6. C. Tanford, *J. Amer. Chem. Soc.* **84**, 4240 (1962).
7. E. D. Korn, *Annu. Rev. Biochem.* **38**, 263 (1969).
8. V. T. Marchesi and E. Steers, Jr., *Science* **159**, 203 (1968).
9. S. H. Richardson, H. O. Hultin, D. E. Green, *Proc. Nat. Acad. Sci. U.S.* **50**, 821 (1963).
10. M. Ashwell and T. S. Work, *Annu. Rev. Biochem.* **39**, 251 (1970).
11. D. Haldar, K. Freeman, T. S. Work, *Nature* **211**, 9 (1966); E. D. Kiehn and J. J. Holland, *Proc. Nat. Acad. Sci. U.S.* **61**, 1370 (1968); D. E. Green, N. F. Haard, G. Lenaz, H. I. Silman, *ibid.* **60**, 277 (1968); S. A. Rosenberg and G. Guidotti, in *Red Cell Membrane*, G. A. Jamieson and T. J. Greenwalt, Eds. (Lippincott, Philadelphia, 1969), p. 93; J. Lenard, *Biochemistry* **9**, 1129 (1970).
12. J. K. Blasie, C. R. Worthington, M. M. Dewey, *J. Mol. Biol.* **39**, 407 (1969).
13. D. Bownds and A. C. Gaide-Huguenin, *Nature* **225**, 870 (1970).
14. B. Ke, *Arch. Biochem. Biophys.* **112**, 554 (1965).
15. M. Glaser and S. J. Singer, *Biochemistry* **10**, 1780 (1971).
16. J. M. Steim, M. E. Tourtellotte, J. C. Reinert, R. N. McElhaney, R. L. Rader, *Proc. Nat. Acad. Sci. U.S.* **63**, 104 (1969).
17. D. L. Melchoir, H. J. Morowitz, J. M. Sturtevant, T. Y. Tsong, *Biochim. Biophys. Acta* **219**, 114 (1970).
18. D. M. Engelman, *J. Mol. Biol.* **47**, 115 (1970); M. H. F. Wilkins, A. E. Blaurock, D. M. Engelman, *Nature* **230**, 72 (1971).
19. M. E. Tourtellotte, D. Branton, A. Keith, *Proc. Nat. Acad. Sci. U.S.* **66**, 909 (1970).
20. A. A. Benson, *J. Amer. Oil Chem. Soc.* **43**, 265 (1966).
21. D. Triggle, *Recent Progr. Surface Sci.* **3**, 273 (1970).
22. H. U. Schairer and P. Overath, *J. Mol. Biol.* **44**, 209 (1969).
23. G. Wilson and C. F. Fox, *ibid.* **55**, 49 (1971).
24. J. Lenard and S. J. Singer, *Science* **159**, 738 (1968); G. Vanderkooi and D. E. Green, *Proc. Nat. Acad. Sci. U.S.* **66**, 615 (1970).
25. W. L. Hubbell and H M. McConnell, *Proc. Nat. Acad. Sci. U.S.* **61**, 12 (1968); A. D. Kieth, A. S. Waggoner, O. H. Griffith, *ibid.*, p. 819.
26. R. L. Steere, *J. Biophys. Biochem. Cytol.* **3**, 45 (1957); H. Moor, K. Mühlethaler, H. Waldner, A. Frey-Wyssling, *ibid.* **10**, 1 (1961).
27. D. Branton, *Annu. Rev. Plant Physiol.* **20**, 209 (1969). J. M. Wrigglesworth, L. Packer, D. Branton [*Biochim. Biophys. Acta* **205**, 125 (1970)] find no evidence by freeze-etching for the existence of the stalked-knobs on mitochondrial inner membranes that are observed with negatively stained preparations.
28. M. E. Bayer and C. C. Remsen, *J. Bacteriol.* **101**, 304 (1970).
29. P. Pinto da Silva and D. Branton, *J. Cell Biol.* **45**, 598 (1970); T. W. Tillack and V. T. Marchesi, *ibid.*, p. 649.
30. P. Pinto da Silva, S. D. Douglas, D. Branton, *Abstracts of the 10th Meeting of the American Society for Cell Biology, San Diego, Calif., November 1970* (1970), p. 159; T. W. Tillack, R. E. Scott, V. T. Marchesi, *ibid.*, p. 213.
31. T. L. Steck, G. Fairbanks, D. F. H. Wallach, *Biochemistry* **10**, 2617 (1971).
32. M. S. Bretscher, *Nature* **231**, 225 (1971); *J. Mol. Biol.* **59**, 351 (1971).
33. G. L. Nicolson and S. J. Singer, *Proc. Nat. Acad. Sci. U.S.* **68**, 942 (1971).
34. G. L. Nicolson, S. P. Masouredis, S. J. Singer, *ibid.*, p. 1416.
35. G. L. Nicolson, R. Hyman, S. J. Singer, *J. Cell Biol.* **50**, 905 (1971).
36. R. E. Lee and J. D. Feldman, *ibid.* **23**, 396 (1964).
37. F. A. Green, *Immunochemistry* **4**, 247 (1967); *J. Biol. Chem.* **243**, 5519 (1968).
38. W. C. Davis and L. Silverman, *Transplantation* **6**, 536 (1968); T. Aoki, U. Hämmerling, E. de Harven, E. A. Boyse, L. J. Old, *J. Exp. Med.* **130**, 979 (1969).
39. A. Shimada and S. G. Nathenson, *Biochemistry* **8**, 4048 (1969); T. Muramatsu and S. G. Nathenson, *ibid.* **9**, 4875 (1970).
40. J. K. Blasie, M. M. Dewey, A. E. Blaurock, C. R. Worthington, *J. Mol. Biol.* **14**, 143 (1965).
41. M. M. Dewey, P. K. Davis, J. K. Blasie, L. Barr, *ibid.* **39**, 395 (1969).
42. J. K. Blasie and C. R. Worthington, *ibid.*, p. 417.
43. R. C. Warren and R. M. Hicks, *Nature* **227**, 280 (1970).
44. C. D. Frye and M. Edidin, *J. Cell Sci.* **7**, 313 (1970).
45. L. Mindich, *J. Mol. Biol.* **49**, 415, 433 (1971).
46. R. D. Poretz and I. J. Goldstein, *Biochemistry* **9**, 2870 (1970).
47. R. G. Drysdale, P. R. Herrick, D. Franks, *Vox Sang.* **15**, 194 (1968).
48. G. L. Nicolson and S. J. Singer, in preparation.
49. E. H. Eylar, M. A. Madoff, O. V. Brody, J. L. Oncley, *J. Biol. Chem.* **237**, 1962 (1962); E. L. Benedetti and P. Emmelot, *J. Cell Sci.* **2**, 499 (1967).
50. G. L. Nicolson and S. J. Singer, in preparation.
51. V. T. Marchesi and G. E. Palade, *J. Cell Biol.* **35**, 385 (1967).
52. R. K. Kornberg and H. M. McConnell, *Biochemistry* **10**, 1111 (1971).
53. M. M. Burger and A. R. Goldberg, *Proc. Nat. Acad. Sci. U.S.* **57**, 359 (1967); M. Inbar and L. Sachs, *ibid.* **63**, 1418 (1969).
54. M. M. Burger, *ibid.* **62**, 994 (1969).
55. B. Sela, H. Lis, N. Sharon, L. Sachs, *Biochim. Biophys. Acta*, in press; B. Ozanne and J. Sambrook, *Nature* **232**, 156 (1971).
56. S. Hakamori and W. T. Murakami, *Proc. Nat. Acad. Sci. U.S.* **59**, 254 (1968); P. T. Mora, R. O. Brady, R. M. Bradley, V. M. McFarland, *ibid.* **63**, 1290 (1969); C. A. Buck, M. C. Glick, L. Warren, *Biochemistry* **9**, 4567 (1970); H. C. Wu, E. Meezan, P. H. Black, P. W. Robbins, *ibid.* **8**, 2509 (1969).
57. T. L. Benjamin and M. M. Burger, *Proc. Nat. Acad. Sci. U.S.* **67**, 929 (1970).
58. T. R. Podleski and J.-P. Changeux, in *Fundamental Concepts in Drug-Receptor Interactions*, D. J. Triggle, J. F. Danielli, J. F. Moran, Eds. (Academic Press, New York, 1969), p. 93.
59. M. Nomura, *Proc. Nat. Acad. Sci. U.S.* **52**, 1514 (1964).
60. D. Epel, B. C. Pressman, S. Elsaesser, A. M. Weaver, in *The Cell Cycle: Gene-Enzyme Interactions*, G. N. Padilla, G. L. Whitson, I. L. Camerson, Eds. (Academic Press, New York, 1969), p. 279.
61. M. Sonenberg, *Biochem. Biophys. Res. Commun.* **36**, 450 (1969); *Proc. Nat. Acad. Sci. U.S.* **68**, 1051 (1971).
62. W. A. Cramer and S. K. Phillips, *J. Bacteriol.* **104**, 819 (1970).
63. J. P. Changeux, J. Thiéry, Y. Tung, C. Kittel, *Proc. Nat. Acad. Sci. U.S.* **57**, 335 (1967).
64. J. Eckfeldt, G. G. Hammes, S. C. Mohr, C. W. Wu, *Biochemistry* **9**, 3353 (1970).
65. D. F. Silbert and P. R. Vagelos, *Proc. Nat. Acad. Sci. U.S.* **58**, 1579 (1967).
66. E. A. Boyse and L. J. Old, *Annu. Rev. Genet.* **3**, 269 (1969).
67. E. F. Terroine, C. Hofferer, P. Roehrig, *Bull. Soc. Chim. Biol.* **12**, 657 (1930); G. Frankel and A. S. Hopf, *Biochem. J.* **34**, 1085 (1940).
68. M. Sinensky, *J. Bacteriol.* **106**, 449 (1971).
69. G. L. Nicolson, *Nature* **233**, 244 (1971).
70. R. B. Taylor, W. P. H. Duffus, M. C. Raff, S. dePetris, *ibid.*, p. 225.
71. The original studies reported in this article were supported by grant GM 15971 from the National Institutes of Health (to S.J.S.).

NEWS AND COMMENT

The Soviet Space Program: Effort Said to Surpass Peak U.S. Level

A new and authoritative study of the Soviet space program indicates that, while American space efforts continue winding down toward the last Apollo flight this year, the overall Soviet space program remains "a strong and growing enterprise," its ambitions unhindered by budgetary strain and undimmed by the deaths of three cosmonauts last year.

The study,* produced for the Senate Committee on Aeronautical and Space Sciences by analysts in three divisions of the Library of Congress, concludes that the current level of Soviet space activity exceeds that of the United States at its peak in 1966. The space study also indicates that the Soviet Union is almost certainly pressing ahead —cautiously but intently—with a manned lunar program that may be expected to put cosmonauts on the moon in the mid-1970's and possibly as early as 1973. A related conclusion, perhaps the most surprising of the 670-page study, is that the Russians may end up spending the equivalent of $49 billion to land men on the moon, far more than the cost of the Apollo program.

Whether or not the Soviets actually carry through with their evident intentions, the study goes on, "it is not possible to establish that the Russians have invested smaller total resources in lunar exploration than the United States" even though the Soviet effort "has not produced the visible result in this regard which the United States has achieved." These and other findings stand in direct contradiction of assertions by Soviet

* " Soviet Space Programs, 1966-70" Report of the Committee on Aeronautical and Space Sciences, prepared by the Science Policy Research Division, Foreign Affairs Division, and the European Law Division, Library of Congress; available from the Government Printing Office, Washington, D.C. 20402, $3; stock number 5271-0263.

officials that, for the present, they favor the use of unmanned lunar and planetary spacecraft for reasons of safety and economy.

Such conclusions might ordinarily be cause for suspicion as to motives, coming as they do at a time when the National Aeronautics and Space Administration's budget is effectively on the skids and its gaze is being directed away from the stars and down toward the earth's more prosaic domestic problems. The study was, after all, commissioned by the Senate space committee, whose sympathies generally lie with NASA.

But whatever credibility the study may lose by its sponsorship should be more than recouped by its authorship. It was directed, illustrated, and to a great extent written by Charles S. Sheldon II, the chief of the Science Policy Research Division of the Library of Congress and its senior specialist in space and transportation technology. Over the past decade Sheldon has made a career out of watching the Soviet space program. On the strength of his past performance, and that of the science policy division, the new study deserves close attention.

This is the third such analysis of Soviet space efforts Sheldon has directed since 1962, and it is unquestionably the definitive work in this area, at least in public print. Like the previous two, this study is based on unclassified American and Western European sources and on information released by the Soviet Union and Eastern European news media, but outside sources say it also benefits in perspective from the main author's access to classified data.

As for punditry, the space study has already scored one high mark: Sections written before the Soviets launched two probes toward Mars last year predicted that such launches would take place, went on to nearly guess the weight of the two probes, and correctly anticipated what they would do when they reached the planet.

Steering clear of any prescriptions for the U.S. space effort, the study makes a stab at comparing the size of the two space programs—an effort fraught with difficulties, not the least of which are a nearly total lack of useful Soviet budget figures and the fact that the value of the ruble varies from one sector of the Soviet economy to another. By the Soviet effort's visible dimensions, however, it appears that the "total level of Soviet space activity and total level

HEW Study on Financial Distress in Medical Schools

A Department of Health, Education, and Welfare (HEW) task force on medical school funding has produced an astringent "Financial Distress Study" which clearly has distressed some partisans of increased federal assistance to the financially hard-pressed medical schools.

The HEW intradepartmental group emphasizes that its study should be regarded only as a "status report," but there is nothing tentative in its complaint that data on medical school costs are so inadequate that no really complete analysis of financial problems is possible. The group also makes no bones about seeing a pattern of poor management in the medical schools and an accompanying unwillingness to make structural changes to correct organizational weaknesses. In addition, the reader gains the distinct impression that the group is impatient because the financial problems of the medical schools are being blamed on the costs of educating students for the M.D. degree when they believe it is the cost of other kinds of teaching, research, and patient care which are really causing the trouble.

Critics Dispute Analysis

Critics of the report seem to react most strongly to this point. They argue that separating the costs of educating students for the M.D. degree from the costs of other activities in the health science center, which is the setting for the medical school, is based on a false definition of modern medical education.

The study on the need for emergency financial assistance for medical and dental schools was called for in the Health Training Improvement Act of 1970 and was due for delivery to Congress last 30 June. It was released without fanfare last December and got little attention during a period when Congress was going and Christmas was coming. Little effort seems to have been made to call it to congressional attention. As one outside observer put it, "Nobody was out hawking it on street corners," and those working for increased federal support of medical education were obviously relieved that the study did not appear when health education aid legislation was before Congress, since they assumed that it would not have helped their cause.

The report, on balance, is not hostile to federal aid. Its recommendations do ask for better data-gathering and better management in the health science centers but also warn of possible adverse effects of pending legislation and point to inadequacies in present federal programs which provide financial support to medical education. At the same time, the study does leave the impression that medical schools/health science centers are inefficient and perhaps are even hiding something.

Part of the impression is conveyed by the report's spare, staccato style and its tendency to raise an important question, note that factual evidence is lacking, and thereby leave the question hanging.

For example, the study quotes from the book *Financing Medical Education* which Rashi Fein and Gerald I. Weber wrote for the Carnegie Commission on Higher Education, to the effect that there is an "excessive allocation of medical school resources to the research function with a consequent adverse effect on the attention of the medical school toward the provision of services." Taken out of context, this has an accusatory ring, whether intended or not.

The report was produced by a seven-man group chaired by Robert C. Harris, of the HEW comptroller's office. A range of professional expertise is represented in the task forces membership, and the two M.D.'s in the group were balanced by an accountant and an auditor. It is not surprising, therefore, that the HEW study reveals an interest in cost accounting not common in previous efforts on the subject.

The study, as a matter of fact, consists of two general sections. The first is a survey of the general topography

of hardware commitment is running higher than did the U.S. program at its peak in 1966." Drawing on Defense Department analyses of the Soviet economy, the study indicates that funding for military and civilian space ventures is equal to about 2 percent of the U.S.S.R.'s gross national product (GNP). The overall U.S. program, by comparison, peaked at 1 percent of the GNP and is now down to about one-half percent.

The study deals gingerly with the sensitive question of who is ahead of whom in what respect, although the United States does seem to have eked out and maintained a marginal supremacy in the technology of large booster rockets.

In the early years of the space age, the U.S.S.R. held the upper hand with its large and rugged "A" vehicle, the first stage of which developed 1 million pounds of thrust. This was the original Soviet ICBM. It launched Sputnik 1, and improved versions are still the mainstay of the Soviet space program. The heftiest launch vehicle in the Soviet stable, however, is now the "Proton" booster, roughly the equivalent of the infrequently used American Saturn 1-B. Even after 6 years of use, though, Proton's reliability still leaves something to be desired, and only last year did any evidence appear to suggest that the Soviets had begun to use liquid hydrogen and oxygen in its upper stages. What's more, there is evidence that Russian missilemen are still trying to fly their ledendary "G" rocket, a colossal booster with a first stage that is supposed to produce substantially greater thrust than the 7.5 million pounds of the Apollo moon rocket, Saturn V.

As for an alleged computer gap between the two nations, this seems to be more a problem of production and bureaucratic bungling than laggard technology. The space study reports Soviet complaints that a number of general purpose computer systems have turned out to be incompatible with one another—that a design philosophy of "each for himself" seems to prevail among the various ministries. And there is a dearth of computers available for lower priority space program tasks such as processing scientific data, as well as a "grave" lack of programmers. Nevertheless, the space program has not fared badly, as one might surmise from the ability of ground controllers to dock two orbiting spacecraft (Kosmos 186

Focuses on Shortcomings in Data Showing Cost Allocation

of health science center problems. It documents, for example, the increase in the ratio of faculty to students in medical schools during the 1960's and notes that this is attributable mainly to the growing enrollments of residents, graduate students, and fellows who take a relatively greater share of faculty time.

The study observes by quoting the available literature that faculty are attracted by opportunities to provide advanced training in their own fields and that this is true in both the basic and clinical sciences. And it describes the anomalous situation created by federal research policies under which much of the teaching is done by faculty members who spend a much greater portion of their time on research.

The heart of the study, and the part which seems closest to the hearts of the task force members, however, is a discussion of cost allocation studies in which medical schools try to tell where the money really goes.

Medical schools receiving funds are required to account for the use made of these funds, but so far the federal camel doesn't seem to have its nose very far under the tent. The task force did, however, make a close study of 11 cost allocation reports filed by medical schools/health science centers, and these formed the main basis of the group's conclusions on costs.

The 11-school sample included only schools classified as financially "distressed," but the distribution of costs in various sectors of expenditures seems to differ only a few percentage points from those shown in a pilot study of several centers with assorted financial situations. The 11-center study showed an average expenditure of 22.4 percent of the budget for instruction, 20.3 for research, and 57.3 for patient care.

Even allowing for the report's admission of the difficulties of separating the costs of instruction, research, and patient care, the assertion in this section which is likely to be most quoted and controversial is that ". . . after adjusting to eliminate large items of unrestricted income such as State appropriations which have been allocated in a manner to simply cancel out functional deficits, the severity of financial difficulty directly related to 'undergraduate M.D. instruction' is at least open to question."

In reply to this and other assertions in the report, the Association of American Medical Colleges (AAMC) is preparing a detailed analysis of the study to submit to Congress. An AAMC spokesman said his organization views the study as "an honest effort to understand the problem," but is critical of the study's measuring the cost of medical education while there is no real agreement on the experience necessary to qualify an individual for an M.D. degree. "Our basic concern," he says, "is that they do not allow basic limitations of the measurement process to prevent them from drawing fundamental conclusions."

More on Subject Coming

More on the subject is certain to be heard from the AAMC and its allies and also when a major study of the cost of educating manpower in the major health professions is completed. This study, required in the Comprehensive Health Manpower Act passed last year, will probably be carried out by the National Academy of Science's Institute of Medicine, if negotiations prosper, and is due in 1973.

Meanwhile, the HEW task force report is likely to affect the dialogue on aid to health education in Congress and elsewhere because it focuses not on the very real financial needs of health education institutions but on questions of unit cost and of how extensive and expensive the "educational environment" of a health science center should be. And these questions are awkward ones since there are at present no really solid data to consult—JOHN WALSH

Table 1. Summary of Soviet and U.S. payloads by mission.

Mission	Soviet		United States						
	1971	Cumulative	1966	1967	1968	1969	1970	1971	Cumulative
Earth orbital science	7	57	17	12	16	14	4	11	137
Earth orbital engineering	0	0	1	6	1	5	1	10	50
Communications	3	23	11	19	11	6	6	6	83
Weather	4	21	6	6	4	3	5	4	49
Navigation/ferret	27	84	4	3	1	0	1	0	25
Geodesy	0	0	4	1	1	1	1	0	17
Military observation:									
Low orbit recoverable	28	202	23	19	16	12	9	7	198
Low orbit nonrecoverable	12	70	12	7	7	11	4	6	77
Intermediate orbit	0	4	3	0	0	0	0	0	10
Synchronous or higher	0	0	0	2	1	3	5	1	18
Fractional orbit bombard	1	17	0	0	0	0	0	0	0
Military inspector/destruct	8	25	0	0	0	0	0	0	0
Earth orbit man-related	2	20	6	1	0	1	0	0	11
Earth orbit manned	3	19	5	0	0	0	0	0	14
Lunar man-related	0	8	1	1	2	0	1	3	13
Lunar manned	0	0	0	0	2	8	2	4	16
Moon—unmanned	2	25	4	8	1	0	0	0	21
Venus	0	17	0	1	0	0	0	0	2
Mars	5	10	0	0	0	2	0	1	5
Interplanetary	0	0	1	1	1	0	0	0	5
Vehicle tests	0	0	2	0	0	0	0	0	13
Subtotal	102	602	100	87	64	66	39	53	764
Orbital launch platforms*	7	59						0	0
Total	109	661	100	87	64	66	39	53	764

* Earth-orbiting vehicles used to launch lunar and planetary probes.

and 188), to run three manned missions simultaneously (Soyuz 6, 7, and 8), and to produce full-color, real-time displays of computer graphics at mission control centers.

In the field of civil applications, the study comments, "the Russians were latecomers . . . but the next several years should see distinct improvements" in satellite systems for weather observation communications. As for unmanned research satellites, "the level of activity currently runs ahead of the corresponding level of work in NASA." And whereas the United States "once could pride itself as having made a larger number of significant contributions (in basic space sciences), this leadership seems likely to pass" to the Soviet Union.

Beyond these general comparisons, one of the space study's most valuable contributions is a detailed unraveling of the intimate relationship between Soviet military and civilian space programs. The study indicates that, probably for practical reasons, the Soviets have made little effort to separate the two. Strategic Rocket Troops still conduct all space launches, for example, and the three Soviet launch sites serve both military and civilian programs—all of which helps explain why the entire Soviet space program remains as secretive as it is.

Nowhere is this commingling more evident than in the Kosmos program of unmanned earth satellites, nearly 500 of which have been launched since 1962. If one accepts the Soviet news release issued on the occasion of the first Kosmos launching and reiterated each time since, these have all had purely scientific missions. As one might suspect, this is not quite so.

Sheldon and his group provide a brief accounting of the probable missions of every known Soviet launch that achieved earth orbit. From this compendium it is evident that, along with bona fide scientific satellites, the Kosmos program consists of unmanned tests of spacecraft destined to carry cosmonauts; lunar and planetary probes that failed to leave earth orbit (the most recent of these was Kosmos 419, a Mars probe that flopped last May 10); and most of all, accounting for 80 percent of the Kosmos payloads, military R & D and observation satellites.

Orbiting spies make up the bulk of the Kosmos program, and by all indications they are not difficult to identify. They consistently follow similar orbital paths and they have the habit of remaining aloft for 8 to 13 days before plunging out of orbit conveniently over the customary Soviet recovery area in Kazakhstan—only to be replaced by another Kosmos. Presumably they carry the same sort of film packets which U.S. Air Force planes periodically snag in midair over the Central Pacific.

To further complicate Kosmos, it appears that some ordinary scientific and navigation satellites also carry military "ferret" gear, for eavesdropping on Western communications and radar. Still further, the study builds a compelling though circumstantial case to show that the Kosmos series has included no less than 17 tests of a Fractional Orbital Bombardment System (FOBS) and 25 tests of an experimental spacecraft evidently designed to inspect and destroy other nations' observation and navigation satellites.

In discussing these tests, Sheldon tends to corroborate statements by the Defense Department that a Soviet FOBS weapon is operational and that work on military inspector–destroyer satellites is proceeding apace. There is no public evidence that the United States has pursued similar lines of development; nor is there reason to believe, Sheldon emphasizes, that any of the Soviet tests involved nuclear material or in any way violated the international treaty banning weapons testing in space.

One satellite, however, may have been a test dummy of an orbital bomb carrier. This was Kosmos 316, chunks of which fell on Oklahoma, Texas, and Kansas in August of 1970. During its flight the previous December the satellite had resembled both a FOBS warhead and a maneuverable "police" satellite. What remained of it on the ground consisted of oddly thick slabs of metal which some analysts privately interpreted as being weapons-related.

The Library of Congress study also treats manned Soviet flights at length. Laced through these dicussions are some anecdotal footnotes to the history of man's first experiences in space, among them the misadventures of Voskhod 2. Piloted in 1965 by Pavel Belyayev and Aleksey Leonev, this flight is remembered mainly for having achieved the first "space walk." Less fondly, Soviet sources recall that a malfunction in Voskhod's retrorockets forced a landing hundreds of miles off target, in an isolated pine forest in the Taiga region west of the Urals. A full day passed before rescue teams could locate the errant spacecraft, hack their way through the forest, and bring the crew out on skis. All the while, the cosmonauts were kept at bay in their cramped quarters by howling wolves.

A Frustrated Race to the Moon

Most intriguing of all, though, is the study's answer—speculative as it is—to the lingering question of whatever happened to Apollo's presumed competition. Was there ever really a race to the moon? Sheldon and his group are convinced that there was: "There seems ample evidence [from] throughout the several middle years of the 1960's that the Russians thought they would be first to land men on the moon. They were used to being first. . . ."

What apparently dashed this hope was a series of technical setbacks between 1967 and the summer of 1969 that bedeviled the development of manned lunar spacecraft and the rockets that were intended to launch them. As Apollo scored one success after another in 1968 and 1969, leading up to the first manned landing in the summer of 1969, the Soviet program is believed to have fallen far behind schedule. Accordingly, this line of reasoning goes, Soviet space planners pushed their moon program to a back burner and stepped up manned earth-orbital efforts instead.

The Library of Congress study infers this sequence of events from what it admits is scanty evidence—some of it in the form of statements by Soviet officials and boastful hints dropped by cosmonauts, for which there is little hard, supporting information. Still, this analysis has a ring of plausibility.

Several possible scenarios of Soviet plans and the events that spoiled them are offered. The one the study favors runs like this:

A landing on the moon was seen by Soviet space officials as a "real goal" as early as 1953. Concrete planning began in the aftermath of Yuri Gagarin's triumphant first orbit of the earth in 1961. The lunar plans that resulted are thought to have involved first building a family of spacecraft capable of taking two or more men to the vicinity of the moon—but not to its surface—and back to earth. At the same time various unmanned spacecraft would practice soft landings on the moon. These would deliver roving vehicles to the lunar surface, bring back token samples of rock, and, in time, carry animals to the moon and back. All of this would be followed by a second and larger kind of manned spacecraft, launched by the huge "G" rocket and intended to put cosmonauts in orbit around the moon, and later, directly on it.

Bits and pieces of this program have, in fact, been accomplished. Four "Zond" spacecraft, described by the Soviets as capable of carrying men on lunar flyby missions, did skim past the moon and return to earth in unmanned test flights between 1968 and 1970. Two or three attempts have been made to grab lunar soil samples and return them to earth by means of unmanned landers. (Luna 15, which crashed on the moon during the Apollo 11 mission in 1969, may have been one of these failures, although Sheldon is inclined to the view that it was "on a one-way trip," perhaps to deliver a lunar rover.) In 1970, Luna 16 did retrieve a quarter pound of lunar soil for Soviet scientists. Late the same year Luna 17 carried the eminently successful Lunokhod I to the Sea of Rains.

But in the face of this success there is good reason to believe that things did not proceed at the pace the Russians had hoped they would. For example, British radar measurements suggest that two "Kosmos" launches in March and April of 1967 were actually unmanned tests of Zond capsules that failed wholly or in part, thereby scotching Soviet hopes of sending men around the moon and back in time to celebrate the 50th anniversary of the Bolshevik Revolution that November. By this analysis, delays in the Zond program and the unreliability that plagued its Proton booster may have led the Soviets "well in advance of 1969 to settle for a less ambitious program than a manned lunar landing before 1970." Even that less ambitious goal—a manned circumlunar flight—"lost its urgency when Apollo 8 was put into lunar orbit" on Christmas eve of 1968.

If this reasoning is correct, the study comments, certain remarks by cosmonauts early in 1969 may be taken to suggest that Soviet plans were in such a state of flux that even the cosmonauts themselves were unsure whether they would be flying around the moon or landing on it (or neither) by the end of the year.

To further confuse matters, the study goes on, it is "conceivable" that some space engineering group continued working toward a lunar landing on the chance that the Apollo timetable would slip by 2 or 3 years, particularly if Apollo 11 failed. In that event, a Soviet landing mission would have required the extraordinary feat of at least three successful preliminary flight tests of the G vehicle. The study gives substantial credence to rumors current in 1969 that at least one such test that summer failed. And none is known to have succeeded.

Armstrong, Aldrin, and Collins ended the contest in late July of 1969, and almost immediately some American analysts detected a shift in Soviet space priorities. New emphasis was placed on manned missions in earth orbit, leading eventually to a permanent space laboratory. The manned Soyuz program was resumed after a long delay. In October, Radio Stockholm reported M. V. Keldysh, president of the Soviet Academy of Sciences, as saying, "We no longer have a timetable for manned moon trips."

Down but Not Out

Despite these demurs, however, the space study concludes that "there is not enough evidence to prove that plans to land on the moon have been abandoned. The safest presumption would be that if 10 years of work have gone into preparing hardware and facilities and plans for a lunar landing [then] some effort is continuing."

What of the future? Prognostications here are subject to all the usual pitfalls of Kremlinology, but a few relatively safe bets can be advanced.

Spectacular achievements in the near future are seen as hinging on the success or failure of the G booster or something like it. Unless the Soviets turn to the more cumbersome and costly technique of assembling numerous pieces of equipment in earth orbit, advanced boosters are probably essential to manned lunar missions and to the most prominent Soviet dream, a large, manned laboratory in near-earth space. The deaths of three Soyuz 11 cosmonauts last year may delay such a sta-

tion, but 1974 is still considered a possible date for this counterpart to the U.S. Skylab, scheduled to fly next year. Soviet officials are also said to be showing increasingly keen interest in building a reusable space shuttle.

Further studies of the moon are foreseen as continuing along the lines of the current Luna series, featuring lunar orbiters, rovers, and samples returners. An advanced booster might permit combining the latter two missions into one soft-landing spacecraft.

As for planetary probes, the congressional analysts predict a continuation of a large Soviet commitment to this program, partly for the sake of science and partly to convey the impression that the solar system is a "Soviet pond." Little Russian enthusiasm has been detected for sending a leapfrogging spacecraft on a Grand Tour of the outer planets, but a flyby mission to Jupiter, comparable to Pioneer F, set for launch this month, is probable. So is a race with the U.S. Viking spacecraft, which is to land on Mars in 1976 to televise pictures of the landscape and look for signs of life. Viking, the study predicts, "may be beaten in time, if not in overall quality and amount of data returned."

Whether or not this makes any difference is another question. But it seems safe to say that the space race is alive and moderately well at Tyuratam, Kapustin Yar, and Plesetsk, if not at Cape Kennedy. Most assuredly, Sheldon writes, "the Soviet program is not a sham. It may be exploited for political purposes, but it is real and it is pursued in earnest."—ROBERT GILLETTE

Human Environment Conference: Search for a Modus Vivendi

London. As the U.N. Conference on the Human Environment draws closer, the problems of organizing a massive international meeting on such a politically touchy subject become increasingly apparent. As well as a diplomatic dispute over whether East Germany should have full representation at the Stockholm conference, there are also sharp divisions over the seriousness of environmental problems —and hence over the importance that should be attached to the conference.

The first problem continues to be the most important. Although East Germany appears likely soon to become a full member of the United Nations, it remains until then in a kind of international limbo. The U.N. General Assembly last October turned down an attempt to extend invitations to the conference to all de facto governments, favoring instead what is known as the Vienna formula. This admits countries that are full members of the United Nations or that belong to one or more of the associated international agencies. By this reckoning, East Germany is out and West Germany is in, by virtue of its belonging to several of the international agencies.

Followers of the late John Foster Dulles no doubt find the dispute satisfying, but it has brought environmentalists close to despair. East Germany is a major industrial power and a major polluter; by all logic it should have a place at Stockholm. Worse, the dispute also includes the Soviet Union, which has already refused to take part in the preparation of the Declaration on the Human Environment, an environmental bill of rights that is supposed to climax the Stockholm meeting.

Official British spokesmen are at pains to appear reasonable. "This is not an attempt to exclude East Germany," one of them told *Science*. "The British government, with France, West Germany, and the U.S., has made it clear that some formula should be found to allow East Germany to participate fully in the conference, though not on the basis of full parity."

One such formula, the Foreign Office spokesman suggested, would be for East Germany to be invited to send a team of scientific experts to the conference. The conference organizers feel, however, that it would make little sense to send scientists to what is billed as a political conference. Nor, for the same reason, is it likely that the conference could be downgraded into a symposium—a form of meeting that escapes the full rigor of diplomatic protocol. This has already happened once, when the East Germans turned up in Prague at a preparatory meeting organized by the Economic Commission for Europe and were allowed to stay only on condition that the "conference" became a "symposium." By such niceties cold warriors are kept happy.

For the conference proper, it is very doubtful that the Swedish government would be willing to accept such a face-saver. "The Swedes won't wear it" was the comment of one U.N. man. As instigators and hosts to the conference, the Swedes are in a fairly strong position to impose their own view. "They would be frightfully disappointed if the diplomatic problems did disrupt the conference" is the view of a source at the Swedish Embassy in London. "I'm sure they are trying very hard to go ahead with a full-blooded conference."

A more satisfactory solution to the impasse would be to elect East Germany to one of the international agencies before the Stockholm conference begins in June. The World Health Organization has a meeting in May, for example, but has not put the question on its agenda. Another possibility would be for East Germany to be quickly elected a member of the International Atomic Energy Agency.

The amount of pressure the Soviet Union is prepared to exert on behalf of the East Germans is still not clear. Although the Russians have refused to help draft the conference declaration, they have not yet refused to turn up at the last of the preparatory meetings, to be held in New York from 6 to 17 March. So it is not yet clear whether they will definitely withdraw from the conference if East Germany is not seated on a parity with West Germany. The Foreign Office view seems to be that the Russians will back down, par-