

erating pressures are the goal of the designer of our future rockets, I believe it is obvious that the problem of acoustic resonance in solid-propellant motors must be considered to have current interest.

A Philosophical Note

I would like to close by returning to a philosophic vein. It seems to me that if anything characterizes our times it is the necessity of facing the problems which arise in closely coupled systems. Systems may be broken into components which may be studied independently. Yet the system may exhibit behavior which is by no means the simple sum of the behaviors of the components. The components acting in unison produce phenomena which might not have been expected from studies of

them individually. The lesson is that in our studies of the isolated components we must not overlook the vital necessity of finding and defining the properties which allow these components to couple closely with one another, to produce the behavior pattern of the system. For the servo engineer this concept has become a profession. The alert biologist senses it in the relationship between the properties of the individual molecules of deoxyribonucleic acid, ribonucleic acid, and protein and their remarkable performance in unison in the living cell, or, again, in the relationship between properties of individual cells and the performance of a multicellular functional structure—say, a brain. But is there a more dramatic demonstration than the ability of a relatively unknown individual in, say, the Congo to take a small action and thereby rock the world, disturbing the comfort, even

threatening the security, of the great powers? Can we not summarize these matters, with choice of words appropriate to the particular context, by paraphrasing the vivid line of John Donne: "No man is an *Iland*, intire of it selfe . . .?"

Notes

1. In this brief discussion of the science of solid-fuel rocketry it would be quite impossible to properly credit the many contributors to our knowledge. I would be remiss, however, if I did not acknowledge my indebtedness to my colleague Dr. Robert Warren Hart, without whose close collaboration I should never have been able to discuss the subject of acoustic resonance in solid-fuel rockets.
2. I wish to thank T. Angelus of the Allegany Ballistics Laboratory for this illustration, taken from the results of his extensive studies of this phenomenon at that laboratory.

Bibliography

- F. T. McClure, R. W. Hart, J. F. Bird, *Progress in Astronautics and Rocketry*, M. Summerfield, Ed. (Academic Press, New York, 1960), pp. 295-358.
E. W. Price, *ibid.*, pp. 561-602.

News and Comment

The Civil Defense Debate: Neither Side Is Talking the Other's Language

As noted here last week, the debate in Congress over the Administration's Civil Defense program is shaping up as primarily one over whether the program will be worth the money that will be spent on it; this congressional debate is not likely to be very pertinent to the debate going on outside of Congress, particularly in scientific and academic circles, which is chiefly concerned with whether the whole idea of an extensive civil defense program is well-advised to begin with.

The Administration's position, at heart, is a simple one: there exists an undefinable but undeniable possibility now and for the foreseeable future that we might be subjected to a nuclear attack; therefore it would be prudent to take some precautionary measures. The

opposing case, at heart, is almost equally simple: that a nuclear attack, on almost any scale, with or without civil defense, would be such an indescribable disaster that it would be folly to adopt a policy which might mildly mitigate the disaster if the price of adopting the policy is to make the disaster itself more likely to occur. A case can be made, on various grounds, that a civil defense program would increase the chance of the disaster; therefore, depending on how firmly one believes he has made this case, it would be at least questionable, and at most, outright folly, to adopt a civil defense program.

The Administration position can be attacked directly, on the grounds that it is just not worth the money it would cost. This is the heart of the debate in Congress, but is not particularly pertinent to the debate discussed here. The opponents here are not directly concerned with wasted money.

Their statements usually discuss the extent of a nuclear disaster even with shelters, but rarely as the basis for calculations of relative utility. Their point is not so much to attack the Administration's view that there are some significantly useful things that can be done now that will be valuable in the event of an attack, but to establish firmly their own basic premise on the immensity of the disaster with or without civil defense.

For some, and in fact for a great many people, the argument really ends right here with a statement of the extent of a nuclear disaster. Herman Kahn made the point before the Holifield committee that while someone could reasonably say "I prefer to be dead than Red," no one could reasonably argue that he preferred everybody to be dead than Red. If the choice came down to "Everybody Red or everybody dead," the choice had to be "Everybody Red." The choice does not have to be made anything like this unambiguous to convince someone that there is more danger involved in failing to work effectively to prevent war than in failing to prepare (with what very limited effectiveness it is possible to prepare) against the possibility that war will take place. So one can take a position against civil defense and fallout shelters, not as particularly evil things in themselves, but as a convenient symbol of the arms race.

This seems to be the commonest reaction, and does not even necessarily imply that the protester is particularly opposed to civil defense. The important thing, in these terms, is not so much to defeat the Administration program, but to protest against it. In the extreme case, you could even privately feel that on balance the program is well-advised, and still be perfectly consistent in joining the protest—on the grounds that the danger of damaging or destroying the program is heavily outweighed by the gain, through the protest, of impressing on the public the extent of the danger we are in. In this view, you might feel that it would be preferable to see the Administration get its program through Congress after a great debate that served to awaken the public to the dangers of the arms race, than to see the program quietly smothered in Congress without a great debate. This position, essentially one of general protest against the arms race, seems the strongest of those that have been taken. Indeed, unless one is willing to discount everything the President has been saying about the arms race as insincere, the President would have great cause for concern if such a protest failed to develop. His own actions have not been particularly directed at discouraging it—the gesture, for example, of sending out coffee to the peace marchers in front of the White House, or his blunt remark at a press conference last month that in the event of a nuclear war there would be no winners.

But beyond this generalized protest, when the opponents attempt to build a formal case against the specific program of fallout shelters, as opposed to a generalized case against the arms race which happens to pick the shelter program as a symbolic target, the case appears to become weaker to the extent that it centers on fallout shelters as a separate subject for opposition.

There is nothing mysterious about this progressive weakening: the general protest position depends only on some simple and widely accepted points: that the arms race itself is at least as much of a problem as Communism; that we have not made much progress in restricting the race; that even if we had an opportunity to make progress, it would be made difficult, perhaps impossible, unless there were general acceptance of the view that the race itself is an enemy; and that a single-minded policy concentrating solely on containing or reducing the communist threat

is likely to lead to disaster. All this leads readily to the conclusion that it is extremely important to bring home to the public the nature and extent of the dangers of the arms race. The more specific position, singling out civil defense as a particularly undesirable policy, depends on the hypothetical possibility that civil defense will increase the chance of war. No one can prove this, of course, and there are good arguments that the program would be more likely to lessen the chance of war. Just as a case for fallout shelters would become progressively weaker the more it tended to concentrate on a hypothesis that the shelters would somehow reduce the likelihood of war, the case for shelters becomes weaker as it tends to concentrate on the opposite hypothesis.

A case for shelters decreasing the chance of war, for example, could be based partly on the argument that the program will force the public to face the possibility and meaning of a nuclear war, and therefore to accept the view that the risks involved in arms-control agreements might be preferable to the risks of an uncontrolled arms race ("I am told that nobody wants to read about the hydrogen bomb, or even think about it," Elmer Davis wrote 7 years ago, "but it will be there whether we think about it or not, and perhaps especially if we do not."). Partly the case could be based on the argument that the more fully the Russians believe that we are thinking realistically about the possibility of nuclear war, the less likely they are to push us into a position where using nuclear weapons seems the only alternative to a humiliating defeat.

The case that can be made with such arguments is by no means a compelling one, but it is hard to see where it is a noticeably weaker case than the contrary one that civil defense will increase the chance of war, particularly if civil defense is attacked as something uniquely unsound, as opposed to an attack which happens to single out civil defense, but which is really an attack on the deterrence policy generally.

Much the same points which are effective in arguing that civil defense would increase the chance of war—those centering on the idea that the increase in the credibility of our deterrent makes it more likely that we would actually fight—seem to apply at least as well to a number of other policies which increase that credibility: for example, the build-up of conventional forces, the build-up of an

elaborate control and command system for fighting a "controlled" nuclear war, as opposed to a suicidal, and hence unlikely, massive attack. One can argue that it is unlikely that a limited war between the great powers could be kept limited, and therefore that these steps, which clearly increase the chance of our fighting in the event of a major crisis, increase the chance that we will fight an all-out war.

Then again, though, it might not; for the increase in credibility reduces the likelihood that we would be pushed into the position of having to make the choice. So, in general, if one thinks of war as the overwhelming danger—to the extent that opposing the communists seems unimportant by comparison, then it is far from clear in many cases whether whatever we do within the framework of a deterrence policy would decrease the chance of disaster, and it may seem logical to turn to unilateral disarmament.

A somewhat related position is that of the person who does not reject the policy of deterrence, but feels that the Administration is already too aggressive, or might become too aggressive—attempting to deter Russian moves which are really not important enough to take any risk to deter, or in the extreme case, attempting to use a nuclear threat to force the Russians to give way on what they regard as *their* vital interests. Whether one takes this position depends mainly on how much confidence one has in the judgment of the Administration, particularly of the President. An easy test on this point is available to readers who are not strongly opposed to the Civil Defense program, but who were strongly opposed to Nixon during the election. Would your feelings about the civil defense program be any different if it had been proposed by President Nixon instead of President Kennedy?

An impressive example of a critique that includes touches of the positions outlined so far is Gerard Piel's Commonwealth Club speech, which is reprinted in the February issue of the *Bulletin of the Atomic Scientists*. In contrast to Piel, several recent attempts to build a narrow case against civil defense seem quite weak—and the weakness seems to be accentuated when the case is presented in a format which suggests that authors are not speaking as partisans in a public debate, but are merely reporting the objective judgments of science.

A group of scientists, mainly from Columbia University, for example, have put together a series of papers relating to civil defense (available from Box 577, New York 27, N.Y.) which is being used in presentations to Congressmen and their assistants. Some of the papers relate to the immense costs of a deep shelter program, which no one in a position of responsibility has proposed. (Even Congressman Holifield has been pushing only for fallout shelters augmented by a modest amount of blast protection, a program that differs in cost by an order of magnitude from a deep shelter program.) Others describe the immensity of a nuclear disaster, which one can accept and still favor fallout shelters. The final paper, by Otto Klineberg, summarizes in 800 words three quite different arguments against shelters on psychological and strategic grounds, and in this limited space does not, unsurprisingly, build a serious case for any of them. It is hard to see how the paper could make much of an impression on anyone who had not already convinced himself that shelters are undesirable.

The problem of possibly confusing a general readership about whether it is getting an objective scientific statement or a partisan statement that happens to be made by a scientist comes up even more strongly in a report called "The Shelter Centered Society" (Peace Research Institute, 1329 18th St., NW, Washington 6, D.C. 35 cents). The report presents numerous possible objections on sociological grounds to the civil defense program, usually in the form of questions or suggestions of things that "might" happen. The report offers virtually no evidence and rarely even a detailed argument to suggest that they would happen, or how likely they are to happen, although a good many of the possibilities seem rather unlikely ("Might there be sizable emigrations from North America?"). In particular, the report strongly suggests that a policy of civil defense is incompatible with seeking disarmament. The only explanation is the suggestion that "almost all the people" would lose interest in pursuing negotiations because they would believe that "negotiations have failed and war is looming." If this is true, "almost all the people" must be about as rational as a man who sees lifeboats on a ship and concludes that the ship is about to sink.—H.M.

Announcements

Seventy-four faculty members of the University of North Carolina felt that the news article **Science and segregation** gave an incorrect impression of the attitudes of the faculty on segregation. They have, accordingly, signed the following statement.

"We, the undersigned, of the faculty of the University of North Carolina, a nonsegregated institution, wish to comment on the Science and segregation article in the 8 December 1961 issue of *Science*.

"First, let us point out that academic freedom flourishes at the University of North Carolina and none of us would want to prevent anyone on our faculty from publicizing sincerely held viewpoints no matter how we disagree with them.

"In the same spirit of academic freedom we should like to concur with the resolution passed by the American Anthropological Association on this issue:

"The American Anthropological Association repudiates statements now appearing in the United States that Negroes are biologically and in innate mental ability inferior to whites and reaffirms the fact that there is no scientifically established evidence to justify the exclusion of any race from the rights guaranteed by the Constitution of the United States."

Proceedings of an international symposium on **power reactor experiments**, held from 23 to 27 October 1961 in Vienna, have been released by the International Atomic Energy Agency. Volume I (\$6) contains information on high-temperature gas-cooled reactors; volume II (\$4) covers nuclear superheat and steam-cooled reactors. Papers, preceded by abstracts in English, French, Russian, and Spanish, are published in the original language of presentation—English, French, or Russian. (IAEA, United Nations, New York)

A group of **Communist Chinese chemical abstracts**, translated from a publication of the U.S.S.R. Academy of Sciences, is available through the U.S. Department of Commerce. The group covers physical, analytical, organic, and high-polymer chemistry; organic, inorganic, and general chemical technology; chemistry and processing of wood; solid fossil fuels; chemistry

and technology of food production, detergents, flotation agents, and perfumes; and technology of high-molecular compounds. (Office of Technical Services, USDC, Washington 25, D.C. \$1.25. Order 62-11104)

Grants, Fellowships, and Awards

Fellowships in **clinical investigation of radioisotopes** are available at Oak Ridge Institute of Nuclear Studies, beginning 1 July. The program includes the basic radioisotope course and clinical training in the use of radioisotopes as tracer and therapeutic agents, and offers opportunities for research in radiation effects, hematology, thyroid disease, and cancer. (Ralph M. Kniseley, ORINS, Oak Ridge, Tenn.)

Fellowships in the physical chemistry and physics of **radiation processes**—the interaction of radiation with matter—are available at the University of Minnesota. Stipends will be sufficient to match yearly salaries for older, experienced investigators as well as for new Ph.D.'s. (Rufus Lumry, Division of Physical Chemistry, University of Minnesota, Institute of Technology, Minneapolis 14)

Predocutorial graduate students in **space-related sciences and technology**—including biochemistry and nutrition, biology, geology and geophysics, oceanography, and plant sciences—are eligible to apply for 3-year scholarships at Texas A.&M. The ten fellowships, sponsored by the National Aeronautics and Space Administration, will amount to \$2400 per annum plus up to \$1000 for expenses. Deadline: 15 May. (Wayne C. Hall, Graduate School, Texas A.&M., College Station)

Courses

A professional advancement course in **nomography**, dealing with projective and nonprojective transformations, will be given from 9 to 20 July at Lowell (Mass.) Technological Institute. The course, which will include the underlying mathematical theory, is designed for those who are concerned with the construction of graphical devices for use by mathematically untrained personnel. (L. Ivan Epstein, Department of Physics and Mathematics, LTI, Lowell, Mass.)