieving their own solution to business problems that require computer resources and data" (Carr, 1987).

"An Information Center (IC) is a portion of the Information System (IS) development resource organized and dedicated to support the end-users of IS services in activities such as report generation and modification, data manipulation and analysis, spontaneous inquiries, etc. The fundamental premise underlying an IC is that if provided proper education and training, technical support, usable tools, data availability, and convenient access to the system, end-users may directly and rapidly satisfy a portion of their business area requirements that depend on an IS environment" (Hammond, 1982).

The IC is a new IS and end-users relationship, a relationship built on cooperation and a joint dedication to getting the job done (Hammond, 1982). The IC is simply a center within a business organization which typically serves the needs of those who computerized information resources (White, 1988).

The concept of the IC was conceived by IBM, Canada (Hammond, 1982) as a response to the increased number of end-user requests for new computer applications. This demand created a huge backlog of work in the DP department, and end-

users had to wait several years to get their system installed. The solution, of course, was to provide an IC which supported end-users while they learned to write their own application programs.

An Information Center is a group of employees specially trained in the use of information technology. An IC can also be defined as an organizational unit within a company that provides end-users with proper education and training, technical assistance, and general support services.

Sometime in the future, when end-users become more educated and the software becomes easier to use, we can expect that end-users will refer to the IC only for complex or unusual cases. In a short time the IC concept has become very popular : there is a large IC society, a special journal (i.e., *Information Center*), and regional and national conferences catering to ICs.

2. The Philosophy and Mission of the Information Center

The long-term success of an Information Center (IC) depends upon establishing a philosophy which links the IC strategic development plans and the end-user business strategic plans.

The philosophy of IC development must be based on some of the following fundamental ideas :

- a. The information Center development is a conducive process to learning and is supportive of the creativeness that end user computing fosters.

- b. The information Center should influence rather than control end-users.
- c. The information Center should provide options for the end-users rather than mandate solutions.
- d. The information Center should serve while allowing itself to evolve as end-users become more sophisticated.
- e. The information Center should remain responsive to the end-users' changing demands. As business needs change, the end-users' needs for IC service will change.
- f. Although bureaucratic operations do exist where end-users are directed rather than supported, their effectiveness can be questioned. Recent EUC literature (Euske and Dolk, 1988) lends support to norm-based strategies that move away from bureaucratic control to promote EUC.
- g. End-users should decide what they want done, the IC should determine the options, and end-users should then make the final choice (Ambrosio, 1988).
- h. The Information Center should be one of assisting advice. End-user should not look to the IC for completed solutions but for help in designing their own solutions.
- i. Finally, the philosophy should be one of training, not production. The major IC deliverable should be more sophisticated end-users, not software applications.

The Information Center's mission statement is an extremely important document for defining its function in the larger information system environment and the roles and responsibilities of the end-users and the IC staff. Hammond (Hammond, 1982) suggests that the mission statement should be divided into three sections.

The first section describes what the IC is. A statement concerning the environment to assist users, the interface between the IC and established project teams, and

marketing IC within the organization should be included here. The next section of the mission statement describes how the mission will be accomplished. Hardware and software issues, user needs and feedback, IC staff technical competence, and methods of user training are discussed. The last section details the criteria for work appropriate for the IC and, to some degree, what is not appropriate.

Duration of effort, complexity of the task, level of user participation and frequency of execution are addressed. The mission statement emphasizes to all levels of end-users and staff that the IC is not a substitute for applications that require extensive system analysis and design. *The IC is designed to complement the existing IS/DP organization by handling the one time, user produced tasks.* It is not a vehicle to circumvent the traditional analysis and design required for large systems.

3. The Information Center Services

There is a wide variety of services performed by the Information Center (IC) and the mix of these services are driven by the needs of the business the IC supports. Management must define the services offered by the IC and the technologies encompassed by it. The typical services for a hypothetical IC at a mature stage of development in a medium-to-large corporate environment are (Jeffery, 1986) :

- Training end-users via formal classes, for example dBase III, SAS, Lotus 1-2-3
- Consulting, one-to-one product and design support, and troubleshooting
- Providing hotline support
- Preparing end-user requirements to assist in selecting technology and assisting in file and report design
- Providing access to Corporate data
- Providing Mainframe-Microcomputing link
- Establishing PC-to-PC communication via local area network
- Providing computer graphics facilities
- Developing applications programming
- Demonstrating hardware and software standards for end-user computing
- Preparing cost-benefit and cost-avoidance analyses with end-users or upper management
- Selecting and proposing end-user hardware and software
- Purchasing and inventorying end-user computing equipments for the corporation
- Recommending and implementing new technologies for the corporation
- Selecting pilot projects for new technologies
- Assisting in making portions of production data and data extracts available to end-users as appropriate
- Assisting in obtaining disk space and log-ons for end-users
- Maintaining records of end-user profiles, applications developed, and training provided to end-users
- Coordinating corporate user group

- Developing presentations and demonstrations for the IC to market itself and to transmit its goals and objectives to organization
- Publishing a newsletter

4. Staffing

Information centers should be staffed by people with the following attributes: (Carr (B), 1988)

- Business knowledge (usually MBAs)
- Analytical skills
- Current software package knowledge (DSS generators, tools)
- Current basic hardware knowledge
- Knowledge of where to go outside the organization for needed information
- Patience and enthusiasm
- Good interpersonal communication skills
- Programming skills (especially in 4GLs)
- Drive and motivation to complete programs without direct supervision
- End-user and service orientation

5. Organization Structure for The Information Center

The organization of an Information Center (IC) differs from those of the Data Center Department. It is based on the assumption that if end users are provided with proper training, effective technical support, and convenient access to data and to computing facilities, they will be able to

satisfy a portion of their business information requirements more or less independently. This will be done without increasing the burden of the DP department's analysts and programmers. A common organization structure for information center may consists of:

a. *The Information Center Manager*

The IC Manager oversees all activities of the center and usually reports to the senior information system executive. The manager coordinates the general usage and support of the system as well as training of users. The manager receives information on emerging corporate strategies, policies, and operating activities.

b. *Information Center Consultants*

They work with users who need a large system. The consultants contribute from one-third to one-fourth of the effort on a development project, including development of user requirement and the translation of user requirements into tasks which the center can address to the development of strategies for meeting them; the user then does all the rest of the work. In its well-developed information center, consultants play five important roles:

- Project manager
- Database designer
- Configuration manager
- Tool expert

- Quality assurance inspector

c. Application specialists

They are end users who have become experts using one or more software packages and who create application programs for others. In some cases, the users run these program on their own; in other cases, the specialist runs the programs and gives the results to the users. The works of application specialists are not only shortening the visible back log at the corporate data center, because these requests are too individual to warrant a system, but they are also writing 'invisible backlog' applications.

d. Trainers

They work directly with the users to familiarize them with center products (such as spreadsheet), or high-level languages (such as Query-By-Example or Focus). In addition to running individual and group classes, trainers are available for questions from users about specific features of the system or usage techniques.

e. Technicians

They maintain the equipment in the center. They are responsible for diagnosing malfunctions and making repairs. In many organizations technicians also stay in touch with vendors and monitor new developments in software, which they evaluate for potential use in the information center.

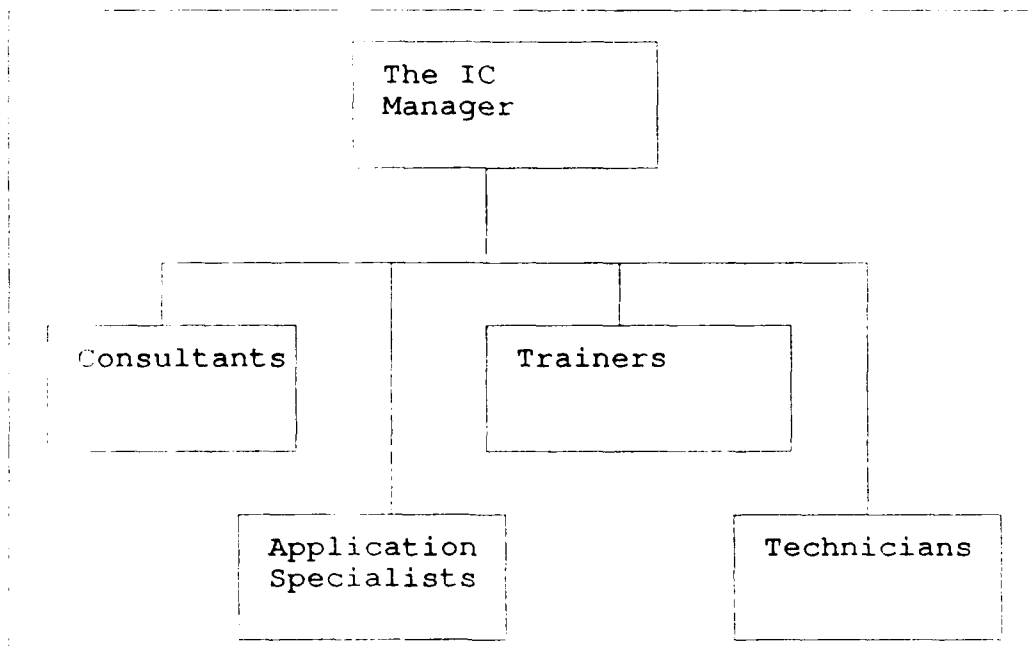


Figure 3-3 : The common organization structure of the IC

6 Management of the Information Center

Information centers will not be successful unless they are properly managed and supported. In fact, without good management, they can be harmful to an organization. To appreciate the management issues posed by end user developments, one must clearly understand the shared responsibilities between end users and the information center staff.

a. User responsibility.

First, when doing system development themselves, whether through an information center or on their own, end-users should have a good grip on the business problem at hand.

Second, end users must know what generic data they need in order to address the problem under consideration.

However, it is the responsibility of each user to know how to operate the terminals, work stations, or personal computers as well as storage devices and peripheral equipment such as printer and graphic plotters. Everyone who plans to undertake a system development task should attend a workshop or training session on how to use the hardware. Similarly, end users should acquire familiarity with the software product they will be using and generally should know about spreadsheet and data retrieval products.

b. Information Center Responsibilities

The Information Center staff must recognize the benefits that are attributed to user-developed applications. They should clearly understand the difference between end-user development and the conventional pattern of development.

It is the responsibility of the Information Center to find and correct errors or problems in the applications which have been developed by end users. The Information Center addresses these problems and provides debugging assistance. The Information Center should continually be on the look out for new tools such as language, package, or computer devices that will facilitate user driven system.

7. The benefits of the Information Center

The establishment of the Information Center (IC) has resulted in benefits for almost everyone. The IC has established a new user-IS partnership which has benefitted the entire organization.

Users benefit because their short-term, often one-shot, IS related business can be addressed immediately. The IS/DP Department benefits because it can satisfy the short-term, one-shot user needs in a more efficient manner, thus being able to devote more of its resources to new project-oriented development necessary for the long-range success of the business (Hammond, 1982).

The finance and accounting departments make up the largest segment of IC users followed by the marketing and administration departments (Garcia, 1987). Some of the benefits of the IC which have been documented are described below.

a. Forestall staff increases

Some IC managers contend that use of an IC forestalls staff increases in user departments. These managers have convinced user department managers that widespread use of personal computers and the services provided by the IC has kept these departments ahead of their work until the budget was adjusted to support more personnel (Kelleher, 1986). One company, which tracked IC benefits, reported a

significant portion of cost savings which avoided extra hiring (Hammond, 1982).

b. Freeing of ADP programmers

IC's free data processing programming staffs for more sophisticated projects. Before the use of IC's, ADP programmers had to be "jacks of all trades" because they were the only source of programming talent. They often had to get involved in "basic" programming tasks.

IC's free these programmers for more strategic ADP tasks because the user, with the help of the IC, can create his basic applications independently (Carr, 1987).

c. Increased Productivity

"Increased job productivity is the No. 1 benefit of the IC, with 80% of the IC's in 1987 citing this as a benefit compared with only 60% in 1985." (Garcia, 1987).

An often cited justification for the IC is its tendency to increase individual productivity by delivering computational resources to the actual user (Benson, 1983; Gerrity, Rockart, 1986). The total organization benefits because a scarce and valuable resource, the ADP programmer, is used in a more effective and cost-efficient manner (Carr, 1988).

d. Improved ADP/End-User Relations

Relations between the end-user and the ADP department have improved mainly because of the increased

understanding of computer issues on the part of the users stemming from the use of the IC. "Armed with new computer skills, end-users are now automating routine, time-consuming clerical tasks with computer generated reports, graphs and spreadsheets." (Garcia, 1987) The 1987 CRWTH survey found that 70 percent of the participants felt that user computer literacy increased while utilizing the IC.

The survey described this as follows:

There has been a thaw in the relationship between Data Processing and end-users. End-users working in tandem with Data Processing on business applications start to comprehend not only the jargon used by Data Processing but also its problems and value to the organization" (CRWTH, 1987).

This improved literacy has made dealing with ADP issues easier for all concerned. The result has been a more harmonious relationship between users and the information systems department (Carr, 1987).

e. Improved Decision Making

"Implementation of IC's has improved the decision making ability of the user." (Carr, 1988; Hammond, 1982) states that using IC's results in improved access to information in the format desired by the users. In general the user has greater access information which is useful in the decision-making process. Decisions in business are often time sensitive. Managers are always looking for ways to improve their ability to respond to requests. Utilizing applications

they developed, users can often respond to a wide variety of requests in a more timely fashion. (Hammond, 1982)

f. Freedom from scheduled ADP runs

Most corporations are dependent upon computer reports for almost all phases of business. Many of these reports are produced based on a static ADP processing schedule.

One of the greatest advantages of creating and controlling a program is to be able to run it whenever necessary rather than being bound by a formal scheduled "run" procedure (Rockart, Flannery, 1983). With the assistance of the IC, the user has the ability to produce reports when they are needed with no regard for computer availability which they may not control.

g. Cost Savings/Cost Avoidance

The kinds of cost savings that are attributed to the IC include: reductions in hardware costs, software costs, people and the elimination of space and associated support functions. These costs are saved because the IC reduces the need for centralized ADP support. The cost avoidance savings are in the same areas as the cost savings but are attributed to the monies saved on future costs as opposed to past costs (Ferry, 1987).

Another cost saving which can be attributed to the IC is in the area of software maintenance. The users'

involvement in the creation of software products earns dividends in the area of software maintenance because the users are now capable of doing some of the maintenance because of their initial involvement. User maintenance on their own software products reduces the learning curve for the maintenance effort and results in more timely fixes for software products (Carr, 1988).

H. MANAGEMENT ISSUES

In establishing end-user computing policies, management must tread a fine line between control and support. Control may stifle end-user creativity and experimentation, which is not desirable. However, completely unguided uses of computers might be detrimental and lead to incompatibilities that are wasteful or harmful to the organization. Furthermore, information systems management needs to keep the future in mind and anticipate what users will want. There are five areas that need policies and support :

Hardware:

- The ownership of the computer
- The economic justification of personal computers
- Hardware compatibility

Software:

- Sensitivity of the applications
- Controlling end-user developed application

- The Pros and Cons of software packages
- Software piracy

Data:

- Data integrity
- Data security and privacy consideration

Communication:

- Communication options
- Mainframe-micro considerations

Training:

- Managing education for executives, managers, and end-users

1. The ownership of the computers

The managers should be concerned whether employees can be allowed to use their own (personally bought) microcomputers for application development of the organization. If the answer is "Of course, yes", then managers must be aware of this practice, because it can lead to unusable software. For instance, if an employee's microcomputer is not compatible with the PCs in the company, the company has no backup hardware to run the applications that the employee has developed. And if the employee leaves, all those applications will be unusable.

2. The economic justification of personal computers

Buying relatively few personal computers is no big budget item. But, buying thousands of PCs, and the software to go with them, is something else to be cautiously considered.

There are two approaches to buying PCs in the organization; the experimental approach and the strict return-on-investment approach (Shaeffer, 1987).

In the experimental approach, some companies are providing PCs to many employees without much cost justification. They have seen the benefits of a few PCs and they expect to replicate the pilot successes on a greater scale. In addition, they believe this practice will encourage innovative new uses. So they see themselves investing in potential future innovation that could give them a competitive edge. In return-on-investment approach, companies are taking a cost-justification to buying PCs. In these companies, The IS/DP department does not provide funds for PCs; instead, the cost of the PCs is borne by the end user departments.

The potential buyers must cost-justify the expense based on the applications they plan to implement. In some cases, IS/DP departments provide "loaner" PCs, so that users can experiment to see how the machine might help their work.

3. Hardware compatibility

In most organizations, the first attempt to guide or control PCs took the form of an acquisition policy for hardware compatibility among different machines.

Prior to the IBM PC, there was little compatibility among different brands of PCs for exchanging data, text, or programs. As a result, establishing data communication between

a variety of micro and host computers was a serious problem in ABRI.

Some vendors have attempted to solve this problem by selling PCs that emulate IBM 3270 terminals. The emergence of the IBM PC as the ad hoc standard is making some contribution to the compatibility problem. But even if all the PCs were IBM PCs, compatibility problems would not be completely solved. It is not easy to retain compatibility and at the same time make use of the latest technology. For instance, if IBM tightens up its products so that fewer possibilities exist for third-party enhancements and compatible products, then the "open market" would disappear and competition and innovation would be reduced.

Controlling Add-Ons should be also included in acquisition policies to keep track of *the complete descriptions of all the circuits boards and peripherals* for each system. These procedures will control end-users who are requesting to buy PCs for the office that are identical to the ones they already have *-plus numerous extra circuits boards and attachments.*

4. Sensitivity of the application

One criterion for deciding whether end-users should develop certain applications is the sensitivity of the application, meaning the potential exposure to fraud or the disclosure of important information to unauthorized persons.

In a traditional computerized system, a separation of duties occurs in development, operation, and use. For instance, an end-user department might want to develop its own application programs for tracking cash flows.

In such a case, both the IS/DP department and Internal Audit Group will want to investigate the sensitivity of the application. If it is to be developed, operated, and used by the end-user himself, the company may be exposing itself to trouble. In financial accounting procedure, there is a distinct separation of those employees who authorize specific transactions from those who record them as well as from those who have custody of the results (Hansen, 1983). Thus, management may want only both programming and operation of such applications to be done through the IS/DP department.

Program change control is another important issue for sensitivity of applications. Verification procedures are clearly needed, but if the end-user wrote the program and can easily change it, a program change procedure cannot easily be enforced. In general, sensitivity application should not be written by end-users, especially not for use on their personal computers.

5. Controlling end-user developed application

Most organizations first implemented end-user computing policies by controlling the acquisition of microcomputer hardware and software packages. It may be more

important to control end-user developed programs, data, or usage of all of these. Management should come to realize that the area of greatest concern is application software written by end-users (Zawrotny, 1989).

Zawrotny recommends that companies establish a policy that employee-developed applications belong to the company if they have been written on company time. Such a policy would be administered by end-user department management that is currently responsible for keeping track of proprietary company work. In addition, it would be a good idea to keep copies of end-user developed programs in a software library. This will provide a central site for backup as well as for sharing software among users and informing them of software changes. End-users should be taught to document their programs properly so they can be understood and used by others, since they are a company assets.

6. The Pros and Cons of Software Packages

Any of the software packages available from software vendors can be developed in-house (IS/DP department). The question is : Should these packages be developed in-house ? The primary advantages of acquiring software packages are : immediately availability, which means that the benefits of the software can be obtained with minimum delay, lower cost, and the fact that quality can be evaluated, and generally well documented (Tozer, 1986).

Acquiring a software package will also relieve end-users of system maintenance. However, some packages actually disrupt processing, incur excessive cost and time overhead. Many software vendors are small and have small capital resources. If an end-user has not received source coding, enhancement and maintenance of the software is merely dependent on the vendor.

In addition, if the vendor does not have definite rights to the software, or to parts of it, a third party may involve the buyer in a lawsuit.

When acquiring packages, the question arises, Should packages be obtained from hardware vendors or from independent software suppliers ? Generally, software suppliers would be preferred. End-users preferred independent supplied software which was easier to install, had better installation support, provided better services, and exposed end-users to less risk of a defective product.

7. Software Piracy

Most vendors license, rather than sell, the use of their copyrighted software. The license generally applies to use on specific machines or specific end-users, so all copies of the package other than authorized backup copies for that machine or end-user are illegal. Many microcomputer industry leaders state that illegal copying of these packages, commonly called software piracy is rampant.

Most software vendors feel that large corporations should be concerned about the piracy that is occurring in their organizations because they are the ones most likely to be sued for permitting this practice.

Some vendors threatened to put a "worm" in its software, which would randomly destroy users' data files accessed by an illegal copy of the software. Due to public uproar over this solution, many vendors withdrew the intention to alter its products in this manner.

Numerous hardware, software, and combination hardware/software protection schemes have been proposed and are in use to protect software piracy; none is yet fully satisfactory.

8. Data integrity

If end-users can access corporate data on their own, and if they are allowed to change data, then that integrity risk already exists. Most corporations restrict end-users to only extracting data from corporate files. End-users cannot input new data or change existing corporate data, as a matter of corporate policy. The most likely uses of PCs will be to extract data from corporate files, store it on the micro, and manipulate it locally. This does not differ from a computer terminal user.

Here the question of integrity does arise : Should an information system allow end-user data to be put onto a

corporate computer so that it can be used by others ? Generally, most IS/DP departments do not want to become responsible for the integrity of data over which they have no control, so they do not allow data from end-user developed programs to be uploaded into corporate files (Hector, Garcia, Molina, 1982). End-users who want access to uploading data, having the proper validation programs in place, must get permission from that department directly, not from IS/DP department. Some Information Centers in corporations deal with this problem of data integrity by identifying the name of the generating programs or the users.

9. Data security and privacy consideration

In some ways, PCs may be more secure than a corporate mainframe. Users can lock up floppy disks that contain sensitive information.

Without proper care, however, floppy disks can be greater security risk, because they are so widely distributed and so easily carried off. Security becomes an even more serious concern on multi user systems. The small multi user systems do not have the same quality of data security features as the larger machines. The problem exists whenever there is data on a hard disk unit that is shared by multiple users.

The privacy issue is a problem on any type of system because it deals with the type of information that is being stored. There is really no way the data administrator can know

whether illegal personal files are being created on a system. One approach is to inform employees about the type of data that are illegal to compile and store, and why. Violations might be detected by surprise audits, and the penalty for violations could be severe.

10. Communication Options

PCs have been proving valuable as stand alone machines for spreadsheet analysis, decision support, word processing, graphics, and other applications. However, they only begin to fulfill their potential to serve as a powerful and comprehensive work station when they are interconnected through communication technology. Communication among and between PC-based work stations and other larger computers presents end-user management with another set of problems and issues. Several types of communications that end-users are most likely to want : (Burges, 1987)

a. Access the corporate mainframe in a time-sharing mode

This is currently the most common form of communication between PCs and mainframes, which requires communication interface/ adapter and terminal emulation software on the micro as well as a modem and a communication line.

b. Download data to micro

One approach is to extract portions of corporate database to an end-user files or perhaps an information center computer. Using the information center also facilitates advising end-users of the correct interpretation of the data or restructuring the data into a more accessible format. Rather than download raw data or programs, end-users may want to have report downloaded directly to micro, where they can be reviewed and perhaps reformatted before printing. Corporate management needs to decide not only what data will be allowed to be offloaded but also what access policies and restrictions should be put on downloaded files.

c. Upload data to mainframe database

End-users also want to use PCs as intelligent data entry machines to upload data to a mainframe database. This has advantage for removing the delays of transporting source documents to a corporate mainframe location, minimizing the risks of loss, damage, and tampering if the source documents must be transported physically to the corporate mainframe.

The other advantage is that data uploading provide end-users to put the data entry function under the control of the people who had a stake in the transaction itself. In addition to data uploading, end-users may want to upload programs, for backup on another machine or to store in a program library.

d. *Send documents and graphic images between work stations*

The same compatibility problem occurs in the more general case when end-users try to send documents and graphic images between two word processors. Text representations and formatting characters vary from product to product. Sending graphic images may also require broader bandwidth, or longer transmission times, than is required for only data or text transmission.

11. *Mainframe-Microcomputer Considerations*

A number of communication aspects should be considered when looking for a suitable mainframe-micro data exchange facility. Here are some of them :

a. *Variety of operating systems*

Many larger organizations have a variety of PCs that use different operating systems. For mainframe-to-micro links, the mainframe operating system must be able to communicate with several micro operating systems.

b. *Capacity problems*

Many larger organization have literally thousands of PCs that may be accessing the mainframe facility. This raises problems concerning the cabling for all these micro. The other problems are the capacity needed by the mainframe's front-end communication processor, and the capacity needed by the mainframe itself.

c. Data transmission problems

Most data communications software packages for micro use asynchronous transmission, while most mainframe use synchronous transmission. Most micros communicate at the transmission rate of 300 or 1200 baud, perhaps using inexpensive acoustic couplers, while mainframe systems usually involve higher speeds and more expensive modems. Most micros, use the ASCII code, while most mainframe use EBCDIC. This whole area of mainframe-to-micro data transmission can be characterized as a mess, with very few standards.

d. Error detection and correction

Although micro with asynchronous transmission has the parity facility for detecting, but not self-correcting, this facility is seldom used. The synchronous systems have much better error detection and either automatic correction or automatic retransmission.

12. Managing Education for Executives, Managers, and Users of EUC

In the cost-justification studies of many new computer systems, little thought is given to training and education costs. Many systems people consider these to be of secondary importance, the really important parts are the technical features, they argue. The introduction of new applied technology has shown that training and education are two of the most important criteria for success (Spargue and McNurlin,

1986). Executive education on information system technology prepares management to make better informed decisions about allocating resources for EUC systems. Executive education will also provide guiding the planning of these systems, evaluating their implications on the organization, and being supportive during their introduction. More informed executives are also better able to evaluate advertising claims.

Middle managers need a different type of computer education. They will be the middlemen between the system technicians and the end-users, so they will need to handle most of the people problems that occur when systems are introduced. Some of the complaints of new users are : it never works properly, unpredictable, too hard to understand, too hard to learn, too hard to use, too many mistakes, and cannot get help. Thus, middle management needs education and training to develop skills in change management. They should also be responsible for assuring the security of the EUC systems under their control, so they will need risk assessment training.

End-users will need both computing concepts education and hands-on training. Computer-based training (CBT) courses provide a relatively new education vehicle in both of these areas.

An example of end-user training curriculum (CRWTH Computer Coursewares, 1986) offers this course in four groups, which form the following phases :

Phase 1 :

The introductory courses define terminology, equipment, and job functions associated with information processing, data communications, and office automation.

Phase 2 :

General DP skills courses give end-users hands-on experiences with different types of data processing tools and procedures, such as text editors, algorithm, data selection, sorting concepts, control breaks, computer-generated reports, debugging tactics, and cost analysis.

Phase 3 :

The operating system courses (IBM VM/CMS, TSO/ISPF, or PC DOS/MS-DOS) are taught through interactive exercise in which end-users create and manipulate the files they will use with fourth generation languages.

Phase 4 :

Fourth generation language courses are simulated on basic, intermediate, and advanced topics. Students learn by actively writing commands and programs in these courses.

Future courses based on interactive videodiscs promise to increase the strength of the education and training program further, in order to support the productivity use of computer-based technology in the organizations.

I. ORGANIZATIONAL RISKS TO EUC

There are organizational risks to EUC system, because it is occurring in a new environment outside of organizational mechanisms for traditional information system management and control. Most organizations have not yet developed strategies to ensure that EUC applications meet the organizational

objectives or meet quality assurance standards appropriate to their functions. For example, some of the critical risks posed by EUC are :

1. Proliferation of private information systems

End-users can create their own systems that are hidden from the others. This private system can be used to conceal information from other part of organization. If the private system is undocumented it can't be easily turned over to other individuals who take over a position.

2. Insufficient review and analysis.

EUC is often created rapidly without formal data processing specialists. While its productivity to be gained, EUC would have no independent outside review. There are no independent source of analysis and no alternate solution evaluations. It may also be difficult for end-users to specify complete and comprehensive requirements.

3. Using uncontrolled data

Each end-user may define and update these data in a different way. Without formal data administration discipline, it will become increasingly difficult to determine where data are located and to ensure that the same piece of information is used consistently throughout the organization.

IV. SCENARIOS FOR IMPLEMENTING END-USER COMPUTING IN ABRI

A. GENERAL

Information system (IS) planners rely increasingly on the use of scenario analysis into its IS planning process to predict future business environments. Scenario analysis identifies conditions leading to major changes in these environments. A scenario can be defined as a narrative description of a consistent set of factors which define, in a probabilities sense, alternative sets of future business conditions (Golfarb, 1988).

The scenario planning process is also flexible and relatively adaptable to any major long-term decision (e.g. investment new technology, marketing, capacity addition) under conditions of uncertainty for which a technology strategy must be developed. Strategically, scenarios teach the critical lesson of the need for flexibility. Despite the difficulty to forecast the future, strategic decisions must be made, and in uncertain conditions, strategic flexibility pays off.

The primary purpose of this chapter is to provide a scenario planning approach using the intuitive logic, define the alternative scenarios to cover the uncertainty, interpret the scenarios in term of some possible incomes, and search the flexible strategy for implementing end-user computing (EUC)

for ABRI in the 90's given the problems and issues in data processing environments.

B. THE SCENARIO APPROACH : Intuitive logic

Intuitive logic (SRI International, 1988) is regarded as one of the most appropriate scenario planning techniques for developing EUC for the ABRI in the 90's because it provides the ability to develop flexible, internally consistent scenarios from a logical perspective. It provides the business decisions which are based on a complex set of relationships among economic, political, social, technological, resource, and environmental factors. And because this scenario approach is not tied to any mathematical algorithm, it can, with careful tailoring, be adjusted to the particular needs and political environment of any organization. Most of the decision factors in the intuitive scenario are external to ABRI information system but must be understood in order to provide insights and improved decisions relating to new technology, capacity expansion, and EUC development strategy. The intuitive scenario methodology involves a five-step process (Golfarb, 1988) :

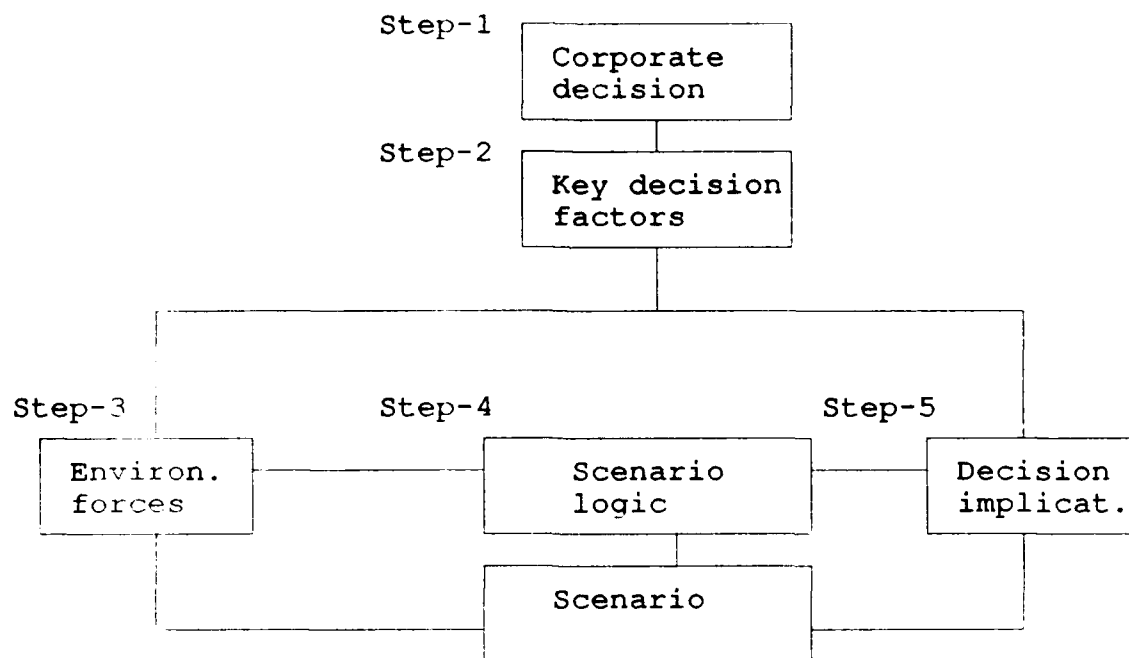


Figure 4-1: The Intuitive Scenario Methodology (Golfard, 1988)

1. Step 1 : Analyzing the corporate decisions

This step defines the scope of the analysis by concentrating on key organization decisions with long-range consequences such as capital allocation, diversification, facilities investment, and market strategies. The narrower the scope of decision, the easier the scenario development will be.

For scenarios to be useful in decision making, they must be 'decision-focused'. That is, their analysis of the alternative futures must focus on the specific trends and issues that are important to the decision being made, i.e.

what decision makers would need to know about the future in order to make a better decision. Doing so would ensure that the resulting scenarios are sharply focused on those trends, events, and uncertainties that are strategically relevant to the decision making process.

This step typically involves close work with the top management and staff to define and clarify what decisions and concerns need to be addressed. The main focus of the decision is to be the managerial and technological requirements for end-user computing (EUC) development efforts for the ABRI over the next ten years (1990-2000). However, these requirements would be embedded in the context of computer industry and the end-user environment, which in turn, are subject to global technology and human behavior forces.

2. Step 2 : Identifying key decision factors

Once the decision is defined, factors which most directly influence the outcomes of the decision must be identified. The more that is known about these factors, the better the quality of decision-making. Standard business analysis tools usually suffice for identifying these factors, but interviews with key executives can add much insight. These factors must form the basis for the scenario stories of the future.

Some of the key factors which to influence the ABRI decision on developing EUC in the 90's are :

- The nature and intensity of the existing and planned applications, i.e. data processing, information processing, word processing, office automation, scientific and/or business applications
- The operating workload of the existing IS/DP department including future level of utilization and production, the geographic distribution of the computing facilities, and the interconnection among computing devices.
- The availability of EUC technology e.g., from IS/DP department, IC centers, research organizations, and user departments.
- The availability of the trained professionals, non-programming end-users, functional support specialists, and DP programmers.
- The availability of EUC supports, including the Information Center services and responsibilities.

These factors have important bearing on the strategic decision. At the same time, all of them can vary considerably according to the way in which the future develops. However, all of them could be deduced, to one extent or another, from the environmental forces that the scenarios are expected to describe.

3. Step 3 : Analysis of environmental forces

Analysis of the environmental forces will shape the future business strategy confronting the decision-makers. These environmental forces are usually analyzed in two categories : micro level forces which most directly impact the key decision factors, and macro level forces that set the overall (global) context for the business environment. Some assumptions of the ABRI's environmental forces in the 90's will be :

| | 1981-1990 | 1991-2000 |
|-----------------------------|------------|-----------|
| Manpower/Professionals | 3,000 | 12,000 * |
| Telephone/Units | 1,200 | 4,200 |
| Terminal/VDU | 600 | 10,000 |
| Support Printer | 350 | 3,000 |
| Computing capacity/IBM 3033 | 5 MIFs | 25 MIFs |
| Storage capacity | 500 MBytes | 5 GBytes |
| System spending by category | | |
| IS/DP Department | 70 % | 40 % |
| End-user Department | 30 % | 60 % |
| Annual clerical cost | 8 x | 5 x |
| Annual professional cost | 3 x | 7 x |
| Investment | | 5 x |
| Growth rate | 2 % | 10 x |

* The trained-professionals from the end-users is projected up to 1000 persons per year, which means gaining 10,000 persons in ten years.

The assumed environmental factors are identified through the use of environmental monitoring and scanning systems, business models, specialized information services, general literature about the future, and outside consultants.

For ABRI, given the technological advances which will have the most impact on information development, the high uncertainty environmental forces can be grouped into three clusters : the posture of the information systems, the end-users behavior, and EUC technology.

These three "axes of uncertainty" constitute a logical structure on which to build the scenarios. Each axis contains the possibility of three alternate outcomes of possible future trends that are logical. The three possible outcomes can be summarized as follows :

1. The posture of the information system : Will ABRI information system be centralized, decentralized, or distributed ?
2. The behavior of end-users : Will end-users be heavily dependent to IS/DP department ? Or will they successfully be integrated into a diversified form by using a mix of IS/DP and Information Center support ?
3. Technology : Will technology evolve in a fragmented and somewhat incremental manner ? Or will a more integrated and accelerated evolution take place ?

4. Step 4 : Defining scenario logic

This step represents the core of the intuitive approach and establishes the basic structure of the scenarios. Scenario logic is organizing themes, principles, or assumptions that provide each scenario with a coherent, consistent and plausible logical underpinning. Scenario logic should encompass most of the conditions and uncertainties identified in the preceding steps. Trial and error are usually necessary in arriving at useful scenario logic.

Scenario logic does not consist simply of optimistic or pessimistic scenarios, i.e. high, medium, or low scenarios. Instead they describe alternative futures such as PC markets, minicomputer markets, or fragmented/integrated technology. Each of these scenarios presents opportunities and threats to the end-user organizations. Therefore they cannot be considered exclusively optimistic or pessimistic. The domination of the PCs in the future ABRI information system is

one of the potential scenario logic for implementing EUC in the 90's (See Section C).

5. Step 5 : Analyzing implications for decisions and strategies

This final step focuses on determining what implications each scenario has on the decisions and strategies in Step 1. The most important part of this step is to assure that the information is presented in a way which is clear and informative to decision makers. Often, more detailed implication analyses are addressed by these questions :

- What do the scenarios imply for the design and timing of particular strategies ?
- What threats and opportunities do the scenarios suggest to future environment ?
- What critical issues emerge from the scenarios ?
- What kinds of flexibility do the scenarios suggest are necessary from organization's planning perspective ?

C. THREE SCENARIOS FOR IMPLEMENTING EUC FOR THE ABRI IN 90'S

The three scenarios are selected to cover the uncertainties of the EUC development for the ABRI in the 90's. Each scenario has a descriptive title and a brief story line that outlines its central thrust and action. An important benefit of these titles and story lines is that they provide a quick, shorthand reminder of the detailed contents of the scenarios. The three scenarios are :

1. Scenario A : The Future ABRI Information System is Dominated by PCs

There is no way to avoid the growth of microcomputers. PCs will grow in every business and in many levels of the organization, which will lead to the high demand for end-user applications (EUC). Today, the growth of PCs is unmanaged in the ABRI and if continued, this policy will result in a nightmare for ABRI information systems. Consequently, the application of data processing rebound and PCs regain dominance in the 90's. ABRI debates restructuring its information systems, but the actions proposed and taken to date are not sufficient to divert the strong push toward further development of end-user applications (EUC).

This scenario is characterized by the unstructured ABRI posture in the use of microcomputers, high demand of end-users applications, less control from IS/DP departments, and fragmented technology. Some of the key descriptors are

| Descriptor | Characteristics |
|----------------------------|---|
| End-user category | Non-programming skills, Command Level, and End user programming |
| Diverse needs of end-users | Clerical needs and Management needs |
| EUC level | Desktop |
| EUC tools | PC tools, Query Generator Software, Office automation tools |
| EUC supports | Information Center is under User's Departments |
| Application portfolio | Functional |
| Data communication | Send data between PCs |
| Network | Stand alone, LAN |
| Data integration | No standard, redundant |
| Technology | Fragmented |
| User satisfaction | High if user's acceptance of IS technology is high |

Figure 4-2: The characteristics of future EUC development in the ABRI in Scenario-A.

2. Scenario B : PCs Benefits Lead to a Restructuration of the ABRI Information Management Function

The perceived high cost of mainframe-based application processing, the more rapid diffusion of new EUC technology (microcomputers, office automation, telecommunications), and the pervasive use of PCs by end-users have given rise to the debate over the location of the ABRI information management function, for convenience called Data Processing (DP), within the organization structure.

Therefore, it would behoove ABRI to use the EUC technology and the benefits of the PCs for developing a departmental system. This system tends to fill the need for handling the information management function, a need that is not presently being addressed adequately by the centralized corporate mainframe system, and one that cannot be effectively addressed by a stand-alone PC.

This scenario is characterized by the semi-structured ABRI posture in the use of microcomputers and minicomputers, high demand of end-users applications, the need for management and IS/DP control, and integrated technology (see Figure 4-3).

3. Scenario C : ABRI is Driven out of PCs Dependence by Restructuring

This scenario represents the highest evolution of the globalized information system development. High-tech breakthroughs in such areas as information technology, office

automation, telecommunication radically change the structure, mix, and location of global information system management activities.

Information-based value increases, because it is not only providing general support for ABRI organizations, but it is now seen as a strategic resource, a potential source of competitive advantage, or strategic weapon useful for defeating and frustrating the competition. ABRI has no choice but to restructure its information system architecture.

This scenario is characterized by the restructuration of the ABRI 's posture in the use of microcomputers, minicomputers, and mainframe; high demand of end-users applications, the need for users and management control, control of data, organizational fit, and integrated technology (see Figure 4-4).

The three scenarios above help identify some external problem areas that could arise if some factors or descriptors should change. Once these scenarios have been generated, ABRI chooses a 'most likely' scenario to be used as the basis for long range planning.

Scenario-B is probably the most likely scenario for describing the future EUC development for the ABRI in the 90's. It predicts the rapid increase in computer resources devoted to end-user computing (EUC). And it will cause ABRI information system to develop a unique strategy for managing the demand for its services. While it is clear that this evolution is taking place, however, it is not yet understood

what models should be adopted to successfully manage the information system under the EUC mode. Scenario-B also provides flexibility in the plans and provides a means of escape, should one be necessary. This is the role of the Scenario-A and Scenario-C that are less likely but still feasible.

| Descriptor | Characteristics |
|-------------------------------|---|
| End-user category | Functional Support Specialists, End-user Support Specialists |
| Diverse needs of end-users | Staff, Managers, and Executive |
| EUC level | Work group, Departmental |
| EUC tools | PC tools and Query/report |
| EUC supports | Information Center is under End-user and IS/DP Management |
| Application portfolio | Partially integrated |
| Data communication | Download and Upload data |
| Network | Local and Metropolitan (LAN/MAN) |
| Data integration | Semi standard and redundant |
| Technology | Fragmented/Integrated |
| User satisfaction | Depends on the support quality of end-user management and IC |

Figure 4-3: The characteristics of future development in the ABRI in Scenario-B.

| Descriptor | Characteristics |
|----------------------------|--|
| End-user category | EUC and IS/DP programmers |
| Diverse needs of end-users | Managements, Professionals, and System needs |
| EUC level | Corporation |
| EUC tools | Very high level language |
| EUC supports | Information Center is under User's Departments and IS/DP Departments |
| Application portfolio | Integrated |
| Data communication | Access the corporate mainframe in a time sharing mode |
| Network | Long haul networks |
| Data integration | Integrated, standard, no or less redundant |
| Technology | Very integrated |
| User satisfaction | Depends on compatibility between organizational goals and the IS goals |

Figure 4-4: The characteristics of future development in the ABRI in Scenario-C.

D. SELECTING AN EUC DEVELOPMENT STRATEGY

1. Assessing Goals and Application Portfolio

The scenario is provided on basic input for EUC development strategy, i.e., assessment of the future external

environment. The other basic input includes assessment of the internal environment which can be provided by defining the goal of EUC programs, and the current EUC application portfolio.

The portfolio evaluation focuses on assessing how each current EUC application advances the technical state-of-the-art in its field as at the same time meet anticipated market/user needs. The results of the evaluation are grouped into four clusters depending on high or low of the technological assessment and market/user needs: Market/User needs, Incremental Improvement, Technology Push, and High-Leverage Breakthroughs (Stokke, Boyce, Wilson, 1990).

This classification provides ABRI managers with guidelines to implement EUC in each scenario, given the current application portfolio (see Figure 4-5). The aim for this step is culminated in a central question : What seems to be the best EUC development strategy for dealing with the condition of each scenario

The expected goals of the EUC development strategy for ABRI in the 90's are most likely to encourage and facilitate the use of computer resources by end-users to raise personal productivity, enhance the effectiveness of decision and departmental actions, and to improve the timeliness with which applications suitable for direct use by managers and staff members are developed.

The current EUC application portfolio for ABRI is most likely in the Market/User Pull group, which means that ABRI has a high application demand in end-user needs, but the technological advances are still low due to the fragmented technology being used as well as the unavailability of the skilled professionals.

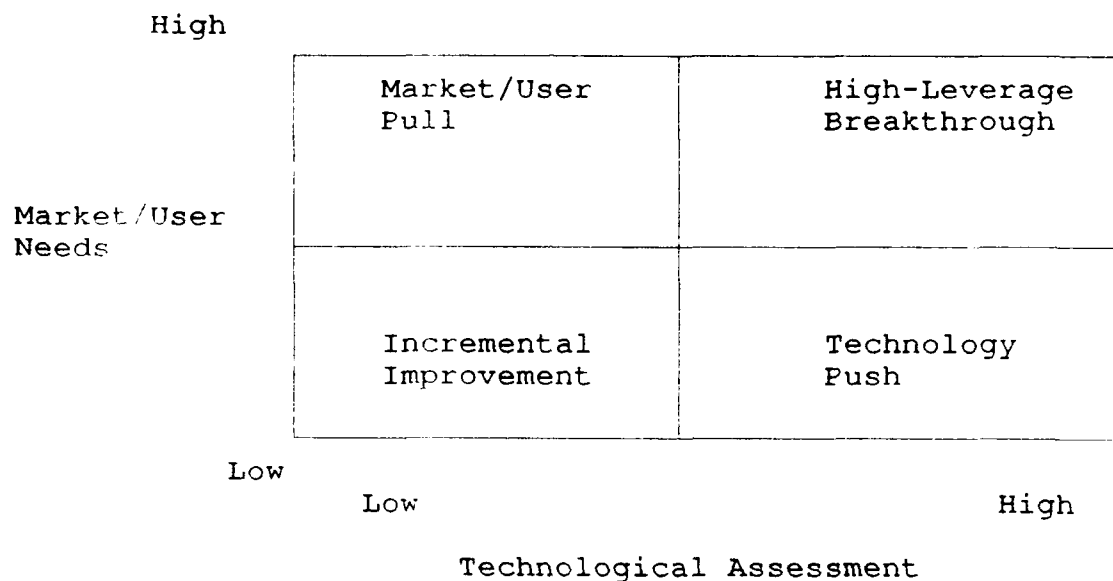


Figure 4-5: Current EUC Application Portfolio (Stokke, Boyce, Wilson, 1990)

2. Resilient Strategy

There are some EUC development strategies to prototyping that ABRI might pursue. However, one key objective of any scenario planning effort is a 'Resilient Strategy'; one

that is flexible and adaptable enough to adapt itself to a fairly wide variety of unpredictable changes.

ABRI would maintain technical flexibility by supporting EUC program activities to cover a broad technology base suited to a diverse set of possible external scenarios. With this resilient strategy, ABRI would be competitive in serving technical needs under a wide range of future conditions. The following are some of the ground rules under resilient strategy (Tom, 1987) that might ABRI utilize in developing EUC for the 90's :

- Use application software packages whenever possible. This is based on the principle of not reinventing the wheel. Packages offer the benefits of quick installation, good documentation, user training aids, and vendor support.
- If a package approach is not suitable, the next step is to identify the importance and impact of the requirements. In other words, the importance of this system to the organization. Management should identify priorities of those applications where a package solution is not feasible. The number of users should also be identified. In-house development by the Information Center, can then be considered for those applications that are important to the business of the organization, or are to be used by many users, and which have clearly defined requirements.
- If the application development is to be used by just a few end-users (e.g., an engineering application), or if the requirements are not clearly defined - (e.g. a planning model), then ABRI should consider the use of the prototyping approach.
- Finally, if the user is willing to commit time and effort to learning and using the computer, then these applications could be done through end-user developed systems.

It appears that the resilient strategy accelerates EUC development through extensive use of packages, prototyping, and user-developed applications. According to Gremmilion and Pyburn, the properties of EUC that can be used as criteria for selecting a development strategy are the commonality of the sub-systems, the importance and impact of the proposed systems, and the structure of the application architecture (Gremmilion and Pyburn, 1983). A matrix for selecting a EUC development strategy is presented in Figure 4-6 :

| Commonality | Impact | Structure | Suggested method |
|-------------|---------|-----------|------------------|
| 1. Common | Broad | High | Package |
| 2. Uncommon | Broad | High | Traditional |
| 3. Uncommon | Broad | Low | Prototype |
| 4. Common | Limited | High | Package |
| 5. Uncommon | Limited | High | User-developed |
| 6. Uncommon | Limited | Low | User-developed |

Figure 4-6 : A matrix for selecting an EUC developme strategy.

Each strategy has its own particular rationale, degree of flexibility, source of competitive advantage, level of risk, and so on. But by using the selected scenario, the implementation strategy would have the ability to act first and move fast for supporting the end-user needs in dealing with the information system management (Huss and Honton, 1989).

3. The End-User Development Life Cycle Strategy

In general, if a user-developed system involves only ad hoc querying or extracting data from an existing database, then the recommended end-user programming guidelines are not mandatory. However, if an application requires creation of a new database, then at least the system development guide needs to be followed. If the application is to be used by others, or if it is to become an integral part of the job and supply information to others, then it also needs to be certified by an Information Center or IS/DP Department. Certification means that the system fulfills the quality assurance standards for developing and operating an application.

There are four steps in the end-user application development life cycle which is quite different from the traditional life cycle development strategy (Sprague, McNurlin, 1987) :

- Requirement definition
- Design alternative
- Prototyping
- Certification and implementation

a. Phase 1 : Requirement Definition

This first step is done almost entirely by the end-user. Guided by the information center's system development manual, the end-user fills out an application

request form. On it, the end-user describes the problem with the current system, the scope and objectives of the new system, the known requirements of the proposed system, and the benefits expected from the proposed system. In this step, the information center consultant helps the end-user link the requirements closely to the business plans and establish a priority scheme for the development efforts. At this point the end-user needs the approval from the department manager.

At this point, too, the end-user usually has a good idea how much effort this project will take. In signing this form, however, the manager realizes that the end-user must be given the time to develop the new-system. Generally, this phase takes about 10 to 15 percent of the total system development effort. It ends with an agreement that an information center consultant will help the end-user develop the system.

b. Phase 2 : Design Alternatives

The second phase mainly involves identifying the data to be included in the system. This phase accounts for another 10 to 15 percent of the total system effort. The programming guide describes what types of data the user should collect from the documents used in the department.

It also describes the various attributes to be defined for each data item, various types of validation

checks, and the different relationships between data elements that the user must specify.

End-users are encouraged to use the information center's new online data dictionary to locate and organize the data for their application. Since it stores the data definitions for all the user-developed systems, the end-user can borrow data definition from other applications to shorten the data definition phase. More importantly, it increases the use of standard data definitions among user-developed systems. Phase 2, the initial part of the database definition, concludes with a completed data dictionary for the new system.

c. Phase 3 : Prototyping

The largest portion of the development cycle occurs in this third phase. Between 40 to 50 percent of the effort goes into prototyping the system. Using the data definitions created by the end-user, the consultant designs the database. Using that database design, the end-user creates the system logic. The end-user is aided in the programming by models created by the information center. These models include input screen layout, output report layout, and system-menu layout for adding or making changes to database, inquiring into a database, and deleting records from a database.

The prototyping phase is iterative. A first attempt at the database design leads to a first-round system design. If this attempt is satisfactory, then end-user loads

in test data and tests the system. This inevitably identifies needed changes, perhaps in both the database and the system. Then there are more test runs, and so on. The prototyping phase ends when the user has a complete and running system that performs all the necessary functions.

d. Phase 4 : System Certification and Implementation

The remaining 20 to 40 percent of the project consists of checking the system against the quality assurance standards, training the users, and documenting the system. Quality assurance is performed by an information center consultant who tests all the system functions, looking for problems and incomplete options. The main purpose of the check is to increase the maintainability of the system. Both documentation and training are the responsibility of the user.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Up to the early-1980's, the primary application of the ABRI Information System was geared toward data processing i.e., transaction processing system and management information system (MIS). Then in the mid-1980s, a wave of microcomputing and office automation applications began, along with the expansion of the ABRI communication system. Each information technology historically was driven by a different form of management. It is important for ABRI to integrate or at least manage these applications as a network of loosely but interrelated systems.

It is foreseen that there will be a greater demand of IS/DP professionals in ABRI, from programmers to managers. While these general shortages are severe, there is an even greater shortage of experienced, highly skilled, and perceptive system analysts and managers. Moreover, as the scope of applications broadens as well as their level of sophistication, it is rare to have system developers who understand both the IS technology and the problems within the organization.

An observation of the implementation of ABRI information system reveals that the key to the successful system

development depends on user management commitment and participation in the system design process.

ABRI Data Processing (DP) managers face critical decisions in organizing the information system project developments. There are much greater demands from end-users for developing new applications than the IS staff can possibly meet. The excess demand results in a backlog of application requests and causes ABRI to take several years to eliminate the accumulated backlog.

Nolan's stage model teaches IS/DP managers to understand its basis and direct its information system development growth along paths compatible with the organization's strategic goals. The stage model divides the growth of computing into six distinct stages; *initiation, contagion, control, integration, data administration, and maturity*. Of the choices provided by the Nolan matrix, the ABRI information system fits best into the "contagion" stage. This stage describes the growth process of ABRI information system as extensive use of "user-oriented programmers" since "senior and middle management become frustrated in their attempts to obtain information from the organization's computer-based system".

Significant trends in the information technology industry will assist in the development and operation of the future ABRI information system. These trends are numerous and ABRI does not want to lock itself out of promising technological advances. Faster computing speed and increased memory capacity

will likely have the most impact on ABRI information system. More reliable networking and telecommunication, higher quality of input/output devices, more flexible package software, and system applications with embedded artificial intelligence have also been in strong demand for improving the ABRI information system.

Most of the technological advances which are being implemented are also a result of the increasing demand of computer literate end-users. The increasing computer usage will create a need for larger capacity, better communications between multiple systems, and of course, improved organizational structure and system management.

The end-user computing (EUC) is a relatively new phenomenon in the ABRI information system. It occurs when end-users develop their own applications outside of the traditional IS/DP channels. The increasing technical improvement in microcomputer, fourth-generation languages, office automation, and proliferation of computer literacy in the business are viewed as the main reasons for EUC's swift growth in ABRI.

The implementation of EUC for ABRI has several expectations. If successfully managed, EUC will provide reduction in backlog of application requests, reduction and lower maintenance requirements e.g., routine debugging, emergency corrections of errors, accommodation of changes to data, refinement to applications; and improvements in

productivity. ABRI should be very much concerned about EUC because there are some applications appropriate for development by end-users, such as one-time inquiries, sample reports, minor changes to existing reports or inquiries, and 'what-if' analyses using high-level languages.

The Information Center (IC) exists for supporting end-user computing. End-users benefit from the IC because their computing needs are satisfied more quickly. The IS staff will also benefit because with the IC they have time to focus on the development of the long-range projects that are essential to the continued growth of the organization.

There are a variety of methodologies for information system planning. The three-stage model provides ABRI an insight into the planning process, i.e. strategic planning, organizational information requirement analysis, and resource allocation. This model helps reduce confusion in selecting competing planning methodologies. For example, rather than using Zero-based budgeting, this model will guide ABRI to use the strategic grid method when the stage development is still in the strategic planning.

Scenario planning provides a tool for the forecasting of long range, complex and highly uncertain business environments. Intuitive logic is selected as the appropriate scenario planning for ABRI. The scenario planning process is flexible and can be easily adapted to any major long-term decision under conditions of uncertainty. Once these scenarios

have been generated, managers choose the 'most likely' one as the basis for long range actions. We contend that the most likely scenario is that the future information system of ABRI will be dominated by PCs driven by a quick implementation of end-user computing.

B. RECOMMENDATIONS

The future of end-user computing (EUC) depends on the direction chosen for its development. There are two approaches of EUC development strategies that can be applied to ABRI. The first approach increases controls and deals with EUC as a traditional computer situation. IS/DP managers may control EUC with this option but may also tend to stifle its growth. Based upon the analysis presented in previous chapters, this option is not in the best interest of the end-users and could have an adverse impact on the organization. The second approach encourages ABRI to adopt the EUC concept for promoting user-developed applications, and incorporating them in the overall ABRI Information system. It is recommended that the Office of Command and Control Center (PUSKODAL ABRI) addresses the issues of EUC in ABRI through policy that incorporates EUC into future ABRI Information System Planning. An instruction at the PUSKODAL level that addresses EUC through reinforcement of norms rather than bureaucratic regulations could have significant impact on EUC growth.

It is recommended that ABPI establish Information Centers throughout the services, force commands, and functional commands. The critical IC responsibilities are listed below :

- Develop, establish, and maintain end-user computing policies, standards, and procedures,
- Establish and maintain the priorities for end-user computing
- Manage and control the efficient use of the basic end-user computing resources i.e., people, machines, software, and dollars
- Select end-user tools for broad use throughout the organization, and
- Maintain a liaison between end-users and IS/DP departments, making sure all their needs are met.

The level of sophistication and need for end-users will vary from location to location. It is recommended that the structure of the Information Center be individually tailored, not centrally dictated. Methods such as user bulletin boards , informative newsletters, information center journals, seminars, and Computer-based Training (CBT) are all recommended as vehicles for increasing end-user awareness.

It is also recommended that IC act as a clearing house for user-developed programs. In this manner the IC can perform quality control on end-users' applications and promote the software and hardware that management feels is important to end-users.

It is inevitable that the benefit of a scenario planning can be used to improve the EUC development strategy for ABPI

in the 90's. Decision-making now gives explicit recognition to the full range of internal and external forces. This would lead to closer integration of the EUC strategy with the ABRI's corporate goals, objectives, and strategies. Recognition of the enhanced scenario planning also leads ABRI to increase confidence in deciding to start, maintain, or stop specific EUC development programs and applications.

It is recommended that ABRI begins to manage its EUC concepts and the information resources more effectively through a combination of all four development methods in the resilient strategy : Package, Prototype, User-developed, and Traditional.

The scope of this research was limited to a study of EUC technology applied to ABRI in the 90's. There is a variety of remaining areas which should be considered for future research, including:

- Research of ABRI control strategy for EUC development,
- Examination level of standardization be established in ABRI among centralized, decentralized, and distributed Information Center for software, hardware, communication, data, and training,
- Analyze the technical feasibility for integrating existing EUC technology in Desktop, Work group, Department, and Corporation level for the ABRI in the 90's.

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