Letters

Space Effort: The Third Culture

Growing opposition to the space budget, as reported by D. S. Greenberg [*Science* **140**, 790 (17 May 1963)], must remind many an amateur historian of previous occasions when fads were opposed by a body of sensible men: anatomy of the human body in medieval Italy, or sailing westward from Spain to India in 1492. Moreover, it is unfortunate that, just as we have become used to C. P. Snow's idea of "Two cultures," a third should appear on the scene to isolate one group of engineers from another. Hence this effort to find a common ground for reasonable discussion.

Between the new space-effort culture and the two older ones there are at least two communication bridges: (i) modern science and engineering has much to gain from billions of dollars spent on space technology, and (ii) the possible shift of national prestige symbols away from nuclear stockpiles should gladden the hearts of all but the most extreme anti-scientists.

The first bridge is closely associated with astronomy and astrophysics. Almost all the techniques involved in putting men on the moon are directly applicable to research of immediate importance: photography and spectroscopy of celestial objects from outside the earth's atmosphere, radio astronomy from the sheltered back side of the moon, samples of the unweathered lunar surface, magnetic and seismic data, lunar materials for use in deeper space probing, full sampling of meteoroids, and many others. It should be admitted that unmanned space-probes will be most suitable for several of these experiments, but the NASA programs (Orbiting Solar Observatory and Orbiting Astronautical Observatory) certainly allow this. The links with meteorology, geology, physics, chemistry, and even biology and psychology are clear enough that most professionals in these fields have an interest in one or more technical aspects of the space effort.

What about the charge that the man-in-space program is overfinanced, drawing many men away from more significant research effort? In the field of astronomy, again, this has already had drastic effect, but it promises also to attract a great many more young scientists into the field. After a brief shortage of professionally trained men, astronomy certainly stands to expand and prosper from the space age. Those who argue that there is only a limited supply of competent research talent to be divided between Culture Two and Culture Three should examine the wastage rates in the earlier years of our educational system and explain unemployment among high school and college graduates.

Because opposition to the space budget is mainly political in nature, the second bridge mentioned above (between Culture One and Culture Three) should be more fully exploited. There may well be other valid reasons for winning the "space race" than an orderly extension of scientific knowledge. The one proposed here is somewhat more subtle than bowing to popular demand; it rests on a pronounced trend in the recent history of international conflict, and the measure of a nation's power.

Technical advances are obviously involved, but in a way that has changed markedly in the last century or so, a period which saw development of artillery, tanks, battleships, submarines, airplanes, and missiles. It is easy to see the increase in tempo; the "lifetime" of weapons, or weapon-systems, has decreased from a matter of decades to that of years. Partly as a result of this, the military force-in-being lost importance as a measure of national power, and it is generally agreed (after the fact) that *industrial capacity* was a significant factor, if not decisive, in the two world wars. Naval tonnage, air squadrons, and standing armies are no longer a simple measure of national prestige and power.

But, since 1945, atomic weapons have brought back the simple measure of force-in-being—atomic stockpiles, plus associated delivery systems, are clearly used as the primary measures of a nation's importance today, though we hope that economic aid is also playing a role.

Now the space race, which has been taken seriously since 1957, offers the hope of a new area of international competition. It is *not* based on the repugnant goal of destructive power, and it has fired the imagination of more people than any one religion or political ideal. In the humanistic terms of Culture One, it provides a purpose comparable with that of the explorers of the 16th and 17th centuries; it complements our technological culture, provides a use for our over-productive labor force, and may make nuclear-tipped missiles as old-fashioned as battleships or castles on the Rhine.

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Operant Conditioning in Planaria: A Criticism

A report by Lee [*Science* **139**, 1048 (15 March 1963)] has suggested that planaria can be operantly conditioned. In the experiment, individual planaria were placed in a circular, clear dish in which a tiny photoelectric beam shown through the center. When the planaria moved through the photoelectric beam, a bright light shining on the animal was immediately shut off for 15 minutes. Since planaria prefer the dark, the shutting off of the light was considered a positive reinforcement.

Although the results were clear cut and objectively obtained, the interpretation of the data as demonstrating operant conditioning is debatable. As is well known, when planaria are exposed to bright light, they become active and seek a darkened area. When the darkened area is found, the animal usually reduces its activity and remains relatively inactive as long as it is not molested. When it is exposed once more to a bright light, it becomes active again and seeks a dark area.

Since the animal is in a restricted en-