XEROX

XEROX RESEARCH CENTERS

The value of research and the subsequent return it brings to a company, its employees, its shareholders and the public in general has long been recognized by Xerox Corporation. The company has invested millions of dollars in research and will continue committing its support toward the discovery of new ideas and their development in its research facilities.

The belief in the importance of the contributions made by its researchers has been a vital factor in the success of Xerox. The willingness to try something new and the dedication to see it through to a commercial product led to the Xerox 914, the first automatic copier to use plain paper. The 914 changed the way people in offices communicate. It was a catalyst sparking more than a quarter of a century of continued creativity.

Today, Xerox is more than the world's leading copier enterprise. We are now involved in a wide area of activity to help manage information on paper and electronically. Advanced technologies have been pioneered by Xerox for networked office systems. Xerographic marking engines, combined with electronically controlled laser scanning, have produced the fast-growing electronic printing business.

Xerox, with operating revenues of nearly $9 billion, is ranked 38th in the Fortune 500 listing of industrial companies and has more than 100,000 employees worldwide. The two main segments of our company are business equipment and financial services. Within the business equipment segment, reprographics consists of the development, manufacture, marketing and maintenance of xerographic copiers and duplicators. We also are involved in the related marketing of paper and the manufacturing and marketing of toner and other supplies.

The other segment of business equipment operations is information systems. It consists of the development, manufacture, marketing and maintenance of electronic, impact and electrostatic printers, information processing products and systems, electronic typewriters, facsimile transceivers and related supplies. Xerox also offers computer-related products and services.

The financial services segment is composed of a property and casualty insurance holding company, an investment banking firm and Xerox Credit Corporation.

The mission of Corporate Research is to devise and transfer to the Xerox development organizations technological advances that support and extend our business strategies.

Research opportunities will often flow from and rest upon new science outcomes. Awareness of world science—and a strong coupling to it—is best achieved through direct participation in scientific research. In the early 1970s we set a target of approximately fifteen percent of our Corporate Research effort in fundamental science.

The major portion of our effort however is dedicated to applied research, aimed at developing enabling technologies for future products. These technologies may be carried into the development stage within Xerox, or through joint ventures, or by licensing to universities or outside companies.

As the principal research resource of Xerox, we have the responsibility to identify and expand the technological options for the future.

The primary requisite for outstanding research is excellent professionals. An environment that will attract, nurture and support outstanding professionals requires stable leadership and funding, and long-range commitment. A simple philosophy, the better the environment the better the scientists and engineers it will attract, is the guiding principle. We endeavor to have our research groups populated with superior people—from highly accomplished senior individuals to extremely promising young people.

A balanced technical program for the corporation requires an appropriate and intricate blend of science, applied research, exploratory development and engineering. The research units therefore are comprised of many interacting groups. And, as an intellectually motivated enterprise, we strive to maintain an open mind toward alternative viewpoints—a supportive atmosphere for new ideas.

From launching a research concept to announcing a product can be a journey of a decade, but what is learned along the way sets the stage for future advances. The ability to maintain and support a sophisticated research organization, with its broad spectrum of capabilities and programs, flows from a management that understands the importance of research to the corporation and to its future.

The Research Centers. Within the Corporate Research Group there are three major research centers and a number of smaller, remote satellite operations. The Palo Alto Research Center, the Webster Research Center and the Xerox Research Centre of Canada are unique, not only in their geographic locations and architecture, but in their missions and achievements. Taken together, the three centers form a synergistic research organization that lays the technological foundation of Xerox business strategies.

Computer Science Laboratory

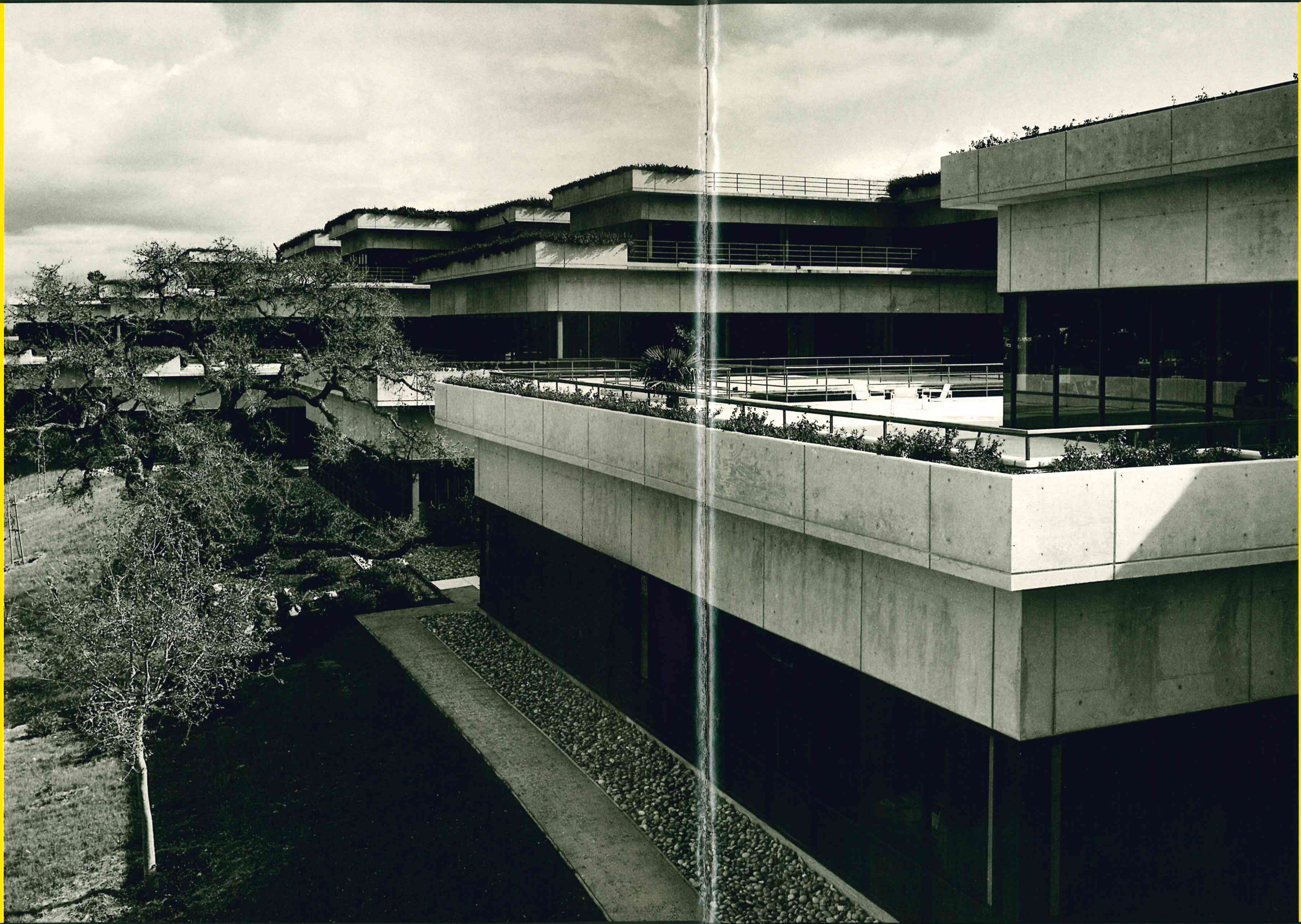
Exploratory Development Laboratory

General Sciences Laboratory

Integrated Circuit Laboratory

Intelligent Systems Laboratory

System Concepts Laboratory



The Palo Alto Research Center has become widely known for its research and prototype development of Ethernet-linked computers, file systems and printers. The Center, which is known as PARC, was established in 1970, and occupies a 200,000 square foot facility in the Stanford University Industrial Park in Palo Alto, California.

In 1971 PARC began research on the architecture for office-information systems. The transition from the large mainframe computer with many terminals, to the fully distributed network computer systems that PARC pioneered has become part of computing history.

The technology for Xerox electronic printing business was developed through the skills of three of PARC's laboratories. Precise laser scanning was demonstrated in 1971, software-controlled character generation and page-formatting software in 1972, and by the mid-1970s a prototype printer was in daily use at the Center. In 1977 Xerox began marketing the model 9700 electronic printing system, the machine which was the forerunner for our rapidly growing electronic printing business.

But the revolutionary transition really is just beginning. The research we are doing now will provide the exciting extensions of the technological revolution which will take full advantage of the new information systems environment.

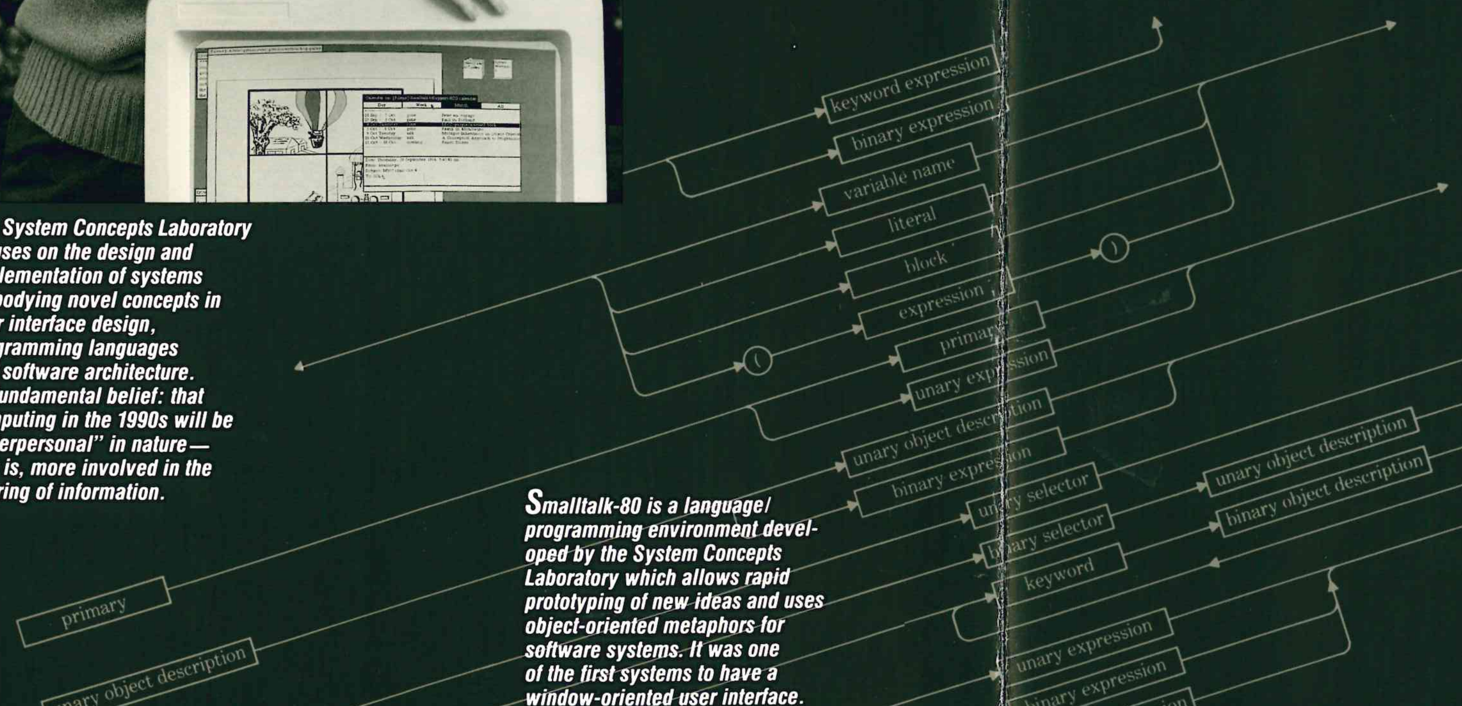
One of the first of these extensions is occurring in the integrated circuit domain—very large scale integration (VLSI). As VLSI advances continue, we will be able to provide greater computing power in even more compact machines which will make possible new capabilities for graphics and voice, and dramatic improvements in system function.

The greatest advances for the future are most likely to be in software. Computer scientists want ever more computing power to take advantage of the dramatic improvements in software development. The integrated circuit designer wants to build higher density chips to provide greater function at lower cost. The Integrated Circuit Laboratory was created at PARC to extend our capabilities to put more and more elements on a chip. But with components packed ever more densely, the chip becomes so complex that new design tools are needed. The result is a succession of iterations—more powerful software enables the design of more powerful chips—which provide the machinery to devise still more powerful software.

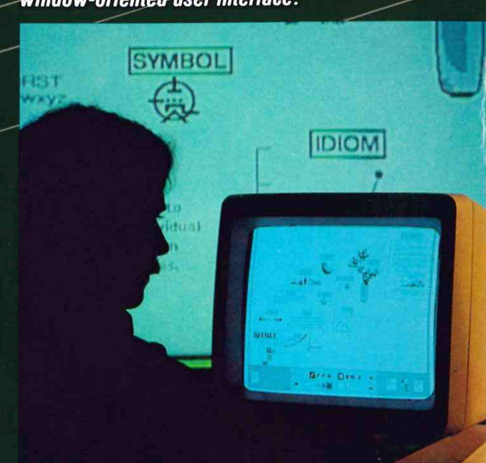
The uniquely powerful distributed computing environment, pioneered and developed by our computer science research, enabled many of the major advances made by PARC. Current research in the Computer Science Laboratory, from basic work in combinatorial geometry to implementation of graphical interface packages and construction of hardware/software systems, concentrates on the use of networks of high-performance personal computers to increase productivity and to enhance communication.

Artificial intelligence, knowledge-based systems and expert systems are topics of intense interest. With increased systems power, and an increased understanding of how people think and learn, we are exploring how to build and use workstations as amplifiers of ideas and problem solving processes. The artificial intelligence language, Interlisp-D, was developed by the Intelligent Systems Laboratory as a computing environment for its research in cognitive science. In the study of natural and artificial intelligence systems the first priority is to establish a firm scientific basis informed by a deep understanding of natural intelligence. Activities range from the design of systems to assist collaborative problem solving and writing to the study of physical intuition and reflection. This diversity of interests is well represented by the multiplicity of disciplines: anthropology, philosophy, linguistics, psychology and information science.

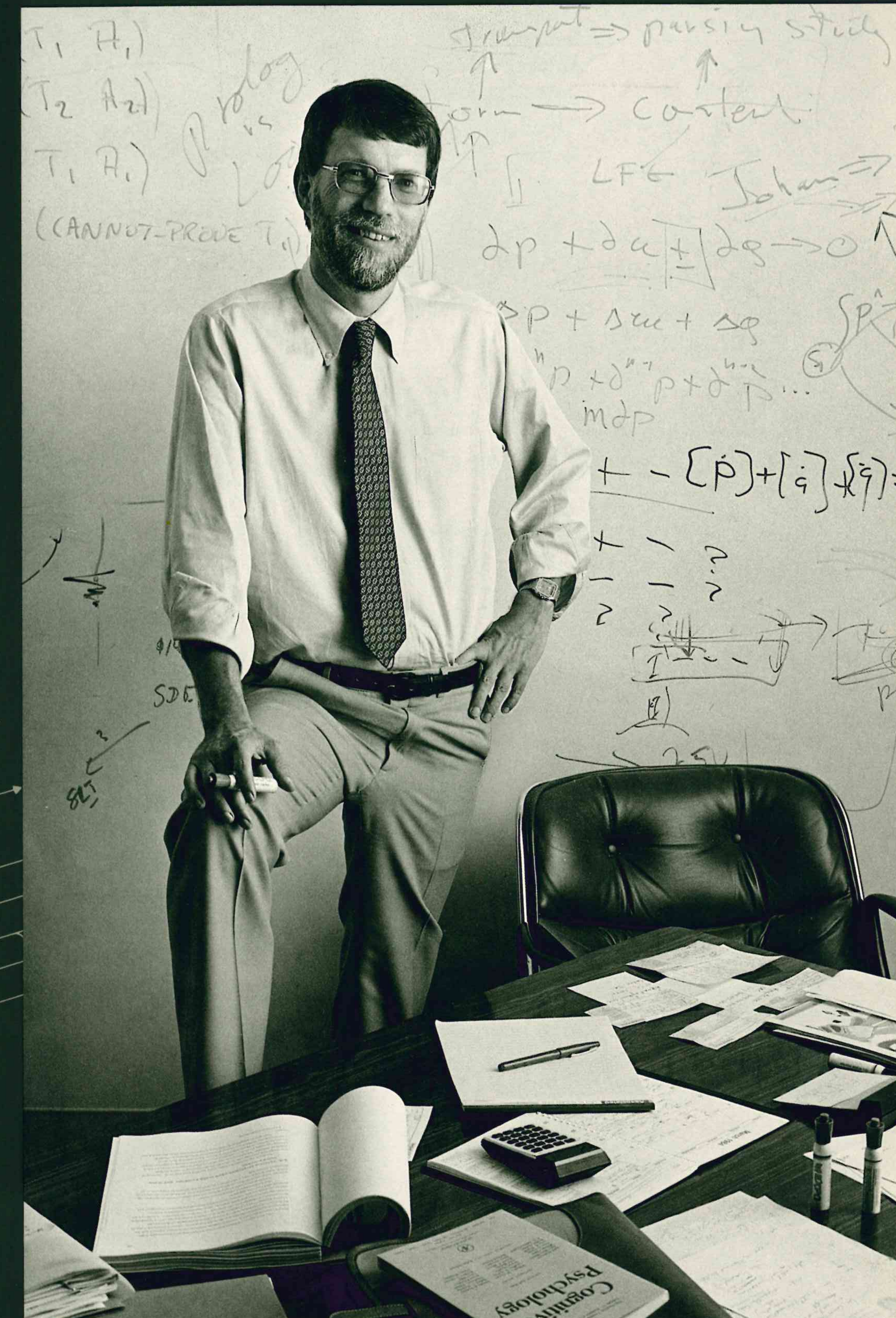
The System Concepts Laboratory focuses on the design and implementation of systems embodying novel concepts in user interface design, programming languages and software architecture. Its fundamental belief: that computing in the 1990s will be "interpersonal" in nature—that is, more involved in the sharing of information.



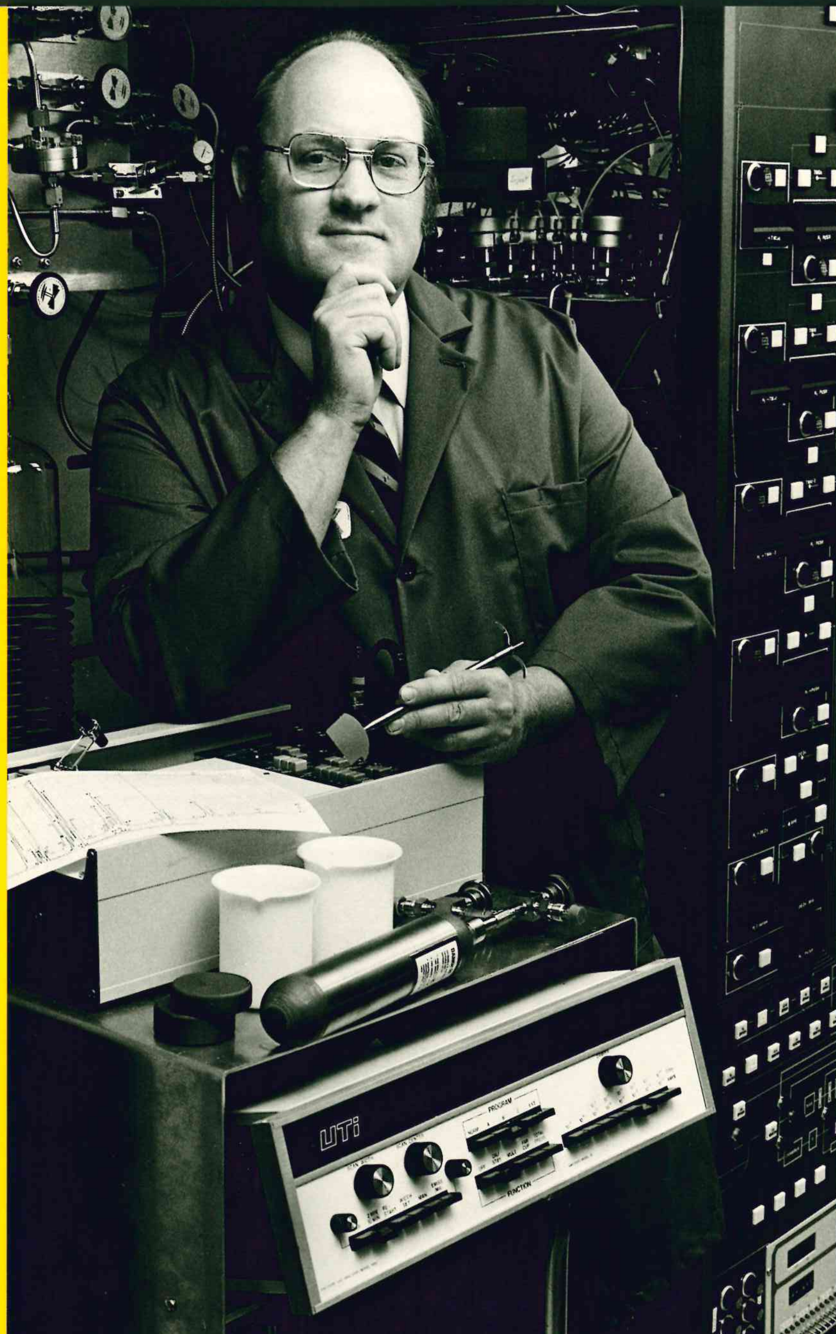
Smalltalk-80 is a language/programming environment developed by the System Concepts Laboratory which allows rapid prototyping of new ideas and uses object-oriented metaphors for software systems. It was one of the first systems to have a window-oriented user interface.



A researcher in the user-system area of the Intelligent Systems Laboratory assembles "protocols," or transcripts of a typical user/system interaction, for analysis. By making explicit the cognitive processes that people use in interacting with systems, Xerox researchers are building a "science-of-the-user" base to support user-interface design.

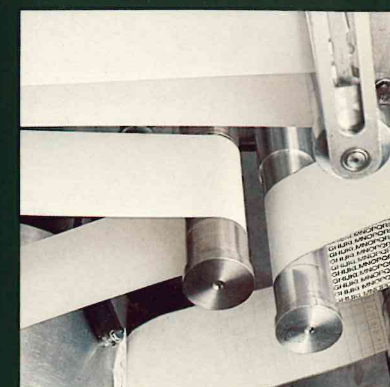


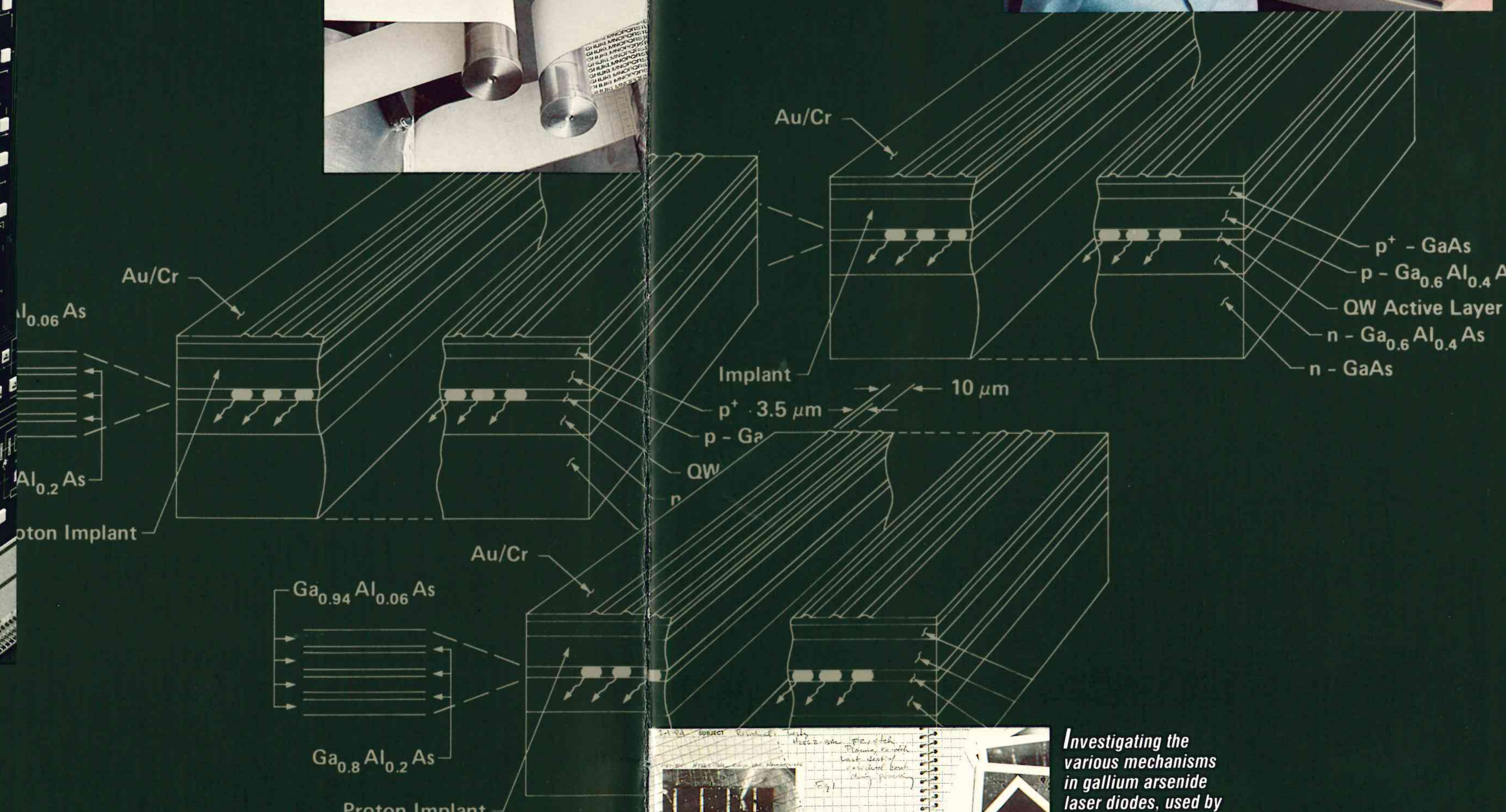
The Intelligent Systems Laboratory seeks the scientific underpinnings of intelligence in order to develop tools to match and extend the human mind. Its primary goals are to augment the human intellect of not only individuals but, significantly, of collaborative teams; to construct tools for probing the structures and processes of the mind; and to construct "robust" expert systems informed by serious study of the human mind.



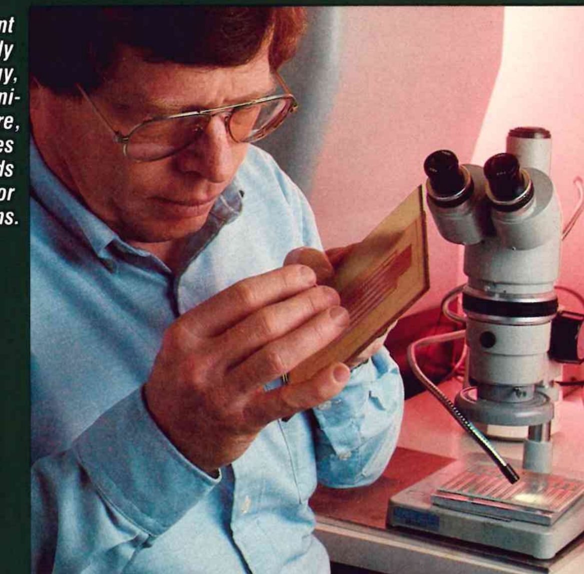
The integrated opto-electronics area of the General Sciences Laboratory is involved in the study of III-IV semiconductor compounds, with emphasis on lasers and light-emitting diodes (LEDs). This chemical vapor deposition reactor is capable of growing quantum-well heterostructures with ultra-thin layers (10–20 angstroms) and monolayer abrupt interfaces.

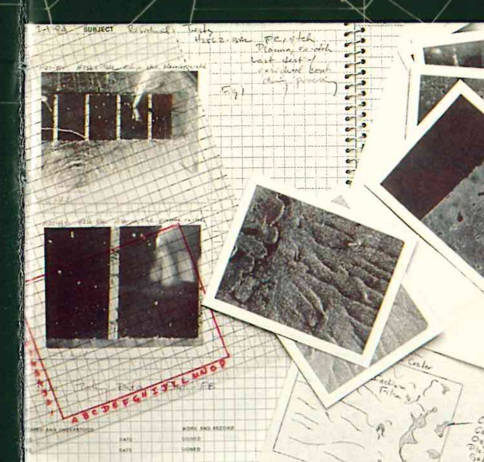
This test electrographic printer, developed in the Exploratory Development Laboratory, features both low-cost operation and high-quality graphics.





The Exploratory Development Laboratory focuses on the study of color printing technology, ionography, optical communications and electro-optics. Here, a Xerox researcher examines a pair of printed circuit boards developed internally for printer applications.





Investigating the various mechanisms in gallium arsenide laser diodes, used by Xerox in laser printers and optical communications devices, requires state-of-the-art micro-chemical analysis.

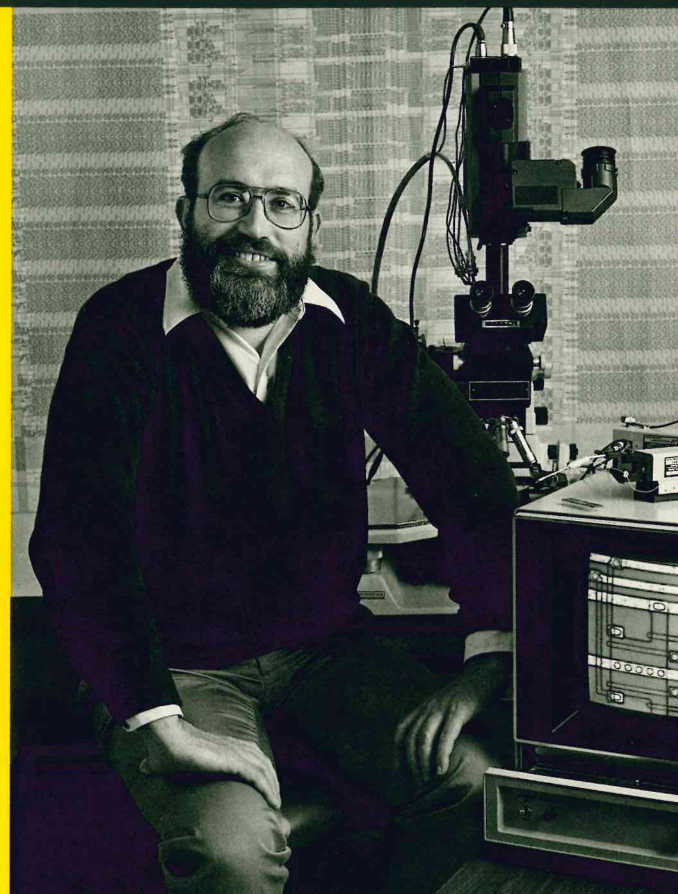
The now common term personal computing was used in the early 1970s to describe the research vision of the System Concepts Laboratory. The strategy for realizing this vision was to concentrate on two principal areas of research: a language of description to serve as an interface between the models in the human mind and those in computing hardware, and a language of interaction to match the human communication system to that of the computer. The result was the Smalltalk-80™ interactive programming environment. Publication of the Smalltalk-80 system included a series of four books describing the system, and licensing to universities and commercial institutions.

To that early vision is now brought the added insight that electronically mediated communication between people (rather than between people and machines) is a significantly different problem to which computer technology offers interesting solutions. Techniques must be developed to deal with the exchange of data and processes between people at different workstations, regardless of the physical distances between workstations. The System Concepts Laboratory is now directing its effort to the study of "interpersonal communication," the phrase coined to cover this larger view of the exchange of information. The goal is both a hardware and software challenge in that notions of casual interrupt, teleconferencing and video and voice interaction must be combined with access to large shared information sources and powerful computational services.

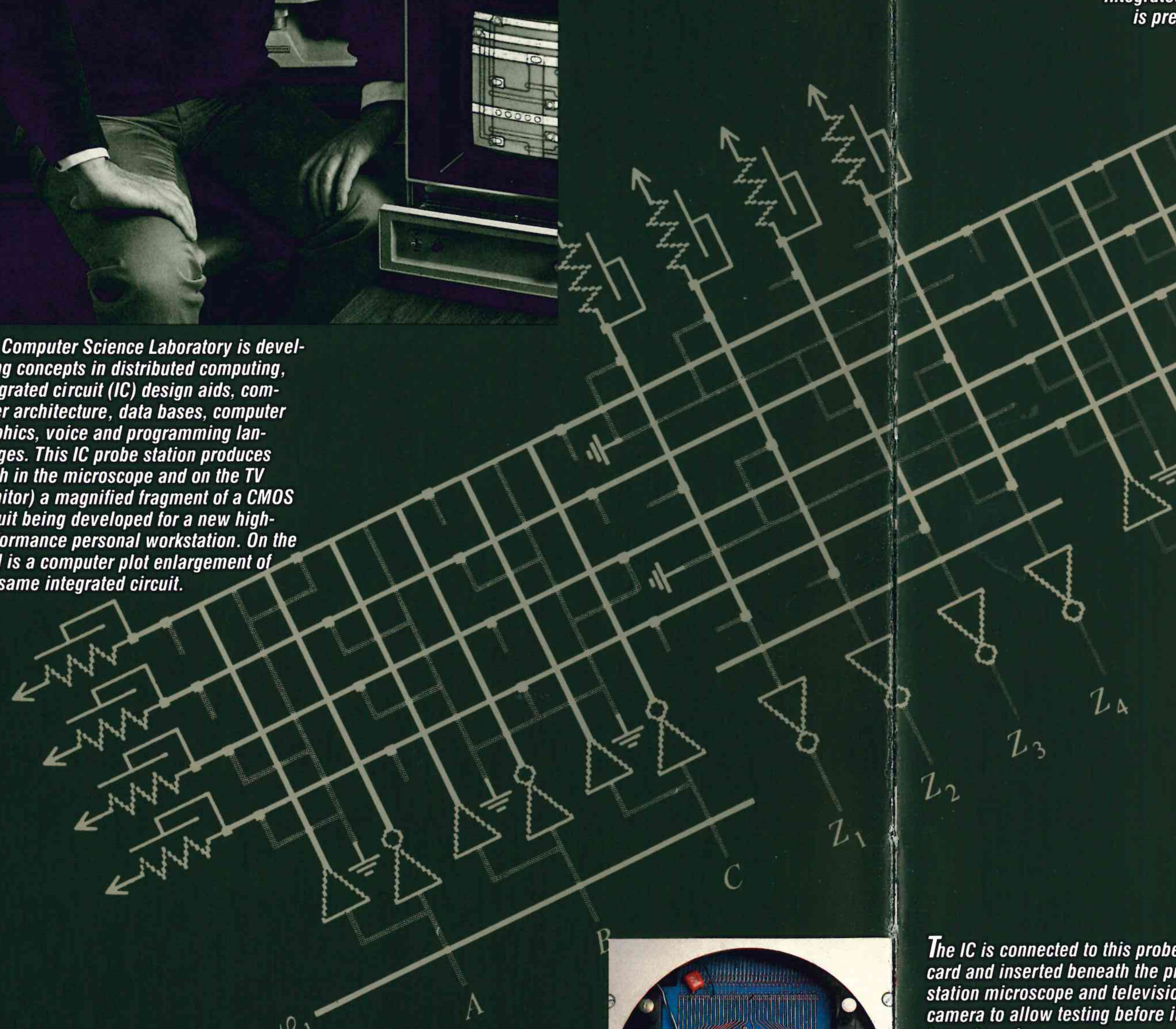
Research in the Exploratory Development Laboratory includes investigation of direct marking technologies in which the marking structures can only be fabricated through integrated circuit methods. This is an interesting reversal of history; earlier demonstration of laser xerographic printing in the Exploratory Development Laboratory laid the foundation for electronic printing technology which required electronic processing power affordable only through the economies of microelectronic techniques.

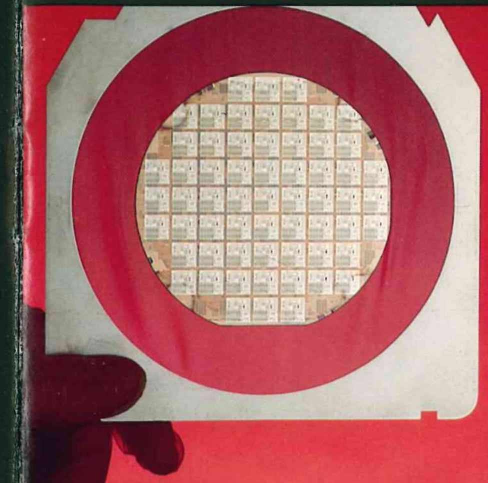
A laser-based optical disk drive, a device capable of digitally storing 400,000 typed pages of text on one side of a twelve-inch disk was also developed from a concept researched in the Exploratory Development Laboratory. The Optimem 1000 disk drive represented a major milestone in the information processing industry. The laboratory has continued to extend its advances in optical storage, as well as in the fields of image generation, color printing, optical communication and marking systems.

Among the fundamental science researches of PARC are those which relate the atomic structure of materials to their electrical properties. In the mid-1970s the General Sciences Laboratory began studies of gallium arsenide, a material of considerable electronic interest. PARC scientists used modern molecular fabrication methods to build gallium arsenide structures having exceptional electro-optical properties. The result was tiny solid-state laser devices having higher radiation power output than had been achieved anywhere else in the world. Spectra Diode Laboratories (a joint venture of Xerox and Spectra-Physics Inc.) was formed to develop, manufacture and market these state-of-the-art semiconductor laser diodes and laser devices. This is but one example of fundamental science leading directly to a commercial product. New materials offer unique opportunities for special devices which provide the basis for new products. Research in the General Sciences Laboratory explores the frontiers of physical science in basic materials, storage materials, and solid-state lasers and electronics. A remote site group, located in Tarrytown, New York, the Mechanical Engineering Sciences area focuses on structural dynamics, fluid mechanics, kinematics and simulation. These interlocking skills form a substantial basis for productive interaction with their colleagues throughout the Xerox technical community.



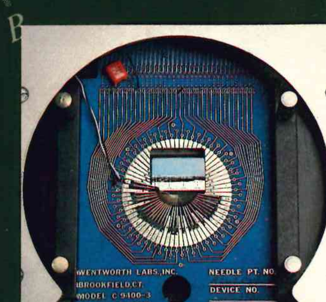
The Computer Science Laboratory is developing concepts in distributed computing, integrated circuit (IC) design aids, computer architecture, data bases, computer graphics, voice and programming languages. This IC probe station produces (both in the microscope and on the TV monitor) a magnified fragment of a CMOS circuit being developed for a new high-performance personal workstation. On the wall is a computer plot enlargement of the same integrated circuit.





A finished wafer in the Integrated Circuit Laboratory is prepared to be cut into component chips.

A batch of silicon wafers undergoes high-temperature processing. The researchers of the Integrated Circuit Laboratory form a core of Xerox expertise in CMOS technology.



The IC is connected to this probe card and inserted beneath the probe station microscope and television camera to allow testing before it is packaged.

Sophisticated chemical vapor deposition systems help fulfill the dual mission of the Integrated Circuit Laboratory: to provide support for computer systems research and to be a center of expertise in IC technology. This computer-controlled processing equipment performs silicon nitride, silicon dioxide and polycrystalline silicon depositions.

Xerographic Technology Laboratory

Electronic Marking Laboratory

Imaging Systems Laboratory

Exploratory Printing Systems Laboratory

Webster Science Laboratory

The Webster Research Center participated in the early formative days of Xerox, with the Center's actual inception and most rapid growth occurring during the decade of the 1960s. Located on the 1,000 acre site of the Joseph C. Wilson Center for Technology in Webster, New York, 15 miles east of Rochester, the Center employs more than 400 scientists, engineers and support staff.

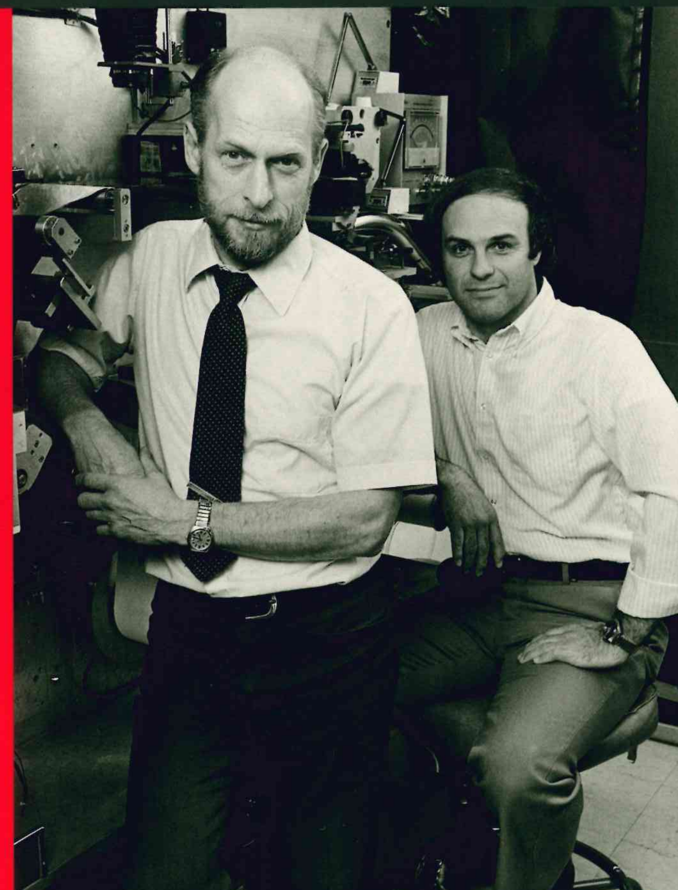
The technical horizons of Xerox have expanded markedly since those early days. The Webster Research Center's dominion now ranges across semiconductors and photoconductors, electronic properties of amorphous materials both inorganic and organic, polymeric materials, physics of small particles, electrostatics and triboelectricity, corotrons and lasers.

More recently, as Xerox business has come to encompass electronic printing and office systems, the Center has expanded its research endeavors to include such areas as digital electronics, microprocessor-based diagnostics and controls, software, distributed computing, VLSI design, special-purpose computer architectures, and feedback sensing and control devices.

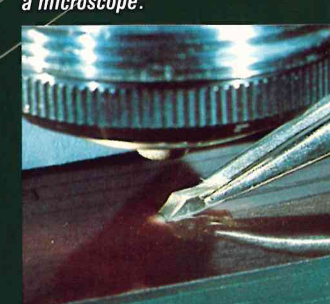
The Webster Research Center has attained international scientific recognition for its pioneering work in the physics, chemistry and applications to reprography of the broad class of amorphous or disordered materials. Such materials became the photosensors of the once-revolutionary new technology called xerography, evolving subsequently from selenium to its alloys, thence to flexible and layered polymeric structures, and now touching upon amorphous forms of silicon. Polymeric forms of amorphous materials were also essential for the inks and the fuser rolls of xerography. This generic class of materials has now reached world prominence, both for its scientific interest and for its value in new and important materials for high-technology.

Of the Webster Research Center's five Laboratories, the one related most closely to the Center's historical role of scientific and technological backing for reprographics is the Xerographic Technology Laboratory. Here are addressed problems as fundamental as the motion of microscopic particles in electric fields and as complex as the design of innovative marking devices. The lab environment, with its multi-disciplinary requirements, nonetheless focuses on a simple set of goals: to maintain Xerox leadership in xerography and related technologies, and to apply basic knowledge in the field of reprographics to the new area of electronic printing. Photoreceptor and developer materials, improvements in subsystems such as charging, cleaning and fusing, and the innovative use of electronic and feedback control devices are currently under investigation. And the horizons of xerography continue to expand. Color is playing an ever larger role in office documents, spurred by the increasing use of color in computer and workstation displays. Electronic copying, which substitutes scanners and lasers for optical lenses, is on the near horizon. With electronics, customers will be able to improve and to modify the copying process on-line to meet their individual needs. The Laboratory currently is addressing each of these areas.

The marketplace of the modern office demands a total systems approach. As office equipment becomes more sophisticated in its structure and in its ability to handle and process information, the need for integration of its component parts increasingly becomes essential. The broad distribution of information, as it exists in a variety of forms and structures, is being addressed by the Imaging Systems Laboratory. A variety of research and exploratory development initiatives related both to image structure and processing and to the general area of distributed information systems and services are undertaken. These initiatives include image and text creation



Elaborate test fixture equipment in the Xerographic Technology Laboratory allows scientists to examine the various subsystem steps of the xerographic process — charging, cleaning and fusing. Here an open fixture offers a microscopic examination of a cleaning blade/photoreceptor interface.



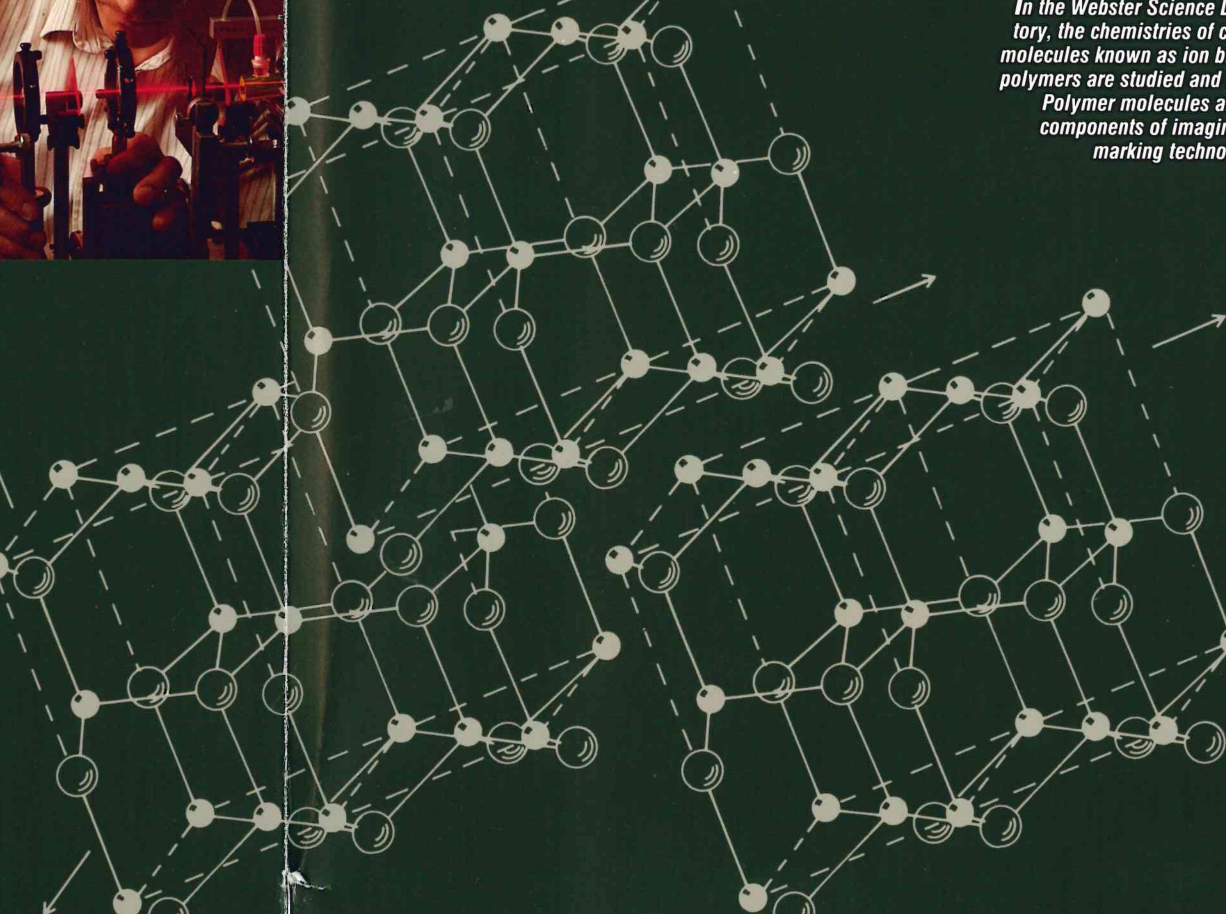
While in action, a cleaning blade is examined by a microscope.

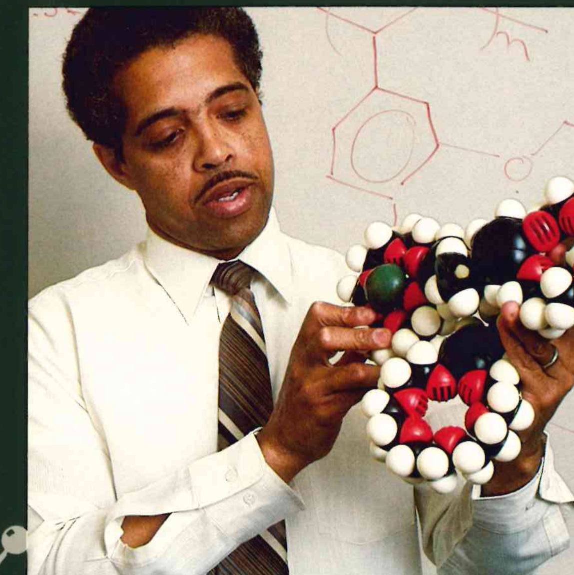
The Webster Research Center investigates a number of marking technologies for electronic printing.

A key focus of the Exploratory Printing Systems Laboratory is the study of electro-optic phenomena and materials. Here, a researcher uses a spectrometer and scanning (Fabry-Perot) interferometer for spectral analysis of light produced by an injection laser with an external resonator.

Members of the Webster Science Laboratory use an ultra-high vacuum system for analysis of metal-semiconductor interfaces on an atomic scale. The system is equipped for ESCA Auger electron spectroscopy and UV photo-emission spectroscopy.

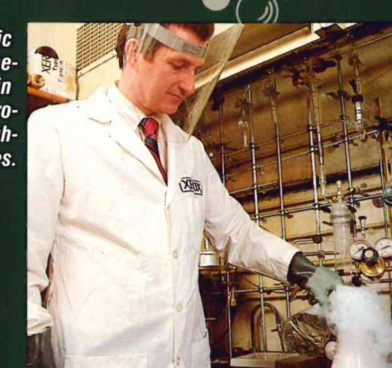
This picosecond tunable dye-laser and streak camera is used for ultra-fast time-resolved spectroscopy in the study of basic properties of new thin-film materials.





In the Webster Science Laboratory, the chemistries of certain molecules known as ion binding polymers are studied and tested. Polymer molecules are key components of imaging and marking technologies.

Polymers for electronic applications must sometimes be prepared in inert atmospheres or provided by glass high-vacuum lines.

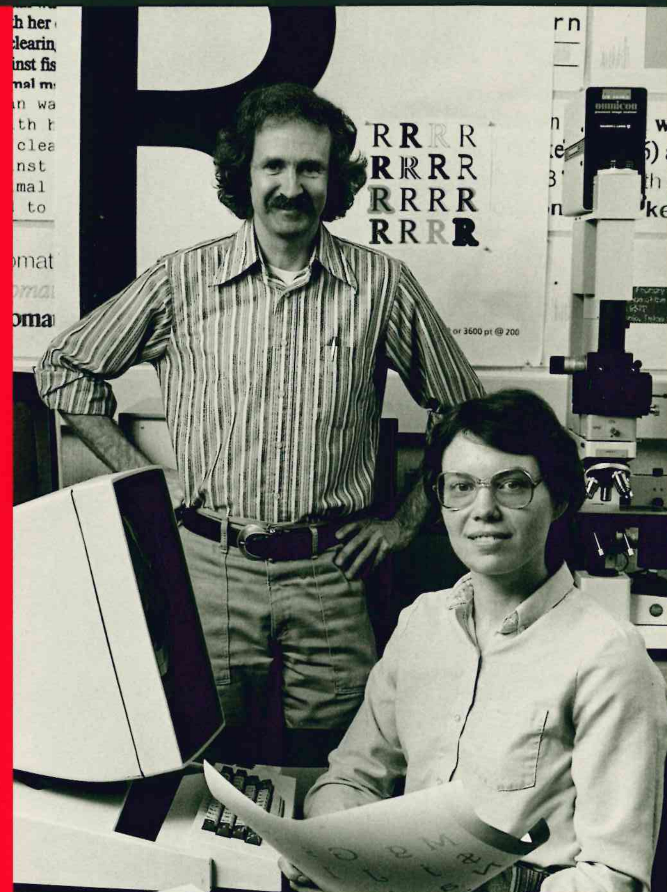


and processing, digital typography, distributed computer systems, special-purpose computer architectures, as well as real-time software and custom VLSI hardware for high-speed raster printing. These are being integrated through the design and construction of an experimental distributed electronic document publishing system, which will embody the latest technologies relating to the publishing process, including document creation and editing, page composition, graphics processing, information storage, retrieval and distribution, and electronic printing.

As electronics continues its trend to dominate both the office and the marking worlds, it becomes important to study and explore new marking technologies that can directly convert sequential electronic signals to marks on paper without the necessity for an intervening optical system. The Electronic Marking Laboratory and the Exploratory Printing Systems Laboratory share this responsibility. The increasing importance of printing, particularly from electronic input in today's office and business world is reflected in the research programs of these two laboratories. Innovative printing systems, inclusive of color, are explored at the breadboard and research prototype level. Among the technologies studied are the use of light-bar and light-valve inputs to xerographic marking. To explore novel device innovations, the laboratories jointly operate a large-area, thin-film facility for fabrications such as liquid crystal displays. The elaborate diagnostic displays on Xerox' Marathon copiers, which include color and animation, are an outgrowth of this activity.

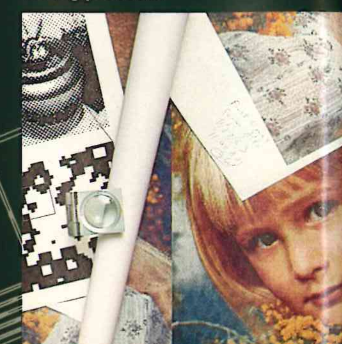
The technological activities of the four Laboratories just described benefit from a more basic scientific approach in materials and processes which is undertaken in the Webster Science Laboratory. These research activities comprise a wide range of problems in physics and materials: studies of the electronic properties of thin-film semiconductors, semiconductor interfaces, the physics of *amorphous materials and the spectroscopy of solids. The Laboratory combines state-of-the-art characterization techniques such as electronic transport, picosecond spectroscopy and UHV analysis of surfaces and interfaces with capabilities to produce new materials and device structures using, for example, plasma deposition and laser processing. There is also a Theoretical Physics and Chemistry area, which researches the theory of the organic solid state as well as the surface science of molecular solids and compound semiconductors. An area of experimental emphasis is that of organic materials, involving synthesis, characterization and utilization, which extends to macromolecular and organometallic compounds with potential application to future reprographic and electronic printing systems.*

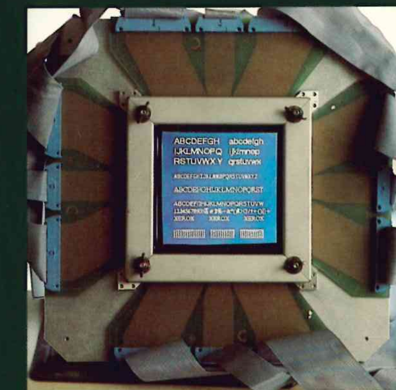
Another area of emphasis is the physics of photoreceptors. A historical landmark was the Scher-Montroll model for dispersive transport in amorphous photoreceptors. More recently, scientific findings and insights in charge transport by small molecules have led to a commercially successful flexible layered polymeric photoreceptor. Basic scientific understanding, Xerox believes, is an essential foundation and a key to commercial success.



High-resolution laser xerography, ink jet printing, and electronic displays of information are creating new challenges in the development of high-quality digital type and typography for electronic printing applications.

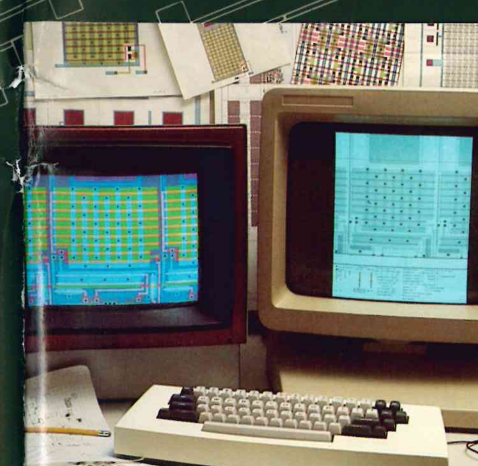
The Imaging Systems Laboratory performs research in the fundamental algorithms, architectures, software, and custom-VLSI electronics of digital printing and color image processing for future electronic publishing products.





A flat panel TFT (thin-film transistor) liquid crystal matrix display shows an array of 62,500 transistors, each of which controls one pixel. The panel itself is only about one-eighth of an inch thick and requires one hundredth of the energy of a standard CRT. Flat panel display technology is an important future requirement for user interfaces for Xerox systems and reprographics products.

Scientists in the Electronic Marking Laboratory work with a semi-automatic wire bonder to make state-of-the-art device interconnections in integrated circuits on hybrid devices. The Large Area Electronics staff engages in a wide variety of microfabrication methods and sophisticated device packaging technologies.



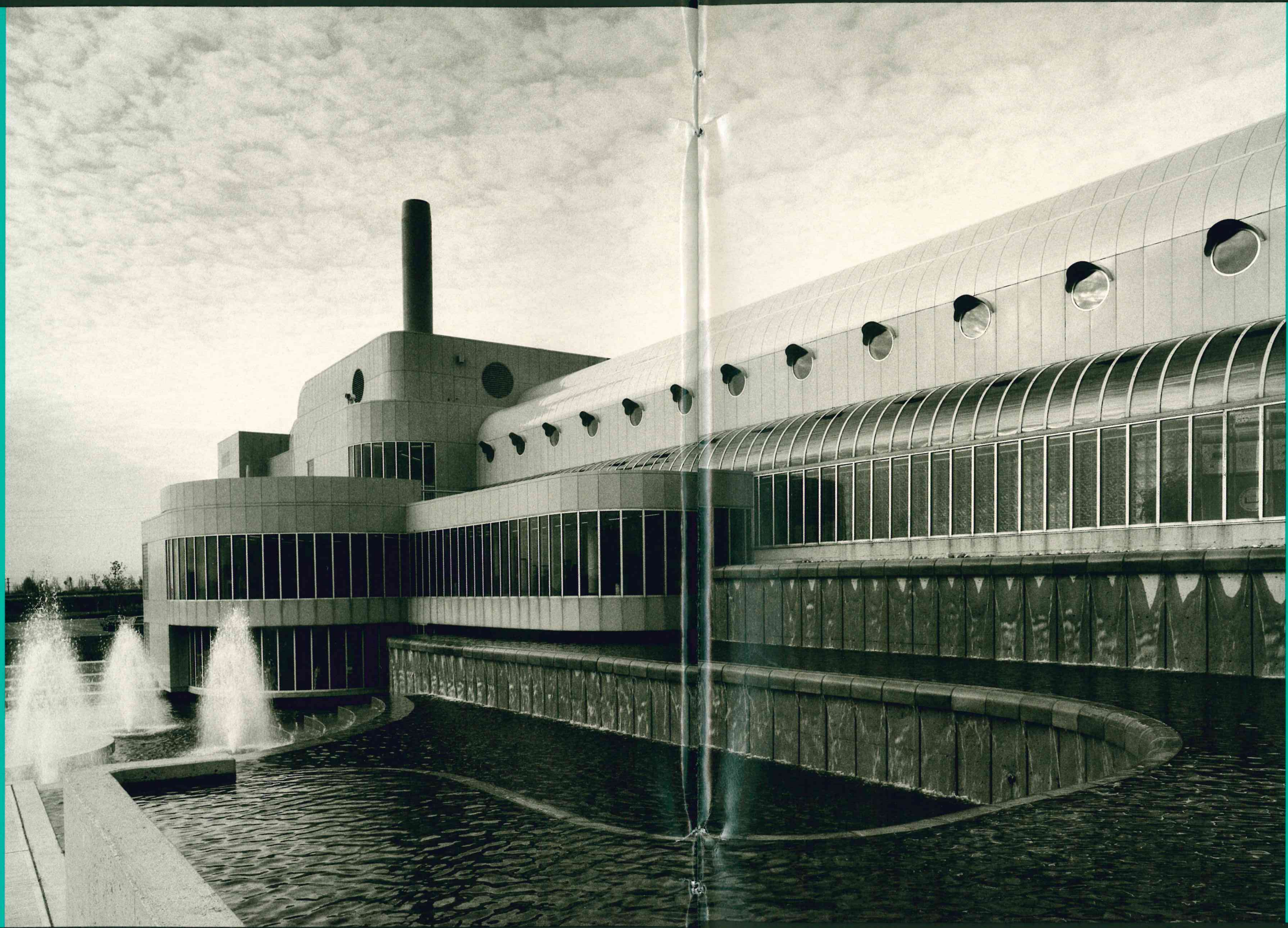
Monitors display portions of special-purpose VLSI circuitry in the development of high-speed raster printing concepts.

Materials and Control Engineering Laboratory

Materials Science and Characterization Laboratory

Physics and Engineering Laboratory

Synthesis and Exploratory Research Laboratory



The basic Xerox technology—xerography—is materials-oriented. Papers, inks, fusers, toners, and photoreceptors are critical components of the imaging process. If Xerox is to maintain its preeminence in the business of office information transfer, a primary goal of its research must be to understand the fundamental natures of these materials. Thus the recent completion of the chemical research laboratories at the Xerox Research Centre of Canada (XRCC) is a major milestone in company history.

With the addition of these laboratories, the Centre—located in the Sheridan Park Research Community in Mississauga, Ontario (just 20 minutes from downtown Toronto)—now encompasses 120,000 square feet of modern chemical laboratories and instrumental facilities, including a conference center, a museum of historical exhibits entitled "Man's Writing Materials," and a sophisticated, 27,000 square foot chemical engineering pilot plant completed in 1981.

One of the primary benefits of the XRCC location in Ontario's "Golden Horseshoe," along the Lake Ontario shore, is that the site is within a half-hour drive of five major universities. Since the molecular sciences and process engineering are the strong suits of Canadian academics, Xerox has actively developed a healthy symbiotic relationship with the schools in Canada. University professors on sabbatical leave, visiting scientists from overseas and industrial post-doctoral fellows are frequently invited to join the XRCC staff for one or several years. XRCC professionals often participate in university activities as adjunct professors and seminar speakers. Support for university research through grants-in-aid and sponsorship of lectures and symposia has been a hallmark of the Xerox presence in Canada.

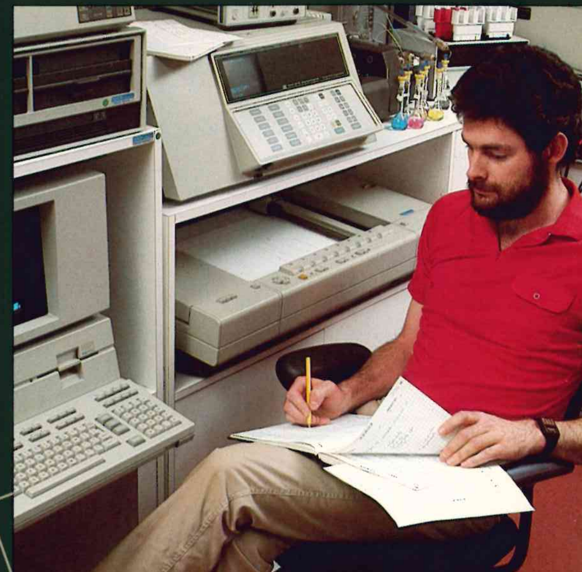
The XRCC installation is organized into four generic areas of research: Organic and Polymer Synthesis, Materials Science, Physics of Materials, and Process Engineer-

ing. The common denominator is a "molecular sciences research culture" which brings together people with diverse backgrounds and a wide variety of research interests such as physical organic chemistry, photochemistry, polymer science, thin-film science, chemical engineering and paper physics.

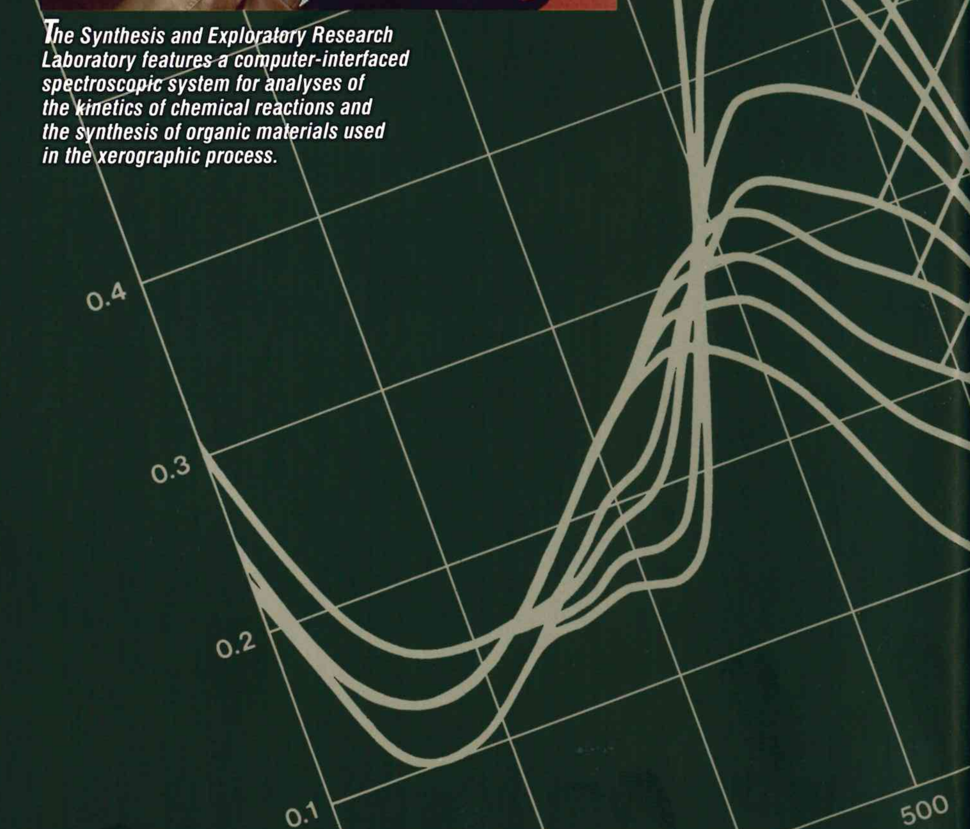
One of the unique features of XRCC is its ability to meld bench-scale chemistry with pilot plant process engineering. Housed in a three-story modernistic structure, the fully automated chemical synthesis facility—with state-of-the-art equipment for materials synthesis and conversion—is truly a blend of a university chemical engineering laboratory and a modern industrial chemical plant. Special attention is given to process design, scale-up and innovative unit operations. Control engineering and process modeling are essential to Xerox' ability to provide custom chemicals, polymers and composites meeting precise specifications.

A key generic area of research at XRCC is molecular design and synthesis—particularly in the critical areas of photoreceptors, developer materials, dyes and photoactive pigments. The driving philosophy of XRCC management is that innovative materials require a starting synthesis step. A primary concern over the past few years has been the synthesis, purification and scale-up of the charge transport molecules which are part of the modern photoreceptor. The design and characterization of this material device, essentially an organic semiconductor, requires synergy between physics, chemistry and process engineering.

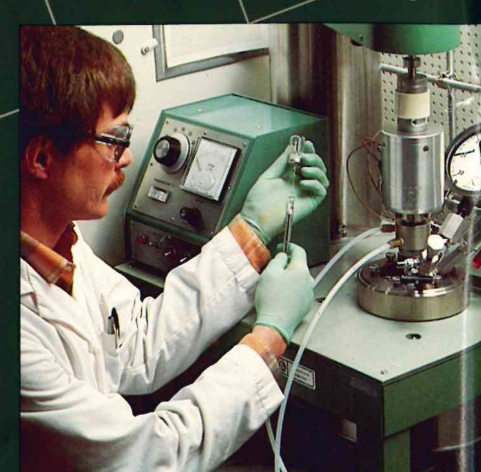
An important part of the XRCC research mission is the design, synthesis and fabrication of the developer systems for liquid marking. These toners have had an immediate impact in dental radiography, low x-ray exposure mammography, thermal printing and color electrography. XRCC is also conducting ground-breaking research in low-energy fusing toners, reduced stage fabrication of



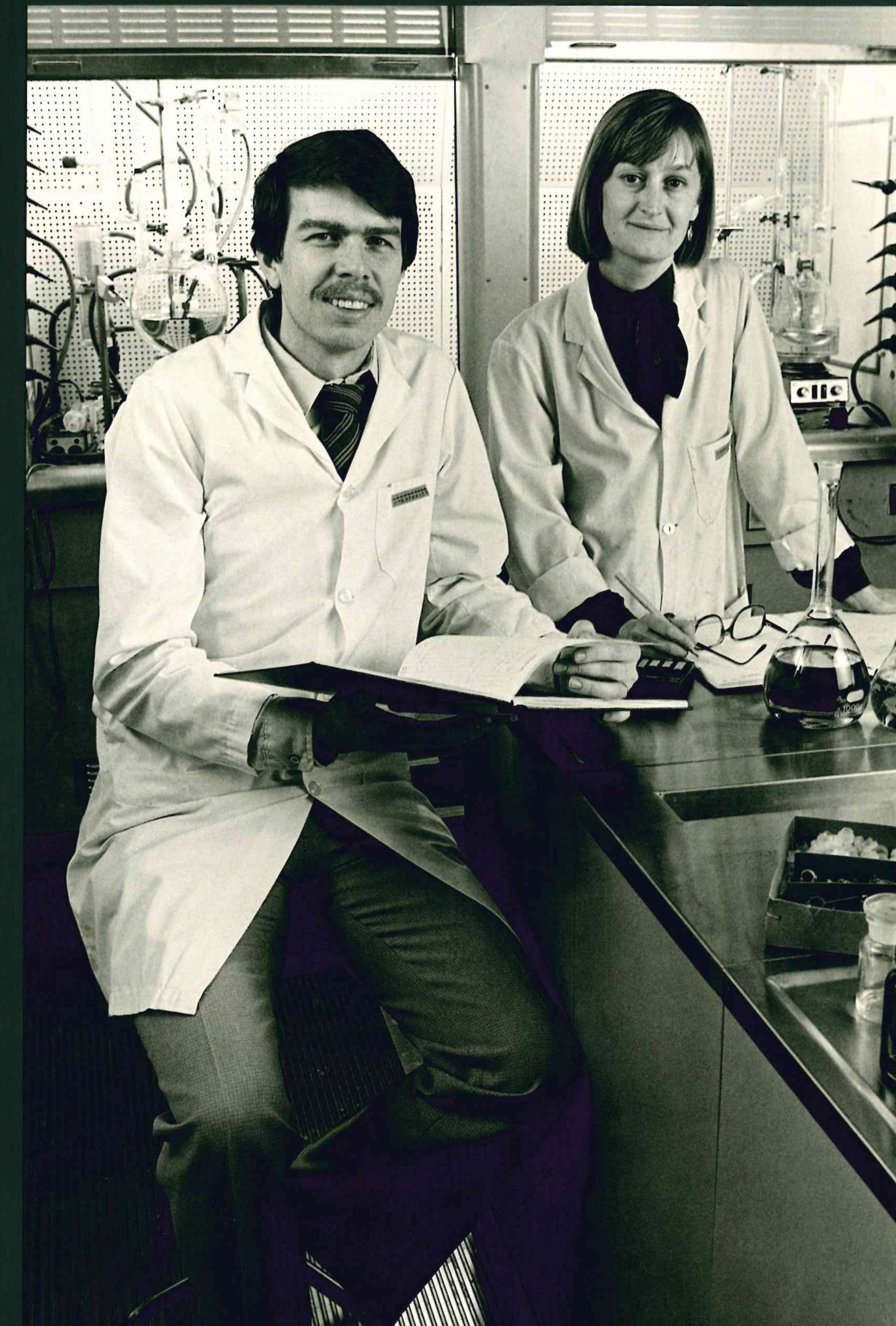
The Synthesis and Exploratory Research Laboratory features a computer-interfaced spectroscopic system for analyses of the kinetics of chemical reactions and the synthesis of organic materials used in the xerographic process.



This fineness grind gauge is used for ink studies related to color printers.



Scientists in the polymer lab work with polycondensation reactors to synthesize high-performance polymers such as nylon and polyesters.



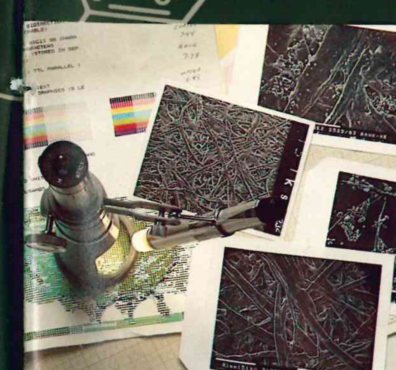
Chemicals are synthesized for photoreceptors as well as pigments and charge control agents for use in toners.

Researchers in the Materials Science and Characterization area use nuclear magnetic resonance spectroscopy to characterize and study the molecular structure of organic and polymeric materials.

Another of the many facets of materials science is the characterization of materials—toners, ink particles and organic photoreceptors—utilizing this transmission electron microscope.

The X-ray Diffraction facility gives XRCC scientists a look at the structure and morphology of both monomeric and polymeric materials. Shown are a Kratky small-angle x-ray camera, a Philips x-ray powder diffractometer and a Warhus camera.

Key research in the Physics and Engineering Laboratory includes the testing of the functional/mechanical properties of paper—both commercial samples and special lab-created specimens. Tensile-test equipment is used to determine the strength of a particular paper sample.



Paper samples are carefully analyzed. These paper and printed paper specimens were photographed through an electron microscope to be studied in minute detail.

toner, and molecular charge control and color. This modern approach combining molecular design with economic means of production demands close coupling with copier architects in the Webster Research Center so that customized and proprietary developers are ideally integrated with new machine concepts.

Paper has always been an essential part of the copying process and is increasingly important to achieve reliability specifications. A fundamental understanding of how paper curl and paper dust affect the copying process has been an ongoing concern. Because of the Canadian research strength in paper science and technology, XRCC has focused on such crucial areas as fabrication of fibrous laminates, electron beam writing and ink-paper interactions. The paper thrust includes coating technology as a generic method to create novel substrates, either fiber or film-based. A basic objective of this group is to leverage the strong paper research community in Canada to engineer the optimum low-cost xerographic paper. For this need, XRCC maintains a fully equipped TAPPI standard test laboratory and has designed one of the world's most modern "wet laboratory" for papermaking.

Synthesis and processing thrusts for high technology place unique demands on materials scientists to characterize the products. This need is felt first of all at the molecular level for which all of the classical spectroscopic and microscopy equipment (NMR, ESR, mass spectroscopy, FT-IR, UV-visible, DSC, rheometrics, electron and visible microscopy, x-ray diffraction, etc.) are available. Beyond this, an important challenge is the functional testing of the complex materials which are created to satisfy the need of modern reprographic engines. An example of special functional testing equipment is an automated photoinduced discharge device for evaluating photoreceptor chemicals. Another example is a charge spectrograph which provides a distribution curve of the charge to mass in a toner powder. Methodology for evaluating properties such as these is an ongoing challenge to the scientists working at XRCC.

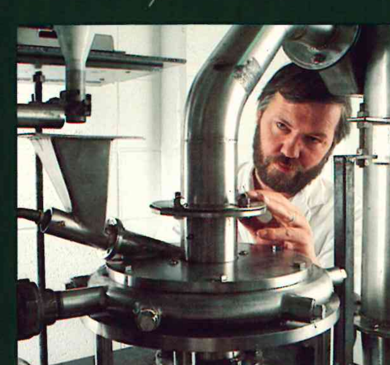
To support these technical activities, XRCC dedicates a significant fraction of its resources to basic science explorations, including theoretical studies. If research is to ensure the long-range viability of Xerox, it must go beyond the anticipation of near-term crises. Long-range research relating to topics such as molecular electronics, biomimetic reprographics, interparticle forces in colloids and statistical mechanics of phase separations in macromolecular systems are meant to keep Xerox in the forefront of marking technology for the decades ahead.

Sixty percent of the research done at XRCC is applied, twenty percent is oriented toward scientific research and twenty percent is exploratory. An example of the latter is XRCC's response to the Canadian government's identification of solar energy as a field for intensive research during this decade. With support from the Canadian National Research Council, XRCC developed an inexpensive organic photovoltaic device, based on its extensive knowledge of fabrication and mechanisms in photoreceptor technology.

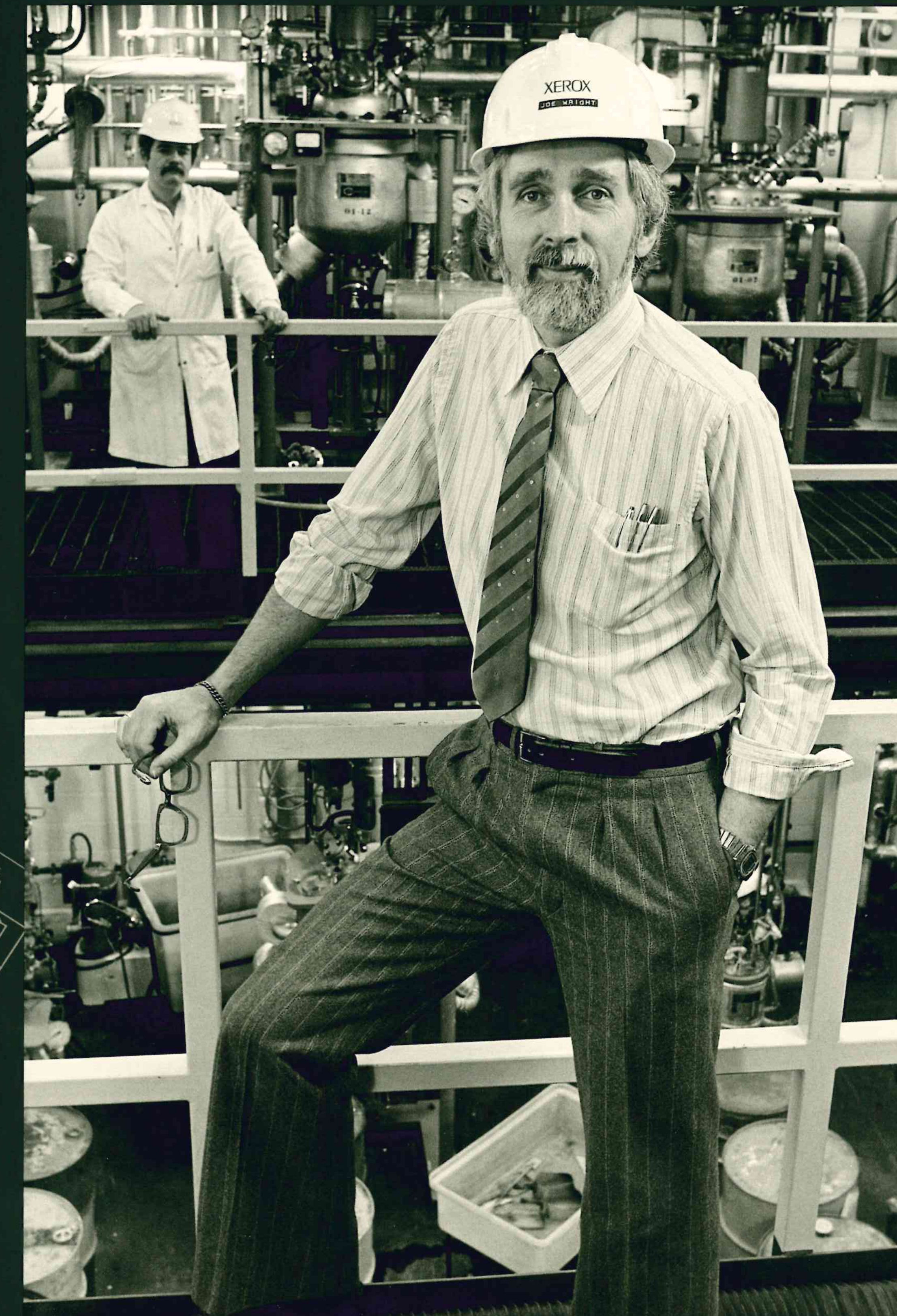
Another example of exploratory research has been XRCC's work in security printing using Xerox' proprietary micrographic film process. Based on migrating selenium particles to create an image, this photographic film has become a promising new material for information storage. Present-day applications are focused on graphic arts, microfilm and instrumentation recording businesses. The film, on which Xerox holds more than 90 U.S. patents, is therefore a direct replacement for silver halide materials in markets estimated to be in the billion-dollar region worldwide.

The XRCC Pilot Plant—computer controlled for both data acquisition and process control purposes—is used to design state-of-the-art automated processes as well as to enhance the productivity of the research team.

The XRCC research facilities include several large-scale chemical reactors. This one is used for the production of photoreceptor materials.



Particle micronization completes the cycle of process research. Materials from the organic synthesis pilot plant are blended with pigments and ground into powder for use as toners in xerographic processes. If successful, the technology is transferred to downstream development organizations.



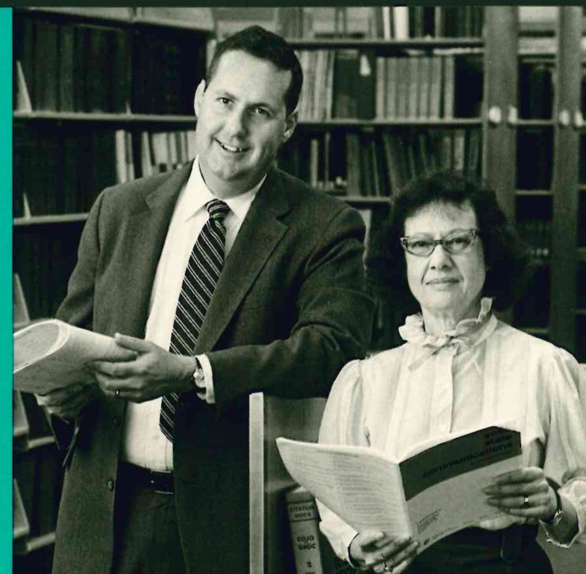
The reactors in the Materials Processing Laboratory take raw materials and convert them into the base chemicals for toners, photoreceptors and coatings used in Xerox processes.

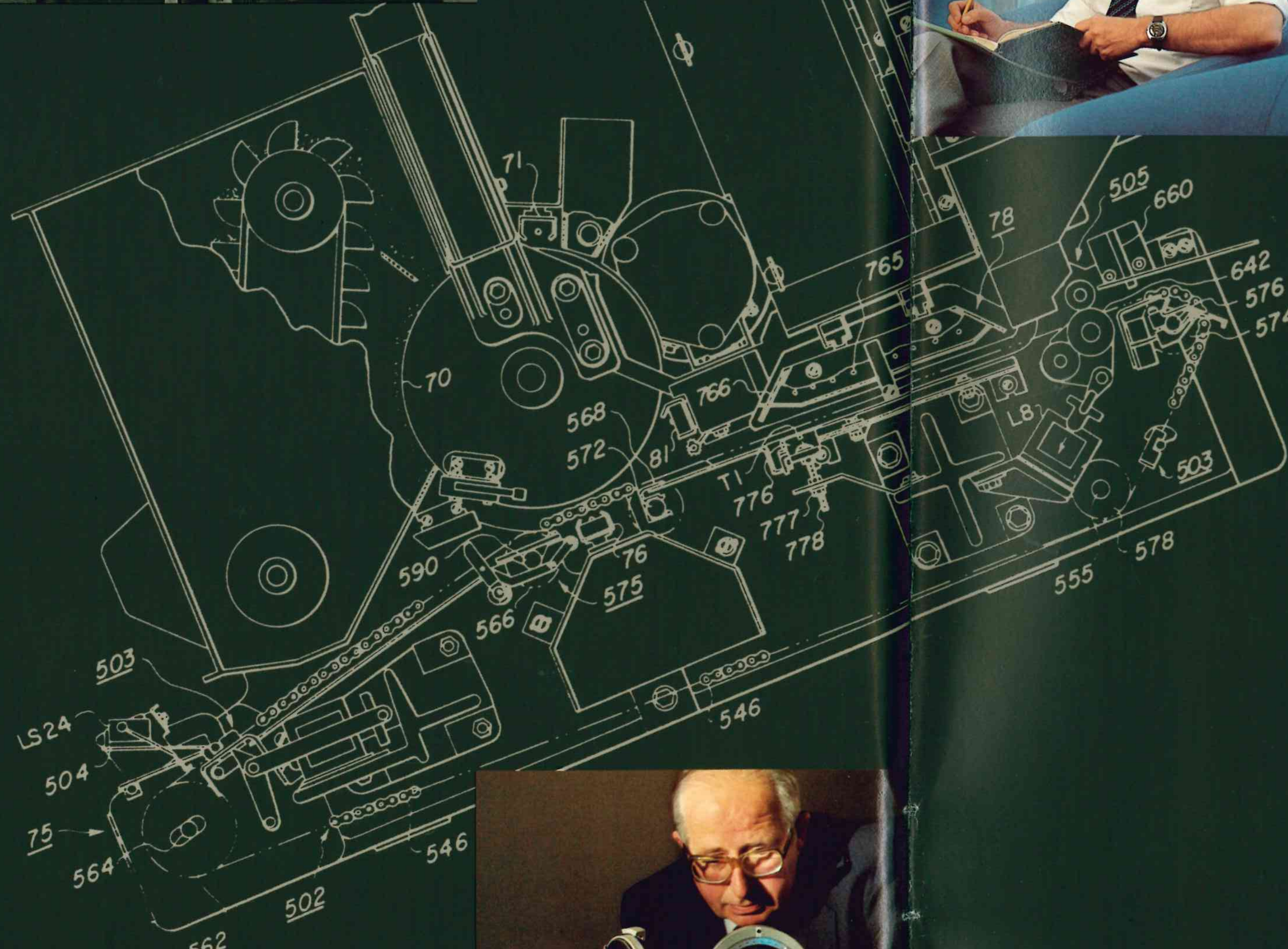
As we have tried to show in this brochure, we believe that our people are our most important asset. Sophisticated equipment and modern facilities only become productive tools with the creative ideas and concepts of imaginative scientists and engineers.

Early in the history of Xerox research, we set up a plan to reward and recognize our outstanding scientists and engineers for their technical accomplishments. This may sound elementary but all too often organizational structures do not have enough high ranking positions for technical contributors. They can rise only so far until further promotion would require them to take on managerial responsibility. Dedicated scientists are not always happy managing groups of people and therefore Xerox established the positions of Research and Senior Research Fellow. The Fellows program is comprised of scientists who are widely recognized in the national and international technical and academic communities—scientists who have earned unqualified acknowledgment that their technological contributions have had significant pivotal impact on the objectives of the corporation. The Fellows receive promotions and appointments based upon their individual achievements and recognition by their peers.

The Research Fellows independently choose research directions and resolve problems associated with the development and implementation of new programs, and are responsible for extending the body of knowledge within their fields.

As a group, the Council of Fellows represents Xerox' leading edge at the technical frontier.





Daniel G. Bobrow produced one of the first theses in the groundbreaking artificial intelligence project at M.I.T. Since then he has been a leading contributor to the growing body of knowledge in that rapidly expanding field, and is currently both editor-in-chief of the international journal, Artificial Intelligence, and a Fellow in the Intelligent Systems Laboratory at PARC.

Robert D. Burnham is a noted authority in the growth and characterization of III-V materials, with emphasis on lasers. He is a co-recipient of the IEEE Morton award for his work in the field of solid-state electronic devices. His most recent work is concerned with growing quantum well heterostructures by metal-organic chemical vapor deposition. The high-power lasers achieved by this technique are the basis for Spectra Diode Labs, a joint venture between Xerox and Spectra-Physics Inc.

Vittorio (Rino) Castelli, former chairman of the department of mechanical engineering at Columbia University, has interests that range from machine dynamics and gas film lubrication to elasticity and numerical methods. In addition to his work in both academia and the computer industry, he has made notable contributions to the space program and bio-medical engineering.

Esther M. Conwell is a member of the National Academy of Engineering, elected for her contributions to semiconductor theory. She is currently studying the nature of electronic transport in novel organic semiconductors—polymers and quasi-one-dimensional molecular crystals—and the electronic and optical properties of composites.

Peter Crean has been a member of pioneering groups in laser printing, high-resolution document scanning and ink jet printing. Most recently he has directed his efforts to the development of a new generation of electronic systems for the creation, transmission and printing of office documents, with a special emphasis on color and advanced graphics.

L. Peter Deutsch has focused his research efforts on the design and implementation of interactive programming systems. He has been a major contributor to key projects such as the Xerox Cedar system; AltoLisp, the precursor of Interlisp-D, a renowned artificial intelligence language; and, most recently, the Smalltalk-80 system.

Charles B. Duke has spearheaded Xerox research in the crucial area of organic photoreceptors. During the 1970s he led a group which generated design algorithms and a quantitative description of polymer-metal and polymer-polymer triboelectric charge transfer, as well as a unified theory of photoemission, ultraviolet absorption and charge transport in polymers and molecular gases.

Andrew Gabor led the development of the first commercially successful electronic typewriter, commonly known today as the "Daisy Printer"—now a worldwide industry standard. He is the inventor and holds the basic patent on the "daisy wheel." As a Senior Research Fellow in charge of the Advanced Technology area, he continues to work on new concepts for electronic typing.

Robert W. Gundlach has a contagious enthusiasm for invention, particularly in xerography. During the last thirty-two years he has contributed to improvements in most of the subsystems of the xerographic process. He invented an early strip lens concept, a method to increase development speed and a unique method to produce highlight color images; he now holds 130 U.S. patents. His current interests are in electronic printing systems, simplified high-quality xerographic development methods and improved ion charging techniques.

William Gunning's current research centers on the design, analysis and simulation of electronic and electromechanical hardware systems. Over the past decade he has been involved in such important Xerox projects as the Ethernet and Astranet high-speed local area network communication systems, as well as the development of various non-impact and impact printing systems.

Werner E. Haas is a Senior Research Fellow and manager of the Exploratory Printing Systems Laboratory in the Webster Research Center. Since 1966, he has conducted pioneering work in the development of magnetic imaging, non-impact printing and liquid crystal display technologies. His projects have included studies in fiberoptic coupling and a matrix addressed phosphor panel.

Michael L. Hair's primary scientific concern is the chemical nature of surfaces and interfaces. His early research in infrared spectroscopy contributed significantly to the understanding of surfaces in colloid chemistry. His recent work has focused on the nature of the solid/liquid interface.

Edward M. McCreight is best known for his work in the algorithms and data structures for searching (most notably B-Trees). He has taught at the University of Washington, Stanford University and the Swiss Federal Institute of Technology in Zurich. He is part of a PARC team which is designing a high-speed general-purpose multi-processor computer system.

Calvin F. Quate made his mark in the field of acoustic imaging by introducing the concepts used in the Scanning Acoustic Microscope. A commercial version is now available with resolution comparable to that of an optical instrument. He is presently dividing his time between Stanford University and PARC, where he is investigating the development of liquid printing techniques.

Paul G. Roetling's research specialty is digital image processing, with concentration on scanned-in raster images—including text, line art and pictures. Past projects include the generation of the Versatec Gray Scale Versaplot adaptor and 6500 Color Graphics Printer. He is also a Fellow of the Optical Society of America and the Society of Photographic Scientists and Engineers.

Nicholas Sheridon pioneered the fields of acoustical imaging and blazed holographic diffraction gratings for Xerox. His inventions include projection and flat panel display devices which have set technology standards in these areas. His current research interest is ionographic printing.

Gary K. Starkweather is a leader in the study of optics and laser scanned xerographic systems; his work sparked the development of the Xerox 9700 Laser Printer. In 1977 he received the Xerox President's Achievement Award for his contributions to laser scanning technology.

John Webb is a xerographer whose product concepts have filled key niches in Xerox' most important market—the Xerox 2600 and 8200 copiers are notable examples. His current interest lies in the development of novel marking technologies.

Design:Jonson Pedersen Hinrichs & Shakery. Major Photography:John Blaustein. Printing:George Rice & Sons

The Xerox commitment to research is rooted in two key corporate objectives:

One, Xerox wants to understand—in the most truly fundamental sense—what its products are and should be.

Two, Xerox wants its technological future to grow out of direct participation in world science, and to rest in the hands of the finest research minds available.

Xerox has devoted considerable resources to these ends since the founding of the original Webster research unit more than 35 years ago. The results: an unceasing flow of knowledge, inventions, new and/or enhanced technologies and highly trained, creative people—people who are dedicated to innovative leadership and surrounded by a well-funded, nurturing yet intellectually challenging research environment.

Even though Xerox is a business corporation, much of the work that goes on in each of the three research centers—PARC, WRC and XRCC—is indistinguishable from quality university research. Xerox understands the nature of knowledge and the pursuit of knowledge: knowledge flows from people and its pursuit thrives on spontaneity. Truly groundbreaking research often emerges from a grass-roots level and by its very nature is the result of various, sometimes independently, evolving efforts.

Thus, while Xerox may define certain "corporate" areas of research, these areas are extremely broad (microelectronics, distributed computing, etc.) and there is a great deal of freedom within their parameters. Although Xerox as a corporation is concerned with the business of providing essential services to the officeplace, the Xerox research centers in Webster, Palo Alto and Toronto will continue to support research in a wide spectrum of fundamental disciplines. Xerox is proud of its contributions to science and proud of its renowned staff of researchers, all fully participating members of the international scientific community.

XEROX

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Xerox Corporation
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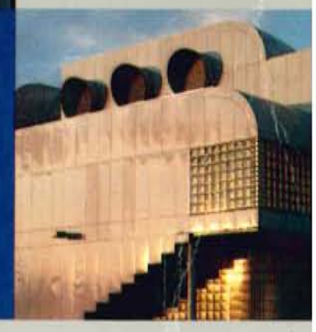


Xerox Research Centers

Xerox Research Centers

"We store up information the way cells store energy. When we are lucky enough to find a direct match between a receptor and a fact, there is a deep explosion in the mind; the idea suddenly enlarges, rounds up, bursts with new energy, and begins to replicate. At times there are chains of reverberating explosions, shaking everything; the imagination, as we say, is staggered." — Lewis Thomas

Relatively few corporations in the United States support sophisticated centers for industrial research. Xerox is one of these corporations. In our research centers we strive for a nurturing climate for all kinds of reverberating explosions and staggered imaginations, maintained within a structure that channels and transforms ideas into new products and systems.

Xerox is proud of the commitment it has made to the progress of science and the demonstration of new technology in its research laboratories. In this brochure about the research activities and environments in our Corporate Research Centers, we hope that there is evidence of a company deeply rooted in the belief that an individual with a vision can create the foundation upon which the ideas of many will continue to build.

Webster Research Center

Palo Alto Research Centers

Xerox Research Centre of Canada

Xerox Research Centers

Science is knowledge of man and the world about him. Invention is the creation and demonstration of new concepts. As science has become ever more sophisticated and intricately structured, and as society has developed more complex interdependences, invention requires more resources and more sophisticated tools; it has become increasingly difficult for the individual to invent. Yet Xerox–the corporation whose genesis was in Chester Carlson's inventive demonstration of xerography–cannot rest on its past pioneering accomplishments in office copying. Xerox' role of providing essential services to the office requires a continuing infusion of innovation. To that end, Xerox, as a major technology-based company, provides an environment where science and invention meet and sustain each other in support of corporate objectives.

Xerox Corporate Research operates in three major sites, four research center organizations, and six separate geographic locations. The first Xerox research center was established in Rochester. Here Xerox had its business origins as the Haloid Corporation, a small photographic paper company which, through Joseph Wilson's vision, developed Chester Carlson's invention and introduced it to the business office. Known as the Webster Research Center, (WRC) this original research unit is located in suburban Rochester; it also maintains a laboratory in association with the Office Products Division in Dallas.

The second research site established by Xerox is on the West Coast, where the two Palo Alto Research Centers (PARC) are co-located. They maintain two additional laboratories on the Pasadena site of Xerox Electro-Optical Systems and near the Xerox engineering and electronics operations in El Segundo.

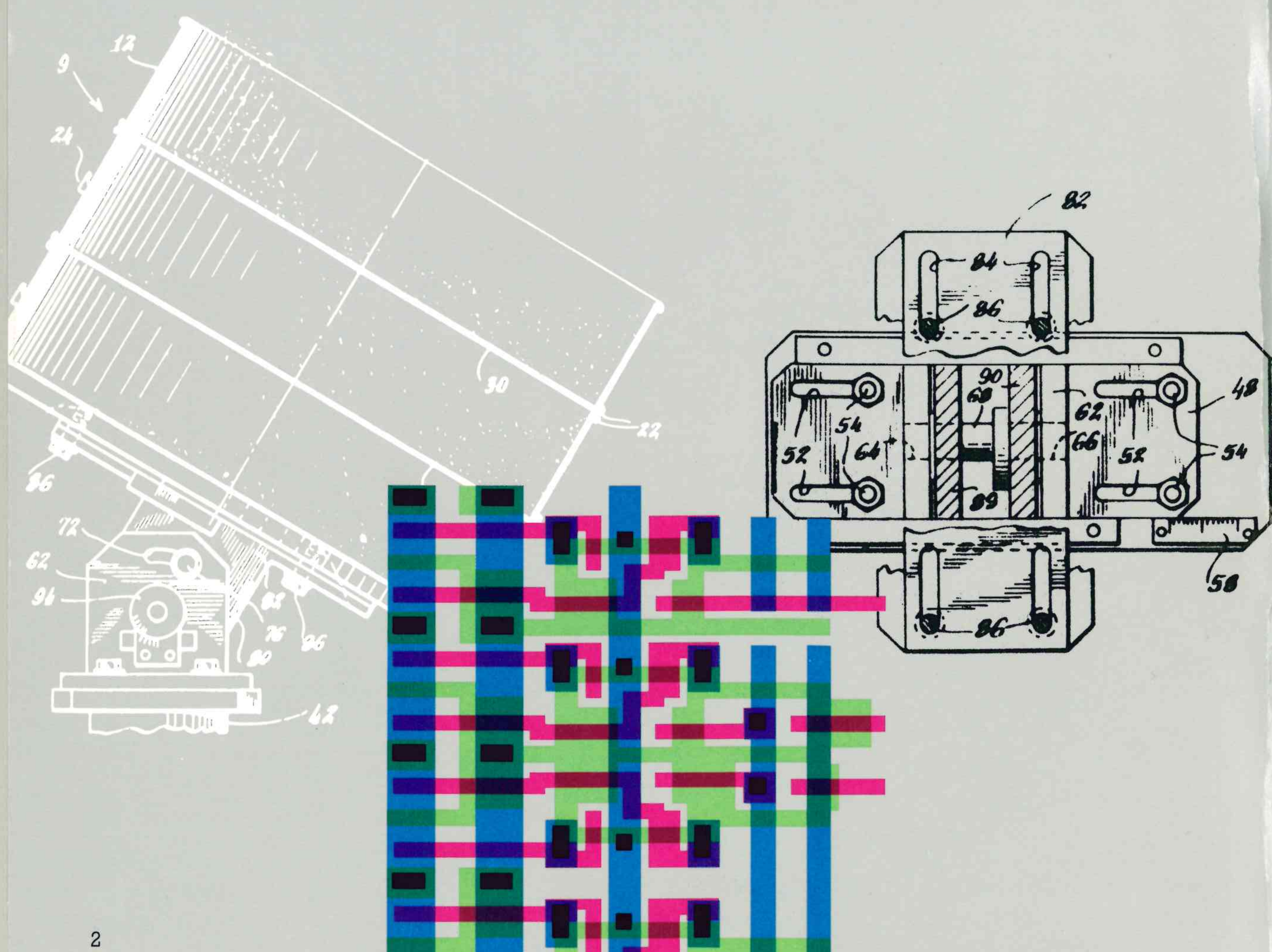
The newest Xerox research installation is Xerox Research Centre of Canada, in Mississauga, Ontario, just outside Toronto.

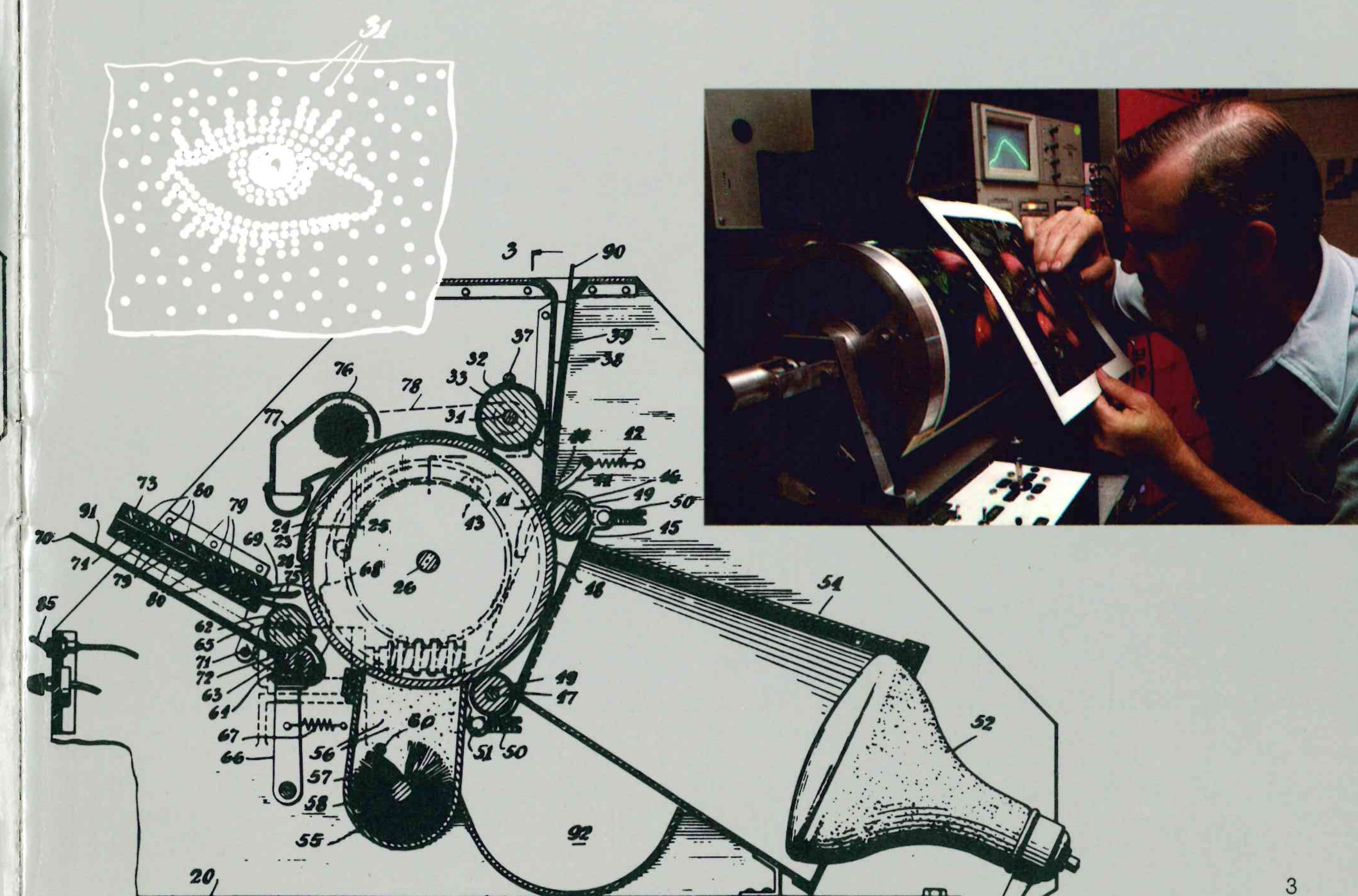
There are additional R&D efforts associated with the corporation's multinational operations, Rank Xerox, headquartered in the United Kingdom and Fuji Xerox in Japan; these activities are not covered in this brochure.

The Functions of Research

Researchers in Xerox expect to generate a continuing flow of concepts, knowledge, inventions, and product prototypes from which the corporation can draw in providing the functions and services enabling increased productivity in the business office. For this purpose, the research programs include some basic research in those sciences particularly relevant to technologies utilized by the corporation, applied research aimed at new or improved technological capabilities, and selected exploratory development of research prototypes as forerunners to products and services which the corporation can market.

In the category of relevant science, Xerox maintains groups of chemists, computer scientists, engineering scientists, materials scientists, and physicists who help to keep the corporation abreast of new developments in their respective specialities by being active participants in advancing their sciences. Xerox must continually make use of the reservoir of knowledge generated by the international scientific community. As a responsible corporate enterprise, Xerox also feels an obligation to contribute to that reservoir from which it continually draws. Just a few examples for which Xerox work



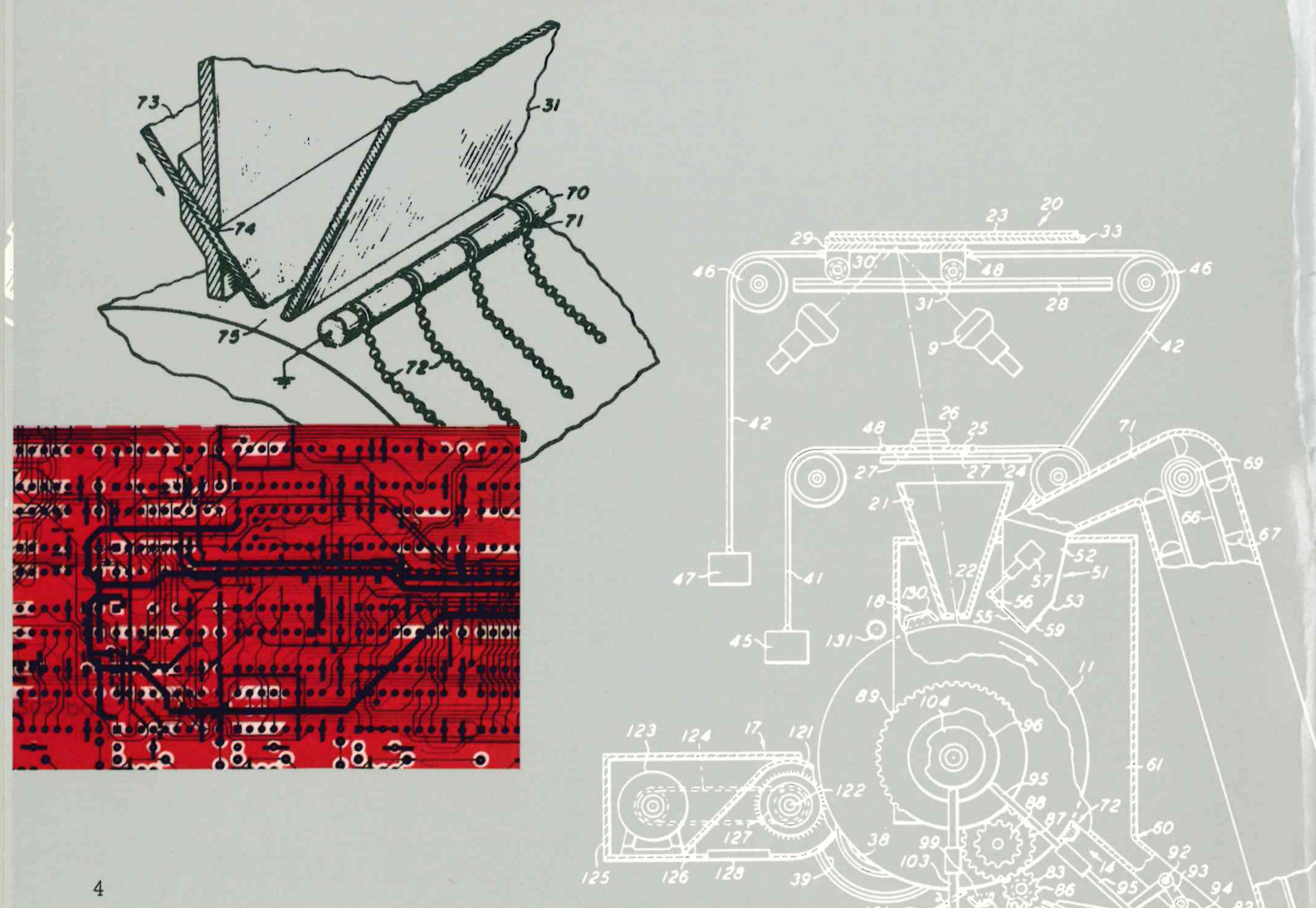


has achieved world recognition in science are amorphous semiconductors (used by our copiers for capturing the latent image), liquid crystal science underlying applications in display technology, and, in computer science, distributed computing for which we have pioneered a communication technology called Ethernet.

Most of Xerox Corporate Research could be called applied research. Here scientific principles and knowledge are combined with new concepts of possible applications in an effort to show laboratory feasibility. Once a new idea is shown to work at the laboratory bench, the process of developing it into a cost-effective, manufacturable, reliable product or service can begin – but laboratory feasibility is a prerequisite to such product development. Examples of applied research carried forward by Xerox research centers in the past are creation and demonstration of alloy photoreceptors, laser xerographic printing, and high-density optical digital storage.

Based upon applied research successes, selected ideas for products or services may be carried to fully functional prototype form for evaluation prior to possible engineering of a product for manufacture. We call this activity exploratory development. Recent examples include variants on our xerographic copiers, such as the 6500 Color Graphics Printer which came directly out of research into the product stream, and the distributed computers and laser printer systems, coupled through Ethernet communications, that have been in daily use and evaluation within Xerox for a number of years.

Sometimes the end results of research are not concepts for new products or services, but rather new techniques that increase the productivity, capability, or effectiveness of other Xerox divisions or enterprises. Examples of such tools include sophisticated instruments for measuring the characteristics of electrostatic charging in the materials and subsystems of our copiers, and powerful computer aids for designing integrated circuits.

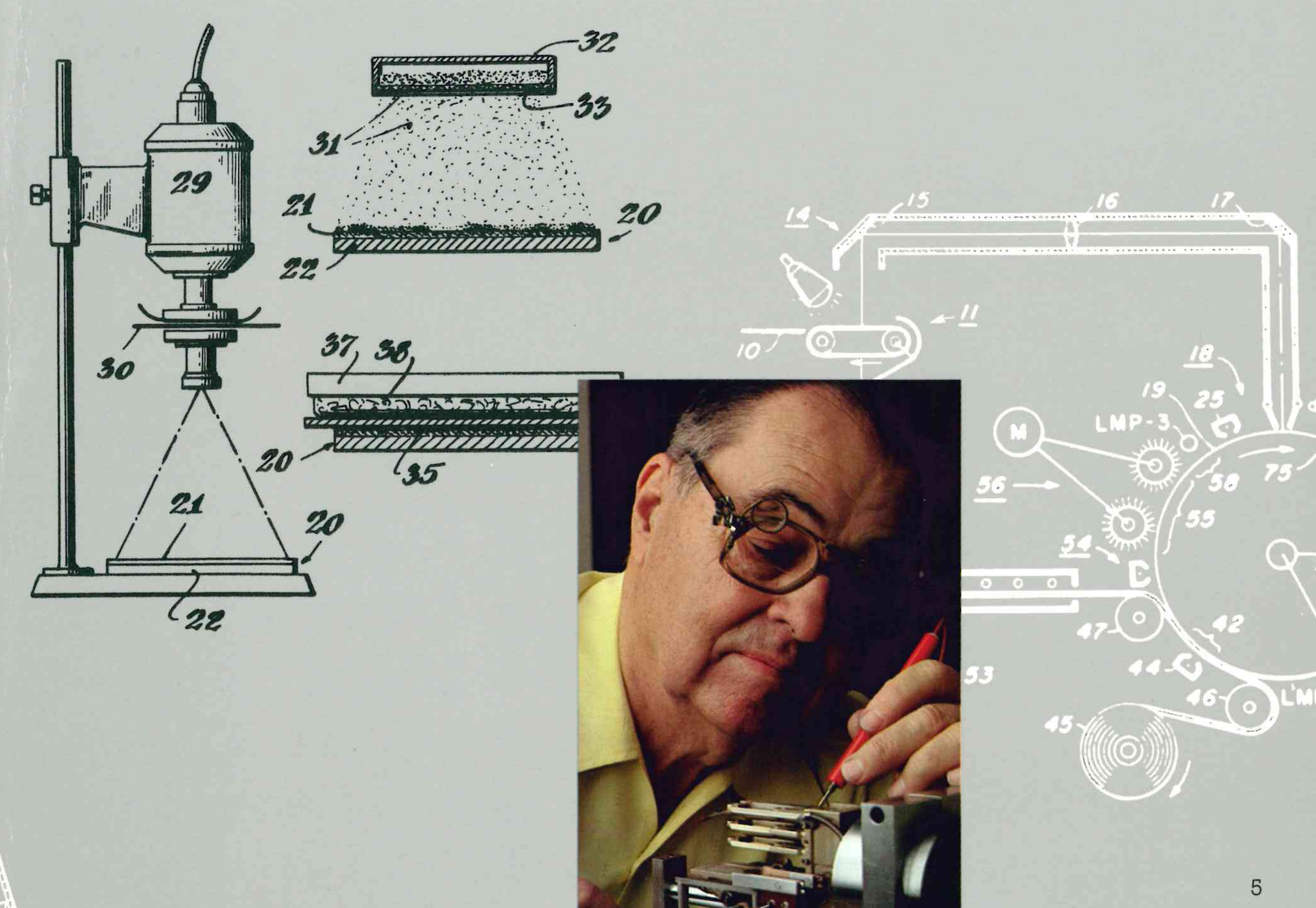


Realizing the Benefits of Research Success

Achievement of a research objective in the laboratory is only one step in launching a new concept toward the marketplace. If a new product is involved, what has been shown feasible must then be implemented in a reliable, cost-effective, manufacturable engineering design. Passing on the knowledge and initial experience from Corporate Research to the engineering units which perform the essential task of product design is often called technology transfer. This process has its own special challenges for Research. Whereas new technical tools can be transferred to engineering divisions through the direct interactions of scientific and engineering professionals in their respective organizations, product concepts must usually win the approval of business and product planners before corporate management will authorize an engineering program to develop the new product. Therefore, the transfer of both concepts and technical skills from research to other Xerox organizations is important.

One of the most effective modes of technology transfer is the flow, from Research to the engineering organizations, of some of the people who participated in the research work that generated the new concept and demonstrated its feasibility. Occasionally individuals migrate from Research to the planning organizations. Corporate Research is not only an important entry point to Xerox for scientists and engineers; it is also an environment from which individuals can launch themselves into careers in other parts of the corporation.

Descriptions follow for each of the major research centers comprising Xerox Corporate Research. Together, these centers strive to maintain optimum environments within which to generate the products of research: knowledge, inventions, new or enhanced technologies, and highly-trained creative people.



The mission of the Webster Research Center is to develop imaging and marking technology options– new concepts and systems to enhance or supplant existing technologies.

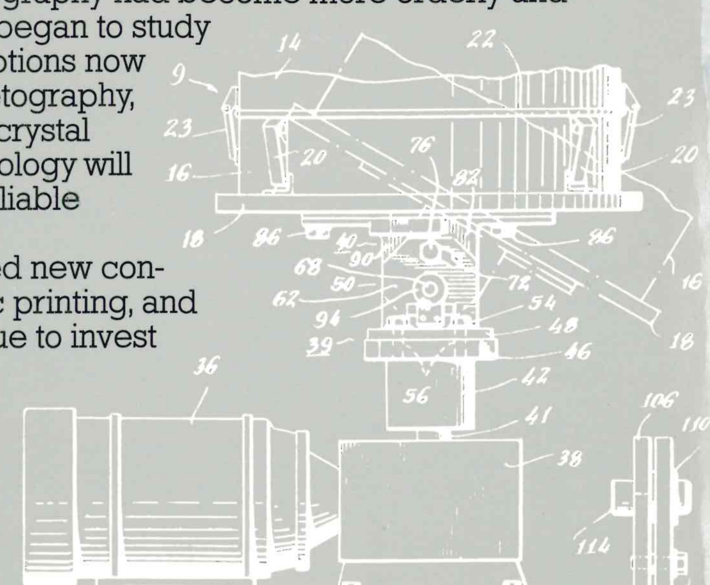
The Webster Research Center is located in the Joseph C. Wilson Center for Technology, along with Xerox engineering and manufacturing organizations. This 1,000 acre site, where the company's U.S. reprographics products are designed and produced, is in Webster, New York, approximately 15 miles east of Rochester.

The Webster Research Center (WRC) employs over 400 scientists, engineers and support staff. Disciplines among the professionals and technicians who make up the Center's staff include chemistry, physics, computer science, materials science, and electrical, chemical, and mechanical engineering. The Center's mission is to conduct research and exploratory development in imaging and marking technologies. Although the areas of concentration are reprographics and electronic printing, the demands of maintaining the state-of-the-art in those fields require the study and application of many related sciences and technologies. In addition to xerography, WRC is engaged in research on laser scanning for image input and output, digital and electronic components and systems, and microprocessor diagnostics and controls. The dominant mission however, continues to be invention and advances in the quality, reliability and economics of xerography.

WRC began modestly about thirty years ago, when a small group was established to study various properties of silver halide and the new discipline of xerography. The products which came out of these early efforts have formed the mainline product family of the corporation–its copiers and duplicators. At the end of ten years, the research staff had grown in number to only 20, but the decade of the '60s was explosive. It ended with a staff of 200. During the last ten years, WRC has continued to grow as the principal center for reprographics research.

By the mid-1960's successes in xerography had become more orderly and evolutionary, and WRC scientists also began to study alternate imaging technologies. The options now being explored include ink jet, magnetography, scanning laser xerography, and liquid crystal displays. It is possible that a new technology will some day be even less costly, more reliable and more versatile than xerography.

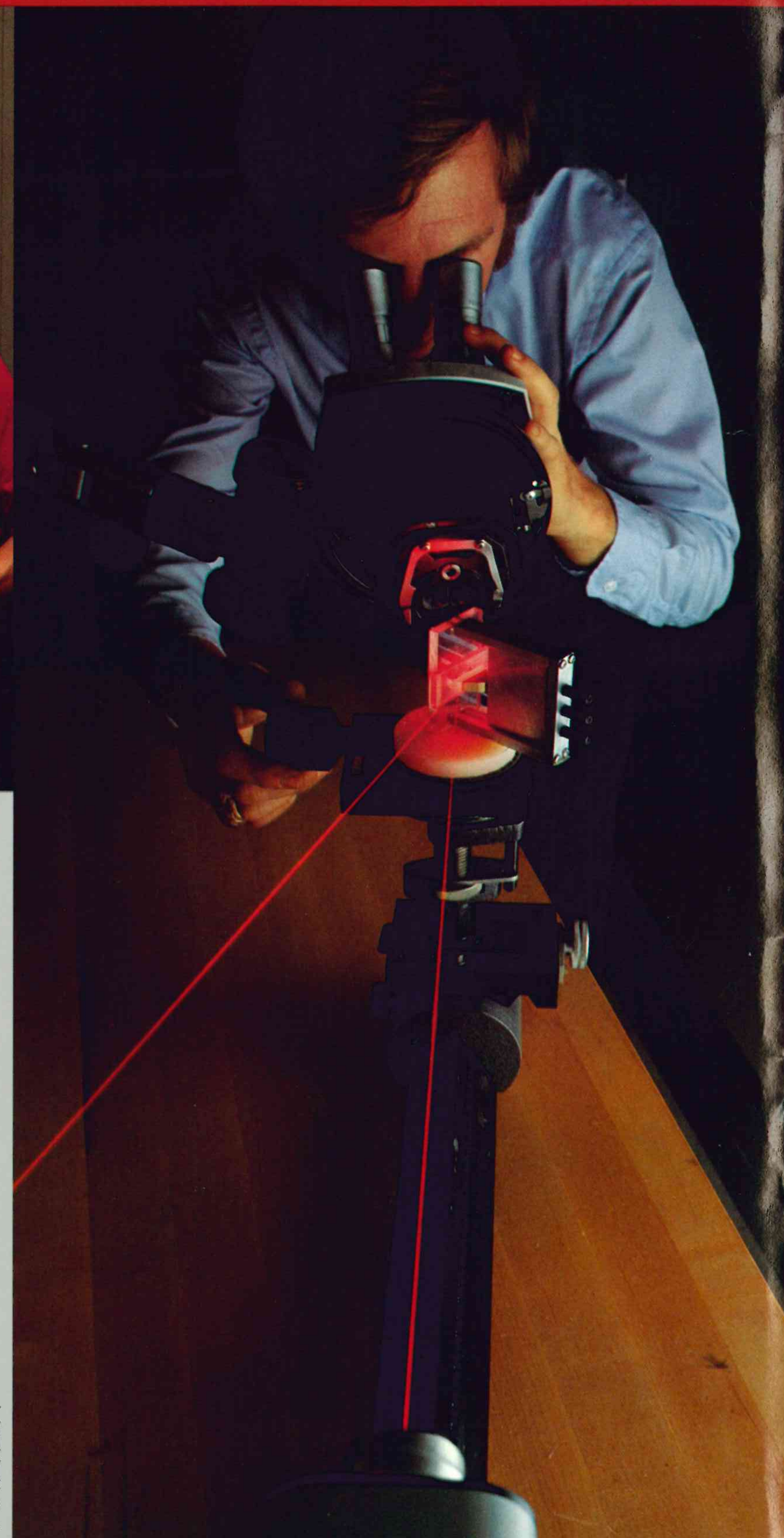
In recent years WRC has developed new concepts in small copiers, in color graphic printing, and in electronic printing. WRC will continue to invest major research efforts in xerography, as well as related and novel marking technologies, and to maintain its basic science programs in support of these researches.



The Webster Research Center is concerned with two types of informational representation, pictorial and electronic. A wide range of technologies for future Xerox products is reflected in the scope of the six laboratories.

Xerographic Technology Laboratory
The Xerographic Technology Laboratory maintains Xerox research leadership in xerography and related technologies, and enables extension of xerographic technology to other marking systems. Photoreceptor materials, developer materials, and improvements in various subsystems such as charging, cleaning and fusing are under investigation. Technologies useful for low-cost copiers and printers are also a focus of study.

Scientists working on photo-electronic properties of amorphous semiconductors use this deposition system for the production of amorphous thin films.

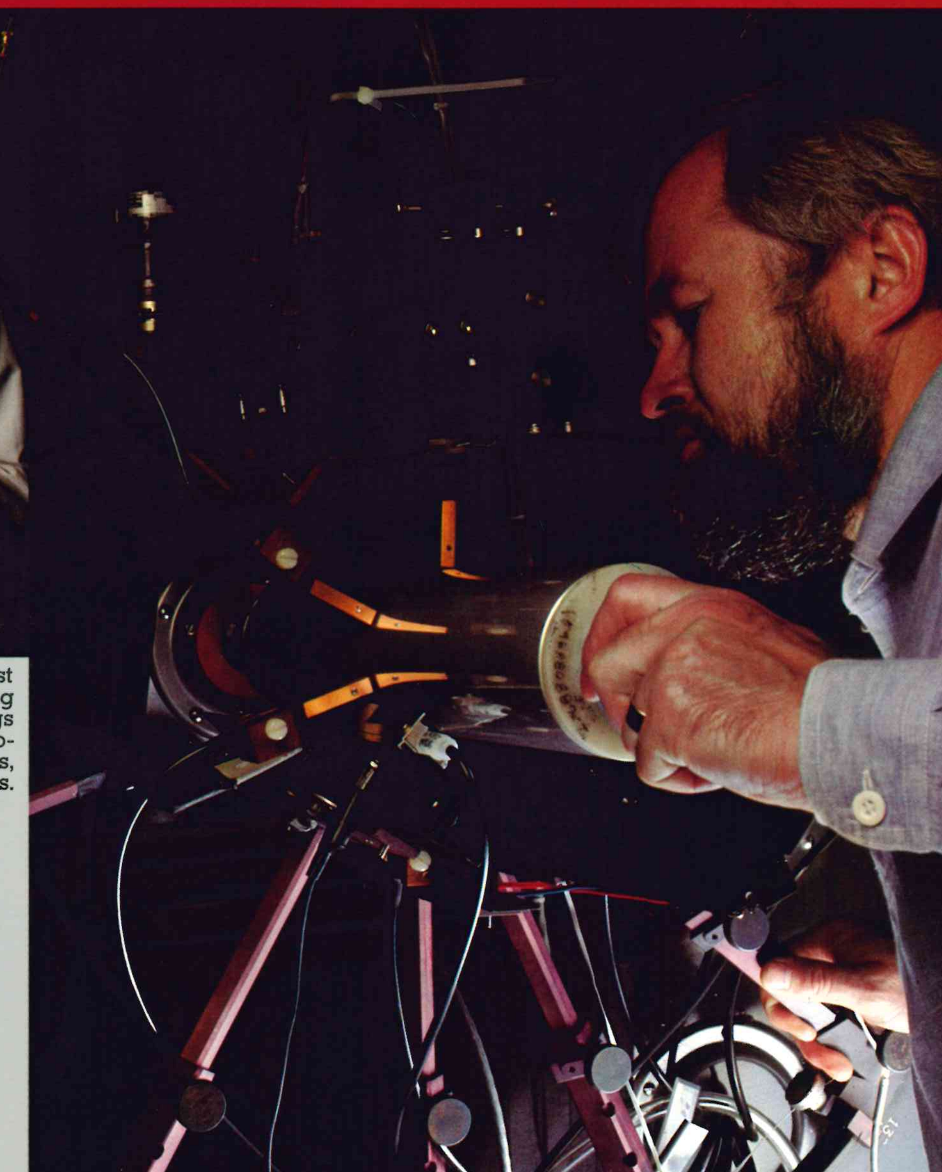


Multimode waveguides are being investigated as optical couplers for efficiently transferring light from print bars to photoreceptors.

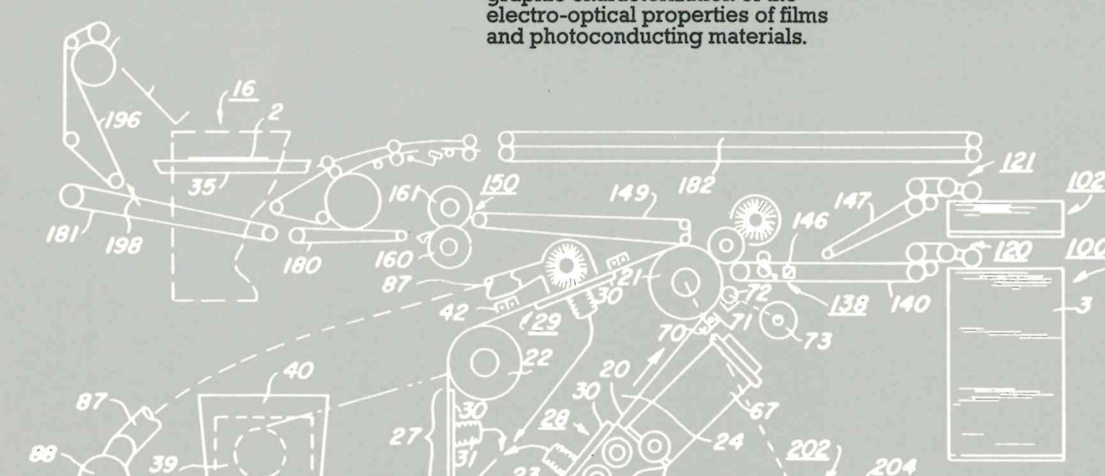
Electronic Marking Laboratory
The Electronic Marking Laboratory investigates technology options for reproducing electronically captured images in printed or display form. Scientists are evaluating several new approaches that promise advantages in cost and image quality. Emphasis is on study of electronic input to printing devices, communication among copiers and printers, and new types of displays for current and future products.

Direct Marking Laboratory
The Direct Marking Laboratory investigates ink jet technologies for use in printers for personal and office use. Experimental work includes design of jet nozzle arrays, inks, transducers and fabrication methods.

A WRC scientist works on preparing polymer film coatings for use in microelectronics, displays, and digital printers.



Special fixtures enable xerographic characterization of the electro-optical properties of films and photoconducting materials.

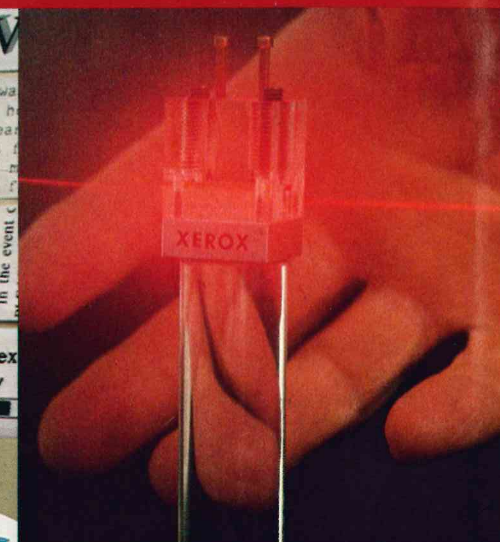


Imaging Systems Laboratory
The Imaging Systems Laboratory conducts research into processing methodologies, printing software, and electronics. The research addresses creation and perception of certain aspects of imaging, as well as the study of algorithms for picture editing, representation and compression. Other activities include development of electronic printing devices, and image measurements and its application to product design. Software for creating images for marking and display devices is also being studied.

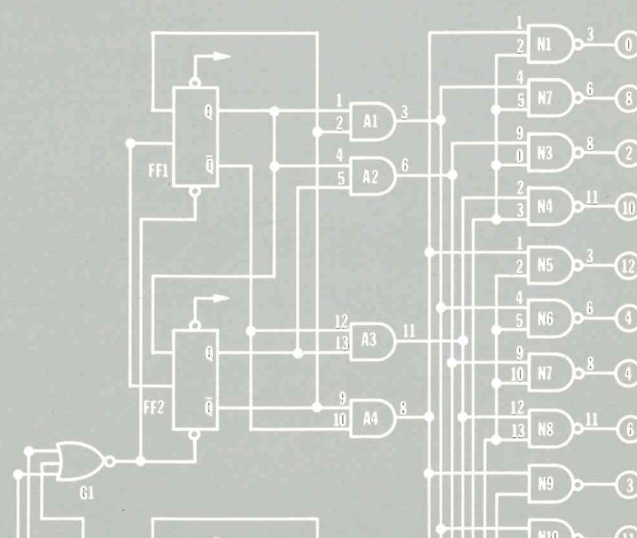
Materials Sciences Laboratory
The Materials Sciences Laboratory provides a fundamental research capability in polymer science, photochemistry, photophysics, and the physics and chemistry of solid-state materials. A range of projects for the synthesis, characterization and evaluation of polymeric and molecular materials is supported. Areas of emphasis include the design and fabrication of materials with specified optical and electrical properties, and on materials for optical recording media.

Physical Sciences Laboratory
The Physical Sciences Laboratory conducts basic theoretical and experimental research into physical phenomena and related materials science. Projects include studies of amorphous and heterogeneous inorganic and organic semiconductors, charge transfer and intermolecular interaction in molecular systems, and characterization of metal-semiconductor interfaces.

Alpha-numeric-images are studied to determine their legibility and quality, with emphasis on electronic printing applications.

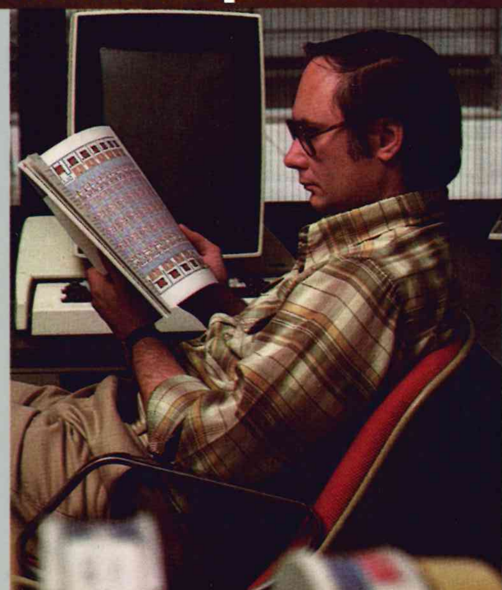


This electro-optical waveguide modulator may represent the beginning of a transition from discrete optical components to integrated optics for xerographic laser printing systems.



This high-resolution photoemission spectrometer provides unique experimental capabilities for design and characterization of organic materials used in xerography.

The challenge at the Palo Alto Research Center is to provide the research underlying the technologies for future Xerox office information products.



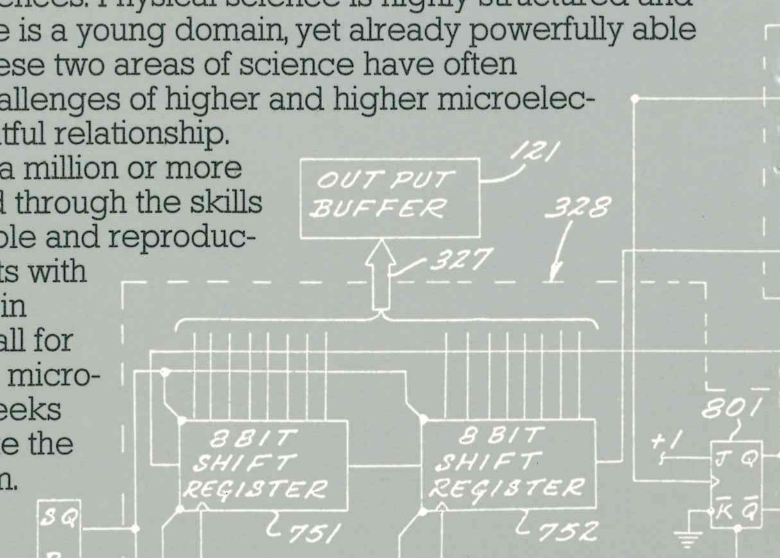
Xerox established the Palo Alto Research Center in 1970 as part of the corporation's decision to extend its role beyond reprographics into information handling and communications. A location was selected in the Stanford University Industrial Park, because the close relationship with a major research university is attractive to research professionals, because of new and planned Xerox business activities on the west coast, and because of the recognized future importance of microelectronics technology which was beginning to flourish in Santa Clara county.

The center, which became known as PARC, undertook to merge digital electronics with the corporation's existing strength in xerographic copiers and duplicators. The scientific and engineering disciplines represented in PARC include computer science, cognitive science, imaging science, integrated circuit electronics, materials science, optical science, and solid state physics. PARC also maintains, in the Los Angeles area, a laboratory which emphasizes electromechanical technologies and engineering science. And there are smaller PARC groups in Pasadena and Hayward, California, working on imaging and printing technologies. In 1980, in order to facilitate its many interactions with Xerox product engineering organizations, PARC was organized into two units, the Palo Alto Research Centers.

Perhaps the most important strategic task undertaken by PARC has been the research and prototype development of the systems architecture underlying Xerox' future office information systems. These efforts have produced the Ethernet-linked systems of Alto computers, file systems, and printers for which PARC research has become widely known. PARC has also substantial research on the materials, devices, and electronic structures that have continually reduced the cost of digital processing so as to permit wider access to high computing power and rich software systems.

An interesting characteristic of PARC is the association under one roof of the physical sciences and the computer sciences. Physical science is highly structured and extensively explored. Computer science is a young domain, yet already powerfully able to extend human capability. Although these two areas of science have often seemed to have little in common, the challenges of higher and higher microelectronic circuit density bring them into fruitful relationship.

The enormous design complexity of a million or more features on a chip can only be managed through the skills of the computer scientist. Comprehensible and reproducible physical behavior of circuit elements with dimensions so small as to be measured in thousands or even hundreds of atoms call for the skills of the physical scientist. As the microelectronic revolution proceeds, PARC seeks to have the disciplines both to accelerate the advances and to take advantage of them.

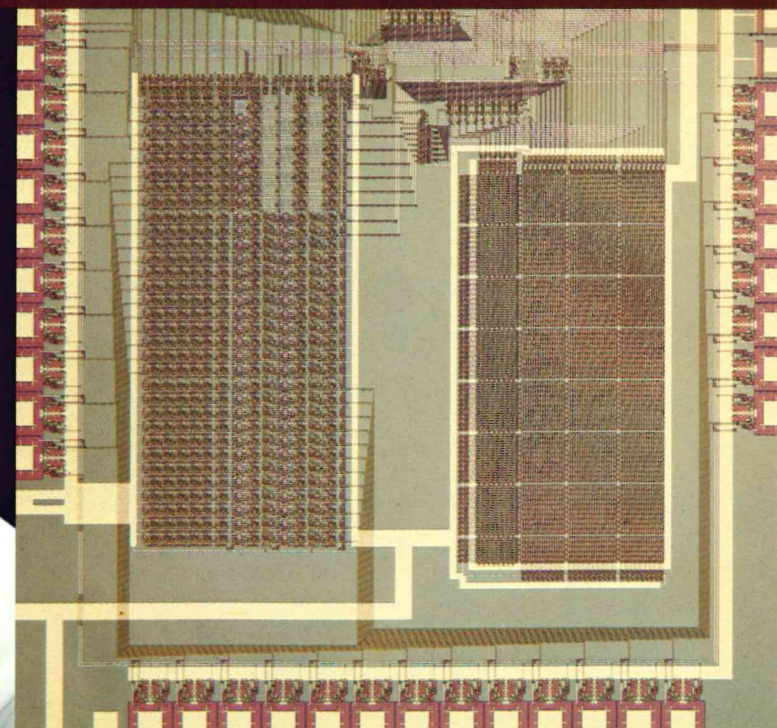


Scientists in the six laboratories and several research groups at PARC conduct research in three major domains: information systems, information technologies, and scientific foundations. Research in information systems is focussed on the design of functioning research prototype systems and their applications to office environments. Information technology is concerned with exploring the subsystems and devices that are elements of interactive systems. Research on scientific foundations seeks fundamental understanding of the processes and materials employed in the systems and technology domains.

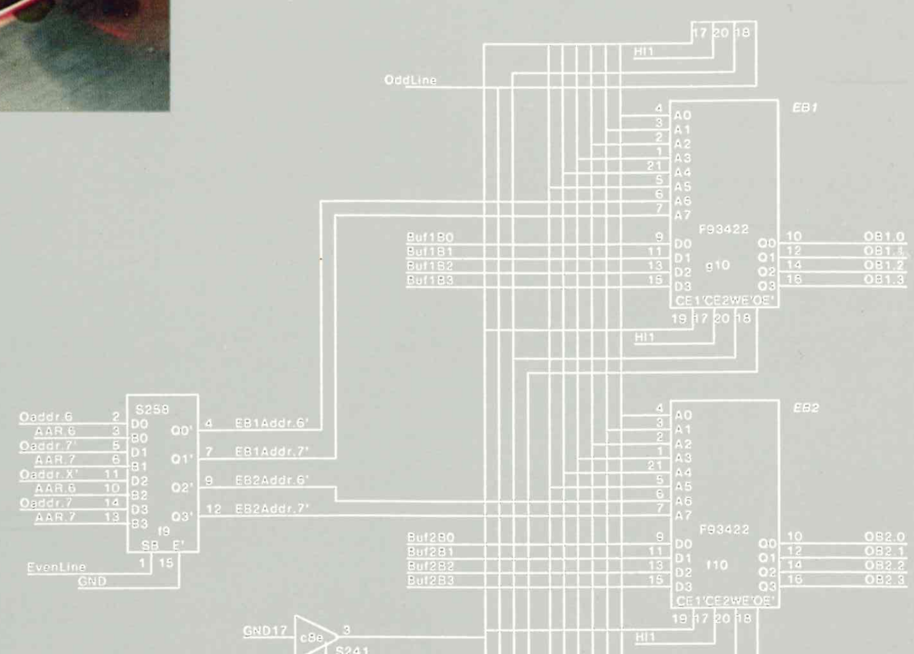
Computer Science Laboratory
Research projects encompass distributed computing, programming languages, programming methodology, communication systems and protocols, and language understanding. The laboratory has developed a versatile research environment: Ethernet-coupled systems of computers, files and printers, and the Mesa programming language. The resulting knowledge, techniques, software, and electronic design have been transferred downstream to Xerox development organizations, and the laboratory is now designing and constructing a new more powerful research environment for attacking the critical issues of computer science.

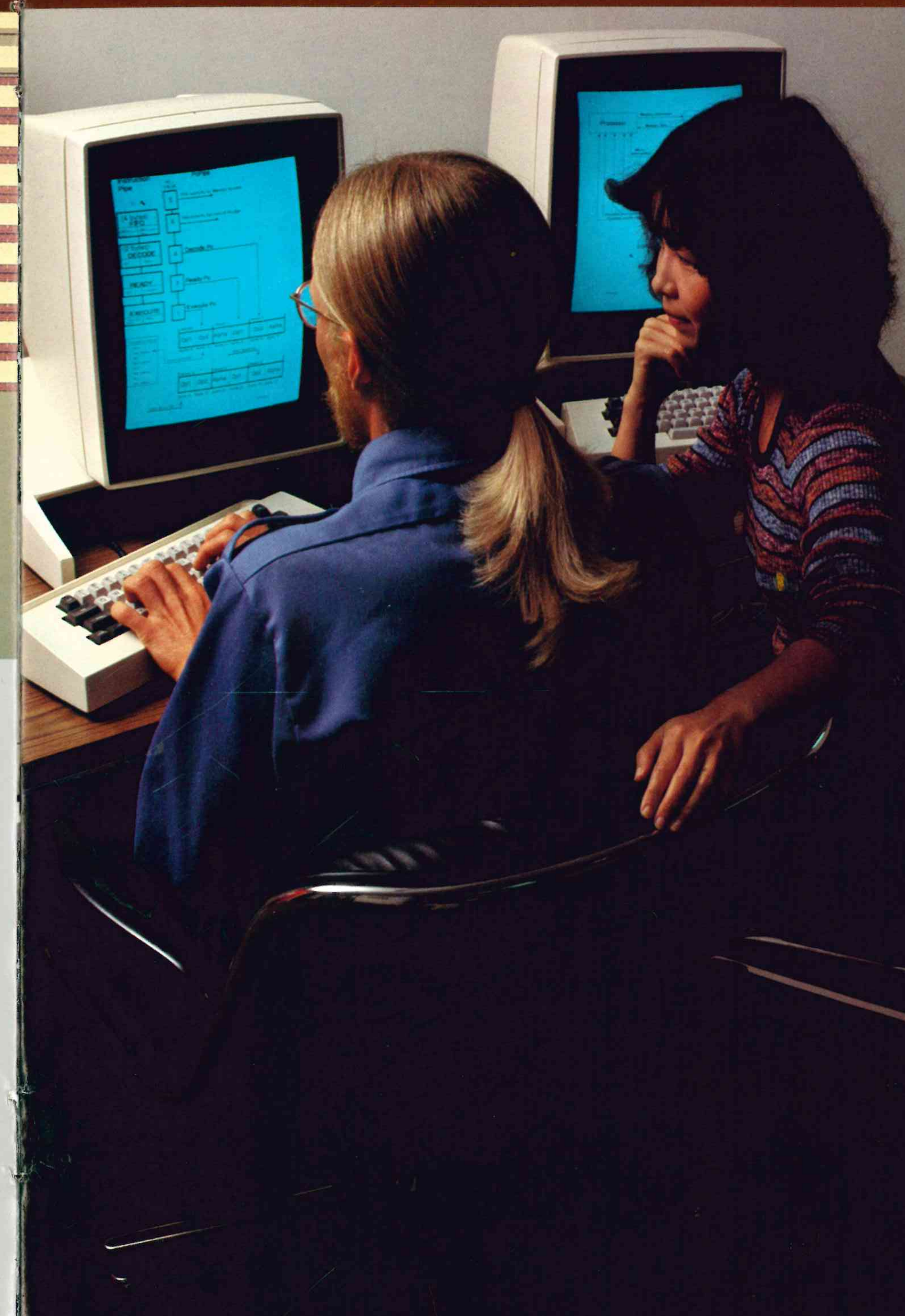
Imaging Sciences Laboratory
Contributions from computer science, optics, image processing and integrated systems design combine into one broad area of investigation–the creation, modification, and reproduction of textual, graphic, and photographic images. Projects include systems for document preparation and graphic arts composition, digital printing standards, imaging workstations and high resolution image generators. Recognizing the heavy demand of imaging systems for computational cycles coupled with the inherently parallel nature of many image processing algorithms, the laboratory supports research into the application of custom VLSI for imaging.

The Optical Sciences Laboratory is working on the development of optical disk memory systems which will provide greatly enlarged capacity for the storage of digital data.

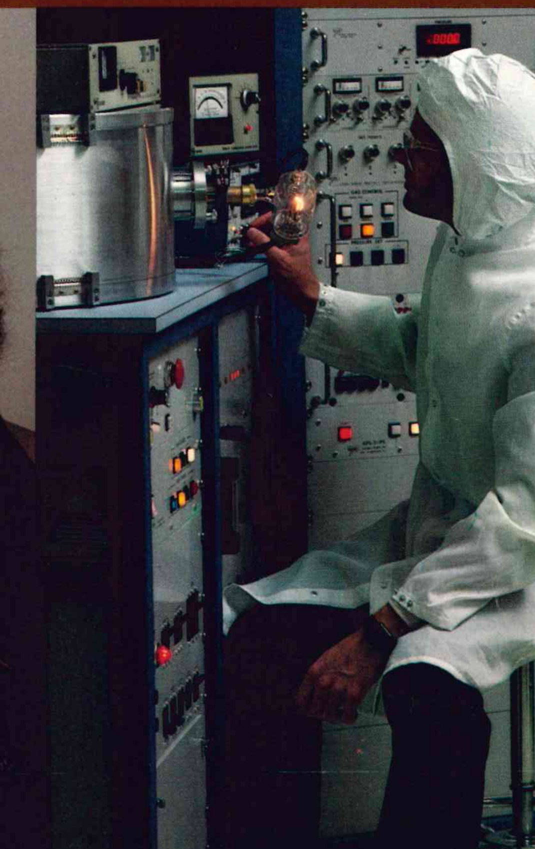


Xerox researchers often collaborate on the development of new design processes. This experimental LISP microprocessor chip is a joint effort between PARC and the Massachusetts Institute of Technology.





Experimental information processing systems result from the work of PARC's Computer Science Laboratory. Two computer scientists work with information which is represented in both graphical and textual form.

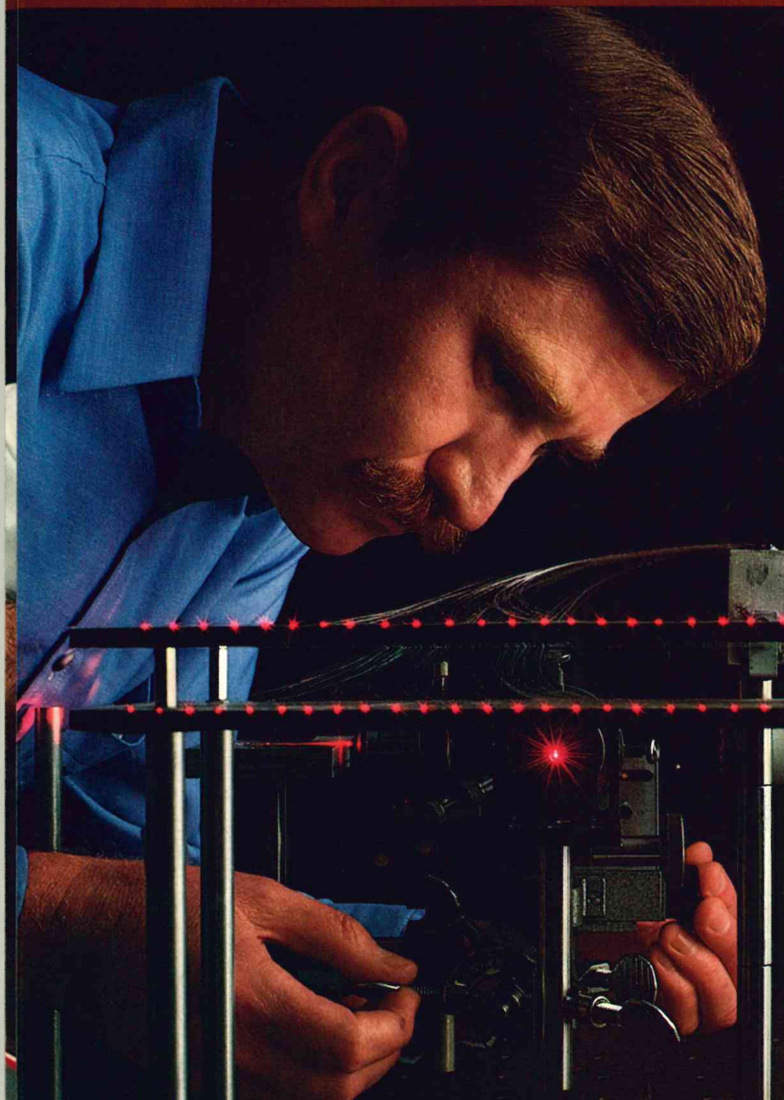


The Integrated Circuit Laboratory is concerned with the advancement of IC processing technologies. Here a scientist works with a reactive ion etcher.

Optical Sciences Laboratory
The goal of the Optical Sciences Laboratory is to develop the optical components and subsystems for future office information systems. Such optical subsystems are intimately involved in the input, output, (both hard copy and soft display) communication, and storage of information.

General Sciences Laboratory
Properties of materials useful for electronics, opto-electronics, and digital storage are investigated. Studies involving new materials, include developing methods to modify their physical or chemical properties. There is strong interest in preparation, analysis, and properties of surfaces, interfaces and thin films.

Integrated Circuit Laboratory
Computer assisted operations maintain microelectronic fabrication at state-of-the-art feature size and complexity. Scientists at the laboratory are extending integrated circuit processing techniques into the area of VLSI for Xerox electronic needs.



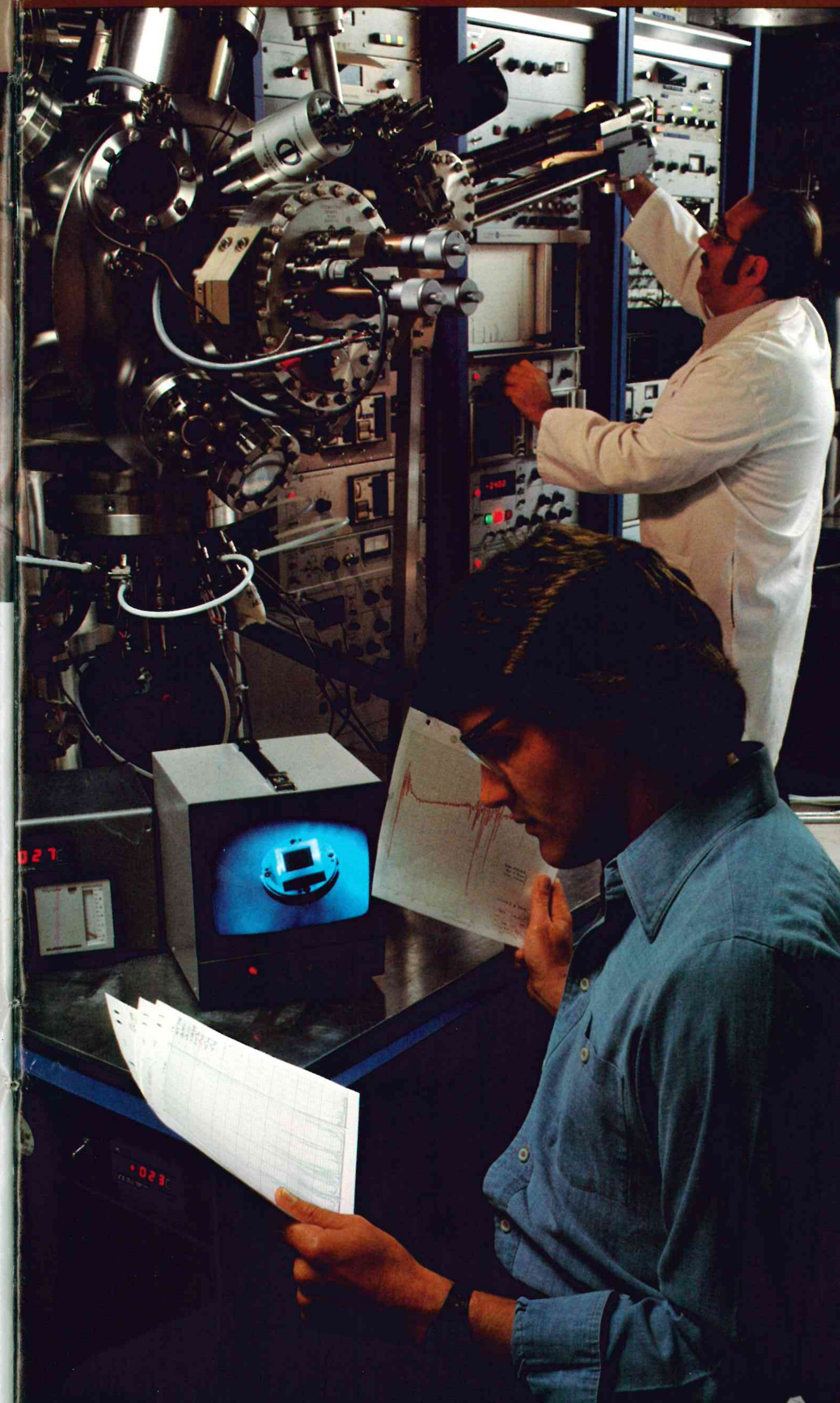
Scientists in the Optical Sciences Laboratory work with experimental fiberoptics components for computer communications systems.

A scientist in the General Sciences Laboratory studies the computer output from a microprobe analysis of a rare earth transitional metal alloy which is of interest as a possible optical storage material.

Advanced Development Laboratory
Combining academic backgrounds in the engineering disciplines with experience in design and manufacturing, members of the laboratory act as consultants to other Xerox organizations. On-going projects are magnetic recording theory, fabrication technology, elasticity, and machine design.

Learning, Cognitive Science, and Computing
PARC has groups of computer scientists concerned with designing computer languages to be of maximum value for knowledge tasks, psychological studies of human interaction with office machines, and more effective application of computers to teaching and the performance of office tasks.

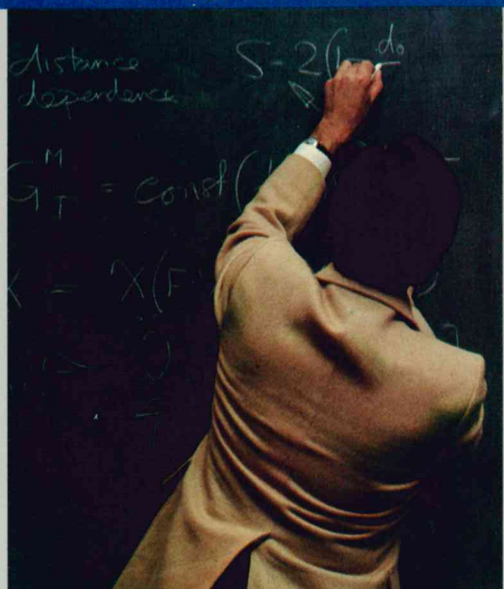
VLSI Systems Design
Organizing the concepts and design principles for developing microelectronic chips with 100,000 to 1 million elements is an extremely complex challenge. PARC researchers, in collaboration with universities, are pioneering in systematizing the methodology and information management tasks of VLSI design.



The Advanced Development Laboratory in El Segundo develops improved equipment, such as this automatic non-referenced inspection scanner, to facilitate manufacture of electronic circuitry.

The molecular beam epitaxy equipment in the General Sciences Laboratory is programmed to develop, grow, and characterize semiconductor lasers.

The Xerox Research Centre of Canada works primarily in research that will lead to better, lower cost materials for use in marking and imaging applications.



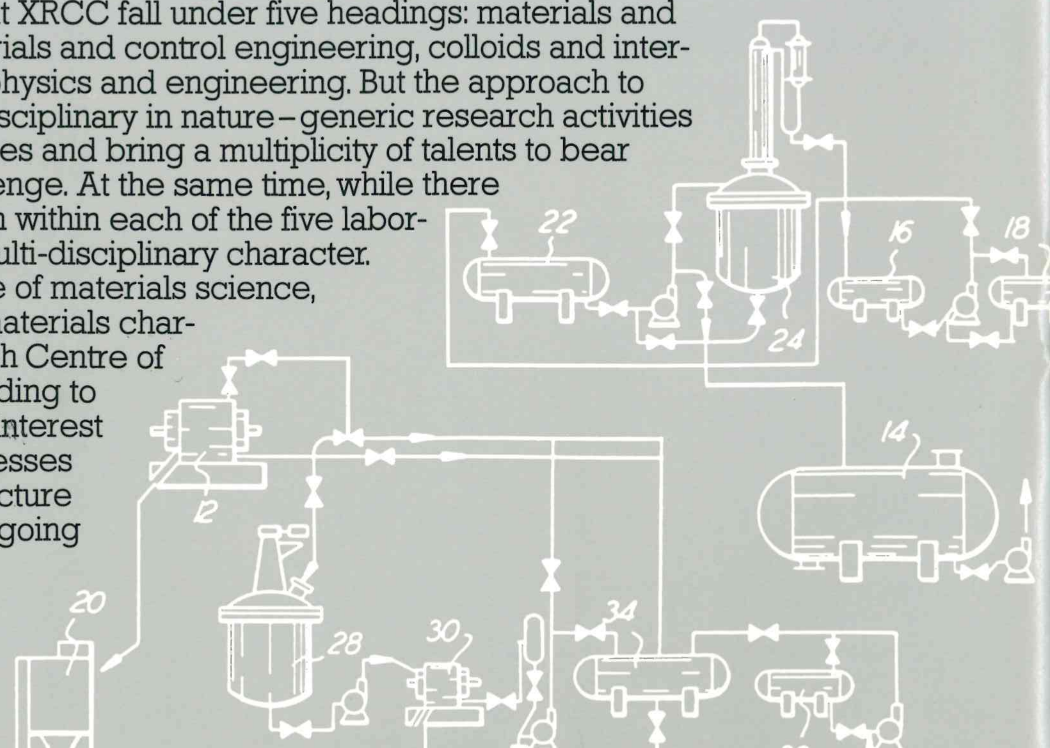
The newest Xerox research center was established in Canada in 1974 as an expansion of the company's long-range research efforts in imaging science and information transfer. There has since been a gradual convergence of emphasis toward materials dominated programs. Xerography and most other marking technologies are dependent upon materials properties which must be well understood if they are to be stably reproducible in the fabrication processes.

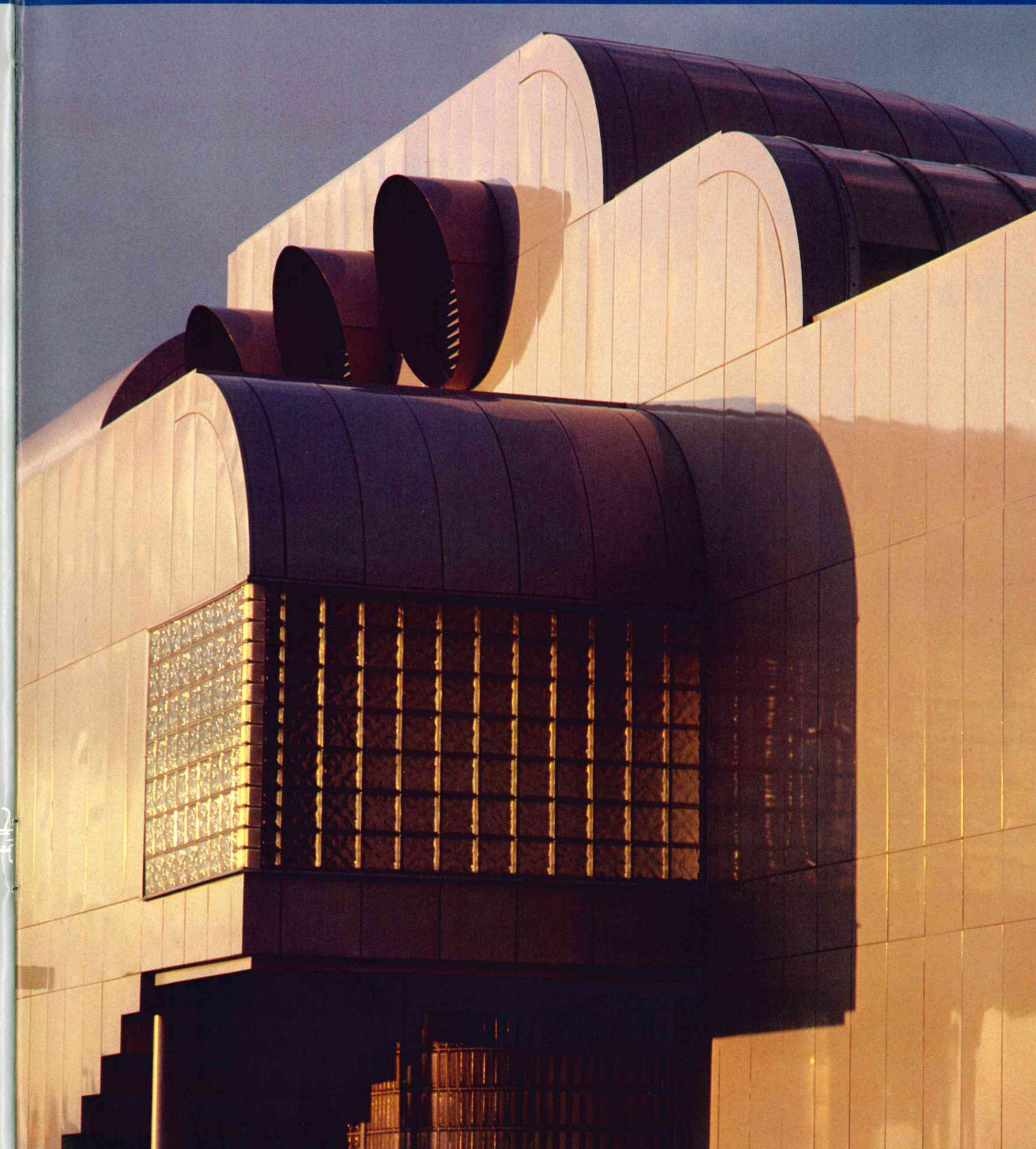
The Xerox Research Centre of Canada (XRCC) is located about equal distance from Toronto and Hamilton in Ontario's "Golden Horseshoe" along the Lake Ontario shore. The new Materials Processing Laboratory, formally dedicated in 1980, is a 27,000 square-foot chemical engineering pilot/research facility. The original XRCC facility, some two miles to the north, is about twice that size. Both sites accommodate a staff of approximately 120, most of whom are professional technical people. Their disciplinary specialties include solid state physics, optics, photophysics and photochemistry, colloid and surface science, electrochemistry, organic synthetic chemistry and polymer science, thin film science, paper science, chemical engineering and computer control of materials processing.

Within each Corporate Research Center, one can identify a generic research culture that defines the principal pathway whereby that Center will best contribute to Corporate objectives. The XRCC culture is one of molecular science. Molecular science is also one of the strongest scientific areas in Canadian universities. XRCC has a unique advantage in that it recruits exceptional talent from Canadian universities which have international stature in chemical physics, chemical engineering, and organic chemistry.

The research activities at XRCC fall under five headings: materials and exploratory research, materials and control engineering, colloids and interfaces, polymerization, and physics and engineering. But the approach to research at XRCC is interdisciplinary in nature – generic research activities cut across organizational lines and bring a multiplicity of talents to bear on each problem and challenge. At the same time, while there is a degree of specialization within each of the five laboratories, they too exhibit a multi-disciplinary character.

Embracing a wide range of materials science, materials processing and materials characterization, Xerox Research Centre of Canada opens the door leading to the creation of materials of interest to Xerox, and to novel processes and systems for the manufacture of materials required for ongoing Xerox programs.





The generic research activities of Xerox Research Centre of Canada encompass materials technology, materials processing, and exploratory research.

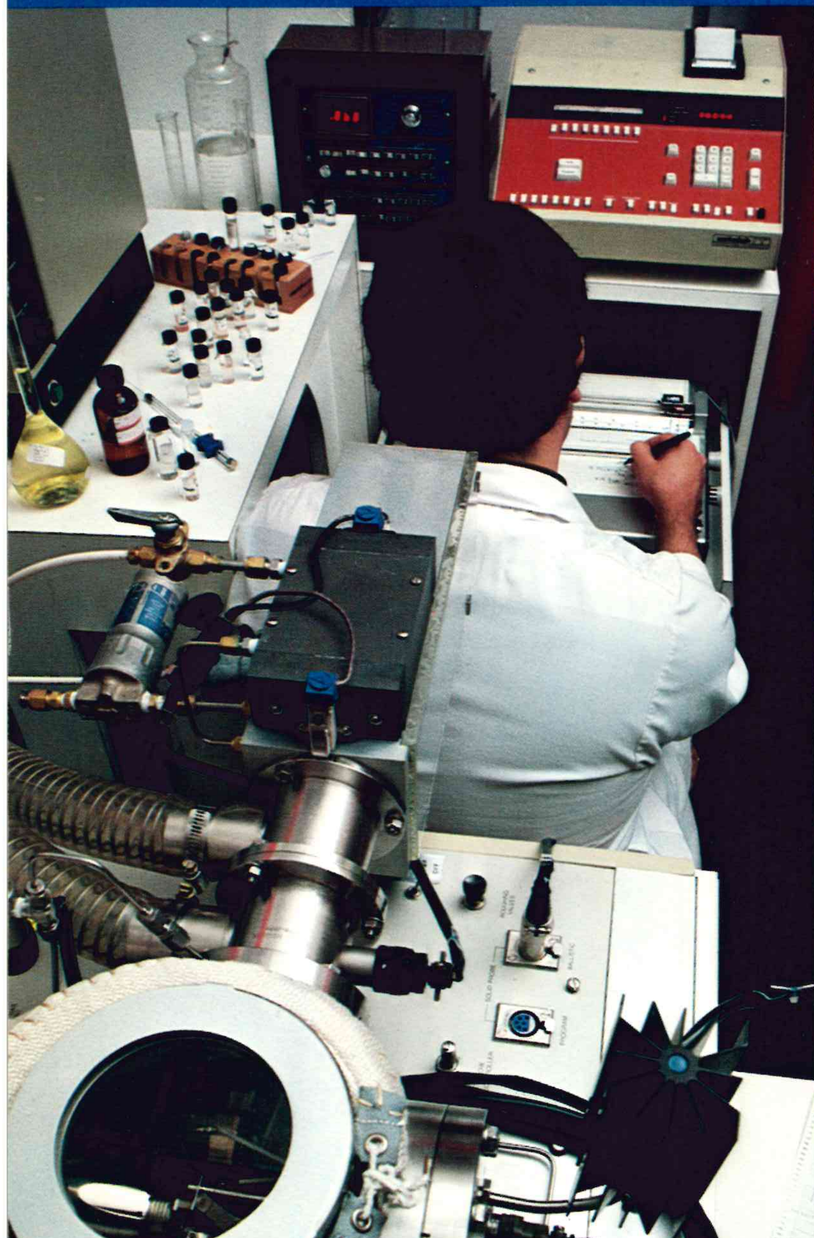
Materials technology research responds to the requirements for office systems materials in such critical areas as photoreceptors, developer materials, dyes, photoactive pigments, and paper. An example is the synthesis and purification of small charge transport molecules that are of importance to modern photoreceptors.

An important part of the XRCC program involves the design, synthesis and fabrication of consumables for marking. Canadian strength in paper science and technology facilitates projects such as fabrication of novel fibrous laminates, electron beam writing on paper, and study of laser-paper interactions for marking. XRCC is also working actively in the areas of one-step fabrication of toners, low energy fusing toners, and molecular charge control.

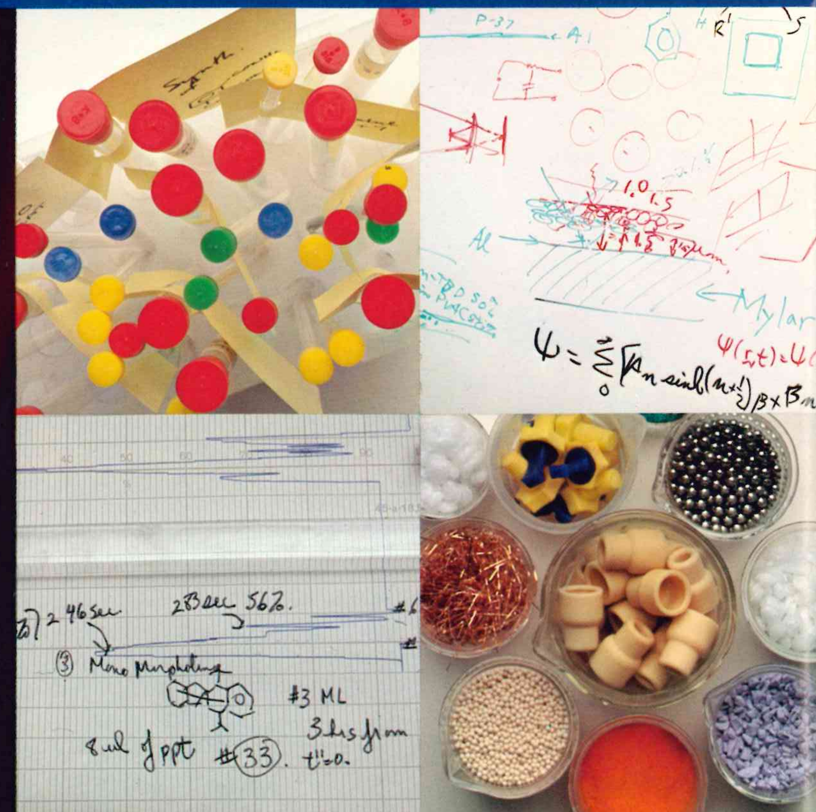
Materials processing research pursues a systems approach to the creation of materials. Involved are the many interactions between fundamental chemical engineering, pilot-scale engineering, and control and system engineering.

Building on Xerox' knowledge of photoreceptor technology, XRCC stepped outside its traditional endeavors in the exploratory development of an inexpensive organic photovoltaic device capable of direct solar energy conversion with reasonable efficiency.

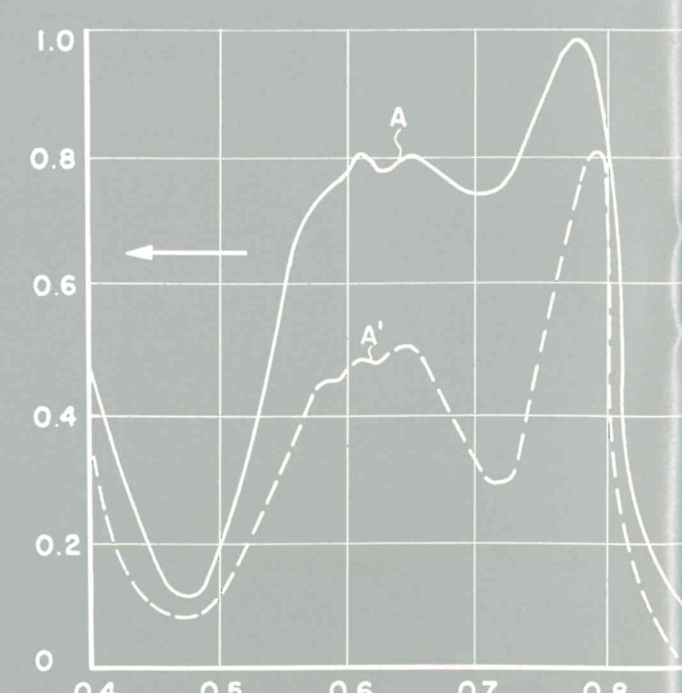
There are five areas of research at XRCC: materials and exploratory research, materials and control engineering, colloids and interfaces, polymerization, and physics and engineering.



Equipment in the Materials and Exploratory Research group runs analyses of reaction mixtures.



XRCC has programs in chemical physics, chemical engineering, and organic chemistry.



Research in the Paper Science group includes samples made with a centrifugal sheet former for analysis of physical, optical and surface properties and for testing with ink-jet printing processes.

Electron microscope analysis makes possible detailed studies of chemical compositions and crystalline structures in the Materials Characterization group.

Materials and Exploratory Research
Materials and exploratory research investigates special chemicals and polymers, organic chemistry, opto-electronics, micrographics, electro-chemistry, and energy conversion.

Materials and Control Engineering
The materials and control engineering area is concerned with pilot process engineering, chemical and polymer engineering, and process control.

Colloids and Interfaces
The colloids and interfaces group investigates inks, materials characterization in general, and special scientific instrumental methods.

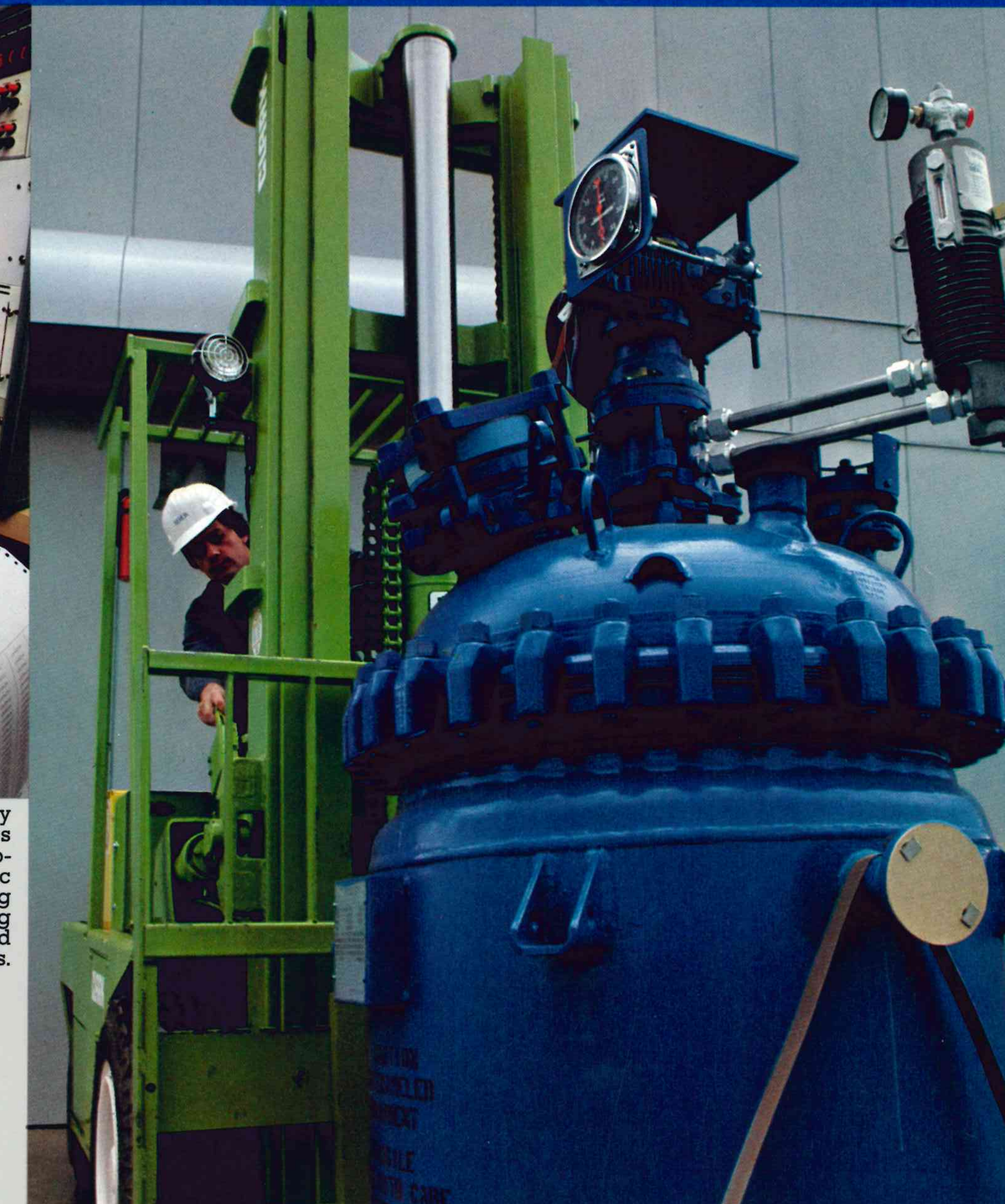
Working in conjunction with the information centers in Webster and Palo Alto, the Technical Information Center provides research information services for XRCC scientists.

Analysis of the magnetic properties of chemical compounds with a nuclear magnetic resonance spectrometer is only one of many facets of materials characterization in the Colloids and Interfaces Science area.

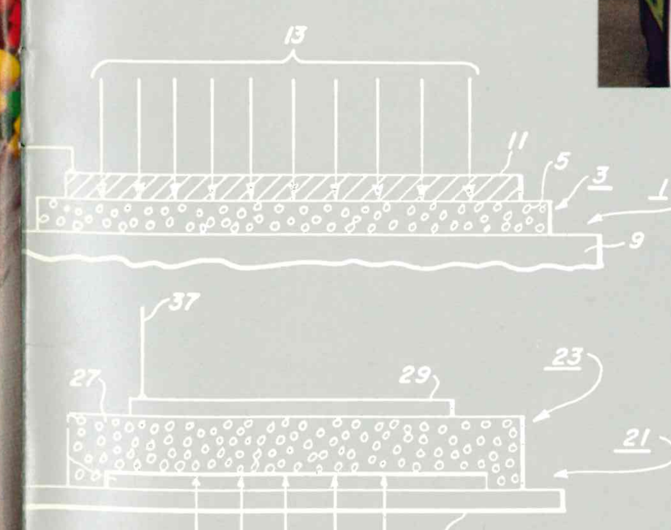
Polymerization
The primary focus of the polymerization work is to explore fundamental and applied aspects of methods for preparing novel macromolecules.

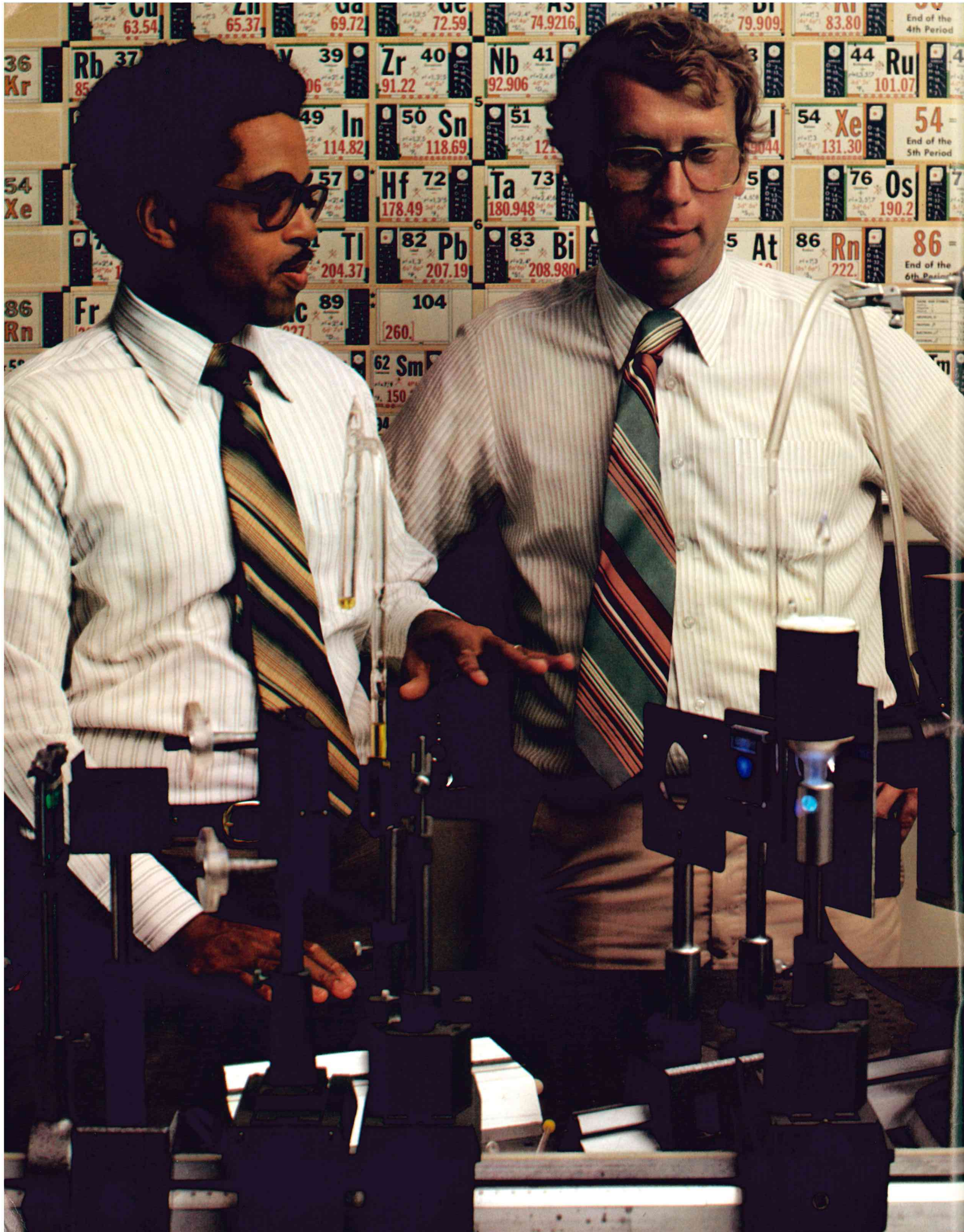
Physics and Engineering
The physics and engineering area explores paper technology, the physics of materials, opto-electronics, and the functional assessment of new materials.

The rheology laboratory analyzes the mechanical properties of polymeric materials, providing data for modeling studies and end use applications.



A new addition to the research center is a chemical engineering research facility which includes large scale chemical reactors.





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