How to Solve the "The Quiet Crisis" in a Single Stroke*

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* "The Quiet Crisis" is I believe a phrase coined by Dr. Shirley Ann Jackson, current President of Rensselaer Polytechnic Institute, the oldest technological university in the English-speaking world. See her comments in the chapter "The Quiet Crisis" in (Friedman 2007). Meteorological metaphors are also sometimes used to point to the problem: Dr. Jackson is in addition one of the praiseworthy authors of *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, available online from the National Academies Press, published in 2007. This may not be a bad place to unequivocally state that for weal or woe the views expressed herein are: my own; not intended to be implied by any of the views of others concerned about the crisis in question; ones the possible defects in which are due to me and me alone.

America is slowly, but undeniably, dying. The reason is three-fold: its youth tenaciously avoid training in traditional STEM fields (such as electrical engineering, physics, and mathematics); two, their studies in the disciplines they choose almost invariably permit them to steer clear of STEM content and skills; and three, as pointed out by Brynjolfsson & McAfee (2011), the state-of-affairs composed of points one and two obtains in a global economy in which non-STEM jobs are being destroyed by ever smarter computing machines.

The data confirming the avoidance in question is now mountainous; like Kilimanjaro, visible from miles away on placid plains, the avoidance-confirming data is in turn visible to so many that I feel no need to rehearse the numbers here — numbers which, while acutely discouraging for P–16 education, are positively *scary* at the graduate level.[1] It may or may not be a threat to the U.S. that China is financing our gargantuan national debt, but the fact that our PhD programs in traditional STEM fields would instantly die if students from Asia stopped coming here is rather obviously a threat. Why? Well, ceteris paribus: no traditional STEM PhD programs, no pays-the-bills innovation; no such innovation, no sales and no national defense; no sales and no national defense, no companies and no army; no companies and no army, we fade away, or are vanquished. In short, we would follow in the footsteps of Rome, Portugal, the United Kingdom, and ... well, you know enough history to recite the many long-gone civilizations that were once superpowers, but now lie as carcasses or weaklings left in the wake of the ever-onward march of time and technology.[2]

The lion's share of the answer, my friend, is not to be found in traditional STEM fields, or in well-meaning rigamaroles designed to attract students to such fields. You may find this jarring, but trust me: We can try with every fiber of our being, backed by billions from government at the federal, state, and local levels (and by billions from foundations, for good measure), and at best only a tiny fraction of our youth will in the foreseeable future ever reject their current predilection and turn to traditional STEM. The reason? Traditional STEM fields are *fundamentally* unattractive to the vast majority of our youth. It's not that most of our children *happen* to find, say, computer programming unappetizing. Rather, it's that they have seen the belly of the beast (e.g., the mental toil and trouble of crafting a computer program in which *every single character absolutely positively* ***must*** be in place in order to ensure that the computer does produce the solution), and they don't much like what they have seen.[3] "No thank you. I'm out of here, in search of degrees that will put me

[1] Some of the data is presented by Friedman (2007). See also *Rising Above the Gathering Storm*, 2007.

[2] Objection 1: "But Selmer, as long as foreign students come to our graduate programs, the worrisome domino-chain you describe will never befall us." That's stupid; wake up. The chain I describe will be activated even if (again, ceteris paribus) a significant percentage of those graduating with our traditional STEM PhDs decide to return to and stay in their home countries. And what reason, pray tell, have you to think that students will always come, and will always stay when they do?

[3] I confess to regularly thanking the Almighty that I'm a professor at a place where students have come knowing full well that toil and trouble of this type can be entrancing. But technological universities are exceptions.

in charge of scientists and engineers. Don't call me, I'll call you." The sad fact of the matter is that we're busy burning greenbacks in calling them, but they have no intention, nor will they ever, of calling us back.

Let's stop phoning them with tales of how sexy physics, or robotics, or ... really is in light of this or that shining experiment or phenomenon we — like fast-talking car salesmen — show them. Let's stop trying to coax them into the fold with clever marketing schemes and the "sexification" of what they don't, and probably won't, find sexy. Let's face up to the fact that they don't want to study traditional STEM, because they understand what's entailed in studying traditional STEM. Given this state-of-affairs, it's time to act — paternalistically, firmly, unapologetically. It's time to make an executive decision that will make a real difference.

The secret is to be found is in that marvelous little phrase 'ceteris paribus,' which I deployed twice above. Why did I use the phrase? Because we *don't* have to leave all things equal. Instead of just standing back and watching our world-wide leadership die, we can tap *non*-traditional STEM fields to which hordes of students flock. The answer is to be found in those not-STEM-at-first-glance disciplines which nonetheless partake of what can be called the *formal sciences*. Which disciplines, specifically? One example is philosophy. The field of philosophy is assuredly not a traditional STEM field; indeed, most people unfamiliar with it regard it to be quintessentially in the "humanities." But formal logic within philosophy can in many ways be more STEM-ish than traditional STEM fields, and indeed anyone who knows the history of computing knows that it grew out of logic (as elegantly chronicled e.g. by Glymour 1992), and that computing is still today based on formal logic (as explained e.g. by Halpern, Harper, Immerman, Kolaitis, Vardi & Vianu 2001). This is why (by my lights, anyway) the most efficient, elegant introductory treatment of the nature of accurate computer programming in the known universe appears in a logic textbook studied mostly by students getting *humanities* credit toward a B*A*: *Language, Proof and Logic* (*LPL*).[4] What I say about computer programming can be said as well about circuits, and indeed correlates to what I give here for philosophy can be easily provided with equal accuracy for the most popular majors in the U.S., for example for business (the single-most popular major in America, by far), economics, psychology, and others.

Okay, so what is the solution to be found in these disciplines? Here you go: Don't let any student graduate with a BA or BS degree in any of these disciplines unless they can demonstrate by performance on tough examinations that they are thoroughly proficient in the formal parts of these fields. As an example to illustrate the point in the context of the previous paragraph: Don't let a single student in this country obtain the BA or BS in philosophy unless he or she learns the computer science- and electrical engineering-relevant material in *LPL* (or some workalike) inside and out. (This would require a two-course sequence in formal logic.) Correlates to what I give here for philosophy can be

[4]Written by Barwise & Etchemendy (1999). (The first author, alas, is deceased; the second author is Stanford's current Provost.) The "stealth" STEM coverage of computer programming can be found on pages 458–467.

easily provided with equal specificity for business, economics, psychology, and other non-traditional STEM fields: Don't let any student graduate with a BA or BS in psychology unless he or she knows *mathematical* psychology. Don't let any student graduate with a BA or BS in business or economics unless he or she demonstrates mastery of the most rigorous, mathematical side of business and economics ... you get the idea. And of course also implement the obvious parallel at the PhD level for the same fields.[5]

If we do this, in one fell swoop the ranks of minds of the sort we desperately need will increase exponentially.

Does my solution strike you as a rather harsh top-down edict? I hope so, because it *is* top-down. But it will work. We can paternalistically craft the educational system to make it infinitely harder to escape acquisition of a STEM mind- and skill-set.[6] The alternative is to continue to bang our heads against the wall, and to dream up desperate, pathetic, often ridiculous advertising schemes designed to convince students to pick majors they don't want to pick. Such schemes may sometimes work, and their sustained use may lead to a glacial creep upward in the number of students in traditional STEM fields. But that's about it.

Perspicacious readers, and certainly quiet-crisis cognoscenti, will see that my recommendation is at bottom this: Require students to master significant parts of the 'M' in 'STEM,' in disciplines rarely thought to be STEM fields, but which include sub-disciplines that are formal in nature. As such, my solution has the welcome side-effect of delivering a partial antidote to the avoidance of the mathematical dimension of traditional STEM education.[7] We are in the middle of a trend in which what measly growth there is in students studying traditional STEM tends to be in the *least* mathematical fields within this domain. To meet the quiet crisis, let us have a business major who has deep understanding of formal decision and game theory, or a philosophy major well-versed in formal logic, potentially over a biology major happy to find in that field little need for mathematics. And remember, history has shown us that the 'M' in 'STEM' is the midwife which time and time again brings innovation into the world.

I conclude by anticipating two objections, and giving two rebuttals:

A second objection (see footnote 2): "Selmer, there is no free lunch in this world. There must be massive, hidden costs in what you recommend. Confess."

May I respectfully suggest that you read Appendix E of *Rising Above the Gathering Storm*, if you haven't done so already? It provides price tags for the 22 recommendations that are supposed to allow us to rise above the gathering storm. The grand total for just the year 2010 was $15.2 billion. Yes, that's

[5] I don't discuss herein the possibility of implementing a version of my proposal across P–12 education. I do believe this is entirely possible, because many non-traditional STEM fields are taught in our P–12 system.

[6] This mind-set is discussed in (Bringsjord, Bringsjord & Noel 1998).

[7] And while we're on the subject of welcome side-effects, I ask you to consider the somewhat distasteful fact that the status-quo approach to trying to rise above the gathering storm leaves those we have mastered the rigorous side of non-traditional STEM completely off the hook and out of the game. Do we really want our approach to be one that leaves, say, logicians to the side while the country dies?

billion. My solution can be had, almost literally, for pennies — and a country that is already perilously in debt just might want to consider something that gets the job done without bankrupting the very system we're trying to save. I carried out a back-of-the-envelope calculation for the case of my own institution. The main cost is less than a handful of additional faculty — but of course I concede that RPI is a technological research university and hence we have a head-start against universities that currently let undergraduates "escape." Yet, even at places behind the curve relative to my prescription, the cost is relatively small.

Objection #3: "Selmer, one, I don't believe we *have* tried to make traditional STEM fields attractive to students; and two, your proposal is based on forcing curricula to be changed in heavy-handed fashion."

We have tried, trust me. As an instructive microcosm, consider that millions and millions of dollars have been spent in the attempt to attract females to the more formal engineering fields, e.g., electrical engineering. All to no avail, as the female population in this field is basically flat over four decades. The same is true for mathematics as well. I suggest that you look up the number of senior professional electrical engineers, mathematicians, and physicists who are female in the U.S. These numbers are astonishingly low chiefly because women, for the most part, knowing full well what these disciplines are about, simply decide not to wholeheartedly pursue careers in them.[8] Your strategy is to convince such women that these careers, despite what they believe, will be wonderful for them. I'm skeptical, but even if you're right to a degree, my strategy is decisive, and can be implemented alongside the continuation of yours: We can hedge our bets and go with *both* approaches, yours, and my new one. We can work together, you in the faith that evangelism for traditional STEM can work, and I in the knowledge that many students determined to escape traditional STEM can be, to put it baldly, outmaneuvered.

Regarding your second point: You're right! But we have government not only to sustain an army to defend us, but to do the right thing, sometimes by stepping in from on high. You *must* wear a seat belt. Odds are you can't smoke in your office, or even at your favorite restaurant. Your children are routinely measured by government-administered tests. And even if you're at a private university, if it's in a State like my own, the State Education Department (or a correlate) must approve any degree program you propose to start. My proposal, in this context, is hardly as radical as it first appears. Besides, we are talking about a national crisis, and the possible end of our superpower status; the stakes are rather high. Given that, the paternalism I recommend just might make some sense.

References

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[8] You may disagree, but at best the science on this and related matters is inconclusive; see the excellent Sommers (2009).

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