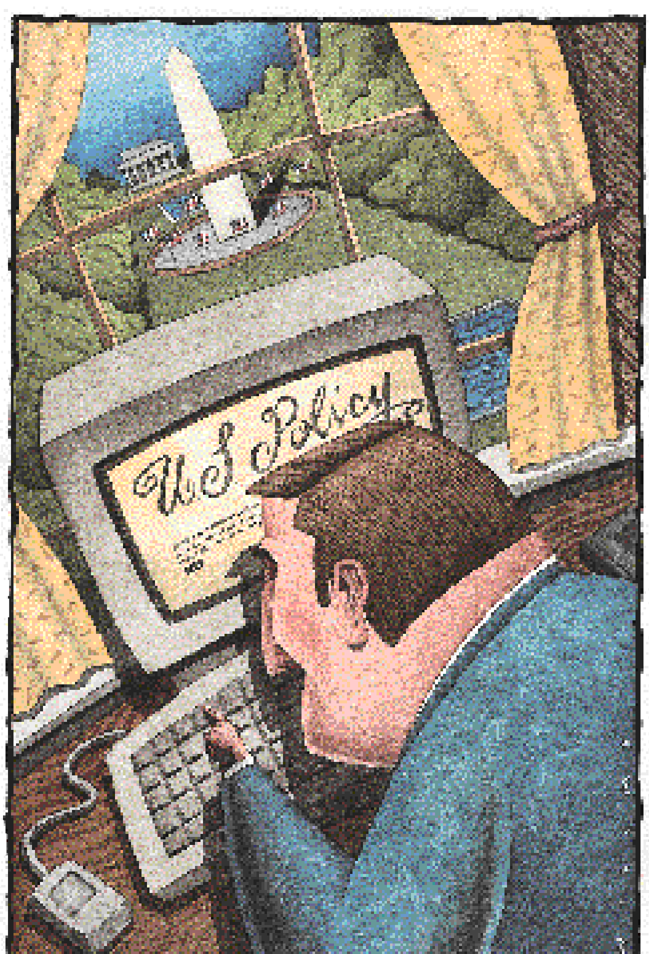
U.S. Technology Policy in the Information Age

Hal Berghel

During the first few years of the Clinton administration, the frequency of published articles and reports on the deficiencies of the U.S. science and technology posture reached a feverish pace. Articles and opinions representing varied perspectives on the issue found homes in publications from erudite texts and monographs to the popular press. It appeared for a while that opining about science and technology policy might become a national pastime.

In retrospect, while the dialog has been healthy, it's not clear that much has come from it, especially within the field of computing. It is an open question whether, or to what extent, such initiatives as the High Performance Computing Act, the National Information Infrastructure, and the computers-and-network-connectivity-for-schools programs will contribute critical advances in technology understanding that would not have occurred anyway without government involvement, perhaps at significantly less cost.

In fact, the promotion of a government-directed (vs. industry-directed) information infrastructure may well have impeded its progress. History may record that the hoopla over the Information Superhighway did little more than popularize a technology that was already highly evolved and well established within the computing industry and academia.



Russ Willms

Is an overhaul of our technology policy likely to produce genuine, or merely cosmetic, changes? We are fearful many of the proposed changes in technology policy ignore some fundamental realities:

- The biggest hurdle to a successful U.S. global technology policy is the acceptance of enormous cultural differences between the institutional players.
- There is ample reason to question the value of a proactive government stance. These realities seem to mitigate against the potential effectiveness of the spectrum of technology policy proposals.

The Technology Policy Spectrum

Several different positions emerged from the public debate. The policy-vacuum group, represented by the Clinton administration, several key Congressional leaders, and some prominent government policy analysts believe the failure of the U.S. to maintain a dominant position in some areas of technology is primarily the result of a lack of a coherent, focused, and realistic science and technology policy. On this view, the "science" component is working well enough as a freestanding unit but isn't fully integrated with the U.S. technology transfer agenda. This lack of integration, they claim, to a large degree, is the result of the science community avoiding its responsibility to the society which it serves. The Vannevar Bush social contract between society and the science establishment has been irreparably broken.

Policy vacuumers believe that the first order of business should be the creation of a policy both mindful of our national security and sensitive to economic realities. With a carefully planned and accurately articulated implementation of this tradeoff, the science and technology communities will redefine their missions, fit together like hand and glove, be more responsible to society, and as a result help the U.S. regain its leadership position in technology.

An opposing position has historically been held by some major institutional players in the big-and-hard science game. On this account, the fact that the U.S. leads the world in basic science and graduate education is sufficient reason to leave science and technology policy alone—a variation on the "if it's not broken, don't fix it" theme. This group was quite vocal some years back in opposing the Congressional mandate that the National Science Foundation place more emphasis on technology transfer and the needs of industry, a position articulated by its then director, Walter Massey.

Between these two camps lies a pragmatic school that doesn't favor the wholesale restructuring of research priorities, but neither does it want to preserve the status quo. The solution lies, it is believed, in a more pragmatic approach to scientific research—one that doesn't ignore potential applications. It is there that government will get the most bang for its science and technology buck. A variation on this theme is that an overhaul of the research infrastructure—both academic and industrial—will produce the gains in efficiency and effectiveness necessary for U.S. global leadership.

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While the intermediate position seems to us to be the more reasonable alternative, it remains in some ways as unrealistic as the more extreme positions it seeks to moderate.

Technology Policy Reality Check

All three of these technology policy positions over-simplify the problem. They all seem to ignore the time-honored traditions and well-entrenched cultures that drive the research establishment, and they underestimate the enormous inertia behind the present science and technology infrastructure. For any of these proposals to succeed, there first needs to be revolutionary changes in our attitudes towards the proper role of publicly and privately supported research.

To illustrate this point, it is useful to begin with a reality check.

Passive Policy

For most of its history, the social-benefit aspect of U.S. science and technology policy was primarily passive. Until recently, the paradigm was the spin-off model of technology transfer whereby useful, globally competitive technology was assumed to come to commerce as a byproduct of government- and military-sponsored research. The spin-off model never worked well, for the successes were largely serendipitous. For every beaker of silicone spun, there are buckets of commercially useless polymers. Even when it worked, it was inefficient—a fact easy to overlook when funding for science and technology seemed limitless.

Active Policy

The more active technology transfer policy that has evolved since the 1960s may not be working much better once the successes are measured against the ambient overall economic growth. This latest incarnation typically involves universities spawning start-up companies through their own industrial parks and business incubators, seeking to market technology in which the university has a vested interest. I suspect that successes, except in a fairly narrow range of settings and research areas would be difficult to document.

We also suspect that the active

policy will prove to be only marginally more effective than the passive policy because it is typically conducted in a climate of mixed motives and convoluted organizational structure. Participants from the universities, the industrial sponsors, and the start-up companies frequently wear too many hats and have too many different objectives to sustain a tightly focussed development effort for long without feeling the effects of debilitating distractions. The requirements of maximizing indirect costs, educating and supervising graduate students, advancing the frontiers of science, attracting investment, and maintaining corporate solvency produce conflicting passions in otherwise like-minded colleagues.

Decreased Funding

Government funding of science and technology is likely to decrease over time as a percentage of GNP. When the sentiment of Congress looks favorably toward reducing the funding for such sacred cows as Medicare, food stamps, and children's lunches, while simultaneously considering tax reduction, the funding for science and technology is definitely in jeopardy. Last October, the House reduced the budget for federal research agencies by $3 billion in its version of the Omnibus Civilian Science Authorization Act of 1995. We are very likely to enter the 21st century with most of our focus on the national debt and deficit spending, and less and less on the needs of science and technology.

Knowledge Acquisition and Diffusion

The variegation of the science and technology knowledge base works against cooperation. In some subcultures, primarily in industry, knowledge is likely to be proprietary and informally documented. In academic cultures, it is usually public and disseminated in the scientific and technical literature. These are two fundamentally different, largely incompatible and irreconcilable approaches toward knowledge acquisition and diffusion, and these differences permeate all aspects of the two subcultures. These differences surfaces in the way the cultures look at their mission, their competitors, and the world in which they operate.

The corporate worlds of nondisclosure agreements and ftp lockouts on network firewalls are as foreign to academic institutions as peer review and indirect cost accounting are to business. Even within these cultures, associations are frequently more competitive than cooperative and collaborative. The 1984 National Cooperative Research Act doesn't seem to have changed much.

Mixed Performance

The government's track record in supporting science and technology reveals mixed performance. To be sure, diseases have been cured and life expectancies extended. But we have also invested in superconducting supercolliders and Star Wars lasers, and placed earthquake engineering centers where there are few earthquakes. When added to targeted purchasing practices run amok, cost overruns, and documented biases in the peer review of proposals for government-funded research, one wonders whether science can ever hold its own when mixed with politics. The occasional boondoggle, bad or secretive science, and confused priorities detract from the enthusiastic endorsement one would like to give government support of science.

Cultural Differences

Comparisons to successful technology transference practices in other nations may be misleading when they ignore vast cultural differences. These differences impact almost every aspect of institutional life and well-being, from employee attitudes toward corporate rivalry and collaboration, especially between domestic and international corporations, to their acceptance of international copyright and patent law.

Where Do We Go from Here?

Within the last few years, enormous energy has been put into discussing encryption standards (noteworthy instances include the Clipper chip and the Digital Signature Standard), new copyright policies for the digital age, the V-chip, telecommunications policy, and obscenity over the Internet, to name a few. In each case, it is not clear whether many of the scientific and technical communities are confident in the outcome of the resulting legislative initiatives and policy decisions.

Espousing a doctrine, policy, or legislative mandate is the easiest part of technology policy. Making technology policy work is another matter. Even seemingly innocuous and unobjectionable recommendations, such as fostering precompetitive cooperation among corporations, don't seem problematic until held up against corporate nondisclosure agreements and proprietary research agendas.

An acceptance of the cultures involved should be a fundamental precept for future discussions of technology policy, for these cultures are unlikely to change soon. Acceptance leads us away from the technology transfer paradigm where applications follow basic research and toward strategic research where applications are anticipated before the research begins.

All of the business incubators and small-business initiatives in the world won't make a nation globally competitive. They may spawn a multitude of successful start-up ventures, and that may be good for the economy, but we won't be able to incubate ourselves into a competitive technological stance. At best, government-sponsored start-ups will be progenitors of the corporations that develop cutting-edge technology.

A primary reason for the limitation of business incubators lies in the very nature of new commercial ventures. There the focus is on cash flow, meeting payrolls, finding market niches, establishing distribution channels, and most important, remaining solvent until the products succeed in the marketplace. Global competitiveness requires an expensive commitment to R&d (vs. r&D), which is unlikely to be sustainable under these economic conditions. While support of technology transfer may be good for the economy, it is ineffective as the foundation for a technology policy.

Strategic research—research-cum-purpose approach—may provide the needed focus. Research evolves with the range of applications rather than preceding them. Strategic research is genuine peer-reviewed research (big R) differing from basic research more in motivation than perhaps anything else.

For both basic and strategic research, achievements are measured by some form of peer review, by the production of useful and/or interesting artifacts, and by novelty and innovation. In addition, strategic research would contribute directly to global competitiveness and security by fostering mutually rewarding partnerships, to the extent that they may be realized at all, between academia and industry and produces prototypes of all shapes and sizes.

Strategic research is also surgical—conducted with one eye focused on solutions of real problems. It also conforms to the highest standards of science and remains committed to the peer review process. When conducted properly it overcomes the two major criticisms of its basic research and pork-barrel science siblings: lack of relevance and lack of rigor. Strategic research is not divorced from, or adjunct to, the business of science, as technology transfer is, remaining part of the business and culture of science.

From the practical point of view, strategic research targets the needs of the institutional sponsor but has sufficient technical and scientific depth to warrant the interest of the professional researcher. From our experience, only a small fraction of the potential collaborations between the research community and private or governmental sponsors have this property. Finding win-win strategic research partnerships is an art, not a science.

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Forecasting the Future

Space limitation does not allow discourse on technology policy. But for readers resonating with these observations and suggestions, there should be concern that the era of technology-policy overhaul in which we live may not fix the larger problems.

If my analysis is correct, the importance of a shift away from the technology transfer paradigm to that of strategic research cannot be overstated. The former doesn't seem to be sustainable and productive in the new economic climate. I foresee a return to the old days of conducting science—before the days of Vannevar Bush, and before the Cold War. I expect within 25 years the number of college and universities that garner significant research support will be a small fraction of those in place now—perhaps only three or four dozen. And of the research done, most will be strategic, even if it involves federal funding agencies. The days of widespread curiosity-driven research are coming to an end. Even pork-barrel research will be rotated through a very few hallowed research institutions within the most populous states, because there won't be much pork to divide.

If these predictions hold, ever-shrinking government resources will bring an economic triage on research institutions. The premier research institutions may be left unscathed, but the second- and third-tier institutions will be forced to redefine their missions if they are to survive. Universities that have prepared for a strategic research orientation will have a competitive advantage over their peers in obtaining sought-after research support, while technology transfer agendas will be increasingly difficult to support. As I have argued, a major shortcoming of the current technology policy advocates is they fail to address this likelihood and the cultural realities that bring it about.

So it may be that a passive approach toward technology policy will survive after all. But in the 21st century, it may well be oriented toward strategic research rather than technology transfer.

Some readers may recall Berghel's criticism of computer contributions legislation (Mar. 1994, pp. 188–193) that spawned a lively debate with Congressman Pete Stark on the merits of the "Apple bill," which, incidentally, was defeated.

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