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Sustainability of Innovations

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With the recent flow of funding to support instructional technology and interactive learning environments through the E-Rate, Technology Innovation Challenge Grants (TICG), Technology Literacy Grants, Preparing Tomorrow's Teachers to use Technology (PT3) grants, and grants from various foundations, there is an increased emphasis on exploring the sustainability of these innovations once the grant funding has ended. The literature on institutionalization, scalability, and sustainability that is explored within this article goes back several decades, but in all cases, the innovation is considered to be sustained within an organization. Although institutions of higher education, educational consortia, and K-12 schools are organizations, grants cannot be considered as organizations. Hence, issues of bringing about systemic change, transforming traditional institutions into learning organizations, scaling the innovations, leveraging funds, forming new partnerships, and spawning new entities to support and sustain valued activities are areas that are ripe for further research.

FOUNDATIONS: ADOPTION WITHIN A CLOSED SOCIAL SYSTEM

This article focuses on the process by which one can simplify and assist an individual's or a group's accommodation to new ideas. To explore the concept of sustainability, it is important first to be familiar with the adoption and systems theory literature. Only then can parallels be drawn and differences identified among these very varied theoretical domains.

Although the notion of "sustaining innovations" is new to some, many of its associated concepts have roots within various bodies of literature. The author begins with a discussion of the nature of innovations, the processes by which resistance to them can be overcome, and the dynamics of adoption.

What is an innovation?

According to Morison (1984, p. 135), an innovation can be a new concept. Alternatively, it can be thought of as a combination of existing concepts that, when brought together, make a particular activity possible for the first time. Rogers (1995, p. 11) defined an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption...if the idea seems new to the individual, it is an innovation."

Traditionally, an innovation is a relatively discrete practice, product, process, or organizational arrangement that is to be diffused, disseminated, or introduced to users throughout the system. This process takes place in three stages: initiation, implementation, and institutionalization. Change agents or change facilitators promote the awareness of the innovation and encourage its use through a dissemination strategy that combines various incentives and supports. Since systems seek to maintain equilibrium, the innovation encounters varying degrees and forms of resistance as it diffuses (Knapp, 1997, p. 249).

The study of diffusion of innovations has had a history spanning over four decades. Beginning with Rogers' (1962) seminal work, Diffusion of Innovations, researchers began to realize that an innovation—"an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1995, p. 11)—often required a long period of time from the time they become available until the time they are widely adopted and used. Diffusing an innovation is the process by which an innovation is communicated "through certain channels, over time, among the members of a social system" (Rogers, 1995, p. 5). According to Rogers (1995, p. 6), "Diffusion is a kind of social change, defined as the process by which alteration occurs in the structure and function of a social system."

Adoption

Rogers (1995, p. 21) defined adoption as a decision to make full use of an innovation as the best course of action available, and rejection as a decision not to adopt an innovation. According to Lowry (1996, p. 16), this decision

can be made by an individual, by a group that is using consensus, or by a few individuals who have the power to decide for the group. An important feature of adoption is its reversibility: "Such decisions can be reversed at a later point; for example, discontinuance is a decision to reject an innovation after it has previously been adopted" (Rogers, 1995, p. 21).

There are five main steps in the innovation-decision process:

1. knowledge—when the individual learns of the innovation's existence and gains some understanding of how it functions;
2. persuasion—when an individual forms a favorable or unfavorable attitude toward the innovation;
3. decision—when an individual engages in activities that lead to a choice to adopt or reject the innovation;
4. implementation—when an individual puts an innovation to use; and
5. confirmation—when an individual seeks reinforcement of an innovation-decision that has already been made (Rogers, 1995, p. 20).

The key point of the Rogers model was that adoption of an innovation depended on the individual's perception of five attributes:

- the innovation's relative advantage as compared with the status quo;
- its compatibility with the individual's existing values, past experiences, and needs;
- its simplicity/complexity;
- the degree to which it may be experimented with on a limited (and safe) basis; and
- the degree to which its results are visible to others (Rogers, 1995, p. 15-16).

Thus, the adoption process depends on perceptions not only of the individual end users, but also upon perceptions of others who are a part of his/her universe (Bateson, 1972).

Another feature of the adoption process is the need for an empathetic relationship between change agents and the other individuals within the social system. Rogers saw the adopting population as a normal distribution curve along a time axis: 3% innovators, 13% early adopters, 34% early majority, 34% late majority, and 16% "laggards"—a disparaging term for those individuals who adopt the innovation later than the rest of the population. It is important that the change agent, usually a member of the early adopter population, be trusted and respected by the rest of the adopting population because "most individuals evaluate an innovation, not on the basis of scientific research by experts, but through the subjective evaluations of near-peers

who have adopted the innovation." (Rogers, 1995, p. 36). The near-peers are seen as role models, and their behavior tends to be imitated by others. In contrast, innovators are usually viewed with mistrust by the rest of the population because they deviate too far from the norms of the system.

Implementation

Hall and Hord (1987) shifted the focus from the innovation as an object, process, or concept with properties and attributes to the concerns of the individual users. In their Concerns-Based Adoption Model (CBAM), they clarified the levels of use of the innovation, which was alluded to by Rogers as implementation. In the CBAM model (Hall & Hord, 1987, p. 84), the individual passes from nonuse through six levels of use of the innovation, namely, (a) orientation; (b) preparation for use; (c) mechanical use or task mastery; (d) routine use and refinement; (e) integration; and (f) renewal.

In the integration stage, the user "combines his/her own efforts with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence" (Hall & Hord, 1987, p. 84). In the final stage (renewal), the user "re-evaluates the quality of use of the innovation, seeks major modifications or alternatives to increase the innovation's impact on the target audience, and explores new goals for self and system" (Hall & Hord, 1987, p. 84). This final stage is roughly equivalent to Rogers' notion of reinvention, that is, "the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers, 1995, p. 174).

In the CBAM model, there are certain assumptions that must be considered (Hall, George, & Rutherford, 1979). Two of these are particularly important. First, individuals must be the focus if change is to be facilitated. Institutions will not change until their members change. And second, the change process is an extremely personal experience. How the innovation is perceived by the individual will strongly influence the outcome. These ideas are consonant with those of Rogers, namely, that the innovation must be personally and culturally compatible with the perceptions and intentions of the individual within the social system.

Institutionalization

Institutionalization means continuing the newly implemented change or stabilizing the use of an innovation. Implementation activities that help people

use the innovation more skillfully and increase their sense of ownership are preconditions for institutionalization (Saxl, Miles, & Lieberman, 1989, p. 6-20). According to Rogers (1995, p. 173), the implementation stage "may continue for a lengthy period of time, depending on the nature of the innovation. But eventually a point is reached at which the new idea becomes an institutionalized and regularized part of the adopter's ongoing operations. The innovation finally loses its distinctive quality as the separate identity of the new idea disappears." This is an important distinction between institutionalization and sustainability: when an innovation has been institutionalized, "the change is no longer seen as a change, but has become 'invisible,' and is 'taken for granted'" (Saxl, Miles, & Lieberman, 1989, p. 6-24).

Generally, routinization or institutionalization refers to organizations, rather than simply to individuals. According to Saxl, Miles, and Lieberman (1989, p. 6-24), "institutionalization involves exerting legitimate power to build in modifications to the existing…organizational structure." In essence, the Rogers model moves the user from adoption to implementation, and thence to confirmation or disconfirmation of the adoption process; it does not describe the routinization or institutionalization process within the social system to any great degree.

Apple Computer, Inc. conducted an important study of institutionalization. (1990). For five years, the Apple Classrooms of Tomorrow (ACOT) Research project provided teachers and students at five public school sites with individual computers for use at school and at home. Researchers found that beginning teachers progressed through a series of stages: survival, mastery, and impact (Fuller, 1969; Hall & Loucks, 1979). "When first entering the classroom, teachers focus on themselves, concentrating on issues such as controlling student behavior. As they gain self-confidence, they become better able to anticipate and solve problems, and gradually the focus shifts to their impact on students' achievement and attitude." (Apple Computer, Inc., 1990, p. 1) At this point, teachers perceived that the benefits of the innovation significantly outweighed the drawbacks, despite the fact that some technical problems could never be completely eliminated. According to one teacher, "It would be hard to live without a computer…It has become a way of life." (Apple Computer, Inc., 1990, p. 6)

Miles (1983, p. 14) also explored institutionalization of educational practices in both high- and low-institutionalizing sites. He concluded, "whether or not a program becomes a durable part of the curriculum depends on teacher mastery and commitment and administrative action—as well as other factors."

In Miles' process model, there are 20 key variables that enable the organization to provide supports for and ward off threats to the innovation. The

process begins with administrative pressure, support, and assistance to new users. Increased user effort led to greater commitment and technical mastery of the innovation, which in turn, led to increasing stabilization of use of the innovation.

The model contained a second path by which the administration could mandate use of the innovation, which increased the percentage of use of the innovation, thereby encouraging institutionalization. However, as Wilson and his colleagues (1999) pointed out, if the innovation originated with the administration, it could be mandated but resisted.

A third path also existed: administrators could take direct action to bring about organizational changes beyond those created by the users, thereby creating new policy. New policy creates changes in hierarchy, technology, communication networks, and other facets of an organization. As Schneider, Brief, and Guzzo (1996, p. 7) pointed out, unless the changes that are introduced into an organization as a result of implementing a new innovation alter the fundamental psychology or "feel" of the organization to its members, there can be no sustained change. It is the multitude of specific changes in the organization's everyday policies, practices, procedures, and routines that alter its psychology and permit the changes to actually take hold.

In the low-institutionalization sites, Miles observed that the dynamics were quite different. Threats to the innovation included environmental turbulence (funding cuts, shifting populations) and career advancement motivation. Whereas job mobility is an asset to the individual, it is a threat to institutionalization of an innovation. Both environmental turbulence and career advancement motivation destabilized the program staff and the leadership, increasing vulnerability of the innovation. However, in cases where organizational change took place, vulnerability was reduced.

Scalability

One alternative to the term "institutionalization" is Elmore's (1996) concept of scalability, which is related to Rogers' idea of diffusion. One often sees pockets of change, or grassroots activities among a small set of users within an organization in an effort to share and implement an innovation. All too often, these efforts remain localized and do not become institutionalized.

Elmore (1996) noted that there are two important features that facilitate or inhibit the scalability of an innovation. First, if the teachers considered the innovation to be a tool that made their daily work easier and more efficient, then they were likely to adopt it. However, if adoption of the innovation meant that they had to change the core of their instructional processes—

especially without an observable incentive structure to reward their efforts—then in all likelihood, the innovation would not be adopted. In contrast, if there were an incentive system in place, and if the adopting population valued those incentives, then the innovation was more likely to scale up. Elmore (1996, p. 18-24) suggested four proposals for scaling good educational practice:

1. develop strong external normative structures for practice, such as content and performance standards created by professional associations;
2. develop organizational structures that intensify and focus intrinsic motivation to engage in challenging practice;
3. create intentional practices for reproduction of successes; and
4. create structures that promote learning of new practices and incentive systems that support them.

Means (1998, p. 11) explored scalability for technology-supported educational reform. She noted that many of the features associated with successful technology-supported reform efforts within individual schools were often missing from large-scale technology implementations. She suggested that the designers of technology implementations need to work with their stakeholder groups to clarify their goals and then reason backwards about the experiences they believe will produce the desired outcomes and the inputs that will be needed to create those experiences. In other words, implementing an innovation without an associated theory of learning is unlikely to change the structure or climate of the participating school(s) as a whole.

SYSTEMS AND COMPLEXITY THEORY

Older, linear models such as Diffusion of Innovations and CBAM have some fundamental limitations, which are enumerated in the following list.

1. They tend to deal with centralized organizations rather than school districts characterized by site-based management, online learning communities that are held together by the common interests and focus of their members, or consortia of educational organizations that are held together during the funding period of a grant. Schon (1967) first challenged classical diffusion theory because it did not match the reality of emerging diffusion systems within distributed organizations.
2. They tend to deal with an innovation as a stable entity that is subject to re-invention by its users, rather than an innovation (such as telecommunications) whose very nature is to evolve and change with time.

3. Traditional organizations tend to have hierarchical structures within which an innovation can diffuse vertically (especially if top-down mandated), whereas grassroots innovations within schools tend to diffuse horizontally (Rogers, 1995).
4. They focus on learners within an organization, rather than on a learning organization as a system that adapts and grows. As Gibson (2000a, p. 4) stated, "as people adapt to supportive policy they both contribute to an emergent collective vision and encourage innovations."
5. These are linear models with time as the independent variable. However, the change process is often better described as cyclic in nature.
6. Most importantly, the traditional models deal only with internal factors, and ignore external factors. For example, "good teaching practice" as an internal factor may be commonly understood within a school and evaluated by one's principal and peers. However, formal statements of "good practice" such as NCATE, NCTM, and ISTE content and performance standards represent external factors that must be considered by schools of education for credentialing purposes.

It is important to note that both the Rogers and CBAM models dealt with adoption, implementation, and institutionalization of an innovation within a social system or organization. However, many educational innovations take place within the time and funding limitations of a grant. One cannot speak of a grant as being institutionalized; hence, alternatives to institutionalization must be explored. Moreover, the adopting systems tend to be large and complex, and often diffused.

Systemic Change

Stiegelbauer (1994) and Fullan (1996) shifted the emphasis of change from the management and implementation of a single innovation to the development of a system's capacity for change. While all innovations lead to change, not all changes are innovations. Change is a process of altering the form or function of a person, a thing, or a system; systemic change comes about slowly. Clearly, systemic change is far more difficult to implement than piecemeal change efforts or localized efforts to implement an innovation. Stiegelbauer (1994, p. 38) emphasized collaboration among people who are working together to cope with problems and who are furnishing support to one another to make the risk taking more rewarding. "Thinking about change as a learning process opens the door to opportunities to reframe, look at results differently."

Systemic change requires resources in the form of people, money, supplies, facilities, and time to learn and experiment. Change must be effective at the local level, or it will not work at the system level, no matter how good the innovation may be. To Stiegelbauer, changing the culture of the organization is the real issue. "Effective change no longer affects one teacher in one classroom, but the very culture of schools." (Stiegelbauer, 1994, p. 26) This requires collaborative work to institutionalize the interactions and communication channels that link the different levels and participants in the system, to address both local and global concerns, and to respect all elements of the system for what they can contribute to the change process. As the change process moves from initiation to implementation to institutionalization, "administrative support is vital to change, and policy decisions make and break change efforts" (Stiegelbauer, 1994, p. 35).

Anderson (1993) explored systemic change in the context of school restructuring, that is, fundamental change in the nature of the educational system. She described six stages of change that characterize the shift from a traditional educational system to one that emphasizes interconnectedness, active learning, shared decision making, and higher levels of achievement for all students. Her model is linear, like Diffusion of Innovations and CBAM, but the end point is different. The six stages are:

1. maintenance of the old system;
2. awareness that the current system is not working as well as it should;
3. exploration of new ways of teaching and managing, generally in low-risk situations;
4. transition as a critical number of opinion leaders and groups commit themselves to the new system;
5. emergence of a new infrastructure; and
6. predominance of the new system.

Havelock and Zlotolow (1995) offered a set of system dimensions that can help change agents facilitate systemic change. First, there is the breadth of change that must take place, whether the changes affect the whole system, the roles of individuals, or simply the specific skills that they must master. Second, there is the readiness of the system to inaugurate change. Organizations that perceive themselves as "ready" believe that a change is possible and desirable; but those who believe they are "fixed" are not presently willing or ready to undertake a major change effort. Finally there is system capacity. This dimension addresses whether or not the system has the structure, resources, personnel, time, and communication openness to support

the change (Havelock & Zlotolow, 1995). Considering that systems tend to maintain equilibrium, Havelock and Zlotolow emphasized making small-scale changes in the context of systemic change.

Organizational Learning

One of the most important developments in change theory was Kurt Lewin's change model, developed at the M.I.T. Sloan School of Management. Lewin was among the first scholars to shift the focus from organizational change to organizational learning. Schein (1995) based his systemic change model on Lewin's theoretical foundation of unfreezing, changing, and refreezing. Much of Senge's (1990, 1999) work with learning organizations was based on this foundation as well as on complexity theory.

Schein found that human change, whether at the individual level or at the group level, involved painful unlearning and relearning while individuals attempted to restructure their thoughts, perceptions, feelings, and attitudes. Unfreezing refers to removing the restraining or balancing loops that are often associated with group norms embedded within the organizational culture. Note that a restraining loop is a factor or force that inhibits change within a system, helping the system maintain equilibrium. Its opposite is an accelerating loop, a factor or force that facilitates growth and change of the system (Senge, 1990). The interplay of these restraining and balancing loops are the foundation of systems theory, and are amenable to computer simulation and analysis.

Unfreezing leads to cognitive dissonance or conflict that can be very disorienting to group members as they begin to change. In dealing with such disorientation or disequilibrium, group members must learn how to reframe their thought processes, redefine the words and representations they use to make meaning out of situations, and interpret new concepts more broadly than before. This perspective shift is what Schein refers to as refreezing. Alternately, this process may be viewed as cognitive restructuring, or in simple terms—learning.

The key to effective change management is "to balance the amount of threat produced by the disconfirming data with enough psychological safety to allow the change target to accept the information, feel the survival anxiety, and become motivated to change" (Schein, 1995, p. 4). Here is where mentoring, coaching, and scaffolding come in—they build confidence, help reduce learning anxiety, and thus create genuine motivation to learn and change.

Another important contribution of organizational learning theory to the diffusion of innovations is the concept of boundaries—a concept shared

with complexity theory. Gibson (2000a, p. 1) stated, "Boundaries do not only separate an organization from its environment. They define the internal and external interchanges between the system, its subsystems and their respective environments, which can include other internal parts of the organization as well as the outside." Often, an innovation can succeed within a given subsystem, such as an individual classroom or school, but the innovation may not diffuse beyond the classroom or school boundary to the rest of the system.

Schein (1996, p. 4) explained this as "avoidance of entropy." In other words, what holds a subsystem, division, or subculture of an organization together is not necessarily aligned with what holds the organization as a whole together. Moreover, what stabilizes one subsystem is not necessarily what stabilizes another subsystem. Thus, if a fundamental change occurs in one subsystem—even if it is a more effective innovation—"such a change will threaten the equilibrium in all of the neighboring systems. To avoid the anxiety and possible upsetting of their equilibria, the neighboring systems will defend themselves against the implications of the change." For the entire organization to learn, adapt, or implement an innovation, each subsystem within the organization must go through its own adaptive learning cycle before it can be said that it has learned, changed, or transformed (Schein, 1996, p. 7).

Complexity Theory

Proponents of systems theory and complexity theory have studied the interplay between internal and external factors. Systems theory has a long-standing tradition within both hard sciences and soft sciences such as anthropology (Bateson, 1972). Complexity theory is related to both systems theory and chaos theory. It deals with the dynamics of self-organizing, open systems (Wheatley, 1992; Senge, 1990; Nardi & O'Day, 1999). As in systems theory, complexity theory deals with forces and information that are transmitted through semi-permeable boundaries. Senge (1999, p. 240) stated that as one's work moves out of the initiating phase of profound change into the sustainability phase, one must become increasingly concerned with boundaries: "You are increasingly dealing with organizational culture; you can no longer isolate your team from the larger-scale priorities of your company or agency, from its values…from its ways of measuring success, and from its members' attitudes about you."

Gibson (2000b) treated a school district as a complex system, with schools embedded within it. District resources connect innovators with resources within the school. The district sends information about the amount

of support for innovators within the schools, and information flows back across the school-district system boundary from all unchanged teachers and the newly innovating teachers.

Gibson's view is essentially the same as Nardi and O'Day's (1999), namely, healthy systems are not closed, but are open to external environmental forces and respond to local environmental changes and local interventions. Nardi and O'Day used the metaphor of an ecology to discuss change within a complex system: "Change in an ecology is systemic. Local changes can disappear without a trace if they are incompatible with the rest of the system" (p. 51).

Jenlink (1998) focused on the self-organizing feature of educational systems. He posed the question: how and why do stakeholders organize into communities for change? He found that sharing ideals, beliefs, and values within communities of and for change is important. Honoring these core ideals is crucial to the sustainability of a change community. Moreover, the community must embrace authentic stakeholder participation while honoring diversity of perspectives.

This is similar to Nardi and O'Day's (1999, p. 51) view that different kinds of people, using different kinds of tools in a healthy information ecology, work together in complementary ways: "Information ecologies are filled with people who learn and adapt and create. Even when tools remain fixed for a time, the craft of using tools with expertise and creativity continues to evolve. The social and technical aspects of an environment coevolve" (p. 53).

SUSTAINABILITY

In contrast with the systemic reform literature, which comes primarily from the educational sector, and with the complexity theory literature, which comes primarily from the scientific sector, the sustainability literature tends to focus on lessons from the corporate community. Sharing a knowledge base with both the organizational learning theorists and the complexity theorists, Senge and his colleagues (1999) addressed the questions: How do we go beyond the first steps of corporate change? How do we sustain momentum?

Sustaining Momentum Within a Learning Organization

According to Senge (1999, p. 240), efforts to sustain momentum past the initiating stage must address three challenges: (a) fear and anxiety; (b) the

gap between the change initiative and the organization's ways of measuring results; and (c) the tendency for profound change to fall into an escalating dynamic of perceived threat and siege mentality. Later, there are larger organizational issues to deal with, such as leadership, large-scale diffusion, and reinvention of the organization itself.

Dealing With Fear and Anxiety

Like Hall and Hord (1987) and Schein (1995), Senge (1999) noted that fear and anxiety are natural, healthy responses by individuals to changes in the level of openness among a group of people who are piloting a new innovation. These innovators are often referred to as a "pilot group." Feelings of anxiety may surface among members of the larger organization as concerns, as objections to unintended side effects, or passive resistance masquerading as superficial support.

As learning capabilities develop, Senge noted that candor and openness increase in the pilot group. This can be considered an accelerating loop within the system. However, if there is not a corresponding growth in the members' capacity for openness, an "openness gap" may result, in which people do not have the skills to deal with the emerging issues and problems. Strategies to deal with fear and anxiety include valuing diversity, setting an example of openness, working toward a common vision, and nurturing trust through freedom of choice.

Another strategy, often used in scientific knowledge building, is called progressive discourse (Bereiter, 1994, p.7). Mutual understanding, empirical testability of hypotheses, a commitment to expand the existing body of knowledge, and a commitment to allow any belief to be subjected to criticism if it will advance the discourse characterize scientific discourse. According to Bereiter, these commitments are maintained with sufficient consistency that they define cultural practice. As Schein (1995) noted, this means creating a psychological safety net for members of the group so they can discuss their concerns candidly.

Dealing With Assessment and Measurement

The pilot group sees many innovations as "working" or "producing observable benefits." However, as Rogers (1995) pointed out, those benefits must be observable and measurable by a person OTHER than the innovator.

Senge (1999, p. 281) noted that new practice often results in many changes in traditional measures of assessment. Conversely, if the measures of accountability do not undergo change, then the "no significant difference" effect—as debated hotly by Clark (1983; 1994) and Kozma (1991; 1994) regarding educational media for over a decade—can undermine the innovation.

The link between diffusing an innovation and providing evidence of accountability is undergoing close scrutiny in the area of instructional technology and digital content in K-12 schools today. More and more, academic standards and high-stakes tests are influencing how teachers use technology in their classrooms. A spokesperson for the National Education Association is quoted by Hoff (1999, p. 51) as saying "What I hear from teachers is that, unless we can show them a direct correlation to the standards that they live and die with every day, it may bet the best content in the world, but there's just no way they have time to use it." As a result, the perception of lack of time—which corresponds to lack of personal priority—becomes a balancing loop that limits the diffusion and sustainability of educational technology projects.

There are actually two parts to this balancing loop: a "results gap" between expected results and actual results within the pilot team, and a "negative results gap" within the organization. The first inhibiting factor is frustration within the pilot team because of the time it takes to implement a new innovation. The second inhibiting factor is lack of credibility for the innovation within the organization because assessment of results may require hitherto-undeveloped forms of measurement in order to show some significant difference when compared with the status quo. Rogers (1995) noted that, for an innovation to be adopted, it must have a high degree of observability, that is, a degree to which others see its results as beneficial.

Strategies suggested by Senge (1999, p. 287-289) for dealing with these challenges involve appreciating the time delays that are involved in profound change, learning to make interim assessments, building partnerships with executive leaders around assessing the current assessment processes, and making assessment a priority among change advocates.

Dealing with Perceived Threat

Senge (1999) referred to perceptions of threat from a new innovation as the factor that divides the "true believers" from the "nonbelievers." This is not a new concept. Rogers (1995) referred to this factor as compatibility with the individual's existing values, past experiences, and needs. Wilson and his

colleagues (Wilson, Ryder, McCahan, & Sherry, 1996; Ryder & Wilson, 1996) referred to this as personal/cultural compatibility between an innovation and the adopting population.

In studying the diffusion of the Internet in an institution of higher education, Sherry (1998) noted that the individuals referred to by Rogers (1995) as "laggards" or "resisters," and by Senge (1999) as "nonbelievers," often believed that the innovation may not be compatible with their personal vision, nor worth the time and effort that they must put into mastering a new set of skills. On the other hand, the "true believers" may be closed to the voices of those who disagree with them. Whereas the early adopter faculty members incorporated technology into their teaching and learning, made effective use of it, and were able to express exactly how they were making effective use of it, Sherry (1998) noted that they tended to perceive themselves as radicals, or at times, iconoclasts. Recalling Rogers' (1995) emphasis on client-change agent empathy, it is clear that these faculty members were often fighting an uphill battle in attempting to influence their peers to do likewise.

Sherry (1998) cautioned us to listen to the resisters, because they often are aware of unintended consequences of the innovation, to which the innovators may be blind. On the other hand, Senge (1999) also cautioned us to be aware of the feelings of threat and isolation on the part of the innovators, who often feel unappreciated and misunderstood. "They can easily develop a siege mentality pitted against enemies, even some of whom were former colleagues" (Senge, 1999, p. 320). The complex interactions between these ends of the adopter spectrum, and between members of the pilot team and the larger organization, were enumerated by Senge as follows:

- perceived threats to people outside the team arising from the pilot team's new behaviors, new practices, and improved results;
- lack of credibility of the pilot team because they are not able to explain their efforts and results in ways that the larger organization can understand;
- defensiveness by the pilot team as a result of external criticisms;
- increased confidence and feelings of arrogance within the pilot group, who feel that their way is the only right way; and
- psychological isolation from the rest of the organization and the development of a "siege mentality" by the pilot group.

There are two important ways to deal with this vicious cycle of events. The first is to promote tolerance and cultural flexibility within the organization. This is referred to by Nardi and O'Day (1999, p. 52) as valuing diversity: "Diversity is necessary for the health of the ecology itself, to permit the system to survive continual and perhaps chaotic change. Monoculture—a fake,

brittle ecology—gives sensational results for a short time, then completely fails."

The second way is to promote reflective openness within the pilot group. This is the capacity for people to continually question their own assumptions—the very commitments that underlie Bereiter's notion of progressive discourse within the sciences. Bereiter (1994, p. 9) stated that these commitments are not limited to the scientific community; "the important thing is that the local discourses be progressive in the sense that understandings are being generated that are new to the local participants, and that the participants recognize as superior to their previous understanding."

Specific strategies suggested by Senge (1999, p. 328), in addition to valuing cultural diversity and multiple perspectives, are mentoring, engaging the larger system in dialogues with the pilot group, cultivating reflective openness, respecting people's inhibitions about personal change, communicating simply and eliminating jargon, and connecting all members of the organization through a common sense of purpose and core values.

Dealing With Organizational Issues

As the pilot group develops new learning capabilities, greater focus, and intended results, they act with higher levels of autonomy, often leading to an "autonomy clash" between the group and the organization's governing structures. Addressing this challenge means that change agents must either work within the current governance structure for building up their own capabilities, or to work with executive leaders who have the authority to create or redesign existing governance structures.

Strategies suggested by Senge (1999, p. 372-374) included being strategic when crossing organizational boundaries, experimenting with cross-functional, cross-boundary teams, making executive leaders' priorities part of the pilot team's creative thinking, and articulating the case for change in terms of observable results. Other useful strategies are appreciative inquiry (Cooperrider & Srivastava, 1987), action research (Argyris, 1985) carried out by administrators and innovative practitioners alike, and collaborative inquiry (Isaacs, 1996), referred to by Senge as collective inquiry.

:In exploring collective inquiry, Isaacs (1996) saw a complex interaction between dialogue and organizational "steering mechanisms." Whereas dialogue among team members and across organizational boundaries is based on a willingness to listen to diverse opinions, to inquire into defenses and self-limited reasoning patterns, and to negotiate differences; it is the relatively stable "steering mechanisms" or policies that routinely move the organization

toward its goals. For collective inquiry to take place across boundaries, special environments must be created that foster shifts in thinking and the loosening of these rigid steering mechanisms. Concurrently, there must be a shift in conversational interactions from discussion or "hot inquiry," polarization and conflict, and resistance to changes in self-image; to a true dialogue in which all members share common meanings and develop common understandings.

Isaacs (1996, p. 26) described these shifts as a four-stage process. As dialogue is initiated, participants are concerned with safety and trust in the dialogue environment. Once this crisis is past, they begin to struggle with polarization and the clash of personally held beliefs and assumptions. This is the point at which group members must move from discussion to progressive discourse (Bereiter, 1994) and suspend their personal assumptions to move the dialogue forward. In the third stage, participants begin to inquire into polarization and new ideas, often leading to cognitive dissonance. Here is where generative learning begins to take place.

As Schein (1996, p. 3) explained, an organization's knowledge and learning are embedded in its culture. Culture is what provides meaning and stability. Generative learning means a change in the culture itself, "…a change in the organization's sense of identity, its goals, its core values, its primary ways of working." It also means a change in the members' assumptions. If those assumptions need to change because they are not aligned with new data, then this will lead to anxiety. Anxiety produces denial and various other defense mechanisms that bring about resistance to change. "…This resistance to change is normal and must be sensitively dealt with." As Jenlink (1998) pointed out, it is the skill of the leader or the dialogue facilitator that can help participants move gracefully from cognitive dissonance to generative learning.

In the fourth and final stage, members begin to think generatively, and new understandings emerge, based on collective perception. Gibson (2000a, p. 4) cited an observation by Clarke and his colleagues that aptly described this fourth stage: "In places where innovation succeeds, policy formulation creates tension between aspiration and actuality, allowing a collective 'vision' to emerge that celebrates and encourages new innovations."

Once the innovation begins to produce results and the change process is well underway, the dynamics of diffusion play a critical role in the innovation's sustainability. It is at this point that the system's readiness and capacity for change come into play. The organization's capacity for change depends on the permeability of organizational boundaries, its communications infrastructure, and a learning culture that encourages mutuality, collaboration, curiosity, and reflection across internal and external boundaries (Senge, 1999).

The communications aspect is particularly important here. For a system to function effectively, information must be communicated among all parts of that system. The system's infrastructure must support system-wide dialogue, not just dialogue between the pilot team and key administrators. "Lessons learned" must be captured; data banks of best practices must be created; and networks must be set up that connect experts in the use of the innovation with their peers for internal consulting and mentoring. Finally, responsible organizational members must have the autonomy to make changes when and where they are needed. This harks back to Rogers' (1995) concept of reinvention, that is, the users must be given latitude to modify or customize the innovation to suit their express needs and purposes.

The final stage in this process is the rethinking of the organization's strategy and purpose once changes are well underway. At this point, pilot groups are becoming more reflective and are questioning the basic assumptions or "steering mechanisms" of the organization. They are also dealing with basic questions of the creative process. If new ideas about strategy and purpose conflict with those of the administrators, this could act as a constraint. On the other hand, it could lead to a significant capability for the organization to reinvent itself (Senge, 1999, p. 494).

Once an organization is reinvented, then what? Has the organizational climate changed? Schneider, Brief, and Guzzo (1996) identified four key climate dimensions that helped to sustain organizational change:

1. The nature of interpersonal relationships: is there mutual sharing and trust?
2. The nature of the hierarchy: are decisions affecting work and the workplace made only by top management or with participation from those affected by the decision?
3. The nature of work: Are jobs adaptable by the people performing them? Are the necessary resources available to support new tasks?
4. The focus of support and rewards: Are the goals of work and standards of excellence widely known and shared? What facets of performance are rewarded?

Schneider, Brief, and Guzzo (1996, p. 11) found that the probability of having a change take root was enhanced "when people feel their work is challenging, when they can participate in decisions regarding how the change will be achieved, and when their interpersonal relationships are characterized by mutual trust."

Sustaining the System's Capacity for Innovation

Light (1998) built on the systemic change literature and the organizational learning literature to develop a model for sustaining innovation. His emphasis was on how nonprofit and government organizations can transform occasional initiations of innovations into an everyday occurrence by developing a culture of natural innovation within an organization. According to Light, four main factors influence the degree to which innovations are sustained:

- the external environment in which an organization exists;
- its internal structure;
- its leadership; and
- its internal management system.

The organization's core values also influence the way it pursues its mission. Light identifies four core values: honesty, trust, rigor, and faith.

> Asking about mission is utterly useless if the organization is not honest about answers. Pushing authority downward is a shallow gesture if the organization does not trust its own people. Measuring performance is a waste of time if the organization does not do so with rigor. And successfully challenging the prevailing wisdom without faith in the possibility of success is impossible. (Light, 1998, p. 244)

Like Senge, Light noted that many innovations are abandoned, not at the initiation or implementation phase, but after the implementation phase. Examples of late-stage failure of innovations are Teasley's (1996) study of integration of computers into a K-12 school and Sherry's (cited in Wilson, Sherry, Dobrovolny, Batty, & Ryder, 2002) observations of a work-study training program in a higher educational setting. In each of these cases, "lack of administrative support" was cited as the critical factor that contributed to the failure.

Alternatively, one may view the failure of the work-study program as the interplay of an accelerating loop and a balancing loop. Incoming university freshmen acquired the knowledge and skills to serve as work-study technical support staff within their chosen academic departments (an accelerating loop). However, they met with insurmountable hurdles from the university's student registration and payroll structures regarding access to computer labs and lack of work-study positions within their respective departments (a balancing loop). The internal management structures overpowered the

energies pushing for innovation, and a stable state was maintained through rejection of the innovation.

External Environment

According to Light (1998), five factors in the external environment facilitated or inhibited innovation:

1. turbulence in the environment;
2. level of shock in the system;
3. support/encouragement for the innovation;
4. collaboration; and
5. availability of support for the innovation.

The term "turbulence" originated with Miles (1983). It referred to the level of uncertainty in the surroundings, that is, external forces in the environment such as the introduction of state standards into K-12 instruction. A shock is an extreme event of some kind, such as a budget crisis or the resignation of a key leader. Support/encouragement for the innovation referred to the capacity of the organization to meet a new idea with enthusiasm and absorb innovations.

Collaboration between the various subsystems of an organization is a particularly important concept, especially with the new grants from the U.S. Department of Education, in which funding is given to consortia of educational institutions such as universities, community colleges, K-12 school systems, and external institutions such as private research and evaluation facilities and corporate sponsors. In distributed organizations, balancing cooperation with competition to achieve collaboration is crucial. One way to achieve this balance is to foster the development of "teamnets" (Lipnack & Stamps, 1993, p. 7)—networks of teams that cross conventional boundaries and that help to bridge barriers inside and outside the organization. The teamnet concept brings two ideas together:

- teams, where small groups of people work with focus, motivation, and skill to achieve shared goals; and
- networks, where disparate groups of people 'link' to work together based on common purpose.

Teamnets support healthy competition by bringing together independent members and multiple leaders, but they also reflect cooperation through

a unifying purpose, voluntary links, and connectedness at all levels, both vertically and horizontally throughout the organization (Lipnack & Stamps, 1993, p. 38).

The final factor is external support for the innovation, sometimes referred to as slack or the level of resources available for discretionary investment. It is this supply of slack resources, whether it involves internal funding for creative projects or a cadre of volunteers who are willing to explore new ideas, that often gives the extra needed "lift" to an innovation.

INTERNAL STRUCTURE

According to Light, five factors that describe the organization's internal environment are important to the success or failure of an innovation:

1. the shape or hierarchical structure of the organization;
2. the demographics or level of diversity of its members;
3. internal turbulence, such as high staff turnover;
4. internal boundaries; and
5. internal resources.

Light noted that successful innovations are generally the product of relatively loose, centralized, organizational structures with good vertical communication channels. This is in consonance with Rogers' (1995, p. 367) observations that in decentralized diffusion systems, innovations tend to spread by horizontal networks among near-peers in a relatively spontaneous fashion.

Both Light (1998)and Nardi and O'Day (1999) believed that diversity is important for generating more points of view and more prospects for new ideas. This is consonant with Rogers' (1995) findings, namely, that information about an innovation flows most freely among individuals who are "homophilous" (empathetic, similar in outlook) and close in physical distance. However, It is the "heterophilous" links (between individuals with different perspectives) among dispersed individuals that play a crucial role in the flow of information about an innovation throughout a system.

The third factor that disrupts the sustainability of innovations is internal turbulence. This may take the form of high staff turnover or frequent reorganizations.

The fourth factor, internal boundaries, has been recognized for a long time in the organizational learning literature as creating barriers to the widespread diffusion of ideas and innovations within a system. As internal

boundaries become more permeable, communication becomes more seamless, and diffusion is enhanced. An example is The WEB Project, a Technology Innovation Challenge Grant in Vermont (RMC Research Corporation, 2000). At any given time, the project director and manager know exactly what is going on at each partner school and cooperating initiative. They understand and immediately respond to needs, and engage in responsive problem solving, typically in close collaboration with their partners. The final factor is internal resources, whether they are staff time, funds, office space, a new computer, or some other tangible signal of organizational support.

Leadership

According to Light (1998, p. 19), "leaders play a central role at virtually every stage of the innovation process, from initiation to implementation, particularly in deploying the resources that carry innovation forward." Leadership in an innovating organization involves five components:

1. the leader's vision;
2. temperament;
3. communication;
4. durability; and
5. innovation skills.

According to Kouzes and Posner (1987, p. 85), vision is an ideal and unique image of the future. The leadership challenge, then, is to envision the future, enlist others and obtain buy-in, foster collaboration through trust, strengthen others by giving them autonomy and recognition, and lead by example or "model the way." The exact way of carrying out this process depends on the temperament of the leader, whether that leader is flexible, entrepreneurial, intuitive, or whatever.

The third component is regular, clear communication that forges a link between the leader's vision of innovation and the organization's overall commitment to implementing and sustaining it. As a result of their studies of distributed organizations and "virtual corporations," Davidow and Malone (1992, p. 59) stated that "The success of a virtual corporation will depend on its ability to gather and integrate a massive flow of information throughout its organizational components and intelligently act upon that information." They also noted that "not only are we receptacles of information, we are also generators. And the information that we generate often induces and controls

the actions of others." This is true of virtual communities of learners that share common interests as it is of corporations in the global marketplace that share a common purpose. A case in point is The WEB Project (RMC Research Corporation, 2000), in which some teachers found that the lack of administrative support within their schools for the innovation (using critique and feedback for improving student products) was offset by the supportive and informative messages that they received from their cohorts in the global, virtual, arts and music communities.

The fourth component is durability or endurance: a leader must prepare for the stress and anxiety that will be encountered as a result of the organizational learning process. Finally, a leader needs innovation skills, which are associated with management skills. A leader must be able to create room to experiment, distribute authority and responsibility, lower the barriers to internal collaboration, and foster new ideas (Light, 1998, p. 98).

Internal Management Systems

Whereas a good leader creates vision and buy-in, a good manager helps to keep the organization on track. There are six management systems identified by Light (1998) that contribute to an innovating organization's success:

1. mission management;
2. pay and personnel;
3. learning;
4. idea generation;
5. budget; and
6. accountability and governance.

Mission management refers to knowing whom the organization serves, what it values, where it is headed, and how it will know when it gets there. It involves strategic planning, forecasting, evaluation, and contact with the external environment.

The relationship between remuneration, career advancement, and diffusion of innovations is not clear because different adopter categories value different types of incentives. Morse (2000, p. 11) cited Martin's (1991) motivational model, which links five motivational forces and the attitude types that are most influenced by each force:

- experimenter—excitement, prestige;
- early adapter—excitement, prestige, pride, money;

- pragmatist—prestige, pride, money;
- late adapter—money, fear; and
- resister—fear

However, it is not clear whether or not this model has a firm empirical basis.

Lack of pay is certainly a disincentive, especially when adopting an innovation means that an individual must go through a learning curve and possibly take on new responsibilities as a result of developing expertise. Release time, college credit, credit for recertification, and discounts for home computers have often been used as incentives for teachers to adopt technology and use it in their classrooms to support teaching and learning.

In the context of sustainability, "learning" means organizational learning rather than skill and knowledge development by an individual. An organization learns when it uses feedback for continuous improvement, whether that feedback comes from within (as in course evaluations for in-house training sessions) or from without (such as from external evaluators for a grant).

Idea generation refers to establishing systems for provoking new ideas. These can be formal systems such as online forums, or informal systems such as suggestion boxes.

Budget is an essential characteristic of any organization. There must be a balance between protecting the organization's assets and making investments in risky ventures. There must be a means to protect the organization if the innovation proves too costly to implement and sustain.

Accountability is assured through monitoring, support, capacity building, and increased performance. The nature of the organization will dictate whether a compliance-based model that puts its faith in carefully written rules and protocols, a capacity-based accountability that invests in people and technologies as a way to assure that tasks are managed and carried out effectively, or a performance-based accountability that measures outcomes against some standard will be chosen. Regardless of which model is chosen, it is important that the organization pay careful attention to outcomes.

SUGGESTIONS FOR FURTHER RESEARCH

The organizational literature emphasizes changing the structures and culture of an organization to turn a traditional organization into a "learning organization"—an organization that adapts to innovation and restructures itself to accommodate change. However, this model may not necessarily apply to school restructuring in the same way as it does to corporate restructuring. For example, Elmore (1995, p. 26) noted that educational reformers

tend to focus on changing school structures before they focus on changing norms, knowledge, and skills of the teachers who adopt and implement new forms of teaching and learning. He suggested that "researchers should probe underneath the structures to discover, both conceptually and empirically, what changes in teaching practice and student learning are actually entailed in them, and what evidence one would accept that changes in structure were actually related to changes in practice and learning."

Another area that deserves further study is this: once the funding period of an innovative grant is over, and the organization no longer exists. How do the innovation, the valued activities associated with it, and the structures that support it, evolve? For a Technology Innovation Challenge Grant (TICG) such as The WEB Project (RMC Research Corporation, 2000), the art and music initiatives joined together to form a new, nonprofit entity with the purpose of continuing and refining the art and music critique activities. For other grants, there are possibilities of forming new partnerships and leveraging new funding to continue to support the innovation. This is currently being done within the 1999-2000 round of Preparing Tomorrow's Teachers to use Technology (PT3) grants, notably the GENASYS, TEN, and TALENT Projects. However, as the leadership changes, how might the innovation be reinvented to suit the new, distributed organization's mission?

A third area to explore is one referred to by Miles (1983) as job mobility or career advancement motivation. Sherry and her associates (Sherry, Billig, Tavalin, & Gibson, 2000) observed that as teachers gain expertise with a new instructional innovation, they expand their roles to become active researchers who carefully observe their practice, collect data, share the improvements in practice with peers, and teach new members. Their skills become portable. An important research question emerges: how does "portability" affect sustainability? According to Miles (1983, p. 19), "job mobility, whether driven by advancement motivation or by funding cuts, is a threat to institutionalization." However, when these teachers are connected by a virtual network that allows them to cross-institutional boundaries, as in a "teamnet" (Lipnack & Stamps, 1993), they actually strengthen the virtual community and sustain the innovation. This is an area that is ripe for further investigation.

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