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# Educational Technologists, Chameleons, and Systemic Thinking

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Reiser and Salisbury (1991) report several studies that reveal educational technology having relatively little effect on public education in the United States. Similarly, a report by the Alberta Department of Education (1987) noted that:

> Historically, the role of technology in education has been incremental and peripheral, with new technologies being added to the traditional teacher-centered model of instruction. This process has resulted in large expenditures and increases in teacher workload with no significant improvement to the performance of the education system (p. 26).

Meanwhile, we educational technologists are being confronted with an accelerating rate and magnitude of change. This change has two driving forces. One is the change in needs that educators and trainers must serve. As we evolve from the industrial age into the information age, the educational needs of society are dramatically changing (as are the training needs of corporations), requiring educational technology to dramatically change to meet those new needs.

The other driving force is changes in technology. As educational technologists, we now have tools at our disposal that are far more powerful, numerous, and complicated than just a decade ago. Like the chameleon, as this "environment" in which we work changes, we must adapt to those changes if we are to succeed. If we don't change, we will likely find ourselves, in an age of CDs, either still using Victrolas or committing ourselves to 8-track audiotapes.

Under these circumstances, how can we make good decisions about changes for our schools or training departments?

Systemic thinking is a powerful tool that can help us to understand why educational technology has had relatively little effect on education and training, and to understand the changes that are swirling around us, so that we can respond to those changes in ways that will enhance our success. This article will explore what systemic thinking is and how it can help educational technologists in these turbulent times.

## *WHAT IS SYSTEMIC THINKING?*

Hall and Fagen (1968 in Weinberg 1975) define a system as "a set of objects together with relationships between objectives and between their attributes" (p. 63) whose function as a whole is to achieve a common purpose (Betts 1992). Ackoff (1981) describes a system as having a set of two or more elements that satisfy the following three conditions:

1. The behavior of each element has an effect on the behavior of the whole;
2. The behavior of the elements and their effects on the whole are interdependent (no element has an independent effect on the whole); and
3. However subgroups of the elements are formed, each has an effect on the behavior of the whole, and none has an independent effect on it.

Therefore, when a system is taken apart, it loses its essential properties. Because of this, analysis and reductionism do not work in understanding systems.





Systems thinking is a process through which all aspects of a situation or problem are considered, including the objectives, functions, personnel, and available resources (Tiffin 1978) with the primary purpose of understanding the *whole* (Weinberg 1975). It is a holistic approach to problem-solving (Bawden 1991) further described by Ackoff (1981) as synthesis, the act of putting things together, the opposite of reductionism. The reductionist view was the prevailing mechanism for understanding problems in the industrial age. It reduces problems to their smallest elements in an attempt to analyze and understand each piece. Complex and dynamic questions go unanswered and problems unresolved when reductionism and analysis are employed, because these methods inhibit understanding the whole (Ackoff 1981).

Systems thinking combines the complementary processes of analysis and synthesis in a new way. Ackoff (1981) describes three steps that reverse the analytical (reductionistic) thinking of the machine age:

1. Identify a containing whole of which the thing to be explained is a part;
2. Explain the behavior or properties of the containing whole; and
3. Explain the behavior or properties of the thing to be explained in terms of its role or function within its containing whole.

In this sequence, synthesis precedes analysis. Analysis focuses on structure, while synthesis focuses on function, for it reveals why things operate as they do. Synthesis yields understanding and enables us to explain. The purpose of systems thinking is, then, to understand the *function* of the system within the context of its environment. An application of systems thinking would be to understand the function and roles of educational technology within the context of the larger educational system, not in isolation.

## *HOW SYSTEMIC THINKING CAN HELP EDUCATIONAL TECHNOLOGISTS*

The "containing whole" (or supersystem) for an educational system is the society (or community) it serves. Similarly, for a training system, it is the company (or organization) it serves. When the suprasystem changes in significant ways, the educational (or training) system must change in equally significant ways. For example, as has been described in more detail by Reigeluth (1994), in the Agrarian Age, the horse was the predominant and most appropriate mode of transportation. But as we began to evolve into the Industrial Age, the transportation needs of society changed dramatically. It became necessary to ship large quantities of raw materials and finished goods to and from factories. The transportation system responded with a systemic change, or paradigm shift, in which the railroad became the predominant mode of transportation, and it afforded a quantum improvement in the ability to meet the new transportation needs. Now, as we are evolving into the information age, we find our transportation needs have again dramatically changed, and a new, more complex, and diverse paradigm has emerged: a combination of the automobile and airplane, which has similarly afforded a quantum improvement in meeting our new needs.

Educational systems are like transportation systems in some important ways. The one-room schoolhouse was much like the horse in that it was personalized and flexible. And our current educational system is much like the railroad in that everyone must leave from the same place at the same time and travel at the same speed to the same destination, or be dropped off along the way (Reigeluth 1994).

We have seen similar paradigm shifts in other major systems in our society, as table 1, page 134, illustrates. This helps us, as educational technologists, to understand that our educational and training systems are at a point where a true paradigm shift is necessary, and we have a particularly important role to play in shaping the systemic changes that will inevitably occur within our organizations.

**Table 1**
Major Paradigm Shifts in Society

| Society: | Agrarian | Industrial | Information |
|---|---|---|---|
| Transportation: | Horse | Train | Plane & car |
| Family: | Extended family | Nuclear family | Single-parent family |
| Business: | Family | Bureaucracy | Team |
| Education: | One-room schoolhouse | Current system | ? |

*Source:* From Reigeluth 1994.

To help prepare for our role in the systemic change process, we educational technologists must understand the ways that education is likely to change, which of course depends on the ways in which the educational needs of our supersystems are changing, as well as the advances in tools that are available to help meet those new needs. Reigeluth (1994) describes in some detail the ways that society and its various systems are changing (see table 2) and explores the educational implications of those changes.

**Table 2**
Major Differences Between the Industrial Age and the Information Age That Affect Education

| Industrial Age | Information Age |
|---|---|
| Mass production, etc. | Customized production, etc. |
| Adversarial relationships | Cooperative relationships |
| Bureaucratic organization | Team organization |
| Autocratic leadership | Shared leadership |
| Centralized control | Autonomy with accountability |
| Uniformity | Diversity |
| Autocracy | Democracy |
| Compliance | Initiative |
| One-way communications | Networking |
| Compartmentalization (Division of Labor) | Holism (Integration of tasks) |

Perhaps of most significance to educational technologists is the move from mass to customized: mass production to customized production, mass transportation to customized, mass communication to customized, and so forth. In education, we certainly use a mass approach, as reflected by the railroad analogy. We teach a large group of learners a fixed amount of content in a fixed amount of time. But if there is one thing educators can agree on, it's that people learn at different rates and have different learning needs. So, if we hold time



constant, we force achievement to vary. If we truly want all learners to succeed, we need to allow time to vary.

Having an attainment-based system rather than a time-based system has tremendous implications for our whole educational system, in that it truly represents a paradigm shift. It means having personal learning plans, rather than group-based progress, which means doing away with classes and grade levels as we know them. Because the teacher cannot be teaching different things to each learner all at the same time, it also means a different role for the teacher—more of a guide on the side than a sage on the stage. Teachers are freed from their role as sole disseminators of content and allowed to develop a more personal relationship with the learner, leading to the development of a personalized learning plan for each, and more time spent guiding and motivating learners (Frick 1991). It also requires more reliance on team-based learning, as well as a more central—rather than peripheral—role for technological tools, which interestingly are becoming far more powerful than ever. The very information technologies that are making a paradigm shift in education necessary are also providing the tools to make it possible, just like the industrial technologies that made the railroad necessary also provided the tools to make it possible.

Reigeluth (1994) and Reigeluth and Garfinkle (1994) provide considerable discussion of the kinds of changes that seem likely as we evolve to Information Age systems of education and training. Some of those are summarized in table 3.

**Table 3**
Emerging Picture of Features for an Information-Age Educational System Based on Changes in the Work Place

| Industrial Age | Information Age |
|---|---|
| Grade levels | Continuous progress |
| Covering the content | Outcomes-based learning |
| Norm-referenced testing | Individualized testing |
| Non-authentic assessment | Performance-based assessment |
| Group-based content delivery | Personal learning plans |
| Adversarial learning | Cooperative learning |
| Classrooms | Learning centers |
| Teacher as dispenser of knowledge | Teacher as coach or facilitator of learning |
| Memorization of meaningless facts | Thinking, problem-solving skills and meaning making |
| Isolated reading, writing skills | Communication skills |
| Books as tools | Advanced technologies as tools |

*Source:* From Reigeluth 1994.

But here we would like to focus on how the use of media and technology is likely to change as the educational paradigm shifts. We envision the changes shown in table 4, page 136.

**Table 4**
Changing Use of Media and Technology

| Industrial Age | Information Age |
|---|---|
| Primarily used by teachers | Primarily used by students |
| Adjunct to the teacher | Stand-alone |
| Used individually by students | Used collaboratively by students |
| Instructs all learners in the same way | Customized for learner's needs, style |

These changes in the use of media and technology will have a significant impact on the educational technologist's methods, role, and expertise. Our success in these turbulent times will depend to a large extent on whether we anticipate and prepare for these kinds of changes.

Furthermore, given the more central role of educational technologies in our future instructional systems, it is imperative that we educational technologists become actively involved in the change processes that our organizations undertake. As with the change from the record player to the CD player, systemic changes are driven not only by changing educational needs but also by advances in technological tools available for meeting those needs. As those tools become more and more powerful, they make new ways of teaching possible. Our input is essential to successful change efforts in our organizations. In fact, we should be playing leadership roles in those change efforts.

This raises the issue of how to help your organization engage in a systemic change process. Educational technologists can play a significant role in a systemic change effort through an awareness of the systemic effect of any changes being considered. You can communicate this awareness to other educational professionals, creating a grassroots activity that can lead, facilitate, and support a systemic change effort. The most important activity in any systemic change effort is fostering an evolution in mindsets. We educational technologists, typically on the cutting edge of change, are in optimal positions to facilitate this process. For more information about how to enhance the success of a systemic change effort, see Jenlink, Reigeluth, Carr, and Nelson (1996); Fullan (1991); and Banathy (1991, 1994).

## *CONCLUSION*

Systemic thinking is a powerful tool that can help us to understand why educational technology has had relatively little effect on education and training. And it can help us to understand the forces for educational change around us that are driven by the changing educational needs of society and the changing technological tools at our disposal, both of which become more pronounced as we evolve deeper into the Information Age. We have looked at what systemic thinking is and how it can be helpful to educational technologists, so we may adapt, like the chameleon, to changes in our environment (supersystem). Systems thinking can be used to synthesize and analyze current instructional problems and to design solutions. If it is used appropriately, we can end up with CDs, which became the predominant paradigm of music medium, rather than ending up with 8-track audiotapes, which obviously didn't. It seems likely that time-based, teacher-centered instruction will give way to customized, learner-focused instruction in which educational technology assumes a more central role. But for this to happen, we educational technologists must learn more about systemic thinking and the systemic change process so that we can provide the kind of leadership and vision so sorely needed in education and training today.



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