Principles of Oceanographic Instrument Systems -- Sensors and Measurements
2.693 (13.998), Spring 2004
Albert J. Williams, 3rd

Economics of Instrumentation

There is a sequence endlessly repeated in science of improvement in observational capability followed by new observations followed by development of new models requiring better observations to test them. One link in this sequence is development of instrumentation. This is often expensive and at least one step removed from the direct goal of a science program manager. In oceanography, instrument development has ridden the coattails of science. If a science program required an observation that could not be made because no technique existed, then an instrument development program might be permitted. In large programs there might be a general recognition that some instrument development would be appropriate and a sum set aside for it.

Rarely has an instrument been developed in the science sector because it would save money. This principle, which is dominant in the private sector, is rarely considered in science. I believe this is short sighted and should be corrected. However a realistic economic model is needed to assess the costs of developing a new instrument versus some alternative action.

Some examples may be appropriate for this discussion. The first is the Fast Profiler, an alternative to the slower winch lowered profiler. There is the direct development cost, the risk of technical or economic failure, the production costs, and the training and operating costs to be balanced against the savings in ship time. There are then the alternatives to the Fast Profiler such as a constant speed winch, streamlined profiler on a wire, expendable telemetering profilers, remote sensing. An analysis of ship supported observations versus aircraft and satellite observations could be included. It is easy to see why one tries to make a case for instrument development based on a need for the unique measurement that the new instrument can make.

Another example is a bigger tape recorder. Such a development might be economically pursued as a direct research effort. In practice it is being developed as part of many systems independently. Again an economic analysis should concern the development costs, production costs, and training and operating costs to be balanced against the costs of doing it many times as a part of other projects. It can be assumed that the need for a bigger recorder can be justified on absolute scientific need. But in fact there is a cost benefit relation to the size of the data set that is recovered. An alternative to a large data set is a more intelligently selected data set but this implies more development costs for the processing algorithms and tests of the algorithms.

A third example is a bottom mounted acoustic Doppler velocity profiler for shelf studies. In fact such an instrument was developed commercially and is now available. This affects other velocity profiling programs and the economic decision might well be how much can be saved by a single instrument of high cost over an array of lower cost spot current meter sensors.

There are also some examples of instrument developments that did not ride on the coattails of science in oceanography. Most recently the NASA funded RELAYS instrument system has been funded without any particular user or problem in mind. NASA has used this technology development procedure successfully in its other programs and is at home with it. RELAYS will collect oceanographic data from moorings, drifters, and its own sensors and transmit them by satellite to the users. National cost benefit analysis may be required to demonstrate the economic advantage of this system in the next twenty years over not having it.

Construction of new research vessels also is not specifically targeted for a single scientific task. The magnitude of the cost and its general benefit to the community frees us from the need to tie it to a scientific problem. However here too an economic evaluation is appropriate and rarely done. For example there is now a plan to use the Glomar Explorer as a scientific research vessel that could remain on station for 6 months exchanging scientific parties and crew by air. The cost of the Explorer is something like one-third the cost of the rest of the oceanographic academic research fleet. An economic analysis might reveal that although it is attractive to have this new capability, it is not as effective as keeping the existing capability. Then again it might show that the benefits of occupying a station for this length of time is so great that it is a saving over conventional ships.