Letters

Overkill

Seymour Melman's reply to D. S. Greenberg's analysis of his views (Letters, 17 July, p. 232) deserves fuller comment. I should like to return the discussion to its central thesis: the calculation of "overkill ratios."

Melman's method of calculating fatalities due to a nuclear detonation, which is not made fully explicit, is this: the number of fatalities varies linearly with yield, the derivative being given by the ratio of fatalities to yield in the Hiroshima experience. In the exchange between Melman and Greenberg, much is made of whether the Hiroshima fatalities were 68,000, or 100,000, or perhaps 180,000. As a contribution to the accuracy of this debate, I would offer the fact—now public knowledge—that the yield of the Hiroshima bomb was about 17.5, not 20, kilotons. Nevertheless, let us use Melman's assumed data to obtain a constant of proportionality of 5000 fatalities per kiloton, or 5 million per megaton.

It is at this point that the argument can be inverted. Instead of calculating the "overkill ratio" by reference to the populations and nuclear stockpiles, let us, for example, calculate that a single 38.4-megaton bomb could destroy the entire United States population. If this were true, it is evident that the Soviet 58-megaton test of 1961 would have killed everyone in the Soviet Union. Melman's method also allows us to calculate that a 10-megaton bomb dropped on Wake Island (population, 349) would kill 50 million people.

This is not mere haggling over 68,000 versus 180,000 or 17.5 kilotons versus 20 kilotons. The assumption upon which the "overkill ratio" is calculated is an extremely blunt instrument. It makes no provision for the complex and time-varying distribution of population, nor does it differentiate effects of very small and very large weapons which are of a known nonlinear character. It is not sufficient to observe, as Melman does in his letter, that "all forecasts concerning the effect of the use of nuclear weapons on a large scale involve estimations for circumstances where the error of estimate cannot be known." Of course this is true; but it seems rather unreasonable to support a hypothesis on the basis that it cannot be proved false without conducting a large nuclear war as an experiment.

It seems clear that available knowledge is not being used to the fullest feasible extent in Melman's theory. I was able recently to calculate the effects of nuclear attack on New York. The model used took into account the time-dependence of population distribution, the varying density of haze over the region, and various other detailed effects. The result (for 35 megatons) varied between 8.8 and 9.2 million fatalities, short-term. The model used was considered pessimistic. The linear theory indicates 175 million fatalities: the minimum discrepancy is a factor of 19. A much more representative city, Wichita, Kansas, had a discrepancy of 27 times between the linear and detailed models for 1.5 megatons (150 times for 10 megatons), effectively indicating that Melman's theory is worse, not better, when smaller population centers are considered.

These results do not mean that one should merely divide Melman's "overkill ratios" by a factor of 19 or 27, or 150, to obtain the "actual" ratios. About 63 percent of the U.S. population is in cities (212 of them) with a nominal population over about 60,000. Perhaps 250 Soviet missiles might be needed to destroy 80 percent of this 63 percent (50.4 percent of the total population). Thereafter, however, a truly impressive number of missiles would be required to destroy each additional 5 or 10 percent of the population. This saturation effect, which is *not* overkill but rather diminishing returns, is observable both in the case of calculations for individual population centers and in the percentage of the total population contained in an increasing number of cities (it is particularly marked for the Soviet Union). It is extremely questionable that the world's nuclear stockpile is sufficient to overcome the effect of diminishing returns and to approach the destruction of the world population. This observation is made in full appreciation of the estimate that the world stockpile is probably 200,000 to 300,000 megatons, about ten times the common estimate. One might note that the strict meaning of overkill implies that at some level of nuclear attack precisely everyone in the world (or whatever other group is considered) will have been killed. If this is not true for some finite attack, overkill (in the strict sense necessarily implied by statements of the form "capability to kill everyone in the Soviet Union x times over") is not possible. In some situations it might require quite a bit of energy to destroy a few people. If we were to take the 1964 Alaskan earthquake as a model, instead of Hiroshima, it would require 1400 megatons to kill a single human. Thus we calculate that the world nuclear stockpile (say 200,000 megatons) could kill 143 people. The fact that there are uncertainties involved does not qualify the crudest theories as the best.

To forestall certain types of reasoning, I should perhaps note that I am in no way connected with the Air Force or any other part of the Department of Defense.

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Montreal: Historical Note

The recent correspondence about the circumstances under which the tradition of the inertness of the noble gases became implanted in the literature has cast a good deal of light on the conservatism of science. It is consequently amusing to see an even more venerable tradition, no less unfounded, perpetuated in the description of Montreal in the issue of 22 May (p. 1033).

The Indians whom Cartier found in 1535 at the village of Hochelaga, on the site of Montreal, were indeed linguistically related to the Hurons. This relationship may have been re-

sponsible for the tradition, reported very early, that they were Hurons. However, archeologists have been pointing out for more than half a century that their artifacts—their pottery, at least—were far more closely related to those found on both sides of the upper St. Lawrence and on the town sites of the Onondaga Indians of central New York. These pottery styles are quite different from those of the Huron proper, whose homeland was between Lake Simcoe and Georgian Bay; however, Hurons, Onondagas, and the people of Hochelaga and "Canada" —the region around Quebec—all spoke dialects of the Iroquoian language.

One of the many stories told in the 17th century to account for the disappearance of the Hochelagans before Champlain's arrival in 1603 says that they were attacked and scattered by the Hurons proper, and that some sought refuge among the New York Iroquois and others settled among their conquerors in Huronia. This may account for the tradition that "Hurons" had occupied Hochelaga, as well as the circumstantial evidence that Hochelagans and Onondagas were similar. Canadian archeologists are only just beginning to piece together the evidence and to look for more.

Historians who do not understand or accept archeological evidence have perpetuated the "Huron Hochelaga" tradition. So have the popular histories. So have Chambers of Commerce and convention bureaus. And so has the AAAS.

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The Pharmacist as Drug Consultant

With great pains not to detract from Lasagna's excellent discussion ("Problems of drug development," 24 July, p. 362) I would like to add one point concerning the physician's continuing education in regard to drugs: physicians do not use the nearby professional pharmacist, in whom they could find an up-to-date and, more important, a dispassionate adviser on pharmaceuticals. Manufacturers' representatives doubtless serve a purpose to the physician, but the same purpose (the maximum gain in information on drugs) could be better met by the unbiased pharmacist.

To be objective, I must admit that some pharmacists are not enthusiastic about practicing their profession to the extent of serving as drug consultants to the medical profession. There are many reasons for this, and a not insignificant one is the all too common disparagement by the physician of the pharmacist's education. But the objectives of that segment of the pharmaceutical profession devoted to education include the education of pharmacists as drug consultants to the medical profession. The interested physician can find, by one or a few phone calls, a capable professional pharmacist willing and able to provide intelligent counsel on drugs. However, the practicing physician often accepts the information of the detail man, who is not as objective in pharmaceutical matters as the pharmacist. The case rests that there is a vast untapped source of information available to the physician which will obviate some of the problems of continuing education for the medical practitioner.

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Training Grants

Abelson's editorial (5 June, p. 1181) regarding the present predoctoral and postdoctoral fellowship programs places considerable emphasis on the pitfalls of the program without mentioning its merits and offers as a solution to the problems an alternative that would probably not be free of other difficulties. According to the editorial, the method of dispensing training grant funds directly to a senior principal investigator, rather than to institutions and thence to the trainee, fosters a channelled, restrictive training program and stifles the initiative of the trainee. While this may be true of some programs supported by training grant funds, it is not fair to say this is the general finding. In many, and perhaps most, cases pre- and postdoctoral fellows apply for research training in hopes of becoming competent in a particular research area being studied by one or a group of senior investigators. I am particularly familiar with this, as I recently finished training in such a program and have now joined in the responsibility for its management. It would be very difficult for the senior investigators under whose responsibility the fellow will work to supervise his training in any area other than that in which the investigators themselves are competent. This necessarily means that the problems that the fellow will be occupied with are problems familiar to the senior investigator. This allows the senior investigator to make helpful suggestions, avoid unnecessary errors for the fellow, increase the speed of learning of involved techniques, and so forth. Allowing the fellow complete freedom in his choice of problems, especially when he is beginning his training, often leads to an unhappy stage of floundering. While the bright and able fellow is often able to occupy himself profitably, by and large the newcomer has difficulty in getting into a profitable line of research. Besides being a most efficient method of training individuals in a chosen discipline which is of particular interest to the grantors, this is probably also the most efficient way of developing scientific maturity in young men. During the first year the fellow usually stays within certain guide lines, but the next years often find the more competent individuals picking up on their own. In many institutions this development is eagerly sought by the principal investigators.

The suggestion in the editorial that training grant funds be awarded to institutions rather than to competent scientists working in a particular field could well lead to chaos. The administrators of the institutions would soon find themselves in a position of having to pass judgment as to which laboratories were desirable places to which to assign trainees. This would not avoid what the editorial in *Science* wishes to avoid. In many instances, local politics rather than scientific capability could well determine the course of events.

Perhaps a more workable solution to the problem raised in the editorial could be achieved by more rigorous efforts during the grantor's visits to project sites to ferret out undesirable situations. Perhaps trainees could be asked to appraise various parameters of the program. Attempts of this nature at least would get at the problem raised in the editorial without destroying structure that has been beneficial in the past or creating local administrative problems that could bring about defeat of much of the program.

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