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ership with a vision, not inflammatory rhetoric.

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3/87

Declining SATs pose a threat

Robert Beck Clark's editorial (June 1986, page 144) notes that only 0.33% of students taking the SAT exams intend to major in physics. Clark notes that although this number is "woefully small," the future physics majors rank first in median math aptitude and a photo-finish second on the verbal test.

In view of the not surprising news that physics majors are recruited from the very top-scoring students on the SAT exams, it is pertinent to call attention to what has been happening to the number of top scorers in recent years. It is well known that there have been declines in average SAT scores, but the data on the high-scorers are much less discussed.

The number of students whose scores on the verbal test are in the 700–800 range show a stunning decline[1] since 1967: from 2.3% of those taking the exams down to 0.83% in 1982. The decline in top math scorers has been somewhat less severe, but of the same order of magnitude. While the declines seem now to be bottoming out, what we see over the past 20 years is a cumulative loss of about half of the top scorers that we had in 1967!

Not only are the top scorers the ones who are more likely to major in physics, but they fill key positions in every niche of American economic life that requires distinctive intellectual ability. Thus the loss that has occurred must eventually be felt in leading positions in all fields of intellectually demanding endeavor. This is a very sobering thought, but it is one to which we have hardly paid any attention at all.

It is significant of at least part of the problem that those who would concern themselves with the decline in the high-scorers can expect to face criticism as "elitists." In short, we seem to be caught up in the pursuit of mediocrity that Alexis de Toqueville warned us a hundred and fifty years ago might be the Achilles heel of democracy.

The fact is that those who scorn "elitism" scorn democracy in its essential sense of giving all citizens the opportunities to develop to the best of their abilities and, by so doing, to make the greatest contribution to the general welfare. Only the most benighted among us equate democracy with mediocrity. And it is high time that we recognized what has been happening to the ranks of our intellectual elite, and take strong measures to recoup our losses of the last 20 years. One measure that is already being taken is the creation of special secondary schools for the talented. But we need more of them, and it would be singularly helpful if there were a model school in the Washington, DC, area to serve as an inspiration for model secondary schools all over the country.

Reference

1. R. Jackson, *An Examination of Declining Numbers of High-Scoring SAT Candidates*, Educational Testing Service, Princeton, N. J. (October 1976). Annual reports of the College Board, New York.

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6/86

What's best for space science?

From my perspective in the private sector, a commentary on Irwin Goodwin's interesting news story on NASA in the September 1986 issue (page 37).

First a couple of nits:

▶ Goodwin's assertion that the Uranus results prove "without question that humans can explore the Solar System at no risk to themselves" is just not so. Robots are extremely cost effective in investigating simple systems where our initial ignorance is profound. They are much less useful in dealing with complex systems; for example, the results from the Apollo missions could not have been obtained with robots.[1] Dealing with complex systems requires extremely high-order pattern recognition, which is far beyond the present capabilities of robots.

▶ Goodwin's aside about "Reagan's pet space station" is off the mark. The Soviet Union has been flying space stations for over a dozen years. To believe that it has devoted such long-term effort to a program of little scientific or technical value is preposterous. To believe that the United States cannot respond to this effort without severe economic and political consequences is dangerously naive.

More generally, space scientists should beware of presenting their studies as something that "should" be done. Furthermore, protests from scientists to the effect that "we've devoted our careers to these studies and deserve to finish them" will carry little conviction with the public. There are legions of folk out there who can no longer make a living at their chosen careers—steel and auto workers, farmers and so on—despite years of investment in training.

As Milton Friedman asked some years ago, why *should* the public support science? (Especially in tight economic times!) The short answer is that a society that supports science prospers, and indeed, science traditionally has been sold on just this basis.

However, scientific research is occasionally justified as a "cultural" endeavor that *per se* demands support, and this seems implicit in Goodwin's story. Such a reason may be valid for making a career choice, but not for spending public funds. This notion is further weakened by the fact that most research is intelligible only to other specialists, a remoteness exacerbated by many scientists' suspicion of popularization. Indeed, scientists who do try to reach a wider audience typically come in for criticism.

This whole approach makes the scientific community seem a particularly naive special interest: "We need this funding because we want to do this work; besides, we've invested years in our careers to this point. However, don't ask us to justify the project on any cost–benefits basis; it's merely of cultural value. But the results will be intelligible to only a few specialists, and furthermore, although we resent any attempts by others to explain them to a wider audience, we can't be bothered to do so ourselves." To the extent that the public who is picking up the tab perceives such attitudes, science funding will suffer. Indeed, inchoate resentment of "big science" by the public probably had as much as anything to do with the decline of space science during the 1970s.

Academic scientists traditionally bristle at suggestions that their research should be cost effective. How, after all, can one quantify the value of results one doesn't know yet? Certainly there is much truth in this view, and with the severe damage excessive short-term thinking has done to US business (as noted below), one would not want to inflict such thinking on academic science too.

Nonetheless, public-supported research should support the public interest. Virtually all basic research has had long-term payoffs, and it is those payoffs that justify—indeed compel—the public sector investment. With the currently fashionable concern about the necessity of "long-term thinking" to restore US technological leadership, space science (and other basic research) could enjoy a much more favorable political climate. But space science needs to be put into a general context of basic research as representing vital, long-term national interests.

To be sure, the aerospace companies and NASA are also not blameless for the present state of space science. The

aerospace companies are happy to do research—if the government pays for it. If space really has payoff potential, much more up-front investment should be forthcoming from the private sector. This consideration leads to larger economic issues: Much of the decline of the US global competitive posture, including our eroding technological leadership, probably results from a preoccupation with symbols over substance.[2] Additionally, despite lip service to privatization, NASA has responded in the manner of a bureaucracy, defending its turf against entrepreneurs attempting to develop private launching alternatives. Thus private expendable launch vehicles were shut out while public ELVs were phased out.

To conclude, here are two suggestions for the space science community:

▶ Get involved with the private sector. Declining Federal budgets and increasing commercial interest, coupled with rising concerns about the US's declining technological posture, provide a favorable setting. In particular, private capital should be involved in the space station.

The major oil companies may provide useful analogs for such private research. They have traditionally supported students and faculty with scholarships and grants, including a surprising amount of longer-term research. And whatever their undoubted faults, the oil companies have not billed Uncle Sam for such research.

In addition, the hardware (especially electronics) for space science has also gotten much cheaper. It's premature to sigh that the "easy things are all done." For example, the Radio Amateur Satellite Corporation satellite that is to be launched on the Ariane in a few years incorporates much effort by nonprofit, nongovernment organizations.

▶ Present space science as part of a general program of research and development to help restore our technological edge. Such a program would enjoy broad-based public and Congressional support.

Popular concern about America's declining technological edge, and companies' reaction to criticism that American business has degenerated into exercises in short-term paper shuffling, should favor sustained support of space science even with dwindling budgets. But silly assertions that manned flight is useless and pronouncements that the public "should" support space research merely generate much heat and little light. They also will not generate any funding.

References

1. R. Reich, *The Next American Frontier*, Times, New York (1983).
2. S. R. Taylor, *Lunar Sciences: A Post-Apollo View*, Pergamon, Elmsford, N. Y. (1975).

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5/87

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The three letters on the shuttle program (November 1986, page 13) present three different views of the future of the US space program. Geoffrey A. Landis is a strong believer in the shuttle program, at least in the interim. Thomas M. Donahue believes that more emphasis should be placed on expendable launch vehicles and less on the shuttle. John Bartel and Tom Coughlin believe that the issue is best settled by privatization of the US space industry. Of the three approaches, privatization is the most sensible and practical.

If the space shuttle, ELV or any other means of space transport is useful, economical and practical, then it can pass the test of privatization. Whatever system does survive the test, competition will force the launching companies to improve capacity, reliability and safety. As a result, it will be possible to lower insurance premiums.

Competing private companies detect a society's economic needs more rapidly and efficiently than a government agency; therefore pharmaceutical, medical, military and many other industries will be able to make tremendous advances as they can choose among more launching facilities for their payloads.

The increased launching capabilities and improved space technology under privatization will increase the demand for scientists, engineers and technicians, which in turn will increase the demand for advanced education.

The US is the leader in private industry and has the experience and skill that are required to accelerate our space industry beyond the imagination of any comparable socialized space industry. With privatization, we have the potential of being remembered in the history books as the 21st-century Phoenician sailors of outer space.

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12/86

Tying nuclear dumping to SSC

The letters on the "social purpose" of the SSC in your February 1987 issue (page 11) were presumably written before a social purpose was proposed in Congress—namely, for the SSC to serve as a carrot to get some state to accept a high-level nuclear waste dump. This proposal was immediately and forcefully opposed by Energy Secretary John Herrington, and it is doubtful that any SSC supporter would willingly accept the suggested albatross. Nevertheless, and whether or not the proposed tie-in becomes a significant factor in SSC decisions, the physics community should at least reflect on its possible poetic justice.

At the simplistic level, physicists are responsible for the nuclear waste problem, first by having contributed to the discovery of radioactivity, and then by having caused radioactivity to be increased by reinventing the self-sustained chain reaction. I do not view these things as "sins" since it is the responsibility of society as a whole to determine what uses are made of the discoveries of its more inquisitive members. But I consider that The American Physical Society has "sinned" by being at least partially responsible for the exaggerated public apprehensions concerning low-level radiation that make the nuclear waste problem a political hot potato. The APS did this by concocting 20 000 deaths from hypothetical public exposures of 600 millirems/year for 15 years in its 1975 light-water-reactor safety study. [See PHYSICS TODAY, July 1975, page 38.] From a historical perspective, these 20 000 deaths emerged at a critical point in the nuclear power debate and played directly into the hands of the alarmists who were marshaling their forces to combat nuclear power. Whether or not the APS deliberately intended to give credibility to the distorted viewpoints of the nuclear opponents, the failure of the APS to place public exposure to ionizing radiation from different sources in proper perspective, either in its 1975 report or in subsequent actions by its Forum on Physics and Society, has, in my opinion, been inexcusable.

While I would not expect physicists to carry their atonement to the point of allowing the SSC to be jeopardized, it would be refreshing if SSC supporters were at least to become sufficiently aware of the quantitative aspects of radiation in our environment to talk intelligently to politicians and reporters about nuclear wastes if the tie-in proposal ever does gain momentum. For example, the figure of 600 millirems/year used by the APS to concoct the 20 000 deaths is roughly equivalent to the exposure from the Environmental Protection Agency's indoor radon "guideline" of 4 pCi/liter, which has been eagerly interpreted by the public as being "safe." (The latter guideline level of indoor radon leads to a cumulative lifetime radiological exposure comparable to the 54-rem average exposure