

Systemic Change in Education

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**EDUCATIONAL TECHNOLOGY PUBLICATIONS
ENGLEWOOD CLIFFS, NEW JERSEY 07632**

1994

Introduction

The Imperative for Systemic Change

Charles M. Reigeluth

There has been much publicity about the need for systemic change in education recently. Increasing numbers of educational leaders are advocating it, including Ernest Boyer (1983), John Goodlad (1984), Theodore Sizer (1984), Lewis Perelman (1987), Ann Lieberman and Lynne Miller (1990), Albert Shanker (1990), and Bela Banathy (1991, 1992). The New American Schools Development Corporation has drawn national attention to it with their ambitious, highly-publicized effort (see the article by C. Reid Rundell in this volume).

But what actually is systemic change? And why is it needed in education today?

What Is Systemic Change?

It is helpful to think in terms of two different kinds of change:

- piecemeal change, often called tinkering, which entails modifying something (fixing a *part* of it), and
- systemic change, often called paradigm shift, which entails replacing the *whole* thing.

Systemic change is comprehensive. It recognizes that a fundamental change in one aspect of a system requires fundamental changes in other aspects in order for it to be successful. In education, it must pervade all levels of the system: classroom, building, district, community, state government, and federal government. And it must include the nature of the learning experiences, the instructional system that implements those learning experiences, the administrative system that supports the instructional system, and the governance system that governs the whole educational system (Banathy, 1991).

Such an approach to change is indeed radical, not to mention difficult and risky. Do we really need such a radical change?

Why Is Systemic Change Needed in Education?

Daniel Bell (1973), Alvin Toffler (1980), Robert Reich (1991), and others have identified several massive changes that our society has undergone: from the agrarian age to the industrial age, and now entering into what some call the information age.

The dawn of the industrial age brought with it massive changes in *all* of society's systems, including the family, business, and education. In fact, that is the only time in the history of the United States that education has undergone systemic change—from one-room schoolhouses to the industrial, assembly-line model we have today. The current system is substantially the same as it was when we became an industrial society. The reforms that have been made since then have all been piecemeal changes.

Now that we are entering the information age, we find that paradigm shifts are occurring or will likely soon occur in *all* of our societal systems, from communications and transportation to the family and the workplace. It is little wonder that we again find the need for a paradigm shift in education. Society is changing in sweeping ways that make our current educational system obsolete.

Changes in Society

Let's begin with a look at the family. The extended family in the agrarian age entailed the parents and children living together with grandparents and even aunts, uncles, and cousins. This gave way to the nuclear family in the industrial age. In turn, the information age has given rise to the single-parent family and the dual-income family. This societal change has important implications for the kinds of changes needed in education.

As a second case in point, businesses in the agrarian age were organized around the family: the family farm, the family trade (e.g., bakery, carpentry). The family represented the organizational structure and lines of authority. This gave way to the bureaucratic form of organization in the industrial age. Today, corporations are restructuring to create horizontal "enterprise webs" in place of vertical layers of middle managers (Reich, 1991). Transformations based on team approaches, total quality management, and technological imperatives are rapidly changing the structure of businesses worldwide.

Of all our societal systems, business is the most user-driven (client-driven), so it has naturally been among the first to systemically transform itself (Ackoff, 1981). However, *all* our other societal systems, including education, health, legal, and political, are also becoming increasingly dysfunctional as we evolve deeper into the information age; and

systemic transformation will be needed—and will be inevitable—in all these areas, including education.

By way of comparison, educational systems are like transportation systems in some important ways. Like the one-room schoolhouse, the horse was ideally suited to the agrarian age. It was highly flexible and individualized. But as we evolved into the industrial age, the transportation needs of society began to change. It became necessary to transport large quantities of raw materials and finished goods to and from factories. Rather than trying to improve the prevailing system, an alternative paradigm was developed—the railroad. Like our current educational system, it offered a quantum improvement in meeting the new needs of the industrial age, but everyone had to travel at the same rate to the same destination.

Since the dawn of the information age in the 1950's, America's transportation needs have again been changing in dramatic ways. And again we have turned to a new paradigm, a combination of the automobile and the airplane. Society has been changing in such dramatic ways (see Table 1) that we need a new educational system that is as different from our current system as the automobile and airplane are from the railroad. Like the new transportation system, the new educational system will likely grow up in parallel with the current system, will be separate from but coexist with it, and will slowly grow while the current system slowly declines. It is simply not logistically possible to change the current system everywhere at once.

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	?

It is clear that paradigm shifts in society cause (or require) paradigm shifts in *all* societal systems. This explains why educational performance has generally declined in the United States since the early 1960s, while educational costs have dramatically increased. Furthermore, it indicates that the situation will continue to get worse no matter what piecemeal changes we make and no matter how much money we pour into the current system.

Relationships Between Society and Education

The need for a new paradigm of education is based on massive changes in both the conditions and educational needs of an information society. Therefore, we must look at those changes in order to figure out what features the new system should have. Table 2 shows some of the major differences between the industrial age and the emerging information age. These differences have important implications for the features of the new educational system: how it should be structured, what should be taught, and how it should be taught.

Table 2: Major Differences Between the Industrial Age and the Information Age that Affect Education

Industrial Age	Information Age
Adversarial relationships	Cooperative relationships
Bureaucratic organization	Team organization
Autocratic leadership	Shared leadership
Centralized control	Autonomy with accountability
Autocracy	Democracy
Representative democracy	Participative democracy
Compliance	Initiative
One-way communications	Networking
Compartmentalization (Division of labor)	Holism (Integration of tasks)

Our current system has adversarial relationships not only between teachers and administrators, but also between teachers and students and often between teachers and parents. Consolidated districts are highly bureaucratic, centrally-controlled "dictatorships" in which students get no preparation for participating in a democratic society. Leadership is vested in individuals according to a hierarchical management structure,

and all those lower in the hierarchy are expected to obey the leader. Learning is highly compartmentalized into subject areas. Students are treated as if they are all the same and are all expected to do the same things at the same time. They are also forced to be passive learners and passive members of their school community. These features of our current system must all change (and are indeed beginning to change), for they are counterproductive—harmful to our citizens and our society—in the information age.

In the industrial age we needed minimally educated people who would be willing and able to put up with the tedium of work on the assembly lines. However, those assembly-line jobs are rapidly becoming an endangered species. Just as the percentage of the work force in agriculture dropped dramatically in the early stages of the industrial age, so the percentage in manufacturing has been declining dramatically over the past few decades. As Reich (1991) points out, even in manufacturing companies, a majority of the jobs today entail manipulating information rather than materials. Just as the industrial age represented a focus on, and extension of, our physical capabilities (mechanical technology), so the information age represents a focus on, and extension of, our mental capabilities (intellectual technology). This makes effective learning paramount. But, surprisingly, our current system is not designed for learning!

Systems Thinking Applied to Learning

Two things educators know for certain are that different children learn at different rates, and different children have different learning needs, even from their first day at school. Yet our industrial-age system presents a fixed amount of content to a group of students in a fixed amount of time, so it is like a race in which we see who receives the A's and who flunks out. Our current system is *not* designed for learning; it is designed for selection.

To emphasize learning, the new system must no longer hold time constant and allow achievement to vary. It must hold achievement constant at a competency level and allow time to vary. There is no other way to accommodate the facts that different children learn at different rates and have different learning needs. But to have an *attainment-based* rather than time-based system, we must in turn have *person-based progress* rather than group-based progress. And that in turn requires changing the role of the teacher to that of a *coach* or *facilitator/manager*, rather than that of dispenser of knowledge to groups of students who pass by at the ring of a bell like so many little widgets on an assembly line.

If the teacher is to be a facilitator and educational manager, then that requires that the system be *resource-based*, utilizing powerful new tools

offered by advanced technology, rather than teacher-based. And it requires much more collaboration and teamwork among students, including *cooperative learning* and cross-age tutoring, rather than our traditional view that collaboration among students equates with cheating.

Interestingly, the industrial age not only made a new system of transportation—the railroad—necessary (to ship large quantities of raw materials and finished goods to and from factories), but it also made the railroad possible (with its manufacturing technology). In a similar way, the information age has not only made a new educational system necessary, but has also made a new system possible (with its information technologies). We now have powerful tools to facilitate learning that we did not have a few years ago. And the power of those tools continues to increase, while their cost continues to decline dramatically.

Hence, based on changes in the workplace, the emerging picture of the new educational system includes the changes shown in Table 3.

Table 3: Emerging Picture of Features for an Information-Age Educational System Based on Changes in the Workplace

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

Education and Systemic Changes in the Family

The information-age family also has important implications for the new educational system. Given the predominance of single-parent families and dual-income two-parent families in advanced countries, parenting is not occurring today as it did in the industrial age. Latch-key children are just the tip of the iceberg regarding the shortage of communication, caring, and structure that students receive in the home. Add to that the increasing incidence of mental and physical child abuse and the alarming increase in the number of children born with chemical-abuse problems. We can see that our society will face very severe social problems 20 years from now if our educational system does not team up with other social service agencies to become a system of learning and human development—a system that is concerned with the development of the whole child, not just the child's mental development.

In the new educational system, the "school" needs to become a caring environment. Our current system seems to have been designed to be just the opposite. Not only do we require students to change teachers every year, but we require them to change every 45 minutes! And teachers only see students in large groups, as if to minimize personal interaction. Schools are often so large that an atmosphere of impersonality, bureaucratic control, and helplessness results in feelings of anonymity and behavioral problems. We need to create smaller "schools within a school" that operate independently of one another, and each child needs a mentor who will stay with her for a number of years, perhaps a developmental stage of her life. And the mentor should be concerned with the development of the whole child, including all of Gardner's (1987) "seven intelligences" and more: mental, physical, emotional, creative, social, psychological, and ethical (see Table 4).

Decision-Making Systems: Accountability, Incentives, and Resource Allocation

In our industrial-age educational system, as in our industrial-age businesses, accountability, incentives, and resource allocation are all handled by a bureaucratic system in a top-down manner. Many businesses have recently been moving away from the bureaucratic system to a more team-based organization (what Reich calls "enterprise webs") in which decisions are much more client-driven than bureaucracy-driven. Indeed, it is emerging as a characteristic of information-age organizations. Given this, the American movement to establish national standards will likely be counter-productive if the standards become a tool for a bureaucracy-driven system for making

Table 4: Emerging Picture of Features for an Information-Age Educational System Based on Changes in the Family

- A "teacher" is responsible for a child for a period of about 4 years.
- That teacher is responsible for educating the *whole* child.
- Each school has no more than 10 teachers, to create a smaller, caring environment (the notion of schools-within-a-school).
- Each student develops a quarterly contract with the teacher and parents.

decisions regarding accountability, incentives, and resource allocation. Alternatively, standards will be very useful if they are a tool to serve a client-driven system.

Summary

When we look at the ways society is changing as we evolve more deeply into the information age, we can see definite trends in the workplace, the family, and decision-making systems. From those changes, we can identify new features that an information-age educational system should have to meet the needs of society. Unfortunately, educators aren't taking this kind of needs-based, systems-design approach to improving education. Without such an approach, we will almost certainly be condemned to a system that does not meet society's needs. □

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Envisioning a New System of Education

Charles M. Reigeluth and Robert J. Garfinkle

Authors' note: This article is taken largely from a proposal to the New American Schools Development Corporation. We are grateful to Ruth Mitchell, Alison Carr, and many others who provided valuable input to this vision. However, the statements presented herein do not necessarily represent their views.

In an earlier article in this book, Reigeluth indicated that the need for a new paradigm in education is based on massive changes in both the conditions and educational needs of the emerging information society, and that we must therefore analyze those changes in order to figure out what features our new systems should have. Furthermore, he discussed some of the most important changes in society and identified their implications for some general features that a new educational system should have.

This article presents a more detailed image of the features that appear to us to be emerging from the new conditions and educational needs of an information society. We call this image "LearningSphere 2000." The purpose of this article is to present one possible image of a different paradigm of education, to help those interested in systemic restructuring both to "jump out" of their current mindsets about education, and to offer some ideas they might find useful for their own new system. Although this image contains many features that are likely to be universal in a successful information-age system of learning and human development, it also contains many particulars that could vary from one community to another, and some controversial features that will vary as community values vary. Due to space limitations, no attempt will be made to justify any features. They are included as illustrative rather than prescriptive and to stimulate thinking rather than to present a solution;

not all aspects will be necessary or even advisable for any given community.

1. Learning Experiences

In the LearningSphere 2000 system, each student will have specific learning goals (set by a process described later). Progress will be continuous and personalized. The student may work on a goal in many different ways:

- alone, in a pair, or in a small team;
- with an expert (teacher or community member), a facilitator (assistant, volunteer, or student), or nonhuman resources (hands-on materials, computer-based resources, multimedia resources, or print materials);
- at a site in the community, a computer-based multimedia simulation, a hands-on learning lab, or a meeting room or library.

Learning will be an active process whereby the learner constructs meaning. Tasks that are vehicles for such learning will be "authentic" tasks, often in real-world environments, rich for learning. As students seek to solve real-world challenges, they will find the need for mathematical and communication skills and will then be more motivated to learn them. Most tasks will be interdisciplinary, drawing on both specific knowledge and such general skills as transfer of information across settings, negotiation and interpersonal skills, and decision-making skills.

Each learner must master a task before progressing to a task that builds on it. Students will gradually be given more and more responsibility for directing and managing their own learning, although some will require more structure than others. They will prepare for periodic performance mastery assessments. Great emphasis will be placed on finishing what they start.

2. New Roles for Teachers: Guides

To implement this vision of learning, the teacher must be more a "guide on the side" than a "sage on the stage." She or he will be an instructional manager and facilitator who helps the student and parent(s) decide upon appropriate instructional goals (subject to standards set by the community, state, and nation), and then helps identify and coordinate the best means for the student to achieve those goals.

A guide will assume responsibility for each of her students for one developmental stage of the student's life—approximately 3 to 5 years. Instead of grade levels, the school will be structured around five developmental levels (see Section 8, "Developmental Levels," below).

Each guide will work with a child for an average of four years, building a long-term, caring relationship. Mechanisms will be in place to appeal for a change if the parents, children, and/or guide are not pleased with the pairing.

Each guide will use apprentices, advanced students, and volunteers as assistants to further the learning and development of his students. Assistants and volunteers will be able to earn credits for their services. Those credits will entitle them to personal use of the learning centers (see Section 6, "Learning Centers," below) to continue their own education, or use of the child care center for their children.

3. "Clusters" as Schools

In professions such as medicine and law, colleagues often consult with each other, rather than always working in isolation. Unlike current teachers, they have a high degree of decision-making participation in, and control over, their organization. In a similar way, even though parents will choose a guide, that guide will not work independently, but will be a member of a "cluster" of guides.

A cluster will consist of about 4 to 10 guides (including a leader, a "master guide"), their assistants, and their students, and it will function somewhat like an independent contractor hired by the school district. In the larger industrial-age school buildings we have inherited, each cluster will occupy a separate wing or floor of the building, but will share some facilities, such as the gym, library, and cafeteria. Anywhere from one to a hundred clusters will be located in a single building, depending on its size. New educational buildings will likely have a very different design.

As does a lawyer in a law firm, each guide will have considerable responsibility for the success of the cluster and considerable incentive and authority to meet that responsibility.

4. Choice, Incentive, and Decision-Making System

Parents will request, in order of preference, about three to five guides for each of their children. An independent, district-wide, Consumer Aid Agency will provide information about each guide, as well as diagnostic testing and interviews to help parents make the best decision, or to make it for them if they won't participate. Each guide will decide how many children to accept each year, but will not decide which children to accept. That will be decided by a formula that maximizes the number of first choices filled district-wide, within the constraints of racial and socio-economic balance guidelines. The guide's pay will vary directly with the number of students she accepts, as well as with the cluster's success in teaching.

If the number of first-, second-, and third-choice requests for all of its guides is high, a cluster will get a certain percentage increase in full-time-equivalent (FTE) money for its guides' salaries (regardless of how many students the guides accept). This will provide an incentive for all guides to improve and for the best guides to remain in teaching. The Consumer Aid Agency will help to keep this from turning into a popularity contest. Guides will be able to choose to take a reduced load, or may be forced to if they are in low demand.

Competition among clusters can have negative effects unless the system is designed to avoid them. Therefore, the salary supplement for each *cluster* will vary with the demand for its guides, not the salary supplement for each *guide* directly. The distribution of any salary supplement will be determined collectively by the cluster guides, and its guides collectively will decide how to spend their budget. This will result in a combination of *competition* among clusters (providing incentives for excellence and responsiveness to the community's diverse desires and needs) and *cooperation* within each cluster (providing support and encouragement among guides), like that characterizing most other professions.

Excluding the guides' salaries, the expenditure per child will be equal across all clusters for a given developmental level, except for supplements for special-needs children. A cluster will have full authority to decide how it spends that money, including the amount of space it will rent from the school district, the amount of learning resources it will buy or rent, and the number and type of support people it will hire.

A cluster whose guides are in high demand will be able to accept more students, hire more support personnel, and even hire (or promote from within) a new guide, like a new partner in a law firm. On the other hand, a cluster whose guides are in low demand will get less FTE salary money to split among its guides, plus its guides will receive less than a full (FTE) salary if they don't have a full load of students. Therefore, a guide who is not successful will receive less money, as happens in other professions, and may decide to look for another job. In this way, personnel hiring and firing will be removed from a bureaucracy-based decision-making process and turned over to a client-based system that allows for constant adjustment to the changing needs of the community. "Incubation" policies will encourage the formation of new clusters. And a rating mechanism will exist whereby other "clients" of education, such as employers and senior citizens, will have an impact on the client-based decision-making system.

5. Clusters as Flexible Learning Organizations

Our current educational system is highly resistant to change, so that a crisis is necessary before any significant change can take place. To design an information-age system that would also be highly resistant to change would be to ensure another educational crisis in the not-too-distant future. The LearningSphere 2000 system will be a self-designing "learning organization," where change will be continuous and crises will be minimized. Making change client-based rather than bureaucracy-based will be the most important innovation to accomplish this.

6. Learning Centers

The guide and her students will have access to various learning centers, as well as specialists in other settings. A learning center will provide instruction in a *focus area*. It might be a traditional, discipline-oriented area such as biology, a cross-disciplinary, thematic area such as pollution or cities, an intellectual area such as philosophy, or a technical area such as automobile maintenance and repair. In all cases, centers will incorporate instruction on other higher-order skills into the focus-area instruction, and the cluster guide will be responsible for helping the student put together a program of study that represents a good progression of such higher-order skills instruction.

Learning centers will usually operate independently of the clusters. Every few months all children will receive a certain number of *passes* that will entitle them to use of the learning centers; additional passes can be earned. As a general rule, the older the child, the more she will use the centers. The learning centers' budgets will be based on the number of students served (the number of passes collected), so there will be considerable incentive to attract students and satisfy cluster guides' needs. Again, there will be a combination of competition among centers and cooperation within a center.

We currently envision three types of learning centers: mobile centers, community centers, and "shopping mall" centers. The *mobile centers* will be centers on wheels that travel around from one cluster to another and even from one community to another. They will be found mostly in low-population areas and for high-technology applications. *Community learning centers* will be located in community settings, such as museums and businesses. These centers will provide extra income and tax breaks for their sponsors, and will offer students important learning resources in real-world settings. The "*shopping mall*" centers will be centrally located facilities ranging from one-person "craft shop" operations to regional or national chains. As in retail businesses, the client-driven system will pressure centers to adjust their offerings to meet changing

needs. Therefore, we can anticipate that centers will spring up and die off on a regular basis.

Cooperative arrangements will be made so children may use centers located in other school districts. Learning centers will be staffed by certified teachers, technical and creative people, and parents and community members as volunteers. "Shopping mall" learning centers will offer powerful learning environments that incorporate a range of resources, from hands-on materials to multimedia learning environments.

7. Learning Contracts

Learning contracts will serve a planning and monitoring function. The parent(s), teacher, and student will meet on a regular basis (perhaps every three months) to establish a contract (plan) for the next period and to review the student's accomplishments on the previous contract. The parents and student will have considerable input to specify what the goals and outcomes will be in the contract, but the teacher, the community, the state, and even the nation will all have the right and obligation to assure (through assessment mechanisms; see Section 11) that appropriate standards are being met. The means to attain the goals will also be discussed, with the parents and teacher assuming certain roles in support of the student's efforts.

Only through this kind of collaborative team approach will we overcome many of the obstacles to learning in some home environments. A computer-management system will help the teacher, student, and parent(s) to prepare the contract and to keep abreast of the student's progress. And a locally administered, computer-assisted, attainment-based (performance-based) assessment system will help to keep track of the learner's progress, as well as to compare the effectiveness of the instructional methods, the learning centers, and the clusters.

8. Developmental Levels

The first level of development in the LearningSphere 2000 system will begin at birth. This will help *all* students get a head start. The learning at this level will occur either at home through parents or siblings (with possible guidance from a guide), or in a "home room" as a day-care option (with young assistants under the direction of a guide).

The second level of development will begin at about age 3, as the Montessori system does, and the guides will be similar to Montessori teachers in many ways. Most of the learning will occur in a "home room," where the guide introduces the children to well-designed resources as the children become ready for them. Caring guides and

assistants will have high expectations and will nurture the full, well-rounded development of their students in cooperation with the parents.

On the opposite extreme, in Level 5, which will begin about age 14, the cluster facility will be more of a conference room than a home room and activity room. Most content learning will occur in the learning centers, including center-sponsored seminars, projects, and tutoring sessions, and students will tend to work in small groups in the centers. Intellectual scavenger hunts entailing interdisciplinary problem solving will be widely used. The guide will also work on developing the student's attitudes, values, and ethics, such as honesty, the work ethic, responsibility, initiative, and conscientiousness. Service projects will be required of students often. The guide will work closely with the parents on such other concerns as the child's emotional, social, creative, and psychological development. This will entail (1) identifying with the parents any aspects of development that need work or any obstacles to further development that need to be overcome, and (2) developing with the parents an appropriate plan that entails certain parental actions, as well as certain guide actions of which the parents approve.

Levels 3 and 4 represent intermediate stages or combinations of the activities described above.

9. Children with Special Needs

The LearningSphere 2000 system will accommodate children with special needs in the very fabric of its design. In the LearningSphere system, **all children will be special**. Education will be personalized for all children; all children will be closely monitored for progress and will get the emotional attention that they deserve. Special-needs children will require this kind of attention and will be integrated fully into the system. Financial incentives will be offered to clusters to recruit special-needs children, and some guides will receive special training for meeting different kinds of special needs.

10. Curriculum in the LearningSphere 2000 System

Recognizing that dramatic changes in the workplace have important implications for curriculum, the U.S. Department of Labor prepared the SCANS (the Secretary's Commission on Achieving Necessary Skills) Report for America 2000. The report recommended that the curriculum should include:

- basic skills, including the ability to read, write, perform mathematical operations, and listen and speak effectively;
- thinking skills, including ability to think creatively, make decisions, solve problems, and visualize;

- personal qualities, including responsibility, self-esteem, good interpersonal skills, self-management, and integrity; and
- five broad competencies: use of resources, information, technology, interpersonal skills, and systems thinking.

The LearningSphere system also seeks to foster all aspects of the human development, including what Banathy (see references in his chapter in this book) refers to as the socio-cultural, ethical, moral, physical/mental/spiritual wellness, economic, political, scientific/technological, and the aesthetic.

The objective of LearningSphere 2000 will be to develop people capable of using appropriate technology for their work, with historical and contextual knowledge to make them good citizens of both their country and a global society. They must also be able to continue their learning throughout their lives. The curriculum therefore will provide a solid understanding of knowledge in the core curricular areas and the ability to apply that knowledge to real-life problems and situations. Many of the target understandings and skills will be the same for every student, but personal learning plans and variety among learning situations will provide different means of attaining the same ends.

Work is currently underway to make curriculum more relevant to the needs of the information age, and present and future work will be regularly used to improve the LearningSphere curriculum. Since understanding the world around us will be a particularly important part of the curriculum, we offer the following brief summary of characteristics for science curriculum:

- It will be interdisciplinary; concerned with processes, phenomena, and concepts, and, where appropriate, integrated.
- It will present science, first phenomenologically and descriptively, then empirically and semi-quantitatively, and finally theoretically.
- It will be related to experience and evidence, rather than assertions, and it will encourage students to pose questions about the natural world and to acquire evidence to formulate answers to those questions.
- It will be related to other broad areas of human knowledge and experience, such as history, philosophy, and literature, and will have relevance to students' lives.
- It will seek to provide students with a depth of understanding, rather than an encyclopedic knowledge, so that science concepts can be fruitfully applied to new situations.

11. Assessing Student Outcomes

A variety of companies will produce competing assessment instruments calibrated to national and state standards. The individual

clusters and the community will review and utilize what they consider to be the most appropriate of these assessments, and will develop their own assessments as needed to fill in any gaps. The purpose of these assessments will be to certify attainments, not to compare students, and all students will be expected to reach a passing standard. Hence, they will not be monolithic; a student may be assessed on a single competency or attainment, rather than a large number of them all at once, and she may request the assessment when she feels she is ready for it, rather than having to take it at a predetermined time.

Students' progress will be assessed in two ways: (1) separately, in the academic disciplines, and (2) across the disciplines in a series of real-world projects. This approach will have two important advantages. First, although disciplinary boundaries will certainly be looser than in the current system, concentrated attention to a subject (e.g., mathematics or literature) will permit solid understanding of the essentials. Second, allowing students to demonstrate competence in multiple modes will provide a more accurate picture of their strengths and weaknesses.

For both disciplinary and interdisciplinary assessments, the guide will not be a "judge" who serves as a perceived obstacle to the student's progress, but a "coach" who helps the student surmount an external obstacle. With the support of learning centers, the guide's duty will be to prepare students for the two kinds of system-wide assessments. They may wish to design interim examinations to be administered at a single site or in a cluster of sites, or they may use the examinations from former years for practice. The selection of learning tasks and instructional strategies will be made by the guides who are ultimately responsible for their students' performance.

12. New Roles for Technology

Technology will play central roles in teaching, assessment, and keeping track of learner progress in LearningSphere 2000. Computer-based simulations will be excellent tools for modeling the real-world, authentic tasks, and for maximizing active involvement and construction of learning. Multimedia systems will integrate computers and interactive video. Hypermedia, especially, will be important tools both for managing diverse resources and for supporting authentic learning activities. Such media will allow the student to pace himself and spend as much time as needed to master particular learning objectives. They will also be more dynamic in aural and visual modes, thus accommodating a greater variety of learning styles. Electronic networks will connect students and teachers across geographic and cultural boundaries for a greatly enriched learning environment. Using distance education, many different kinds of media will serve unique needs,

including staff development, especially in rural areas. Learning resources will frequently be designed for several students to use at a time.

Guides will be able to design and produce instructional materials themselves with computer-based authoring systems, desktop publishing, and other developer tools. Guides will also have much greater access to furthering their own learning with the richness and variety of materials available.

Computer technology will facilitate assessing mastery of educational objectives and will alleviate the drudgery of record-keeping. Computerized adaptive tests have been shown to be accurate and time-saving for assessing student mastery of learning objectives when attainment of those objectives can be realistically evaluated by computers. Such tests will be taken individually whenever a student is ready, they will usually be very short, they will be repeated as needed without burdening a teacher for evaluation and feedback, and results will be fed automatically by computer network to a central database which will be provided by the administrative support system. Thus, advanced technology will significantly reduce the amount of student and teacher time devoted to carrying out assessment activities.

This centralized system will help the teacher, student, and parent(s) prepare the contract and keep abreast of the student's progress. It will also analyze the effectiveness of the instructional methods, the learning centers, and the clusters. Aggregate measures of each cluster's performance (in terms of student mastery of objectives) will be prepared automatically and will be available as "consumer reports" to parents and their children. Similar measures of each center's performance will be prepared automatically for cluster guides.

13. Administration of the LearningSphere 2000 System

A district-wide administrative system will facilitate the efforts of the clusters and learning centers. It will be a very different paradigm of administration than that which characterizes our industrial-age system. The **Cluster Support System** will manage the incubation of new clusters and provide support services to existing clusters (budget management, purchasing, custodial, transportation, etc., many of which will be contracted out to private contractors). The **Learning Center Support System** will serve the same function for the learning centers. Clusters and learning centers may opt out of these services and find others better able to serve their needs. The **Consumer Aid Agency** will serve as a placement counseling service for matching children with guides, and as a watchdog service for collecting and disseminating information about the quality of performance of the clusters, guides, learning centers, and support systems.

14. Governance of the LearningSphere 2000 System

There will be important differences from the current system on both the community and state levels of governance. Local school boards will not micro-manage the affairs of the educational system. Their purpose will no longer be to control the system, for the consumer-driven decision-making system will assume that function. Boards will facilitate the efforts of the individual units (clusters, learning centers, and other support units), and will set and monitor the attainment of community standards. Furthermore, there will be a community-elected Citizen Review Board. It will be entrusted with the authority to adjudicate disputes among stakeholders (e.g., clusters, learning centers, parents, students) and protect the rights of the disadvantaged. It will also govern the affairs of the Consumer Aid Agency.

On the state level, again, the purpose of the state departments of education will not be to micro-manage the local systems. Rather than dictating means, they will set standards (outcomes) and monitor their attainment. They will use incentive systems and contingencies to correct any deficiencies in meeting high standards. They will also serve a support role and a financial equity role with an equitable revenue collection and distribution system. And there will be a state-level Citizen Review Board for cases that the community Citizen Review Board cannot resolve.

15. Relationship to Other Human Service Systems

To meet the needs of students in the information age, we must think of school systems as systems of learning and human development. This would result in considerable overlap with other human service systems at both the community and state levels. Therefore, the LearningSphere system will integrate services for birth through age-five children and their families, as has been done in the Independence (MO) School District (see the chapter by Caccamo and Levitt in this volume). These services will include health care, family and parent education, contact with the children and parents from birth, child care services and support for working parents, and family literacy efforts.

Health care and family services will be based in the school with case workers and health care workers contacting families and identifying and accessing necessary services in the school. The school will be the one place a majority of families find themselves for an extended period of time. The LearningSphere 2000 system will maximize the opportunities for exploiting that contact to shore up the family's resources and commitment to education, and thus to maximize the experience of children in schools.

16. Cost-Effectiveness

It is often said that if you want to learn something, teach it. Peer tutoring has proven to be a highly effective instructional strategy for the tutor as well as the tutee. Students are perhaps our most underutilized resource in education. Parents, senior citizens, and other volunteers have also been greatly underused. The LearningSphere 2000 System will utilize these human resources greatly, increasing the human dimension of learning while reducing the labor costs of education. Add to this the labor-saving and increasingly cost-effective technologies for learning and the considerable savings from a reduction in the administrative bureaucracy, and the LearningSphere system will increase by an order of magnitude the amount of time learners are actively engaged in learning, at a cost per child comparable to current costs.

A Final Note

This preliminary design has evolved over eight years and is based on accumulated experience and analysis of massive changes currently gripping our society and transforming our complex social systems. Some of these ideas undoubtedly need revision, some are likely to vary from one community to another, and most need further elaboration and operationalization. Nevertheless, this image hopefully provides a useful tool for helping those interested in systemic change to "jump out" of the industrial-age mindset about education, and it may also suggest some features that a new educational system might require to meet our *present* and *future* needs.

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7

Putting Technology to Work for School Reform

Allan Collins, Donald Morrison, and
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Introduction

A potential stimulus toward reform in schools is the increasing role of technology in every aspect of life outside schools. Work in the real world of offices, factories, laboratories, hospitals, police stations, and supermarkets is becoming dependent on technology, as working adults increasingly do their reading, writing, and calculating in computer environments (Collins, 1991). In schools, where reading, writing, and calculation are primary activities, it makes sense that there should be a strong tendency to import and press into service the tools of the late 20th Century workplace.

In fact, schools have been resistant to the use of computer and video technology to do useful work, partly for economic reasons (substantial investments are required to make schools truly technology-intensive)—but also because schools are not seen as typical workplaces. As a result, we find that we are educating people to live in the 21st Century with technology from the 19th. If technology is going to enter schools successfully, we need to understand that schools can be places in which students and teachers do meaningful work, of the type that technology can support, in a way that is cost-effective. This implies systemic change in all aspects of school life—in governance, technology, physical structure, curriculum, assessment, and teaching practice.

As part of the New American Schools Development Corporation's initiative for the redesign of American schools (Rundell, this volume), we have been developing and refining a school design concept (called the "cooperative networked educational community of tomorrow" or Co-NECT) based on four integrated components: a project-based curriculum; a "personal growth system" for individualized assessment