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SPACE STATION TECHNOLOGY PLANNING

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I am certainly pleased and honored by the opportunity to come back and speak again to a group that has been working together for so many years with great benefit to spacecraft technology and to the organizations represented. Many of you were here in 1976 at the first conference. Colonel Brooke and I spend a great deal of energy in those days trying to generate cooperative programs between NASA and the Air Force Laboratory structure. This group is one of the many shining examples of success in that area.

We both are proud of what we were able to set in motion in those years. There already was a great deal of interchange at the individual level, but it did not extend as far as it should have to give the maximum benefit to both organizations. We have tried to establish not just cooperative programs but a spirit of cooperation among the people involved in technology programs all along the management chain.

I am going to speak for a few minutes about space station technology and what NASA is pursuing in terms of a space station program. It has long been my belief that a manned space station in Earth orbit is almost an imperative. Now it is not a matter of "if," but a matter of "when" and "what kind" the initial station will be.

First, a few words about the Space Station Technology Steering Committee, of which I am Chair. I joined this organization just a few months ago. It had been chaired by Walt Olstad, who had been the Acting Associate Administrator of OAST for quite some time. He moved over to be the Associate Administrator for Management. Walt made some major contributions to the committee, and I am pleased to follow in his footsteps.

We have in the committee a tremendous process by which to generate ideas and plans for the technology we should be pursuing in order to most benefit a space station program once it is begun. Each discipline area has a working group that addresses the particular technology from that discipline that would enhance a space station program, either through greater system performance or through lower life-cycle costs in a program that would extend over many, many years. Once we begin a space station program we expect it to continue indefinitely. It may evolve - in fact it will evolve - over time, but it will not necessarily have a defined endpoint such as many of our programs, including the Apollo Program and the Skylab Program, have had. A space station program is something that will continue into the foreseeable future.

The Centers have assigned their most innovative and competent people to these working groups, so we get very good reports from them. Our problem becomes one of sorting out, from all of the good ideas, the ones that should have the highest priority - the ones we should enact first in a space station program - and trying to combine them into something manageable within a budget we might expect to receive for this project. The work of the Steering Committee, then, is to interact with the working groups and try to prioritize and package the technology programs so that we can pursue them within our allotted resources. We also must generate the data that will allow us to advocate these programs through the management, OMB, and Congressional chains in order to acquire the resources to do this important work.

In this project there are some great technological opportunities to benefit not only an evolutionary space station, but also an initial space station. Usually you think of new technology as something that gives you greater performance. In a space station program, once you have defined your requirements, you want to meet those requirements at the lowest life-cycle cost.

Some people argue that we really do not need new technology to build a space station. They say that we have, in effect, created the equivalent of a space station in Skylab and we have the technology from the shuttle program that will allow us to build a space station with what we have today. And that is true. We could do that. But it would be a shame if we did precisely that. If we are able to bring some areas of technology, particularly power and thermal to a state of readiness to apply to the first space station, that first station will actually be less expensive, both in initial cost and in life-cycle cost. We must verbalize this message and convey it in such a way that it is believed and we can go ahead with it.

We will most likely pursue the space station program by using a modular approach (fig. 1). We believe that the space shuttle will be the basis for putting a manned base in orbit; therefore the station will be built of modules put into orbit by the shuttle and docked to form a core. Other modules will be added as the station evolves. There may also be platforms of various sorts, either in polar or in low-inclination orbit - probably both. These would be tended by the space station. Some kind of transfer vehicle will be used to move payloads from the station to other orbits. A smaller device, called a maneuvering system, will allow servicing of co-orbital platforms.

Figure 2 shows the types of equipment that may eventually be part of the space station. The initial station would be a core consisting of a power system with a few modules attached to it for experimentation in Earth orbit: a co-orbiting platform for experiments that require very good stability; some sort of maneuvering system that could tend the platform; and possibly a polar-orbiting platform. The core station would evolve into something larger and more capable over approximately 10 to 15 years, so a station after this model might be possible about the year 2000.

We are being careful not to produce a particular design before we have had a chance to do a significant amount of concept development and Phase B studies. So this is really an artist's vision of what might be, not any particular design that NASA is advocating. We try to define program requirements and let those requirements drive the technology, rather than the other way around. We think that we should be involved in many programs at once but that there should always be at least one program that is sort of a "technology push." Within a year or so we would like to go into Phase B studies toward the start of the station in a few years. Therefore we need to pin down the requirements for the station and define the technology to be pursued.

The first requirement is that it be a permanent system, one that you put up and expect to use for a long time. Thus we want it to be able to grow in an evolutionary manner. New technology will come along or requirements will change from those set in the first years. It is essential that it can be relatively easily added to, or changed, to incorporate products of the new technology. You want operational flexibility, because you really do not know right at the beginning all of the things you are going to use it for. The structure should be as flexible as possible in its operation; it should be multiple-use.

Most of the purposes that the space station might be designed to serve require high power across the board. No concept of a space station that I have seen involves other than relatively high power, in the 50- to 75-kW range. That in itself leads to a consideration of higher voltages than we have been accustomed to using in space. The thermal loads will be large because of the high power, and they will vary over an extremely wide margin. With a human presence, and the intention of using the station for many years, we will most likely want to go to closed loop. Extravehicular activity is going to be very important; we are finding this to be more and more true as time goes on.

All automated operations, the data system and the communication system, must be very flexible and adaptive. We will probably want distributed control throughout the station so that we do not get locked into just one way of doing things. Propulsion and fluid management, particularly cryogenic fluid management, will be important drivers in the space station design.

At OAST, the Aeronautics and Space Technology Program has always had what we choose to call a generic technology program. It is sort of a "technology push" program where you do things because the state of the technology indicates that you are able to make certain advances. That program has existed in OAST and is still there. They have identified a certain part of that program that is contributory to the kinds of things that a space station might need. Beyond that, the next step is to define, from the generic program, a focused technology program that would be very specifically oriented toward advancing technology for space station requirements.

I have emphasized in the Steering Committee that the program should have as its output things that can specifically benefit a space station program in its Phase B as well as its Phase C and D activities. That technology is not just hardware. It can be analysis and simulation; it can be results of laboratory tests, results of activity in test beds, and even experimental flight test programs.

The technology flows from this focused program into a number of areas, and the products that come out, again, are not just hardware. In fact hardware is probably the least important thing that comes out of the technology program. Those things that people and organizations are going to need to do this job are what is important. And they need to happen on a schedule that will fit into the overall plan. So we must move forward quickly.

Figure 3 is a flow chart of how technology might develop from the requirements of the space station through the focused program. There are other approaches. One way is to cut through disciplines and say that you will make progress in power, or in thermal, or on attitude control, etc. Another is to look at something like energy management, which is a combination of thermal and power and can affect nearly all of the other technological areas. This can even be extended to structural technology, and to the attitude control system, which becomes important with very large arrays.

We need to integrate all of these activities so that we pay attention to the most important parts of the technology involved (fig. 4). The structures people alone, for example, without understanding what the power people need, may not produce the technology that best coincides with what is needed in the power area. So one activity of the Steering Committee is to encourage this type of integration.

All of these ideas flow into a sort of "bus" of technology (fig. 5) that can then go into all areas of the development of the space station - including a very important area, the evolution of the station beyond its initial capability, or a flexibility over time. This is one of the problems in a technology program: you can never be exactly sure where the benefits are going to show up. We are trying to focus on the specific products needed for a space station.

Now, just a short discussion of a particular activity that might be of interest to this group. OAST is planning flight research as well as their traditional ground-based research. One element of that is a voltage operating limit test, the VOLT Program, for space testing of photovoltaic concepts. A number of people here know more about this than I do, but I would like to mention it in the context of this conference.

The idea at OAST is to use the shuttle to conduct research in the space environment in a number of areas. In the VOLT series (fig. 6) there will be four in-flight experiments beginning in 1985, two inside the bay and two outside the bay; two are planar arrays and two are concentrator arrays. VOLT-1 and VOLT-3 use applied bias voltages; VOLT-2 and VOLT-4 use self-generated voltages. So the entire structure has some symmetry to it. These experiments are needed to obtain data from high-voltage planar and concentrator arrays, the idea being to produce design guidelines for large high-voltage arrays in low Earth orbit, data on the limits on operating voltage, a validated analytical tool for the final designers of the space station array, and a design evaluation for these array technologies.

Figure 7 illustrates the technology flow for the specific case of high-voltage array design. Out of generic technology and the focused program come design data for the creation of the flight experiment. Out of the flight experiment come data that benefit the space station, and it feeds back from the space station into the requirements area. One of the beauties of the space shuttle is that as we learn, we can repeat what we have done before and improve on it. This is just one example of how a technology program can flow into flight testing and eventually result in very specific products that improve other programs, in particular the space station program.

I thank you for your attention. Again, thank you for inviting me here.

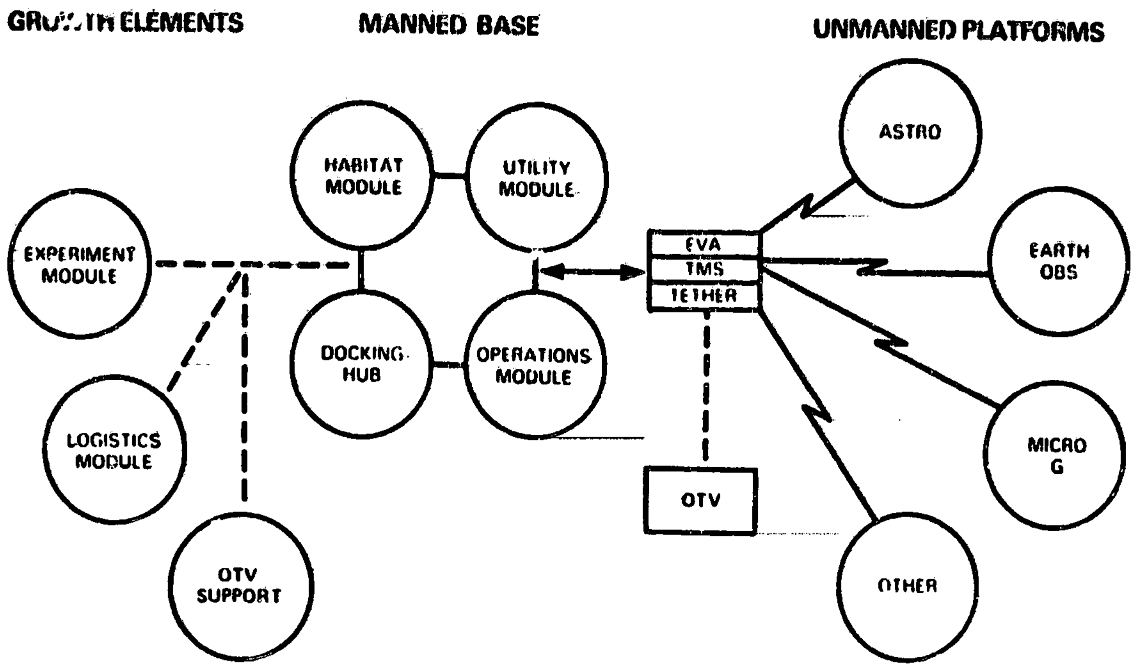

Figure 1. - Space station architecture: a cluster concept.

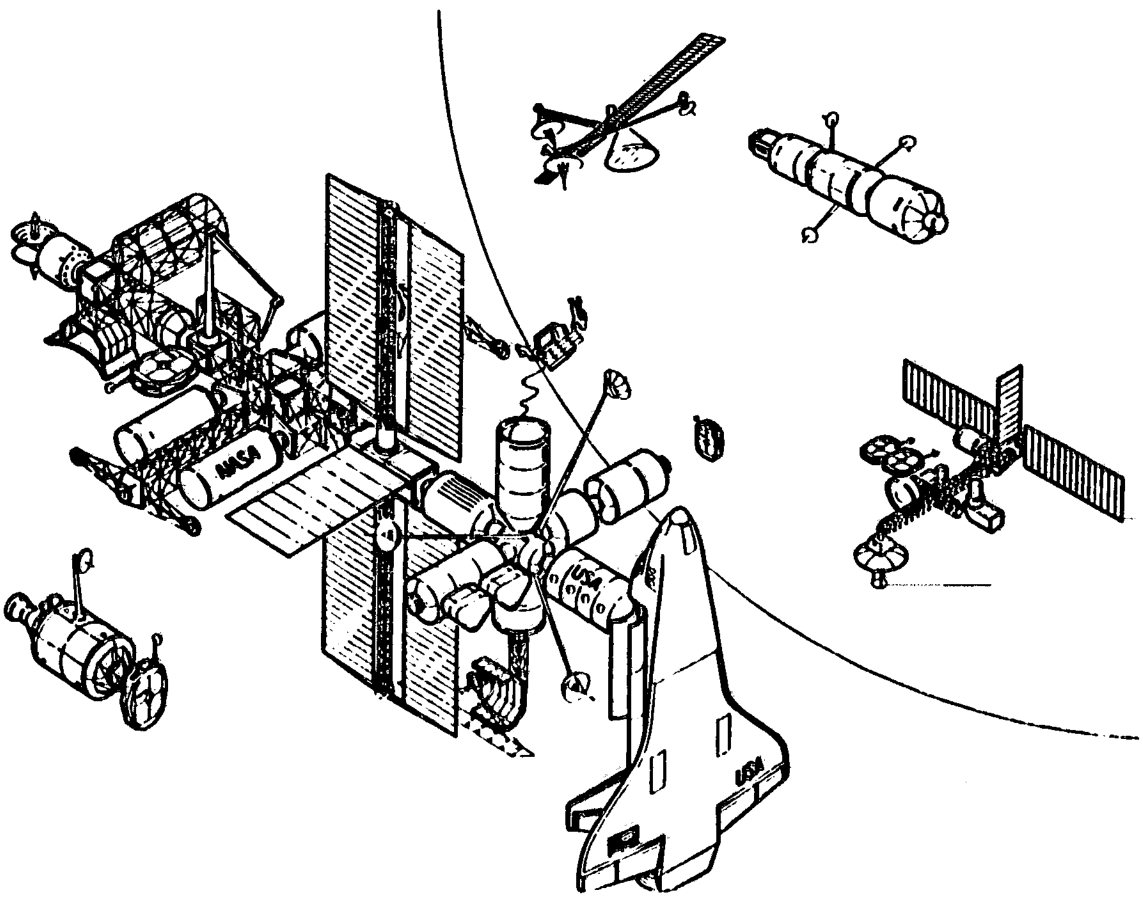

Figure 2. - Artist's concept of a space station.

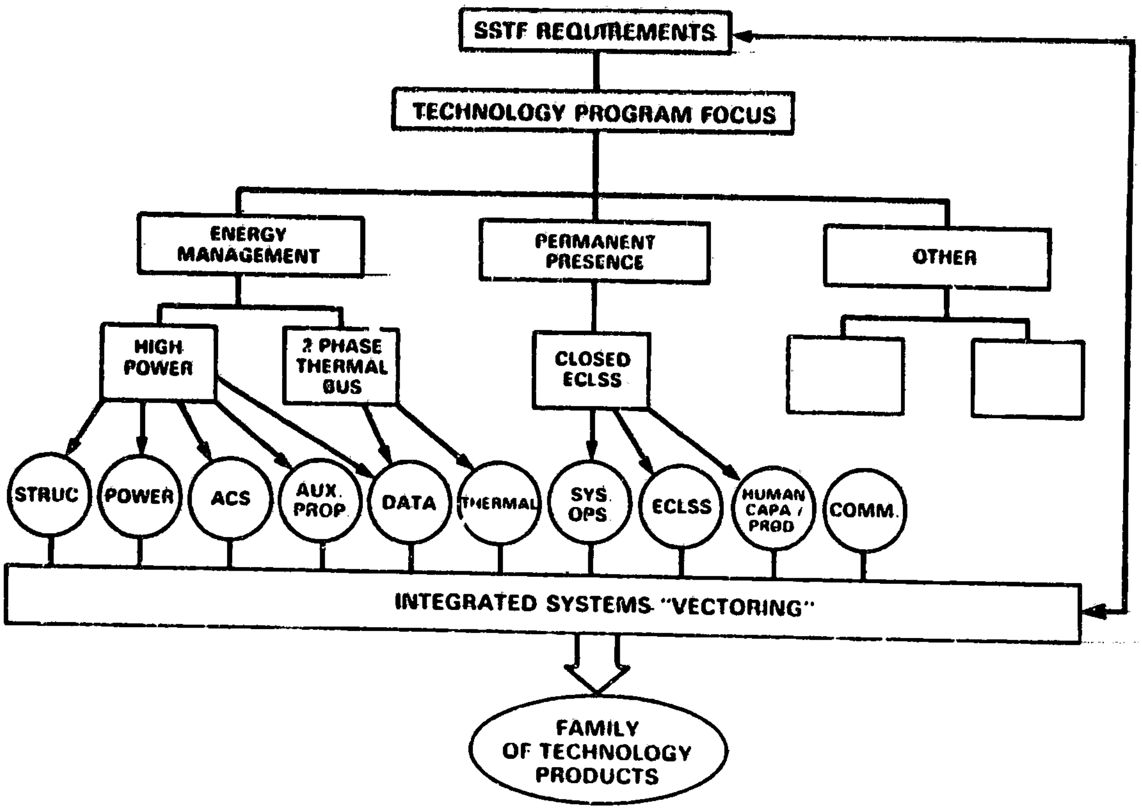

Figure 3. - Integrated activity.

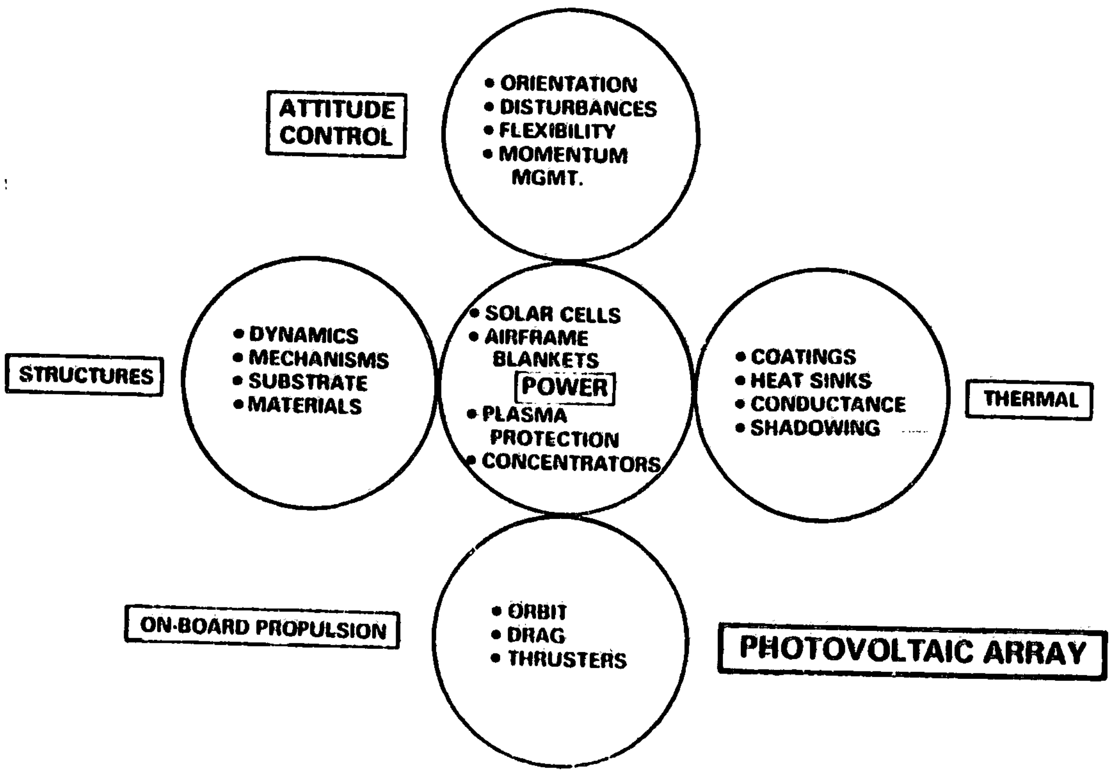

Figure 4. - Subsystem focus to integrate disciplines.

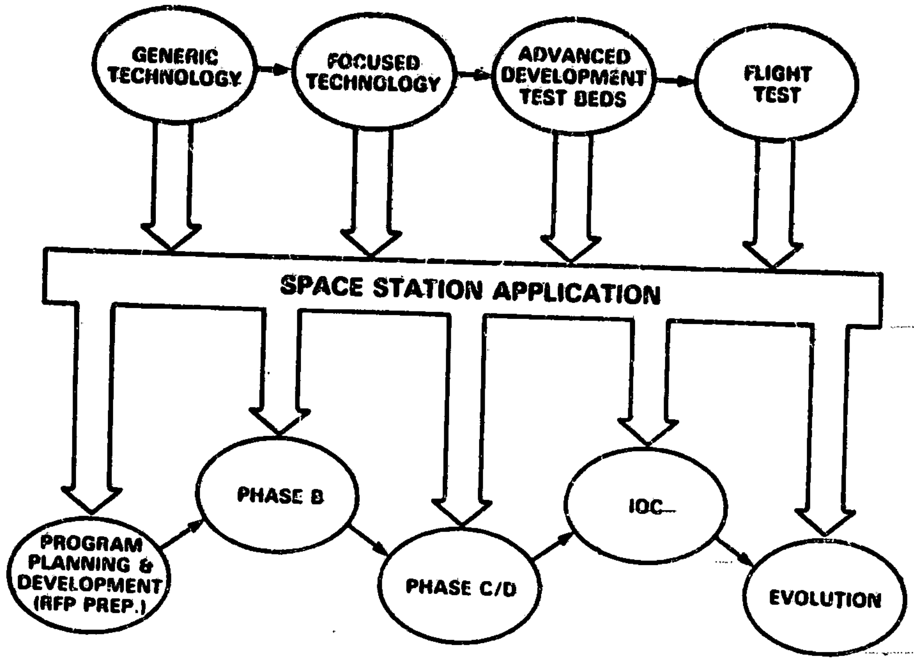

Figure 5. - Technology transfer.

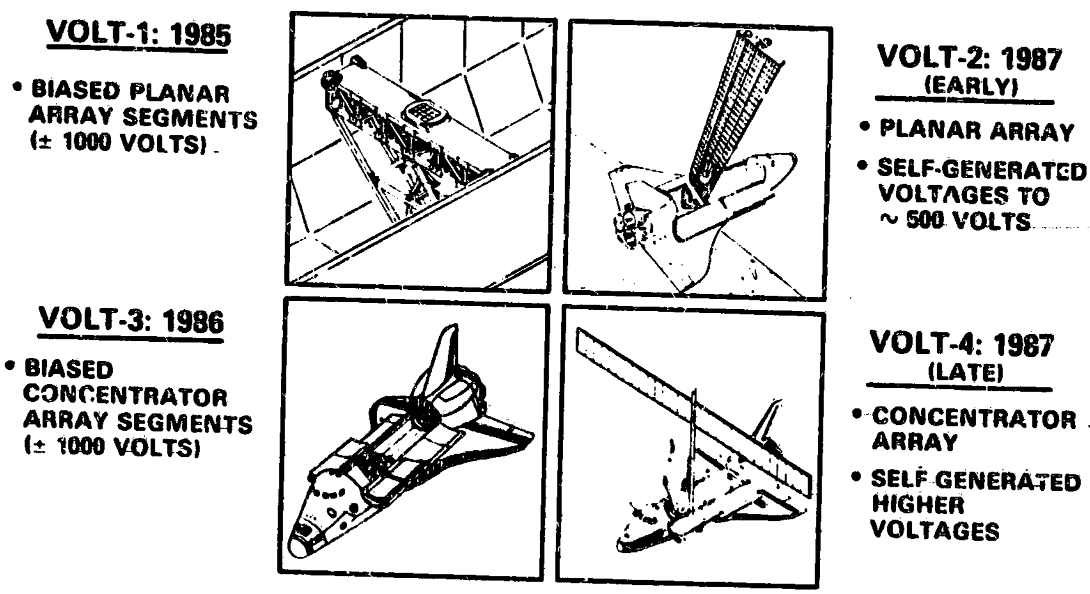

Figure 6. - Voltage operating limit tests.

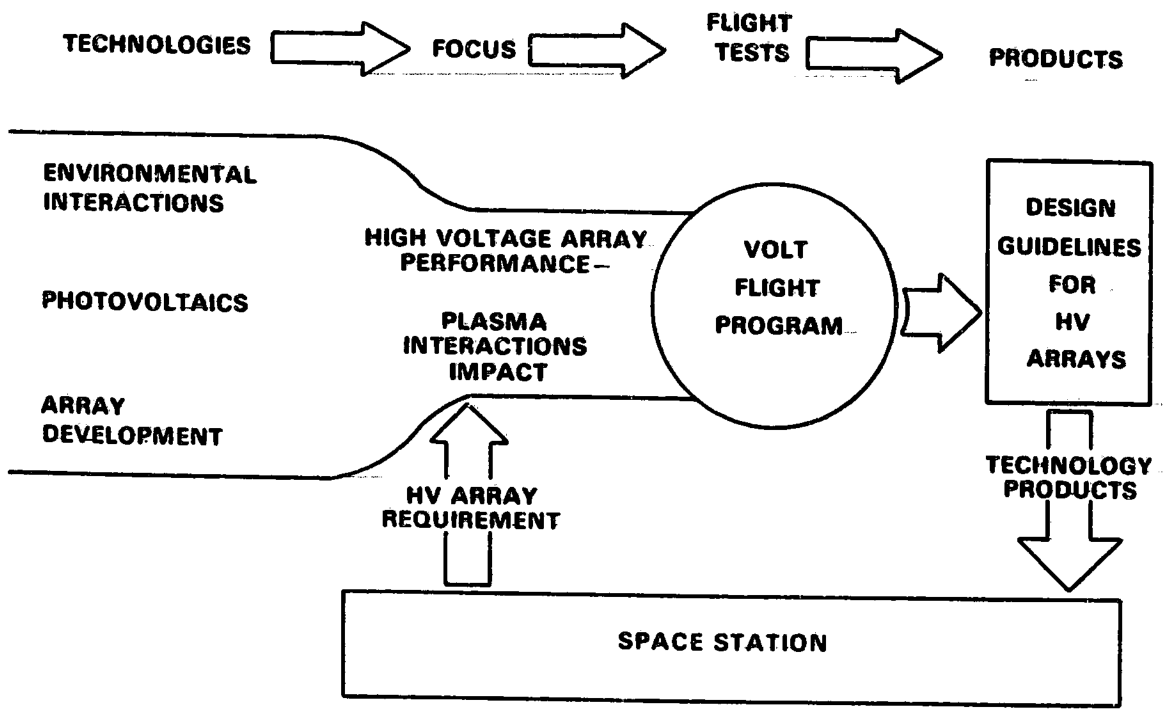

Figure 7. - High-power, high-voltage photovoltaic array for space station.