short of the great man's is an absolute failure, he characterizes the young scientist as having "a self deceiving fantasy: that a life of science well may be tough for everyone else, but that it will not be for him," and as having "ambitious dreams; unspoken hopes of making great scientific discoveries; dreams of solving the great riddles of the universe."

Kubie states that the young scientist "dreams unattainable dreams." More directly relating his judgments to great men, he cautions against choosing science as a career, because of the "many failures it took to make one Pasteur." He states that most young scientists, in using great men as models, unwittingly set themselves up to become failures: ". . . most young men view their prospect solely by identifying with their most successful chiefs, never stopping to consider how many must fail for each one who reaches this goal." Without making the distinction between absolute and comparative failure, this last statement clearly implies the former.

Admittedly, from this standpoint many must fail and few will attain the stature of their models, but this is hardly a reason for dissuading young men from becoming scientists. The chance is slight that they will equal or surpass their models, but they should be informed that most can gain the fundamental degree of recognition indicated in my study as necessary for a promising career in science. Surely the career to which they commit themselves need not be, as Kubie says, "devoid of security of any kind, whether financial or scientific."

Furthermore, these young men should be encouraged to enter science and take great men as their models, for most will be the artisans who do the commendable, but not earth-shaking, research which accumulates to form the foundation for future decisive advances. Kubie himself has recently, although somewhat ambivalently, recognized this, in comparing the typical scientist with the internationally famous scientist (*8*): "These little known and unrewarded men are the expendables of science. They are no less essential than are the few who reach their goals. Therefore, until many years had passed it would be hard to weigh which of these two men had had the more profound impact on scientific knowledge."

Perhaps my discussion draws the kind of "implication" from "statistics" that Kubie is looking for in future research when he says in his article on the scientific career: "It is the . . . duty of scientists and educators to gather such vital statistics on the life struggles of a few generations of scientists and would-be scientists and to make sure that every graduate student of the sciences will be exposed repeatedly to the implications such data may have for his own future." Career decisions are perhaps among the most important determinants of a man's fate, and anything which contributes to an understanding of the career in science may help people make these decisions more wisely.

References and Notes

1. Merton accounts for this in the following manner: ". . . originality can be said to be a major institutional goal of modern science, at times, the paramount one, and recognition for originality a derived but often as heavily emphasized goal" [R. K. Merton, *Am. Sociol. Rev.* **22**, 640 (1957)].
2. B. T. Eiduson, *Scientists: Their Psychological World* (Basic Books, New York, 1962).
3. See O. Klapp, *Heroes, Villains and Fools* (Prentice-Hall, Englewood, N.J., 1962), pp. 18–24 for some functions of role models. I have reference to the function of "providing the individual with self-images and corresponding motivation."
4. In their comprehensive statement on careers, Becker and Strauss note the relative nature of failure: "Of course, failure is a matter of perspective. Many positions represent failure to some but not to others" [H. S. Becker and A. Strauss, *Am. J. Sociol.* **15**, 257 (1956)]. The relative nature of failure can be seen in marked contrast to its absolute nature when a person simply has failed to keep a position. On absolute failure, see E. Goffman, *Psychiatry* **62**, 451 (1952).
5. B. G. Glaser, *Organizational Scientists: Their Professional Careers* (Bobbs-Merrill, Indianapolis, 1964).
6. C. V. Kidd, *Personnel Admin.* **15**, No. 1, 16 (1952); W. Kornhauser, *Scientists in Industry* (Univ. of California Press, Berkeley, 1962), pp. 131–133.
7. L. S. Kubie, *Am. Scientist* **41**, 596 (1953); *ibid.* **42**, 104 (1954) [reprinted in M. R. Stein, A. J. Vidich, D. M. White, *Identity and Anxiety* (Free Press, New York, 1960) and in B. Barber and W. Hirsch, *The Sociology of Science* (Free Press, New York, 1962)]. The remarks by Kubie are based on 30 years' observation. He sees these observations as "random," but their consistently negative character suggests that, by and large, they are observations of his analysands and are random only in that context. My references are to but one short section of an excellent article.
8. ———, *Daedalus* **91**, 304 (1962).

News and Comment

JPL: Ranger VI Failure Increases Speculation on Jet Lab's Future Links with Space Agency, Caltech

Pasadena, California. The Jet Propulsion Laboratory (JPL) here, which is NASA's chief agent in the unmanned exploration of the moon, the planets, and interplanetary space, has lately been having some trouble with both its spacecraft and its image.

The Ranger VI spacecraft, which suffered an unscheduled TV power turn-on about 2½ minutes after it was launched and no turn-on in the crucial moments when it was approaching the moon, followed a series of five previous Rangers which had also encountered mishaps, although some of the earlier failures involved troubles with launching vehicles and guidance systems rather than the spacecraft themselves.

Ironically, Ranger VI appears to have performed its extremely difficult assignment admirably up until the big moment when the TV cameras were supposed to start sending back pictures of the lunar surface. No matter how near the miss, however, JPL's bad luck with the Rangers has to some extent diverted attention from the triumph of the Mariner II spacecraft fly-by of Venus and earlier achievements of JPL and California Institute of Technology, which manages the laboratory as a nonprofit institution.

NASA director James E. Webb, in a long Washington press conference devoted in substantial part to the unmanned program, made some remarks about the necessity of providing "a strong, hard-headed, industrial type of management of programs" for JPL. Newspapers in Southern California played up Webb's implied criticism, causing speculation about future NASA-JPL relations and anxiety among JPL wives.

Webb himself and Caltech president

Lee A. DuBridge soon dampened the fires of rumor with statements indicating that essential relationships between NASA and JPL-Caltech would be preserved.

Webb had made what some took to be an ominous reference to renegotiation of NASA's $1.2 million a year contract with Caltech for management of JPL, but also said in a less widely noted remark that "the experience of this whole period since 1958 will be incorporated in some new arrangements that will be probably more satisfactory from the standpoint of both Caltech and NASA."

The main points of the new contract have, as a matter of fact, already been settled, according to JPL director William H. Pickering, who says he sees no real obstacles to the renegotiation. The main change, and an important one, will be a modification of the mutuality provision of the contract which requires both JPL and NASA to approve tasks to be undertaken. NASA will in future have the decisive voice, or, as Pickering said: "It is a tighter contract than before; NASA will be more in a position to dictate tasks."

NASA, which owns the JPL facility, could bring in industrial management or make JPL a national laboratory, but such action seems unlikely for the reasons which moved NASA to establish a unique tie with JPL and its parent Caltech in the first place.

Early NASA Role

JPL has devoted itself almost exclusively to the unmanned portions of the national space program since shortly after the formation of the National Aeronautics and Space Administration in 1958. JPL had just teamed with the von Braun group at the Army's Redstone Arsenal in Huntsville, Alabama, to design and launch the nation's first orbiting satellite, Explorer I. And the lab was still carrying on the research and development work on guided missile systems which had grown out of its wartime work.

It is worth noting that when NASA adopted JPL and its Caltech management it was making the single exception to its rule not to create laboratories operated by universities and other nonprofit institutions. JPL is one of a kind for NASA, with a relationship to the space agency similar to that which the Lincoln electronics laboratory in Massachusetts bears to the Air Force.

Included in NASA's motives were not only a desire to keep a successful research combination going, but also to maintain a tie with Caltech, a distinguished scientific and technical institution which provides a conduit into the scientific community. NASA has consistently tried to encourage university scientists to participate in and support the space program. Webb in his press conference said it is necessary to involve "a number of eminent scientists to conceive of new experiments, to design the specific measuring equipment involved and a method to get the data back, and then to understand the data and publish scientific [results]."

JPL undertook administrative as well as technical supervision of contracts from the outset of its union with NASA, and as the size and complexity of the lunar and interplanetary program grew this dual responsibility became an acknowledged source of stress.

Growth of Staff

The JPL staff has grown from a total of slightly less than 600—142 of them scientists and engineers—in 1960 to something over 4000 today, with more than 1100 of them scientists and engineers. As the volume of subcontracting activities has grown, the number of upper level employees supervising contracts rather than conducting research has naturally also grown, and it is not difficult to find faculty at Caltech who feel that the administrative tail threatens to wag the research dog at JPL. Pickering and other JPL officials admit concern over the effects on the atmosphere at JPL, but point to measures taken to maintain important active "in-house" research projects and give them strong emphasis.

When JPL, under NASA, assumed responsibility for development of complex systems the lab was not, as a matter of fact, breaking with its past. It is true that JPL got its start in rockets and jet propulsion research—at that time viewed as rather eccentric—conducted by a group of scientists and graduate students headed by the now legendary Theodore von Karman, director of the Guggenheim Aeronautical Laboratory at Caltech. They conducted their experiments north of Pasadena in the Arroyo Seco, a rough and at that time desolate dry wash which was to become the site of the lab.

In 1939 a National Academy of Sciences grant of $10,000 for work on rockets to assist Army Air Corps planes to take off set the group on the road which led to development of the jet-assisted takeoff (JATO) units for military planes in World War II.

JPL became a major Caltech project during the war. Much productive work was done on rockets and propellants, and by the end of the war the lab was engaged in R&D work on guided missiles.

After the war, while many of the staff went back down the hill to Caltech, JPL continued as a research facility under the Caltech aegis, with Army Ordnance acting as the lab's primary federal patron. The lab did pioneering work on telemetry and in the late '40's undertook to develop the Corporal research rocket into a tactical weapon system. This meant complete system responsibility for JPL, down to writing the training manuals; hence JPL got extensive experience in managerial collaboration with industry. JPL then went on to develop the Sergeant, the nation's first "second generation" missile.

The lab in the mid-50's had proposed wedding a cluster of Sergeant missiles to an Army Redstone missile to serve as a launching vehicle for an orbiting satellite. This proposal was sidetracked in favor of the Navy's Vanguard program. When, however, the Soviet Union's Sputnik I was launched and Vanguard ran into trouble, the JPL-Huntsville proposal was revived and produced the Explorer I orbiter.

Moon Exploration

With the agreement between NASA and JPL that unmanned exploration of the moon and the planets was a suitable task for the lab, JPL's objectives became much more difficult to accomplish. As in most phases of the space program, it appears that most people connected with the unmanned program underestimated both the complexity and the cost of the undertaking.

Webb estimated in his press conference that NASA payments to JPL will amount to $200 million in the current year. JPL, however, will in turn pay out about 75 percent of this to subcontractors. JPL does not build Rangers, Mariners, or other spacecraft; rather, the lab designs them, assembles them from components built by industry, and then checks and launches them.

After the Ranger V failure, a NASA review panel investigated the Ranger program. The Karth subcommittee of the House Science and Astronautics Committee was briefed on the panel's findings and the congressional unit made known that the study committee urged application of industrial management techniques to the Ranger program (*Science*, 27 Dec. 1963, p. 1636). The report was never made public, however, and it was never made clear which aspects of management were under fire.

More NASA criticism of JPL management after the Ranger VI failure brought to public attention what are essentially—in aerospace jargon—"interface" problems involving industry, NASA, JPL, and Caltech. What has developed could be an instructive case study in an increasingly important and touchy area of government-industry-university relations.

Some observers in and out of JPL trace the difficulties of the program for unmanned flight back to its beginnings. Plans were made in the late '50's which still strongly influence what JPL does, and these plans were made when there was no commitment to a manned landing on the moon. The manned and unmanned plans have never been meshed successfully, these observers say.

They add that NASA officials did not appreciate the complexity of the projected unmanned program and point to the fact that initial plans called for much more extensive operations than those undertaken.

Budget Problems

While the unmanned program was premised on straining the state of the art in space instrumentation, it is clear that many JPL scientists feel that the channeling of resources into the Apollo manned program has straitened the unmanned program.

Their argument adds up to a claim that the probability of success would be decidedly enhanced if more money and, therefore, more spacecraft were available to accomplish specific objectives. And, incidentally, unit costs would go down. Achieving what space engineers call "reliability" in a new system is difficult and usually involves many failures, they say, and they point to the early epidemic of misfortunes with earth satellite launches, which were much simpler operations than the Ranger and Mariner launches.

Comparison with the successful Mercury manned-satellite program is unfair, they suggest, because of the greater investment in Mercury and because of the greater demands imposed by a longer mission depending exclusively on instruments in a much smaller package.

Sensitivity to criticism within JPL arises in good measure from a sincere feeling that the difficulties and risks of the unmanned program are not sufficiently understood. Among faculty at Caltech there is some concern that criticism of JPL will reflect unflatteringly on Caltech, and this seems to have increased tension between JPL and Caltech a little.

University scientists concerned with the unmanned program seem generally to feel that JPL scientists are competent, but it is not difficult to find those who say that many NASA-JPL decisions are questionable. One Caltech faculty member pointed out that it would have been possible to get pictures of the moon with spacecraft much less complicated than Ranger. And another scientist, not from Caltech, said that, in the case of Ranger, "failures are to be expected but not failures without explanation." He criticised the failure to use telemetry to monitor power levels in Ranger VII so that it was "virtually impossible to tell what went wrong." This was not a matter of reliability, he said, but of "bad design."

Scientists in universities and the nonprofit institutions do not express great enthusiasm for the idea of overall management by industry of such projects as Ranger. They say that most corporations do not in fact have and cannot afford large groups devoted to basic research and that industry experience in imparting reliability to complex systems is based on production of large numbers of units, as in the case of missiles. This experience is not applicable to the unmanned program, they say.

NASA itself roundly criticized industry's performance last year in a stinging report on poor quality and low reliability of components delivered for the Mercury program, and Admiral Rickover has had the same sort of thing to say about industry's failure to meet the exacting specifications set for contractors on the Navy's nuclear program.

Industry, however, will get a broader test of its prowess, for the Surveyor spacecraft, the Rangers' successor, will be built by Hughes Aircraft, which will have a greater measure of management responsibility than any contractor to date.

NASA itself is working to develop a cadre of managers in its own organization, but first-class managers are proving hard to find for everybody, including industry, which can pay higher prices.

The result of what was first billed as a managerial crisis over Ranger is not likely to be clear-cut. JPL is seeking to strengthen its management corps, and NASA's reins on JPL and the lab's links to industry are likely to be tightened.

Meanwhile Ranger **7** is at Cape Kennedy and its TV cameras are at RCA in New Jersey, and everybody concerned is hoping that the next Ranger mission won't make the interface red.—JOHN WALSH

Population: New U.S. Interest in Offering Assistance Reveals Lags in Underdeveloped Nations

With "research into problems of population growth" now a duly legalized part of the foreign aid program, the Agency for International Development (AID) is beginning to grapple with one of the most curious paradoxes of population control—namely, that many of the countries that need it most are yet to rank it very high in their priorities of national concern.

In most cases, it is true, these countries have placed themselves formally and conspicuously behind population planning programs, and their national leaders have repeatedly issued expressions of alarm and demands for action. But anguished oratory and tables of organization are quite different from effective programs, and this is becoming increasingly apparent as the change in the American climate of opinion (*Science*, 20 Dec. 1963, p. 1554) makes it much easier for this country to offer assistance abroad. This situation is now demonstrating that it is difficult to give when the other party is not fully of a mind to receive.

Persons directly associated with the problem are not inclined to discuss it publicly, since many political and social sensitivities are involved in one nation's imploring another to limit its population growth. But within the U.S. government there is the feeling that the political leadership of many of the overpopulated and underdeveloped countries has simply not owned up to the gravity of their population problems.

Examples in support of this conclusion are not difficult to find. In one major nation, where the national leadership regularly produces admirable