Workshop summary on data acquisition

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Two presentations were given during the data acquisition session of the ICANS X conference. Bill Pulford of the Rutherford Laboratory and Gary Cort from Los Alamos delivered formal talks. The latter included a demonstration using a DEC workstation.

Generalizing the presentations and ensuing discussions, I feel that the first generation of data acquisition systems for pulsed neutrons sources may expect some significant changes in the next two years. There are principally four factors driving these changes. First, neutron scattering facilities have been operating now for several years and experience with higher neutron intensities has revealed certain operational problems. Second, the computer technology underlying our data acquisition systems continues to advance rapidly and to offer better alternatives for our applications. Couple technology changes to the imagination of users and system implementers, and change is inevitable unless constrained by the costs for change. Thus, imagination and cost are the third and forth factors contributing to predicted changes for data acquisition systems.

In the hardware area, changes will be significant. First, systems using Multibus I modules, e.g., IPNS and ISIS, are experiencing growing pains as memory requirements push into the 16 Mbyte memory addressing limit imposed by this architecture. Memory demands are rising with the increased use of position-sensitive detectors. Large memory capacity is a common requirement in data acquisition systems, and designers should expect to provide systems supporting 32-bit addressing. Costs for memory continue to decline as technology delivers ever higher densities in RAM chips.

Second, processing power at the front end is too limited. Either the performance is sufficient but data handling is inflexible, or performance is inadequate but flexible. Currently, processor performance problems are apparent in two roles: descriptor generation and data formatting. Increased memory utilization further aggravates the problems for both of these functions. For descriptor generation, users want to see in real-time or near-time meaningful results for experiments in transformed physical coordinates. Waiting several minutes for the host to prepare an image is not acceptable. Data formatting at the end of the run is becoming a bottleneck for data acquisition. With increased intensity, the runs are becoming short enough that spending 3 to 5 minutes saving the data can consume 25-50% of the beam time allocated to an experiment. Additional front-end processors may alleviate this difficulty. While the cost of the microprocessors decreases as their computational

power increases, there remains some expensive software to be written to realize these potential benefits.

Third, on-line archive capacity for stored data will be greatly increased by exploiting optical disk technology. With access times for arbitrary files under 20 seconds, automated robotic systems with capacities of up to 500 to 1000 Gbyte will be available. Such systems would cost on the order of $1000K a few years ago, but today can be found for one quarter of that cost.

The last major impact of hardware change is strongly coupled to software change as well. Expect to replace terminals with graphics-oriented interactive workstations. Generally, such workstations include a multi-window work surface (screen) and a pointing device (mouse). The computation power in a single workstation today rivals that of the VAX 8600, which is often dedicated as the centralized data analysis computer. The graphics capability enables the use of alternative interfaces frequently regarded as significantly more friendly to the novice user, *e.g.*. the Macintosh interface. Because old ways will die hard and experts will want shortcuts around menu-driven protocols, terminal-like commands must be included in all future software-interface strategies. While the costs of workstations will exceed the costs of graphics terminals by a factor of four, keep in mind that the requirements for the central analysis computer will significantly diminish. Costs for the user friendly interface may be high initially as we mount the learning curve of this new technology.

In conclusion, technology has provided feasible and affordable solutions to many problems posed by the neutron-scattering community. But there is mounting evidence that some "cultural" changes may be required. While it may be feasible to capture and save a 50 Mbyte data file five times an hour, is it a reasonable thing to do? Perhaps science is adequately served by saving some derived quantities, and discarding most of the raw data. Combining and reducing histograms may not only be desirable but essential, least the experimenter be hopelessly buried in data. Equally well, can the neutron-scattering community evolve from a terminal-oriented society as earlier it evolved from a card-punch society?