the earlier programs show that more sophisticated laboratories are required.

Studies investigating possible uses for more complex operational stations are being conducted and, while no definitive conclusions are possible, preliminary results indicate that sufficient requirements will be available to make their employment economically feasible within the next 20 years. Already, there is much evidence to support the probability that the greater part of the communications service and most of the surveillance of natural resources will be done from space. The economic logic has already been demonstrated by the commercial communications satellites now in operation. It remains to be seen what part of the communications load will need to be carried by manned satellite systems and, as yet, there is no conclusive evidence that will either substantiate or preclude the need for permanently manned stations to do resource tracking. There are also the attendant questions about the possibility of intermittently manned substations and of operating them remotely for the majority of the time. A concurrent problem is proposed by the need to define the configurations and functions of the devices that would be used to accomplish the communications and tracking tasks. This requirement, too, is dependent upon whether or not the station is manned.

However, assuming that space stations prove to be functionally feasible, the problem of transport has still to be resolved. Again it appears that present systems are not equal to the foreseeable personnel transport and resupply task. It is unreasonable to suppose that more than a few scientific investigators, maintenance crewmen, or station operators will be willing to tolerate the transportation environment to which astronauts are now subjected. Obviously some astronaut-scientists will always be available. However, the pure scientist and the development engineer will need a more stable transportation environment. To fill that need, and to afford the cost of resupply, reusable spacecraft will have to be developed.

The utility of reusable spacecraft is not questioned. It increases operational efficiency and, once it is achieved, spacecraft operating costs will be reduced by a factor of 2 to 4. This advantage will accrue even though expendable boosters are used in conjunction with the reusable spacecraft.

At this time, while various space transport configurations are still being investigated, there is a wide variety of opinion about what the optimum reusable spacecraft should look like. One school of thought has it that a reusable spacecraft should resemble the Apollo in its fundamental landing characteristics, others propose a spacecraft that looks like a hypersonic or supersonic airplane (fig. 56). This controversy may continue for some time. However, so far as we are concerned here at Douglas, a logical consideration of cost/effectiveness in conjunction with the mission requirements shows that neither the 6-g. device (shown at the right of fig. 56) nor the comforts of the commercial airline approach (shown at left in fig. 56) should be employed. Scientists and engineers who are not trained as astronauts cannot be expected to fly in a 6-g. device. On the other hand, space transports will not be carrying little old ladies from Pasadena, at least not in the immediate future. Consequently, we believe that