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The Challenges of Infusing System Dynamics into a K-8 Curriculum

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ABSTRACT: If system dynamics is to fulfill its promise of fundamentally improving education in kindergarten through twelfth grade, then it must be fully integrated into the curriculum. This means not only developing effective lessons using the tools and perspective of system dynamics, but also finding the best ways to help teachers adopt them. Both are very challenging. Teachers and administrators at the Carlisle (Massachusetts) Public Schools have been working to infuse system dynamics into their K-8 curriculum since 1994. This paper will describe the process of developing and implementing system dynamics lessons. Using one lesson as an example, it will illustrate what the children do and what they learn. It will also present the problems of imbedding the lesson and the systems approach into the curriculum.

INTRODUCTION

System dynamics can fundamentally improve education for students in kindergarten through twelfth grade (K-12). Experience in the classroom has shown that system dynamics can help students develop critical thinking and problem-solving skills. It can also enhance their understanding of the current curriculum by helping them to ask better questions and to recognize connections and patterns across subjects.

The potential of system dynamics in education reaches beyond the subject learning of individual students, however. It promises to transform the structure of education itself. When students use the tools and perspective of system dynamics, education becomes more learner-centered. Teachers become guides helping students construct their own knowledge. Instead of being passive receptacles of information dispensed by the teacher, students become engaged in working together to figure things out for themselves. As teachers also begin to work together to build their own system dynamics skills and develop interdisciplinary lessons, the change permeates the school culture, fostering even further change.

The curriculum is the driver in initiating and sustaining improvement in education through system dynamics. The challenge is to find the best ways to improve current teaching using the tools and perspectives of system dynamics and then to embed them so deeply into the curriculum that they take hold and grow on their own. Teachers at the Carlisle Public Schools in Carlisle, Massachusetts

Infusing *continued on page 3*

Barry Marshall Richmond

November 14, 1946 – August 3, 2002

This summer we in the K-12 system dynamics community lost a dear friend, Barry Richmond. He gave generously of his time, energy and intense intellectual power. His contributions to our efforts to introduce system dynamics into K-12 education were epitomized in his vital presence at the ST/DM conference this summer. His thoughts from his excellent keynote address will resound in our heads. We will miss him terribly.

This is a tribute from the system dynamics list serve, followed by one from the CC-SUSTAIN group in Portland, OR.

Barry Marshall Richmond, 55, died August 3 at home surrounded by his family.

He was born November 14, 1946, in Boca Raton, Florida, the only son of Seymour and Mary Richmond. Due to his father's Air Force career he spent his young life in many different parts of the country. He shared those experiences with his sisters, Bonnie and Lori. His family's journey to Alaska and the time they spent there was Barry's favorite adventure growing up.

Barry Richmond *continued on page 9*

EDITORIAL

After the lull following the completion of our biennial conference in 2002, September finds us looking ahead to June of 2004, and a conference to be held in the Portland, Oregon area. The next newsletter should announce a location and a date . As we think back over the 2002 conference, many faces and thoughts go through our minds. So many good conversations and ideas! None of those re-surfaces as consistently, however, as the brilliant keynote given by Barry Richmond, made more meaningful as it was his last public speech. We will miss his voice and his caring about K-12 education. As you read through this issue, you will note many mentions of his name, a graphic reminder of all he has done to support and further the cause.

The beginning of the school year always makes me think of spring. I sometimes find myself looking around for crocuses and other signs of new life. For those of us who have been linked to the academic year for a vast percentage of our lives, it is a new beginning, often with new faces. Many of us start with high resolves and hopes. For any of those resolves which center around learner-centered learning and system dynamics, we at the CLE are here to help. If there is a resource to which we can guide you or a conversation we can have with you, don't hesitate to call or write.

Lees Stuntz <stuntzln@clexchange.org>

UPDATES…

Learning Opportunities

MSST—A self-taught, self-paced course to learn the basics of system dynamics modeling. The first three units are available for free; download from clexchange.org. Contact John Heinbokel for the remaining units. <heinbokel@vtcommonsschool.org>

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University of Illinois Dynamic Modeling Online Course

"Dynamic Modeling," an online self-paced graduate level course taught by Professor Bruce Hannon, will be offered by the University of Illinois at Urbana-Champaign October 10 - December 19, 2002.

Dynamic modeling is a process of scientific thinking and extending our knowledge, aided by a machine. It allows one to formulate and revise scientific hypotheses and theories using logic and evidence and is a truly interdisciplinary skill. In this course, participants will learn the utility and power of dynamic modeling and simulation as research, teaching, and business tools. They will learn how to develop a computer model of their choice using the modeling tool STELLA. For further details about the course (NRES 399 DM), to learn more about dynamic modeling, or to register online for the self-paced online course, visit http://www-s.outreach.uiuc.edu/aop/ or the course Web site at http://www.aces.uiuc.edu/aim/model/ .

This course is offered by the University of Illinois Office of Continuing Education Division of Academic Outreach, in partnership with the College of Agricultural, Consumer and Environmental Sciences.

Report from DynamiQueST

On May 3· 2002, the third DynamiQueST gathering was held at Worcester Polytechnic Institute. Sixty-two students were joined by fifteen teachers and ten coaches. The projects showed the mature insight and critical thinking characteristic of learning guided by system dynamics. High Performance Systems, in the person of Barry Richmond, Pegasus Communications, represented by Ginny Wiley, and WPI, represented by Michael Radzicki and Jim Lyneis, contributed not only their coaching talents but small gifts for the participants. One of the most enjoyable portions of the day was the interaction of students with some of the most eminent system dynamicists in the world. Barry, Ginny, Jim, and Mike were joined by George Richardson, Khalid Saeed, Dave Packer and, of course, Jay Forrester for the day's activities. A note sent by Janan Hamm from Murdoch School in Chelmsford, MA shows how engaged the students were:

"I had many excited students when we left at the end of the day. We will be meeting as a group on Tuesday to plan how we will be reporting back. I have already had one 5th grader who was so taken with the whole thing that he wants to look at some models on the computer and then tell everybody about how kids can use them to figure out stuff. I had a sixth grader who wants me to come down with her to her class and help her run the last activity for her class so they can figure out things like that on their own. Last but not least I had two girls who read to us the story about penguins and walruses—a gift from Pegasus given to the students—in the car on the way home. They recognized the connection to the writing piece they missed on the human genome project and want to read the book to a class and do an activity connecting to their science project. I borrowed their book and we will do that on Monday!"

One can't ask much more than that from students!

***Updates** continued on page 16*

Infusing System Dynamics into a K-8 Curriculum continued from page 1

have been working to integrate system dynamics into their K-8 curriculum since 1994. This paper will describe the process of developing and implementing a curriculum using system dynamics. Using one lesson, the In and Out Game, as an example, it will explain what the students learn. It will also illustrate the difficulties of getting a lesson to stand on its own.

SYSTEM DYNAMICS FOR EVERY STUDENT IN CARLISLE

Carlisle is a small affluent town west of Boston, known for its excellent school system. Carlisle has one school campus for students in kindergarten through eighth grade (K-8, ages 5 through 13) with a total enrollment of 815 students. It is a caring friendly place where everyone knows everyone else, in a community that holds very high expectations for its schools. System dynamics was first introduced here when a few teachers and administrators attended the Creative Learning Exchange conference on system dynamics in education in 1994. From a small beginning in two middle school science and math classes, system dynamics has very slowly spread to all other grade levels and subject areas in the school as more and more teachers have witnessed its benefits for their students. Now, seven years later, every student in the school has some exposure to system dynamics every year. With strong active support from the school board and the administration, system dynamics is gradually becoming part of the school culture.

The growth of system dynamics in Carlisle has been led, nudged, and occasionally salvaged by a team of five people. Rob Quaden, the original math teacher involved, and Alan Ticotsky, a former elementary classroom teacher and science coordinator, are Systems Mentors. Generously supported by the Waters Foundation since 1997, their role has been to develop lessons and help other teachers learn how to use the tools of system dynamics with their students. Eileen Riley, the district business manager, has been interested in organizational learning as well as the smooth operation of the program. Davida Fox-Melanson, Carlisle School Superintendent, has led the school with a clear vision of improved education while also fostering progress in system dynamics through building community support, faculty collaboration and risk-taking, and professional development. Debra Lyneis, former teacher, Carlisle parent and former Carlisle school board member, now works with Alan and Rob to develop and publish curriculum materials available free on-line through the Creative Learning Exchange (clexchange.org). In addition, Jim Lyneis, a professional system dynamicist at PA Consulting Group and Senior Lecturer at MIT in system dynamics, has been a valuable and steadfast resource for system dynamics expertise over the years. This team has worked hard, despite setbacks, to infuse the principles and practice of system dynamics into our school. We are pleased with our progress so far, but we realize that that progress still depends on our being here to nurture it along. Our ultimate goal is to have system dynamics so tightly knit into the fabric of our school that it will thrive without us.

SYSTEM DYNAMICS IN THE CURRICULUM

In Carlisle, system dynamics is not taught as an end in itself; it is not a separate school "subject." Instead, system dynamics offers a set of tools which teachers use to improve what they are already teaching about change over time. These tools are: behavior over time graphs, stock/flow diagrams, causal loop diagrams, simulation games, and computer models. They are used across disciplines and grade levels to help students gain a deeper understanding of whatever patterns of change they are studying. For example, students use behavior over time graphs to examine changes in science experiments and literary plots. They use causal loop diagrams to explore the unintended consequences of environmental policies. They use games and models to learn about epidemics, over-fishing, and their own bank balances. They use the tools to study common patterns across different disciplines, such as exponential growth. Throughout, they build their math reasoning, problem solving, collaboration and communication skills.

When students are using these tools, their instruction becomes more learner-centered because system dynamics involves an engaging process of asking better questions, figuring things out and learning from mistakes. While improved pedagogy is one benefit, we also have a higher goal. We teach our students to use the tools of system dynamics because we want them to learn to think and act systemically. We want to equip them with the skills and perspectives to deal effectively with the dynamically complex social, economic, and environmental problems that they will face. We would like them to recognize the effects of positive and negative feedback on accumulations over time. We would like them to understand that cause and effect can be distant in time and space, that policies involve tradeoffs and unintended consequences, that unlimited growth cannot last forever, and that what they do makes a difference. We would like to give them the tools and the courage to address complex problems objectively with logical consistency. These are very high expectations.

Obviously, we are not there yet! Our students have only rudimentary system dynamics skills. Our curriculum is new and evolving, and we still have not seen students move up through our entire K-8 sequence. Meanwhile, our teachers are still learning too, all at different stages. Ultimately, we would like our graduating eighth graders to leave with the ability to build and interpret basic system dynamics models. Again, model building would not be for

Infusing *continued on page 4*

Infusing System Dynamics into a K-8 Curriculum continued from page 3

its own sake but in service of the curriculum. Furthermore, there are many preliminary skills that students must learn to prepare for and complement model building. In Carlisle, developing a system dynamics curriculum is definitely a work in progress, with a long way to go.

WHAT MAKES A GOOD SYSTEM DYNAMICS LESSON?

As systems mentors Rob Quaden and Alan Ticotsky have worked with teachers to infuse system dynamics into the Carlisle curriculum, several criteria for successful lessons have emerged:

- **The lesson must enhance the current curriculum**. It must provide teachers with a way to teach what they are already teaching, only more effectively. Teachers are already busy with a full curriculum. A good system dynamics lesson must demonstrate to teachers that it benefits their students without adding to the load. Usually when teachers see how absorbed and insightful their students can be using the system dynamics approach, they are convinced of its merits.
- **The idea for a good lesson often comes from a classroom teacher who recognizes a possible systems application in a current lesson.** Often in Carlisle a classroom teacher will invite one of the mentors in to help develop a systems lesson around what begins as a vague idea. These lessons fill a perceived need in the curriculum and the teachers take ownership of them.
- **A good system dynamics lesson has a hands-on component that helps students reach from the concrete to the abstract**. Students learn by doing. In an effective lesson for K-8 students, the use of system dynamics tools should flow directly from the concrete activity. For example, students count and graph beans to learn about exponential growth, or they spread a "disease" by secret handshakes before they use a model of epidemics.
- **A good lesson is learner-centered**. Students are engaged in figuring things out for themselves.
- **A lesson must be suited to the developmental level of the students**. Because K-12 system dynamics is still in its infancy, developing a sequence of system dynamics skills and determining their age appropriateness is still a matter of trial and error. In Carlisle, often a lesson is presented at one level and later moved to a younger or older grade to find where it fits best.
- **Lessons deliver two kinds of learning: curriculum content learning and system dynamics skill building.** The primary aim is to help students think more deeply about science, social studies, literature, math, etc.; the tools of system dynamics aid that process. However, students also need to sharpen their system dynamics skills if they are to use the tools most effectively. The best system dynamics lessons do both.
- **A good system dynamics lesson stands on its own**. If the lesson meets the above criteria, classroom teachers are willing to adopt it and make the approach an integral part of their curriculum. As teachers build their own systems skill and confidence, they are willing to conduct the lesson independently and develop more applications of their own.

HOW DOES A LESSON GET INTO THE CURRICULUM?

System dynamics was first introduced in Carlisle in eighth grade science and math classes. As these two teachers conveyed their enthusiasm for the approach to colleagues, the use of the tools began to spread very slowly into other classes. After Rob Quaden and Alan Ticotsky became systems mentors supported by the Waters Foundation, the spread accelerated down into elementary grades and across middle school subjects. The mentors sought places in the curriculum where systems tools could improve instruction, and worked with classroom teachers to develop and co-teach lessons. Initially, they worked with the teachers who were most inclined to be interested and on applications that were most obvious, usually in math or science – in pioneering, new ideas get their best start in "fertile ground." Gradually, as the word has spread, the mentors have reached out to other teachers and disciplines. The fifth grade team of teachers has been a wellspring of ideas and enthusiasm, now generating many of their own lessons with the support of the mentors. Eighth grade has been another very active grade. There are now lessons at every grade level, K-8, taught in all sections of each grade.

System dynamics is now becoming an expectation in our curriculum. Improving our curriculum through system dynamics is an explicit system-wide goal presented by the superintendent to the school board and evaluated annually. Furthermore, through collective bargaining several years ago, we established a financial incentive for teachers to build competencies related to the school system goals. Teachers are compensated for participating in local system dynamics training and demonstrating their competency in the classroom. Although there are still widely disparate levels of skill and interest among the staff, system dynamics is becoming more and more a part of "what we do here."

The mentors and the administrators are not the only forces behind the growing use of systems tools. The students also play an important role – maybe the most important role. Recently, eighth graders were using behavior over time graphs and causal loop diagrams in science class to structure the research and writing of their interdisciplinary ecology term papers. Each student also worked with another teacher as an advisor. For a long time, the system mentors had been trying unsuccessfully to find an entrée into the social studies curriculum. The eighth grade teacher was willing, but system dynamics seemed too difficult and foreign. However, after she saw her student advisees' facility and depth of understanding with causal loops on his science project, she decided to let her social studies class loose with them too. With a little support from Rob, the students drew perceptive causal loop diagrams of the causes of the rise of Nazism. The teacher was impressed with the richness of the class discussion. Now she is ready for more.

ONE LESSON: THE IN AND OUT GAME

The In and Out Game is an example of a lesson using system dynamics tools in math. In the first and second grades, very young students use the game to learn about graphing and the concept of stocks and flows. Later, students revisit the lesson in the fifth and eighth grades to reinforce and extend their learning. This lesson is a good example because it shows that, although the lesson benefits students, integrating it into the regular curriculum is not assured. It is a dilemma that currently puzzles us.

Alan Ticotsky created the game for young students; Rob Quaden adapted it for older students. The complete lesson, "The In and Out Game: A Preliminary System Dynamics Modeling Lesson" by A. Ticotsky, R. Quaden, and D. Lyneis, 1999, is available free on-line from the Creative Learning Exchange at clexchange.org under the List of Materials, #SE1999-09In&OutGame.

The First Grade Lesson

Six year olds physically act out and graph an accumulation. Mentor Alan Ticotsky delineates a place in the classroom that will hold the "players in the game." There is also a path "in" and a path "out." First, the class discusses the "rules of the game," starting with "two in and one out." Each round, two students walk into the designated area and one student walks out. Meanwhile, the teacher "keeps score" on a large table recording the flows in and out as well as the total number of players at the end of each round. The teacher also plots the number of players on a large line graph. The class discusses the emerging pattern on the graph. They also notice that while the flows in and out remain constant, the number of players in the game increases.

From the In and Out Game, first grade students learn that the line graph is a representation of the information they have gathered. They learn that the vertical axis stands for the number of players in the game, and that the horizontal axis records time, or rounds in the game. As they play the game, they see that the line on the graph shows how the number of players is changing over time – if the number of players is increasing the corresponding line on the graph goes *up*. They are learning the concept of stocks and flows in a concrete way without using these terms yet. Reinforcing their regular math instruction, students practice addition, subtraction, and estimation each round.

It takes about 45 minutes to explain and physically play four or five rounds of the game with these young children. The students love everything about it: following the rules, counting, and thinking about graphs. They soak it all up.

Infusing *continued on page 6*

Round	Players Going In	Players Going Out	Total Players
(Start)			0
1	2	1	1
2	2	1	2
3	2	1	3
4	2	1	4
5			

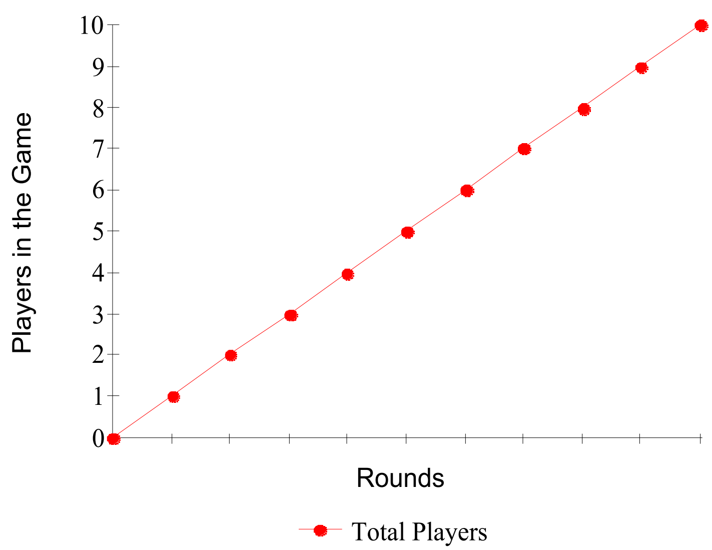

Figure 1. Table and graph of "Two in and one out."

Infusing System Dynamics into a K-8 Curriculum continued from page 5

The Second Grade Lesson

We know that students have absorbed the lesson because when Alan returns to play the game with them a year later in second grade they remember the details and are eager to play again. Needing only a brief review, second grade students are able to play and graph more rounds of the game. They can also change the "rules." After playing "two in and one out" for a few rounds, they can try "one in and two out," "one in and one out," or "three in and one out" and observe and graph the difference as a class.

At the second grade level, students are introduced in a concrete way to the concept of slope. A "steeper" line means faster growth in the number of players; a "flatter" line means slower growth, or no change if the inflow and the outflow are the same. This year they are also introduced to a basic stock/flow diagram as another way to represent the game. They observe that the change in the stock depends on the flows in and out in the game as well as in the diagram, the graph and the table

Playing the game continues to reinforce the students' regular math instruction; students practice their more advanced skills of adding, subtracting, predicting, and graphing. In 45 minutes these second graders are able to do much more than the first graders could. The first grade lesson laid the groundwork.

The Fourth/Fifth Grade Lesson

In the upper elementary grades, the In and Out Game serves as a review of the concept of stocks and flows and as an introduction to computer modeling with STELLA. The lesson was first used in fifth grade because the teachers were very receptive and because the game tied in with other system dynamics lessons there. The mentors are now considering moving part of it to fourth grade because the younger students appear ready for it and because this preparation would allow students to "hit the ground running" in the fifth grade.

By age 10, fifth grade students no longer need to walk into and out of the game to understand the concept of stocks and flows. They still need some reminder of the concrete activity to solidify their grasp of the abstract concept, however. For those students who played the game in second grade, a brief recall of the game is enough. Another option is to describe the game to students as "little kids" would play it and play an abbreviated version. Instead of moving around the room, students going "in" or "out" just stand and sit at their places while the teacher records the progress of the game on a large graph. It only takes a few rounds before the students are ready to manipulate the ideas without the actions. Students can try different rules, discuss the slopes, and predict accumulations 20 or 30 rounds out. They briefly review a stock/flow diagram of the game, noting that the graph and the diagram describe how the accumulation changes over time as a result of the flows in and out.

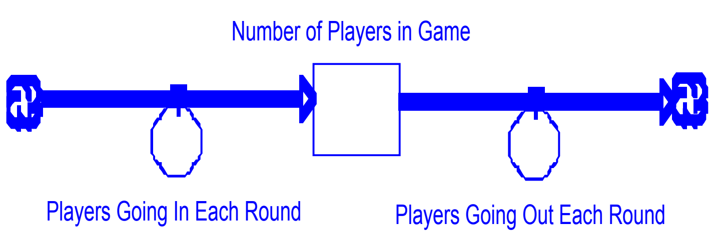

Figure 2. Stock/Flow diagram of the In and Out Game

This year, fifth grade students went on to build STELLA models of the game. Originally, modeling was an eighth grade lesson, but younger students have taken to it easily and it has prepared them well for other fifth grade system dynamics lessons. (An introduction to model building through the In and Out Game may also appropriate at the fourth grade level, but probably not younger than that.) The mentors and, increasingly, the fifth grade classroom teachers lead the students through the mechanics of STELLA using a computer with a projection device. The teachers very briefly explain how to drag down and label stocks and flows of the players in the game. They show students how to set up a graph and run the model. (Students are always impressed when the model generates the same table and graph that their classroom game did!) The explanation takes about 10 minutes. Then, students go to their own computers in teams and build the same model. As a challenge, they try other rules for the game, predicting the graphs before running them. They love doing this. (See figure 3)

At the upper elementary level, the In and Out Game helps students gain a deeper understanding of stocks and flows. They learn more about slope and rates of flow. Finally, they are introduced to the concept of a computer model as another way to represent and examine change over time.

The Eighth Grade Lesson

Thirteen year olds no longer need to play the concrete game. However, a quick review of it does refresh their memories of the concept of stocks and flows. When Rob Quaden conducts this lesson in his eighth grade Algebra I class, he spends 10 minutes at the board going over the rules of the game, the graph of a few rounds, and the stock flow diagram.

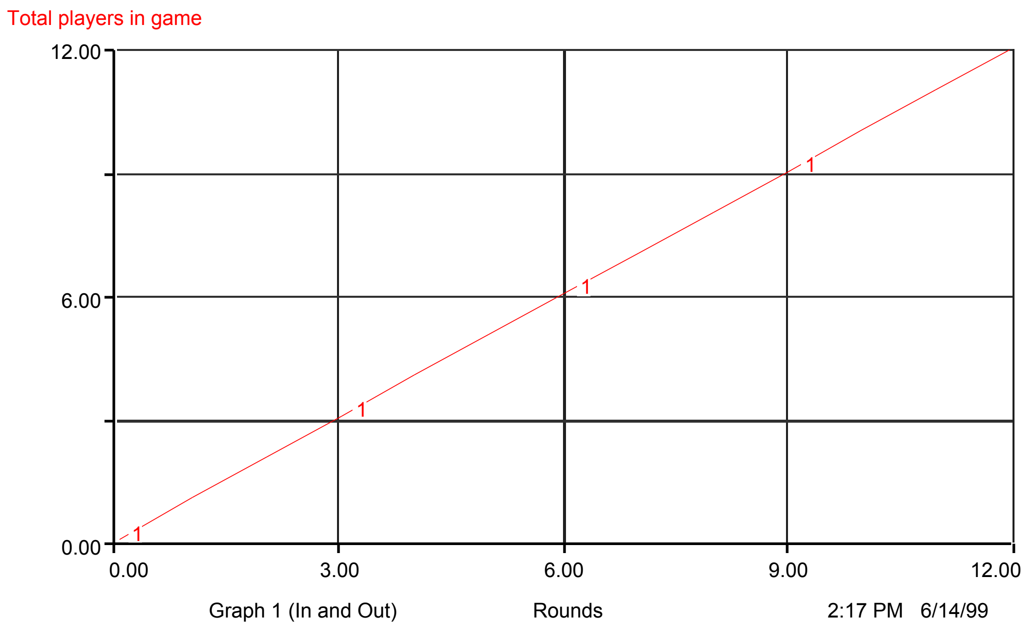

Figure 3. STELLA graph of "Two in and one out"

Students spend the remainder of the period in teams at the computers building their own models of the game. They use their models to answer questions like these:

- Can you get the line on the graph to be less steep? (Less slope, smaller net in-flow.)
- Can you make it steeper? (Greater slope, larger net in-flow.)
- Can you start the line at a different level. (More initial players.)
- Can you make the line slant the opposite way? (Out-flow >in-flow.)
- Can you make it horizontal? (Out-flow = in-flow.)
- Can you make it horizontal starting at a different level?
- What does it mean when the line crosses zero?
- For any graph, can you predict the value after 20 or 30 rounds? (Change the length of simulation.)
- What happens to the line if the flow changes during the game? (Step functions.)

At the eighth grade level, the In and Out Game further develops students' system dynamics reasoning and modeling skills. It also ties in to the math curriculum as another way to express $y = mx + b$, where m is the slope and b is the y-intercept. Modeling gives students another way to visualize and understand the equation.

The In and Out Game is still a preliminary system dynamics lesson because the game and model do not include feedback. Also, especially at the youngest ages, the game focuses on discrete rather than continuous change. These more advanced steps come later in other lessons. The In and Out Game is an attempt to present sophisticated system dynamics concepts in manageable concrete pieces for young children.

SO, WHAT'S WRONG WITH THE IN AND OUT GAME?

In Carlisle, we have been very pleased with this elegant little lesson, and we hear that mentors in other school districts have found it useful too. The students gain an understanding of the concept of stocks and flows based on their own concrete experience. They learn to construct and analyze behavior over time graphs. They sharpen their math reasoning and computation skills. They build nice little models on the computer. And, best of all, the students love doing all of this. They are engaged in learning by doing.

The problem we are encountering now is getting the lesson to stand on its own in the lower grades, however. In the upper elementary grades and in middle school, the classroom teachers are beginning to adopt the lesson and conduct it themselves, without the assistance of the mentors. They see its benefits to their students and a need for it in their curriculum. The In and Out Game helps them more effectively use the tools of system dynamics in teaching other social studies, science, literature, and math lessons. It is taking root.

The first and second grade teachers do not see a similar need,

Infusing *continued on page 8*

Infusing System Dynamics into a K-8 Curriculum continued from page 7

however. Alan Ticotsky has conducted the lesson in their classes and they have always participated, but instead of adopting the lesson, this year they have suggested that their students do not need the graphing lesson at all. They are feeling pressured for time and concerned about diverting any from their primary goals. In first and second grade, the teachers have a strong, almost single-minded, focus on early literacy, with good reason. Students who are not proficient readers by the end of second grade fall behind in school from the very beginning and never catch up. Primary teachers devote most of their attention to helping students develop essential reading skill. Furthermore, because primary teachers' interests and training have focused on literacy and early childhood development, they have not studied as much advanced math or science. They are not inclined to see how a system dynamics graphing lesson fits into their curriculum or into the larger picture. The choice is up to them.

While it is easy to point to the teachers as the reason for our stall in system dynamics progress in the primary grades, perhaps we should look at the lesson itself. In Carlisle, the primary grade teachers are conscientious and skilled; they work hard to educate their students well. If they thought the In and Out Game could benefit them and their students, they would adopt it. It may help to take another look at the criteria for a good lesson presented earlier:

- **The lesson enhances the current curriculum**. While the In and Out Game at the primary level does reinforce arithmetic skills, it does not grow directly out of the current math curriculum. It also does not address reading skills. In the older grades, the lesson does blend with the curriculum offering math problem solving skills, computer literacy, and groundwork for other system dynamics lessons.
- **The lesson comes from the classroom teacher**. The primary teachers did not come up with the idea for this lesson. Instead, Alan Ticotsky presented it to them and they allowed him to teach it because they respect him and because they were curious about the systems initiative in Carlisle. The primary teachers do not own the lesson. In the upper grades, teachers have adapted the lesson to their needs.
- **There is a hands-on component.** Yes, the In and Out Game meets this criteria well, especially in the primary grades. The students learn by doing.
- **The lesson is learner-centered.** Again, the In and Out Game succeeds. The students love to play this game in the primary grades as well as in older grades. They are absorbed in the activity, and the sophistication of their understanding is impressive. The knowledge they construct stays with them and prepares them for subsequent learning.
- **It is developmentally appropriate.** Because this lesson has been moved around and adapted for different ages, we think that it has found its developmentally appropriate spot…for now. It will take time for a complete and consistent system dynamics curriculum sequence to evolve fully.
- **The lesson embodies both curriculum content learning and system dynamics skill building.** Maybe this is our biggest problem. The In and Out Game is fundamentally a system dynamics lesson. It is designed to teach students about behavior over time graphs, stocks and flows, and computer modeling. It does build other skills and touch on other curriculum topics, but the balance tips toward system dynamics. In the later grades, there are many Carlisle lessons that use systems tools to teach a broader curriculum subject; the content learning is the objective of those lessons. However, students also need to learn system dynamics skills if they are to make the best use of them. The In and Out Game fills this need. In the older grades, the teachers recognize this need, but in the primary grades the need is not so apparent.
- **The lesson stands on its own.** In the older grades, the In and Out Game is beginning to happen without the support of the mentors. In the primary grades it is losing ground because the teachers do not see its need. If we cannot engage the teachers, we have no hope of engaging the students. If lessons cannot stand without our support, they will not last or spread.

WHAT CAN WE DO?

System dynamics debuted in Carlisle in the middle school curriculum. As we have worked at that level, we have always felt that students could benefit if we could help them become systems thinkers at a much earlier age. The In and Out Game has shown us that young students can indeed begin to build and use system dynamics skills. Integrating the lesson into the curriculum is proving to be a challenge, however. What can we do?

- If the K-2 curriculum focuses on early literacy, and if the systems approach enables students to become engaged in constructing their own knowledge, then we need to find a way to infuse the systems approach into the teaching of reading. As with older students, young children can also benefit from asking better questions and learning by doing (in fact, this is their natural inclination—they do it all the time.) The goal is not just to find a way to fit system dynamics into the curriculum; instead the aim is to use the tools to teach children more effectively in a departure from the way we do things now. At the primary teachers' suggestion, Alan Ticotsky will work with them to use behavior over time graphs in literature. Students will draw graphs to trace and discuss changes in stories and think more deeply about what they read. Alan is gracious and tireless in his efforts to find a way to improve instruction using systems tools; now teaching reading has become his target.

- Alan has developed another primary grade graphing lesson based on the Friendship Game (also available on-line from the Creative Learning Exchange.) This lesson complements the current social competency curriculum. Students play and graph a classroom game that shows how friendly behavior can spread in a class; they discuss the implications for their own class. Since primary teachers are very interested in early childhood development and socialization, we should observe how well this lesson is accepted. (Alan also has a similar kindergarten lesson and game about planting and harvesting trees that ties into the current rainforest unit. We need to observe and learn from this lesson too.) Perhaps the graphing can be useful in a different context than the In and Out Game.

- We need to pay attention to our own criteria for good lessons. Through the In and Out Game, we have learned at least that the criteria are valid because when we violated them the process did not work!

- We may need to rethink or delay the introduction of system dynamics graphing in the primary grades. Of course, we are reluctant to do so because the students seem to understand, but we also know that we cannot push these ideas onto teachers. They may be right. It might be better to save the graphing for an older grade when students can learn it more quickly just when they need it. For now, maybe it is enough to use the tools in a more general way. We need an open mind to achieve the best long-term results.

- Meanwhile, we need to explain the goals and benefits of system dynamics to all teachers, including primary grade teachers. Because they are busy with their own curricula, many teachers do not often get a chance to see what is going on in the rest of the school. It might help primary grade teachers to see older students engaged in an exciting system dynamics lesson in science, math, social studies, literature, or health. System dynamics is new in K-12 education. If it were already integrated into the curriculum, all teachers would see it as one of the life-long skills that we help students acquire as they progress through the grades. For now, the challenge is getting that reinforcing cycle started.

CONCLUSION

The In and Out Game has been a good lesson for us in Carlisle. We are pleased that it is such a successful system dynamics lesson for our students, and the systems team has learned a great deal from the process. It is a concern that the lesson does not stand on its own, but it serves to give us insight into what we don't know – which is the first step in finding a solution.

We suspect that finding ways to integrate system dynamics lessons and perspectives into K-12 education is a challenge that extends beyond Carlisle's experience with the In and Out Game. Most teachers are pressed for time and already very busy "covering" their current curriculum in the ways that they have been taught. For a few of these teachers, the systems approach suits their curriculum and their own way of thinking – they are natural systems thinkers already looking for a change. These are the pioneers and initiating change with them is easy. Carlisle's fifth grade team is a good example.

The bigger challenge is to move beyond these early adopters into the larger group of teachers for whom the curriculum applications or teaching approach are not so obvious. It can happen at any level in a school. In Carlisle, the issue has arisen in the primary grades, but we suspect that it would also be the case in high schools where the philosophy and structure of the school make teachers even more inclined and pressured to cover their own separate subjects in the traditional way. In Carlisle, we have found that some teachers who were not early adopters have given system dynamics lessons a try and found them very effective and useful; they now develop applications of their own. Each has approached the idea in a different way and at a different pace. We need patience and creativity to find a good path "In" for the K-2 teachers too.

Developing good systems lessons is a challenge, but finding ways to integrate them into the current curriculum requires equal attention if K-12 system dynamics is to flourish.

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This paper is available free of charge from the CLE website, catalogued as SE2001-09InfusingSDIntoK-8. The two lessons used as resources for this article, each prepared with the support of the Gordon Stanley Brown Fund, are also accessable on the website clexchange.org. They are catalogued respectively as SE1999-09In&OutGame and CC2000-10GraphFriendshipGame.

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Barry Richmond continued from page 1

His life-long passions for teaching, learning, and challenging himself and others led him to pursue a very fulfilling and altruistic life.

Barry married Katherine Wisman in Colorado Springs in 1969. They have 4 daughters, Jessica, 30, Joy, 28, Julia, 26 and Anna, 21. Barry valued his family and daughters' well being above all other commitments. He traveled through many a blizzard to make it to every one of his daughters' basketball games. He'd leap out at halftime to teach proper shooting techniques. At soccer games, he was asked to restrain himself from racing up and down the sidelines alongside his daughter. His love for his family overflowed and was apparent in everything he did.

Barry loved children and appreciated the enthusiasm and joy they had for life. His own youthful and carefree spirit enabled him to forge a special bond with them and enjoy endless hours of play. The play didn't stop with the children. His sense of humor permeated all aspects of his life. He never failed to find or create humor in any and all situations. He also loved his dogs, those from his childhood and his most recent favorite, Roxanne, the low-rider.

Barry's educational training culminated with his PhD in System Dynamics from MIT in 1979. He then accepted a teaching position at Dartmouth College as an Assistant Professor in the Thayer School of Engineering. Barry was one of the most popular and well-respected teachers at Dartmouth for 8 years. Students consistently gave Barry the highest rating among Dartmouth College faculty. He regularly had over 100 students sign up for his Principles of Systems class. Barry always had time for every one of those 100 students and every one of their projects.

In 1985 he founded High Performance Systems, a software development and consulting business, with Systems Thinking as its foundation. Barry dedicated the rest of his life to teaching people all over the world how to live by Systems Thinking principles. He worked endlessly to make people aware of interdependent relationships and long-term consequences of their actions, striving to make everyone better Systems Citizens. His expertise was respected worldwide.

He was granted the 1989 Jay Wright Forrester Award, a prestigious honor awarded by the System Dynamics Society. The award was for producing the STELLA® software, his pioneering work which revolutionized the System Dynamics modeling process. He strove to make learning Systems Thinking accessible to everyone, from grade school students to business executives.

Barry was a superb athlete and loved hiking, kayaking and camping. He completed a marathon on Cape Cod in 1998 and a triathlon in Vermont in 2001.

Barry always felt very strongly about supporting non-profit organizations and helping others. Every year he donated to the Haven in White River Junction. We know Barry would appreciate donations in his memory to be sent to:

Upper Valley Haven
745 Hartford Ave.
White River Jct., VT 05001

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From CC-SUSTAIN

In working with us in the K-12 community, Barry somehow managed to be both colleague and mentor—a rare combination that is testimony to the openness and honesty he brought to dealing with everyone. Without a doubt, we would never have accomplished what we have without his support and encouragement. He has taught us, directly and by example. He has supported our dreams and shared his. He shared himself in a way few are willing to.

Many people have great intellectual achievements. Far fewer also touch people. A very few not only touch, but inspire others and support others in finding their own inspiration. Barry was one of these very special individuals.

Among the many times Barry shared his expertise were the Day-After events following SYM*FEST when we spent a full day with Barry. Yes, we learned new things, but mostly we learned we had a new friend in this work. On one of these occasions, he talked to us about his daughters. Barry evidently followed everything they did in their youth and missed them terribly as each moved on. On the special occasions when they returned to their childhood home, their laughter filled the bedrooms. "They go back to their own bedrooms, as if they were little again," he said. "I just love it." By telling this story, he reminded us that all our work was still about the relationships in our lives—how we sustain them, and how they sustain us. He was always available and easy to talk to. A conversation with Barry was filled with multiple-layers of content. Many of us got into the habit of writing notes afterwards to remind us of what was said so that we could mine those conversations for insights and inspiration.

His dream was of a world/ learning environment in which everyone was empowered to think, to reason, to build understanding. When he was working with others in support of this, he glowed. Barry was transformed by the excitement of watching others develop into thinkers. In spite of all the assistance and support he provided for our work, our defining image of Barry will always be him at SYM*BOWL/SYM*FEST. Barry squatting down next to third graders who were explaining their popcorn model, one system dynamicist talking with others. Standing next to a group of middle school students, discussing their work with an excitement and a respect that elevated them. Engaged in a technical discussion with high school students about their model, teaching while giving a sense of respect that made them excited about what they had done and could yet do.

Murdoch Middle School

by Dan Barcan

Murdoch Middle School began as an idea shaped by the writings of Jay Forrester and Peter Senge and grew into a middle school of nearly 200 students. Systems thinking and system dynamics objectives were codified in the charter and approved by the state. Teachers read *The Fifth Discipline* before they were even interviewed. Local companies provided hardware and High Performance Systems donated Stella and hours of training. Board members, teachers, and the local ST/SD community watched in anticipation of sustained growth in the use of simulation models. Finally, everyone thought, there's a school where we don't need to worry about convincing people to try this. Where parents will come because they are looking for non-traditional work like modeling. Where students and teachers will have the time and support systems thinking and system dynamics demand. But sustained growth never came. There were moments of excitement, moments of backlash, and plenty of small victories and defeats. Here's the story.

Part I: Peterson in Chelmsford. An expert comes to train the staff before the school opens. What impact did the training have?

Part II: Heads above Water. The staff gels. Systems thinking and dynamic modeling show up the most public project of the year. Have they "made it"? What next?

Part III: Fear of Sustaining. The school begins to find some success and acclaim. One teacher begins to work as the ST/SD Mentor. Does the use of the tools spread?

Part IV: Negotiation. For the first time, people begin to choose publicly whether they will use ST/SD tools or not. What is the effect of this erosion of the original goal?

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Steve Peterson stood in the middle of a room of teachers, talking at their backs as they hunted for different icons on the battered computers that made a stark counterpoint to the brand new walls and floor. He walked them through the concrete steps of loading Stella, registering the software, and opening new screens on which to build models. They turned in their chairs to watch him pour water back and forth between two small plastic cups, illustrating how they could find stocks and flows in everyday happenings, and then he directed them back to their screens to model the pouring water. Peterson, a tall, rangy man with an encyclopedic knowledge of thousands of situations begging to be modeled, from milk production to forestry to rocket launches, worked the room to help the eight faculty members find the features they needed. Over the next fifteen minutes, some modeled the water moving between the two cups. Some tried it and got tangled in the software's features, erased what they had with the very popular dynamite icon, and started again. Some took out catalogs hawking young adult novels or art supplies or gym equipment and began to make selections, and still others wandered out of the room, making phone calls or locating desks for their empty classrooms, then wandering back and asking colleagues what exactly they had missed over the past hour.

There were times, in fact, during which Peterson, who had delivered this training successfully scores of times before, found himself alone in the room, offering a costly and specialized training (This session was offered free to the school.) to no one at all. "The building," recalled Peterson, who remembered being impressed by the energy level of the teachers with whom he was working, "was completely chaotic." But consider that these were teachers unburdened by any sort of contractual restrictions that might limit the amount of time they could stay for training. Indeed, they were teachers who had come together specifically to start a school in which students would, among other things, learn to use Stella, the modeling software produced by Peterson's company, High Performance Systems, Inc. In addition, there was no possible way the staff would be able to find the money or time to replicate the training within the next twelve months. So what in the world was going on?

Peterson had arrived at what was then called the Chelmsford Public Charter School (The school has since been renamed after one of its founders, Linn Murdoch, and is now called the Murdoch Middle School.) in the middle of August 1996, about two weeks before the school would begin to educate its first students. The faculty, seven teachers and the principal, Sue Jamback, had spent their time leading up to his visit in what many schools would consider an unorthodox way. Jamback, a veteran art teacher and principal who had worked in schools in New Hampshire and Connecticut over a twenty year career, believed strongly in establishing a "shared vision" before plunging into what might be called short tasks—the ordering, organizing, decorating, and alphabetizing that passes for summer work in many schools. To be sure, there are numerous teachers across the country who spend their time away from students in rigorous pursuits that improve their professional practice, but to find an entire school engaged in higher level work together is rare. And so their first day together, Jamback talked with

Murdoch *continued on page 12*

Barry Richmond

continued from page 10

Talking to the Young Masters group this year, making 15-years-olds feel like they had no limits to what they could accomplish, offering his help to allow them to achieve it. However much Barry was captivated by the idea of thinking, he was more excited about helping others do it. He was the ultimate teacher, drawing huge satisfaction from the achievement of others. As are all great teachers, he was a model of what we could become.

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Murdoch Middle School continued from page 11

the staff about the vision spelled out in the charter – one calling for real-world, hands-on work, preparing students for the 21st century – and how they might go about making it their own.

Within a few days, they had settled on the wording for four academic objectives for all of their students and had begun to create projects. Since the charter dictated that classes would be based on real-world events and not simply on textbook material, the work of "creation" extended from dreaming up scenarios that would pass for "real-world" to locating numerous trade books to provide content for the activities kids would be asked to do. The work was often interrupted as prospective students wandered in with their parents and were enthusiastically shown around the nearly empty building and put through the uncomfortable process of making small talk with their seventh-grade teachers while their beaming mothers looked on. Teachers asked students their opinions on matters ranging from possible colors for the walls to topics about which the students wanted to learn. In the evenings, as energy for writing curriculum waned, teachers made attendance lists, organized grade books and classrooms, and pasted up bulletin boards.

By the time he arrived, then, Peterson encountered a group that saw little time in its day for anything resembling a traditional *I talk, you listen*, or even an *I show, you do*, classroom. Though they sat through his instruction, which many remember as interesting, and even fun, most could not conceive of mastering a new piece of software, integrating it into projects that they were not entirely sure of how to plan in the first place, teaching students to interpret graphs and charts as the software generated them, and then making the whole thing run dependably on the school's donated, jury-rigged computer network. He was doomed before he started. Peterson says that he was convinced that the teachers and principal were very interested in systems, and that some people definitely showed a knack for building models, but also that he doubted that the new school would have the "infrastructure to support all the activities" that would need to go on to take them from interest to instruction. He reiterated High Performance's desire to support the school in its mission and scheduled a follow-up meeting for a time that seemed incredibly far away, certainly long enough to allow people to get on their feet – November.

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The Chelmsford Public Charter School, housed in a rickety office condominium equidistant from an expensive coffee bar in one direction and a trailer park in the other, was the product of roughly two years of work by a small group of parents from Chelmsford, Massachusetts. Laws allowing groups of citizens to petition state Boards of Education for the right to start their own publicly funded schools were first passed in Minnesota in 1991. In 1994, Massachusetts passed the Education Reform Act, which aimed to improve the Commonwealth's public education offerings by injecting equal parts autonomy and accountability into the system through the law's two most notable features: charter schools and high-stakes testing. Charter schools are independent public schools that are approved and carefully monitored by the state and receive their funding from the same sources as district public schools. Students attend by choice, and the schools are not allowed to require that students take entrance exams or demonstrate academic qualifications any more rigorous than to prove that they live somewhere in Massachusetts and are of the appropriate age to attend the grades offered.

Chelmsford sits roughly twenty-five miles northwest of Boston and is home to a good many engineers and sales vice-presidents, though it does draw students who qualify for free and reduced lunch and still boasts more than one working farm and an Agway feed store. In addition, and more relevant, Chelmsford was already the sort of place to which people move "for the schools." Most of its students graduate from Chelmsford High School or one of a few well-regarded religious schools in the area, and nearly all of them go on to four-year colleges. And yet, as the founding group had seen firsthand while trying to bring some energy for reform to the town's school system, some residents were not satisfied with the institutional feel and resistance to change endemic to large public schools. Their charter proposal included a focus on what is often called student-centered or hands-on education, as the founders envisioned a school in which students did not attend one-size-fits-all lectures but instead worked on a mixture of individual and small group projects. An example from their application to the state describes a scenario in which students notice pollution in a local lake and, with coaching from their teachers, concoct a series of labs to diagnose the problem and devise a cure. With visions of this sort of assignment in mind, one of the founders heard Jay Forrester speak on the topic of system dynamics in education. From there, system dynamics was an easy sell to the rest of the board, and it appeared prominently in what became the final proposal.

Once the school year began, whatever modeling knowledge teachers might have picked up from the work with Steve Peterson was nowhere to be seen. The day-to-day work of rolling out (and almost immediately adjusting) the new projects to students conditioned by years of fill-in-the-blank schoolwork proved to be an even larger task than simply inventing the new projects in the first place, and the infrastructure about which Peterson wondered as he drove away in August was certainly not there. On the subject of whether changes in the initial training could have produced more teachers who were actually able to build models while attending to all the other tasks before them, Peterson is straightforward, saying, "There's no way we could have done that."

Indeed, the initial units, in which some students had to design and implement a physical education program for the school and others wrote a school constitution, did not call for even the tiniest bit of either systems thinking or system dynamics. The projects began with great fanfare and rolled on for weeks. Parents raved about the quality of instruction. The server crashed almost daily. Orders came in late or failed to go out. The parking lot remained full during nearly all daylight hours. There were days of wild excitement, such as the one when a girl managed to get a local judo teacher – judo did, in fact, ultimately become one of the phys. ed. offerings – to provide a demonstration lesson, complete with the breaking of boards and a great deal of shouting. There were days of nearly unbearable frustration as students and teachers confronted the idea that it isn't always that interesting to research and plan gym classes or school constitutions. And then, in an attempt to add some order to the curriculum, the teachers picked due dates and cut the projects short. Kids settled on solutions and implemented some of them. It was, to everyone's surprise, nearly November. Steve Peterson was on his way back.

He met with the staff in a fifth-and-sixth grade classroom one afternoon as the school buses were hauling kids around the winding roads of Chelmsford and the sun was beginning to set. Again, he poured water between two cups. This time, though, no one sat at a computer. Peterson drew behavior-over-time graphs representing the movement of water and got more of a response than he had over the summer. He asked the group, point-blank, what they wanted to get out of using the Stella software. Did they want kids to learn to build their own models? To understand dynamic behavior? To understand solutions to specific problems or nuances of particular situations? It turned out that, while no one really knew, most liked Peterson's idea that he might arrange for a local system dynamicist who could come more frequently and actually plan with teachers—something that the group thought might be more useful than the "airlift" method they had been trying. The conversation turned from one in which Peterson led the group to learn modeling techniques and more towards one in which he helped them figure out how they might continue their training in ways that would better fit into the sort of work that they were already doing and would not require him to drive three hours from Hanover, New Hampshire, to conduct the training himself. Satisfied that two people in particular, a fifth-and-sixth grade teacher named Leah Zuckerman and a seventh-and-eighth grade math teacher named Ruth Corbett, would begin to fulfill the school's mandate to use system dynamics in its curriculum, the staff went back to their classrooms to grade papers and prepare for the next day. Most would still be there at seven o'clock that night, and all would be back before seven the next morning.

The conversation turned from one in which Peterson led the group to learn modeling techniques and more towards one in which he helped them figure out how they might continue their training in ways that would better fit into the sort of work that they were already doing...

Zuckerman and Corbett set up meetings with Gary Hirsch, a management consultant who had studied under Jay Forrester at MIT and had made a career solving problems for a variety of industries using dynamic models. Hirsch lived only a few miles from the school and graciously offered to take advantage of his somewhat flexible schedule by coming in whenever the teachers found it most convenient. He met with each of the women for planning sessions and then came in for Zuckerman's ecology unit and Corbett's algebra class. In both situations, the teachers planned the lessons and reviewed them with Hirsch, who offered a few ideas here and there and then showed up for class with a plan to work with students on the computers as they manipulated flight simulator models from the High Performance archives or the Creative Learning Exchange. Hirsch's role was a combination of tech support, science instructor, and middle school system dynamics teacher. He soon found himself trying to talk old computers out of crashing and asking questions along the lines of, "What do you notice about the slope of the line in this graph?" to groups of ten- to fourteen- year olds, who provided answers along the lines of, "It's slanted?" Earnest effort on both ends led nowhere. Zuckerman, Corbett, and Hirsch concluded jointly that there had to be a better way, but, lacking knowledge of what that way might actually be, they agreed to suspend efforts to collabo-

Murdoch *continued on page 14*

Murdoch Middle School continued from page 13

> Yet again, the new school had taken on the best that the system dynamics world had to offer and stared it down. … this was not a case of a faculty rising up to crush a new initiative foisted upon it by an out-of-touch administration. It would be hard to imagine an administration more in touch…

rate to avoid further frustration. Yet again, the new school had taken on the best that the system dynamics world had to offer and stared it down.

To be sure, this was not a case of a faculty rising up to crush a new initiative foisted upon it by an out-of-touch administration. It would be hard to imagine an administration—admittedly, a silly word when it is used to describe only one person—more in touch than Sue Jamback. She insisted on weekly, two-hour staff meetings at which the group tackled large and substantive issues. Though she had as little spare time as the teachers, she managed to get herself into all of the classrooms several times. She demanded and encouraged staff input on issues ranging from the school's budget to its teacher evaluation system to its graduation ceremony. She was a student of systems thinking, if not system dynamics, herself, and would later allocate more than half of the next year's professional development budget to sending more staff to High Performance Systems' training over the next summer.

In addition, staff was hired only after an interview that, in part, focused on their understanding of the concepts explained in Senge's writings. They were, by and large, well-educated, technologically able, and quite devoted to the school, and not at all averse to hard work. Most had participated enthusiastically in dialogues centering on *The Fifth Discipline*, which, though its content does not lead one directly to dynamic modeling, could be considered a fine introduction to the concepts involved.

So why did the implementation fail to take off in what seemed like a fertile environment? One explanation offered by Peterson and echoed by several teachers was that it "probably wasn't the optimal time for the training." Though it seemed better to begin with the training early to avoid having it appear like something tacked on to the "real" curriculum, such scheduling also brought with it the consequence of adding yet another variable to the equation of projects, materials, classroom management, and all the other uncertainties facing a new school. In other words, even if you aren't sure how to create a project around, say, *The Outsiders*, you can be confident that you will be able to read it and that you will most likely grasp S.E. Hinton's themes and symbolism. Not so with system dynamics modeling. Though the teachers were generally comfortable learning to use new applications on the computer, the idea that all were learning together and were then expected to quickly begin teaching students to use this program scared people off. It was, after all, the first time many had tried to learn and apply anything in public, with a group of peers to which they could be compared, since high school. Unsure of how to do the job before them, perhaps they didn't want to get into this kind of risky learning until they felt more settled.

Hidden within this explanation is another one: learning to build system dynamics models is *hard*. Go back to the example with *The Outsiders* and imagine hiring a building full of illiterate teachers to teach it. And then imagine that there is no *Outsiders* – just a mandate that teachers should plan classes that use something new called "novels," which they will learn how to write in three days and should prepare a few of for the school year. Would the trainer spend a day on basic reading skills, a day on basic writing skills, leave a day for free writing, and then expect to see manuscripts? Would you want your kids reading those manuscripts in school? Even Peterson now says that the number of people that he would expect to learn to construct models while they were busy teaching school is "very, very small."

Another possible reason involves what I will call "survival addiction." Teachers got used to planning one day's lessons—one that would, for example, help kids make sense of research on different physical education programs—just hours before that day began. The staff would regularly plan long parent nights—at which parents would have a choice of four different activities, plus a speech from the principal and, for example, a short talk on the school's new report cards—on the afternoon of these events. By and large, the classes, parent nights, and whatever else they tried went well. There were bumps, and kids left by choice and new kids came in to replace them, but most parents were happy with the school.

The support offered by Hirsch and Peterson, while the equivalent of having Pedro and Nomar [two superstars of Boston's baseball team] come and offer input for the phys. ed. project, called on the teachers to plan weeks, or even months, in advance. While there was no one at the school who would have regarded this planning as a bad idea, there was also no one who would have thought it possible. To take time on a winter evening to plan something for a unit to be delivered in May, when the very next day held gaping stretches of time for which teachers had specific academic goals but little in the way of actual plans, seemed preposterous. Perhaps the work would have to take place over the summer. Or the next year, or the year after that, or the year after that.

Dan Barcan <djb221@yahoo.com>

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New Product Announcements from High Performance Systems, Inc.

STELLA Reader

A free, downloadable Reader version of the STELLA software is now available for download from the High Performance Systems, Inc. website. This new reader version enables you to view and print stock-flow diagrams, view equations, use input devices to change parameters, and also to conduct simulations. To download a free Reader version, go to the High Performance Systems, Inc. website at www.hps-inc.com

NetSim Creator v2.0

High Performance Systems, Inc. is very excited to announce the introduction of a completely re-written version of NetSim Creator! NetSim Creator 1.0 required you to be a programmer in order to render your STELLA models suitable for running over the web (or an intranet). With Version 2.0, all you need to do is set up the interface for your netsim within STELLA. Then, when you choose "Export for NetSim" from the File Menu within STELLA, the entire interface from your model is ported over to HTML format so that you *instantly* have a runnable, *interactive* netsim! You will probably want to polish the crude interface using an HTML editor, but all of the interactive devices (including graphs and tables) will already be there, automatically! Version 2.0 finally brings netsim capability out of the back room!

In order to run NetSim Creator, you will need to have the NetSim Creator components installed on a Windows 2000 or NT 4 server running IIS 4 or IIS 5 web server software. For more information, including full description of System Requirements for NetSim Creator, visit our website at http://www.hps-inc.com/netSim/netsimIndex.htm.

Food Chain

High Performance Systems, Inc. is pleased and very proud to announce a new STELLA-based Learning Laboratory called *Food Chain*! The STELLA software is used to create the underlying simulation engines that drive *Food Chain's* virtual ecosystem laboratory. In Part 1 of the Lab, students are confronted with three challenges involving a freshwater lake and a group of plant and animal species that span the four trophic levels. Students are asked to develop hypotheses, design (simulation-based) experiments to test their hypotheses, and then to write explanations of their results. *Food Chain* offers students the opportunity for gaining lots of experience in applying the scientific method while building a solid understanding of the interdependent relationships that govern the dynamics of food chains.

To ensure that students have the opportunity to generalize the concepts they will encounter in Part 1, Part 2 of *Food Chain* re-visits several of the key concepts in contexts taken from students' day-to-day life experience. Maintaining grade point averages, the spread of the AIDS virus, and the creation of pop music CDs are but a few of the contexts within which key concepts such as counteracting and reinforcing feedback loops, nonlinear relationships, and unintended consequences, are couched.

Throughout *Food Chain*, students direct a *discovery-oriented* learning process! The product contains built-in *just-in-time, just-what's-needed* coaching to ensure that "learnable moments" are fully harvested—whenever they occur for the various student teams across a busy classroom. Students can export all of their answers to an external file for electronic submission or printing. *Food Chain* comes with a detailed Teacher's Guide that provides sample solutions and contains diagrams suitable for photocopy distribution to students, or for use in making overhead transparencies to support classroom discussions.

For more information about *Food Chain*, or to learn about demo options, visit our website at www.hps-inc.com.

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Story of the Month: "Hot Air and Greenhouse Gases"

Click on the link below to access our latest Story of the Month, entitled "Hot Air and Greenhouse Gases." The story focuses on the Bush administration's policies toward reducing the rate of growth in greenhouse gases. Using a very simple model, Barry Richmond and Steve Peterson examine the "physics" of global warming, showing in the process why the administration's policies toward global warming are likely to be of very limited effectiveness, particularly against a backdrop of economic growth.

http://www.hps-inc.com/greenhouse.asp

As many of you are aware, our friend and colleague Barry Richmond died earlier this month. This story, then, is a bittersweet one for us to announce, as it marks the end of Barry's direct contribution to the Story of the Month Series. His legacy will live on, however, as we continue the series, providing monthly stories that offer a systems perspective on what's happening in the world.

Take it easy, and enjoy the story!

Newsletter Subscription Information

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<milleras@clexchange.org>

UPDATES… continued from page 2

From a discussion of the use of system dynamics in the Carlisle Public Schools, gleaned from the k-12 list serve:

(If you wish to join the k-12 list serve, just e-mail k-12sd@sysdyn.mit.edu.

"In Carlisle, Massachusetts, USA, we do a few things with Kindergartners. We play a version of "The Friendship Game," developed originally at the Catalina Foothills School District in Arizona. Our methods are described in an article "Graphing the Friendship Game." Both articles are available from the CLE website clexchange.org/lom/.

"We also play a simulation called "The Rainforest Game," which is unpublished but pretty far along in development. I would be glad to describe it in detail off the listserv and would welcome feedback from teachers who try it in their own schools.

"Some Carlisle teachers are piloting simple causal loops about avoiding fighting. We have had good success in grade 5 but I don't know how it will go with the younger students. I know that some of my colleagues around the US have worked with very young students. I am always encouraged when groups of systems educators meet and trade stories."

Alan Ticotsky

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If you would like to invest in our effort here at *The Creative Learning Exchange*, your contribution would be appreciated. You may donate any amount you wish; perhaps $50.00 is a reasonable amount for a year. All contributions are tax-deductible.

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Thank you!

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The Creative Learning Exchange is a trust devoted to encouraging exchanges to help people to learn through discovery. It is a non-profit educational institution and all contributions to it are tax deductible.