Automatic test program generation was widened during 1975 to include ROM test procedures. The ROMTEST program uses the actual bit pattern that specifies the contents of a customer's ROM to construct the test program, thereby eliminating *all* error-prone human intervention. Since the customer must specify the contents of his ROM, no additional labor is expended to feed this information to the ROMTEST program.

During the year, Design Automation and SSD Power Transistor Engineering departments cooperated to develop computer software to optimize device yields at final test. The developed solution predicts the yield for a manufacturing process based on the previous yield percentage for this process. These programs currently run on computers found on the factory floor in SSD's Mountaintop plant. Our pilot use of this program has demonstrated a potential yield increase of 5 percent—thus substantially increasing the potential profit margins in this high-volume production environment.

3.3 LSI System Design

The role of the LSI Systems Design group is to apply the latest semiconductor technology to useful products that can be used by the Corporation and sold to others by SSD.

In May of 1975 the COSMAC microprocessor operations were formally taken over by SSD. This represented the culmination of work begun in 1971 at the laboratories and transferred to the SSTC in 1973. By May, COSMAC microprocessor chips were in small-volume production in the SSTC Custom Monolithics pilot line; Microkits, the prototyping systems, were in factory production in Palm Beach Gardens; CSDP, the assembler/simulator/debugger package for software development, was available through commercial timeshare services or as a FORTRAN IV program; and the basic manuals were written. In July, much of the LSD group was put on loan to SSD to help further develop the microprocessor business.

During 1975, the COSMAC microprocessor chips were characterized and put into full factory production. A series of enhancements were made to the Microkit, including the design of new, bigger memory cards and an improved set of utility routines, all of which are now in production. A major accomplishment was the completion of software for the Microkit to allow "resident" assembly and editing of user programs, followed by provision of a macro capability for the assembler. Microkit demonstration systems were built. CSDP was successfully installed on a wide variety of timeshare systems, undergoing a series of enhancements throughout the year.

A number of hardware/software experiments were carried out and documented within RCA. They will emerge in 1976 as "Application Notes" and, in some cases, as I/O IC's in the COSMAC product line. These include dynamic RAM systems, time-of-day logic, a data coupler, a multiply-divide unit (as an I/O device!), keyboard logic, A/D and D/A interfaces, systems to write data into programmable ROM's, and, very important for our 1976 plans, a low-cost COSMAC-controlled floppy disc interface. We also initiated in 1975 a substantial effort to develop a new product line, to be competitive with the best of INTEL, Motorola, and others. The central issue was a new 1-chip version of COSMAC. For this we devised a new "bit-slice" approach to the layout and developed a new architecture. We breadboarded, simulated, and checked thoroughly and, as a result, it worked on the first implementation.

Complementing the new microprocessor chips, we have also designed a new ROM part, and have initiated design on several new I/O parts and a small RAM part (32 X 8), all in silicon-gate bulk CMOS. Our LSI work in memory circuits has resulted in an extensive patent position in this area.

The COSMAC MicroTutor, designed in 1974, is a small, complete microcomputer which, with its manual, allows the reader to learn the mysteries of computers and quickly to appreciate the elegance of COSMAC architecture. More than 100 have been built so far and used to train RCA engineers and SSD field men, and to convince potential customers to choose COSMAC over the competition. The MicroTutor has gone into volume production for sale by SSD.

During 1975, we initiated a program to explore the application of COSMAC in the coin-operated games business. This project led to a new concept in home entertainment systems, FRED, which is a COSMAC-based TV-display home game system. In 1975, several attaché-case FRED systems were built and demonstrated. A new approach was also developed, which replaces the previously used audio cassette input with ROM boards and partitions the software into permanently resident general-purpose subroutines separated from the plugged-in personality software. This FRED concept has been accepted by D&SP and is being vigorously pursued with a 1976 product as the goal.

A COSMAC-based system was also developed in 1975 to control a capacitance/voltage monitor in the SSTC semiconductor manufacturing line. The system is now being evaluated in the SSTC pilot line.

Our repertoire of IC sensors for automotive applications was widened in 1975. Improvements in our temperature sensor were made, and Hall-effect circuits were designed and applied as position sensors. Design work was carried out for IC sensors utilizing external on-site variable inductances and resistances.

Installation of a COSMAC system in our test vehicle to monitor and display simple speed and fuel variables, begun in 1974, was augmented in 1975. Experiments were carried out to monitor the behavior of commercial anti-skid braking systems, and then to implement our own control system. A COSMAC control system for ignition timing was designed and installed. Our systems work has allowed us to write a convincing proposal to Minicars, Inc., to provide the electronic subsystem for their "safe car of 1980". Most importantly, it has been a crucial factor in selling COSMAC to the automotive manufacturers in the face of very stiff competition. These and other customer exchanges have made automotive applications the single most promising market area for COSMAC products beginning in 1977.

3.4 Integrated Circuit Technology

J. H. Scott, Jr., Director

The Integrated Circuit Technology Laboratory resides in both Princeton and Somerville. Its role is to develop new semiconductor technologies and improve existing ones so as to make RCA competitive and profitable in the semiconductor business. Advanced technologies are developed and specialized variations, such as radiation hardening of MOS devices, are carried out for our G&CS divisions under government contract funding. These efforts nearly always lead to eventual product sales for SSD.

The following detailed descriptions of technology development reflect the joint efforts of both the Somerville and Princeton locations. In fact, many of the people have worked at both locations during the year. This interchange of personal is the most effective way of transferring new technologies.

Silicon-on-Sapphire Technology

With the introduction of SOS technology into the solid-state memory products area, work on SOS has shifted from introduction of a new business to product development, product support, and yield improvement.

In support of SSD's SOS/MOS product line a new five-transistor static 1024-bit random-access memory was designed and is being used with the bulk microprocessor.

A study of SOS/MOS device characteristics has led to new understanding of the role of substrate orientation. It has been shown that suitable performance is obtained only in two of the four possible quadrants of tilt from the major crystallographic axis.