SYSTEM ANALYSIS AND DESIGN IN END USER DEVELOPED APPLICATIONS

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ABSTRACT: End-user computing has enjoyed rapid expansion during the last few years for many reasons, most of which have to do with the recent introduction of fourth generation languages, the continuing sophistication of the end-user, and the proliferation of inexpensive, but powerful personal computers; all coupled with the dissatisfaction of users with traditional data processing capabilities. But this rapid growth has not taken place without its share of concerns; such as security of data, documentation of programs, and compatibility of hardware and/or software. Traditional computer applications that were being developed in the 1960's shared these same concerns. Problems with those systems were largely solved by the development of structured analysis and design methodologies. The focus of this paper will be an examination of the problems in the user environment and how a user-oriented SDLC should be developed to solve those problems.

KEYWORDS: End-user computing, SDLC, monopolist, Laisser-Faire, information center

INTRODUCTION

End-user computing, the development of computer applications by non-data processing individuals (usually using fourth generation languages in the microcomputer environment), is growing at a tremendous rate. A study by Massachusetts Institute of Technology [9] in 1983 found that end-user computing was growing at a rate of 50 to 90 percent per year, while traditional data processing was increasing at only a 5 to 15 percent rate. Mayo [9] further points out that "some professionals predict end-user computing will absorb 75 percent of corporate computer resources by 1990." Gerrity and Rockart [5] verify these findings in a more recent article where they point out that "the growth rate of end-user computing is at least five times that of conventional systems." They illustrate this point with an example of Xerox Corporation where over 40 percent of their total computer resources are now dedicated to end-user computing and is continually growing.

End-user computing has enjoyed such rapid expansion for many reasons, most of which have to do with the dissatisfaction of users with traditional data processing capabilities. But this rapid growth has not taken place without its share of concerns. The increased satisfaction of the end-user appears to be in conflict with other goals of the corporation. Rivard speaks of an unfulfilled need "to demonstrate that tangible benefits result from such user activities" [12]. Henderson and Tracy [6] point out that end-user satisfaction also conflicts with the desire of top level executives to control end-user computing.

An interesting aspect to this situation is that these same concerns were voiced for systems that were being developed in the 1960's. Efforts to solve these problems led to the development of structured analysis and design methodologies in the 1970's. A systems development life cycle (SDLC), which uses structured tools and methods, was adopted by most firms as a framework for the orderly development of information systems.

Today similar solutions must be developed for the end-user computing environment. However, this is not a simple process. Although traditional and end user developed systems are similar in that they have the same goal of finding computer solutions to user problems, there are many differences that make many components of a traditional SDLC unnecessary in the end user environment. New processes must be developed to meet the specific needs of the management of end-user computing. The focus of this paper will be an examination of the problems in the user environment and how a user-oriented SDLC should be developed to solve those problems.

The steps to be taken in this examination will first be to determine why end-user computing is expanding so rapidly. The next section will identify the major concerns associated with this rapid growth. A traditional systems analysis and design methodology will be looked at in the next section as a possible framework to solve some of the problems with end-user systems, followed by a discussion of how such a methodology meshes with the user environment. Three different methods that firms have developed to manage end-user computing; the Information Center Approach, the Monopolist Approach, and the Laissez-Faire Approach will be described next. A discussion of each of these approaches will evaluate their strengths and weaknesses in dealing with end-user concerns. Finally, the conclusion will attempt to draw these ideas together to determine what must be done to assure success for end-user computing.

GROWTH OF END-USER COMPUTING

Today there is growing discontent among users because they perceive MIS departments as unable to deliver a system to the user as MIS said it would, that is on time and within the predicted cost estimate. Other complaints deal with the inability of the MIS department to speak to the user in a language he can understand and the unwillingness of MIS to let the user play a significant role in project management. Many users feel that MIS has lost sight of the fact that they are a support function that was created to serve the customer (the user). [1]

Perhaps of greatest concern for users is the time required to complete an application because of the backlog of requests that can delay a project for years. Even when these projects are completed, less than half of the systems developed by MIS are useful for decision-making purposes, which is what most mid and upper-level managers need. The systems that many users want (modeling, simulation, and statistical analysis systems) are not requested because they are afraid of increasing the MIS backlog. This invisible backlog for development of applications can be many times greater than the known backlog. [13] For these reasons end-user computing offers an attractive alternative to the user. However, it has only been recently that users could even consider an alternative to traditional application development through the MIS department.

Many feel that the major concern with the growth of end-user computing today is ...unmanaged expansion.

Mayo [9] lists five factors that have been the main contributors to the rapid expansion of end-user computing.

* Technological Improvements
* Increased awareness on the part of users
* Economic conditions calling for productivity and cost-effectiveness
* Needs not satisfied by EDP departments
* Independence

Technological improvements have come about because of powerful personal computers that are available at continually lower cost, the increasing availability of "sophisticated and easy-to-use software," and the development of fourth generation languages [12][10]. Along with this superior technology, the knowledge of the user has also improved because of greater exposure to computers in school and the awareness of the benefits of computer technology. Knowledge is power, and the user is putting his knowledge to work. No longer must he stand idly by, grateful for whatever help he can get from an over-burdened DP department. Driven by the growing discontent with traditional solutions, which have failed to meet users needs, users have used their knowledge and the technology available to them to develop viable solutions. As users rebel and are successful in their efforts others, have joined them in ever increasing numbers. Most have found increased satisfaction in their new independence. However, the many advantages that can be realized through end-user computing can also create their share of problems.

CONCERNS WITH END-USER COMPUTING

Many feel that the major concern with the growth of end-user computing today is that it is following the same path as the growth of computing in the 1960's; unmanaged expansion. The research of Huff, Munro and Martin [7] confirms this fear. They found that "there currently exists no general understanding of how this growth is taking place and no framework for the occurrence of responsible planning and management." [7]. It is important to note that his lack of planning and management is prevalent even though end-user computing is consistently ranked as one of the top ten concerns by IS managers. This situation may be understandable given the limited resources of IS managers and their already over-burdened demand for traditional application development.

One of the main reasons that end-user computing is not being managed is that many upper level managers feel that too much interference will stifle its growth. They realize that their MIS departments are overtaxed and they see end-user

computing as a way to shift the workload. These managers also feel that end-user applications can be developed in less time. But unfortunately, many of them also think that the use of a fourth generation language eliminates the need for proper systems analysis, design, testing, and documentation. [10] Nothing could be further from the truth.

Too much control over end-user computing may inhibit its growth, but too little control also has its share of concerns. The unmanaged expansion of end-user computing has created several problems that not only concern EDP professionals, but internal auditors as well. Mayo [9] identifies these concerns as:

* Poor documentation of programs.
* Lack of physical security over hardware and software.
* Lack of cost justification for hardware and software.
* Lack of adherence to management policies and standards.
* Incompatibility.
* Inadequate controls over data integrity and security.
* Different people solving the same problem without communicating.
* Unreliability.

In their research, Necco and Tsai [10] concur with these findings, but add that a "lack of a systematic way to develop computer applications" and "inadequate testing of computer applications causing the use of erroneous output information" are also relevant concerns.

Of these problems, control over the security of the data is of major importance, yet in one study it was found that fewer than 20 percent of the users that were surveyed had developed any type of security procedures [13]. In the end user PC environment, data is often stored on floppy disks in a plastic box next to the computer or on a hard disk that has no security method. For many user applications data is entered manually into the computer from a hard copy of a report from some other source. This data is not only unprotected from getting into the wrong hands, but the loss of data is also a very real threat. For a number of reasons, backup of data by end users is almost nonexistent. Although users may not see the importance of data security and integrity, it is actually a mishandling of a major corporate resource [3].

Finding a solution to these many problems, while at the same time allowing for the growth of end-user computing, is a major concern for information system managers. Necco and Tsai [10] found that most IS managers believe that end users should follow the same standards and procedures that are required when data processing personnel develop computer applications, although they believe that the standards and procedures should be modified to account for differences of the creators of the systems. The next section of the paper will present a traditional approach to systems analysis and design, after which will follow a consideration of whether such an approach can be adapted to the needs of the end user.

TRADITIONAL SYSTEMS ANALYSIS AND DESIGN METHODOLOGY

Use of a system development life cycle (SDLC) is regarded as a proper, disciplined approach to the analysis and design of traditional computer applications. The number of SDLCs is almost as numerous as the companies that use them. However, all SDLCs have the same goal and are fairly similar in the general way they achieve that goal. For our purposes we will consider the model presented by Whitten, Bentley, and Ho [15] to provide an overview of how the SDLC works.

These authors present an eight-phase process that is followed to help assure the success of any new application. These eight steps are summarized below:

1. Survey the situation.
2. Study the current system.
3. Define user requirements.
4. Evaluate alternative solutions.
5. Design the new system.
6. Select new computer equipment and software.
7. Construct the new system.
8. Deliver the new system.

This whole process is started when a project request is submitted by someone within the firm because of a problem he/she has encountered that would appear to be able to be solved by a computer application. Once this has been done, the first step, survey of the situation is begun. The purpose of this phase is to decide if resources of the firm should be committed to this project. A preliminary cost/benefit analysis is done to determine if the project is feasible and can therefore be approved for further development.

If the system is feasible and is important enough for the firm to commit its resources, then the current system is evaluated. This phase will help determine where problems in the current system exist and where opportunities for improvement can be found. A data flow diagram is constructed that traces the flow of documents and reports in the current system.

Next, user requirements are determined. Users of the current system are questioned to give the analyst (the person developing the system) an idea of what users will expect the new system to do. During this phase inputs, files, processing, and outputs for the new system are defined along with policies and procedures that will need to be implemented. The requirements, which are written down in a formal document are then used to continue the SDLC.

Alternative solutions to the problem must be evaluated to help specify how much of the new system will be computerized, how data will be accessed (online or batch), whether the system will be centralized or distributed, etc. Alternatives will also be evaluated for technical, operational, and economic feasibility. Once this general evaluation is under way, then the detailed

design of the new system can begin along with the search for new computer equipment and software.

In the design phase, the specific inputs, outputs, files, methods, and procedures (i.e. backup of files, security) are determined. These components are all gathered in a form which will be understandable to the computer programmer when he begins to construct the new system. During the construction phase, any software packages that have been purchased will be installed and modified along with programming any custom applications. As the programmers construct the system it is continually being tested to assure it is operating properly.

Finally the new system can be delivered to the user. However, before the new system is ready for use, files must be converted and the users must be trained.

Because this type of SDLC has been in existence for several years, many tools have been developed that can be employed to help make the development process proceed smoothly and to make sure that the new system is well documented. The use of an SDLC such as this has helped to make sure that the development of traditional systems are not plagued with the problems that exist in the current end-user environment.

WILL THE SDLC WORK IN THE END-USER ENVIRONMENT ?

What is immediately apparent from the preceding discussion is that a complete development of an SDLC is a very involved and time consuming process. Research has shown that in many instances, the use of structured tools have had a lack of support even by data processing workers who feel they take too much time to develop [14]. The problem with a lengthy SDLC is that the user has a full-time job that he must be concerned with and does not have time to devote to such a major endeavor. However, several aspects of the end-user environment that are different from the data processing approach may permit streamlining the traditional SDLC.

First of all, steps one through four of the SDLC presented here would appear to be already accomplished, because the user is the person that is developing the application. The user knows he has a problem and has a fairly good idea that a computer solution would work. The need to survey the situation or study the current system is not as great because the user, more than anyone else, is most familiar with the system. He also has a fairly good idea what his requirements are for the new system and has probably evaluated some alternatives to his problem [4].

A second major distinction is that the user is less interested in developing a solution that will work perfectly the first time. His approach is most likely to develop a solution quickly (a prototype) that approximates what he envisions the ultimate capabilities will be. As he continues to use the application, it will be updated to account for any deficiencies. Therefore, a very structured design phase is also undesirable.

Third, after the user has decided on his first application and bought the hardware to meet his needs, he will probably have no need for additional equipment. Most subsequent applications will be developed on the same hardware. This should also hold true for the software that he will use for his application. The typical user will learn one or more sophisticated software packages that will meet his needs, such as Lotus 1-2-3 or dBase IV. After these packages have been purchased, there should be very little need for further software expenditures.

Although most companies have realized that this environment calls for a unique approach to an SDLC, there has been great difficulty in attempting to implement a plan that addresses these issues. The major problem in this endeavor is trying to decide who will make the decisions concerning the development and control of end-user computing. Usually both the MIS department and end users each feel they are most qualified to make these decisions. The MIS department argues that they are the ones qualified for the job. After all, they are the most knowledgeable about computer applications and how to solve the concerns involving end-user computing. The end users, on the other hand, struck out on their own in the first place because they were extremely dissatisfied with the solutions the MIS department had to offer. They now want control of their own environment. To resolve this conflict most firms have implemented one of three managerial approaches which Gerrity and Rockert [5] have labelled the Monopolist, Laissez-Faire, and Information Center Approach.

THE MONOPOLIST APPROACH

The monopolist approach is used by firms who wish to keep a tight control over end-user computing. The Information System (IS) organization is given complete control of all computing resources, including both mainframe and micro computers. End-user computing is only allowed to grow at a very slow, controlled rate that is regulated by policies of the IS organization. For example, the acquisition of each personal computer is thoroughly researched to determine if it is really necessary and all applications must be approved and developed by the IS department. Firms that believe that the IS organization should have control of all information processing systems will adopt this approach.

This "go slow" arrangement solves many of the problems of end-user computing such as security, inadequate documentation, and incompatibility, but fails to satisfy the needs of the user. The huge backlog of applications that still persists and the inability of the user to get the exact system that he wants are problems that cannot be solved by using this approach.

In the past, this approach has failed or been discontinued for several reasons. As was just mentioned, users are still faced with an enormous backlog of applications which causes some of them to circumvent the system and buy their own computers rather than go through

the formidable IS department. Another reason is that due to the constantly declining cost of microcomputers, any intensive research to justify their acquisition may cost more than the hardware itself. A third reason is that users are becoming more knowledgeable and capable of developing their own systems. They see no reason to wait months or years for an application they know they can develop themselves in only a few days. Finally, tight controls and extensive documentation are unnecessary for some applications the user could build quickly and use only one time [5].

This approach is basically trying to impose a traditional SDLC approach on the end-user environment. This assures that concerns about end-user computing will be dealt with. However, little has changed from the traditional approach and the user is probably no better off than when the IS was developing all applications.

THE LAISSEZ-FAIRE APPROACH

The laissez-faire approach is almost the exact opposite of the monopolist approach. In this system, departments within the organization are each given their own budgets for end-user computing needs. It is felt that each department will make better use of this money in acquiring systems tailored to their needs than by letting a central organization do it for them. IS managers have no say in the growth of end-user computing. While this approach allows for extreme creativity and perhaps greater short term user satisfaction, it also has some major drawbacks.

The greatest problem with this approach is that there are many benefits that will be missed because no central organization is established. For example, the firm may miss out on quantity discounts offered by hardware and software vendors. Also, there may be extensive duplication of effort by many users developing the same systems because they are unaware of other similar applications. Not only might duplication exist, but an application that could be of major benefit to the whole firm may go unnoticed. Compatibility could also become a major concern if computer links between departments are to be established in the future. In the end the laissez-faire approach may fail because it proves too costly [5].

What happens in this environment is that an SDLC ceases to exist in any form. Users with very little training have not been taught and do not see a need for any type of an SDLC. There is usually insufficient/little backing up of files to protect information, no security measures for data, as well as other problems that have been outlined earlier. Although initial satisfaction of end users will probably be very high, it will likely diminish over time as they become frustrated because applications that need to be changed have not been well documented or because they are continually losing important information.

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THE INFORMATION CENTER APPROACH

The Information Center (IC), which has been implemented by many firms and is known by many names in different organizations, is in the best position to deal with the problems concerning end-user computing. Those firms who have used the IC to its potential have achieved good results. The main duty for information centers has been to purchase hardware and software that meets the needs of the end user while maintaining standards that ensure compatibility and a good use of resources. They determine what products will be used, where they will be bought, and how they will be maintained [16].

Sumner and Klepper [13] have found in their research that many IC managers are also initiating policies and procedures to guide user development. They found that companies are establishing guidelines to assure that systems are compatible which will help to guarantee that microcomputers and main-frame-based data resources and network facilities can be linked. "Some organizations are also creating policies for quality assurance to motivate users to adhere to procedures for data validation, documentation, and backup and recovery" [13].

The IC has also been a catalyst in ensuring that data which is accessed by users from corporate databases is secure. This has been accomplished through policies that limit the types of applications that users are allowed to develop and what data they are allowed to have access to. At the same time, however, policies for data security on PCs was found to be almost nonexistent [13].

While it is true that ICs have shown much promise in dealing with problems concerning end-user computing, many corporations are seeing the demise of the Information Center. One reason is that in these organizations, strong initial support has begun to wane over time. The level of support is withdrawn by various means such as smaller budgets, less adequate facilities (or being forced to share facilities with others), and smaller staffing [10]. Usually support is diminished when the belt must be tightened throughout the corporation. Since the IC is one of the newest departments in most organizations, it is also one of the first to be cut [16].

Another reason for the decay of the IC is their status as a support function. In many cases they are able to establish

policies, but are unable to enforce them. Many times users are unaware that these policies even exist [13]. This support role also makes it difficult for them to cost-justify their resources to corporate management. In a survey of IC managers whose centers supported more than 500 users, nearly 40 percent were unable to justify costs [11].

This same survey [11] also showed major disagreement between IC managers concerning their role in the development of user applications. While half of these centers provided support and actually coded applications for users, the other half allowed users to develop their own applications. However, eighty-three percent of the managers surveyed felt that users were not properly trained to develop applications. Many of these managers felt a lack of control over the whole development process [11]. Because the IC is usually created out of the MIS department, it is often unsure of exactly what its role should be. This is a difficult time for MIS people who must switch from the role of "owner and operator of all corporate computers to the role of facilitator of the use of computers by users." [8] This link with the MIS department has created other problems as well because of negative attitudes that persist toward users.

The information center has been the most recent structure set up by firms to address the end-user dilemma in an attempt to exploit its benefits. Of the three major management approaches, it has met with the most success. In this environment there is a realization that the uniqueness of end-user computing calls for a different approach than the traditional SDLC. Users are trained on the importance of backing up files, security of information, and documenting their programs. Once they have realized this importance, both the IC and the users can work together on developing an SDLC that meets the unique needs of the end user environment. This SDLC is very different from a traditional approach. It is much less structured and consists of policies that must be followed by users who develop applications. What should make this system work where others have failed is that users will be involved in these decisions and have a voice in the development of the policies that govern them.

CONCLUSION

From the literature, it is evident that the use of end-user computing has been a positive endeavor that is growing rapidly in many organizations. It is not a question of whether or not end-user computing will exist, but rather how it can be managed in order to provide the maximum benefit to the firm. Non-management of this resource, such as the laissez-faire approach, can only yield increasing problems. The result of non-management is wasted resources (i.e. duplication of effort and incompatibility) or loss of systems and data integrity (i.e. lost data and poor documentation). Management that is too controlled, on the other hand, will result in many of the same problems that fueled the need for end-user computing in the first place.

It is also true that this resource is too important for decisions concerning its development to be left to the IS organization or to the end users themselves. This key issue deserves and must have the attention of top management [2]. What has so far been a bottom-up approach must now be planned from the top down.

This top-down plan must attack the concerns of end-user computing that were elaborated on earlier without squelching the creativity of the end-users. This can only occur if both the IS organization and users are deeply involved in the planning process. The program that results from this process would include the development of an SDLC that would speak to the needs of the end-user environment. The positive contribution of the information center approach must be further enhanced by this plan in order to eliminate its weaknesses.

Finally, although today's users are more sophisticated in their computer use, their education must be allowed to continue to grow. The user needs to understand the importance of such things as data security, backup policies, and documentation in order to help solve these problems.

If this type of planning is implemented, the benefits to the organization can be substantial.

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