munication of feeling and the quest for meaning? This is obviously a rhetorical question, and its reverse is even banal. But it remains true that many people who ask and attempt to answer such questions in a professional capacity view with bitterness, disdain, and fear the interweaving of science and contemporary affairs. They are not inspired, but repelled, by the multiplication of choice. What Seaborg calls symbiosis, they call parasitism.

I suggest that, in spite of their tone, these are not irrelevant considerations. Science may have to enlarge its house, to accept that it is not a temple but a kind of rambling, unfinished, temporary shelter, to accommodate this problem.

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Mathematical Authorship

As a mathematician, I have been following the recent discussion about multiple authorship with a certain amount of smugness, since the problem hardly exists in mathematics. Joint authorship is not uncommon in mathematics, but it rarely extends beyond three authors, and the almost universal custom is for the authors' names to appear in alphabetical order. This is so well understood that no mathematician ever assumes that the first author is in any sense the principal one. Moreover, most mathematicians who write joint papers will refuse ever to say who contributed how much. It seems to me that Cleveland's suggestion (Letters, 12 June, p. 1295) that "authors' names should appear in the order of the magnitude of their contributions" would inevitably lead to bad feelings and would not really solve any problems; I hope it will not be taken seriously. I find it shocking that senior scientists are so hungry for credit that they must get their names on everything that they had a hand in. Surely mathematicians are no more altruistic and no less subject to "publish or perish" than other scientists, yet I know of plenty of cases where a senior mathematician has been content with a footnote of thanks instead of joint authorship.

As for papers with thirty or so authors, why cannot a group, even one of varying composition, adopt a collective name, as the Bourbaki group of mathematicians does? To a young scientist, it should be worth more than many individual publications to be able to have it said of him that he has been a member of such a group; an established scientist shouldn't care anyway.

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Overkill and the Defense Budget

The News and Comment article by D. S. Greenberg in the issue of 17 April (p. 271) requires correction.

1) The report *A Strategy for American Security* (Lee Service, 45 East 21 Street, New York, 1963, 50¢) prepared by six colleagues and myself is described in the article as a "disarmament proposal." The "maintenance-of-present-forces budget" proposed therein allowed for maintenance of all the present weaponry and manpower of U.S. armed forces. It would entail a reduction of about $22 billion in military spending, leaving $34 billion—which includes all personnel and operation and maintenance requests of the Department of Defense. Some persons may regard any reduction in a military budget as disarmament, but that is another matter. The maintenance of current U.S. military power is not disarmament.

2) In order to estimate the destructive capability of U.S. strategic forces we assumed that 20,000 tons of TNT-equivalent in the Hiroshima bombing destroyed 100,000 people. Greenberg says, "The generally accepted figure is 68,000—a fact noted for the sake of accuracy, not as a consolation." Since no one has ever observed a nuclear war, 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. Gauging the number of fatalities at Hiroshima involves this problem.

The U.S. Atomic Energy Commission (*The Effects of Nuclear Weapons*, 1962, p. 550) says that casualties at Hiroshima included 68,000 killed. The U.S. Strategic Bombing Survey reporting on *The Effects of Atomic Bombs on Hiroshima and Nagasaki* (1946, p. 15), stated that

> the exact number of dead and injured will never be known because of the confusion after the explosion. Persons unaccounted for might have been burned beyond recognition in the falling buildings, disposed of in one of the mass cremations of the first week of recovery, or driven out of the city to die or recover without any record remaining. No sure count of even the pre-raid population existed. Because of the decline in activity in the two port cities, with constant threat of incendiary raids, and formal evacuation programs of the Government, an unknown number of inhabitants had either drifted away from the cities or been removed according to plan. In this uncertain situation, estimates of casualties have generally ranged between 100,000 and 180,000 for Hiroshima . . . the Survey believes the dead at Hiroshima to have been between 70,000 and 80,000.

A Japanese study on *Atomic Bomb Injuries* (Nobuo Kusano, Ed., 1953, p. 60) accounted for 92,000 dead and missing by 2 February 1946, and further found that

> these figures do not include the deaths among the army in the city. According to information published later by Hiroshima City the number of dead, including those in the military employees and Army, and the injured who died in the meantime, is estimated at 210,000 to 240,000. Another estimate put the number of dead as 270,000.

The effect of a warhead like that used on Hiroshima is influenced by many factors—for example, population density, which is much higher in large modern cities. Estimates of deaths at Hiroshima range from 68,000 to 270,000. Deaths traceable to the Hiroshima bombing are still occurring and are not counted. Accordingly, we regard the figure of 100,000 fatalities at Hiroshima as one reasonable yardstick for estimating the destructive power of nuclear weapons.

3) In one of the short papers in the *Strategy* report, entitled "The Military Budget—Is There a Choice?" we presented the administration's defense budget for the fiscal year 1964, the maintenance-of-present-forces budget, and a finite-deterrent budget. The latter was given to illustrate a range of conceivable alternatives. We know from Jerome B. Wiesner that "studies made independently by the U.S. Army and Navy have indicated that, even in the absence of (international) agreement limiting force size and permitting inspection, 200 relatively secure missiles would provide an edequate deterrent." Your article describes the finite-deterrent budget as one "which would limit our military establishment simply to 200 secure missiles." The $9.2 billion of this budget estimate included $3.5 billion for military personnel, $4.2 bil-

lion for operating and maintenance, $1.0 billion for procurement of new material, as well as $500 million for atomic energy activities.

Greenberg makes much of the problem of estimating the number of weapons deployed in American strategic forces, and in this exercise draws generously from the Air Force release ("A Response to Professor Melman and 'Overkill'," 2 March 1964) prepared by Murray Green. In the name of this analysis (soon nullified by the data on U.S. arms superiority from Defense Secretary McNamara, 14 April, and President Johnson, 3 May) we are accused of "casual treatment of numbers." We used the best available nongovernmental estimates of American and Soviet strategic forces and gave the counts of U.S. military power a conservative bias by excluding from calculation the largest number of aircraft, all the intermediate and short-range missiles, and all the other devices that are useful for delivering nuclear warheads. To this partial statement of U.S. forces we applied an attrition factor of 50 percent to allow for losses of weapons from all causes. For Soviet cities of 100,000 population and over, the estimated overkill was 1250 times.

After this was published several people suggested that 50 percent attrition was not a sufficient allowance. I responded by allowing for 90 percent loss of aircraft and 75 percent loss of intercontinental missiles. The warhead power remaining after such extreme losses would amount to a factor of 231-times overkill on the industrial-population system of the U.S.S.R. These estimates were submitted in statements to the Armed Services Committees of the House and the Senate. The same analyses were published in the New York *Herald Tribune* (7 July 1963), but were not mentioned by your writer. Neither were these estimates mentioned in the 69-page Air Force "Response," which is nullified by the estimate of massive overkill after 90 and 75 percent attrition.

5) Large overkill *after* 90- and 75-percent attrition rates vitiates the meaning of the Air Force dispute as to how many missiles of each sort were in place in April 1963. Greenberg writes, "No more than half the bombers in Melman's retaliatory total are on short alert—and prudence therefore calls for considering the remainder unusable." During international crises the number and proportion of armed forces that are put on the highest levels of alert are dramatically increased. But suppose Greenberg's comment were correct, and suppose that meant a reduction of residual overkill capability by as much as 50 percent, to 115 times: between overkill magnitudes of 1250, 231, 115, and 1, there is no meaningful difference.

6) Greenberg writes, "Melman is satisfied that no defense is possible against missiles." I have no record or recollection of such a statement. Rather, we noted that destructive power can now be delivered by a great variety of weapons and that "all defensive strategies and technologies can be saturated, overwhelmed, or evaded by variety and quantity of offensive power. A 99 percent effective defense against overkill of more than 100 leaves overkill." Further large-scale military research or production is an exercise in futility. That is the reasoning which led us to recommend a military research budget of $262 million against the proposed budget of $7262 million.

7) Greenberg simply omitted reference to the largest part of the contents of our report—the nine papers (of eleven) concerned with depletion in various aspects of American life—traceable to our concentration of capital and technical talent on military work—and the discussion of what may be done to remedy these conditions.

8) The essential point is this: There is no conceivable technology for destroying a person or a society more than once. Accordingly, as a first step toward a rational security policy we should stop the research and production that piles up overkill, and turn these resources to productive use for our people.

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Since military technology changes rapidly, the unilateral elimination of virtually all U.S. military research and development, as proposed by Melman, is a "disarmament proposal," no matter how he dresses it up under the label of "maintenance of present forces." His contention that existing forces could be maintained despite a $22-billion reduction is so nonsensical that not even its imaginative author attempts to substantiate it. Furthermore, what's wrong with disarmament proposals?

Melman's analysis of the difficulties in assessing the fatalities at Hiroshima is touching, but tardy. *A Strategy for American Security* simply refers to "The bomb dropped on Hiroshima, which killed 100,000 people. . . ."

The "warhead power" described by Melman might indeed produce the "overkill" that he calculates—if it were directed at Soviet population centers. But if our warheads are aimed—as Secretary McNamara says they are—at military rather than civilian targets, Melman's arithmetic is of dubious validity. Soviet missile sites, airbases, and communications centers are presumably in lightly populated areas.

Melman suggests that during international crises more than half our bombers are on airborne alert. But what if war should occur without the warning of an international crisis? He doesn't say.

Although Melman says he has no "record or recollection" of having cast doubt on the possibility of defense against missiles, on page 3 of *A Strategy for American Security* he wrote: "Offensive capabilities have become so varied and deadly that there is no basis for assuming the feasibility of constructing reliable defensive methods against all possible warhead delivery systems."

Finally, Melman's goal of a disarmed world is admirable; his tactics are not, and can serve only to bring disrepute to a worthy cause.—D.S.G.

Overlooked Volcano

There have been a number of papers recently in *Science* (29 May, p. 1121) and elsewhere which attribute brilliant sunsets and allied phenomena to dust from Mount Agung in Bali.

I have no objection to attributing brilliant sunsets to Mount Agung, but I suggest that to attribute all these phenomena to it alone may indicate too restricted a view. Volcán Irazú in Costa Rica is a lot closer to us and has been in more or less constant eruption, emitting vast quantities of dust, since March 1963. I wonder if Agung is not being overworked and Irazú neglected.

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