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SPACE DEPARTMENT OVERVIEW

The fourth of October of this year marked the 27th anniversary of the launch of Sputnik-1 and the beginning of the "Space Age." One might cavil at this choice; there were many high-altitude rocket launches before that date, including U.S. V-2 and Aerobee launches in the 1940s that carried APL instruments. Nonetheless, Sputnik marked a distinct turning point in the same way as did the Wright brothers' first flight at Kitty Hawk.

There is no question that Sputnik was a notable event for APL; we would not be active in the space arena today were it not for the dramatic effect Sputnik had on the United States. And we have been active. We've designed, built, and launched 50 satellites. We've designed, built, and delivered more than 200 instrument packages for launch in other spacecraft, including the detectors on Voyager for APL scientists, the SEASAT radar altimeter, and most of the precision tracking systems for low-altitude Department of Defense (DoD) satellites. We've been responsible for the design of most of the Global Positioning System receivers and processors installed in satellites. We've designed and built most of the high-precision quartz crystal oscillators flown in U.S. satellites and have built an even dozen hydrogen maser clocks for the National Aeronautics and Space Administration (NASA). We've been responsible, under the aegis of NASA's Technology Utilization Program, for the invention, design, and fabrication of a number of implantable programmable medical devices, some of which are now undergoing clinical trials.

The complete list is too long for this overview, but it is worth noting that a list, "Major Space Firsts," contained in a recent report of the House of Representatives Committee on Science and Technology, included eight APL accomplishments (navigation satellite, multiple spacecraft payload, geodetic satellite, color picture of the full earth, satellite isotope power, detailed Jupiter survey, detailed Saturn survey, and sea resources satellite).

Among our current activities are the final test and integration of GEOSAT, currently scheduled for a February 1985 launch, and the Hopkins Ultraviolet Telescope, to be launched on the Shuttle in March 1986, in time to observe Halley's Comet. We have two energetic particle instruments that will soon be delivered for launch on NASA's Galileo Jupiter Orbiter and on the European Space Agency's Solar Polar Spacecraft. Also scheduled for launch, in October 1986, is the Polar Bear satellite, which is now in the design stage. It is of some interest that Polar Bear will use a TRANSIT satellite built at APL around 1965 and retrieved from the Smithsonian Air and Space Museum where it was on exhibit. TRANSIT, in this instance, will be used as a bus to carry a set of DoD experiments.

Other ongoing programs are the development of a 2-centimeter precision altimeter for NASA's Ocean Topography Experiment satellite (with a primary mission of measuring global ocean circulation), the altimeter for the Navy's Remote Ocean Sensing System spacecraft (focusing on mesoscale oceanographic features), the development of a quartz crystal oscillator for satellite use with a stability of parts in 10^{13} per 1000 seconds, which is an improvement of an order of magnitude over the present APL design, and the development of superconducting and trapped-ion frequency standards for eventual use in space.

Looking further ahead, we are involved in the early planning and design phases of several NASA and DoD programs. The list includes the NASA Geopotential Research Mission for measuring the earth's gravitational and magnetic fields, the international Interplanetary Solar Terrestrial Program, and the attitude control and pointing systems for the Cosmic Background Explorer (for NASA's Goddard Space Flight Center) and the Shuttle Infrared Telescope Facility (for NASA's Ames Research Center).

To provide a more balanced view of the Space Department, I should add that we have an internationally recognized research group in solar-planetary magnetohydrodynamics. This group published 50 papers in refereed journals in 1983. We have also started a basic research group in physical oceanography that is showing steady growth.

All in all, the APL Space Department has a balanced mix of research scientists, computer scientists, systems engineers, and electronic and mechanical analysts and design engineers. And we are aided by highly competent personnel in the Technical Services Department's Data Processing Branch and the fabrication groups in its electronic, microelectronic, and machine shops where most of our space hardware is built.

As I view the record of the Space Department's past accomplishments and the diversity of our current programs with their many fascinating and challenging aspects, I am compelled to be optimistic about our prospects. Although it is evident that space science and technology cannot do all—or even most—things, the potential of the space arena seems endless. More particularly, within a decade it will be possible to design space-qualified, sophisticated knowledge processors. That quantum jump in technology will be a watershed; space technology will enter a new era.

The articles in this issue can best be viewed in the historic context of the Space Department. The first (by Danchik) updates our continuing role in APL's first satellite program. It is a tribute to the Laboratory's scientific and engineering skills that Frank McClure's March 1958 memorandum to Dr. R. E. Gibson first proposing a satellite navigation system is an accurate description of the TRANSIT operational system as it exists today, some 26 years later; the major substantive change is a marked improvement in system accuracy. Viewed with perspective, the more recent APL developments such as the introduction of NOVA I into the system—although important—must be considered fine tuning a successful system. However, it is worth noting that NOVA was designed to be a hardened spacecraft and is a modest move in the direction of autonomous satellite operation.

The Baer and Westerfield papers both represent departures from satellite Doppler positioning; the first describes a ground-based Loran system, the second, a future satellite system. Nonetheless, both are derived from our TRANSIT experience.

The articles on altimetry (by Kilgus), synthetic aperture radar imagery (by Beal), and rain attenuation (by Goldhirsh) are directed toward an important new application of space technology, viz., satellite remote sensing. Physical oceanography (and concomitantly, global weather and climate) will surely be a major beneficiary of the inherent ability of satellites to obtain rapid global measurements. The three most important research tasks in this application are to determine how oceanographic signatures are formed when radio signals interact with the ocean surface, what happens along the satellite-ocean propagation paths, and—most difficult of all—how to process the data rapidly and efficiently, and to interpret the received signatures.

The Moore and Jenkins article addresses a technology area that, inter alia, will be of far-reaching importance in remote sensing; even a modest degree of on-board satellite processing could alleviate the enormous burden of multimegabit data streams generated by satellite imagery. Indeed, one can envision terabit data rates from high-resolution surveillance imagery that would raise serious practical difficulties in transmitting reliable information to tactical users on the ground—particularly when one considers vulnerability to jamming. The rapid evolution of very large scale integration and very high speed integrated circuit technology will soon present the users of space systems with a totally new spectrum of possibilities, completely transforming space technology. The availability of hardware for constructing spaceborne information processing systems is not in doubt. The part that lags is the tool we need for exploiting the hardware: the very high level languages that are necessary if we are to efficiently design highly sophisticated and complex knowledge processing systems. As Moore and Jenkins note, we have started on this path.

The next issue of the *Johns Hopkins APL Technical Digest* will contain a collection of articles on various aspects of spaceborne instrumentation and space research.