iron gun casing, generating x-rays. For the minimum wavelength generated at 100 kv of 0.12 angstrom, about 6 percent of the radiation would penetrate the 1-centimeter-thick casing.

Continuous emission of x-rays apparently requires at least three things: (i) a higher than usual amount of oil vapor in the column, (ii) a vacuum better than about 10^{-5} torr, (iii) a gun casing not thick enough in relation to the kilovoltage employed. If these conditions exist, gun-current readings exceeding 1 or 2 microamperes indicate a need for caution and for monitoring of x-ray levels, although they can be due to leakage along the high-voltage insulator rather than to ion current. The safest procedure is to place additional shielding around the gun if its thickness and material are such that appreciable penetration of x-rays could occur. Although observed on a particular instrument, the hazard is possibly existent in other instruments and should bear watching where continued high-voltage operation is a practice. We take the opportunity of noting that additional lead glass protection has been found desirable over the viewing window on our instrument when lining up the column with 100 kv applied and the condenser aperture removed, because of x-ray emission from the screen.

V. A. PHILLIPS
J. A. HUGO
General Electric Research Laboratory, Schenectady, New York

The Project System in Grant Allocation

H. R. Albrecht's statesmanlike assessment of the problem of support for research in the smaller educational institutions (*Science*, 24 Jan., p. 306) deserves thoughtful legislative response. Even for large and successful grant-getting institutions, the project method of research funding has generated undue administrative complexities. It needs to be more broadly supplemented or supplanted by institutional grants that will shore up higher education and research on a nationwide scale and in all legitimate fields of learning, without generating so much pressure for individual investigators to become "big astronomers." If a large fraction of the available funds were dispensed in a pattern adopting the better features of the British University Grants System, quality would not suffer, and productive scholars might flourish with better effect in a more generally enlightened setting and without pressure to produce new "breakthroughs" every time their grants come up for renewal.

It is easier to endorse what someone else has said than to phrase it oneself. As Albrecht has said the things I should like to have said on behalf of the smaller public institutions, so Barry Commoner, in an article in *The Science Teacher* for October 1963, has said superbly well the things it is important to say about the effect of the project system on freedom to choose our own problems, and on the need for equally strong support for all the forms that truth can take.

PRESTON E. CLOUD, JR.
Department of Geology and Geophysics, University of Minnesota, Minneapolis

Science, Culture, and Determinism

It was a pleasure to read Hoagland's article, "Science and the new humanism" (*Science*, 10 Jan., p. 111). Perhaps it will further encourage biologists to express their views on cultural evolution and other aspects of the science of culture.

Several of Hoagland's points are puzzling to me. For instance, he writes, "[Cultural evolution] accelerated markedly in the last 100,000 years with the emergence of *Homo sapiens*." The prevailing view of students of human evolution appears to be that the emergence of *Homo sapiens* is largely the result, rather than the cause, of cultural evolution, though it may be that a reciprocal relationship has existed between the human biological and cultural developments. Also, Hoagland refers to agriculture and the nation-state as inventions. I wonder how the biologist would react to a reference to photosynthesis or mammals as inventions.

The analogy between ideas and mutations is one of many such analogies which can be drawn between cultural and biological evolution; but it should be recognized that a particular idea may or may not be adaptive, depending upon the cultural context in which it arises, just as a mutation may or may not be adaptive, depending upon the biological context. And it is my impression that mutant genes are lethal for individuals rather than for species, which become extinct as a result of failing to adapt to changing environmental conditions. The same would seem to be true for individuals and cultures (and thus for societies) where mutations (ideas) and adaptation are concerned. It might be added that man has no more control over the nature of the new ideas than he has over the nature of new mutations. What they are to be depends upon what is already in existence and, to a large extent, upon cause-and-effect relationships which are not directed by man but operate according to their own nature.

It is possible that we are entering an era in which we will acquire knowledge requisite to influencing many of the cause-and-effect relationships of our own cultural evolution in significant respects, but the vision of man in *control* of his own destiny is a dim one and one which has the effect of obscuring, rather than enlightening, our view of ourselves.

RICHARD A. YARNELL
Department of Sociology and Anthropology, Emory University, Atlanta 22, Georgia

Hoagland is to be commended for his excellent article, which calls attention to the fact that, because man has not used science to any significant extent to test and thereby direct his value systems, we now have value systems which are all too often based on archaic notions completely at odds with scientific findings. Further, he correctly attributes much of this result to a rigid compartmentalization of thinking whereby religion, science, and personal behavior are walled off from each other. Scientific method and the results of science are regarded as being applicable only to the concrete conditions under which men conduct their daily lives, and not to matters involving values, ethics, morals . . . In practice this means that the most important of man's affairs are decided by custom, prejudice, class interest, and religious dogma or other institutional traditions. . . .

Without meaning to detract from the general excellence of Hoagland's article, I find myself puzzled by the line of reasoning he has used on the issue of free will. Difficulties in knowing and assessing the weight that past experiences will have on future be-

havior cannot logically be used to validate the postulation of free will. Not knowing is simply that—not knowing. Hoagland implies that difficulty in pinpointing the determining cause (lack of knowledge) can be equated with free will.

Further, I would maintain that for most people free will would have to encompass a more inclusive independence from prediction than that prescribed by Hoagland. His omnipotent physiologist would be able to predict behavior precisely, with the lone qualification that he not inform the subject of his prediction. Presumably any number of others could be so informed and would thus also be able to predict the subject's behavior, again provided they do not inform the subject of their predictions. Under these circumstances, wherein a universe of outsiders could infallibly predict what the subject's behavior was destined to be, I believe few people would regard the subject's behavior as the manifestation of his free will.

Finally, I do not see why a modern society must assume the existence of free will in order to function. If an individual performs an act judged unacceptable in a free-will society, he is held responsible and is disciplined. If an individual performs an act judged unacceptable in a deterministic society, he is disciplined in order to alter his experience complex in hopes of thereby preventing recurrence of the act. To paraphrase Hoagland in a deterministic context, the advancement of civilization depends on the assumption that you can alter a person's response by changing his "plethora of past experiences."

The above contention notwithstanding, Hoagland's article is welcomed for its lucid statement of the relation of values to the facts of experience.

GEORGE MACINKO
Department of Geography,
University of Delaware, Newark

Hoagland's article illustrates again how illogical and unscientific able scientists can be when they venture to discuss problems traditionally delegated to theology and philosophy. . . .

Hoagland says that "scientists have an . . . operational ethic" which includes "the conviction that there exist objective truth and rules for discovering it." But the doctrine that objective truth exists is metaphysical, not ethical. And the rules which help scientists to create scientific truths are not absolute, unverifiable ethical principles, but principles of expediency verified by their utility. They require no unscientific ethical justification.

Hoagland quotes with approval Bronowski's claim that "we can only practice science if we value the truth." The term *value* is ambiguous. It may mean value as a means or as an end in itself. The context suggests that he means value as an end. If he does, his claim is false, for men can practice science if they value the uses of scientific truths. And, if he uses *value* to mean value as a means, his claim is a truism irrelevant to his thesis.

Hoagland argues that if the factors affecting human choices are so numerous or so complex that we will never be able to explain choices fully, we are justified in calling them undetermined and therefore free. Here again his argument is plausible only because he uses an ambiguous term, *undetermined*, which may mean either uncaused or unexplained. When philosophers assert that men have freedom of will, they mean that choices are uncaused. Hoagland's argument suggests only that they may be partly unexplainable, an irrelevant point.

As further support for free will, he restates a "logical indeterminancy" argument. This asserts that a scientist able to predict perfectly the behavior of a man, X, would alter that behavior, and thus disprove his prediction, by advising X of his prediction. It assumes arbitrarily that the scientist could not predict the effect on X of such advice and thus begs the stated question. Moreover, the relevant question is whether conduct is caused, not whether it is predictable. Finally, the argument is purely verbal, and scientific proof always requires observational data.

Hoagland concludes, "I know of no scientist today who works outside of a deterministic framework" (p. 113). Why then does he argue that human conduct is undetermined? Apparently he does so because he wants to justify the conclusion that "society can hold [men] responsible for their actions" and punish wrongdoers (p. 114). But it is unnecessary, as well as senseless, to hold men morally responsible. By the use of rewards and penalties we can train animals to act as we wish, without holding them morally responsible, and men are far more amenable to such training. Belief in moral responsibility is needed only to justify punishments which produce no observable improvements in behavior.

Hoagland claims that scientists who reject ethics "are antagonistic to the humanistic claims of science" (p. 113). But is it not more humanistic to treat scientific truths as means to the satisfaction of human wants rather than as "intrinsically good"?

BURNHAM P. BECKWITH
2110 Catalina Street,
Laguna Beach, California

Yarnell raises the question whether the emergence of *Homo sapiens* was a result of cultural evolution or its cause. Although there is no satisfactory proof of an answer to this question, I have favored a reciprocal relationship, that is, certain chance mutations enhanced the development of an enlarged cerebral cortex with areas able to develop the use of verbal symbols and other special areas facilitating manual skills. These mutations would give a particular breed of hominids advantages over others in tool and weapon making and in communication and social organization and would have a feedback action of survival value for selection over other animals. This would further enhance cortical development and its accompanying higher intelligence. The resulting tools and weapons and organization of behavior, that is, psychosocial evolution, thus had survival value for emerging *Homo sapiens.* Yarnell also raises the question about my meaning of invention. According to Webster, invention is "the power to conceive and present new combinations of facts and ideas; to devise new methods or instruments, etc." Another dictionary defines a social invention as "the creation of new cultural traits, patterns, etc." According to these definitions agriculture and nation-states are inventions—photosynthesis and mammals are not.

I thought I had stressed in my paper the importance of adaptation in relation to the impact and effectiveness of ideas ("ideas may be before their time"). Lethal mutation may affect such a large number of individual animals that the species is unable to continue propagating itself in competition with rival forms in the environment. Lethal ideas may also spread and destroy a society. Finally, man does have control over the uses to which new ideas may be put, and there are many historical examples to

illustrate this. Unfortunately this control has seldom if ever been exercised for the common good of man. My thesis is that man is unique in being able to direct and control his own evolution. He has all too seldom exercised this option deliberately, and I agree with Yarnell that advancing knowledge makes this more feasible and at the same time more imperative for his survival and advancement in this nuclear and increasingly populous age.

Both Macinko and Beckwith point out the thorny nature of any discussion of the ancient pitfalls of free will. I referred to a concept of freedom stemming from our inability to know all that phylogenetic and individual past experience contributes to one's on-going behavior. We may or may not be entirely determined, and I suggested a pragmatic approach—that one may behave empirically as if one were free to make choices and thus justify responsibility, which I assume is socially desirable. An additional point in favor of freedom was derived from considerations of logical indeterminancy. This is a matter of definition of free will as I chose to use it in my discussion. Since we can have no final answer to the question of free will, one might ask, Which position is pragmatically better for society—the assumption that we are free or the assumption that we are not? What would be the social consequences if everyone were convinced that he was an automaton with no freedom to choose? It may be true that he is an automaton, although this contradicts our deepest convictions. In practice it seems to me that it would leave a society in a position in which people could not be held responsible for their acts. This conceivably might be a desirable state of affairs, but I do not think so.

Beckwith's point that "the doctrine that objective truth exists is metaphysical not ethical" seems to me irrelevant to the issue. I hold no brief for "absolute, unverifiable ethical principles." It is true that "principles of expediency verified by their utility" motivate much of science, but regardless of the metaphysics involved, when one compares the arrivals at conviction by the operational procedures of science with methods of myth, superstition, and prejudices that determine the beliefs of all too many people, the ethical significance of truth reached by science seems obvious. Scientific procedures extended more generally to the weighing and evaluation of evidence in relation to events in daily life, politics, and other human relations can have a very considerable ethical "fallout," in my opinion.

HUDSON HOAGLAND
Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts

Scientists and Patents: A Lawyer Comments

An advertisement of the AAAS in your issue of 6 December (p. 1309) quotes this statement of a former AAAS president:

> I have sought . . . no patent for inventions and solicited no remuneration for my labors, but have freely given their results to the world. . . . The only reward I ever expected was the consciousness of advancing science and the pleasure of discovering new truths.

Elsewhere in the ad is the statement that AAAS is "an instrument for securing the benefits of science for human welfare." In the opinion of this reader, these statements are totally inconsistent. The use of the statement by AAAS is a representation of regrettable views of scientists about the patent system.

The picture conveyed is of the scientist cracking the door of his laboratory and throwing his invention out to the world. He then slams the door shut, returns to his bench, and revels in the warm feeling of having made his contribution to mankind. He gives no thought to the question who, if anyone, will transform his invention into a useful product or whether, in fact, his invention might be misapplied, to the detriment of his fellow man.

I do not propose that the social consciousness of the scientist should force him to abandon the bench and dabble in the dirty world of business. But if his attitude about patents is based on a desire to benefit the world, his mantle is soiled by abstinence rather than participation. Of course, many of the scientist's contributions are not patentable because they are not "useful" in the patent sense. They are, instead, the building blocks of future progress in the applied sciences. But scientists should nevertheless be aware of how patents, in proper cases, can increase the measure of their contributions. And those engaged in strictly fundamental research should reject the view that because the patent system may not operate for them it should be curtailed or abolished in areas where it does operate.

The philosophy of the patent system is to provide incentive for doing what must be done to the scientist's work before it can become a benefit to the public. Charles Kettering has said:

> . . . progress will not come through research, science, and invention alone. These are merely the loose strands of progress. They must be joined by cross-strands.

These cross-strands include the provision of an incentive to invest in uncertain developments in the hope that the temporary "monopoly" afforded by a patent will enable the investor to recover his costs and earn a profit. By exercising control through patents the scientist can better assure himself that his invention will do what he wants it to do in the world. He can license it freely to all worthy comers as though there were no patent at all, and he can refuse to license those whose competence or aims he distrusts. And there is no law requiring him to accept a profit in the process.

The *Science* ad refers to the author of the earlier statement as "a prime example of the spirit that has led eminent men of science for more than a century to seek the objectives of the AAAS." If this really represents the spirit of the scientist, we can only hope that one of the "new truths" he discovers is the availability of the patent system to help him fulfill the highest calling of his profession.

ARTHUR R. WHALE
3512 Croyden Avenue, Kalamazoo, Michigan

Consanguineous Marriage and Biological Selection

The exchange of letters between Victor McKusick and Cabot Briggs (*Science*, 10 Jan., p. 100) leaves the impression that the practice of marriage of close kin is on balance always biologically detrimental. But anthropologists are aware that marriage of close kin is a widespread practice among many primitive peoples who do not seem to show a high frequency of genetic defects, even at birth before selection has taken place. Probably the