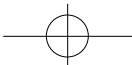




■ 1



2 ■ **Schools That Learn**


5. The Industrial Age System of Education

Peter Senge

We are all products of our age and, in turn, act in ways that re-create that age. As an old joke goes, it is difficult to know what fish talk about, but you can be sure it is not water. It is difficult for any of us in “advanced” societies to overestimate the effects of the industrial age on how we see the world. This “water”—our culturally embedded assumptions and habitual ways of operating—comes back to haunt us when we try to fundamentally rethink and re-invent the industrial age institution we call school.

But how can we “see” assumptions that are so taken for granted? Artifacts can help in the process—like a schoolchild’s backpack.

Stand outside a school and watch the children and adolescents entering. Notice the way they walk—stooped over, bearing backpacks that weigh anywhere from twenty to forty pounds. Pick up one of these packs and see how heavy it feels. It offers a material measure of workload. In most secondary schools, which children start between the ages of ten and twelve, teachers are limited to one group of subjects each. They don't work together in a way that coordinates their day-to-day efforts, and thus they often don't even know the total workload assigned to all students. Would they advocate that sixty-pound children carry twenty-five-pound backpacks? Probably not. But the question is moot, because they have no way of knowing how much stress the system as a whole is piling on to these students, stress that they bear literally as well as figuratively.

Nor do the parents necessarily fully recognize the weight placed on their children. They are dealing with their own stress levels in the high-pressure workplaces of contemporary Western society. I have heard parents say that they approve of their children's heavy workloads: "It's preparing them to deal with the stress of the real world." Metaphorically, the parents are carrying the same backpack themselves. They have to-do lists that they know they'll never finish, so they think it's perfectly appropriate that their kids face the same kinds of pressures.

High-achieving children often seem deeply aware of the consequences of this loss of balance. "We were very surprised to find," says cognitive scientist Howard Gardner about a study of highly talented children that he and colleagues are conducting, "that by the age of eleven or twelve, many children would talk about the importance of balance in their lives. This included kids who were skaters, actors, musicians, and people seriously involved in community service. They love their work and their activity. But they observed their parents and said to themselves, "This is not the kind of life I want to lead."

Meanwhile, the pressures keep growing, and the backpacks keep getting heavier. Driven by public demands for increased performance on standardized tests, schools and teachers find themselves forced to boost workloads continually while also taking more and more class time to prepare students for the tests on whose outcomes their budgets, and even positions, may depend. "There are many ways to measure a successful school," writes *New York Times* education reporter Michael Winerip. "But at this point in American history, the one that gets printed in all the newspapers, the one that individual schools and entire school districts are measured by and all the politicians talk about, is performance on

This quote came from a conversation between Gardner and Peter Senge in December, 1999. For more of that conversation, see p. XX of this book. The study is still being conducted, under the name "Good Work" at the Harvard Graduate School of Education.

Michael Winerip, "Homework Bound," *New York Times*, January 3, 1999.

4 ■ Schools That Learn

standardized tests. And as long as that is true, those backpacks are likely to be full each night starting in grade 1 and maybe earlier.”

By and large the students remain silent as the stress level grows—until problems erupt more visibly. When that happens, schools are blamed for “not keeping order.” They respond, most often, by creating even more pressure. It seems that few have any idea what they can do to address the deeper causes of malaise. This situation leaves students with two basic alternatives: cope or disengage. Many disengage. The system then tracks them into classes for underachievers where they no longer will be challenged. Most students try to cope, like the middle schooler I saw recently pulling a “wheely”—a suitcase on wheels like those carried by airline travelers—full of her books. I wondered to myself just how many more pounds that could hold.

THE INDUSTRIAL AGE HERITAGE OF SCHOOLS

How did this situation arise? A little history is necessary to see a fuller picture.

In many ways, the industrial age had its roots in the fascination of Kepler, Descartes, Newton, and other seventeenth-century scientists with the clock as a model for the cosmos. “My aim,” wrote Johannes Kepler in 1605, “is to show that the celestial machine is to be likened not to a divine organism but rather to a clockwork.” According to historian Daniel Boorstein, “Descartes made the clock his prototypical machine.” Isaac Newton, says Arthur Koestler, assigned to God a twofold function “as Creator of the universal clock-work, and as its Supervisor for maintenance and repair.”

For these scientists, it became natural to conceive of the world as made up of discrete components, which fit together like the parts in a machine. This offered the beguiling implication that ultimately the universe could be understood completely. The behavior of atoms, conceived as tiny bouncing billiard balls, could be predicted, as could the behavior of more complex objects assembled from them. A worldview emerged that became the foundation for 350 years of scientific progress: Once you analyze the parts, the world can be predicted and controlled, as a machine is controlled. As Russell Ackoff puts it, “the universe was believed to be a machine that was created by God to do his work. Man, as part of that machine, was expected to serve God’s purposes. . . . It obviously followed that man ought to be creating machines to do his work.” So powerful was the machine metaphor that writers like Ackoff dubbed the industrial age the “Machine Age.”

See Daniel Boorstein, *The Discoverers* (New York: Harry N. Abrams, 1983, 1991) pp. 108–9; also Arthur A. Koestler, *The Sleepwalkers* (London: Hutchinson/Penguin, 1959) p. 536.

Ackoff, *Creating the Corporate Future*, (New York: John Wiley and Sons, 1981) p. 6.

Machine-age thinking became the foundation for organizations and management when Frederick the Great, the eighteenth-century Prussian ruler, achieved military successes by instituting standardization, uniformity, and drill training. Before then, as management writer Gareth Morgan notes, armies had been unruly mobs of “criminals, paupers, foreign mercenaries and unwilling conscripts.” Now they became great, invisible machines, with interchangeable parts (intensely drilled men who could replace one another easily), standardized equipment, and strict regulations. Not surprisingly, Frederick devised many of his techniques by studying machines. He was “fascinated,” writes Morgan, “by the workings of automated toys such as mechanical men, and in his quest to shape the army into a reliable and efficient instrument he introduced many reforms that actually served to reduce his soldiers to automata.”

Inspired by progress in Newtonian science, industrialists of the nineteenth century patterned their organizations directly after Frederick the Great’s army, including such mechanistic structures as the “chain of command,” the “line” and “staff” organizations, and the “training and development” approach to learning. The organization as machine eventually found its prototypical embodiment in the assembly line. The assembly line produced an unparalleled number of uniform manufactured objects more rapidly than ever before. As scientific progress manifested itself in new and increasingly powerful technologies, they were incorporated into the assembly line, enabling previously unimaginable increases in labor productivity. From 1770 to 1812, labor productivity increased 120 times over in the British textile industry. By 1880, according to business historian Alfred Chandler Jr., “four-fifths of the people working on the production of goods were working in mechanized factories.” The assembly line also transformed the conditions of work: interchangeable, trained workers doing precisely designed repetitive tasks, orchestrated by a rhythm set by external bosses.

It is little surprise that educators of the mid-nineteenth century explicitly borrowed their new designs from the factory-builders they admired. The result was an industrial-age school system fashioned in the image of the assembly line, the icon of the booming industrial age. In fact, school may be the starkest example in modern society of an entire institution modeled after the assembly line. Like any assembly line, the system was organized in discrete stages. Called grades, they segregated children by age. Everyone was supposed to move from stage to stage together. Each stage had local supervisors—the teachers responsible for it. Classes of twenty to forty students met for specified periods in a scheduled day to drill for tests. The assembly line, as a whole, was

For more about Frederick the Great and his influence on the modern organization, see *Images of Organization* by Gareth Morgan (San Francisco: Sage Publications, 1969), p. 22-25.

The figures on labor productivity come from Paul Hawken, Amory Lovins and L. Hunter Lovins, *Natural Capitalism: Creating the Next Industrial Revolution* (New York: Little, Brown and Company, 1990), p. 170; they in turn are quoting N. McPherson, *Machines and Economic Growth* (Westport, CT: Greenwood Press, 1994). The quote is from Alfred Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA: Harvard University Press, 1977), p. 245-246.

6 ■ Schools That Learn

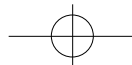
designed to run at a uniform speed, complete with bells and rigid daily time schedules. Each teacher knew what had to be covered in order to keep the line moving, even though he or she had little influence on its preset speed, which was determined by school boards and standardized curricula.

Although few of us today appreciate how deeply assembly-line concepts are embedded in the modern school, nineteenth-century writers spoke admiringly of schools as analogues to machines and factories. According to education historian David Tyack: “as eighteenth-century theologians could think of God as a clock-maker without derogation, so [too] the social engineers searching for new organizational forms used the words ‘machine’ or ‘factory’ without investing them with the negative associations they evoke today.” For example, machine concepts like standardization played a role in creating unified school systems. In 1844 Samuel Gridley Howe, a newly elected Massachusetts Board of Education member, implemented a standardized test and used the dismal results to galvanize public outrage about the decentralized Boston schools, leading to their consolidation as a single, city-wide system, an approach that ultimately influenced schools throughout North America and the rest of the world. The result of this machine-age thinking was a model of school separate from daily life, governed in an authoritarian manner, oriented above all else to producing a standardized product, the labor input needed for the rapidly growing industrial-age workplace—and as dependent on maintaining control as the armies of Frederick the Great.

The industrial model of schools didn’t just change how students learned; it also changed what was taught. In the American colonial period, for example, in local one-room schoolhouses, children might be taught from Ben Franklin’s *Poor Richard’s Almanack*. Other countries had their own local, indigenous texts—both written and oral. They learned about weather and climate, but not for the sake of altering or controlling the seasons. They learned about the world to understand and fit into it, not to command or control it.

While the assembly line school system dramatically increased educational output, it also created many of the most intractable problems with which students, teachers, and parents struggle to this day. It operationally defined smart kids and dumb kids. Those who did not learn at the speed of the assembly line either fell off or were forced to struggle continually to keep pace; they were labeled “slow” or, in today’s more fashionable jargon, “learning disabled.” It established uniformity of

Edward Hall, quoted from David B. Tyack, *The One Best System: A History of American Urban Education* (Cambridge, MA, Harvard University Press, 1974) p. 42. Also see “The Drive to Learn: An Interview with Edward T. Hall, *Santa Fe Lifestyle*, Spring, 1988, pp. 12–14.



product and process as norms, thereby naively assuming that all children learn in the same way. It made educators into controllers and inspectors, thereby transforming the traditional mentor-mentee relationship and establishing teacher-centered rather than learner-centered learning. Motivation became the teacher's responsibility rather than the learner's. Discipline became adherence to rules set by the teacher rather than self-discipline. Assessment centered on gaining the teacher's approval rather than objectively gauging one's own capabilities. Last, the assembly-line model tacitly identified students as the product rather than the creators of learning, passive objects being shaped by an educational process beyond their influence.

Seeing school as an assembly line for producing graduates illuminates the reasons for the ever-weightier backpacks. The assembly-line education system is under stress. Its products are no longer judged adequate by society. Its productivity is questioned. And it is responding in the only way the system knows how to respond: by doing what it has always done but harder. Workloads increase. Standardized testing is intensified. Among neurophysiologists there is a common expression, "The brain downshifts under stress." When we are fearful, we revert to our most habitual behaviors. Larger human systems are no different. Whether they espouse it or not, educators are responding to the extraordinary anxiety and stress they are experiencing by turning up the speed of the assembly line. While this might produce a bit more output, all of us—students, teachers, and parents—should be asking whether it produces more learning.

A SYSTEM TRAPPED

Like other industrial age institutions today, educational institutions are caught in extraordinary cross-currents of change. Businesses also struggle with increasing pressures for performance to please external stakeholders. They too create extraordinary stresses on their members by attempting to get more output while reducing headcount.

Yet, as someone who spends considerable time with educators and businesspeople, it is my judgment that educators feel more trapped and less able to innovate than do their business counterparts. Several years ago I asked a group of educators a question I have often asked of business groups: "Do you believe that significant change occurs only as a result of a crisis?" In business groups, typically three quarters will respond affirmatively. But, then, others will tell stories of significant

8 ■ **Schools That Learn**

changes that arose without a crisis, from passion and imagination, from leaders of many types willing to take risks in favor of something in which they believed. The group of educators responded differently. Very few raised their hands at my first question. Puzzled, I asked, "Does that mean that you believe that significant innovation can occur without crises?" None raised a hand in response to this question either. Now really puzzled, I asked: "Well, if change doesn't occur in response to a crisis, and it doesn't occur in the absence of a crisis, what other possibilities are there?" A soft voice from the audience responded, "I guess we don't believe significant change can occur under any circumstances." Those who have not worked within the institutions of education often do not appreciate just how disempowered educators feel.

Most business-people believe that the reason that educational institutions do not innovate is the lack of competition. Feeling pressed themselves to innovate or die, they see a sense of urgency missing in education. While I believe there is some validity to this view, I also believe it is too simplistic. It implies that all that is needed is more competition in education. Yet I see little evidence that more choice in education, where it is occurring, is in fact creating fundamental innovation. For example, I do not see that private schools, the primary competition for public education among wealthier US families, break significantly from the industrial-age views of learning. Many seem even more stressful and conformist than their public school counterparts.

Meanwhile, there have always been small numbers of highly innovative public schools, often inspired by new insights into child development or learning theory, or bold visions for how a school could truly serve kids. Yet few can sustain their innovations beyond the tenure of a few innovators. Once a key principal, or superintendent, or a few key teachers leave, everything returns to the norm.

The reason for this, I believe, is that there exist distinctive features of schools that make sustained innovation more challenging than in business. Until these are recognized, strategies like increasing competition are likely to lead to disappointing long-term results.

The first distinctive feature is that primary and secondary education is a more purely industrial-age institution than is business. While business adopted machine-age ideas such as the assembly line, it was not born with these ideas. Businesses have been significant social institutions for thousands of years. The corporation as a legal entity dates in some forms to the Middle Ages and, before that, to the Roman Empire. The very word "company" has roots that reach back at least a thousand

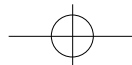
years, deriving from the same roots as “companion”—literally a sharing of bread (*compania*, *com* and *panis*) in Latin. On the other hand, the modern school started with one-room school houses in farming communities in the seventeenth and eighteenth centuries and blossomed into the urban school system as we know it today in the middle of the nineteenth century. As a result, the vast majority of assumptions and practices of school are inseparable from the machine-age view of the world.

Second, as it has evolved, the school system is far more tightly “embedded” in larger social systems than is business. Individual schools sit within local school districts, which in turn nest within state departments of education that set policy and standards. Consequently, schools are buffeted by shifts in the political wind that pass by companies, as we see today with pressures for increased standardized testing. Moreover, schools are part of communities in ways that businesses are not. In particular, businesses do not have parents as part of their system of governance. Businesses have investors who basically let the business run its affairs any way it wants, so long as it achieves an adequate financial return. Businesses have customers who care about the quality of their product. But those customers, by and large, do not concern themselves with how the firm produces products or services. Parents not only have goals for what their children learn, they have very definite ideas about how that learning should occur.

Herein lies probably the most problematic distinction of the education system, viewed from the standpoint of innovation and adaptation. We all went to school together! We are all products of the industrial-age school. Of all institutions, school sits most “upstream.” It was, for all of us, our first and undoubtedly most formative introduction to what Dr. W. Edwards Deming called “the prevailing system of management”—the machine world of teachers in control, students dependent on teachers’ approval, and learning defined as getting an A on the test. Most of us developed our survival skills for industrial-age institutions in first and second grade. We learned how to please the teacher, as we would later try to please our boss. We learned how to avoid wrong answers and raise our hand when we knew the right answer, habits which would later shape the ongoing organizational dance of avoiding blame and seeking credit for successes. We learned how to be quiet when we felt lost, which is why no one questions the boss in the official meeting, even when he or she makes no sense.

Coming to recognize how much the industrial-age school lives in each of us can be sobering. But it is also enabling. Just as school has been

See Fernand Braudel, *The Wheels of Commerce* (Berkeley, CA: University of California Press, 1992) p. 572ff and Tyack, *The One Best System*, op. cit., p. 37



10 ■ Schools That Learn

the generative institution for machine-age thinking, so too could it be a pivot for creating more learning-oriented societies. In truth, the time to inculcate systems thinking is when innate intuitions about interdependency are still alive and before fragmented academic subjects transform us into master reductionists. The time to develop inquiry and reflection skills, likewise, is when we are young, not after thirty years of institutional conditioning aimed at learning to impress people with how smart we are. It is a tragedy that, for most of us, school is not a place for deepening our sense of who we are and what we are committed to. If it was, think of the lasting impact it would have.

Such changes are unlikely to happen until we understand more deeply the core assumptions upon which the industrial-age school is based. This is the DNA of our contemporary school system, and it will continue to exert its iron grip on any efforts at fundamental change until it is recognized.

Industrial age assumptions about learning

It's important to note at the outset that *most educators would disagree in principle with the assumptions* listed below. By most educators I mean everyone from school board members, to administrators, to teachers. Parents often disagree with them as well. And yet the system seems to embody these assumptions, and everyone acts as if they were correct—even if they would prefer to act differently. Such is the power of unexamined shared mental models, “theories-in-use” that often are 180 degrees at odds with theories and beliefs people espouse.

1. CHILDREN ARE DEFICIENT AND SCHOOLS FIX THEM.

Years ago I heard an educator say something that I have not forgotten, “We have no idea the trauma the young child suffers at school.” What trauma was she talking about?

How many of us learned in school that we could not paint? How many of us remember the teacher telling us not to sing with the other children because we were so out of tune? Or perhaps we learned that we were not good at math? Or English? I believe that few of us escaped this self-labeling. Even though we may have long stopped to recall them, we carry these assessments of ourselves inside, often accompanied by strategies of avoidance to disguise our deficiencies.

These traumas occur because conformity is a core value of the industrial age: An assembly line that produced continuous variety would not be considered efficient. This value leads naturally to seeing children as poorly formed “raw materials” from which the school system produces educated final products. Outside the school, learning is active and natural for people; we engage in learning constantly through day-to-day living. But within school learning is viewed in a different way. Ed Joyner, director of the Comer Project at Yale, calls this the “deficit perspective” of learning—an attitude among educators and parents alike who believe that the job of schools is to make up for innate failings in the students themselves.

See “The Dignity of the Child,” page XX; and “Sending Signals,” page XX.

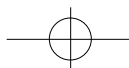
Educators don’t give speeches advocating the deficit perspective, but every school child knows its sting. Young children who get Cs or Ds on their first math test are very likely to conclude not only that their answers are wrong, but that they are “wrong.” They experience school-room evaluations as self-assessments: “I’m not all right. There’s something wrong with me. I don’t have what I need to succeed in life.” These fears are reinforced by a management system that vests unilateral power in the educational system, to determine what is studied, how it is to be studied, and to declare success or failure. It is no wonder that most kids internalize a simple conclusion, “I am not respected here.”

The deficit perspective is especially pernicious because it is undiscussable. Kids have no one to sit down and talk with about the disrespect they experience. It is difficult for children to articulate to an adult that they do not feel respected. When they see their peers treated with similar disrespect, the topic is even harder to discuss. Moreover, the undiscussability is often undiscussable: They cannot talk about the fact that they cannot talk about the disrespect.

Parents have their own form of the deficit perspective; when their kids’ performance does not measure up, they conclude that they have failed as parents. Moreover, the experience of watching their kids struggle to perform often brings back the parents’ own performance anxiety from when they were in school. Their natural concern for their children gets mixed with their own internalized traumas from long ago. They relive their own school anxieties every time their kids take a test or bring home a report card.

The deficit perspective has precursors that predate the industrial era, including some religious attitudes that children are born wicked. But it

Edward Joyner, “To Ask the Best of Children, We Must Ask the Best of Ourselves,” in James P. Comer, Michael Ben-Avie, Norris M. Haynes, and Edward T. Joyner, *Child by Child* (New York: Columbia Teachers College Press, 1999), p. 278.



12 ■ Schools That Learn

See Alice Miller, *For Your Own Good: Hidden Cruelty in Child-Rearing and the Roots of Violence*, Hunter Hannum and Hildegard Hannum/Trans (New York: Noonday Press, 1990) p. 5, 11–12.

is interesting that the industrial age emerged in a time in which child-rearing experts, beginning in Europe, made the deficit perspective a core of parental practice. As German psychologist Alice Miller shows, many popular books on child rearing in this period spoke plainly of the need to “break the child’s spirit and willfulness,” so that he or she would become compliant. Dr. Shreber, a popular 1850s writer, admonished parents to regard an infant’s screaming or crying as a test of wills, and instructed them to employ “stern words, threatening gestures, rapping on the bed . . . or if none of this helps . . . mild corporeal admonitions.” Such methods would be necessary only a few times, Schreber insisted to worried parents, “and then you will be *master* of the child *forever*.” (author’s italics). Miller quotes another eighteenth century writer’s instructions on “abolishing” willfulness in the child’s first year. Here the machine metaphors of control and order are even more explicit. The parent is instructed “to labor over them . . .” to implant a strict “love of order,” which can “come about only in quite a mechanical way. Everything must follow the rules of orderliness. Food and drink, clothing, sleep, and indeed the child’s entire little household must be orderly and must never be altered in the least to accommodate their willfulness or whim.”

The irony of the deficit view is that it substitutes parent- and teacher-centered control for developing self-control. Rather than cultivating a child’s sense of personal responsibility through awareness of the consequences of her or his own choices, it can actually foster a deep sense of victimization and lack of responsibility. Indeed, Miller observes that Schreber’s son was treated by Freud for paranoia.

The deficit perspective assumes that something is broken and needs to be fixed. It is a reasonable way to think about machines, because machines cannot fix themselves. But it is a poor fit for living systems like children, which grow and evolve of their own accord.

George Lakoff and Mark Johnson, *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*, (New York: Basic Books, 1999), p. 17.

2. LEARNING TAKES PLACE IN THE HEAD, NOT IN THE BODY AS A WHOLE

“In the Western tradition,” write philosophers George Lakoff and Mark Johnson, “the autonomous capacity of reason is regarded as what makes us essentially human, distinguishing us from all other animals.” The prevailing Western theory sees reason as independent of perception, motion, emotion, or any other aspect of the body. But, as the authors go on to show, recent evidence from cognitive science (the systematic study of mental operations in humans and computers) has proven this premise

wrong. This evidence tells us “that human reason is a form of animal reason, a reason inextricably tied to our bodies and the peculiarities of our brains.”

In other words, human cognitive development involves just as much “body knowledge” as it does “mind knowledge.” Learning is inseparable from action. “All doing is knowing and all knowing is doing,” as Chilean biologists and cognitive scientists Humberto Maturana and Francisco Varela put it. Knowledge, in this context, does not mean only a mental storehouse of facts and theories, accumulated in memory, but the capacity to do something with this information. Indeed, the facts and theories may be stored not in our conscious reasoning and memory but literally in our bodies. Most of us know how to ride a bicycle, but very few understand intellectually how we do it—that is, the laws of gyroscopic motion whereby the bicycle works. Similarly, we know how to talk, but we probably don’t know all the rules and structures of language in any conscious way. Even something as simple as dialing telephone numbers shows the whole body nature of knowing: I cannot remember many numbers to write them down, but if my fingers are on a key pad, they know where to go.

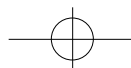
But while learning occurs in the whole body, the traditional classroom is based on the assumption that learning is a purely intellectual affair. Only the head is required; the rest of the body can be checked at the door. The result is a passive rather than an active learning environment. Book-learning and lectures reign supreme. Students are receivers of so-called knowledge—mostly facts and predetermined answers to set puzzles they must solve.

This overintellectualized notion of learning also accounts for why traditional schooling emphasizes mathematical and verbal development over others. This is tragic, because, as Howard Gardner and others have shown, there is a spectrum of intelligences involved in learning, including musical, kinesthetic, spatial, interpersonal, and emotional capabilities as well as the abstract symbolic reasoning of the intellect. Each person has different talents and propensities, but we all have the potential to embrace the full spectrum of intelligences in our personal development, and the more modalities of learning we engage, the broader and deeper is our growth.

See the review of *Intelligence Reframed* by Howard Gardner, page XX.

I will never forget a beautiful story told by a retired chairman of the Physics Department at MIT. He talked of vivid memories of sitting

Humberto Maturana and Francisco Varela, *The Tree of Knowledge: The Biological Roots of Human Understanding*, translated by Robert Paolucci (Boston and London: Shambhala Publications, 1997), p. 27.



14 ■ **Schools That Learn**

underneath the piano, at age three or four, while his grandmother played Bach. He could still feel the sensation of the music washing over him. “That is when I became a physicist,” he said. When we assume that learning takes place only in the head, we deny much of what makes us human.

3. EVERYONE LEARNS, OR SHOULD LEARN, IN THE SAME WAY.

Just as there is extraordinary variety in types of intelligence, so too is there extraordinary variety in how we learn. The past fifty years have seen ground-breaking research on child development, on learning styles, and on the nature of the learning process. All of this work points in the direction of appreciating the variety of ways in which we learn. Some children can learn only when they are moving their bodies. For such a child, especially when he or she is young, having to sit in a chair and not move for an hour can be torture. Others need quiet, while still others thrive on constant activity. Some kids are natural experimenters, always pushing themselves. Others need to be challenged.

See the work of Mel Levine, p. XX, and Dawna Markova, p. XX.

Despite wide familiarity among educators with theories of multiple intelligences and different learning styles, these theories pose almost insurmountable hurdles for the assembly-line schoolroom. Individual teachers, even with a teacher aide, cannot possibly accommodate the variety of learners with which they are confronted. They end up in interminable struggles to maintain classroom order. They try as best they can to make the same subject engaging for different learners. They make themselves available to talk with unhappy parents. But they are trapped, between the forces of a standardized curriculum and educational process on one hand and the variety of human beings sitting in front of them on the other. The tragic outcome is frustration on all sides: teachers who either give up or get burned out and a great many kids who either get cast aside or forced to learn in ways that significantly compromise their learning potential.

Recently, a teacher commented to me that she had eighteen kids in her class and fifteen had different sorts of “learning problems.” What is the real meaning of this comment? For the teacher, I believe it was an expression of frustration, a plaintive acknowledgment that she could not provide all that her kids required. But what does it mean when three-quarters of the kids in a class are “abnormal”? Does it not say something about how normal is defined?

Similarly, what should we make of the explosion of “learning disabilities” that educators now recognize? Is this really a sign of research progress—or a sign of increasing pressure from the assembly line to force nature’s variety to conform, through increasingly sophisticated labels of “disability?” Are we not just making teachers more and more sophisticated “inspectors,” able to detect increasing numbers of raw materials that do not fit the needs of the machine? I understand that the intent among many educators is to do more to help different kids who learn in different ways. But the deficit model casts a long shadow on our abilities to appreciate and work with difference. What we call “disability” is in truth a description of mismatch between educational process and person. Why not label the educational process as “disabled,” instead of the person?

Moreover, what does it mean to an individual to be labeled as having “a disability?” How does that label shape an individual’s sense of self through his or her lifetime? Are we losing our ability to distinguish between appreciating our differences versus seeing ourselves, and each other, as disabled?

This growth in identified learning disabilities is closely related to the growth in drugs prescribed to treat these different disabilities. For example, no one knows how many schoolkids in America are taking Ritalin today, but it is arguably the nation’s largest drug problem. Ritalin is typically prescribed for children diagnosed with “attention deficit disorder” (ADD). Estimates of the number of U.S. school children taking Ritalin regularly range from 1 to 8 million; some think it may be much higher. Conservatively, this represents at least 5 to 17 percent of the students in kindergarten through twelfth grade. A recent study in the *Journal of the American Medical Association* suggested that Ritalin use among preschoolers in day care programs, starting as young as age two, has grown even more rapidly, increasing three-fold between 1991 and 1995, usually in violation of the warnings from the drug manufacturer .

Is Ritalin a boon for frustrated educators and parents and poorly performing students, as is often claimed, or one more sign of the ongoing clash between schools’ drive for conformity and nature’s variety? ADD is a typical diagnosis for children having trouble concentrating in school. They are not able to keep pace with the demands of their classroom. Teachers typically alert parents that their child is having difficulties, and the parents then confer with a physician before the drug is prescribed. But new research on ADD suggests that its symptoms may be characteristic of many highly creative people.

Percentages are based on a U.S. Census Bureau estimate of 48 million elementary and high school students in 1998, reported in “School Enrollment—Social and Economic Characteristics of Students,” Update #PPL-119, (Atlanta: U.S. Department of Commerce Census Bureau, October 1998). Sources on Ritalin include: Joseph T. Coyle, “Psychotropic Drug Use in Very Young Children,” *Journal of the American Medical Association*, vol. 280, no. 8, February 23, 2000, p. 1059; Julie Magno Zito, Daniel J. Safer, MD, Susan dosReis, James F. Gardner, Myde Boles, and Frances Lynch, “Trends in the Prescribing of Psychotropic Medications to Preschoolers,” *Journal of the American Medical Association*, vol. 280, no. 8, February 23, 2000, p. 1025; MD Rappley, PB Mullan, FJ Alvarez, IU Eneli, J Wang and JC Gardner, “Diagnosis of attention-deficit/hyperactivity disorder and use of psychotropic medication in very young children,” *Archives of Pediatrics and Adolescent Medicine*, October 1999, p. 1039; and “Overusing Ritalin,” editorial, *Boston Globe*, Feb. 27, 2000, p. E6.

16 ■ Schools That Learn

A good friend and MIT colleague was recently told by his child's teacher that the child probably had ADD and should be put on Ritalin. Unpersuaded, he and his wife did some reading, discovering a book written by two MDs, both of whom would be diagnosed with ADD were they schoolchildren today. My MIT friend concluded from reading the book that he too probably has ADD. He discovered, for example, that people with ADD tend to excel at "parallel processing"—doing two or more things simultaneously. This is one reason that such children often have difficulty with schoolrooms that force them to do one thing at a time. He and his wife concluded that rather than putting their child on drugs, he should be allowed to develop his gifts and they as parents needed to find a way to make the child's education more compatible with the type of person he was.

This story also illustrates the immense practical challenges posed by the mismatch between assembly-line schools and the variety of children's ways of learning. One wonders why the epidemic in Ritalin and other doctor-prescribed drugs for young children has not been met with outrage by parents. The answer is probably that most parents today do not have the time to be outraged. They are stressed and overworked, and may be coping with their own stress through drugs. They are worried that their child will fall behind in school and not get into a good college. Most feel trapped, with few options—just as the most teachers feel trapped, doing their best to maintain control in a classroom full of very different learners.

Last, the "one-size-fits-all" classroom probably also accounts for why, for many students, motivation for school learning drops off within a few years of starting formal schooling. Their initial excitement wanes when they sense that they are not the favored ones in this environment. They are not highly verbal or do not think quickly. Perhaps they rebel at competing with their peers. Whatever, they are not among those who fit in the machine-age classroom.

Our assembly line thinking forces us to treat the natural variety of human beings as somehow aberrant because they do not fit the needs of the machine. "Those of us who have taught," says Edward Joyner of the Yale School Development Program, "know that you can know the subject matter well and not be able to deliver it if you don't *know the children well*" (italics added).

4. LEARNING TAKES PLACE IN THE CLASSROOM, NOT IN THE WORLD.

The industrial-age school puts the classroom at the center of the learning process. Yet genuine learning occurs in the context of our lives, and the long-term impact of any new learning depends on its relationship to the world around us. For example, in difficult times, painful though they may be we often come to understandings that would not otherwise be possible. Simply living through these times can make us stronger and more compassionate. Similarly, our capacity to learn in any formal setting such as school depends in large part on the opportunity to apply new ideas or insights to challenges that are meaningful to us. But because the classroom-centered model dominates, the many places where learning occurs in a child's life—playgrounds, home, theater and sports teams, and (for many) the streets—are discounted. Every relationship in a child's life carries a dimension of potential learning; everything she or he does can be done in a spirit of learning. These learning places are all, by and large, invisible from the classroom viewpoint.

Of course, most educators understand this, and appreciate the many contexts in which learning occurs. They know the importance of athletics, music, art, and theater. But when there are problems, the tyranny of the classroom model comes to the surface. When there are budget pressures, the arts and electives budgets are often the first to be cut. If classroom budgets are cut, teachers may lose supplies or be forced to squeeze in more children, but no one thinks of eliminating classrooms altogether. "Oh, no, you could never do that," people say. "Because where would children learn?"

Even in an age when networked computers and computer-mediated environments make instruction available to anyone, anywhere, at increasingly lower costs, the traditional classroom is still unquestioned. I do not suggest that we should become uncritical boosters of the Internet or computer technology as replacements for the classroom. Rather, I think it is important to ask what might a classroom full of kids and adults be like if it were truly designed for learning and seen as only one of many settings in which learning occurs.

5. THERE ARE SMART KIDS AND DUMB KIDS

The cumulative effect of the above assumptions is seen in arguably the deepest and most pernicious assumption of the machine-age school: that there are only two kinds of kids, smart kids and dumb kids. The smart kids are those who excel in school. The dumb ones do not.

18 ■ **Schools That Learn**

This assumption of smart and dumb kids is so deeply engrained in our society that it is hard to imagine an alternative. But the alternative is right before us: All human beings are born with unique gifts. The healthy functioning of any community depends on its capacity to develop each gift. When we hold a newborn we do not see a smart or dumb kid. We see a miracle of life creating itself. The loss of that awareness is the greatest toll exacted by our prevailing system of education, in and out of school.

Industrial-age Assumptions about School

There exists another set of underlying assumptions, embodied in the institution of industrial-age school, regarding the way the school itself is organized and sees its task. Like the previous assumptions about learning, these assumptions are very difficult for us to see and often contrary to what people consciously espouse. We take them for granted because we lived in an industrial-era school for a good part of our lives: most educators have been there for most of their lives. Moreover, those of us who are not educators work in industrial-era organizations organized along similar principles.

1. SCHOOLS ARE RUN BY SPECIALISTS WHO MAINTAIN CONTROL

As in all industrial-age organizations, the tasks of an industrial-age school are broken into discrete pieces called “jobs.” One person is a superintendent; another is a principal; and someone else is a teacher. We assume that this sort of division of labor is an obvious necessity of working together. But we see no compelling need to build partnership among those people or a sense of collective responsibility. Instead, it is assumed that if each person does his or her highly specialized job, then things will work out. The industrial-age management model breaks the system into pieces, creates specialists, lets everybody do his or her piece, and assumes that someone else makes sure the whole works. In fact, there are few more individualistic professions today than teaching, with each teacher doing their work in isolation.

But children experience the consequences of the whole, and typically what they experience is a highly fragmented system that is the antithesis of a team. It’s as if basketball players decided that they needed to rebound only at the defensive end of the floor, or if everyone in an

orchestra decided to be soloists. “One of the most important, and challenging, things that you can possibly do in a school system,” says Corvallis, Oregon, superintendent Jim Ford, “is to break down the walls that separate teachers, administrators, parents, and kids—to help people see the school as a community and that the community is the school.”

But what exists in most schools is a far cry from a learning community. As one high school principal commented recently, “As I reflect on my work, and indeed my career as an educator, I realize that my number-one concern has been control. This is the heart of what our system is all about.” In a system based on maintaining control, it is the job of the teachers to control the students, the administrators to control the teachers, and the school board to maintain control over the system as a whole.

Control is not an inherently dysfunctional concept—all viable living systems have evolved capabilities for control or balance. The problem lies in the industrial-age notion of control. A living system controls itself. A machine is controlled by its operator. Teachers, administrators, and boards can easily become the operators of the machine called school.

For example, the teacher-centered assessment process that results in increasingly anachronistic in an era where what matters is lifelong learning. If a child’s primary orientation in school becomes pleasing a teacher, this attitude will draw attention away from developing the capacities for more rigorous self-assessment. Meanwhile, a cornerstone of lifelong learning is the capacity for objective self-assessment—the ability to judge for yourself how well you are doing. In effect, teacher and student collude in shifting the developmental burden from self-assessment to pleasing others. The result can be adults who spend their careers currying favor rather than doing something they truly regard as meaningful. Few educators would espouse this, but the system of specialization and control produces it.

Seen in this light, recent efforts to make schools more “accountable” through test scores exacerbate the same industrial-age control thinking. There is nothing inherently wrong with tests of performance. They are fragmented measures and limited in their validity, but they can be useful indicators for students and teachers alike. It is their context that is problematic. Rather than students and teachers setting their own aspirations, performance standards are mandated from above. Rather than students, teachers, principals, and parents using test outcomes to assess how they, as a whole, are doing, external authorities assess performance and mete out rewards and punishments. Rather than being seen as fragmented and imperfect indicators, which need to be integrated with other ways of

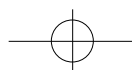
20 ■ Schools That Learn

assessing learning, scores on standardized tests become the penultimate measure of “educational productivity.” Rather than helping develop collective responsibility, they underscore the idea that teachers and schools are solely responsible for education, for it is their budgets and jobs that are at stake.

Those familiar with the business world recognize the management-by-objectives logic behind test score accountability: Management sets quantitative targets, measures of performance relative to targets are driven throughout the system, and people’s pay, budgets, and ultimately jobs depend on meeting those targets. It has been the dominant system of management for many years in industrial enterprise, and continues to dominate many today. Deming accused this system of management of having “destroyed our people,” because of its impacts on intrinsic motivation, curiosity, risk taking and innovation, and personal responsibility. And, despite its many proponents, it is not the only approach to performance improvement. Accounting theorist Thomas Johnson, coinventor of activity-based costing (ABC), has spent a decade studying companies that top their industries in long-term financial performance and yet that do not rely on management by objectives (what Johnson calls “management by results”). Johnson argues that management-by-results thinking “generate[s]enormous amounts of waste, recognized and unrecognized,” and that “business leaders can achieve higher and more secure levels of profitability if they . . . cease to drive work with quantitative goals.” The alternative, “management by means,” focuses attention rather on the way work is organized and particularly on how continual learning is integrated into day-to-day activity.

Last, any system of hierarchical control, even if it has very good people, is subject to abuse. Several years ago, I knew a sixth grader who had been accused of cheating on a multiple-choice test. He was new to his school. The teacher humiliated him—giving him a F and calling his parents. The boy was devastated. “I didn’t look at anybody’s paper!” he said. But the teacher refused to believe him because he had seen the boy’s head moving. Of course, no one except the boy actually could possibly know what he saw, as opposed to where his face was pointed. But the teacher remained resolute in his assessment, ending the meeting with the child’s parents by saying “Look, I don’t believe in holding grudges against kids. If he recognizes that he shouldn’t do this again, it will not count against him.” Interestingly, the teacher never questioned his own assessment or observation, the subjective sense he made of what he observed. He alone, not the child, had the power to define “cheating.” It

H Thomas Johnson and Anders
Broms, *Profit Beyond Measure*
(New York: Free Press, 2000)



was part of his role as a teacher as he saw it. For the child, the experience reinforced his awareness of where control really lay. He felt profoundly disrespected. The teacher's actions, though extreme, were completely consistent with the assembly-line model of control: Just as an inspector has power over whether a product on an assembly line is acceptable, the teacher has power to judge unilaterally a child's behavior.

2. KNOWLEDGE IS INHERENTLY FRAGMENTED.

Control based on fragmented specialization appears to be a logical way to organize schools because of another industrial-age assumption—the assumption that knowledge itself is fragmented, that knowledge arises in separate categories. Over here we have literature, which is separate from mathematics, which is distinct from science, which in turn is distinct from geography and psychology. From this fragmented perspective, it is easy to ignore the fact that life isn't quite like that, that life presents itself to us whole, that challenging problems are challenging because they have many interdependent facets. When was the last time you encountered a problem that was purely a math problem? Or purely an interpersonal problem? Or a problem where you only had to figure out the technically correct solution, and then people would automatically do what was needed? Life's interdependencies tend to remain invisible to the fragmented academic theory of knowledge. Given this theory of knowledge, it comes as no surprise that the farther an individual progresses in the formal system of education the narrower and narrower his or her knowledge becomes.

This fragmented theory of knowledge is antithetical to a systems view of reality, that reality is comprised fundamentally of relationships, not things. The systems view recognizes the interrelatedness of subject matter. Industrial-age schools find it very difficult to recognize those interrelationships; instead, they implicitly tell students that what matters most is the size of their narrow pile of knowledge.

"The fragmentation of knowledge is the saddest irony of our business," says Tim Lucas. "Here we have all of this incredible life-nourishing material—literature, mathematics, and on and on. It's unending. Kids recognize its vitality when they start out, and yet, somewhere along the line, it becomes dead for so many of them. And the institutions are often dead too. There may be little spots of light, but it is so sad, because what could be more exciting than the knowledge of civilization?"

22 ■ Schools That Learn

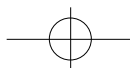
3. SCHOOLS COMMUNICATE "THE TRUTH."

Our system of education is based on an implicit theory that philosophers call "naïve realism." Naïve realists are people who think that "what they see is." We all live most of our lives as naive realists because the data of our senses present themselves to us with such compelling force. We then tend to treat our perceptions as absolute fact. This is not a problem per se; it is a characteristic of human perception. The problem arises when we fail to recognize that it is happening. In the traditional industrial age schoolroom, teachers do not teach as if they are communicating socially constructed views or interpretations. They teach as if they are communicating truth. Kids learn "what happened" in history, not an accepted story about what happened. Kids learn scientific truths, not models of reality that have proven useful. They learn the one right way to solve a particular problem, not the complexities of different perspectives on the same phenomena. As a consequence, students' tolerance for ambiguity and conflict is diminished, and their critical thinking skills fail to develop. They fail to see the contingency of human understanding. Instead, they become habituated to sanitized, politically correct bits of knowledge, only to eventually find themselves deeply frustrated and disoriented by life's complexities.

The *Tree of Knowledge* (op. cit.), p. 27, p. 34, and p. 206ff.

Humberto Maturana and Francisco Varela have developed a pioneering theory of the biological bases of cognition. A synthesis of biological and psychological science, the implications for human beings of the Santiago theory of cognition can be summarized in the simple statement, "Everything said is said by somebody." No human being ever produces a definitive statement about reality. It's not biologically possible to do so. This fact does not invalidate science or history, any more than it does literature or art. But it does invite us to consider science or history as a social phenomena, whereby communities of people agree to certain standards and procedures and thereby advance a continually evolving, shared understanding, which is always imperfect. Nor does the Santiago theory imply that there is no reality independent of human observation (a philosophical view called solipsism). It simply states that human beings cannot make absolute statements about reality.

What does this mean for schools? Consider the teachers who touched you as a student, not because they knew the answer but precisely because they didn't know. Their curiosity inspired you, and their passion fired your imagination. They were so excited about what you might learn together that you loved them as teachers. You valued their experience. You knew they had thought about their subject a lot, and you were inter-



ested in their thoughts, but they didn't give you the answers. When they told you "This is what happened," they were really saying "This is one view of what happened; here is something to think about." Your questions were regarded as a valid way to link established ideas to your own understanding. In fact, they had their own questions, and it was this common questioning that made the two of you, ultimately, equals.

By contrast, naïve realism fits neatly with and subtly reinforces the deficit perspective of learning. It reifies the view that children are deficient, by establishing a caste of experts—teachers—who hold the answers. Because their answers are unquestionable, the superiority of the teacher's knowledge, and the inferiority of the student's, is institutionally established.

4. LEARNING IS PRIMARILY INDIVIDUALISTIC AND COMPETITION ACCELERATES LEARNING

Because we see knowledge as something that teachers have and students are supposed to get, we see it as possessed by individuals, and we tend to see the learning process as being similarly individualistic. But this is a dangerous oversimplification.

Consider something as basic as walking. Learning to walk appears to be a prototypical individual learning process. But is it really? Consider the importance of having the examples of parents, siblings, and other children to emulate. In fact, what it means to learn to walk is to join a community of walkers, just as mastering natural language brings us to membership in a community of talkers. When we think in this way, we come to realize that all learning is social as well as individual.

Yet the traditional schoolroom focuses almost exclusively on the individual perspective. Individual learners are supposed to master subject matter. Individuals are tested for their comprehension, and individuals compete with one another to determine how well they do.

I do not believe that competition is inherently bad. I am the type of person who enjoys competition and have always loved competitive sports. I believe that under the right circumstances, competition can enhance learning. But I also believe that, many of our modern societies, such as the United States, have lost appreciation for the healthy balance between competition and collaboration. The two can coexist. Indeed, they do so in most healthy living systems. Nature exhibits competition when different animals compete for the same food, but it also exhibits collaboration, as when packs of animals hunt together, or when one species creates conditions that aids another's survival. In fact, the whole

24 ■ Schools That Learn

Lynn Margulis and Dorion Sagan, *What Is Life?* (New York: Simon & Schuster, 1995), p. 192. We are grateful to Elaine Johnson for reminding us of this book's statements about cooperation.

Chris Argyris, "Teaching Smart People How To Learn," *Harvard Business Review* May-June 1991, HRB Reprint #91301, reviewed in the Fifth Discipline Fieldbook, p. 265. Alfie Kohn, *Punished by Rewards: The Trouble with Gold Stars, Incentive Plans, A's, Praise, and Other Bribes*, (1999, New York: Houghton Mifflin).

idea of individual competition at the heart of evolution today seems like a curious nineteenth-century oversimplification, as we better understand they ways that entire ecosystems survive or die out. "Living beings . . . are no more inherently bloodthirsty, competitive, and carnivorous than they are peaceful, cooperative, and languid," writes microbiologist Lynn Margulis (codeveloper of the Gaia hypothesis). "Among the most successful—that is, abundant—living beings on the planet are ones that have teamed up." Plants and fungi, animals and bacteria, exist in continual ongoing symbiosis.

Ultimately, the consequences of excessive competitiveness go beyond who wins and loses to affect us all. We internalize competitiveness as a basic ingredient of any organizational setting. In businesses this results in people often expending as much of their energies competing against one another as in competing against their external "competitors." In all settings, we come to see ourselves in a never-ending struggle to win, or at least to avoid losing. This situation affects winners as much as losers, and stamps all of us with habits of thought and action that shape our behavior for a lifetime—what social scientist Chris Argyris calls "defensive routines." His research has shown why "smart people don't learn" in many work settings, because they have so much invested in proving what they know and avoiding being seen as not knowing; these routines are poignant examples of Alfie Kohn's famous phrase, "punished by rewards."

Although many educators today espouse concerns about excessive competition and the importance of collaboration, educational practices remain highly ambivalent on the subject. It often appears that educators fail to see just how thoroughly competition is designed into schools. Many teachers lament that "students focus too much on grades," ignoring the multitude of signals those students have received their entire school career that grades are the key to success in school and what matters to get into college. Several years ago, I participated in a meeting of state school department heads, at the outset of interest in "quality management in education." Dr. Deming was the keynote speaker. He began his presentation by saying "We've been sold down the river by competition," and proceeded to talk about the experience of leading firms around the world in fostering collaboration and shared responsibility. When he was done, one of the state leaders said, "Dr. Deming, obviously you don't know that we educators also value collaboration. Cooperative learning strategies are being used in many schoolrooms in America today. And I don't see anything wrong with rewarding those schools who

do it best.” Apparently, for this educational leader, collaboration was great for kids but not for adults; he had seemingly discounted the idea of teachers, administrators and schools collaborating to build common knowledge.

Conditions for Innovation

Undoubtedly, many will argue that these assumptions have always underlain industrial-age schools. Traditional schools have served society well, and past attempts at radical change, like the free schools movement of the 1960s and 1970s, have not proven themselves sustainable. In response, I would argue that past efforts at innovation, while unsuccessful, also grew out of appreciation of the limitations of machine-age thinking. Moreover, basic institutional innovation takes decades, not years. Many writers have developed the theory that basic innovation, especially the innovations that create new industries, involves ensembles of technologies. For example, the birth of the commercial airline industry involved many innovations in aircraft design in the first three decades of the twentieth century, but it also required the development of jet engines and radar in the 1940s. Like technological innovation, institutional innovation usually arises only as multiple new “component innovations” come together to create ensembles of new ideas and approaches that can support widespread application. I believe the conditions for just such innovation exist today.

First, there are unprecedented signs of breakdown in the assembly-line school concept and process. Extraordinary stress—not just on students, but on teachers, administrators, and parents—is one symptom of breakdown. Another is the increasing separation of “haves” and “have-nots.” Those who can afford it increasingly put their children in private school, where they purchase smaller class sizes, the opportunity to be surrounded by other elite students, and access to teachers who are more satisfied with their working conditions. Others opt for home schooling, by some accounts the fastest growing segment of precollege education, estimated to involve 500,000 to 1.25 million children. But neither private nor home schooling are options for the majority of families, and those in public school are being increasingly shut out of society’s best opportunities. As a result of growing inequity, social unrest and disturbance are growing. Moreover, judging from conversations I have had in recent years, concern over education seems to be growing throughout

On the movement and frustration of school reform see *Change Forces. Probing the Depths of Educational Reform* by Michael Fullan (1993, London and Levittown, PA: The Falmer Press); Seymour Sarason, *The Predictable Failure of Educational Reform* (1990, San Francisco: Jossey-Bass) and David Tyack and Larry Cuban, *Tinkering Toward Utopia: A Century of Public School Reform* (1995, Cambridge, MA: Harvard University Press). I am indebted to my MIT colleague Alan Graham for the insight that basic innovation occurs through the integration of diverse technologies into a new ensemble. See A.K. Graham, “Software Design: Breaking the Bottleneck,” *IEEE Spectrum*, March 1982, pp. 43-50; and A.K. Graham and P. Senge, “A Long-Wave Hypothesis of Innovation,” *Technological Forecasting and Social Change* (1980), p. 283-311.

26 ■ Schools That Learn

On public versus private schools, see: Susan P. Choy, *Findings from the Condition of Education, 1996: Teachers' Working Conditions* (1996, Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, NCES 97-371, available online at:

<http://nces.ed.gov/pubs97/97371.html>;

Private schools: different needs, different worlds, by Mollie Gore, *Richmond Times-Dispatch*, April 7, 1998. On homeschooling Isabel Lyman, "Homeschooling: Back to the Future?" Policy Analysis No. 294, January 7, 1998 (Washington, DC, Cato Institute) summarizes statistics from the Department of Education (500,000-750,000 children taught at home) and the Homeschool Legal Defense Association (1.23 million). Since an increasing number of children are "part-home-schooled" (for a limited number of years, or for only certain subjects), this number may be larger.

The source for this statistic is: Statistical Abstracts of the United States, Table No.661.Families With Own Children —Employment Status of Parents:1995 and 1998. Source: U.S. Bureau of Labor Statistics, News, USDL97-195, June 16, 1997; and unpublished data.

the industrialized world at levels that would have seemed almost unimaginable a few years before.

Second, many of the historic conditions upon which the industrial-age school relied no longer exist. Part of this is due to demographic changes. The captive female labor market that schools depended on to draw the majority of teachers has disappeared, as women now pursue a much broader range of professions. Even more problematic, traditional schools depended on traditional family and community structures that no longer exist. In the United States, the traditional family structure of one parent working and one parent at home to raise kids ceased to be a social norm during the 1960s and 1970s. It has been replaced by families with two working parents or single parents as the norm. Today, among families with children under eighteen, only 26 percent have one or more parents home during the day. (Even this figure may be inflated due to the increasing number of parents working from their homes, which gives more opportunity for contact with children but also creates stress due to conflicting professional responsibilities.) The other three-quarters of school kids have no one to come home to. A breakdown of the traditional parent-child-school relationship has resulted. Schools now have to take on more of a child care role, and conversations between parents and teachers often are more focused on easing parents' stresses than on helping the children academically.

Perhaps as historic is the elimination of the school's monopoly on the provision of information, due to the growth in communication and media technology. One hundred years ago, children knew little of what was going on in the larger world. Today, the typical teenagers has at least as much access to knowledge about the world as parents and teachers have. Moreover, media technologies such as computers, video games, and the Internet provide a mix of fun and learning in ways that school rooms cannot match: they are controlled by the learner, available when the learner is ready, and embedded in networks of mutual interests among peers. Changes in family structure have rendered these media technologies especially influential, since they often fill the gap as substitute parents.

Last, even if these multiple symptoms of profound change were ignored, the simple fact is that the working world is no longer looking for "industrial workers." Employers of tomorrow likely will place a much higher value on listening and communication skills, on collaborative learning capabilities, and on critical thinking and systems thinking skills—because most work is increasingly interdependent, dynamic, and global. The former dean of MIT's engineering school, Gordon Brown,

used to say “To be a teacher you must be a prophet—because you are trying to prepare people for a world thirty to fifty years into the future.” By continuing to prop up the industrial age concept of schools through teacher-centered instruction, learning as memorizing, and extrinsic control we are preparing students for a world that is ceasing to exist.

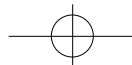
Still, it is easy to be daunted by the challenge of transforming industrial-age schools, especially considering that their underlying assumptions still match the thinking of most people and most of society’s institutions. But, I think such reactions miss an important point. The challenge is not to come up with a simple set of fixes. Indeed, the machine-age concept of “fixes” is part of the problem. Many historians of school reform, from Seymour Sarason to Diane Ravitch to David Tyack and Larry Cuban, have noted the ways in which well-intentioned “fixes” have made problems worse. Schools are not “broken” and in need of fixing. They are a social institution under stress that needs to evolve. The only hope for the future lies in growing awareness and willingness to experiment from many quarters and many philosophical perspectives. No one person has to come up with all the answers; indeed, that may be exactly what is not needed.

But what will cause the diverse innovations needed to lead to a coherent overall pattern of deep change? I believe that the answer lies in a new guiding metaphor. Just as the machine metaphor shaped the thinking that created schools in the industrial age, the emerging understanding of living systems can guide thinking for the future.

AN ALTERNATIVE TO THE MACHINE MODEL OF SCHOOLS

Over the past hundred years, a revolution has been occurring in our scientific view of the world, a “systems revolution.” It started in physics and moved gradually into biology. It has roots in engineering, especially the understanding of dynamic feedback systems. This revolution is penetrating gradually the cognitive sciences and the social sciences. But this process is just at its outset, especially the appreciation of living systems as opposed to static mechanistic systems. Because it takes a very long time for a fundamental shift in scientific worldview to work its way into society, even though the beginnings of the systems view date to 1900 or so, our institutions are still organized based on machine thinking that dates to the seventeenth century. Probably another 50 to one hundred years will pass before the systems revolution to becomes integral to our way of living as has the machine thinking that preceded it.

See Sarason, *The Predictable Failure of Educational Reform* (op. cit.), Diane Ravitch, *The Troubled Crusade: American Education 1945-1980* (New York: Basic Books, 1983); and David Tyack and Larry Cuban, *Tinkering Toward Utopia* (op. cit.)



28 ■ Schools That Learn

What is this revolutionary living systems view all about at its essence? It starts with the assertion that the fundamental nature of reality is relationships, not things. Our Newtonian culture tells us that the world is comprised of things. But the science of the last hundred years tells us that more than 99 percent of every substance is empty space! Even the remaining 1 percent is not just “very little things” such as atoms and electrons, but a kind of probability that tangible properties will occur in that subatomic space.

At a more human scale, this “thing” that we call a body is, in fact, not nearly so material as it appears to us. The inventor Buckminster Fuller used to hold up his hand and ask, “What is this?”

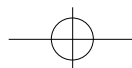
Most everyone answered, “It’s a hand.”

“No,” he would say, “it is a patterned integrity. It is the capacity to produce hands, a structure of relationships which continues to manifest itself as a hand.” Our hand is continually replacing itself, as old cells die and new ones are born. It takes a few months to replace all the cells in the hand, but we get a completely new pancreas every day, and the entire body replaces itself in a few years. In that sense, your body does not “have a hand,” or a foot, or any other particular body part, so much as it has the capacity to produce all of these continually. This is a stunning statement of fact for those of us used to thinking that “We are our bodies.” But this is the nature of living systems. The body is more like a river, with new substance flowing through and being organized continually, just as the banks of the river organize the water flowing through. Seeds do not produce trees. They organize the process of creating trees. Things are not the basic building blocks of living systems but the results of living systems. “Thingness” arises out of a more fundamental reality of relationships.

It is for this reason that biologists call living systems “autopoetic,” or self-producing. A living system has the capacity to create itself. In the revolutionary new understanding of living systems, some scientists also believe that living systems are distinctly characterized by emergent self-organization (behaviors and structures that cannot be predicted based on past behaviors and structures) and cognition, the ability to “make sense” of their environment. Although the new science of living systems is in its infancy, we are clearly learning that we have treated much that surrounds us like lifeless things—trees, planets, even social systems like schools—because we have not understood deeply enough the properties associated with life.

This represents a fundamental distinction between living systems

See for example, Fritjof Capra, *The Web of Life: A New Scientific Understanding of Living Systems* (New York: Anchor Books, 1996); and *What is Life?* by Margulis and Sagan (op. cit.).



and machines; living systems are self-made while machines are made by others. Ironically, the more we understand living systems, the more aware we become of the mental conditioning inherent in the industrial age. Unlike machines, living systems continually grow and evolve, form new relationships, and have innate goals to exist and to re-create themselves. They are neither predictable nor controllable like machines, though they have patterns of behavior that tend to recur and their future development can be influenced. Moreover, living systems create machines, starting with the simple tools used by birds and other mammals, right up to our most sophisticated technologies. In a sense the living systems view subsumes the machine view rather than being opposed to it. When relativity theory gradually became accepted, it was said that "Einstein replanted Newton's plant in a larger pot." The same could be said of the living systems age relative to the machine age. The problem is not machine age thinking per se but the dysfunctional habit of seeing everything through that lens.

What would happen if school was organized around appreciation of living systems rather than machines? In effect, this is the question addressed by the rest of this book. But we can begin with a few ruminations.

First, the learning process would come alive. Consider, for example, the subject of biology. Ironically, the very study of life itself is for most students a dead, boring subject. I was shocked to discover recently that our oldest son was taught high school biology exactly as I had learned it many years ago: endless disconnected facts to memorize about cell walls and nuclei, ectoplasm and endoplasm, then more facts about blood cells and muscle tissue cells, and so on and so on. But biology is a completely different subject when the learner starts with understanding how a living cell functions, how it creates itself, and how it interacts with its environment to maintain internal balances conducive to the dynamic processes continually unfolding within it. Moreover, instead of learning about these ideas as scientific facts to be memorized, what if learners get to discover them themselves through interacting with computer simulations that let them create cells and experiment with how they would survive and adapt under different circumstances. What about cancer? At one level, cancer is nothing but uncontrolled cell division—mitosis run amuck. Could learners create conditions in their simulations that would cause the signals from surrounding tissues that normally limit cell division to fail? All of a sudden, students are discovering for themselves the many lives of the cell, the prototypical living system. When you consider

30 ■ Schools That Learn

the contrast between biology under the machine learning model and the living system model, which do you think would be more captivating and fulfilling?

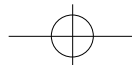
See pages XX, XX and XX for more examples of systems thinking in science education.

Several years ago I met a woman who taught English literature in a high school on the south side of Tucson, in a high-poverty neighborhood. She had to teach Shakespeare to Hispanic and Native American kids who were wondering how they would survive the next day. The industrial model made the story of Hamlet into a kind of a thing—a set of character names and plot lines to be memorized. But her boyfriend, who taught science in another school, had been using computer simulation models like that of the way cells worked. So she decided to build a simulation of Hamlet. It traced the growth of Hamlet’s anger and resentment, the way that this, in turn, made the king and queen misunderstand him, and the tragic results.

Suddenly Hamlet came alive. The kids could ask questions like “What if Polonius hadn’t hidden behind the curtain? What if Hamlet hadn’t slain him? What if he had done something else? What might have happened?” A static tableau became a living tapestry of people interacting with one another, brought alive because the learners could themselves interact with Hamlet through translating their what-if questions into simulation experiments. I will never forget sitting around with some of those kids two years later and listening to one boy, Raphael, a Hispanic student who was thinking of dropping out of school before encountering her class. I asked him to tell me what that computer simulation model of Hamlet had meant to him. “My brain popped open,” he said. He got reconnected to school, his grades improved, and he graduated. He also rediscovered his love for music. We talked about the career he was making for himself as a musician. Spontaneously, he started drawing system causal-loop diagrams with the other kids—to discuss his music!

Clearly, there is something significantly different about studying subjects as if they were alive. Such an educational process rests on:

- Learner-centered learning rather than teacher-centered learning
- Encouraging variety, not homogeneity—embracing multiple intelligences and diverse learning styles and
- Understanding a world of interdependency and change rather than memorizing facts and striving for right answers



There is also something different about treating schools like living systems instead of as machines. In particular, it means:

- Constantly exploring the theories-in-use of all involved in the education process
- Reintegrating education within webs of social relationships that link friends, families, and communities

When we inhabit a school as a living system, we discover that it is always evolving. We participate in that evolution by asking questions like “Why is the system this way? Why do these rules exist? What is the purpose of this practice?” We are not willing to settle for explanations meant to pacify us, such as: “The people who have the power make it that way.” Since we are part of the system ourselves, we are drawn to inquire more deeply, to look for ways that our own assumptions and habitual actions are integral to creating the system as it operates today. Constantly questioning becomes a way of life for students, teachers, parents, and administrators.

The assumptions identified here can provide a starting point. They are generic, not specific. Each will be more influential in some settings than in others. What is important is for all concerned to think together for themselves about how these and other assumptions play out in their own school setting and to see where their energies for innovation really lead. Only then will the idea of school as a living system actually come alive.

The aim of this questioning is not criticism but learning, making the school environment about learning for everyone concerned. I remember asking a principal of a very innovative school several years ago how she defined her job. She answered, “My job is creating an environment where teachers continually learn.” She believed that teachers being deeply engaged in their own learning process would inevitably enable them to create a learning environment for students.

Finally, school can reestablish its place as a social institution by making children’s lives, not the classroom, once again the center of their learning. There are examples in the text that follows—such as the Creswell, Oregon, school district— where the aim became to encourage everyone in the community who had natural contact with school children to see themselves as part of the school process. For example, monthly “kid days” were organized where school was officially closed so that people could get together in informal dialogues and look at the self-creating social networks that were in fact making the school possible.

32 ■ Schools That Learn

We are interested in hearing your views about the assumptions you perceive to be operating in your schools and about others that may apply to industrial-age and living system schools. To post your own comments (and, if you wish, have them visible to other readers of the book) or to read others' comments, see our Web site at <http://www.fieldbook.com/STL/assumptions.html>.

The description of schooling is in Daniel Quinn, *My Ishmael* (New York: Bantam, 1997); pp. 126ff. The quote is from page 129. Our knowledge about rites of passage comes, in part, from conversations with Louis van der Merwe.

"There were people in my dialogue group whom I wasn't particularly fond of," one student recalled later. "I didn't dislike them, but I didn't see them as people I could relate to. Then we started talking; they shared their views and I listened to what they had to say. Now, when I pass that group in the hall, I have less reason to think that they dislike me. The dialogue gave at least one person in each of the different cliques in our school a thought: Maybe this person isn't so different and we should probably treat him or her with some respect."

Another student noted that Creswell, according to a friend's older brother, had been a much more violent place a few years before. "Fights were more common; conflict was part of the school culture. I've just kind of attributed this change to the things we do here now, to the time we spend bringing people into the culture and helping them understand that that's not how most people solve problems."

For Creswell's learning relationship with the community, see page XX.

I believe that stories like Creswell are possible because there exists a deep hunger among adults to be more connected to the lives of children. We cannot walk away from children, even if we are not parents or educators. Human beings are deeply, innately connected to the lives of children. The care for children seems to be rooted deeply in us, as part of our biological heritage.

While reconnecting with education as a social process may seem idealistic, it is worth noting that this how it was for the vast majority of our collective history. Indigenous cultures have educated their young for tens of thousands of years without industrial schools. In Daniel Quinn's novel *My Ishmael*, he describes "the tribal educational system": "Youngsters 'graduate' from childhood at age thirteen or fourteen, and by this age have basically learned all they need in order to function as adults in their community. They've learned so much, in fact, that if the rest of the community were simply to vanish overnight, they'd be able to survive without the least difficulty. They'd know how to make the tools needed for hunting and fishing. They'd know how to shelter and clothe themselves." They have done all this without any schools, simply by doing what all children do: by watching their parents and other members of the community, and spending time with the people who know something about what they want to learn. "Graduation" from the tribal system inevitably involves a rite of passage, where people are not only tutored in the tribe's heritage and traditions but learn the importance of enduring suffering and facing a challenge on their own.

Of course, there are limits to such a system. Life does not move backward. We will not go back to living in tribes. But, one might think that an approach to education that has been around for many thousands of years warrants being taken seriously—that we would look to understand how it works. In particular, to take the tribal education system seriously, we would have to adopt the assumption that children are continually learning, that learning occurs in day-to-day situations of living, and that the institutions that support learning are integrated into the workings of society.

Learning is nature's expression of the search for development. It can be diverted or blocked, but it can't be prevented from occurring. The core educational task in our time is to evolve the institutions and practices that assist, not replace, that natural learning process.

WHO WILL LEAD THE CHANGE?

One last comment on why schools seem remarkably difficult institutions to change and where particular leverage may lie. Industrial-age schools have a structural blind spot unlike almost any other contemporary institution. This blind spot arises because the only person who could in fact reflect on how the system as a whole is functioning is the one person who has no voice in the system, no power to provide meaningful feedback that could produce change. This person is the student.

The student is the one person who sees all the classes, the stress at home, the multiple conflicting messages from media and the total environment. Kids know when the overall workload is too big or small, when the stress level is too high or the level of respect too low. But they have no power or standing in the system. Their opinions are discounted. They are, after all, just kids—in a system run by adults, supposedly for their benefit.

I have come to believe that the real hope for deep and enduring processes of evolution in schools lies with students. They have a deep passion for making schools work. They are connected to the future in ways that no adult is. They have imagination and ways to seeing things that have not yet been reshaped by the formal education process. And they are crying out wanting to be involved, to become more responsible for their environment.

Imagine that we enforced a rule on a company's workers: under no circumstances are you to talk to customers. We would not expect that company to survive for long. Similarly, to the extent that they silence the voice of the student, schools are designed to not innovate.

34 ■ **Schools That Learn**

This does not mean that all that is needed is student leadership. But it does mean that without student leadership, there is little hope. The rest of us have been in the system of education for our entire lives. We are truly the fish in the water of industrial-age assumptions. Young people are acutely aware of how dramatically our world is evolving away from those assumptions, often more so than adults. And young people are still new enough to the system that they can see the tacit rules and assumptions and help the rest of us see them as well.

