

Assembly Lines, Biology, and Customization in Schools

Systems theorist Peter Senge begins his recent book, School That Learn, with a section entitled “The Industrial-Age Heritage of Schools” (Senge, 2000). This industrial model dramatically increased output and was essentially an effective way to serve the needs of an economy based on manufacturing. Despite its successes, as we transition to the information age it is becoming apparent that structural and systemic incongruities are placing an inordinate amount of stress on the school system. We are now seeing charter school movements, voucher plans, home-schooling, and online and commercial endeavors as a reaction to the lack of faith in traditional public education. Given this tension, perhaps it would be wise to reconsider the dominant metaphor for the industrial age—the assembly line—and explore options for a profoundly different model for education.

Senge asserts that “... few of us today appreciate how deeply assembly-line concepts are embedded in the modern school” (Senge, 2000, p. 31). Essentially, students have moved through the system much the same way as a Model-T was assembled almost a century ago. In schools, expert teachers along the assembly line each contribute a small piece to the final product, efficiently ensuring that all students have gone through the appropriate procedures with regard to their area of specialty. If each teacher does his or her task well, the student will exit the “assembly line” as a well-rounded individual. In the assembly lines of the industrial era, the ideal outcome was the production of a consistent product that would be indistinguishable from others—Henry Ford went so far as to have each car painted the same color as he made claims like “The customer can have any color they want as long as its black.” In many ways, American schools have approached the monumental task of educating children with a similar sentiment.

The modern assembly lines of the information age don't operate like traditional assembly lines. Even industrial manufacturing companies have abandoned Ford's approach: "The assembly line was the epitome of work in the old economy. It was both a tool and an expression of the relationship between the worker and the work, the product and the customer. In the old economy, every converter for every customer flowed along the same assembly line and was worked on by the same set of hands, doing the same tasks, over and over again. In an economy based on customization, speed, quality, and flexibility, the mechanical assembly line has given way to the biological cell" (Dorsey, 2000, p. 210). In the words of manager Vick Crawley, instead of each worker "picking something off a conveyor belt and putting it back down, which wastes motion, the employee does multiple things to a product, so there is less wasted motion" (Ross, 2001, p. 2). These multi-tasking employees are organized into teams called "cells," each of which takes the product from beginning to end. These cells allow for fluidity, versatility, and customization made impossible using the old assembly line model. Work stations are built in "modular components ... Nothing is bolted to the floor permanently, and everything can be broken down and reassembled in the event of a sudden surprise order or an unanticipated problem" (Dorsey, 2000, p. 210).

The reconceptualization of the traditional assembly line from a mechanical process to a cellular, organic, biological process has profound implications for the way that work is organized. Workers are given more control over the process and more responsibility (Verespej, 1998). Individuals are organized into teams that determine their own schedules, monitor for quality control, alter procedures as necessary, and communicate with customers (Dorsey, 2000) (Fishman, 1999; Sittenfeld, 1999). Each cell adapts to fit the needs of their team members and their customers. Computer manufacturer Compaq used the concept of cell manufacturing to

allow for mass customization and found that it there was an increase in employee output by 23% and product quality by 25% (McGraw, 1996).

John Deere was able to increase their product line to 45 different models with 1.7 million options by reorganizing their factory. Promoting greater flexibility and customization required “moving machines together, reducing the amount of handling required for each part ... workers were reorganized into 12 modules, each responsible for building particular subassemblies” (Roberts, 1998, p. 164). To help each of the cells to be successful, John Deere “floods” workers and managers with information. These changes employed mental models from bio-mathematics and even uses software that includes genetic algorithms borrowed from complexity theory (Roberts, 1998).

Evidently some educators are taking note of the dramatic changes in manufacturing. A recent article entitled “Japan Shuts Down its Education Assembly Line” describes how a new university has “scrapped traditional academic disciplines in favor of two multidisciplinary faculties” (Eisenstodt, 1997, p. 1) . Instead of focusing on standardized outcomes or standardized test scores, the faculty say that they want the students to be “comfortable dealing in a fluid situation where the standards have not yet been set” (Eisenstodt, 1997, p. 3).

Interestingly, the response in American schools seems to be quite the opposite—more emphasis on standards, testing, and accountability. Senge asserts that “The assembly-line education system is under stress ... And it is responding in the only way the system knows how to respond: by doing what it has always done but harder ... Whether they espouse it or not, educators are responding to the extraordinary anxiety and stress by turning up the speed on the assembly line” (Senge, 2000, p. 32). It seems disheartening that the tractor company John Deere is using complexity theory and biological cells to transition to the information age and schools—

the very institutions that supposedly promote ingenuity, intellectual pursuit, and innovation—are trying to crank up the speed on the treadmill.

What would happen if schools embraced a more organic structural model to reorganize the assembly line? Remembering that the tenets of the information-age assembly lines are multi-tasking teams organized into cells and given high degrees of control and responsibility, what would a school look like that used cells instead of grade levels or departments? What possibilities for individualization, differentiation, and customization would develop? How would customization affect student achievement? Answering these questions requires a brief comparison between mechanical models and organic elements. Recall that mechanical models promote standardization and homogeneity; biological models promote diversity and customization.

Mechanical Assembly Line	Biological Assembly Line—“Cells”	Implications for Education
Industrial Age; Focus on consistency and control.	Information Age; Focus on adaptability and flexibility.	Schools are currently in a period of transition. Consistency is mandated through standards and testing while families and students expect that their individual needs will be met through differentiation and customization.
Components are separated and sorted into homogenous groups to promote efficiency.	Components are mixed together to allow workers to have easier access to parts and/or machines.	Students have traditionally been tracked or ability-grouped. One argument in favor of homogeneous grouping is that it must be done to make it easier for the teacher. The new model implies that there are benefits to heterogeneity and that the process should be based on the needs of the customer (families) instead of convenience of the worker.
Each worker handles only one part of the process and specializes in a specific function.	Each worker handles all components and cross-functional work is integral.	Teachers have conventionally specialized in a grade-level or subject area. The new model implies that teachers should be able to perform with any student composition or subject area. Given potential changes in student demographics, it makes sense that potential customization increases when teachers can perform a variety of functions.
Workers operate	Workers operate in	Think about the phrase “self-contained

individually under the supervision of an efficiency expert.	teams under the supervision of a quality expert.	classroom.” Isolation was the norm under the old paradigm. The new model suggests that teamwork is the best way to meet the individual needs of many students.
Workers may never see the completed product or interface with customers.	Workers take the product from beginning to end and regularly interface with customers.	Teachers typically work with a student for one school year. The new model suggests that teachers should stay with a student until performance targets are completed. This implies that looping and multi-age classes promote greater customization.
Workers are given information on a “need-to-know” basis.	Workers are given lots of information.	Traditionally, administrators determined decisions about personnel, school finance, and curricular issues. The new model suggests that all staff needs to have access to information to allow for more-localized decision-making. Customization is predicated on knowing the needs of the customer and the resources available within the organization.
Workers are told what to do, how to do it, and when it needs to be done.	Workers collaborate with team members to decide how to meet performance deadlines.	In the traditional model, detailed and sequential curricular materials virtually scripted the work of the teacher to optimize control and consistency. The new model implies that performance outcomes need to be clear and that teams must work together to creatively meet the individual needs of their students. Different teams may develop different procedures and use different resources to get the job done.
Products must meet consistency specifications. Deviations from the norm are considered to be problems.	Products must meet performance expectations of customers. Deviations from the norm—customization—are considered to be beneficial.	In the traditional assembly line model, all of the products were identical. Every Model-T was black. The new model encourages and supports the notion that outcomes can and should be individualized.

At Jefferson Elementary School in Carlsbad Unified School District (San Diego County, CA) several new structures exemplify the shift towards the “cell” model for education. Teachers work in teams to creatively meet the needs of their students, often regrouping and recombining within individual classrooms and throughout the teams as well. For example, during the

language arts block students from all six 2nd grade classrooms are treated as if they are part of the same “cell” and move between classrooms to best fit their particular needs. The teachers then form subgroups to better differentiate instruction and customize the lessons for the students. With six teachers and a minimum of three subgroups per teacher, each student has access to at least 18 different levels of instruction. Teachers use a common assessment tool that spans Kindergarten through Second Grade content standards to promote consistency and coherence in the student placement. Regular reviews of student achievement data are used to adjust student grouping throughout the year and other subject areas are taught with heterogeneous groups to ensure that students are not tracked into a low achieving group. Thanks to a similar approach in Kindergarten and First Grade, SAT9 test scores in all areas have jumped more than 80% in just three years for 2nd grade students.

Another example of a more cellular approach is evident in the upper grade “Village” concept at Jefferson Elementary. Students in grades four and five are placed into a “Village” of three teachers, each of whom works with students from both grade levels during different parts of the day. Differentiation and customization options are maximized during language arts as categorical funding supports additional certificated staffing to reduce class size during the morning instruction. Since teachers know that the students will be in the same “Village” for two years, the pace and sequence of instruction is less constrained by the calendar. Further customization is made possible by supplemental funds that support optional before- and after-school programs such for remediation, academic enrichment, band, violin, Spanish, chorus, dance club, writing club, drill team, and use of the computer lab.

Teachers using the “cell” model to promote differentiated instruction need to have systems and structures to promote internal communication. Strategic use of technology for the

purposes of sharing assessment information, lesson plans, and other data can promote more effective team dynamics. Time also needs to be allocated within the contract day for interpersonal communication—student schedules with one minimum day per week or monthly staff development days are a couple of ways to build collaboration into the workday. Using the biological metaphor, a living system needs “food” to survive—in the case of “cells” in schools, nourishment and growth come from access to information.

It is possible to begin to conceive of even more ambitious cross-functional teaming arrangements to promote customization. For example, imagine that all students begin the K-12 experience in a “Literacy Cell” staffed by experts in early literacy. Students remain in the “cell” until exit criteria are mastered. Given different rates of progress and varying backgrounds, students exit the “Literacy Cell” at different ages but all have mastery over certain core standards. Parents may then have the option to place their child in cells with different emphases such as problem solving, communication, arts, or technology. Each of these second-stage cells would have similar core competencies to ensure some basic standards for all students but would go about the task of building student mastery in distinct ways. Instead of having college-prep and traditional tracks for secondary students, “cells” could be also established with different emphases at the middle and high school level.

The possibilities for organic organization in school structures are many, yet few have purposefully redesigned the archaic assembly lines into vibrant cells with the creativity, ingenuity, and success that modern manufacturing companies have demonstrated. Teaming, access to information, and diversity are some of the key components in the new systemic paradigm. Do the majority of the teachers at your site work in cross-functional teams? Is information readily accessible to all staff? Does your site recognize the value of diversity? The

answers must be yes, yes, and yes before schools can begin to realize the promise of customization and differentiation to meet the needs of *all* students.

References

- Dorsey, D. (2000, June). Change factory. Fast Company, 210.
- Eisenstodt, G. (1997, 2-1-1997). Japan shuts down its education assembly line. Fast Company.
- Fishman, C. (1999, October). Engines of democracy. Fast Company, 174-186.
- McGraw, D. (1996, 7-8-1996). Staying loose in a tense tech market. U.S. News & World Report, 46.
- Roberts, P. (1998, November). John Deere runs on chaos. Fast Company, 164-165.
- Ross, S. (2001, 8-27-2001). Workplace: Assembly line changes call for creative employees. Reuters Business Report.
- Senge, P. (2000). Schools that learn. New York: Doubleday.
- Sittenfeld, C. (1999, August). Powered by the people. Fast Company, 178-181.
- Verespej, M. A. (1998, 9-21-1998). The old workforce won't work. Industry Week, 53.