shows a bird developing the ability to leave the nest. The upper symbol represents flying; the lower symbol, youth. For the Asian mind, learning is ongoing. "Study" and "practice constantly," together, suggest that learning should mean: "mastery of the way of self-improvement."— Peter Senge

Senge, P. M. (2000). *Schools that learn: A fifth discipline fieldbook for educators, parents, and everyone who cares about education* (1st Currency pbk. ed.). New York: Doubleday.

Three nested systems of activity

Good connections start with recognition. One of the most consistent themes underlying this book project is the need for a clear expression of "I See You": the ability to recognize each other's identity and value, particularly if one or both of us have been invisible to the other before now. The phrase comes from the opening of *The Fifth Discipline Fieldbook*:

> Among the tribes of northern Natal in South Africa, the most common greeting, equivalent to "hello" in English, is the expression: *Sawu bona*. It literally means, "I see you." If you are a member of the tribe, you might reply by saying *Sikhona*, "I am here." The order of the exchange is important: until you see me, I do not exist. It's as if, when you see me, you bring me into existence.
>
> This meaning, implicit in the language, is part of the spirit of *ubuntu*, a frame of mind prevalent among native people in Africa below the Sahara. The word "ubuntu" stems from the folk saying *Umuntu ngumuntu nagabantu*, which, from Zulu, literally translates as: "A person is a person because of other people." If you grow up with this perspective, your identity is based on the fact that you are seen—that the people around you respect and acknowledge you as a person.

From *The Fifth Discipline Fieldbook*, p. 3. Our understanding of the meaning of *sawu bona* and *ubuntu* derives from conversation with Louis van der Merwe and his colleagues James Nkosi and Andrew Mariti.

Who, then, are the participants in any effort to create a school that learns? Whether the school is public or private, urban or rural, large or small, there are three nested systems at play, all deeply embedded in daily life, all interdependent with one another, and all with interwoven patterns of influence. These systems—the classroom, the school, and the community—interact in ways that are sometimes hard to see but that shape the priorities and needs of people at all levels. In any effort to foster schools that learn, changes will make a difference only if they take place at all three levels.

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 it 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 Boorstin, "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."

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

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."

Russel 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."

For more about Frederick the Great and his influence on the modern organization, see Gareth Morgan, *Images of Organization* (San Francisco: Sage Publications, 1969), p. 22–25. This link is also mentioned in "The Drive to Learn: An Interview with Edward T. Hall, *Santa Fe Lifestyle* (spring 1988), pp. 12–14.

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.

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, 1999), p. 170; they in turn are quoting N. McPherson, *Machines and Economic Growth* (Westport, CT: Greenwood Press, 1994). The Chandler quote is from Alfred Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, MA: Harvard University Press, 1977), p. 245–246.

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 whole school was 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 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, citywide 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.

David B. Tyack, *The One Best System: A History of American Urban Education* (Cambridge, MA. Harvard University Press, 1974), p. 42.

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 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. Finally, 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 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

n the movement and frustration of school reform Michael Fullan, *Change Forces: ing the Depths of Educational rm* (London and Levittown, PA: Falmer Press, 1993); Seymour son, *The Predictable Failure of ational Reform* (San Francisco: ey-Bass, 1990) and David Tyack Larry Cuban, *Tinkering Toward Fa: A Century of Public School rm* (Cambridge, MA: Harvard ersity Press, 1995). On nological innovation, see A. K. am, "Software Design: Breaking Sottleneck," *IEEE Spectrum* (March), pp. 43–50; and A. K. Graham P Senge, "A Long-Wave Hypothesis novation," Technological recasting and Social Change (1980), 3–311. On public versus private ls, see: Susan P. Choy, *Findings the Condition of Education, 1996: ers' Working Conditions* hington, DC: U.S. Department of ation, Office of Educational arch and Improvement, 1996, NCES 71), available online at: //nces.ed.gov/pubs97/97371.html; ate schools: Different Needs, ent Worlds," by Mollie Gore, and Times-Dispatch, April 7, 1998. omeschooling, see Isabel Lyman, eschooling: Back to the Future?" Analysis, No. 294, January 7, (Washington, DC: Cato Institute)

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 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 schoolrooms 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

summarizing 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 the changing families 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.

See Seymour 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.).