AD-A052 008 CALIFORNIA UNIV LOS ANGELES GRADUATE SCHOOL OF MANAGEMENT F/G 9/2
A MULTISTAGE MODEL OF NETWORK USER BEHAVIOR.(U)
FEB 78 B P LIENTZ N00014-75-C-0266

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A MULTISTAGE MODEL OF NETWORK USER BEHAVIOR*

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Abstract

A three stage model of computer service usage is presented. Decision making, data collection, and measurement considerations are examined for this framework.

1. INTRODUCTION

Usage of remote computer services has increased substantially over the past few years. The growth appears to be continuing (see for example [2], [4], [14]. Remote computer services may be obtained through a network within an organization or from an external corporation offering services. The major focus of this paper will be with the second-external corporations. An example of such services is commercial time-sharing. In such an environment real charges must be paid by users.

Coincident with this growth has been a rise in concerns expressed about selection and usage of applications on external services through a network. Security, privacy, and social problems have been cited by Enslow [5], [6]. Economic issues for the user's point of view have begun to be examined (e.g., Lientz [12], [13]). A number of papers have addressed security issues (see for examples, Lientz and Weiss [7], [12]). Selection and evaluation has been considered in Lientz and Arnold [11].

An area that has received little attention is that of user behavior patterns with respect to external computer services. It has been cited as a major area of inquiry (see [1], [4]).

The purpose here is to analyze usage of services from the viewpoint of a user community within an organization. In section 2 a methodology and framework is developed for the evolution of network usage within three stages. This is similar to an approach by Nolan [13] in defining stages of evolution in information systems. Data collection and measurement are discussed. Section 3 considers the problems and possible actions in moving between two of the stages.

2. MODEL OF NETWORK USER BEHAVIOR

In the past, human usage of services has been frequently viewed as an uncontrollable, environmental factor with respect to the computer network service ([1], [5]). Usage is an input for models to optimize performance. The multi-stage model is composed of the following:

- inception -- initial low level of usage; tight control
- expansion -- multiple applications and users, lack of control

*This work was partially supported by The Information Systems Program, Office of Naval Research under contract N00014-75-C-0266, project no. NR 049-345.

- stability -- slow growth or stability in usage, control re-imposed.

Each of these will be examined below in detail. The three stages provide a life cycle framework for using external computer resources. The life cycle was developed after observing and evaluating a number of cases -- some of which are summarized in the discussion.

Consider now a typical user group. Usage begins with a single user beginning to access or build software for a particular problem area. Literally thousands of such application software systems are available from over 200 vendors (see Datapro [2] or Association of Time-sharing Users [3]). The stages of the usage life cycle will now be explored.

2.1. Inception

The first stage begins after the user has become aware of a network service. A selection process has occurred. The usage has frequently been cost justified on some grounds and approval has been obtained from legal, purchasing, and other relevant groups. In some organizations this is a difficult process. Such services are external, direct costs as opposed to internal computing services. Internal computer centers may resist attempts to go outside. Countering this are the availability of specialized software and data bases. These cannot be cost-effectively obtained and maintained internally. Some of the characteristics of stage one (inception) that often appear are:

- initial tight control
- usage based on original cost justification
- high visibility of usage due to review an approval process
- vendor personnel supply substantial user support
- scrutiny by management and potential users

After usage has begun, two modes of behavior have been observed. The first is a stabilization of usage. This might occur if the application is highly specialized and costs are visibly high for even low levels of usage. Controls continue and other potential users do not access the system. The alternative is the second stage of expansion.

2.2. Expansion

In this stage, usage grows. Several factors can contribute to this behavior including some or all of the following:

- Relaxation of controls (with little on-going cost justification required) due to achievement of some benefits
- Growth in number of users of software due to ease of use of the service and software
- Growth in number of users and/or usage of data bases
- Growth in number and type of applications
- Increased or continued vendor support to encourage more usage

It might be thought that cost considerations outweigh these factors. However, at the beginning of the second stage costs are still managably low and usually not visible (especially, given delayed billing by some vendors). Response time, ease of use, availability of services, and range of services have been cited as more important than cost. This was drawn from a small sample survey of four organizations conducted by the author. Users were asked to describe their usage, provide billing and usage data, and discuss the benefits and drawbacks to external services.

Total charges for network services are dependent by the nature of the charging procedure. Most time-sharing networks charge on the basis of storage usage, processing time, and connect time (see Lientz [9]). Storage usage tends to increase unless controls are exercised. The number of programs builds. The amount of data stores for later analysis increases. In two organizations it was observed that storage charges constituted over 50% of the total bill. Processing time reflects CPU and I/O usage. This can increase due to the volume of data being handled and the number and extent of reports. Connect time increases with the amount of output as well.

The growth in the expansion stage can be characterized by increases in some or all of the following:

- number of users for the same applications
- number and type of applications
- processing cost in some applications due to volume

It has been observed that some applications can be very efficient for low volume work and yet lose efficiency rapidly as volume increases.

To some this phenomenon may seem appalling. After all, how could supposedly well managed organizations tolerate this behavior? There are several possible answers. Some are:

- The second stage of network usage occurs very rapidly. Costs escalate by a multiple over only a few months.
- Accounting procedures are weak. Costs are charged to a variety of centers with no aggregation. Billing by vendors is frequently delayed.
- Management is convinced of the importance of the application despite rising costs.

Some examples can be given to support this behavior. Cost escalation occurred in one financial application where charges climbed from $2,500 per month to $18,100 per month in two successive months. Management was unprepared to cope with this rise (a factor of over 7). In all four organizations sampled, accounting controls are very weak. No user organization request status notification for various cost levels. In one case management become increasingly dependent on an expensive, specialized financial forecasting system. Costs rose quickly, yet management continued to support the application.

The expansion stage can be seen as unstable and rapidly growing. There is a point at which this becomes a management concern. Efforts are then made to change the situation. The third stage occurs as controls and methods make usage more stable. Usage may still increase, but at a slower more controlled rate.

There are several ways to traverse from stage two - expansion to stage three - stability. Some vendors recognize this problem. This is one of the reasons for vendor discounting based on volume usage. Some network service vendors also offer discounts for deferred or delayed processing. However, these vendor options can serve merely to mask the underlying problems.

The problem areas characterizing the latter part of the expansion stage can include:

- lack of monitoring and control
- absence of measurement and evaluation of usage
- use of network services for nonorganizational purposes
- overuse of network services for organizational purposes of peripheral interest

The available options faced by management are many. Several are:

- acquisition of a user controlled minicomputer
- migration of work to large internal computer center
- migration of work to another computer service
- reduction in usage and use of deferred processing and volume discounts

The first option represents a major organizational step and has been dealt with in the literature. The second and third options may require substantial conversion and start-up costs. Thus, it is frequently the fourth option that is exercised -- in some cases by default.

2.3. Stability

The third stage, stability, is characterized by the following:

- measurement tools in place
- management control and requirements for at least informal cost-justification
- reduction in costs through more efficient applications and management procedures to reduce storage costs
- heightened awareness of costs

In this stage, the number of users and type of applications are relatively constant. There still may be some growth in costs. However, it is due to increased vendor charges and modification of user demands.

Some examples can be presented briefly which indicate some of the life cycle paths that can occur. Each example leads to a different management decision.

Example 1: A financial group began using a network service. The services included a financial planning "language." The systems used could be categorized as decision-support in nature. Costs rose in six months from less than a thousand dollars per month to seven thousand per month. The

group decided to replace the computer service with a desktop minicomputer. Development and conversion costs of the transfer were paid back in less than a year.

Example 2: An accounting group was using service X. In a four month period usage and costs had more than tripled to over $5000 per month. An investigation revealed that storage usage could not be substantially reduced. Storage costs consumed over 60% of the monthly charges. The group whose software was written in BASIC migrated to another service Y with a much lower storage cost.

Example 3: A mathematical modeling group was accustomed to using a network service organization. The services of the internal computer center were rejected due to difficulty in use for nonprofessional programmers, lack of availability, and response time. The group hired a junior programmer who was familiar with the internal time-sharing system. Since all requests were channeled through the programmer, the group was almost indifferent to the service used. The programmer migrated the applications to the internal computer center.

Example 4: A personnel department used a time-sharing network to handle reporting from a large data base. Reorganization occurred at the same time stage two costs were increasing. The use of the service was stopped completely.

The four examples, drawn from three companies, demonstrate the range of responses to the problems occurring in stage two. In all but one case there was no measurement and decision-making instrument in place. In these cases the crisis in cost-awareness and cost escalation caused major dislocations in the user groups. In the one case where a migration to an internal mini-computer was foreseen, the measurement and decision-making process was oriented to the timing of the migration and scheduling of applications to be converted. The measurement and decision making during the second stage is of particular interest and is examined in section 3. The methods presented in section 3 were employed in this case.

The stages can be contrasted with the approach presented in Nolan [13]. Nolan specifies a life cycle of stages for system development. The stages in [13] pertain to equipment acquisition, system development, controls, and user/service orientation. Here, a life cycle of computer service usage is presented.

3. TRADE-OFF ANALYSIS IN STATE TWO

This section considers the problems associated with moving from stage two to three. The feasible alternatives for a given situation depend on a variety of organizational and system factors. The range of alternatives could include the following:

- acquire minicomputer and transfer systems
- transfer to an internal large/medium computer
- transfer to another network service
- reduce and/or charge usage, but continue with the same network service

These alternatives are quite different in terms of costs, implications on system conversion, and other factors. This points up the need for trade-off analysis.

The definition and measurement questions involve identifying early in stage two (or one) the reasonable alternatives. This frequently is part of a feasibility study to justify the use of computer services. Cost information is available. Estimates can be made on system performance and later conversion costs.

During the first two stages the following information can be obtained and recorded:

- cost schedule of currently used service
- usage in each monthly period by user identification and type of use for processing time, connect time, and storage of programs and data
- performance of the system in terms of response time, personnel and training support, and other factors
- support costs for terminals and telecommunications

The next step is to develop and apply a method for using this information for decision-support. A method was developed based on stochastic processes. Optimal stopping rules were derived for decision-making in stage two. The model requires

information on past and current usage, costs, and the application environment. Bayesian methods are useful for accelerated usage in the expansion stage. Non-Bayesian, classical methods can be used for steady usage or periodic behavior in the initiation and stability stages. The mathematical approach will be presented separately.

4. CONCLUSION

A three-stage life cycle for network user behavior has been presented. The initiation stage can be viewed as the initial period of usage. The second stage of expansion is seen as dynamic, only partially controlled growth in network usage. The third stage of stability represents a period of tighter user control and maturity. Examples have been from a limited survey. A model has been discussed for moving from expansion to stability.

5. ACKNOWLEDGEMENT

The author wishes to acknowledge the helpful comments and suggestions of Professor Ephraim R. McLean.

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7. BIOGRAPHY

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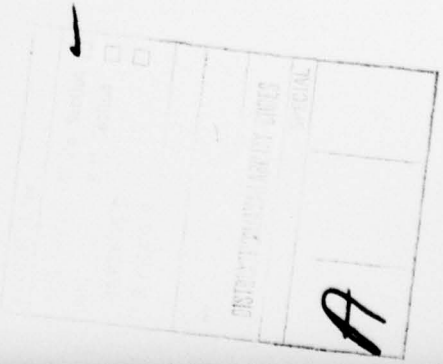

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Report
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): "A Multistage Model of Network User Behavior"
5. TYPE OF REPORT & PERIOD COVERED: Technical
6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): B.P. Lientz
8. CONTRACT OR GRANT NUMBER(s): N00014-75-C-0266

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Graduate School of Management
University of Los Angeles, CA

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NR 049-345

11. CONTROLLING OFFICE NAME AND ADDRESS:
Information Systems Program
Office of Naval Research, Arlington, Virginia

12. REPORT DATE: February 22, 1978
13. NUMBER OF PAGES: 5

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):

15. SECURITY CLASS. (of this report): unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

distribution of this document is unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer network - usage
Network user behavior
Multistage model

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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S/N 0102-014-6601

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