Letters

Civilian Technology Development

The welcome editorials by W. F. Brinkman (23 Feb., p. 901) and Daniel E. Koshland, Jr. (9 Mar., p. 1165), come at a most opportune time. A public concern shifts from national security to a greater emphasis on quality of life issues such as the economy and the environment, it is timely to begin thinking about the optimal way the federal government can support the civilian technology base. New technologies alone will not be the cure-all for our current environmental and industrial problems, but they are indispensable for their solution. The government has been repeatedly successful in such a role; the land-grant colleges and agricultural extensions of the past century formed the technology base for the phenomenally successful agricultural sector in this country. The National Science Foundation promoted science excellence, and the National Institutes of Health fostered giant strides in biology and medicine. NASA brought us to the moon and beyond our solar system, and the Defense Advanced Research Projects Agency (DARPA) provided our armed forces with weapons of unsurpassed sophistication. Now it is time to create a technology base for industrial competitiveness, energy (both production and use), and preservation of the environment.

Brinkman's thoughtful advocacy for a new civilian agency and Koshland's call for careful planning of research funded by the "peace dividend" resonate with concerns we have been focusing on over the past year. To assist in the effort to establish such a new civilian agency, the American Academy of Arts and Sciences is organizing an interdisciplinary research project, Project on Research Resources Redevelopment, to examine alternative institutional arrangements, and to establish priorities among competing problem areas and accessible civilian technologies to address them. The question is, What would be the best administrative, structural, and operational procedures; organizational identity; and planned goals of an agency needed to fund productivity selected high leverage areas of civilian technology and engineering research and development?

There have been numerous suggestions: Senator John Glenn (D–OH) proposes to convert the Commerce Department into the Department of Technology and Industry and nest there an Advanced Civilian Technology Agency; Representatives M. Levine (D–CA), J. Saxton (R–NJ), and E. Markey (D–MA) are all suggesting variants of a civilian technology agency. There have been proposals for an "extended DARPA" to support both civilian and military technology development. Brinkman has joined in with his proposal for a National Engineering and Technology Agency. The Europeans and Japanese have opted for ministries of science, technology, and industry.

To understand how such an agency(ies) might work, the American Academy of Arts and Sciences plans to conduct a model exercise. The project will begin by formulating a "problem-technology map." This will be a listing of important problem areas in the fields of energy, the environment, and industry, and of technologies with long-term payoffs needed for the solution of these problems. The list will be restricted to a dozen or so items. From this list, three items will be selected for further detailed study by the project. In these studies, competing technical solutions will be compared on the basis of effectiveness, R&D cost, and ultimate cost. Studies such as this will suggest the scope and structure of the needed agency(ies) that would be responsible for funding R&D efforts in the civilian sector. The model studies will be conducted by panels

drawn from industry, government, environmental groups, and academia. With this framework in place, it should be possible to evaluate the advantages and disadvantages of the various suggestions for an appropriate agency or agencies.This will consititute the last phase of the project.

The project is now just beginning; it will require inputs and cooperation from the national engineering, scientific, and technical communities if it is to succeed. The American Academy of Arts and Sciences welcomes your comments.

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"Progenote" or "Protogenote"?

The use of the word "progenote" to denote the most recent common ancestor of eubacteria, archaebacteria, and eukaryotes (*1*) (Research News, 3 Nov., 1989, p. 578) (an organism defined by its position in an evolutionary tree) was recently criticized by Carl Woese (Letters, 16 Feb., p. 789). Woese is, of course, correct in pointing out that "progenote" originally denoted an organism with inaccurate mechanisms for replicating and translating genetic information (*2*) (an organism defined by a set of putative biochemical properties). However, the word is now used (*3, 4*) as a simple cognate of "progenitor" (*5*); indeed, Woese himself seems to use the word in this way (*6*). This evolution of meaning is not surprising in view of the relative ease of defining ancient organisms by their positions in an evolutionary tree (constructed by comparisons of the sequence of ribosomal RNA molecules), and the relative difficulty of establishing their biochemical properties.

Nevertheless, we are sympathetic to Woese's effort to defend the original meaning of the word. Therefore, we wish to suggest that a custom in historical linguistics be adopted, where the prefix "proto" designates a language (or an organism) reconstructed with the use of rules of parsimony (*7*). Thus, the most recent common ancestor of archaebacteria, eubacteria, and eukaryotes is the "protogenote" because it contained the "protogenome." Likewise, "protoeubacterium," "protochordate," and "protoartiodactyl" denote the most recent common ancestors of eubacteria, chordates, and artiodactyls, respectively. The encoded macromolecules of each are reconstructed from the sequences of homologous macromolecules in their descendents. Such molecules are now for the first time available in the laboratory (*8*).

Woese also writes that it remains a "key unanswered evolutionary question" whether the "protogenote" was a "progenote." We agree that this question is key, but we also believe that it readily answered in its simplest form with the use of information now available. Many enzymes [for example, glyceraldehyde-3-phosphate dehydrogenase (*9*), enzymes involved in the biosynthesis of histidine and purines (*10*), and ribosomal proteins (*4*)] can now be reconstructed in the protogenote from the sequences of their descendents in all three kingdoms. Others might be assigned more weakly from the sequences of their descendents in eubacteria and eukaryotes alone. These protogenotic enzymes are not obviously either smaller or more limited than their modern counterparts.

As these enzymes could not have stood in metabolic isolation, the protogenote must have had other enzymes catalyzing at least a glycolytic path and pathways for the biosyn-