Baseline Program

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Assumptions

The workshop agreed to use a proposed NASA plan as the baseline program. This assumed program has been developed from several sources of information and is extrapolated over future decades using a set of reasonable assumptions based on incremental growth. The principal source of basic data was a presentation given to the workshop by Jesco von Puttkamer, representing NASA's advanced planning activities. This work shows the space program planning efforts divided into four domains (fig. 1). Future activities are planned with balanced emphasis among these four domains.

It was considered reasonable to assume that the level of activity would remain constant in order to stabilize the use of public resources. This assumption resulted in a sequence of programs with waxing and waning budget requirements. As one program decreases in construction and development costs and becomes operational, public resources are made available for the next program. This approach levels the impact on facilities and capital investments and maintains a skilled and experienced work force.

As for budget estimates, only low to moderate growth after adjustment for inflation was assumed. A key principle underlying the proposed program is that maximum benefits will be obtained from commonality and subsystem evolution. Technologies and program elements will be synergistic and integrated to allow one project to use capabilities developed by another. In addition, the NASA planners tried to make realistic and practical estimates of the technology developments required to support each phase of design and construction. Using this information and previous history on the programmatics involved in the development of space hardware, NASA constructed a phased, evolutionary set of scenarios that we consider reasonable.

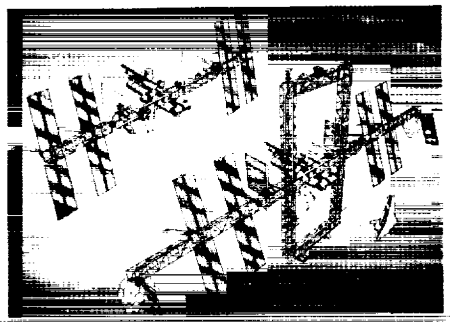
To summarize, the assumptions for the NASA baseline program are as follows:

- Balanced emphasis in four domains
- Constant level of activity
- Low to moderate real budget growth
- Maximum use of commonality
- Realistic and practical technology development

Figure 1

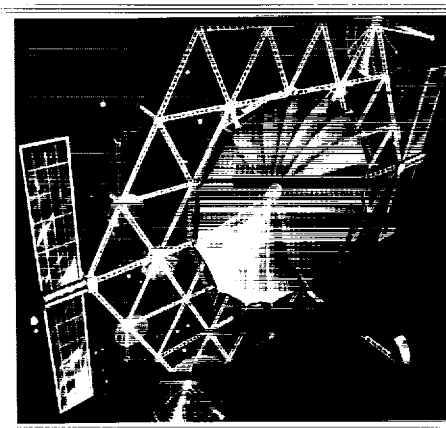
NASA's Advanced Planning

NASA is planning a balanced program, with roughly equal emphasis given to each of four domains. The first domain is low Earth orbit (LEO). Activities there are concentrated on the space station but extend on one side to Earth-pointing sensors from unmanned platforms and on the other to the launch and staging of unmanned solar system exploration missions. The second domain is geosynchronous Earth orbit (GEO) and cislunar space. Activities there include all GEO missions and operations, both unmanned and manned, and all transport of materials and crews between LEO and the vicinity of the Moon. The third domain is the Moon itself. Lunar activities are to include both orbiting and landing missions; the landings may be either unmanned or manned. The last domain is Mars. Missions to Mars will initially be unmanned but they will eventually be manned.



(1) LEO Space Station

Although the Soviets have had cosmonauts continuously occupying their Mir spacecraft for some time, the U.S. space station will be the first permanently occupied space outpost in the American space program. The space station will be the location for a variety of Earth observations and for many scientific and engineering experiments in microgravity. It will also be a transportation node and servicing center for satellites and space vehicles.

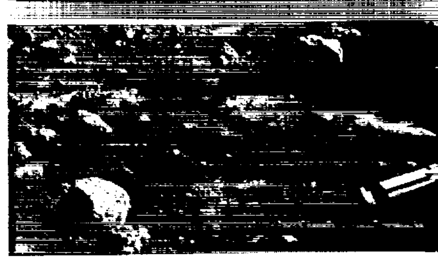


(2) GEO Platform

Location in geosynchronous orbit is required for most types of communication satellites. Because this orbit is filling up, a trend may develop to cluster multiple users on a single platform. The large platform shown in this drawing contains about a dozen separate antennas, each of which can be aimed at a different user. To be cost-effective, such large platforms must be able to be serviced and repaired. For service and repair, either the entire platform must be returned to the space station by orbital transfer vehicle or astronauts must travel to geosynchronous orbit for onsite maintenance.

(3) Spartan Lunar Base

The early lunar base may consist of several modules similar to habitation and laboratory modules for the space station, which can be transported to the lunar surface and covered with lunar regolith for radiation protection. In some scenarios, the early lunar base would be totally dependent on transport from Earth for all supplies and consumables. In other scenarios, a small plant would be emplaced, which would allow the production of oxygen for life support.



(4) Closeup of the Surface of Mars From the Unmanned Viking Lander

While Viking provided spectacular pictures of the surface of Mars and some chemistry data for the two lander sites, an indepth understanding of martian samples and the detailed data necessary to describe the evolution of Mars (age dating, mineralogy, possible fossils) can be gained only from actual samples of rocks and soil returned to Earth for detailed analysis using sophisticated laboratory instruments.

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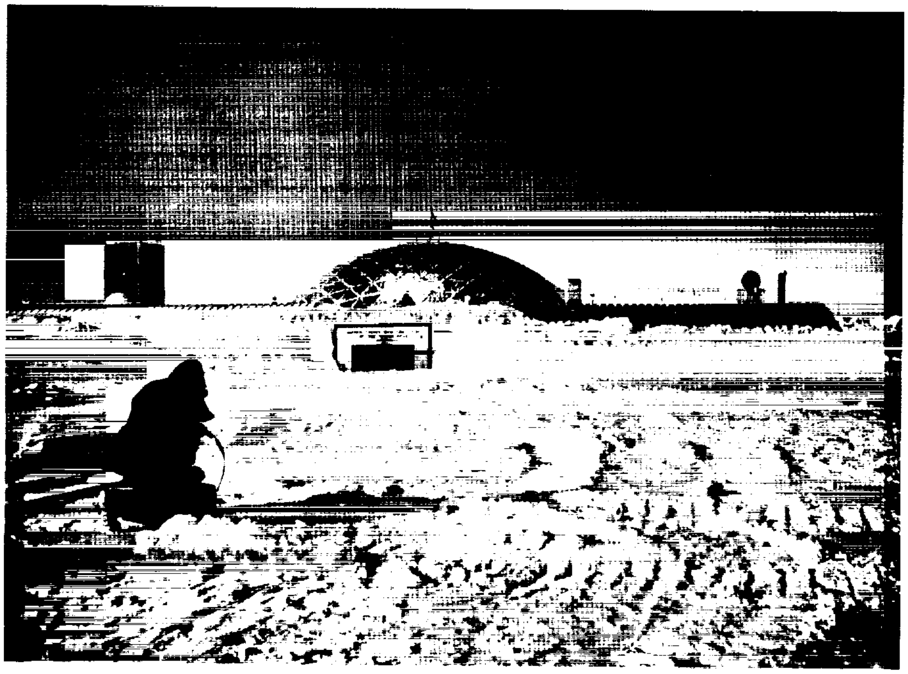

American Station at the South Pole
The station consists of several buildings within a large-diameter (approximately 100-meter) geodesic dome. The buildings include laboratories, service areas, and habitation modules. This station is probably the closest thing we have to a base on another planet. The South Pole station is continuously occupied, but crewmembers arrive or depart only during the summer season. While the occupants can venture outside with protective clothing ("space suits") during the winter, they are mostly dependent on the shelter provided by the geodesic dome and the buildings within the dome, much as they would be at a Moon or Mars base. Most of the supplies must be brought in by air, but some use is made of local resources. Local ice is used for water, and, of course, local oxygen is used for breathing and as an oxidizer for combustion, including operation of internal combustion engines.
Photo: Michael E. Zolensky

Program Elements and Descriptions

The first domain shown in figure 1 (LEO) emphasizes the space station and includes the recommended program of the Solar System Exploration Committee (SSEC), Earth observation satellites, manufacturing in low Earth orbit, and other commercial ventures such as tourism. The second domain (GEO) emphasizes commercial activities in geosynchronous orbit–mostly communication satellites or platforms. Other GEO facilities would include an experimental platform and later a manned "shack" to support and maintain the GEO facilities.

The third domain (the Moon) consists of the establishment of a temporarily manned science and research camp, similar to an Antarctic outpost. The lunar base would be totally dependent on Earth-supplied consumables and transportation. The fourth domain (Mars) includes an unmanned sample return mission.

Folding these four domains into a baseline program in accordance with the above assumptions results in the plan depicted in figure 2.

Critiques of the NASA Baseline

The workshop participants offered some critiques of the baseline plan, which are documented in this subsection in order to use them in the next section on alternative scenarios.

1. *Critique:* Devote more emphasis to asteroids as a source of nonterrestrial resources.

   Rebuttal: Resources on the Moon may be more limited than those of asteroids; however, the high leverage items such as oxygen for transportation and mass for shielding are available there, and the Moon has many other advantages to science and human presence that asteroids may be lacking.

   Resolution: Seriously consider asteroids as a viable source of resources in conjunction with other potential sources.

2. *Critique:* The baseline program demonstrates a lack of vision which is a result of conservative budget requests (or vice versa).

   Rebuttal: NASA is aggressive in its budget submittals and is

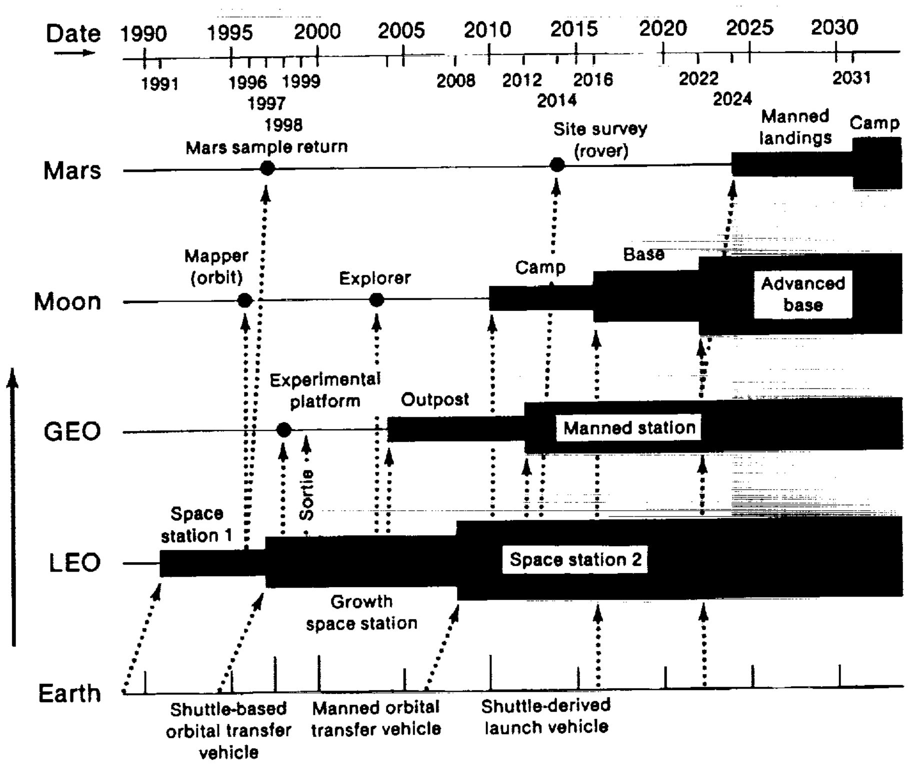

Figure 2

Baseline Scenario

If NASA continues its business as usual without a major increase in its budget and without using nonterrestrial resources as it expands into space, this is the development that might be expected in the next 25 to 50 years. The plan shows an orderly progression in manned missions from the initial space station in low Earth orbit (LEO) expected in the 1990s, through an outpost and an eventual space station in geosynchronous Earth orbit (GEO) (from 2004 to 2012), to a small lunar base in 2016, and eventually to a Mars landing in 2024. Unmanned precursor missions would include an experiment platform in GEO, lunar mapping and exploration by robot, a Mars sample return, and an automated site survey on Mars. This plan can be used as a baseline scenario against which other, more ambitious plans can be compared.

demonstrably second only to the Department of Defense (DOD) in budget growth. However, the fact remains that policy guidelines established by the Administration and Congress do not permit much more than the proposed baseline.

Resolution: A small portion of the planning exercise should not constrain itself within budget limitations but direct its attention to truly visionary space objectives in order to have an impact on our near-term technology developments and thereby contribute constructively to future budget drafts. NASA needs to make a better effort to "sell" its proposed programs to Congress and to the public.

3. *Critique:* The NASA baseline plan should be compressed in time to allow an earlier start on some selected programs.

   Rebuttal: An unlimited budget cannot resolve all problems involving the factor of time. Technology developments require significant time for resolution even when adequately funded. In addition, the technology developed for each new program feeds on or evolves from the technology developed for a precursor program.

   Resolution: Identify key technologies for early development and, where possible and practical, compress schedules.