System Dynamics:
the Foundation Under Systems Thinking

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Understanding systems is crucial to improving the organization of schools and to modernizing material that students learn. But how is one to think about systems? Our educational, social, and economic systems are far more complex than the technological systems faced by engineers. Even with the simpler systems of chemical refineries and space flight, an engineer would never try to design by simply thinking and depending on intuition. The engineer would use computer simulations to anticipate the behavior of a design, and would build prototype systems to demonstrate performance.

By "systems thinking" I mean the very popular process of talking about systems, agreeing that systems are important, and believing that intuition will lead to effective decisions. Without a foundation of systems principles, simulation, and an experimental approach, systems thinking runs the risk of being superficial, ineffective, and prone to arriving at counterproductive conclusions. Those seeking an easy way to design better social systems will be as disappointed as if they were to seek an effortless route to designing bridges or doing heart transplants. Because there is no widespread realization of the complexity of social systems, people are easily beguiled into believing that systems thinking is sufficient.

"System dynamics" is a professional field that deals with the complexity of systems. System dynamics is the necessary foundation underlying effective thinking about systems. System dynamics deals with how things change through time, which covers most of what most people find important. System dynamics involves interpreting real life systems into computer simulation models that allow one to see how the structure and decision-making policies in a system create its behavior.

System dynamics as a solid systems core is being pioneered in many K-12 schools. Conferences for teachers in K-12 schools who are active in system dynamics attract 100 to 200 participants. I have never in my career

been to a professional meeting where the morale and excitement about the future was so high. In schools where system dynamics is becoming a foundation that bridges across and unifies many traditionally separate subjects, teachers have frequently told me, "I had no idea that these students could do so much." My favorite sound bite from one conference was from the high school teacher who said, "The high school teachers who know what is going on here are terrified. They see the day coming when the elementary and middle schools will be delivering to them little MONSTERS who can THINK."

The excitement and promise of system dynamics in K-12 education is best conveyed by quotations from teachers who have experienced the impact on students:

> From Tim Lucas, in New Jersey: "We are introducing kindergartners to the concepts of stocks and flows and the idea that behaviors can be graphed over time. Beginning in first grade students are mapping larger sets of information and working with causal loops to explain cycles in nature and everyday events.… By fifth grade, students are manipulating simple computer models that integrate into their curriculum."
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> Tim Joy at a high school in Portland, OR: "I taught writing and literature for 13 years and always suspected I was party to some intellectual crime. Why is it that so many students thought the world of language began and ended at the door of the classroom? Then I discovered system dynamics. …System dynamics has a logic-based grammar, a universal language that students can readily learn and manipulate to create meanings. What have I found? Creating "meaning" results in bolder QUESTIONS, whole new views which do not house traditional understandings."
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> From the report on a summer teachers' conference: "Models provide a common language with which to engage learners with diverse learning styles and interests. Simulations are especially engaging, and draw out many who might not otherwise participate in more traditional discussions and activities. … Models are extraordinarily powerful for helping to convert abstractions into concrete realities. A learner's ability to 'see' a system—what goes into a stock, where feedbacks exist—and then to run a model and ascertain how the system operates under varied conditions, renders abstractions into real meaningful, concrete terms. This discovery is true for students at all levels."
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> From Jan Mons, at a school in Georgia: "My most fruitful experiences occur when I discuss classroom discipline systems. We have both students and teachers build a discipline system together so that all parties will know

> what the system is capable of producing. When we do this many students have an "Aha!" experience and state that they now understand how a teacher's frustration can accumulate over time. Teachers have their own insights as well--they begin to understand how they have often built discipline systems that were "preprogrammed" to result in unpleasant situations."

Material on system dynamics in K-12 education is available at the web site: clexchange.org.

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