Editorial & Letters

EDITORIAL

Science Roadmaps

Technology roadmaps are gaining acceptance in industry and government laboratories, and now there are signs that the application of roadmapping to the sciences may grow even faster. A "roadmap" is an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field. Roadmaps can comprise statements of theories and trends, the formulation of models, identification of linkages among and within sciences, identification of discontinuities and knowledge voids, and interpretation of investigations and experiments. Roadmaps can also include the identification of instruments needed to solve problems, as well as graphs, charts, and showstoppers.

The optimal process for gathering and selecting the content of roadmaps is to include as many practicing professionals as possible in workshops periodically in order to allow all suggestions to be considered and to objectively evaluate the consensuses that will more often than not emerge. Equal treatment should be given to minority views and individual advocacies.

Roadmaps communicate visions, attract resources from business and government, stimulate investigations, and monitor progress. They become *the* inventory of possibilities for a particular field, thus stimulating earlier, more targeted investigations. They facilitate more interdisciplinary networking and teamed pursuit. Even "white spaces" can conjure promising investigations. In engineering, the roadmapping process has so positively influenced public and industry officials that their questioning of support for fundamental technology support is muted.

Motorola has prolifically used sophisticated engineering roadmaps to great advantage over several decades. Other corporations such as Intel have also benefited.

In the early 1990s, U.S. semiconductor competitors decided to work together to solve some of the more basic, confounding, but precompetitive, technical barriers whose impact was a concern to our companies over a 15-year time horizon. The solution to many of these problems was likely to be beyond one company's affordability. Most competitors assigned their brightest engineers to meet in common, in committees, and in ad hoc specialist reviews. Over a few weekends, 150 to 175 of them convened to flesh out the broadest agendas. A Roadmap Coordinating Group was formed to oversee the process of determining target values for device and circuit specifications. Technology working group teams were then assigned to flesh out tasks more fully. The result was a 200-page roadmap, now in its third edition. This dynamic document is the basis for assigning various initiatives to certain companies or institutions. Self-forming alliances tackle others. These alliances include Sematech, a consortium specializing in developing the most productive, quality driver manufacturing equipment, and Semiconductor Research Corporation, through which the industry pools funding for advanced research to centers of excellence in university science laboratories.

Roadmaps allow our industry leaders to communicate convincingly with those in government and business regarding their support of our goals. I believe a similar use of roadmaps in the sciences would allow a fresh, positive approach to science to emerge among public officials. Similarly business leaders would have a renewed interest in financially supporting science.

The roadmap process as used by industry reveals that industry is "idea limited." For example, industry roadmaps do not answer questions such as what increments of, or breakthroughs in, the fundamentals of nature can we learn from? This is where science roadmaps can play a key role. Fortunately, examples of science roadmaps are blossoming.

NASA has used roadmaps built on basic themes for years and encourages others to do the same. The leadership of the National Science Foundation encourages experiments with roadmapping in science and engineering, while cautioning that history tells us that the most important discoveries cannot be predicted. The Department of Energy is launching science roadmaps and the Electric Power Research Institute has committed to them as well. The Santa Fe Institute has given its unqualified support to science roadmapping and is preparing a Novel Computational Roadmap to synthesize and guide the research needed now to create the computing technologies needed 15 years hence.

Roadmaps are working now in industry and they are beginning to gain a stronghold in science. Just as engineers first scoffed at them, so will some scientists. But who better than scientists to experiment with an experiment that can strengthen sciences' support and accelerate its generation of knowledge.

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LETTERS

Protection?

More than 75 top U.S. AIDS researchers urge that the government effort to develop an AIDS vaccine should remain the responsibility of the U.S. National Institutes of Health. French AIDS czar Jean-Paul Lévy expresses his doubts that an efficacious AIDS vaccine is ready for testing. A social science method for analyzing complex behavior is endorsed. The nature of drug addiction is discussed. And an economic plan to preserve biodiversity in Korea's DMZ is suggested.

AIDS Vaccine Development

In recent months, the U.S. National Institutes of Health (NIH) human immunodeficency virus (HIV) vaccine research program has been criticized by a few activists and public health figures who serve on, or have provided testimony to, the President's Advisory Committee on HIV/AIDS (PACHA) (M. Balter, News, 30 Jan., p. 650). It has been proposed that responsibility for the development of an HIV vaccine should be removed from NIH and transferred to other federal agencies. It has been suggested that an effective HIV vaccine would be available much sooner if only NIH would support efficacy trials of currently available candidates, notably of glycoprotein 120 (gp120) subunits, on an empirical ("trial-and-error") basis.

We are concerned about these criticisms. We believe that NIH exercised appropriate judgment in 1994 when declining to support efficacy trials of the present generation of gp120 subunit vaccines. Clinical and laboratory studies during the past 4 years clearly reinforce the wisdom of that decision. The gp120 proteins do not induce relevant antibody or cell-mediated immune responses of significant potency. Their performance in Phase I/II trials has been disappointing, judging by careful evaluation of individuals who became infected with HIV-1 despite previous vaccination with gp120. Traditionally, the trial-and-error approach has been successful in vaccine development, but empiricism has not delivered an HIV vaccine despite much effort over the past 15 years. This is because HIV has properties not possessed by other pathogens for which