

INTRODUCTION

To design a space mission, in the past NASA has formed a Mission Science Study Team composed of scientific experts in the field and directed them to define the science objectives and to select a set of instruments to serve as a "strawman payload". The Science Study Team identified the most scientifically viable mission within reason, with little attention paid to cost of the instruments (at this stage). Primary emphasis was placed on the reliability of the instruments (past inheritance) and their measurement capabilities (encouraging complexity). Collaborative design efforts between engineers at a NASA center and the Science Study Team led to the design of a spacecraft to accommodate these instruments. However, because of limited funding for travel, there were typically only a few interactions among the Science Study "Team, Headquarters personnel (concerned with cost at this stage), and the spacecraft engineers before a design was set.

After the release of the NASA Announcement of Opportunity, proposals are submitted to NASA for competitive selection. Science review panels set up by NASA are directed to recommend instruments but typically disregard instrument costs. Project (engineering) review panels examine the cost of instruments, but do not discuss this with the science review panels. Size, weight and power come into play in the selection only if the proposed instruments are well above "strawman allocations". 'J'bus, there have been few advantages in proposing small, lightweight, low power instruments.

This process obviously does not produce the least costly or most advanced mission. The weight and power of scientific instruments directly relate to overall mission costs. "This functional relationship varies from mission to mission, but a general rule of thumb is that the relationship is something close to a linear one. As an example, if one can shrink the weight and power of a scientific payload by 50%, the overall mission cost, which may be seven to fifteen times the instrument cost, decreases by a factor of 2570- 50%, giving large savings in total dollars. An additional cost saving is that the launch vehicle can be smaller (and cheaper) as well. In past NASA missions, the cost of the launch vehicle was not included as a "mission cost"; this item was entered elsewhere in the budget. This "linear" relationship between instrument and mission cost has proven to be approximately correct for the Solar Probe/Small Solar Probe studies,

On March 29-31, 1993 NASA held a Workshop on the topic of small space physics instruments. The purpose of the Workshop was to attempt to determine what technology is currently available to reduce mass and power of NASA instruments. It is possible that although the instruments may increase in cost, the overall mission cost could be reduced because of savings to the spacecraft and launch vehicle. The Workshop also addressed future instrument development, such as is presently being pursued by the JPL MicroDevices Laboratory (MDL) and elsewhere. Revolutionary designs for sensors may lead to orders of magnitude reduction in weight and power, but these sensors might not be ready for flight until 5 to 10 years from now.

For the purpose of the Workshop, the instruments were divided into separate modules: sensors, electronics, power supplies and Data Processing Units (DPUs), partly because each is technically distinct from the others and partly to see if it makes sense to have different instruments share modules (for example use common power supplies, common DPUs, etc.).

In the current fiscal environment, NASA is attempting to cut mission costs at all levels. As instrument scientists and engineers, we can do our part to design, develop and build small, lightweight and low power instruments for future space flight.

Bruce T. Tsurutani
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91109-8099