Beyond stage models for EUC management

Chun Wei Choo

Andrew Clement

Faculty of Library and Information Science
University of Toronto
140 St George Street
Toronto, Ontario
Canada M5S 1A1

choo@fis.utoronto.ca@internet#
clement@fis.utoronto.ca@internet#

ABSTRACT

Although stage models have been used frequently to study the growth of end-user computing, they are limited by their failure to capture the inherent social tension between users who wish to control computing and data resources directly, and information systems departments which want to manage and control computing more centrally. Recent process models of organizational computing that emphasize the role of management action and the influence of environmental and institutional factors provide a fresh perspective for analyzing EUC growth. A process view of EUC growth implies that alternative states of equilibrium in organizational computing are possible, and suggests alternative visions of the role of IS and user managements in the evolution of EUC.

1. INTRODUCTION

Over the past two decades, end-user computing (EUC) has risen rapidly to become an important activity in many organizations. In reviewing the trends, Panko (1988) concluded that EUC is the future of information systems and will soon become the dominant form of organizational computing. The theoretical model most frequently used to study the expansion of computing use in organizations is the stage model. Stage models predict that computing growth will proceed through a predetermined sequence of well-defined phases, driven mainly by technological change. Because of their prominence and because of a lack of alternative frameworks, stage models have also been used to study EUC growth. However, stage models of EUC growth do not capture a fundamental social feature that has characterized the historical develop-

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ment of end-user computing in organizations. On the one hand, end-users pursue EUC because they want to have direct control over their own computing and data resources. On the other hand, information systems departments seek to manage the growth of EUC in order to retain or expand their traditional role as the central purveyor of organizational computing. EUC thus takes place at the intersection of these divergent interests, and it is this divergence which gives it a special social character. A theoretical model of EUC growth should therefore include an analysis of the implications of the inherent tension between the interests of end-users and IS department in an organization.

The paper begins with the definition of EUC, and a review of research that suggests a dichotomy between users and IS management, both seeking to control computing resources. Three stage models of the growth of EUC are introduced, with an analysis of their usefulness. We then discuss the need for an alternative process view of EUC growth, and introduce two recent models which may be used to develop such a process view. The first, Laudon's Environmentalist-Institutionalist model, highlights the importance of both environmental factors and organizational traits. The second, Kraemer et al.'s management states model, stresses the interplay between the *locus* of computing control and the interests served by computing. Finally, we apply these models towards developing a process view of the growth of organizational EUC.

2. END-USER COMPUTING—DEFINITION AND DICHOTOMY

In the literature, end-user computing refers to the capability of users to have direct control of their own computing needs (Davis and Olson, 1985). This includes the capability to develop their own applications which may range from simple programs to entire information systems. Applications may be developed by the end-users completely on their own, or with the assistance of others (information systems professionals or other users). In reviewing the research on EUC, Robey and Zmud (1990) propose a definition as follows:

> *We define this phenomenon, typically referred to as end-user computing (EUC), as the development, operation and/or control of information systems by the ultimate consumers of the outputs of these information systems, not by information systems (IS) specialists. (p. 15)*

The central theme in EUC is therefore that end-users have direct control over their own computing needs and resources (Laudon and Laudon, 1988:471).

This view of EUC should be contrasted with the emphasis on management of EUC by the IS department in the EUC literature. For example, Henderson and Treacy (1986) describe four key EUC management issues as relating to education and support, hardware and software, data management, and technology evaluation and justification. Alavi, Nelson and Weiss (1987) identify a similar set of four main EUC management functions as policy setting, planning, support, and control activities.

Management issues are most frequently examined from the perspective of the IS managers, and a common assumption is that, while EUC is desirable and should be encouraged, IS management must balance "expansionist" tactics with "control" techniques so that it can retain its influence over the organization's computing and information resources. Some highly developed forms of planning and control of EUC are deemed to be requisite in the mature growth stage. According to Henderson and Treacy (1986), it is the IS managers who must rise to the challenge "to meet the demands of these users while advancing an end-user computing strategy that will efficiently support the competitive position of the firm." (p. 3)

In their review of the EUC literature, George, Kling and Iacono (1990) observed that there is a common emphasis on the role of the IS management to control end-user computing. Thus the literature suggests that:

> *...the IS function should take charge of EUC matters and create and operate a formidable formal infrastructure for training and support. ...it remains the task of IS management to plan and implement this formal infrastructure. (pp. 6–7)*

The organizational infrastructure to support EUC would encompass a broad range of activities, including the acquisition of hardware and software, training of users, provision of help services, setting of policies on data access and application development practice, and evaluation of new application development proposals. The requirement for effective EUC support is not at issue here, but rather the question of what differences would exist between infrastructure created to serve primarily the interests of the IS department, and that created to serve primarily the interests of end-users.

Klepper (1990) suggests that IS departments form information centers as their agents in order to control the direction of end-user computing. In his analysis, MIS "opposed the virulent and uncontrolled growth in end-user computing, and information centers were one mechanism of MIS control", (p. 254) From an agency theory perspective, he argues that:

> *...the goals of MIS and functional area managers are in conflict. Functional area managers want responsiveness from information systems; MIS managers want stability and control. MIS departments have a poor reputation for responsiveness. If functional area managers make MIS and ICs their agent for the purposes of system development support in end-user applications, there would be high costs of establishing and monitoring a contract with MIS that guaranteed responsiveness. (p. 256)*

In her study of users and data-processing managers in a large Canadian corporation, Smith (1989) found that user attitudes toward the data-processing group were consistently more negative than DP attitudes towards users. Users also tended to feel more threatened by DP, while the DP group felt that users were incompetent. The DP group is in a powerful position relative to users:

> *DP not only has the formal authority to control systems work and to limit access to its resources, but also considerable informal influence. Its technical expertise enables it to create rules which underlie systems and to establish constraints which limit the possible courses of action open to users. The DP group also displays higher social and corporate status characteristics which places users at a social and organizational disadvantage in the relationship. (Smith, 1989:267)*

To sum up, we recognize the dichotomy between users seeking to gain direct control over computing through EUC, and IS management seeking to control and direct the growth of EUC. Insofar as stage models concentrate on how IS management should act to control and direct EUC, they fail to apprehend a fundamental motivation for EUC, and the consequent divergence of interests between users and IS that has accompanied the growth of EUC.

3. STAGE MODELS OF EUC

The best-known stage model of information use in organizations is that developed by Richard Nolan in the 1970s. By observing the S-shape curve of computer budget growth in an organization, he identified six stages of growth: initiation, contagion, control, integration, data administration, and maturity (Nolan, 1979). The ultimate driving force behind the growth of organizational computing is technological change, expressed through the organization's learning responses to advances in computer hardware and software:

> *Organizational learning and movement through the stages are influenced by the external (or professional) body of knowledge of the management of data processing as well as by a company's internal body of knowledge. ... The external body of knowledge is a direct response to developments in information technology. ... The internal body of knowledge, however, benefits from the external body of knowledge but is primarily experiential — what managers, specialists, and operators learn first-hand as the system develops. (Nolan, 1979:116)*

Although empirical attempts to validate the model have produced mixed results, Huff, Munro and Martin (1988) argue that "nonetheless, these studies have confirmed the value of the stage model to promote a more organized approach to research on the subject [of end-user computing] ... to a great extent, the same set of general conditions that prevailed in the 1970s regarding computing growth in organizations also prevails today with regard to the growth of end-user computing" (p. 542). EUC stage models thus fill a need for a framework with which to analyze EUC growth and discuss management strategies.

In EUC stage models, the movement of end-user computing through stages is a function of organizational learning and follows an S-shaped curve: development of EUC as innovation starts slowly, increases rapidly as it gains momentum, and trails off gradually as saturation levels are reached. Among the best known EUC growth models are those proposed by Henderson and Treacy (1986), Alavi, Nelson and Weiss (1987), and Huff, Munro and Martin (1988). They are all based on the stage models of computing growth of Nolan (1979). (See Figure 1.) We discuss the EUC growth model of Huff, Munro and Martin (1988) here as it is probably the most developed. Based on Nolan's stage framework, it provides a descriptive model of EUC growth. The stage of EUC growth in an organization is indicated by the maturity of user-developed applications. An application's maturity is measured by its interconnectedness, particularly its data integration, with other components in the user computing environment. The application maturity stage for the whole organization is the stage where the greatest proportion of EUC resources (measured, as in Nolan's case, by dollar value) are being expended. Five growth stages are suggested: Isolation, Stand-alone, Manual Integration, Automated Integration, and Distributed Integration. In the Isolation stage, applications do not share data. EUC management is *laissez-faire*, and there are few end-users. In the Stand-alone stage, applications are limited to supporting the individual or work group. Multiple applications may run in sequence, but then data are passed along by manual re-keying. In the Manual Integration stage, applications transfer data by manual methods. New acquisitions require justifications, while existing applications are audited. In the Automated Integration stage, applications connect with corporate databases and routinely transfer data among microcomputers and mainframes. Users are required to practise application development disciplines to ensure that the systems can be maintained over time. Finally, in the Distributed Integration stage, applications access data from distributed databases throughout the organization. Distributed databases are supported by data administration practices. EUC is now strategically planned at the organization level.

In terms of EUC management options, there are two independent levers to control the EUC process: "Expansion" and "Control". Expansionary measures increase the pace at which EUC is developed in the firm, while control measures constrain the user's freedom of choice with regard to the direction of EUC development. By combining high and low levels of Expansion and Control, management selects four distinct EUC strategies: *Laissez-faire*, Acceleration, Containment, and Controlled Growth. To summarize, the model of Huff et al. focusses on the growth of EUC toward data integration: EUC technology is applied in progressive stages, creating ever more mature applications which are better integrated with other computing components of the organization.

While a move toward greater integration is clearly desirable and important, there are alternative views about how integration is to be achieved. A widely accepted view within the IS field regards integration ideally as conforming to a single unified scheme that is progressively elaborated to embrace ever more of an enterprise's information activities. This reflects a generally top-down, centralized strategy. On the other hand, integration can be viewed as much more of a grass-roots, bottom-up process. For example, Newman (1987) suggests that the purpose of integration is to bind together the services of information systems so as to support users in carrying out complete sequences of procedural activities:

> *Successfully carried out, integration creates a continuum of functionality where previously there were isolated concentrations; it also ensures that information is continuously accessible. The user can then perform one step after another without encountering blocks to progress or other sources of lost time.* (p. 323)

Newman argues that integration is not just linking systems together but using systems to make a larger contribution to the users' performance of procedural tasks. Integration in his view is therefore driven not only by technology, but also by users' immediate needs.

Fig.1: Three EUC growth models and the general stage model

Nolan (1979)	Growth Stages	**Initiation → Expansion → Control → Integration → Data Administration → Maturity**
	Management Strategies	User chargebacks, Steering committees, Data resource management
Henderson and Treacy (1986)	Growth Stages	**Initiation → Integration → Maturity**
	Management Strategies	Implementation, Marketing, Operations, Economic
Alavi *et al.* (1987)	Growth Stages	**Technology Investment → Learning/adaptation → Rationalization/control → Maturity**
	Management Strategies	*Laissez-faire* or Monopolist, Acceleration, Marketing, Containment, Operations-based
Huff *et al.* (1988)	Growth Stages	**Isolation → Stand-alone → Manual Integration → Automated Integration → Distributed Integration**
	Management Strategies	Expansion or Control, *Laissez-faire*, Acceleration, Controlled growth, Containment

4. USEFULNESS OF EUC STAGE MODELS

There are practical advantages to the concept of a sequence of stages in the growth of computing in organizations. To begin with, the stage model differentiates distinct stages of computer usage in an organization. Stages are defined in terms of the information technology employed, the nature of applications, and the dollar expenditure on resources. After determining the computing stage, the model then highlights the objectives as well as the problems and issues that are likely to dominate at each stage. Thus, during the initiation stage, the organizational objective would be to promote the growth of computing, and an important issue would be how best to educate and support new users in applying the technology. During the maturity stage, the organizational objective would be to plan and control the growth of computing, and an important issue would be how best to develop organization-wide plans to manage the use of computing and data resources. Having predicted the problems that would arise in each stage, the model goes on to prescribe a repertory of management strategies, organizational structures, and planning and control techniques that would be effective in dealing with these problems and so enable the organization to move smoothly into subsequent phases of computing growth.

The most important point made by the stage models is that the phased growth of computing in an organization can and should be managed. By tracing out an evolutionary growth path for computing in an organization, they predict the events and concerns which will appear in each stage of growth. More importantly, they prescribe a number of management actions which can be taken to deal with these issues as they appear. In a practical sense, then, stage models restore a sense of control to the management of an organization: they absorb future uncertainty associated with the introduction of computing technology, and they supply a map and a set of techniques to guide the growth of computing. Stage models also define a direction or purpose for the growth of computing by specifying a desirable end stage that all organizations should aim for — a maturity stage in which computing is well planned and controlled, and is well integrated with the organization's performance goals. In Nolan's case, the maturity stage is when "the applications portfolio is completed, and its structure 'mirrors' the organization and the information flows in the company". In the maturity or end stage depicted in EUC growth models, an essential requirement is that end-user computing now makes a significant, business contribution to the overall success of the organization (see, for example, Henderson and Treacy, 1986).

Stage models of EUC growth share the view that the rise of end-user computing can and should be planned for and managed in the organization. The three well-known EUC stage models are concerned with the description of a range of EUC management strategies, and relate the applicability of these options to various stages of EUC growth. There is consequently a strong prescriptive flavor to these models — they identify *what* management strategies are possible, and recommend *when* they should be applied. As the organization climbs the EUC learning curve, the organization is depicted as reaching higher levels of integration, made possible by "mature" organizational structures and well-developed management and control techniques. Alavi, *et al.* (1987) summarize this assumption:

> *Although there are certain 'natural' growth processes involved, the [five] phases of EUC growth can be planned, coordinated, and managed to move the organization through the phases effectively and efficiently. Management styles and control mechanisms shift to meet the needs of each phase. The phases thus represent a sequence for planned and managed change (p. 47).*

5. THE NEED FOR AN ALTERNATIVE PROCESS VIEW OF EUC GROWTH

Stage models make strong assumptions about the rational behavior of organizations and management. First, the assumption is made that organizations have clearly defined *goals* that are stable and that are pursued by members with equanimity. Organizations can then single-mindedly apply information technology to realize the goals. The second assumption is that organizations have near-perfect *knowledge* about the capability and use of information technologies. Organizational actors will seek and acquire the required knowledge and act appropriately based on this knowledge. The third assumption is that organizations can choose ahead of time *management* actions and policies that would best guide the growth of computer usage. King and Kraemer (1984) question each of these assumptions. Organizational goals rarely stay the same over time. As goals change, the determination of the best ways to manage and use the computer to support organizational objectives will also have to change. Furthermore, a general agreement on organizational goals cannot be assumed. Given the increasing demand for computing as an organization grows, and given the different ways to apply technology that could be made to serve divergent interests, the interpretation of goals can cause conflict and affect the range of possible organizational action. Perfect knowledge is also rarely the case in practice. Knowledge about new technology and how best to exploit it is often ambiguous and confusing. There will be many conflicting opinions and theories about the capability of a new technology, and about how to implement the technology in a particular organization. Finally, managers may not know in advance which way their organization is headed in its use of computing and, consequently, most policies for computing management are actually reactive, being developed to respond to problems encountered in the use of computing.

When applied to study EUC growth, stage models also fail to take into account the inherent tension between the interests of end-users and IS department that characterizes the growth of EUC. This tension arises out of a mismatch between the end-users' motivation for developing EUC, and the IS management's traditional role as the overseer of every aspect of organizational computing.

To go beyond relying exclusively on stage models for understanding and managing EUC phenomena, it is valuable to enlarge the perspectives which have so far characterized most research in this area. In their survey of IS research published between 1983 and 1988, Orlikowski and Baroudi (1991) found evidence that the field is dominated by a single positivistic research paradigm. They feel that:

> *...the dominance of positivism, by not acknowledging the legitimacy of other research traditions, has limited what aspects of information systems phenomena we have studied, and how we have studied them. This has implications not only for the development of theory and our understanding of information systems phenomena, but also for the practice of information systems work (Orlikowski and Baroudi, 1991:7).*

They suggest that there are a number of other philosophical perspectives that may be effective in helping us to study IS phenomena. Specifically, they discuss the interpretative research philosophy and critical research philosophy as useful alternatives, and note the growing importance and popularity of the former approach.

In their discussion of theories about information technology and organization change, Markus and Robey (1988) employ Mohr's (1982) distinction between variance and process theories. In variance theories, an outcome will invariably occur when necessary and sufficient conditions are present, and the focus is therefore on analyzing cause and outcome variables that are measurable. In process theories, causation consists of necessary conditions in sequence, but chance and random events also play a role. Furthermore, in process theories, "outcomes are not conceived as variables that can take on a range of values, but rather as discrete or discontinuous phenomena, that might be called 'changes of state'". (Markus and Robey, 1988:591) Process theories are part of the "emergent perspective" in information systems theory research, a perspective in which the central concepts are "the role of the computing infrastructure, the interplay of conflicting objectives and preferences, and the operation of nonrational objectives and choice processes". (p. 588) Mohr (1982) describes stage models as incomplete process models because they do not identify the mechanisms by which subsequent stages come about.

A similar criticism was raised by King and Kraemer in their 1984 evaluation of Nolan's stage model, where they differentiated between "evolutionist" and "evolutionary" models. Stage models are "evolutionist" in that they propose a predetermined sequence of stages of computing growth. A single trajectory of computing growth is portrayed: one stage follows on from another, and development is toward a normatively desirable "end state." "Evolutionary" models, in contrast, would "focus on the mechanisms by which changes occur and new features of entities come into being". Computing growth evolves through "states of equilibrium" in which the features of the organization are "locally optimized" with the forces of environmental change such as new technology and knowledge (pp. 473–4).

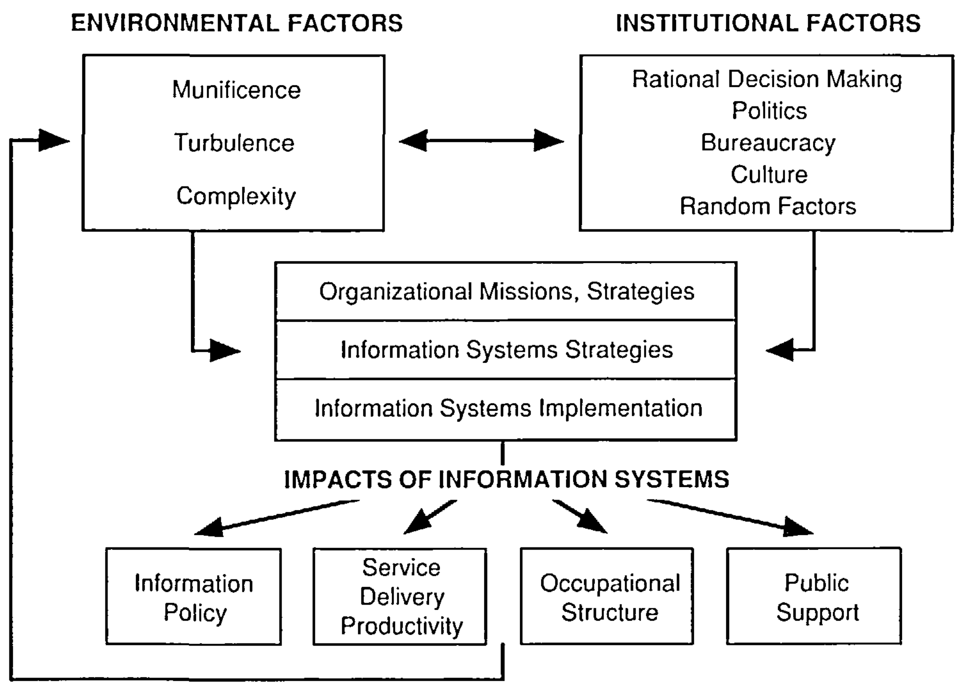
In the following sections, we present two recent process models of the growth of information systems in organizations. Both models adopt Markus and Robey's "emergent perspective" in which computing growth is the result of complex social interactions, conflicting objectives and interests, and nonrational choice processes.

We propose that these models would provide a foundation for developing an alternative process perspective of EUC growth, a perspective that could lead to a break from what Orlikowski and Baroudi have described as the dominant positivist paradigm that restricts IS research.

6. LAUDON'S ENVIRONMENTAL-INSTITUTIONALIST MODEL

Building on over two decades of field research on Government information systems in the USA, Laudon is developing a general model of the process by which large organizations develop and use information technology over long periods of time (Laudon, 1985, 1989). In Laudon's model, the introduction and use of information systems is viewed as organizational innovation, and this organizational innovation results from both internal institutional factors and powerful environmental forces. Organizations adopt and implement information systems because of environmental necessity and opportunities, or because of internal institutional factors, or because of an interaction of both sets of factors. The impacts of information systems depend greatly on the organizational variables and on decisions made during the adoption and implementation process. These impacts in turn feed back to the environment and organization by creating new forces of change.

Fig. 2: General model of IT development in large organizations (Laudon, 1989: 60)



Applying Laudon's model, EUC would be regarded as organizational innovation whose growth is then a function of both environmental and institutional factors which interact and influence one another in complex and unpredictable ways over long periods of time. The increased power and availability of desktop computers, end-user software tools, networking capabilities, and other technologies, all represent a rise in the environment's "munificence" which stimulates the organization to adopt EUC. The existing EUC stage models acknowledge this technology push as the prime mover of change. However, Laudon's model also identifies a comprehensive set of institutional factors which could affect the choice and implementation of EUC management strategies in an organization. As we have noted, the EUC growth models, being derived from stage models, take a rational decision-making view of the organization. Other institutional traits such as its politics, bureaucracy, culture, and random behavior are ignored. EUC growth is treated as an organizational learning process which is unidimensional and homogeneous — there is little discussion about different groups and interests which would contend for valuable computing resources. There is little discussion in the stage models about alternative visions of how EUC may evolve in terms of the relation between various stakeholders. To see how such alternatives may be treated theoretically, we look at Kraemer *et al.*'s "management states" model of computing.

7. MANAGEMENT STATES MODEL (KRAEMER *ET AL.)*

The process model developed by Kraemer, King and colleagues is the culmination of the study of computing in public sector organizations begun in the early 1970s at the University of California, Irvine. In their model, the actions of managers with authority over computing are the critical component of computing change. It is management which transforms environmental changes into computing policies which then shape the computing package and influence the computing outcomes. Why do managers take action? Kraemer *et al.* believe that the actions of organizational participants are best explained by "reinforcement politics", in which decisions about computing are made to "reinforce the power and the influence of those actors and groups who already exercise substantial control over the authority structure and resources of the organization" (Danziger *et al.*, 1982:227).

Management action is an act of volition which is composed of two elements suggested by the two questions, Who rules computing? and Whose interests are served by computing? Who rules computing is answered by the location of control over computing, defined as the person or group with full decision-making authority over the computing package. Three possible locations of control are identified: top management, departmental management, and information system (IS) management. Top management is responsible for the operation of the entire organization. Departmental management represents departments that use computing capabilities to perform their functional tasks, and are the users of the computing package. IS management is responsible for the technical operation of the computing package, and is the provider of computing services. Whose interests are served by computing is answered by "the purpose for which a specific computing activity is initiated and maintained. It represents the motivation for management action." (Kraemer *et al.*, 1989:114) It is expressed in the orientation of computing management as reflected in the functionality and sophistication of computing systems developed. Again, three types of interests served are identified: technical, operational, and managerial. Technical interests are oriented towards developing the technological sophistication of the computing package. Operational interests are oriented towards applying computing to maximize their usefulness to the performance of departmental functions. Managerial interests are oriented towards using computing to further organization-wide goals. The connections between the locations of control and the interests served are clear: technical interests are closely linked to the concerns of IS management; operational interests are the domain of departmental management; and managerial interests are the purview of top management. These variables are combined to give a matrix of possible *states of computing management* (Figure 3). A computing management state is defined as "that combination of control and interests presiding over an organization's computing-related decisions and policies at any one time", (p. 116) Four states of computing management are differentiated: Skill, Service, Strategic, and Mix. In each management state, managers in control of computing exercise their authority in order to channel computerization along a specific computing trajectory. As depicted in the Figure, three combinations — Skill, Service, and Strategic management states — show a congruence between the *locus* of managerial control and the interests served. Each of these states will shape the growth of organizational computing in a specific way.

Fig.3: The States of Management Computing (Kraeme *et al.*, 1989:30)

Locus of Managerial Control

Type of Interest Served	IS Management	Departmental Management	Top Management
Technical	**SKILL**	Service/Skill Mix	Strategic/Skill Mix
Operational	Skill/Service Mix	**SERVICE**	Strategic/ Service Mix
Managerial	Skill/Strategic Mix	Service/ Strategic Mix	**STRATEGIC**

In the *Skill* state, IS management controls computerization and applies computing resources to enhance the technical quality of application systems in the organization. Decisions are made through a form of technocratic élitism. An élite of technical specialists and technical users controls computing decisions through its monopoly of expertise. The computing trajectory is determined by the needs and desires of the IS management, and by which departments are willing to cooperate in bringing about technically desirable systems. Applications grow in particular departments rather than all departments. IS management also seeks to expand computing throughout the organization so that it can use the additional demand stimulated to justify the acquisition of more leading-edge technologies.

In the *Service* state, departmental managers control computing and their operational interests are served. Decisions about computing are made through organizational pluralism. No person or single interest dominates, and decisions are made through compromises and coalitions among various departments. Allocation policies meet the minimal needs of the dominant interests, and these change as the coalitions shift. The computing trajectory is shaped by the interests of the larger and wealthier departments, although applications are also provided to the smaller departments. A variety of operational interests are served, and applications are developed both within and across departments.

In the *Strategic* state, top managers control computing and their organization-wide interests are served. Finally, whenever the *locus* of managerial control does not match the interests served, a *Mix* state exists. Organizations in the Mix state achieve a compromise in which multiple interests are followed. Because Mix states imply a mismatch between the visions for computing and the power to enact that vision, policies are made which conflict or overlap. Resources are not mobilized in coherent efforts nor are they employed consistently. Six Mix states are possible. For example, the Skill/Service state arises when IS management controls computing but serves the interest of operational departments. In this state, the IS group which has control of computing will push for technical sophistication, but this will be in conjunction with, and not at the expense of, departmental interests. Other Mix states will show similar combinations of attributes from the congruent states.

A principal message of the states model is that alternative states of equilibrium are possible in organizational computing. As they expand and evolve their use of computing, organizations may adopt different visions of how they would achieve greater integration and greater benefits from computing. Computing growth through increasing technological sophistication is but one possible route. Computing growth may also be managed by determining whose interests are to be served by computing, the orientation of the computing management, and the placement of authority over computing decisions.

8. TOWARDS AN ALTERNATIVE PROCESS MODEL OF EUC GROWTH

A process view of EUC growth may be developed based on the insights offered by Laudon's environmental-institutionalist model and Kraemer *et al.*'s management states model. A process perspective could be used to examine how the trajectory of EUC growth in an organization may be significantly affected by environmental and institutional factors, and by the location and interests of management action. It would also be applied to show how data integration, the centrepiece of Huff's stage model of EUC growth, could be achieved in alternative scenarios of organizational computing where user and IS managements take up different roles.

Laudon's (1989) model emphasizes the importance of environmental and institutional factors in shaping the growth of computing in organizations. We may expect that these factors would also strongly affect the process of EUC growth. For example, a number of environmental changes and institutional traits could lead to the expansion of user-driven computing. Environmental changes, such as the increased availability of affordable and easy to use computers (corresponding to "technology munificence"), would stimulate the expansion of user-driven computing. A turbulent, fast-changing environment may also require users to access and process their own data in order to react quickly. Again, an institutional trait such as the relative influence of organizational groups (corresponding to the "politics" factor) would suggest that a powerful user department could gain control of its own computing resources and policies.

In direct contrast with stage models which emphasize technology-push as the driver of organizational change, Kraemer *et al.*'s (1989) concept of management states encompasses a range of possible explanations for computing change rather than fixing attention on a single cause of change. The states model does not prescribe a preferred state that is in some sense mature or optimal. Instead, each state represents an equilibrium that balances the existing features of the organization and the environment with the interests pursued. Managerial choice drives the model — managers can choose from a number of courses of action, and they can base their choice on various assumptions and to serve various interests. Thus different modes of management action can be found in organizations at different times, organizations do not necessarily change states, organizations can move in and out of a given state, and they can move from one state to another in no particular order.

Although the management states model was based on field studies of traditional data-processing activities, we suggest that in analyzing EUC, where there is inherent tension between user and IS management to control computing and data resources, there is an even greater need to identify who has control over and whose interests are served by the growth of EUC. Thus user and IS managements pursue EUC to serve divergent interests. Furthermore, user and IS managements wield different amounts of influence over the use of computing in organizations. The management states model would suggest that the location of managerial control over EUC and the interests furthered by it would determine the "state" of EUC in an organization.

A Service state would imply that user managements have control over EUC, and exercise it in their operational interests. A Skill state implies that IS management controls EUC to serve their technical interests. Given that user control is a defining characteristic of EUC, we are more likely to see Service states than Skill states in organizations. A Mix state exists when there is a difference between who controls EUC and whose interests are served by it. It can also represent periods of transition, when the organizational role of EUC has not been clearly defined.

The divergence of interests pursued by the user and IS managements does not necessarily lead to adversarial confrontation. A number of scenarios are possible. User management may choose not to have their departments become heavily involved with the implementation of EUC. They may depend on the IS department for support services, and assume that their needs will be well met. Alternatively, IS management may prefer to let user departments manage their own EUC activities, freeing itself to pursue interests such as technology assessment and systems integration. Yet another scenario is that the user and IS departments would cooperate together. EUC responsibilities are shared between user and IS departments. The IS department may play the "matchmaker," facilitating communication and coordination between previously isolated computing components in the organization.

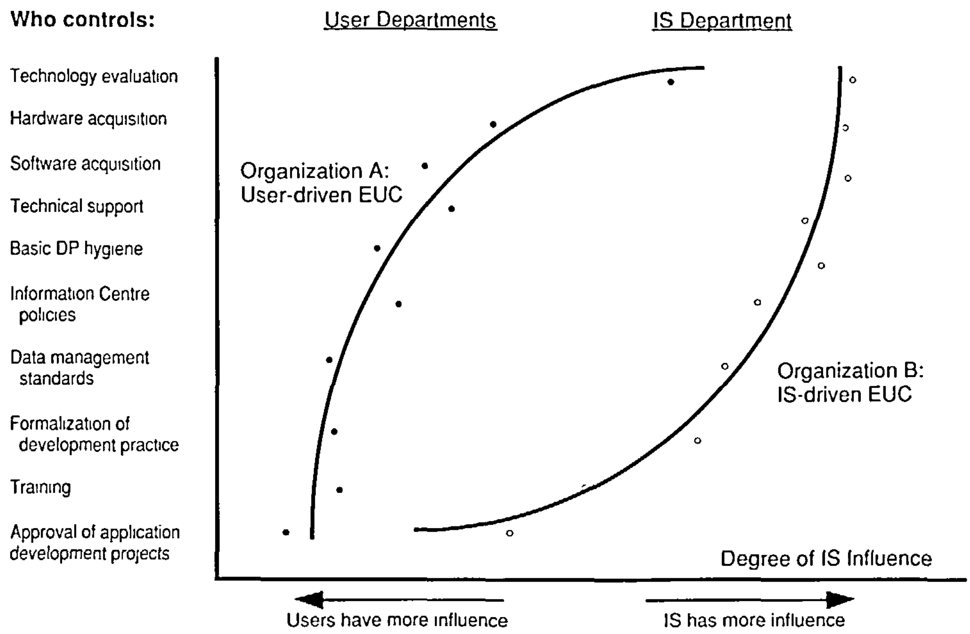
Although the differing interests between the user and IS management need not lead to conflict, it does suggest that end-user computing can evolve in one of two basic modes. In the "user-driven mode", (corresponding to the Service state in Kraemer *et al.*'s model), the interests of user departments are served, and user managements control EUC. In the "IS-driven mode", (the Skill state), the interests of IS department are served, and IS management controls EUC. User- or IS-driven EUC growth will each lead to significant dissimilarities in the design and implementation of EUC policies, procedures, and training and support mechanisms. This will in turn create distinct trajectories of EUC growth for the organization. In an organization where users drive EUC, they are more likely to apply new technologies and learn about application design and development through self-help and sharing knowledge with one another. In this case, the IS department may play a supporting and facilitating role. While user-driven EUC would decentralize decision making about application development and data access, IS-driven EUC is likely to contribute to a dominant role for the IS department in which decision-making authority concerning most aspects of EUC is centralized.

In Huff's stage model, the goal of managing EUC growth is to achieve data integration. A process view of EUC growth would suggest alternative visions of how this integration may be reached. In IS-driven EUC, the IS department would implement data integration in a top-down manner, generally adopting a hierarchical systems architecture that provides centralized control over all an organization's information activities. In user-driven EUC, data integration would develop cumulatively, as users progressively bind together their applications and work tasks. Here, integration would create a continuum of functionality and ensure that information is continuously accessible to the end-users.

A process perspective of EUC would thus have both predictive and prescriptive value for management. Changes in the environment, and organizational traits would tend to move the management of EUC towards either a user- or IS-driven mode. Each state of EUC management would result in its own trajectory of EUC growth. Furthermore, in order to obtain a desired EUC state of computing in the organization, management would need to determine the location of control over computing and the orientation of the interests that computing is to serve.

To operationalize the model, indicators are needed to reveal which organizational group has dominant control over EUC. An empirical method of doing this could be to compare the relative amounts of influence user and IS departments have over a set of common decisions about the implementation of EUC. These decisions may concern technology evaluation, acquiring hardware and software, training and support services, approving application development projects, managing the information centre, setting standards for data integration, formalizing application development practices, and so on (see, for example, Henderson and Treacy, 1986). For each organization, these common decisions may be ranked in order of their frequency of appearing as being more user- or IS-controlled. By aggregating data over a population of organizations an "EUC decision profile" curve may be drawn (Figure 4).

Fig. 4. Hypothetical EUC decision profiles



9. SUMMARY

The study of EUC is in the theory-building stage. EUC growth models have been proposed based on stage models in which organizational computing progresses through a predetermined sequence of phases. Growth is driven by advances in technology, and by the organization's capacity to learn the technology. While providing a framework to discuss management strategies, stage models are limited by their failure to recognize an intrinsic social feature of EUC. The growth of EUC is characterized by the tension arising from users' wish directly to control computing and data resources, and IS departments' desire to manage centrally and control EUC. Recent process models of organizational computing (by Kraemer *et al.*, 1989, and Laudon, 1989) that highlight the importance of environmental and institutional factors, and that focus on the control of computing and the interests served by it, provide a new perspective for examining EUC growth. Rather than predicting a fixed growth-path, they suggest alternative visions about how EUC may evolve in organizations. EUC growth not only is driven by technology, but is also strongly affected by environmental forces and organizational traits. Alternative states of equilibrium are possible depending on the balance between who has control over EUC and whose interests are served by it. In the movement towards data integration, EUC growth may involve top-down centralized control by the IS department. Alternatively, IS may play new roles as facilitators who support the evolution of EUC towards user-driven integration.

REFERENCES

Alavi M., R.R. Nelson and I.R. Weiss. 1987. Strategies for end-user computing: an integrative framework. *Journal of MIS* 4 no. 3: 5–20.

Danziger, J.N., W.H. Dutton, R. Kling and K.L. Kraemer. 1982. *Computers and politics: High technology in American local governments.* New York: Columbia University Press.

Davis, G.B. and M.H. Olson. 1985. *Management information systems: Conceptual foundations, structure and development.* New York: McGraw-Hill.

George, J.F., R. Kling, and S. Iacono. 1990. The role of training and support in desktop computing. *In Desktop Information Technology,* eds. K.M. Kaiser and H.J. Oppelland: 237–252. Amsterdam: North-Holland.

Gibson, Cyrus F. and Richard L. Nolan. 1974. Managing the four stages of EDP growth. *Harvard Business Review* 52 no. 1 (January–February): 76–88.

Henderson J.C. and M.E. Treacy. 1986. Managing end-user computing for competitive advantage. *Sloan Management Review* 27 no. 2: 3–14.

Huff S.L., M.C. Munro, and B.H. Martin. 1988. Growth stages of end-user computing. *Communications of the ACM* 31 no. 5: 542–50.

King, W. and K. Kraemer. 1984. Evolution and organizational information systems: an assessment of Nolan's Stage Model. *Communications of the ACM* 27 no. 5: 466–75.

Klepper, R. 1990. An agency theory perspective on information centres. *Proceedings of the 23rd Hawaii International Conference on System Sciences* held in Kailua-Kona, Hawaii on January 2–5, 1990, vol.IV.

Kraemer K.L., J.L. King, D.E. Dunkle and J.P. Lane. 1989. *Managing information systems: change and control in organizational computing*. San Francisco, CA: Jossey-Bass.

Laudon, K.C. 1989. *A general model for understanding the relationship between information technology and organizations*. National Information Systems Project–Working Paper no. 1. New York University: Centre for Research on Information Systems.

Laudon, K.C. and J.P. Laudon. 1988. *Management information systems: A contemporary perspective*. New York: Macmillan.

Markus, M.L. and D. Robey. 1988. Information technology and organizational change: Causal structure in theory and research. *Management Science* 34 no. 5: 583–98.

Mohr, L.B. 1982. *Explaining organizational behavior*. San Francisco: Jossey Bass.

Newman, W.M. 1987. *Designing integrated systems for the office environment*. New York: McGraw-Hill.

Nolan, R.L. 1979. Managing the crises in data processing. *Harvard Business Review* 57 no. 2 (March–April): 115–26.

Orlikowski, W.J. and Baroudi, J.J. 1991. Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research* 2 no. 1: 1–27.

Panko, R. 1988. *End-user computing*. New York: John Wiley.

Robey, D. and R. Zmud. 1990. Research on EUC: Theoretical perspectives from organization theory. *In: Desktop Information Technology*, eds. K.M. Kaiser and H.J. Oppelland: 15–36. Amsterdam: North-Holland.

Rockart J.F. and L.S. Flannery. 1983. The management of end-user computing. *Communications of the ACM* 26 no. 10: 776–84.

Smith, H. 1989. The user-data processing relationship: A study in power and attitudes. *Proceedings of the 10th International Conference on Information Systems* held in Boston, MA., on December 4–6, 1989.