Editorial & Letters

EDITORIAL

Space Policy in a Vacuum

There is a saying in the building trades that a problem in the foundation chases you all the way to the roof. The U.S. space program faces a similar foundation problem. The heart of the matter is a policy failure—our political leadership has not succeeded in building a sustainable consensus regarding our national purposes in space. The consequences of this policy failure are manifest in the recently announced cost overruns on the International Space Station and in the recent near-miss accidents on the Russian spacecraft *Mir*.

Take the cost overruns in the Space Station, for example. Such overruns have become pervasive, and NASA's record in meeting cost and schedule goals is among the poorest of federal agencies. NASA has attempted to cope with the overruns through efficiency improvements such as procurement reform and streamlined management. These efforts are highly commendable— but not enough. The space agency is simply trying to do too many things with the available resources. A sharper focus is needed, and this requires clear choices of what the space program will and will not undertake. But without political leadership and consensus building from the President and Congress, the space agency has no basis for making these choices.

These purposes need not be of the compelling urgency motivated by the Cold War. Indeed, response to such an urgency can lead to shortsighted policy. Once the lunar landing was achieved, space budgets were cut, and from the time the Apollo missions ended in 1975, U.S. astronauts would not fly in space for another 6 years. Large-scale technology programs do not work well in such fits and starts. Engineering teams dissolve, managerial skills are lost, and once-familiar technology passes from our grasp. Thus, the essence of effective space policy is sustainability—and sustainability requires an enduring political consensus.

The concern about the lack of a federal space policy has been widely and long noted. In 1988 a National Academy of Sciences and National Academy of Engineering report* and in 1994 a Congressional Budget Office study† emphasized this point. Both reports suggested that the public debate leading to such a consensus can be framed according to three alternatives.

The first would emphasize space science. An enhanced program of scientific exploration would rely mainly on advanced robots rather than on human space flight. Scientific observations of Earth would be of special value in understanding the global climate. The Space Station, which is unsuited for much space science, would probably not be built.

The second alternative would eschew robots except as enhancements to human presence in space. It would emphasize manned spacecraft with the goal of increasing the skill and efficiency of human space operations. The Space Station would become the central platform for achieving these capabilities. Further human missions to the moon and perhaps the planets would be contemplated, most likely as a multinational enterprise.

The third alternative would emphasize both the use of advanced robots and human space flight. This alternative is sufficiently costly that it would require a multinational effort in which funding is shared equitably by the participants. Crafting a durable and effective international space program will not be easy, as the largely unsuccessful European efforts of the 1960s demonstrated. Indeed, it will require of the Clinton administration a degree of interest in and commitment to space policy that it has yet to demonstrate.

The public must decide which alternative it wants. The science and engineering communities can and should advise, but they cannot decide. What is needed is an effective political process that connects what is technically achievable with widely shared national values and purposes. To begin, the President should marshal his science advisory apparatus and, with the best counsel available, develop a sustainable vision and the policies to implement it.

Of course, this vision will be hotly debated within Congress and even internationally. The process will be untidy and slow, but this is the price paid for policies founded on political consensus. Above all, the process must be engaged now, before someone's luck runs out on *Mir* and before additional billions are spent on projects of uncertain value.

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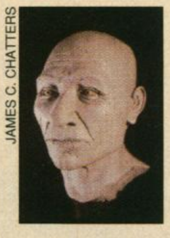
* *Committee on Space Policy, National Academy of Sciences–National Academy of Engineering, "Toward a New Era in Space: Realigning Policies to New Realities," National Academy Press, Washington, D.C., 1988.*
† *D. Moore, "Reinventing NASA," Congressional Budget Office, Congress of the United States, March, 1994.*

LETTERS

Ages of man



JAMES C. CHATTERS

An earlier radiocarbon date for Kennewick Man (left) is presented. The place of scientific data with an unpredictable lifetime on the World Wide Web is discussed. Priority in the field of auditory cortex plasticity is debated. And the topic of infants' memory for the spoken word is explored.

Radiocarbon Dates of Kennewick Man

The News & Comment article "Kennewick Man's trials continue" by Virginia Morell (10 Apr., p. 190) reports the continuing legal and administrative conflicts over attempts by anthropologists and others to regain the ability to sample the Kennewick and other early North American skeletons to complete appropriate analytical studies, including morphological and DNA analyses. As also noted in earlier News & Comment articles (V. Morell, 2 Jan., p. 25; A. Gibbons, 11 July 1997, p. 173), data obtained to date on these skeletons have raised the possibility that some of the earliest American human populations have no modern descendants in the New World. The new data suggest that a very complex set of relationships may have existed among Paleoamerican and Paleoindian human populations during the terminal Pleistocene and early Holocene in North America. The nature of these relationships can be explored and various inferences confirmed or discarded only by a series of carefully designed studies on well-documented New World human skeletal samples.

An age of 9300 years has been associated with the Kennewick skeleton on the basis of a carbon-14 (^{14}C) age determination. In light of the wide dissemination of this value, we think it would be helpful to provide a more complete statement of the results of the initial ^{14}C measurement on this sample.

A portion of the fifth metacarpal bone of the Kennewick skeleton was provided to the Radiocarbon Laboratory at the University of California, Riverside (UCR). The amino acid profile of this sample indicated a collagen-like pattern similar to that which is typically obtained from a modern bone. Because of the good collagen preservation in the bone, a total amino acid fraction was prepared by ion exchange chromatography (*1*) after extensive surface cleaning. That fraction was combusted to carbon dioxide and then converted to catalytically condensed graphitic carbon at the UCR laboratory (*2*). A ^{14}C age was then obtained by accelerator mass spectrometry (*3*) at the Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory. The conventional ^{14}C age of this sample (UCR3476/CAMS-29578) is 8410 + 60 years before present (B.P.), with a δ^{13}C value of –14.9 per mil. As expressed, the ^{14}C age has been normalized to a δ^{13}C value of –25 per mil, with a measurement error expressed at ± 1 sigma (*4*).

This was the value reported to the Office of the Coroner in Benton County, Washington. In response to a request for a calibrated ^{14}C value, there was an indication that approximately 900 years would need to be added to the conventional value to adjust it in light of the known offset between ^{14}C and solar time. However, it was pointed out that there would be a significant reservoir effect because the diet of Kennewick Man would have included a significant amount of marine biomass, presumably salmon, which currently spends a significant part of its life cycle in the north Pacific ocean.

If it is assumed that 100% marine and terrestrial diets would give rise in the total amino acid fraction to δ^{13}C values of –12.8 and 19.6 per mil, respectively (*5*), and given the δ^{13}C value of –14.9 per mil, we calculate a marine dietary contribution of about 70%. The corresponding marine reservoir offset for the Kennewick sample is 530 ± 150 years, based on a 750-year marine correction for the Gulf of Alaska for the early 20th century (*6*). The overall error reflects our estimates of uncertainties in the reservoir correction factor, its constancy since the early Holocene, and its applicability to Columbia River run salmon, as well as in the dietary contribution (*5–7*). On the basis of these considerations, we calculate a reservoir-corrected age of 7880 + 160 years B.P. for Kennewick Man. The corresponding calendar (cal) age if one uses the Seattle-Gröningen method is 8500 to 8950 cal years B.P. (1-sigma range) or 8340 to 9200 cal years B.P. (2-sigma range).

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Science and the Web

The report "Searching the World Wide Web" by Steve Lawrence and C. Lee Giles (3 Apr., p. 98) nicely reminds us about the novelty of the Web as an information resource and convincingly warns scientists (and others) about the current limitations of the popular search engines (such as that they return only a fraction of the available documents that match the query, return documents that are no longer valid because those pages have moved or have been withdrawn, or simply return documents that do not contain the query terms). Apparently, the most likely explanation for the latter malfunction rests with the typical commitment of webmasters to frequently update the content of the pages they maintain on a server. Of course, this highly desirable updating is the main advantage everybody is seeking when surfing the Web in search of information. However, it also means that, unless there is alternative support that guarantees the permanence of the information (as is the case for *Science* and most online scientific journals published with their paper-printed companion), the information one gets on the Web can be altered or may disappear after an unpredictable period of time.

It is increasingly tempting these days to refer to a uniform resource locator (URL) when publishing a scientific paper, and Lawrence and Giles appear to follow this practice, although wisely including the date of publication (last update) of the referred URLs. However, when releasing new data, presenting background, or discussing relevance to previously reported work, scientists might refer to information that could become inaccessible at any time. This would appear to jeopardize the validity of scientific knowledge because interrupting access to a reference is likely to impede reproduction of