PASSION AND PATIENCE:
INFUSING A HIGH SCHOOL WITH SYSTEM DYNAMICS

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System dynamics came to La Salle High School inside the heads of three teachers. Initial models in Physics, Mathematics and Literature developed by our teachers in a 1993 CC-STADUS Summer Institute yielded delightful surprises in the classroom: interest was high (though some clearly came from the novelty), and perceptions were deep (questions and observations were so markedly different from the usual). In time, only two of the three teachers persisted, and we began conversing almost daily, this unusual association of Chemistry and Physics with the Humanities, wondering about next steps. Clearly, these early forays brought success—students were engaged, asked questions in entirely different ranges and depths, and hungered for more—but *within* our comfort areas, in our own disciplines. The two of us, then, began planning how to systematically infuse system dynamics throughout our small parochial school of 600 students and about 35 teachers.

Each of us began by expanding our *own* efforts in our classroom: two models and curricula in English II (10th grade), and models in Conceptual Physics (9th grade) and Physics (12th grade). Cautious and hopeful, bold and occasionally ill-prepared, our first steps in the classroom confounded some students, enlightened others. Not only were we learning system dynamics; we were also *learning how to teach system dynamics*. Our early experimentation led us to significant discoveries about the teaching process, among them, the old notion of teacher-lead instruction had to be radically transformed or—better yet—scrapped altogether. As system dynamics is a mode of thought, a critical perspective on the world, each student necessarily has and discovers his own view. It took months for us to admit to having to let go of some of the classroom control and direction. Students needed to take charge. Five years later, we still remind ourselves to step aside and allow students to go their way.

Successful students in our traditional, college-preparatory, Catholic high school struggled vehemently against this new mode. Suddenly, they were tossed into a region unfamiliar to them; their old methods for achieving scholastic success did not work.

While others strove happily into this systems realm, honors students foundered. Their resistance troubled us for a time, enough to make us rethink some of our efforts: if our smartest students grow frustrated with this, what are we doing wrong? We simply lacked the experience to know what to do; we presumed the trouble lay with us. Finally, truth dawned, light illumined the intellectual landscape, and we saw—maybe, just maybe—that intelligence ought not be confined and defined as we have so long deemed. Further, we needed to push (or shove) these "honors" students to the brink. Thus, initial resistance gave way and honors students, some fatigued from years of sameness, blossomed in this new venue, in some cases leading teachers in a systems awareness. Many of these students emboldened their teachers to ask questions. One student submitted a STELLA model as an addendum to his research paper for American Literature on Isaac Asimov' *Foundation Trilogy*. This teacher now wishes to take the summer training.

In the second year, we began looking outside our narrow disciplines. We started with a simple goal: students should see system dynamics *twice* each year, over their four-year career, each time in a *different* discipline. It was early Fall 1994. Two or three years, we figured. It is now Spring 1998. And we are not yet there.

Like morning dew, myriad problems appeared. A software shortage plagued us for two years; teaching system dynamics to Seniors wasted our energy and time; computer fears and inexperience among the staff were initially high and remain the rule; using computers, even for seasoned teachers, radically changed the student-teacher relationship; some training foundered; inability to *convincingly* tell the "system dynamics story" to both faculty *and parents,* though somewhat assuaged recently, continue to slow the process; promising SD teachers moved, had children, got married, or were reassigned; since traditional departmental boundaries were threatened, some resistance damped our efforts; a regional, school-wide accreditation weighs in and intensifies discussion on the "mission of the school," i.e., traditional vs innovative.

Nonetheless, enthusiasm among students remained high, pushed us to give up personal time to find creases in our instructional schedule and harangue a colleague or two about including some nibble of systems within their own curricula. Still, the most crucial piece of fortune and intellectual purity in those early days was the courageous,

outspoken support of our administration, even though one or two did not know what system dynamics was. Our Academic Dean, having a mathematics background and long-sensitive to the short-comings of *some* traditional approaches, embraced our work, advocated for us with our Principal. Articles began to appear in our quarterly newsletter to parents, who then made phone calls and wrote letters. In year two, our Principal scheduled me for an open Systems period, a time to create curricula, work with teachers, and stretch the idea as far as it might go in a year. In subsequent years, the Academic Dean schedules teacher time in such a way that those with a systems component often have periods off together. Even without this prospect of extending SD, nearly one-third of all students at La Salle were receiving *some* exposure to systems, albeit limited and, likely, flawed.

Owing to the size of La Salle High School at the time (1995: ~540 in grades 9 - 12), we knew that *only one* teacher, in the right department, could have a significant impact; in about three years, with the right teachers in the right department, SD instruction could be infused throughout La Salle. We targeted these departments: Health—all 9th and 10th graders would then see SD *twice*, Social Sciences—potentially 75% of the student body, and Biology—all 10th graders. Over the course of four years, using a systems model in the health curricula, though obviously a rich bed of material, has been a frustrating effort: teacher movement is frequent, few simple Health models existed at the time, most Health teachers were coaches and the CC-STADUS summer training was out of the question since many coaches had full summers. Then, one Fall afternoon, a new teacher assigned to Government asked me about Forestry, and we were on our way.

STELLA models for Government ("Schuster Forest") and Economics ("The College Fund") soon followed. That year, Seniors used systems modeling in three courses; Sophomores saw SD in English, a Health section, some Biology; Freshman (about 30) used STELLA models for acceleration in Conceptual Physics. All this was being produced and conducted amid some frustrating circumstances—lack of software, one of the primary areas of weakness for all schools and a significant reason for systems' very slow implementation in the schools. Initially, we possessed only twelve copies of STELLA for a lab of 30 computers. When the school installed a new lab with grant

money, we made sure funds were available for software. Still, that was only one lab. Consequently, we put run-time versions on the other machines, which only served to exacerbate student frustration and engendered a mistrust of the idea. Just this last Fall did La Salle receive a generous site license that places the latest version of STELLA on all machines, all faculty machines, and *any student's machine,* so long as he or she has a demonstrated need for the program. [Sadly, too few schools have this arrangement and it is a significant leverage point that the Systems Dynamics Society might use.]

Other departments, however, resisted. Within the English Department, inquisitiveness mixed with misgivings: computer models and literature did not go together. Young teachers, savvy with computers, were disposed toward the idea of system dynamics, but the subject matter is steeped in a stodgy tradition. Across the broader academic landscape called humanities—the repository of the Western Canon—not only did teachers not need computers to generate models; doing so would undermine and—to some—trivialize the *entire* thought process: Could William the Conqueror be explained in a graphical function? Resistance continued. An English colleague of mine, stumped by my interest, turned to me one day and said, "You know, you used to be a writer; now you're just a nerd."

And, worse, our brave Government teacher moved downstate to a new school. The new teacher, a basketball coach whose summers fill with camps, had little enthusiasm for the computer model. It was all French to him. Suddenly, our headway gave way; we were again, three years later, where we started.

But openings emerged in the least likely places. At the National K-12 System Dynamics in Education Conference, one participant from La Salle High School was a Religious Studies teacher who saw the inherently deep and, to him, obvious fit with the mission of the school and the purpose of education. Since then, enthusiasm among the Religious Studies Department for systems work has been second only to the sciences. All Juniors are now required, in their Social Justice class, to study a local system, pose appropriate questions, posit a solution and try to implement it; in small ways, these students reach into the core of system dynamics instruction: good questions and helpful attempts to solve always carry a moral imperative. It is what happens to good people when confronted with the truth—they act.

We continued to achieve some measure of success at the 10th, 11th and 12th grades, but could not penetrate the 9th grade curricula. For obvious reasons, establishing a perennial systems component—*at entrance*—would go a long way toward achieving our goal. Still, over the years students have seen, used, adapted and/or built STELLA models in Chemistry, Mathematics, Physics, Biology, Health, Government, Economics, Geology, Literature, and even Religious Studies. Sounds impressive, yet the occasions have been sporadic, save for Physics and Literature, and—as mentioned previously—nothing had been established at the 9th grade level. We continued to encounter troubling pulses in our small, highly adaptive system called "a traditional, Catholic, College-preparatory high school." For instance, as our school has grown, we no longer enjoyed the pervasive influence of, say, a *single* instructor teaching ALL of the 10th literature courses. Or teachers who had previously signed up for the CC-STADUS summer training found themselves pregnant, expecting in summer, or got engaged, a wedding in the summer, or childcare over a three-week period became too onerous. We were having less and less influence.

While the faculty infusion stalled, students continued to warm to systems, demanded more time and began saying some things about it at home. We realized that parents were a significant cohort left out of the systems quest. In short order, STELLA diagrams and classroom success stories using systems appeared in our quarterly magazine (*The Falconer*); we published short systems reading list; presentations at the In-coming students Open House overflowed into the hallway. But the message is not easily given. Words wither when asked to sustain a system dynamics definition. I found myself rambling for ten minutes without defining SD. It is just esoteric enough to defy a popular *and accurate* definition. Thus far, all our efforts were producing more heat than light.

And then the other teacher trained in systems in 1993 transferred to another school and our Principal—who had been a vocal advocate for our cause—suddenly announced his retirement. We were down to <u>one</u> trained systems educator, only three other personnel were conversant with the idea but lacking STELLA experience, another five or so having a moderate curiosity. Four years after our goal-setting, it all appeared ready to collapse.

Even as trained teachers left to other sites, our supportive administration changed over *entirely*, and the highly vocal Religious Studies instructors were also leaving, students were applying pressure as were their parents. System dynamics is a powerful idea, more powerful than even our structural apparatus or frailties could defy. STELLA diagrams were emerging in papers, after school discussions, and the still new SyM•Bowl, a high school SD modeling team competition. Then, with the assistance of the Waters Foundation, a grant organization supporting the bold experiment of system dynamics in the United States, we were able to offer "System Dynamics: an introduction to Computer Modeling," a semester class for Juniors and Seniors. Only seven students signed up. But the effect has been exponential. At our Fall Open House for prospective students, over 1200 people came in groups of 20 to 40 through my classroom as I and my students regaled them on the merit of system dynamics: the infection had found a receptive host and was spreading. In the second semester, 17 students signed on. Sign-ups for the Fall are at 45.

Seems we've had to maneuver through the narrows of some transitions, for the idea of systems to gain some popular notoriety, for students and parents to press the administration into some action, and for other teachers to come to the fore. This Spring, our quarterly magazine will feature system dynamics instruction throughout our curriculum. Our geometry teacher has chosen to use STELLA as a bridge into Algebra II; Biology uses basic population models to study yeast production; Geology uses system dynamics to discuss and explore the rock cycle; a group of students built a blood-alcohol content and reflex-reaction time model for a project in Religious Studies. Our school now has a broad site license and STELLA resides on every machine in three fixed and one mobile lab; this summer, our entire executive administration will attend the National K-12 Systems Thinking and Dynamic Modeling Conference along with two new teachers; two other instructors will take advanced training at Trinity College; our Health instructor, finally, has expressed *considerable* interest in STELLA as an instructional tool in the one course we have so-long wanted to exploit.

Four years later, some patience tested and some passion spent, we again are poised to start anew. What this process has taught above all has been the deep trough of patience; our early hopes were ill-advised, the stuff of exuberance, of passion. We had

not anticipated growth here would occupy a long curve, nor did we anticipate such a damping oscillation. But we should have. Bringing system dynamics into our small Catholic high school—with its traditional college prep curricula—has been humbling, exciting and problematic. The keys for its success have clearly been these: early administrative support of our experimentation, student enthusiasm and achievement that pushed teachers and parents, excellent outside support through CC-STADUS instructors, our collective patience over these times, and the obvious veracity of the systems view. At the National K-12 Networking Conference in June 1995 (Tucson, AZ), Jay Forrester challenged a roomful of teachers: “Be prepared to commit your life to it.” Three years later, a dynamic past behind us, we are now sensing the depth of that prophecy.