CRIME AND ASTONISHMENT

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> "How did all those people know how to act, to speak, to interact in such tidy ways so that, centuries later, all their lives could be codified in a one-week lesson: *Puritan Settlers in Colonial Boston.*"

Traditional education long ago stripped its students of tools of integration; indeed, integrated or interdisciplinary studies take place almost exclusively in pre-school and, later, post-graduate work—the sixteen or so years in between stretch out as a wasteland of discrete, rudimentary tasks bearing little or no connection to any other discipline of one's education, or aspect of one's life. Our American methodology of keeping subjects separate had dismembered their world, served it up to them as lab reports and vocabulary lists and odd-numbered math problems and history work sheets and standardized tests easily graded by Scantron machines. Sometimes there was knowledge, but rarely understanding. What it—along with other factors—produced was a rising illiteracy, a thorough sense of confusion and uselessness about education, and a weeping boredom by about third or fourth grade.

Consider this corollary notion: *The Oregonian* (Portland, Oregon) recently ran stories on the breadth of cheating in schools, even among the prestigious college prep schools—the paper's survey found 76% of students cheat. The initial moral outrage of adults was met with yawns and guffaws from students who said the number was *too low*. Students echoed what most of us believe, "School isn't about learning. It's about getting grades."

It was no surprise, then, that students believed language use began and ended at my door. This was true of other disciplines as well—the lines of demarcation had been rigidly drawn, and the system , including my own academic discipline, reinforced this idea (*The English Journal*, the trade magazine for American English teachers, boldly discourages the use of graphs and charts because "they are difficult to read," and would-be authors should "avoid them whenever possible"). It was true. I was party to a systematic, intellectual crime.

So it has been.

But no longer.

Enter system dynamics offering a graphical means to crack through these arcane academic demarcations—the *same language* can be used in humanities, in sciences, in mathematics. When C. P. Snow published *The Two Cultures and the Scientific Revolution* (1959), he crystallized this idea that institutional learning had produced two specialized groups of highly educated people, each prized, but each unable to understand the other. Possibly this discussion reaches as far back as the British Victorians Matthew Arnold and Thomas Huxley who eloquently debated the educational primacy, respectively, *belles lettres* or natural science. Using system dynamics, however, the aesthete can peer into the same portal as the rationalist and know what to say, what to ask—they can converse. And I've seen it happen.

At La Salle High School in Milwaukie, Oregon, we've begun using STELLA, if not universally, at least occasionally in Literature, Chemistry, Physics, Health and Government. While it is yet early to say conclusively, we can see at least within disciplines and occasionally across disciplines, sharper and more profound understanding. That the same language engenders these results is not lost on students.

In a recent Government class, first-year teacher Scott Schuster, a wildlife biologist, used forestry as a thematic hook to summarize the role of government. We created "The Schuster Forest," using High Performance Systems' Sym Trees© as a base for a simple and—as we later realized—INCORRECT model of owl population and wood products industry. Students assumed the role of government and were, in fact, the planners and administers of their own forest management policies.

"This is harder than [the STELLA in] Physics," said one Senior, "because it is *more* than just math." In the end, Seniors prepared policy papers that included their final models, how they would manage their Schuster Forest and the likely effects of their decisions, which they came to see as far-reaching.

"Everything effects everything else," many said, echoing American microbiologist Barry Commoner's line that "everything is related to everything else."

In Literature, students used "Savage Instincts," a model for William Golding's *Lord of the Flies* that demonstrates the evaporating innocence of the young boys as they, in varying degrees, turn savage. It's a simple model: a stock of innocence drains as another stock of savagery fills—a conserved system. As students cite evidence from the text to substantiate their decisions, arguments ensue. While all agreed innocence was lost, many disagreed with the model, suggesting the loss of innocence was **not** irreversible or irrecoverable, and, consequently, many created their own models or amended the base model. What began as a study of a literary figure evolved into a theological and philosophical discussion on loss and redemption. How *would* one model redemption of the soul?

Apparently, it's a bit like the rock cycle. At least that's what some from this group said the next year, when as Juniors they were in Geology. When presented with a traditional circular schematic of the rock cycle, students obediently took the notes. The instructor then showed them a modified STELLA model: one stock of Magma moving through a "crystallization" flow into a stock of Igneous Rock . There was an audible gasp.

"Oh! It's just like last year, that Savage Instincts thing we did." Sure, maybe crystallization *is* similar to redemption.

This year, another cohort of Sophomores experienced "The Rulers," a population and limited resource model used after students read *Fahrenheit 451*. One group featured an actor and a mathematician, both gifted in their interests. Once the actor understood the inherent grammar of stocks and flows, the diagram made sense, even though some of the mathematical equations remained abstruse. They argued.

"Look at the diagram," said the poet, striking the computer screen with his finger. "We can't just adjust the amount per person without effecting death rate."

"True, but as long as we justify the number with a policy and make sure that ..." And on it went. Their discussion and disagreements went on for two days, but they spoke about the same system, using the same language, knowing the same numbers. Because stocks and flows—for that matter, the entire grammar of systems—bear definable properties that can be mastered, the poet who may not necessarily understand slope in mathematics can nonetheless "read" a model and understand that increasing per capita use of a resource (a slope) will inexorably increase the death rate, and, moreover, their discussion remains inside agreed upon assumptions. That is, what once remained esoteric, now has a door, a way in.

Still, using SD at a high school is not easy. Our daily schedule of 45 minutes periods, each a separate discipline, undermines much of our efforts, but that STELLA might appear in myriad disciplines, that one language might offer equal virtuosity and eloquence in English and Chemistry and Government, has begun to gnaw at those divisions. For the first time, we are now alternating departmental meetings with at-level meetings. And we now have 90 minute blocks, two days a week, which do allow for crossings, though we've yet to truly exploit the opportunity.

And we've made mistakes. Large, complex models for whole-class discussion or simulation thwarted our goals and student enthusiasm. Building such models is like a seduction, so beguiling, as if the teacher were unaware of the transgression, the graphs and diagrams so elegant and enticing. Students just stare at them as some do at modern art.

The smaller, easily adaptable models, however, allowed novice-users to comprehend basic principles and then move on to expand and experiment. It gave them a starting point, a bit like knowing the basics of the five-paragraph theme allows a young writer to compose long, critical writing. Plainly, the teacher should **not** build most of the model. The sooner students can build and experiment and test their own ideas, the more quickly understanding comes. If the teacher does too much, the student will do less.

We found that incorrect models like "The Schuster Forest" worked quite well precisely *because students found our mistakes or limitations*. Nor was it just bright students who noted these always. The Schuster Forest diagram made the competing systems visible, visceral, and later helped them debunk a local timber company's six-page, four-color advertisement distributed to several metropolitan grade schools. Students were able to interpret and discredit graphs and tables, as well as decipher and dismiss vague phrasings and outright untruths.

While skeptics at La Salle High School remain, they are fewer. Those peers who've come to understand system dynamics do understand what's possible; all deeply sense flaws in the current system: repetitive, noggin-splitting assignments, hour upon hour in ergonomically bankrupt furniture listening to adults, and, sadly, so little originality expected. I admit it; I've committed this crime, too. But lately I've been astonished, just enough, I suppose, to reform my sinister ways and move faithfully upon the righteous path of system dynamics.