In 1979, our book, Technological Innovation in American Local Governments: The Case of Computing, sought to identify the factors which were then driving the adoption and diffusion of computer applications software in U.S. cities and counties. Among the conclusions of the research was that local system building was an incremental process which was not significantly facilitated by federal support or inter-jurisdictional technology transfer, a result which challenged then prevailing views about effective implementation. At the same time, the study reinforced several accepted generalizations from the innovation literature, including the importance of innovation attributes in the diffusion process.

Computer technology and the public sector context in which it operates have changed significantly in the last decade. Computing is a complex technological “package” which encompasses an interdependent system composed of people (users, computer specialists, managers), apparatus (including hardware such as computer mainframes and peripherals, software such as operating systems and applications programs, and data) and techniques (procedures, practices, organizational arrangements) necessary to use the apparatus (Illich, 1973). Each of the interdependent components of the computing package have changed significantly in the last decade. Representative of these changes are the widespread introduction of microcomputers and vast changes in the organizational location of computing.

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The context of computing has changed as well. The political economy of government is vastly different today. Government growth has slowed significantly, privatization has become a service-delivery option, and the demands upon governments continue to grow. At the same time, the internal organizational infrastructure for computing has continued to grow. Computing has increasingly become independent of other activities (particularly the finance function) with which it was once joined. Many government departments have developed their own decentralized computing capabilities.

Thus, the technology and its context have changed so radically that the frameworks employed a decade ago are probably no longer appropriate for understanding innovation in public sector computing. This naturally raises questions about what theories are most appropriate for understanding the current status of computing change in the public sector. In what ways has innovation research evolved that would affect the focus of research on innovation in public sector computing? What theoretical perspectives are most useful for understanding change in computing? This review seeks to answer these questions.

The review is divided into three parts: general innovation research; public sector innovation research; and computing research. The objective in each part is not to be comprehensive, but to review the research most relevant to understanding computing as an innovation in a public sector context. The final portion of the paper provides several conclusions about directions appropriate for future research on computing innovation in the public sector.

**General Innovation Research**

As Everett Rogers aptly notes in the preface to the third edition of *Diffusion of Innovations* (1983, p. xv), “there is almost no other field of behavior science that represents more effort by more scholars in more nations.” The volume of research on innovations eliminates any prospect that this review will be comprehensive—there is simply too much material. The strategy for reviewing the general innovation literature is to identify major developments in research since 1979 and to identify specific developments which might be especially relevant for understanding computing.

The recent general literature on innovation research can be placed into perspective by reviewing several criticisms of innovation research circa 1975. In the mid-1970s, diffusion research was criticized on both substantive and methodological grounds. Six criticisms were prominent:

1. the innovations selected by researchers were biased toward innovations that succeeded and ignored those that failed or “fizzled,” presenting a misleading picture of correlates and causes of success (Downs and Mohr, 1976; Warner, 1974);
2. innovations were usually treated as stable technologies and little attention
was paid to the dimensions or characteristics of the technology (Warner, 1974; Perry and Kraemer, 1978);
(3) little attention was given to how the origins of an innovation (e.g., commercial vs. governmental sources) affected its diffusion (Warner, 1974; Perry and Kraemer, 1978);
(4) analyses that rested primarily on fitting S-shaped curves were inadequate for understanding the dynamics of diffusion processes (Downs and Mohr, 1976);
(5) results of innovation studies were highly unstable (Downs and Mohr, 1976); and
(6) dependent variables were not carefully specified and distinctions were not clearly made among adoption, utilization and incorporation (Perry and Kraemer, 1979; Yin, 1978).

Innovation research has made significant strides toward overcoming these criticisms. More empirical studies have begun to look at innovation attributes (Perry and Kraemer, 1978; Tornatzky and Klein, 1982; Bingham, Freeman and Felting, 1984). Utilization has become a more common dependent variable (e.g., Dutton and Kraemer, 1985; Kraemer, Dickhoven, Tierney, and King, 1987; Laudon, 1985). Research samples have begun to include both successes and failures (Lucas, 1975; Perry and Kraemer, 1978; Cerveny and Clark, 1981). Thus, scholars have sought to remedy the limitations of research on innovation.

The major controversy that remains from the 1970s is whether one or many theories are needed to explain innovation. Critics of innovation research argue that the cumulative knowledge represented by the large volume of studies has been limited by the instability of results across studies (Downs and Mohr, 1976). They suggest a primary cause for the instability is the need for multiple innovation theories that account for different primary, i.e., inherent, attributes of innovations. Others (Tornatzky and Klein, 1982) have argued that instability is essentially an artifact of weak research designs and inadequate conceptualization and measurement of innovation characteristics. They contend that if research was more rigorous then the instability in findings would disappear.

This review cannot resolve the above debate, but it can hope to shed some light on the more plausible of the two positions as the discussion proceeds. We turn now to three issues from the recent literature that may have significant consequences for the study of innovation related to computing: (1) re-invention; (2) interrelated innovations; and (3) natural trajectories of technologies.

Re-invention

A major development in recent innovation research has been the emergence of re-invention as an important phenomenon. Re-invention represents the extent to which an innovation is modified in the process of adoption and implementation. Rogers (1983) notes that re-invention was virtually ignored until the mid-1970s.
Rice and Rogers (1980) and Rogers (1983) identified several conditions that affect the likelihood for re-invention.

(1) Re-invention is more likely when innovations are relatively more complex, irreversible, difficult to understand, and when an external consultant does not take an active role. In this situation, re-invention becomes a means for risk reduction by the adopting organization and an opportunity to learn about a complex technology.

(2) Re-invention is more likely when there is a lack of detailed knowledge about the innovation. Under such circumstances modification of the original invention may become a matter of necessity, uninhibited by information to adequately install the original innovation.

(3) Re-invention is more likely when the innovation is a loose bundle of elements that are not highly interrelated. The loose coupling among elements provides flexibility in adapting the technology to local circumstances.

(4) Re-invention is more likely when the individual and organizational problems with which the innovation is matched are heterogeneous. The more broadly a problem is defined, the more likely it will be necessary to modify the innovation to fit local conditions.

(5) Re-invention is more likely when pride of ownership is strong. Pride of ownership is likely to require some stamp of identification that necessitates a degree of re-invention.

Re-invention is particularly salient for the study of change in computing (see, for example, Johnson and Rice, 1987). Computing technology rates high on most of the factors that encourage re-invention. Information systems are highly malleable, afford many degrees of freedom in their use, and can be tailored to local situations (Laudon, 1985). However, in a case study of 12 cities and counties, Danziger (1977) found “the narcissism of small differences” prevented transfer of well-designed software that could be modified for local circumstances. This finding suggests that local pride can be so strong that it prevents considerations of re-invention as an option.

**Interrelated Innovations**

If computing represents a complex technological package, then studying computing innovations is complicated by interrelationships among components of the package. Very little research has been directed toward understanding the diffusion and adoption of complex technological packages. Instead, most innovation research has looked at discrete administrative or technological innovations. Research on re-invention is an initial move toward recognizing that innovations are not usually discrete entities, but complex bundles of attributes.

In a study of interrelated innovations, Wozniak (1984) developed an econometric model of the decision to adopt interrelated technological innovations. He hypothesized that producers with a given level of innovative
ability, i.e., the capacity to be productive with new inputs and to anticipate that capacity, and scale of production were more likely to be adopters of current innovations if they were utilizing earlier complementary innovative inputs than if they were not. The hypothesis was confirmed. Wozniak concluded that the adoption of interrelated innovations and therefore innovative ability is a human capital intensive activity. Although his finding is consistent with those of others who have studied interrelated innovations (Perrin and Kraemer, 1979), it strongly emphasizes the significance of education and specialized knowledge for organizational innovation in dynamic technological environments.

**Natural Trajectories of Technologies**

Related to the questions that interrelated technologies pose is whether the development of a given technology follows any natural trajectory. The natural trajectory concept was introduced by Nelson and Winter in the 1970s, but it has only recently begun to have a significant impact on research (Nelson and Winter, 1982). Nelson and Winter (1977, p. 56) define the concept of natural trajectory:

> However, it may be that there are certain powerful intra-project heuristics that apply when technology is advancing in a certain direction, and pay-offs from advancing in that direction that exist under a wide range of demand conditions. We call these directions “natural trajectories.” If natural trajectories exist, following these may be good strategy.

Implicit in the natural trajectory concept is the idea that technological change could be driven not only by demand for the technology, but also by certain “technological imperatives.”

Research on natural trajectories is highly relevant to the study of computing change because it raises the question of whether natural trajectories are applicable in describing computing technologies. Nelson and Winter (1977) note that while natural trajectories will almost always have special elements associated with a particular technology, certain natural trajectories will be common to a wide range of technologies. The two illustrations of the common trajectories provided by Nelson and Winter, progressive exploitation of latent scale economies and increasing mechanization of manual operations, are applicable to computers. For example, Nolan (1973; 1979) has incorporated improving price/performance directly into his stage theory of computing.

To summarize, three developments in recent general innovation research appear to be relevant to the analysis of diffusion of computing in government: (1) re-invention; (2) interrelated technologies; and (3) natural trajectories. Although these developments have been gleaned from a much larger literature and may not be fully representative of innovation re-
search, they share one thing in common: focus on the technology, per se. This emphasis in the literature is directly related to the criticism cited earlier that until recently innovations were treated as stable entities in most diffusion research. The research focus on technology has helped to emphasize that innovations are themselves changing, contributing to development of a more encompassing view of technology in time and space.

**Public Sector Innovation**

The level of public sector innovation research in the 1970s was quite high because of the active support of the National Science Foundation. However, since the early 1980s, research on the public sector has dropped off considerably, partly as a reflection of a shift in concerns from public sector productivity to private sector competitiveness. The diminished level of research activity prevents any easy identification of trends in this research, but there has been some clustering of studies around at least two areas, institutionalization and interests served.

**Institutionalization**

Since 1980, institutionalization has been studied by multiple investigators in the context of public organizations. Although the concept names have varied—e.g., institutionalization, routinization, and durability—the meaning has been relatively stable across studies. Institutionalization has usually been defined as how an innovation becomes part of standard practice (Yin, 1981). It has been studied in the context of a range of innovations in municipal agencies (Yin, 1981), programs in human service organizations (Glaser, 1981), and a decision support system in police departments (Lawless, 1987).

These empirical studies suggest that institutionalization is influenced primarily by factors internal to a public agency. In the most extensive study of institutionalization, Yin (1978) found that the use of an innovation in an agency’s core activities, presence of top management support, and presence of practitioner support were strongly related to institutionalization. Largely concurring with Yin’s results, Lawless (1987) found that support from top management and an innovation’s versatility and decision-maker awareness of it helped to increase institutionalization.

**Interests Served**

A number of other public sector studies since 1980 have focused primarily on understanding the interests served by public sector innovation. Feller (1980; 1981; 1982), drawing upon his research and that of others, has explored the extent to which public sector innovation enhances efficiency or serves bureaucratic self-interest. The bureaucratic self-interest model draws primarily from Yin and colleagues’ (1976) characterization of
the process. Feller's contention is that bureaucrats prefer service augmenting innovations because they increase agency budgets to which bureaucratic emoluments are positively correlated, expand the clientele served by an agency and obscure agency production costs by simultaneously altering input mixes and services provided. Feller concludes that while public bureaucracies may be more risk averse, the innovations they adopt may improve service rather than efficiency.

Others have implied that some innovations involve trade-offs between citizen interests and bureaucratic control. Summarizing research on computing in federal, state and local governments, Kraemer and Kling (1985) identify two models for adoption of computer systems. In the rationalist model, computer technology serves citizens by providing more services, more equitably. The reinforcement politics model depicts computers as tools for the most powerful interests. According to this model, computerized systems are used primarily for routine operations and overhead control.

The Kraemer and Kling contention is partially at odds with Feller's perspective. They agree that computers are not driven primarily by efficiency considerations. But while Feller argues that computers would be adopted for service augmentation, Kraemer and Kling suggest that service efficiency is less important than reinforcing existing power arrangements. Both the Feller and Kraemer and Kling conclusions are inferred from patterns of computer adoption in governments. In order to resolve the differences, it will be necessary to directly study the motivations of public sector adopters and the judgments made during adoption. It should also be noted that Feller and Kraemer and Kling's research looks only at adoption. A broader view of the innovation process, i.e., what is rational for adoption, implementation, and utilization, might alter the attributions ascribed to governmental actors.

A third approach to interests served is reflected in Hannaway's (1987) research on bureaucratic growth which looked at central office managers in a large school district. Hannaway contends that growth is the result of managers' attention to more immediate concerns, rather than maximizing utility. She argues that the manager is "trying to get a nearly boundless job done without understanding clearly either the means-end relationships involved or the meaning of much of the feedback received, and without incurring much personal risk" (p. 129). Hannaway's arguments and findings are representative of reduced emphasis on self interest characteristic of institutional theories of organizations (Scott, 1987).

In addition to research on institutionalization and interests served, several empirical studies have addressed a range of issues. The largest scale empirical study since 1980 (Bingham, Freeman, and Felbinger, 1984) involved a test of Downs and Mohr's (1976) innovation decision design. In the innovation decision design, the unit of analysis is the innovation with respect to the organization or the organization with respect to the innovation. Bingham, Freeman and Felbinger (1984) used the innovation de-
cision design to study innovation and adoptability of 7 innovations in 231 U.S. cities. Using characteristics of the innovation, resource levels and organizational variables, they explained 19% of the variance in adoptability of process innovations. The same model explained only 8% of the variance in adoptability for product innovations. The model explained twice as much of the variance for mayor-council cities as for council-manager cities (18% to 9%). Bingham and his colleagues concluded that the Downs and Mohr innovation-decision design was weakly supported by these results.

Pelz (1985) studied innovation stages in local governments by coding innovations according to the time of occurrence of each stage (from need identification to diffusion). He hypothesized that the stages would be more disorderly for increasingly complex innovations. Pelz’s hypothesis was confirmed for technical complexity, but not for organizational complexity. He concluded from this result that technically simple innovations are adopted and implemented in a more discrete succession of stages than more complex innovations.

Prottas (1984) reported on the introduction of a new light-rail vehicle in the Metropolitan Boston Mass Transit Authority. He criticized studies of diffusion and adoption for failing to address a third phase of the process, i.e., implementation. Prottas’ case study demonstrated how innovations provide what he termed (p. 133) “clue and motive” for reform and organizational learning. Although his arguments regarding implementation were not novel, his case study is an illustration of the changes that innovations set in motion and the reciprocal relationships between innovation and organizational context.

To summarize, the volume of research on public sector innovation has declined significantly in the last decade since a surge in the late 1970s. Institutionalization, the subject of three empirical studies, has been one of the most common foci of recent public sector studies. However, only one of these studies (Yin, 1981) involved both multiple technologies and organizations. Another stream of research looked at interests served by public sector innovation. The remaining research was eclectic, covering the motivations of public sector adopters, efficacy of the innovation-decision design, and consequences of innovations.

Research on Innovation in Computing

Although many case studies have been written about the failures of particular systems, relatively few recent studies have systematically and self-consciously investigated innovation. One of the exceptions, Lawless (1987), has already been discussed. Another exception is Lauden’s (1988) study of the development of the National Criminal History System. Lauden compared two competing theories of system development, environmental and institutional. The environmental model posits that systems are developed in response to environmental uncertainties or opportunities. Orga-
izations need to respond to these exogenous factors in order to survive. The institutional model involves endogenous variables such as the values, norms and social structure of an organization. According to the institutional model, systems are developed because they fit these values, norms or structures. Laudon found that adoption was primarily influenced by environmental factors and utilization and management were determined by institutional factors. He concluded that a model that incorporates both environmental and institutional explanations is more accurate than a model that relies on any one set of factors alone.

Bozeman and Bretschneider (1986) came at the same issue from a theoretical rather than an empirical analysis, but their analysis supports Laudon’s empirical findings. Bozeman and Bretschneider applied existing theories of public-private management differences to the particular case of information systems, and developed a general framework that distinguished between proximate (institutional) and distal (environmental) factors influencing the adoption and utilization of information systems.

Models of Change in Computing

The research on computing most closely allied with innovation research focuses on models of change in computing. This literature has been dominated by stage models, of which the most frequently cited is Nolan’s (1973; 1979). Nolan’s model encompasses six stages: initiation, contagion, control, integration, data administration and maturity. Nolan posited that organizations move through a series of identifiable stages as they selectively adapt to changes in technological infrastructure. The stages reflect central tendencies in the management of computing: planning, organizing and controlling. Transition across stages can be identified by six benchmarks: (1) the rate of budget growth; (2) technological configuration; (3) the applications portfolio; (4) the data-processing organization; (5) data-processing planning and control; (6) user awareness characteristics. Huff, Munro and Martin (1988) recently adapted Nolan’s stage model to describe the growth of end user computing.

Stage models proposed by other scholars differ from Nolan’s in important respects (King and Kraemer, 1986). Glaser, Torrance and Schwartz (1983) proposed a technology-dependent stage model, consisting of four stages: basic batch, expanded batch, on-line inquiry, and distributed computing. Kraemer (1979) and Kraemer and King (1981) posited a model with four stages: introduction and conquest, experimentation and expansion, competition and regulation, and reassessment and consolidation. In contrast to Nolan, they argued that organizational policy and politics, rather than management needs, drive the evolution of computing.

In a review of empirical evidence, Benbasat, Dexter, Drury and Goldstein (1984) concluded that the overall weight of empirical evidence was not supportive of the stage hypothesis. Empirical research (see, for example, Drury, 1983) has shown that many of the predictions derived from
Nolan's model do not withstand scrutiny. For example, hypotheses about S-shaped progression of budget growth, applications portfolio and data administration have been disconfirmed. Although the empirical research has been directed primarily at Nolan's version of the stage model, it is uncertain whether alternatives would fare better upon close scrutiny. Despite inability to confirm key features of stage models, Benbasat and his colleagues (1984) recommended additional studies of Nolan's stage hypothesis and the need for better measurement and for longitudinal studies.

**Information Systems and Organizational Change**

In a recent analysis of theory about information technology and organizational change, Markus and Robey (1988) concluded that such research has produced conflicting results and few reliable generalizations. Among the most commonly reported studies about information systems and organizational change are case studies about why information systems fail (Lucas, 1978; Cerveny and Clark, 1981). The typical reaction to these innovation failures is to lay blame: "We tend to look for scapegoats when a system does not work. Some of those involved will blame the hardware, some the software, others the systems analysts, the user, or the organization structure" (Cerveny and Clark, 1981, p. 151). The frequently expressed hope is that the reasons for success or failure can be identified.

Case studies of information system failure are frequently used for their instrumental value in diagnosing reasons for failure, but they are seldom exploited as a means for better theoretical understanding of the dynamics of computing change. One unrecognized value of many of the case studies of system failure is that they serve to reinforce the stochastic nature of system development. Systems development is an uncertain activity which cannot be reduced to a deterministic process. Case studies of failure often label as "irrational" behavior which is actually highly adaptive and rational. For example, Miller (1983) attributed the failure of a New Jersey Department of Human Services system to a pervasive "political environment." Another interpretation might have been that the outcome was quite rational because the values and norms preferred by participants survived an effort to displace them.

Other studies have investigated the relationship between information systems development and organizational change. Robey (1983) studied the relationship between formal changes in organizational structure and implementation of computerized information systems. His primary contention was that computer systems did not cause changes in organization structure, but that information systems and organization structure changed simultaneously. Organization design and system design were both subordinate to operating objectives targeted at responding to specific problems.

Taylor (1986) reported on a successful application of socio-technical systems (STS) to a computer operations department. The STS intervention was successful in reducing turnover from 40% to 5% and raising produc-
tivity by about 40%. After a seven-year re-test, the turnover and productivity improvements were still in place.

Johnson and Rice (1987) also studied the evolution of office information systems using a sociotechnical systems approach in two hundred organizations. They found that word processing in organizations evolved into one of four configurations: (1) low-integration systems in which word processing satisfied traditional typing functions; (2) workgroup systems which emphasized efficiency but did not adapt the work performed to the technology's capability or changing user demands; (3) expanding systems which reflected adaptations based on user inputs; and (4) high-integration systems which created integrated information systems by providing special user involvement and support. They concluded that performance of new technical systems is enhanced to the extent that technology, work groups, and resources are adapted to contribute to organizational goals. Although it is unclear how broadly any generalization might apply, the Robey, Taylor and Johnson and Rice studies illustrate the reciprocal relationships between organizational and technological change.

To summarize, change in computing has most frequently been represented as stage models. Although significant parts of the most prominent stage model (Nolan, 1973) have been disconfirmed, Benbasat and his colleagues (1984) recommended additional, longitudinal studies using better measures. Another source of rich information about computing and innovation comes from studies of information systems failure and from studies about the organizational consequences of information system implementation. This research needs to be exploited for the light it can shed on the evolution of information systems in organizations.

**Implications for Future Research**

Several conclusions about how future research on computing change in the public sector should be conducted may be drawn from the preceding discussion. First, the review suggests that innovation in computing is a complex process that should be modeled accordingly. The study of innovation has become increasingly complex and sophisticated during the last 15 years. Curve fitting no longer has the prominence in innovation research that it occupied several decades ago. The study of innovation in public sector computing needs to keep pace with progress in the larger field. This will require that research on the diffusion of computing become more process-oriented, recognize conceptual developments such as re-invention, and systematically incorporate these advances into future research.

Second, the review suggests that more attention needs to be given to describing and measuring the characteristics of computer technologies, including their natural trajectories. As the review of general innovation literature indicated, recent research has focused on better understanding how variations in the technology affect innovation. This research focus has
helped to emphasize that innovations are themselves changing and it has also presented a more encompassing view of technology in time and space. Studies of computing as a technology need to follow the lead of this research. More effort should be devoted to describing and measuring the characteristics and configurations (Miller and Mintzberg, 1983) of all types of computer technologies, including software and hardware.

The natural trajectories of computing technologies also need to be identified. Some features of the natural trajectory of computing technologies are already well known. For example, it was noted earlier that price/performance and automating manual activities are characteristic of computing technology. However, knowledge about the natural trajectories of computing and telecommunications technologies has, for the most part, not been applied explicitly or systematically in models of computing change.

The third conclusion is that understanding the evolution of information systems will be enhanced by recognizing that all three aspects of the computing package—technology, people and organization—should be integral to any theory of computing change. Stage theories appear to have merit because of their ability to represent a complex technological package in a holistic way (Miller and Mintzberg, 1983). However, present theories focus predominantly on evolution of the technology and ignore large parts of its organizational context. Among other limitations, existing stage theories are not able to identify when the consequences of the technology have made a qualitative difference in how an organization functions.

Rothwell and Wissema (1986) offer a model for explaining "technological breaks" in cycles of national prosperity that is useful for thinking about changes that are associated with stages in computing evolution. They suggest there is a triangular relationship among three components: (1) norms, values and objectives in a society; (2) structures (institutions, procedures, social organization); and (3) technology. Two conditions are necessary for technological progress. The first is that there is consensus about norms, values and objectives. Conflicts are limited to means, not ends. The second condition "is the availability of 'structures' on the one hand and a cluster of mutually reinforcing new technologies on the other, both of which match norms, values and objectives of society" (Rothwell and Wissema, 1986, p. 104). Nelson and Winter's (1977) framework employs components similar to the Rothwell and Wissema model.

The fourth conclusion is that, in order to develop a more complete and grounded understanding of changes in computing in organizations, it will be necessary to identify the mechanisms, and not merely the stages, integral to the evolution of computing in public organizations. Dobert (1981) distinguishes between two strategies for studying evolutionary processes. One strategy is to construct stage models and the other is to study evolutionary mechanisms. Although Dobert argues that evolutionary mechanisms should logically be studied before stage models are constructed, he notes that it is usually more practical to construct stage models first because they are
more easily observable. Research about stage models of computing has clearly proceeded much more rapidly than research on evolutionary mechanisms.

The results of the review by Benbasat, et al. (1984) suggest that this may be an opportune time to begin to seriously study the evolutionary mechanisms which drive the development of organizational computing. This recommendation goes considerably beyond Benbasat, et al’s call for more and better research on Nolan’s stage theory. A probable focus for one evolutionary mechanism is the processes of institutionalization. Institutionalization involves several of the methods by which Doherty (1981) suggests social systems transmit messages: association, reinforcement, imitation, structural learning. Institutional theory (Goodman, Bazerman and Conlon, 1980; Goodman and Dean, 1979; Scott, 1987) provides a good starting point for studying these processes.

Another evolutionary mechanism involves organizational imperatives. Wildavsky (1983) offers a provocative view of how information may be conceived in an organizational context. His global thesis is that organizations exist to suppress data, defined as any bit. An organization’s problem is to convert data into information, which is defined as data ordered to affect choice. In general, organizational incentives encourage the production of additional data without commensurate increases in information because data are treated as overhead. The overproduction of data creates a vicious circle (Masuch, 1985). The result is a self-defeating process of data production and reduction. In Wildavsky’s terms:

Indeed, it is precisely the lack of a collective interest in reducing data and inability of any single part acting alone to stem the flow, that leads to vast over-production. Organization is at war with itself; like a person who alternatively beats himself and soothes his bruises, it simultaneously organizes to decrease and increase data. Bureaucracy, the division of labor, and MIS, the multiplication of data, cancel each other out.

Nelson and Winter (1977) define a third evolutionary mechanism—the selection environment. The selection environment determines how relative use of different technologies changes over time. Nelson and Winter recognize that the selection environment in nonmarket settings is quite different than in market settings. Nevertheless, the nonmarket selection environment essentially consists of three primary elements: the motivations of organizations in the sector, the ways in which consumers (usually voters) and financiers (usually legislators) constrain agency behavior, and the mechanisms of information and value sharing among organizations in the investment and imitation process.

Learning about and identifying evolutionary mechanisms will be enhanced by studying the consequences of information systems. Innovation
consequences are changes that occur in a social system as a result of adoption or rejection of an innovation (Rogers, 1983). The studies by Prottas (1984), Robey (1983) and Taylor (1986) discussed earlier are good examples of research on innovation consequences. Although little research has investigated consequences, studying them would facilitate understanding change generally and evolutionary mechanisms specifically. Research on consequences would generate knowledge about innovations as change agents.

Our final conclusion is that future research should be oriented toward capturing the policies and motivations underlying public sector adopters' choices about computing. Nelson and Winter's (1977; 1982) selection construct incorporates as one of its components the concept of motivation of the adopting organization. Very little research has looked at motivation in the context of innovation adoption. This is particularly true in the public sector. Public sector research has been content to infer motivation or values from innovation decisions. As indicated earlier, however, this has led to contradictory results. The absence of direct research on the values or motivations behind an innovation decision has also constrained our understanding of how judgments are made about innovations and what types of tradeoffs occur. Thus, it would be very useful to study the motivations and policy judgments of public sector adopters.

The studies reviewed earlier (Feller, 1980; Feller, 1981; Feller, 1982; Yin, Heald, Vogel, Fleischauer and Vladek, 1976; Kraemer and Kling, 1985) pointed to several competing values that would have to be incorporated into any research about motivation in public sector innovation. Among the values that should be included are: efficiency, service enhancement, professional prestige, risk avoidance, self-interest, and power. The importance of these decision making criteria could be investigated using any of a family of methodologies for probing human judgment and decision making (Hammond, McClelland, and Mumpower, 1980).

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