Letters

Less than Golden Future

Bentley Glass's mixture of pessimism and hubris is not representative of the feelings of all scientists about the future of science in human affairs ["Science: Endless horizons or golden age" (8 Jan., p. 23)]. According to him the recent successes of biochemistry herald the end of the age of discovery. This is about as reasonable as claiming that complete knowledge of the universe is in sight now that pulsars and quasars have been discovered.

Science as a whole is still in the era of analysis and barely on the threshold of the age of synthesis. Even though the number of components of man's universe may be small, the ways in which they can be put together are infinite. Since knowledge will only be complete when we have tried them all, the most exciting years will always lie ahead.

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Glass emphasizes that exponential growth is self-limiting. I have no intention of questioning that too evident fact, but will call attention to a statement along similar lines made over 75 years ago. In 1894, the president of the physics section of the British Association for the Advancement of Science said, in effect, "The last half century has seen such enormous progress in science and technology that similar advances cannot be expected in the future. In my own field (physics) the possible changes can only affect the third or fourth decimal place." Within 2 years the x-ray and radium were discovered and the whole realm of physics changed.

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Having built a case for population control, hardly a startling concept these days, Glass proceeds to couple this with genetic control and happily points out that the scientific basis for such control has already been established. So in this best of all possible worlds our children's embryos will be carefully selected for us. Our wives may or may not be selected to actually bear our children, depending on their qualifications. Presumably the whole procedure will be administered by a hierarchy of eminently learned, wise, and incorruptible scientists. Does the scientific community really support that kind of manipulation of people? I don't think so. But a retiring president of AAAS has made such a suggestion in all seriousness. It is up to those scientists who have some concern for individual liberty, and especially those who are engaged in this line of research, to press immediately for legal and political safeguards to prevent a scientific triumph from being turned into a social disaster.

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Walter Sullivan in the *New York Times* (28 Dec.) attributed to me personally the views of Gunther Stent of the University of California at Berkeley, from whom I took the phrase "golden age" to epitomize the contrast between his view and the alternative perspective of "endless horizons" in the future of science. I clearly stated in my opening sentences that these views were a summation of the views of Stent. My own views were given, with far greater reservation, in a paragraph beginning, "Here, then [referring to the foregoing discussion], are diametrically opposed views of the future of man which grow out of the contemplation by the scientist of the achievements of science itself. What are the basic assumptions on which these views are founded?" I then proceeded to develop the view that scientific knowledge, being based on a finite universe, is itself finite, and is guided by a certain finite number of laws and principles which may be discovered and applied. I continued: "No one really questions, I believe, that even now we may be like little boys on the shores of a vast ocean, tossing pebbles into the waves. What remains to be learned may indeed dwarf imagination." Nevertheless, if possible knowledge is finite, a principal question becomes that of the rate at which scientific knowledge is advancing and enlarging. If indeed it is growing at an exponential rate, doubling in every 13 to 15 years, it will not take long to reach a point at which limiting factors will cry halt. I said: "Indeed, so awesome is already the accelerating rate of our scientific and technological advance that simple extrapolation of the exponential curves shows unmistakably that we have at most a generation or two before progress must cease, whether because the world's population becomes insufferably dense, or because we exhaust the possible sources of physical energy or deplete some irreplaceable resource, or because, most likely of all, we pollute our environment to toxic, irremediable limits." Perhaps I should have added more direct specification of the limiting factors most likely to apply to scientific advance itself, such as the increasing costliness of scientific research not only in sum total but per significant discovery, the inevitable reduction in the rate of increase in scientific manpower, and increasing hostility toward science by a generation that sees in science only the genesis of war and technological maladjustment, a tyranny over individual freedom and happiness. At any rate, the important matter for the present time is that these matters be discussed and that scientists begin the study of the limiting factors that will curb this, like all other forms of exponential increase.

In response to Fink and Meade, therefore, I request that they attribute to me only those views I acknowledge to be my own. I am aware of the immortal balderdash of Lord Kelvin, quoted by Meade, and was most careful *not* to state that science has discovered everything now. In many fields our greatest discoveries are still to come; in some areas, such as the understanding of the brain and mind of man, we have scarcely made even a beginning. That is not the question. The relationship I ask my fellow scientists to consider is simply the interaction of (i) a finite limit to scientific knowledge, and (ii) an exponential increase in scientific knowledge that has already increased it by a hundredfold in the present century. Is the pace not already slackening? Is the cost per breakthrough not rapidly increasing? If one must cube the number of working scientists and technologists to secure each added doubling of significant advance, can we support the educational and scientific establishment required for that?

As for the comment by Steinberger, he too, and far more egregiously than the two other respondents, puts words in my mouth that I spit out. Because one

predicts that the future may bring about certain constraints upon human rights and current individual freedoms neither means that one *endorses* or *likes* such possible eventualities. As soon say that George Orwell *advocated* the state of human society he foresaw as possible in *1984*. If Steinberger is really interested in my views, he will find them discussed at much greater length in numerous earlier writings of mine, especially in *Science and Liberal Education* and *Science and Ethical Values*. I reiterate that "the right that must become paramount is not the right to procreate, but rather the right of every child to be born with a sound physical and mental constitution, based on a sound genotype." And again, "Just as every child must have the right to full educational opportunity and a sound nutrition, so every child has the inalienable right to a sound heritage." Perhaps that can be achieved on a voluntary basis, through educational understanding, genetic diagnosis, and wise counseling. That, of course, would be preferable. But if such means prove insufficient for the task, social compulsion may indeed be the only alternative, whether we like it or not. Human societies in the past have practiced harsher measures, directed against the unfortunate child or infant. Better that restriction be directed at the stages of conception or embryonic implantation, or even at the fetus, in cases of indubitable physical or mental incapacitation. The difficulty will always be to achieve certainty in diagnosis and to harmonize enlightened voluntary action with social compulsion. Much social inventiveness and ethical analysis must be directed at these matters, and I am far from claiming authority in such.

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AAAS Council: Moving Toward Elitism?

As a member of the AAAS Council, I noted Strasser's and Slifkin's concern with the election of the AAAS president (Letters, 19 Feb.). Whatever the Council is, it is not a presidium. Neither is it the "elite" group described by *Time* magazine. In the election of officers the Council acts with little more knowledge than the total membership would have. Routine biographical data really does not give a basis for intelligent choice.

In the same issue (p. 709), there is a summary of the 1970 Council meeting. A point is made that the meeting lasted only 3 hours and 35 minutes and this was attributed to "general economies of time" as a result of doing some business by mail. Far more significant, in my opinion, was the arbitrary and authoritarian manner in which this particular Council meeting was run. There was an obvious attempt to hold discussion to a minimum, probably for fear of disruption. . . .

Few people attend the AAAS Council meeting or accept election to office with other than the best of motives. The basic problem lies in the fact that the AAAS is not fundamentally a professional organization. There are no professional qualifications for membership. Yet in modern times it has tried to take a very professional role as a spokesman for all organized science, thus creating a great division between the Council and the Board of Directors. When a large, unwieldy body with an ill-defined membership and an extremely limited mandate meets briefly once a year, it cannot be expected to have much significance.

In 1969 the Board of Directors announced and the Council endorsed a goal of increasing the membership by an order of magnitude or more by 1980. In 1970 the Council rejected a nominee for president who was a member of the Board and who had been active in developing this goal! Also in 1970 the Council on its own initiative advised the Special Committee on Governance that "it is a sense of the Council that any changes in governance should insure that control of activities of the AAAS will be in the hands of bona fide scientists or societies of scientists." This says that we want the control to be in the hands of a specialized group within the organization without that group paying the financial price of that control; that is, high dues. The 10-year membership goal, if accomplished, will merely exacerbate our problems. The program goals for the AAAS require such a membership base unless the membership costs are to increase greatly. The control is to remain in the hands of a restricted (elite?) group, the bona fide scientists. Apparently we—or at least the majority of the Council voting—wish the larger membership group to support with its dues decisions and programs in whose development and approval it has no real part.

To worry merely about the undemocratic means involved in the selection