discussion of the group has dealt with matters such as the psychological explanation of creativity, the problem of whether creativity can be taught, the relationship between cybernetics and education and the organization of higher education as such.

The technological preoccupation of the seminar is no doubt explained by the way in which Dr Coler himself argues that "one cannot have creativity without productivity". But is a person's creativity a personal endowment, congenital, as it were, or is it a function of the environment in which he works? Dr Coler asks what would have been the creative contribution of "a Rembrandt born into a tribe of illiterate head hunters". Whatever the personal qualities needed to produce the flashes of insight which precede important discoveries, there is also great subtlety and importance in the way in which the environment can be managed so as to increase the output of those who work in it. In this sense, Dr Coler argues, the studies which the Creative Science Program is making must be considered as prototypes for studies of creativity in other fields of intellectual life —the arts as well as the sciences.

APOLLO 13

All but a Post-mortem

Two and a half inches thick and in four volumes, the report of the Apollo 13 review board is in the first instance a monument to American speed and thoroughness. Established on April 17, the day that Apollo 13 splashed down in the Pacific Ocean to an international sigh of relief, the board under the chairmanship of the director of the Langley Research Center, Mr Edgar M. Cortright, has taken only eight weeks to prepare the report issued last week. Because of the telemetry data, cut off for only 1·8 seconds at the time when the explosion occurred, the board started with a fair idea of what happened.

Right from the start one of the two oxygen tanks which supply the fuel cells and the environmental control system was implicated. As set out in *Nature* (**226**, 1001; 1970), the board has established that two thermostatic switches, meant to protect the heaters in the oxygen tank from overheating, became jammed in the closed position during preflight preparations at the Kennedy Space Center on March 27, 28 and 30. This happened when the tank failed to empty as quickly as it ought after the countdown demonstration test, and a power supply of 6 amps at 65 Volts d.c. was applied to the heaters to speed up the process. Although the thermostatic switches could normally carry this supply, it is now established that an arc occurs if the switches are opened to cut off this load, and the contacts are likely to weld shut. Because of this failure of the thermostat, temperatures in the heater could have reached 1,000° F according to tests since carried out at the Manned Spacecraft Center, with consequent damage to the Teflon insulation of the wiring. From then on, the report says, "Oxygen tank No. 2 was in a hazardous condition whenever it contained oxygen and was electrically energized".

For the first 46 hours of the flight the oxygen tank seems to have behaved normally, until fans in the tank were switched on as a routine step to keep the contents stirred. Then the gauge which indicates how much oxygen there is in the tank gave an obviously incorrect reading of more than 100 per cent, now thought to be due to a short circuit somewhere in the gauge. The explosion occurred nine hours later, one and a half minutes after the fans were turned on for the fourth time. What must have happened is a short circuit in the fan wiring, and this would have dissipated about ten Joules or more, setting alight the Teflon insulation of the wiring and ultimately causing the tank to burst.

What was the cause of the difficulty in emptying the tank before launch that led to the jamming of the thermostats? This could possibly have occurred during testing at North American Rockwell on October 21, 1968, when the tank was accidentally jolted. It is now known that the tolerances on the pipe and connexions through which liquid oxygen is expelled from the tank are such that a loosely fitting pipe could have been installed from parts within the tolerance limits. The pipe could have been dislodged by the jolt received at North American Rockwell, or during general handling. Although the report says that in itself a displaced pipe was not particularly serious, it led to the events that almost certainly caused the accident.

All that is left now is to lay the blame and to see that nothing similar happens again, considerably harder than finding what went wrong in the first place. The report criticizes the Beech Aircraft Corporation who were the subcontractors for the cryogenic gas storage system, North American Rockwell who were prime contractors for the command and service modules, and NASA. Beech failed to change the specifications of the switches when North American stated that the heater should be compatible with the 65 Volts d.c. used at the Kennedy Space Center as well as the 28 Volts d.c. power supply of the spacecraft. But the discrepancy was not noticed by North American or by NASA, and neither was the failure of the switches after the countdown test even though it should have been clear that they were not working from readings of heater current.

The report also has much to say about the "unforgiving design" of the tank. For a start, it is alarming that the investigation following the launch pad fire which was particularly involved with the hazards of pure oxygen did not spot the deficiencies in the tank. The use of the particular design of fan motor in supercritical oxygen is described by the report as "a questionable practice", the design of wiring within the tank is said to make it difficult to prevent damage to the insulation, and a second item of equipment which also contains high pressure oxygen, Teflon, and electrical wiring—the fuel cell oxygen supply module—is also called "potentially hazardous" by the review board. The board points out that neither North American Rockwell nor the Manned Spacecraft Center reviewed the tank arrangements to ensure that the switch was compatible with the 65 Volts of the ground support equipment. The report also mentions what it calls "a potentially serious electrical problem" which appeared to have caused a short circuit in the lunar module forty-two hours after the explosion.

Among the board's recommendations are a considerable modification of the oxygen tanks, a thorough re-examination of all spacecraft, launchers, and ground equipment which contain high density oxygen and strong oxidizers, measures to improve the control of engineering by subcontractors, and reviews of the past history of components that give trouble during the final preparations for launch.