

provision for instrumentation, but provision of instrumentation is in competition with many other objectives of URI. It seems to me that the ability to acquire significant instrumentation resources from the DoD is now substantially diminished and likely not to return unless political pressure is used.

In summary, my points are:

- You don't use what you don't own.
- Standardization aids communication and algorithm exchange and thus is highly desirable.
- Movement from minis to workstations seems prevalent and also desirable.

Rejoinder

William F. Eddy

I would like to thank all of the discussants for their uniformly positive comments; I wish they had been members of the Workshop. I would also like to take this opportunity to publicly thank all of the members of the Workshop for their hard work that led to the report. I am sorry that the publication schedule prevented them from having the opportunity to join me in this response.

The activities begun in the Workshop are continuing; we are organizing a session at Computer Science and Statistics: 19th Symposium on the Interface to be held at Temple University on March 8–11, 1987. This session will provide what I hope becomes a continuing public forum for discussion of both technical issues and some of the broader matters raised by this report.

SUPERCOMPUTERS

Prem Goel, David Scott, and Ed Wegman all mentioned the National Science Foundation (NSF) (and other) supercomputer centers. I agree completely with Wegman's principle: *you don't use what you don't own*. I also agree with Goel's recommendation to let others provide access to these centers. And I agree with Scott that supercomputers are not a panacea. Personally, I am not sure that supercomputers will have much positive impact on statistical research. Supercomputers are very good at doing linear algebraic calculations but are distinctly not cost effective for many other kinds of calculations.

An hour on my local Cray X-MP/48 is currently valued at \$1000. An hour on a Cray X-MP is roughly equal to 30 hours on a VAX 11/780 if the particular problem is not amenable to vectorization; if the problem is totally vectorizable a Cray hour is roughly equal to 300 VAX hours (although, see Dongarra and Hew-

- The time is now to explore supercomputing.
- Provisions for maintenance and support personnel are key elements of planning.
- Acquisition of equipment (other than supercomputer access) from federal sources is likely to be somewhat more difficult in the future.

I mention in closing that Wegman (1986) contains some personal perspectives on how computing relates to statistics.

ADDITIONAL REFERENCE

WEGMAN, E. J. (1986). Midcourse musings. *IMS Bull.* 15 238–241.

itt, 1986, for a report on a particular calculation where a Cray hour is roughly equal to 7000 VAX hours). I am able to buy a VAX 11/780 equivalent for \$6000. I would much rather have 10 such machines than 60 hours on a Cray because they will support a much wider range of computing activities (and they will last longer). The most common statistical use of supercomputers is for large simulation experiments. It is interesting to note that if such an experiment is not vectorizable but is decomposable into several parallel computing tasks (such as one for each independent sample), the ten VAX equivalents together operate at roughly one-third the speed of the Cray.

The major negative impact of supercomputer centers on statistics comes from the developing sense within the funding agencies that general computational needs are being satisfied by the national centers together with a few dollars in individual research grants to buy inexpensive workstations. While workstations and supercomputers can satisfy a large fraction of the needs, there will continue to be highly diverse and specialized needs for other sorts of computing equipment. Section 5.2 of the report tried to point out that some aspects of research in computational statistics are more like computer science than like applied mathematics; I believe that graphics and parallel computation both provide fertile ground for statistical research and both require specialized equipment that is expensive and difficult to acquire without substantial external support.

STANDARDIZATION

Doug Bates, Andreas Buja, Ed Fowlkes, Jon Kettenring, David Scott, and Edward Wegman have all referred to our recommendation concerning