

# CHAPTER

## A Mosaic of Problems

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I would like to talk about a predominantly U.S. issue — or better, a mosaic of issues — that concern me. Taken separately, or viewed from “up close”, each of these issues is not a crisis — and hence doesn’t get a lot of attention. Viewed from a distance, however, I think they collectively form a mosaic that paints a very disturbing pattern.

You all know the storied procedure for boiling a frog. “They say” that if you drop a frog in boiling water, it will jump out — but, if you put a frog in cool water and heat it very slowly, the frog won’t jump out and you will boil it. The theory is that each increment in temperature is not enough to make the frog react. I don’t know if this is true, but it is a great story and fits my purpose.

My fear is that the U.S. is getting boiled — that incremental decisions are being made that aren’t by themselves “big enough” to raise a warning about the deeper, fundamental problem evident in the mosaic as a whole.

I have a longer list, but let me mention a few of these issues.

### IN THE WAKE OF 9/11

Below are a “cluster” of points in the mosaic that manifest themselves as reactions to 9/11. Let’s acknowledge that 9/11 really did change things! It is entirely appropriate to rethink our “balance point” with respect to a number of things such as immigration and export controls. In particular the nature of the adversary has changed. The Soviet Union was both a “rational actor” and exquisitely “research capable”; terrorist cells are neither. Thus, we wanted the Soviets to know enough about our capability that they didn’t make miscalculations about them, and it made little sense to hide what they were perfectly capable of reproducing. The same disclosures to terrorists might be counter-productive, to say the least.

- *Visas*: Much has been written about the impact of new visa policies on students, and the situation has improved — as of this writing, the average time to process visas for students is less than two weeks. I continue to be concerned, however, that, while the average time has shortened, the distribution has a long tail — that is, there are still some students that wait a year or more. Moreover, some very senior scholars, including a Nobel laureate, are experiencing the same sort of lengthy, demeaning treatment. It is these latter cases, not the average processing time, that are reported in the international press, with the result that the image of the U.S. being a welcoming “land of opportunity” has changed to exactly the opposite.
- *Deemed exports*: Export controls originated in the U.S. in the 1980s, and were originally intended as an economic tool against the perceived Japanese “threat”. They have now become tools for national security, and are intended to keep critical weapons technology out of the hands of potential adversaries. Export of controlled technology requires a special “export license” from either the Department of Commerce or the Department of State. Disclosure of information about a controlled technology to a foreign national in the U.S. has been “deemed” to be an export of the technology itself, and thus requires an export licence as well. Reports of the Inspectors General of the Department of Commerce and several other agencies have suggested that the implementation of the rules governing deemed exports has been too lax, and suggested tightening them in several ways. The university community is concerned that a literal interpretation of the I.G.s’ suggestions would essentially preclude involving foreign graduate students in research and would require an impossibly complex system to enforce. Given that 55% of the Ph.D. students in engineering in the U.S. are foreign-born, the effect could be catastrophic.
- *Sensitive But Unclassified (S.B.U.) Information*: You may not have as much experience with this — but it has become the bane of National Academies’ existence. On one hand, this is a good example of an issue that needed to be re-balanced after 9/11. There are things not covered by traditional classification that it is clear would be better kept from a less research-capable adversary. But, unlike traditional classification where there are precise laws, limited authority to classify, mandatory declassification after a period of time, and a philosophy to “build high fences around small places”, the counterparts do not exist in the S.B.U. domain. There are no laws, there is no common definition, there are no limits on who can declare something to be S.B.U., etc. In at least some cases it appears as though S.B.U. is being used to suppress criticism.

## TOWARDS A BETTER QUALITY OF LIFE

There is another cluster of tiles in my mosaic that has to do with disinvestment in the future. Prosperity and security require that we forego some current consumption in order to ensure a better quality of life in the future. Quite aside from the notoriously poor individual savings rate in the U.S., I think we are failing to invest collectively as well.

- Demise of corporate R & D: I probably don't need to elaborate this point for this audience, but let me briefly remind you that some of the most fundamental results in the last century came from corporate laboratories: Bell Labs, GE Research, etc. While vestiges of these laboratories still exist, they now have a much shorter time horizon, and a product development focus. As Jim Duderstadt notes in his paper for this Colloquium, the U.S. system for accomplishing research evolved after WWII as a self-reinforcing triangle of industry, academia and government — one side of that triangle is now missing, and the resulting structure is much less stable. Some would say that this is the result of the short time horizon of the stock market, and undoubtedly to some extent it is. But I think it is also a failure to account for research as an investment rather than as an expense — and thus, in effect, to say it has no lasting value.
- The state of physical science and engineering research funding: I probably don't need to elaborate this either, but let me note that while there have been huge increases in the support for the life sciences, most physical science and engineering funding has been flat or even declining. This seems especially ironic since so many of the medical devices and procedures that we enjoy come from developments in the physical sciences and engineering: endoscopic surgery, smart pacemakers, dialysis machines, etc.
- The view of higher education as a “private good”: historically the U.S. has viewed higher education as a “public good”. That is, we took the view that a more educated citizenry was a benefit to the country as a whole — not just to the individual so educated: (a) that is why we supported universal K-12 education; (b) that is why in the 1860s we created the land grant colleges; (c) that is why a system of superior State universities was created and generously supported, and scholarships were given to needy students; (d) that is why we passed the “GI Bill” after WWII, and the National Defense Education Act in the 1950s.

Now, however, we see disappearing state support from the state universities, soaring tuition to replace that support, and we give loans rather than scholarships — all indications that we now view higher

education as a private good, that is, of value only to the individual student.

- The number and percentage of physical science and engineering undergrads: human capital — an educated and innovative workforce — is the most precious resource a country has.

Yet, the number of engineering undergraduates in the U.S. peaked in the mid-1980s, then declined 25% during the 1990s. The number seems to have rebounded recently — but not to 1985 levels, and only to something like a fourth of the numbers from each of China and India.

Perhaps even more troubling is that the percentage of undergraduates studying engineering in the U.S. is the second lowest among developed countries, between 4-5% in the U.S. vs. 12% in most of Europe, and more than 40% in China.

I have a much longer list, for example:

- A failure to really act on the energy issue;
- A failure to really act on greenhouse gas emissions;

but it would be too depressing to recite the whole list.

The mosaic, the pattern, I see in all these is one of short-term thinking and lack of long-term investment:

- It's a pattern of preserving the status quo rather than reaching for the next big goal.
- It's a pattern that presumes we in the U.S. are entitled to a better quality of life than others, and we just need to circle the wagons to defend that entitlement.
- It's a pattern that does not balance the danger in things like foreign students with the good that comes to the U.S. from: (a) immigrants like Einstein, Teller and Fermi, without whom the Germans might have had the bomb before we did; (b) students who return to their home country and are our best ambassadors; (c) economic benefits of open trade, and the increased security that comes with a better quality of life in developing countries; (d) increased quality of life in the U.S. from sharing scientific results and thus "moving faster" in new technologies; and (e) funding the underpinnings of our understanding of nature, and a generally educated citizenry.

Universities are all about long-term investment — investment in people and investment in new knowledge. To the extent that this pattern is real and

reflects a trend in the attitude of U.S. society, the implications for universities as we have known them are not good!

The 2001 Hart-Rudman Commission, which proposed the Department of Homeland Security, said: "... the inadequacies of our system of research and education pose a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine." (Road Map for National Security, 2001).

The report was written before 9/11; had it been written afterwards, I am sure "conventional war" at the end of the quote would have been changed to include terrorism.

Yet, as a country we seem to be taking decision after decision that trades an appearance of near-term security for long-term damage to our system of research and education. The more I look, the more I see such problems — individually sub-critical, but collectively painting a disturbing larger pattern.

If you see the same pattern that I do, then the obvious question is "what should we do about it?" I am sure that I don't have all the answers, but let me suggest a few and then ask you to suggest more.

I fear that some of what we have been doing about, for example, student visas, sounds like special pleading — for example the message in some university statements seems to be "our enrolment will fall, and we'll get less revenue". That may get attention from some members of Congress — just like any constituent gets attention — but not the kind of serious attention that this mosaic of issues deserves.

Let me remind you of Vannevar Bush's *Science the Endless Frontier* (1945) — the report that is largely responsible for the pattern of federally funded, university-based research in the U.S. Recall that before WWII there was essentially no federal funding of university-based research. During the war, university scientists and engineers were critical to the war effort — they produced radar, precise bomb sights, the atomic bomb, etc. After the war, President Roosevelt asked Vannevar Bush how we could be sure that, in the event of another war, there would be the people to do this again. Bush wrote *Science the Endless Frontier* in response to this, and in it he argued:

- The way to ensure the supply of people was to fund research at universities;
- The researchers themselves, not government, should decide what research is done; and
- That, in return, researchers would insure national security, prosperity and health.

Mostly we have delivered on that promise — but I increasingly hear our community talking as though science and engineering research was an end in itself. It's not. It is to create educated people, and to deliver societal goals like

security, prosperity and health. Simultaneously I hear policy makers referring to the research community as (just) another special interest group. So, my first answer to “what to do?” is be sure that we couch our arguments properly, and particularly to tie them to the nation’s goals, not our own.

My second answer is that, the Academy being the Academy, we will be doing a report, or possibly a series of reports. But one, or even several, reports from the Academy are not going to change a national malaise. Lots of people need to be talking about this mosaic of issues and the pattern they create — that’s why I am talking to you. I would like you to go back to your faculties and start a conversation. We need you to write op-eds. We need you to talk to your political representatives.

Let me take a detour for a minute: at its August meeting each year the National Academy of Engineering Council has reviewed our strategic plan. The Strategic Plan’s Purpose begins with the words: “To promote the technological health of the nation...”

As you know, the Academies operate under an 1863 Charter from the U.S. Congress that calls on us to provide advice to the government on issues of science and technology. That’s a passive role... if and when asked, we provide advice to the government. The Strategic Plan’s Purpose, however, does not say “wait till asked”, it does not say “only provide advice” and it does not limit our target audience to the government. Rather, it is a much broader and more proactive mandate.

A question arose in the Council’s discussion of the Purpose, namely will engineers “stand up”? That is, are engineers, both individually and collectively, willing to provide the leadership needed — willing to take a stand? When it was first asked, I thought it was a “no brainer” — of course we would! On reflection, I am not so sure: (1) the culture of engineering is to be unassuming; (2) the culture of engineering rewards technical achievement, not leadership (how often have you heard “she isn’t an engineer any longer, she is a manager”); (3) the culture of engineering proscribes that we advise only with respect to technical matters (how often have you heard, “that’s a political question, we have nothing to contribute”).

Don’t misunderstand me. I believe we should “stand up”, but we’re going to have to ask ourselves some tough questions about our culture, what we value and how we “stand up” and preserve what we value. But, to come back to the question of what we need to do in the face of this mosaic, I believe that what we need most is for all of us to “stand up”.

## CONCLUDING THOUGHTS

I have taken a distinctly U.S. and distinctly engineering perspective in these remarks because that is what I know best. There are some, I know, who would

be delighted to see the downfall of the American hegemony, especially its most recent manifestation. Being an American, I cannot be unbiased about this, but I sincerely believe that is not in the best interest of the world if the mosaic of issues suggested here are ignored. Nor do I think that the rest of the developed world is immune to the underlying causes of the mosaic I have tried to depict here. We have a shared problem!

## REFERENCES

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- “Road Map for National Security: Imperative for Change” (2001). The United States Commission on National Security/21st Century. <http://govinfo.library.unt.edu/nssg/PhaseIIIFR.pdf>><http://govinfo.library.unt.edu/nssg/PhaseIIIFR.pdf>