IN-12
55650
18P.

NASA TECHNICAL MEMORANDUM NASA TM-77717

A NEW DAY: CHALLENGER AND SPACE FLIGHT THEREAFTER

Jesco von Puttkamer

Translation of "Ein neuer Tag: Challenger und die Raumfahrt danach," NASA Headquarters, Washington D.C., February 11, 1986 pp. 1-11

(NASA-TM-77717) A NEW DAY: CHALLENGER AND SPACE FLIGHT THEREAFTER (National Aeronautics and Space Administration) 18 p CSCL 22A

N87-16856

Unclas G3/12 43928

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 MARCH 1986

A NEW DAY:
CHALLENGER AND SPACE FLIGHT THEREAFTER

Jesco von Puttkamer

On January 28, 1986, mankind lost the space shuttle Challenger and her crew: Dick Scobee, Mike Smith, Judith Resnik, Ellison Onizuka, Ron McNair, Christa McAuliffe and Gregory Jarvis. /1*

At an altitude of 14 kilometers, the spacecraft was torn apart by an explosion of the 47-meter-long external tank filled with liquid hydrogen and liquid oxygen. The explosion in turn was triggered by a flame shooting from the starboard solid fuel booster rocket; it must have acted like a cutting torch on the cell structure of the tank.

For us, the accident and its aftermath have been NASA's darkest hours. The families of the crew were hit hardest, as the catastrophe took place before their eyes. On a very personal level, shock, pain and a feeling of helplessness were inconceivably hard and brutal for us all. There were tears and nightmares. The shuttle teams in Florida, Alabama and Texas are still under a cloud of depression and mourning.

It was not the NASA family alone, but the family of mankind throughout the world that was deeply saddened and had to deal with lasting shock and grief. We get letters every day, even from the Eastern block. The worldwide echo confirms what astronauts and cosmonauts have told us all along: There is only one Earth, and from the perspective of space it has no artificial

---

*Numbers in the margin indicate pagination in the foreign text.

borders.

NASA has never underestimated the risk of space flight. When Armstrong and Aldrin landed on the moon's surface in July 1969, it was no secret how much might have gone wrong, leaving the crew to a slow death in the Sea of Tranquillity, with no hope of rescue. The explosion of the oxygen tank of Apollo 13 drastically illustrated how uncompromising space can be when humans are negligent. Yet Apollo 14, 15, 16 and 17 still followed. Each orbital flight of astronauts and cosmonauts implicitly involves the risk of a failure of the recovery systems. The men and women flying in the shuttle are true heroes. They are aware of the risks of a mission in space. Their training lays great emphasis on emergency and rescue /2
maneuvers, on the great "what if...". They know that in space the smallest error can often be fatal. And they know that in some situations there can be no rescue. For most of them, this thought pales into insignificance next to the certainty that they are participating as true pioneers in the greatest adventure of modern times: Shattering the two-dimensionality and the fetters of our existence to give mankind a powerful new chance for the future, for the survival and growth of coming generations. More about this a little later.

A small part of ourselves died with the crew of 51-L. And within us there is anger at human imperfection. But there is rebirth. A top-notch organization, mourning, shaken by the realization of its imperfection, has gone back to work.

We have to go on. The problem will be corrected and we will fly again. As James Michener, America's foremost author of historical best-sellers, told us on television the morning after the accident: "This is a new day. Get on with it!"

It was expressed best on February 5 by the courageous words of the families of the crew:

"The 51-L Crew families want to thank the people of our country and all the countries of the world for their thoughts, their feelings and words of encouragement.

"Space flight serves as an outlet for our human need to learn and expand. What's out there will make our lives better on Earth and help satisfy mankind's natural curiosity to explore and push the borders of the 'known universe.'

"So that their lives were not lost in vain, we must rededicate ourselves to the exploration of space and to keep the dream alive."

In polls, three-quarters of the U.S. population warned, "Don't let their sacrifice be meaningless!," supporting an increase in manned space flight after the accident. "Christa would have wanted it that way," say the letters from the classrooms, including from teachers. When President Reagan visited Thomas Jefferson High School in Annandale, Virginia, on February 7, he had to promise the students and teachers that he would increase manned space flight, not cut it back. Donations, which by law must be "unconditional," arrive here from everywhere, to help NASA pay for a new shuttle. One week after the accident, the fund for the 11 children of the late astronauts already amounted to over $ 200,000.

Space flight after Challenger -- what are the prospects?

The effects of the accident are undoubtedly far-reaching; they have broad repercussions that also affect NASA's international partner organizations. One example is the large ESA /3 solar probe Ulysses, which was to be launched this May from the Challenger. The entire space program has temporarily ground to a halt. The next three shuttle flights up to the end of May have been officially postponed, and it may be that the ban on flights will continue for another 6 - 9 months. Right now all our forces are concentrating on determining the cause of the accident. The investigations by NASA and the independent special committee appointed by Reagan, led by William P. Rogers, former Secretary of State under the Nixon Administration, will find out how a leak could possibly have developed in the centimeter-thick stainless-steel wall of the booster casing -- whether perhaps the torch-like flame might have escaped through a failure of the seals between two of the four booster segments. How could the built-in safety factors, which were considered conservative, have been compromised? The results of these investigations will determine when NASA can resume flight operations with the remaining space shuttles Columbia, Discovery and Atlantis.

The sight of the fireball with the monstrous claw, suddenly appearing before our incredulous eyes in the deep blue Florida sky 73 seconds after launch, is indelibly imprinted in the minds of those people working on the resumption of shuttle operations. That resumption will not be premature. We will only fly again when confidence in the shuttle system is restored. Although the accident again, tragically, demonstrated the inherent risk of all means of transportation built by human hands, and not just of space flight, the previous record of the US space program shows how flight safety and the survival of the astronauts have always been NASA's highest priority.

Since 1961, in the evolution of programs from Mercury through Gemini, Apollo, Skylab and ASTP to Space Shuttle, a total of 55 manned American space flight missions had been flown before Challenger's last flight, including nine moon missions and six moon landings, carrying 196 astronauts into space. They logged a total flight time of 11,500 hours and covered over 272 million kilometers without losing a single human life.

This listing includes 24 missions of the space shuttle itself -- nine of them flown by Challenger, before fate overtook it. In its almost five years of operation it not only became a valuable tool for space exploration and the development of new technologies to improve and enrich human life on Earth, but also developed very rapidly into a diplomatic instrument of foreign policy, with which the USA can clearly demonstrate its readiness to allow its allies to participate in the opening of the new frontier of space.

/4

With the development of the shuttle, NASA provided a transport system based on the accumulated experience of 25 years of manned space flight, and embodying the quintessence of American advanced technology. Its development itself caused a spurt of technological growth that has benefited other branches of industry and business. Still greater significance attaches to the new initiatives that the shuttle made possible in numerous technical, scientific, commercial and finally general cultural sectors.

The first five years of shuttle operation were rich in high points and firsts that contributed to constant improvement and increase in the capacity of the transportation system, on the one hand, and of our useful applications of space, on the other hand.

In 1983, for example, a platform built by German industry was first carried by the shuttle into space and -- more significantly -- retrieved again. A second mission with the SPAS space platform came the following year. The shuttle/SPAS combination expanded the development of retrievable space platforms and thus set its mark on future satellite technology. Other cornerstones of future satellite technology which will be to our decisive advantage in a larger context in the economic opening of space, were successfully tested in later shuttle missions. In February

1984, astronaut Bruce McCandless was the first man to walk in space without a lifeline, and tested a new portable maneuvering device with which he flew as far as 100 m from the orbiter Challenger. Satellite repairs in space were the task of a mission in April 1984. In August, an experimental solar cell support over 30 m long, to generate energy in space, was launched from the shuttle payload area and tested. Refueling satellites with dangerous hydrazine propellant was practiced by Kathryn Sullivan and David Leestma in October 1984, and the retrieval and recovery of satellites was demonstrated superbly by Joe Allen and Dale Gardner in November 1984, with the capture of the two malfunctioning communications satellites Palapa B2 and Westar VI.

Ten shuttle missions were launched in 1985 alone. Among other things, they successfully delivered ten commercial communications satellites and the flew German D1 mission. The shuttle crews included participants from Canada, Mexico, Australia, France, Saudi Arabia and the Federal Republic of Germany, as well as the first representative of the general public, U.S. Senator Jake Garn. During one mission, 51-I, the communications satellite Syncom IV-3 was repaired in space, and during 61-B the two experiments EASE and ACCESS were combined into large framework elements in orbit.

/5

The flight of the first German, Ulf Merbold, into space in November 1983 was also notable as the maiden flight of the Spacelab space laboratory. It represented Europe's entrance into manned space flight. This was undoubtedly an irreversible step and a fantastic achievement by ESA. Certainly, the cost of tuition in Spacelab was high on both sides of the Atlantic, but we learned from it, and the value of this learning process for future projects can hardly be stated in D-marks.

Spacelab was the first large-scale technical project in history on which eleven European countries collaborated peace-fully through thick and thin for a decade. From the technical point of view, the Spacelab-1 mission was 98% successful; from the economic viewpoint it was better than 90% successful. With this considerable success, Europe additionally demonstrated convincingly that in future manned space programs, the European Community can be a technically full-fledged, credible partner; in this respect Spacelab was the admission ticket to the exclusive world of manned space flight. Thus the combination of the American shuttle and the European space laboratory made up a worthwhile whole that served peaceful progress. This flight combined the best qualities of Europe and the United States, over 50 aerospace and electronics firms, and numerous universities with hundreds of scientists all over the world.

In clear recognition of these points and of the opening chances for taking the lead in European manned space flight, the Federal Republic of Germany decided to pursue Spacelab utilization on a national scale with at least two missions of its own, D1 and D2. D1 was launched on October 30, 1985, with the German astronauts Reinhard Furrer and Ernst Messerschmid on board, along with the Dutchman Wubbo Ockels. The successful seven-day mission served to execute experimental programs in basic scientific research and technological development, whose results feed into application-oriented studies. It involved 64 participating scientists from the universities and technical universities of Aachen, Berlin, Bonn, Clausthal, Frankfurt am Main, Freiburg im Breisgau, Erlangen/Nürnberg, Giessen, Hamburg, Mainz, Munich, Stuttgart and Tübingen, the Research Institutes of DFVLR (German Aerospace Research Establishment in Cologne and Oberpfaffenhofen, the Max Planck Institute in Stuttgart, the Battelle Institute, and the firms Krupp, MAN, SEL and Wacker. Also involved were scientists from other European countries and the USA.

The second mission, D2, had been scheduled for 1988 until the Challenger disaster. At present it is unclear how the loss of the orbiter, which had already carried "Deutschland 1", will affect the German program. It is certain that NASA will spare no effort to give the highest possible priority to further participation by other countries in the shuttle program. More than /6 ever, the Earth's peoples will have to rely on each other from now on in space as well as on Earth, if we want to produce a human-space integration model that means a better future for everyone. It is therefore my most deepest hope that in West Germany as well, the government's readiness to participate and the German public's positive attitude towards manned space flight will not lose through the Challenger disaster any of the strength and trust that supported us so well before our tragic loss.

Beyond the projects of the near future, it can hardly be expected that NASA's long-term plans will be particularly affected by the fate of the Challenger. If the current analyses show that the shuttle fleet, which has shrunk by one quarter, is insufficient for the space program requirements of the 1990's, NASA will doubtless order a new orbiter. Some of the larger cell parts of such a craft have already been produced. Conversion of the booster rockets to new spun fiberglass casings will increase the capacity of the system. Some relief may additionally be provided by a new unmanned carrier rocket planned by the US Air Force, which would leave us more leeway in scheduling manned and unmanned missions.

At the top of the priority list for future NASA projects is naturally the manned space station, which President Reagan's directive of January 25, 1984 committed us to develop by the end of 1994; nothing in this will change. So NASA's course is set until the end of the twentieth century -- a momentous step that places mankind on the threshold of a new age, the age of human life and work in space.

The space station will be built by civilian NASA for the peaceful use of space. It is not to be an exclusively American institution, but an international one in whose construction the US has invited friendly nations to participate. The German initiative to participate in its development represents a remarkably far-sighted decision of historic significance. The decision of the Federal Cabinet means that the high technology of manned space flight will be a future focus of research and development in the Federal Republic as well.

The NASA space station is designed first of all as a research and production facility for assignments in materials research, biosciences, space science, earth observation and communications technology. It will furthermore allow the introduction of new processes to routinely open up space near earth, such as the operation of continuously maintained larger observation stations, as well as the supplying, overhauling, equipping and preparation for launch of space platforms and reusable drive systems, the construction of larger support structures and the manufacture of industrial products.

/7

These possibilities make the space station the next logical step in the socio-technological development of mankind. If one considers space a new frontier to which the shuttle provides access, the space station becomes necessary as a focal point for research and development of this frontier, as an operations center for the continuing exploration of the unknown, and as a primary aid in expanding our knowledge. But as always in the transformation of frontier into cultivated land, a synergy must take effect here, a collaboration in which space flight projects relate directly to earthside problems, and thus over the longer term also make it possible to undertake further projects in space. Neither can proceed without the other. Space is the future of mankind, in more than just the technological sense, and its inclusion in our ecosphere yields a new closed system with feedback or control circuits.

It would therefore be a mistake to view the space station and its infrastructure as an end in itself or a final goal, in the sense of a more traditional space project such as the Moon landing in the Apollo program. Rather, it is a means to an end. At first a unique workshop for industrial and experimental purposes in space near the earth, its significance will also grow from its necessary key position for the more remote future. If we shut our eyes to this, we vastly underestimate its significance. For a manned platform in space is not only a research and production project with considerable possibilities for technological progress, which is its original function, but is also a springboard for further projects in space. It will become the bridgehead and launching point for space flights in the outer reaches of geostationary space, and some day for the departure of mankind for support points in the solar system. For the later 1990's, we expect a growth phase in the course of which the initial station called for by President Reagan will increase in size, crew and range of functions. From it we will not only routinely launch, supply and repair other space systems, but also support traffic to and from other space bases. And it will eventually serve as a "transfer station" for flights to destinations far from earth, such as the Moon and Mars, and for the further exploration of space by mankind.

By the year 2000, we will be able to traffic human crews routinely (that is, safely, successfully, punctually and economically) not only between the Earth's surface and near-Earth orbits, but also in the geostationary range, between different orbits, and finally -- after 2000 -- over distances to the Moon and between planets.

In time, we will also see the increasing importance of high-capability robots -- automatic systems standing at mankind's side in space, so as to improve our lot on Earth and help open up new goals in space. There can be no doubt that with the development of the uninterrupted settlement of space by mankind, more /8 than ever there will be room for both people and "intelligent" machines in space and -- through the transfer of technology -- on Earth. Machines will by no means replace people in space, but will relieve us from repetitive, monotonous, routine and especially dangerous duties, to free us for more productive undertakings.

The number and relative ratio of people and machines active in space industries, science and other enterprises in space, will depend largely on the costs of transport and the necessary capabilities in each case -- such as reaction time. Thus one must expect the optimum division of labor in this partnership between people and the various kinds of robots to shift in the direction of an increasing demand for people as transportation costs drop. To this is added the typical human trait that in no case will people allow themselves to be deprived of the adventure of lending a hand anywhere they can in space. The Challenger disaster will change nothing in this. I have long had no doubt that the industrialization of space will not only create new markets and more jobs on Earth, but also that many of the space industries in the decades ahead will need highly qualified workers in inhabitable orbiting facilities.

An especially significant task of the more remote future, one in which the space station will be needed as a springboard, will be the landing of humans on Mars, as Wernher von Braun proposed back in the early 1970's. A manned expedition to Mars would be an extraordinary technical challenge, involving a technological push such as we can hardly conceive today. Still more significant in the long run would be the international collaboration on a large, possibly even global scale, required by a program of the dimension and pan-cultural significance of a manned expedition to Mars. It might even make space flight into a potential "war substitute," as visionaries imagined in the past. Today, these long-term development possibilities are receiving increasing attention as objects of study at NASA.

The positive effects of space flight -- seen as a means, not an end -- are multiple. It provides motivations and applications on both the material and the intellectual and humanistic-social levels. An example of materialistic utilization is the opening of possibilities for innovative industries in space; one intellectual use would be new scientific discoveries in cosmology, and probably the most compelling example of a humanistic-social use would be the potential for international collaboration and promotion of peace through space flight. Its future trends clearly aim to realize these useful applications on the broadest possible fronts. /9

It would be arrogant of us to believe that it will cost us nothing to achieve this future. By the same token, the sacrifice of the Challenger Seven was not meaningless. Indeed, it will certainly, felix culpa, have positive consequences for us in many respects. One very significant one can already be seen in the response of the public: The question of the fundamental purpose of manned space flight, which their heroic death has made the focus of extended publicity. Previous reasons -- "To win the East-West space race," "To commercialize space and make money," "To keep our own national economy from falling behind in high-tech competition" -- are all well and good: They may apply in one way or another. But it would be a demeaning dismissal of the sacrifice of the Challenger Seven to understand the significance of the space program solely from these more superficial viewpoints. People will want a deeper reason. And that is a good thing. Manned space flight can finally only be explained from deeper cultural-philosophical motives.

Above, I said that the sense of the Challenger sacrifice ultimately grows out of the significance of space flight for the survival and growth of mankind. Looking farther into the future, mankind will be confronted with new and largely unpredictable complexes of problems. To master them, though, the human race will also have capabilities that are not necessarily available or even known to us today. These include the new potentials of space flight. As much as we would like to be, we cannot be specific and concrete enough to make clear decisions -- that would only be naive. But we do clearly recognize one duty incumbent upon us, standing head and shoulders above the others: That in planning our agenda for tomorrow, we must leave open the greatest possible variety of options for the people of the 21st century. This is because in the human growth process, alternatives are a fundamental prerequisite for individual freedom of choice. So it important that through short-sighted and self-centered actions or inactivity today, we must not cut off access to alternatives that may seem desirable tomorrow. Any short-sighted restriction or curtailment of still-open alternatives for cultural growth is a crime against future generations. So space flight must continue.

Always in the past, when in the course of socio-cultural development human beings have had a choice of alternative paths, a key element has been to set up transportation centers or "collection points" with their technical and social infrastructures. Although on the one hand we clearly recognize the /10
significance of the availability of options for future humanity, yet on the other hand can say little about the specific nature of these alternative paths, we nevertheless can make a significant contribution today by focussing on these centers for evolving technical possibilities and infrastructures. This is accomplished by shuttle missions like 51-L.

In near and farther space, there are preferred points which seem appointed by nature to be such centers -- in especially low orbit, in geostationary orbit, at some of the libration points of the Earth-Moon system or the Trojan points, on the Moon, on Mars and its moons Phobos and Deimos, etc. In the spirit of the visions of space pioneers like Konstantin Ziolkowski, Hermann Oberth, Robert Goddard, Wernher von Braun, and more recently especially Krafft Ehricke, with all due sobriety I am still fully convinced that for its survival and growth mankind must develop by one or more alternative routes in the direction of a solar civilization built on an economic system of successive opening up of extraterrestrial forces, energies and raw materials. The first steps to explore such extraterrestrial situations are accomplished by missions such as the Challenger.

The worldwide shock triggered by the disaster has drastically shown how fully space flight has become a routine part of human awareness. Yet it was notably more powerful than comparable dismay at airplane crashes with hundreds, or earthquake ~~capacities~~ catastrophes with thousands of victims, or at the roughly 50,000 traffic deaths annually on America's highways.

The response of the world's public to the fate of Challenger showed clearly that today, space flight is no longer just a marginal phenomenon of our culture, involving only a few specialists and dreamers. It must be understood as a cultural process of the first rank, not merely as spectacular technology. The latter is just a structure, like an airplane. We must learn that we must not view structures not as given and unchangeable, but as a manifestation of an underlying process. We do not bring static structures into the world; we initiate dynamic processes. Transformation and change -- the decline of old and rise of new structures -- never takes place without sacrifice and pain. Nor has space flight been spared from this principle of life's system dynamics. The recognition of space flight as a cultural process must especially find a place in schools and universities. Teachers must have the possibility for re-education and continued

education, through the development of consistent programs that allow the new knowledge of system-oriented thinking, the increased understanding of the complexity of the third millennium of our era, to be included in syllabi and lessons. If this does not happen, our young people will at best be educated for the /11
year 1986, but not for the year 2000 and after. And that would be catastrophic, for besides creating our future large-scale technical and scientific systems, we must also create the integrated human being of tomorrow, who understands how to live with such systems. Our survival is at stake.

This is the deeper reason why we have sought early participation by education in the shuttle program. This is why the participation of teacher Christa McAuliffe in the 25th shuttle flight into space was so important. She had a crystal-clear understanding of her role and significance for the future of American education. "I touch the future. I teach," she said in a speech in August of last year. Her fate as a pioneer has won immortality for her, and will make her a quasi-archetypal symbol of the "teacher of tomorrow." And for that reason she, especially, did not die in vain.

The idea of stopping manned space flights because of the Challenger disaster is therefore as absurd as the notion that the first settlers in North America should have stopped their westward expansion because of their great losses of men, women and children. The idea contradicts our innermost essence as human beings. For the knowledge that progress into the unknown never happens without bitter sacrifices is as old as the human race itself. It is one our most ancient realizations, a part of the prehistoric knowledge of our unconscious, from which it emerged even in ancient times as myths: Prometheus, Icarus and Daedalus, Odin's agonizing invention of runes, human sacrifice as the counter-payment for rebirth and fertility, etc. No, a better future will not be given us for free; it must be hard-won.

The disaster was bitter, but will not make us bitter; it will make us stronger. There is no turning back.

Four days after the catastrophe, a memorial service was held at the Kennedy Space Center in Florida. At the time of the explosion, 11:39 a.m., a moment of silence was observed, as it will be on the anniversary of the disaster from now on, as long as the NASA center exists. In the devotional silence, a helicopter dropped a wreath over the Atlantic. As the wreath hit the waves, several dark heads surfaced nearby: a school of dolphins, who seemed to salute the garland.

Some of us here would like to think there were seven of them.

February 11, 1986

STANDARD TITLE PAGE

1. Report No. NASA TM-77717	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle A NEW DAY: CHALLENGER AND SPACE FLIGHT THEREAFTER		5. Report Date March 1986
		6. Performing Organization Code
7. Author(s) J. von Puttkamer		8. Performing Organization Report No.
		10. Work Unit No.
9. Performing Organization Name and Address Leo Kanner Associates, P.O. Box 5187, Redwood City, CA 94063		11. Contract or Grant No. NASW-4005
		13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, DC 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "Ein neuer Tag: Challenger und die Raumfahrt danach," NASA Headquarters, Washington D.C., February 11, 1986, pp. 1-11

16. Abstract

The significance of Challenger and its projected aftermath are discussed in an article for the general public.

17. Key Words (Selected by Author(s))	18. Distribution Statement Unclassified - unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22.
Unclassified	Unclassified	18	