INSTRUMENT FACILITIES AND PREP

Jim Simanton

Instrument Facilities, a section of Research Services Electronic Support Group, includes and administers the Physics Research Equipment Pool (PREP). PREP and its activities were previously discussed in the July 1975 issue of **Fermilab Report.** That general description is still valid, but there have been some changes in areas of emphasis, as dictated by the changing trends in experiments, instrumentation, and Laboratory funding. This report will focus on these new trends, PREP's somewhat changed role, and recent activities.

Instrument Facilities is located on the 14th floor West in the Central Laboratory and is administrated by Art Neubauer. Charles Nelson, a Fermilab high-energy physicist, provides PREP's liaison with operating experiments. He also coordinates external technical development with internal product evaluations performed by Dave Warner. PREP equipment transactions are handled by Cherie Smith.

For experimenters, the most efficient channel for inquiries and consultation is through Art Neubauer's office. That office routinely takes care of 95% of all inquiries directly and can summon additional departmental expertise as required to discuss special situations.

Instrument Facilities' spectrum of activities includes the following:

Instrument Facilities (Duties and Services)

I. PREP Experimental Support
   - A. Liaison
     1. Consultation with experimenters
     2. With Vendors
     3. Information and Equipment Exchange with Equipment-Pool Managers at other Laboratories
     4. With PREP Committee
     5. With Experimental Planning Administration
   - B. Inventory Control, Data Base Management
   - C. Equipment Issues and Recoveries
   - D. Equipment Acquisition
     1. Purchases and Follow-through
     2. Specification, Verification, Justification
     3. Internal Product Development
     4. External Product Development
   - E. New Product Evaluation
   - F. Equipment Modification and Documentation
   - G. Maintenance of Records of all Experiment Transactions
   - H. Implementation of Approved PREP Committee Decisions

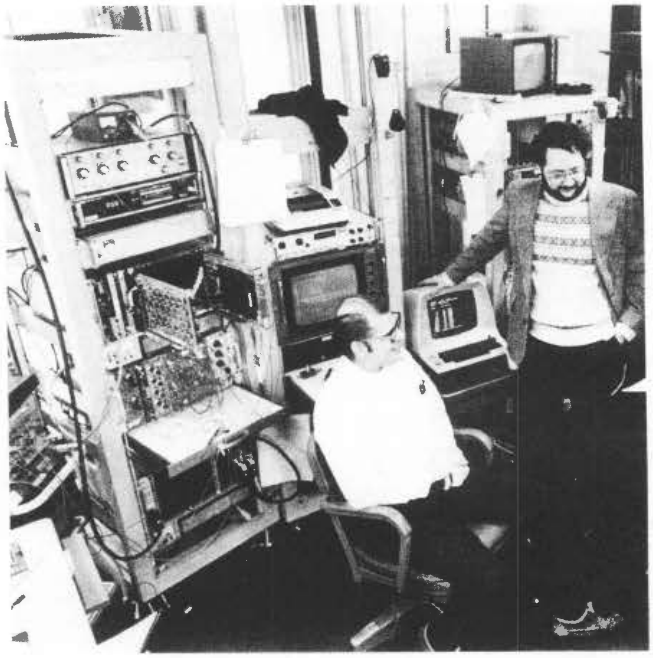
II. Maintenance
   A. Diagnoses
   B. Technician Training and Recruitment
   C. Automated (Computerized) Testing
      1. Software (Program Development)
      2. Test Planning
      3. Test Fixtures and Peripheral I/O Hardware
   D. Calibration
   E. Preventive Maintenance

III. Beam Lines and Accelerator Facilities Support

PREP provides the specialized electronic equipment required to support high-energy physics (HEP) experiments at Fermilab. Administering the PREP services associated with Experimental Support requires detailed knowledge of the specifications, capabilities, and idiosyncracies of some 12,000 diverse equipment items in the PREP pool. Flexibility and patience also help, because equipment acquisitions, reserves, issues, and recoveries must be juggled continually to meet ever-changing experimental schedules and priorities.

At the time of the previous report, annual budgets for PREP equipment acquisition were in the million-dollar range. Acquisitions were based upon the fairly uniform and predictable needs of all experiments. Equipment was generally recycleable. PREP budgets contained reserves for contingencies, and a moderate portion of available funds was allotted to purchase equipment for which a general need could be foreseen, even though specific requests were not yet at hand. Existence of this reservoir of equipment buffered experimental imprecision against the vagaries of equipment delivery schedules. Additional pool acquisitions came about because other departments and individual experiments specified and purchased PREP-type equipment, then transferred it to PREP for maintenance and permanent absorption.

Since those balmy days, PREP's budget has been squeezed gradually to its present half-million (inflation-depleted) dollar level. Therefore, as experimenters are becoming increasingly aware, PREP's FY80 budget is austere and tightly managed. It permits purchase of new pool equipment only to the extent required to fulfill agreements signed with approved experiments scheduled to run in FY80 and early FY81. No contingency funds have been allotted, nor are funds available for general acquisition, even of equipment that is in short supply and for which a general future need may be predicted with certainty. This tight situation occasionally precipitates crises because needs for experiments cannot be precisely anticipated. At mid FY80, PREP reserves of most basic items are substantially signed out or committed, increasing the proportion of new equipment required per experiment. For instance, in FY79, typical experiments required approximately 20-30% in new equipment; at mid-FY80 that figure has increased to 70-90%. In a word, the pool has been



Dave Warner (left) and Charles Nelson shown with equipment they have assembled to evaluate the 2280/2285 system performance. (Photograph by Fermilab Photo Unit)

"drained." This has put increased emphasis upon efficient recovery of equipment as experiments complete their runs.

With PREP acquisitions, issues, and recoveries now based precisely upon agreements with scheduled experiments (whose equipment needs seem to be in constant renegotiation until the beam arrives), performance of these functions is feasible only because PREP maintains a computerized inventory-control system characterized by a large and accurate data base with versatile entry and access capability. With the possible impending demise of Fermilab's PDP10 computers, this data base is being redesigned to be supported by a Research Services PDP11/34 computer. The new software, currently being created by Dave Carlson and Dan Curtis, will provide increased interactive safeguards against entry errors, including provision for future data entry via light-pen scanning of bar-code-labeled equipment. The new data base will also maintain equipment-repair histories, and inventory spare parts for the myriad general Laboratory instruments maintained by Instrument Facilities.

Miniaturization has raised performance and lowered per-channel costs of HEP electronics, making higher-resolution experiments appear economically feasible. This has been reflected in the recent (and projected) trend toward very large experiments having customized HEP electronics that utilize the increasingly dense, high-resolution, hybridized circuitry representative of "new-generation" HEP systems. We must anticipate a low reutilization rate for these systems. The quickening rate of obsolescence, the expectation that large experiments will remain intact longer, and the customized nature of the new electronics systems will decrease recycling potential. Unfortunately, while declining per-channel costs of hybridized ADC/TDC modules have encouraged higher resolution (more analog channels), that trend has also resulted in requests for more multi-channel high-voltage supply systems. Per-channel costs of the latter continues relentlessly upward; the current per-channel HV/ADC cost ratio is approaching 3/1. PREP's future budgets do not extrapolate to cover even currently submitted HV channel requests. Finding lower-cost HV alternatives is a serious PREP concern.

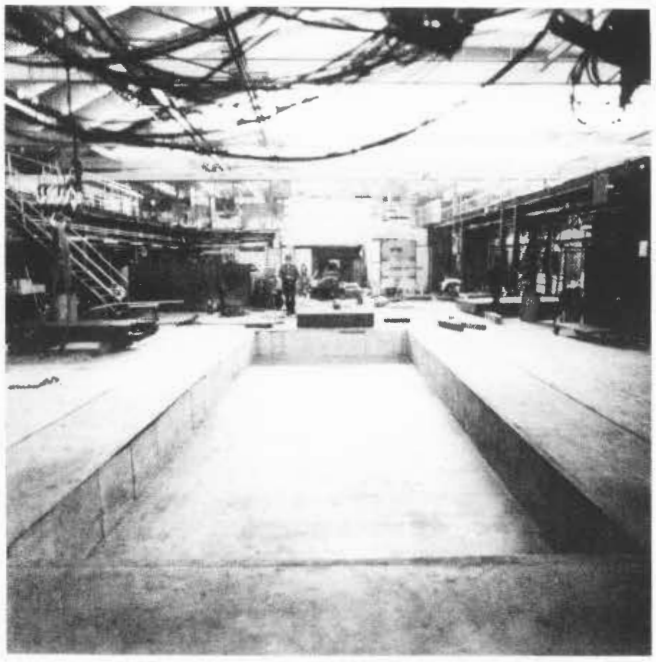
To provide for future HEP electronics needs, PREP generates specifications for state-of-the-art circuitry. Because Fermilab has no integrated or hybrid facilities, the required development involves close, flexible working relationships with commercial suppliers who view the end products as proprietary. Despite this lack of "hands-on" control, PREP strongly influences product development by extensive evaluations, using computerized facilities that document prototype deficiencies. Evaluation, diagnosis, testing, and repair of these "new-generation" systems can be accomplished only by computers adapted by customized software and I/O hardware to simulate the conditions of the experiment. PREP has assembled testing facilities and procedures that are considerably more sophisticated than those of the developers. This fact has enabled PREP to identify subtle but crucial flaws and to engineer significant redesigns, which have on occasion saved needed equipment development from abandonment by the supplier. In-development products arrive in prototype form, which then require extensive evaluation and numerous modifications before being individually acceptable....after which "system" and "field" engineering phases typically occur during operation in user's experiments, which must be monitored closely. In the past this whole development chain has been a traumatic endeavor, because development deadlines have been too closely coupled to experimental deadlines. To avoid such problems in the future, a recently adopted Research Division policy withholds approval of undeveloped products that appear in experimenter's PREP equipment lists, and further witholds payment for such equipment until PREP evaluations reveal performance that is in conformity with specifications.

The LRS 2280/2285 system is an example of a new hybridized product whose co-development has spanned nearly two years from

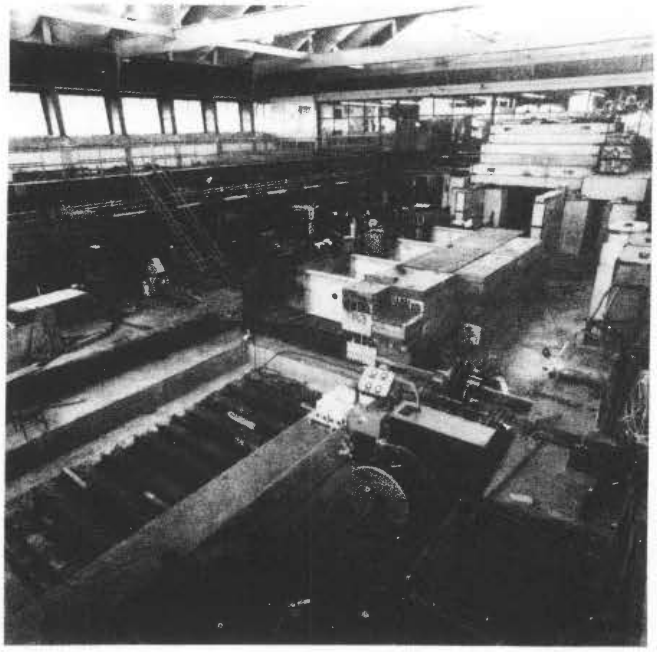
arrival of the first prototype - a process that has been followed with interest by several potential users. The supplier originally submitted responses to two user-initiated Requests for Proposal, each with different specifications, designed to meet the needs of two quite different HEP experiments. They proposed to meet these needs with two different modules, which were versions of the same ADC system. In the give-and-take of the ensuing development, the two modules gradually coalesced into one module capable of performing either experiment (with minor field changes). Linearity improved from uselessness to impressiveness; the essentially useless internal test circuitry was completely redesigned and thereafter accurately replicated the full range of external data. A very serious, non-uniform (channel-to-channel) dependence of the measured result upon event-rate and clearing protocol rendered the original units unuseable for most experiments; solving the problem required two separate hybrid-circuit redesigns and hardware changes to revise data-flow control in the system processor. Systematic linearity deterioration surfaced when a few modules were operated together, requiring power-supply revisions, which in turn required adding fault protection. Finally, large channel-to-channel dispersion in gate turn-on times was improved by rewiring the module.

In response to recent requests, current instrument evaluation emphasis has turned to the LRS 2770A Drift Chamber Digitizing System.

Plans are in progress for a future organization that will administratively couple Instrument Facilities and Experimental Computer Facilities to better serve their mutual clientele.



A rare sight--bare floor in the Meson Detector Building as the M2 beam line is being remodeled.
(Photograph by Fermilab Photo Unit)



A slightly later photograph of the same place--Experiment #613 being constructed in M2.

(Photograph by Fermilab Photo Unit)

WILLARD B. HANSON

We mourn the passing of our friend and colleague, Will Hanson. He was one of the founders of Fermilab and played a major role in the design and construction of both the Booster and Main-Ring magnets. In later years he was the proprietor of the Magnet Factory that builds all the superconducting magnets for the Tevatron. The laminated collars that clamp the Tevatron magnet coils in place were conceived and developed by him.

FTC