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On the cover: A method for making improved electrical contacts to high-temperature superconductors has been developed and patented by researchers at NIST and the Westinghouse Electric Corporation. Here, NIST physicist Jack Ekin inserts a contact test sample into a cryogenic test fixture. See article on page 11.

NIST Research Reports

No more published under this title. See SP 817 for successor

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NIST

Research Update

NIST Reorganizes Management Structure

NIST has reorganized its management structure to improve the agency's support for U.S. industry, science and engineering, and the public. The reorganization eliminates one level of management and combines several research groups into larger laboratory units. No reductions in NIST laboratory programs or staff are involved. New laboratory units are: Electronics and Electrical Engineering, Manufacturing Engineering, Chemical Science and Technology, Physics, Building and Fire Research, and Computing and Applied Mathematics. Functions of the Materials Science and Engineering Laboratory and the National Computer Systems Laboratory remain the same, except the latter's name has been changed to the Computer Systems Laboratory. There is no change to programs within Technology Services.

Measuring Food Components Aim of New Materials

Scientists studying health and disease aspects of food consumption depend on accurate measurements of nutrients and contaminants in food samples. But to ensure the reliability of instruments and analytical methods, they need standards—ideally standards containing a variety of foods representative of an average American diet. A standard reference material (SRM) now available from NIST offers a typical diet combined into a bottled freeze-dried powder. Foods such as eggs, pizza, hamburgers, and beer are all included.

The material contains certified concentrations of 14 chemical elements as well as ash, fat, dietary fiber, cholesterol, and caloric content. Chemists can analyze these materials as they would any food sample and compare their analysis to the numbers provided. The U.S. Department of Agriculture prepared the SRMs for NIST from foods obtained through the Total Diet Study, an ongoing Food and Drug Administration program that monitors foods from various U.S. regions for pesticides, toxins, and nutrients. Total Diet (SRM 1548) costs $251 for two 6.5-gram bottles and is available from the Standard Reference Materials Program, Rm. 204 Bldg. 202, NIST, Gaithersburg, Md. 20899, 301/975-6776.

Materials To Help Measure Mercury in Waterways

Gauging how much of a pollutant is present in sediments of the nation's lakes and rivers can be tricky. Researchers ideally need an actual sediment sample containing a known quantity of the pollutant being measured. NIST now has such samples available for mercury measurements. With this new series of research materials (RMs), scientists can check the accuracy of their analytical instruments, and environmental investigators in different laboratories can be assured they are using the same homogeneous materials as standards. RM 8406 contains only 0.06 micrograms per gram of mercury and is suitable as a background level. RMs 8407 and 8408 contain 50 and 107 micrograms per gram of mercury, respectively. Levels of numerous other elements are given for information only. The RMs are $109 each from the Standard Reference Materials Program, Rm. 204 Bldg. 202, NIST, Gaithersburg, Md. 20899, 301/975-6776.

Using STM To Build Room-temperature Nanostructures

The vision of custom-building atomic-scale structures—perhaps "nanomachines" or ultra-high-performance electronic devices—by individually manipulating atoms with a scanning tunneling microscope (STM) has inspired a number of recent experiments. The most dramatic results to date have involved positioning individual xenon atoms on a very cold (–269 °C) surface. Practical applications of that technique are somewhat limited because it requires that the surface be maintained at cryogenic temperatures, and it only works with a limited class of atoms. NIST researchers recently demonstrated a novel room-temperature procedure for manipulating atoms or molecules on surfaces that promises much more general application. By generating an electric field at the tip of the STM probe, they induced cesium atoms adsorbed on typical semiconductor substrates to collect under the probe tip, forming novel structures that would not otherwise occur by simple adsorption. Details were reported in the March 8 issue of *Science*.

Consortium To Develop New Way To Find Paint Flaws

A government-industry consortium is being explored by NIST to develop an automated non-destructive process to detect and evaluate defects in paints on metal products such as automobiles. An automated detection system using computer image processing and robotics along with techniques to "map" the surface of a product would be faster and more precise than current detection systems, says Jonathan Martin, a materials research engineer at NIST. Research on coating defects, robotics, and non-

destructive evaluation techniques currently being conducted by researchers in the NIST Building and Fire Research and Manufacturing Engineering Laboratories could provide the basis for the new inspection technique. For information, contact Martin at 301/975-6717 or Theodore Vorburger at 301/975-3493.

NSA and NIST Computer Security Project Announced

The National Security Agency's (NSA) National Computer Security Center and NIST's Computer Systems Laboratory will work together to develop new criteria for evaluating the security of computer systems. Expected to last at least 2 years, this effort will lead to a new Federal Information Processing Standard, or FIPS, to specify computer security requirements for federal systems that process unclassified information. NIST and NSA will examine the applicability of the well-established U.S. Department of Defense Trusted Computer System Evaluation Criteria for the systems networking environment and will take into account the migration toward an open systems distributed environment. User and vendor experiences with existing trusted systems will be studied and will influence the direction of the new criteria. Also to be examined are various alternatives for evaluating products and determining their conformance to specified requirements.

Obtaining Liquid Neon at Lower Costs

NIST researchers have designed and constructed a small-scale plant capable of recycling liquid neon for about $20 per liter, $150 per liter less than liquid neon can be obtained commercially. The plant was designed to capture, purify, and refrigerate neon boiling off from calorimetry experiments in the low-temperature measurement of the thermal conductivity of insulating materials. The recycling plant consists of a purification section, a heat exchanger, liquid neon and liquid hydrogen storage dewars, and a fully automated control system. After purification, neon is liquefied in the heat exchanger by liquid hydrogen flowing countercurrently through stainless steel cooling coils. Hydrogen flow is automatically adjusted to keep the neon at its normal saturation temperature of 27 kelvins. The liquefied neon is stored in a dewar directly below the heat exchanger; a low-temperature refrigerator provides cooling during extended storage or low-flow application. Paper no. 4-91 describes the plant in more detail and is available from Jo Emery, Div. 104, NIST, Boulder, Colo. 80303, 303/497-3237.

New Technique Measures Fiber Matrix in Composites

NIST researcher Wen-li Wu has been awarded a patent for a new technique to estimate the strength of the bonding between polymer matrix resin and reinforcements in polymer composites. The mechanical properties of composite materials are strongly influenced by the bonding of resins and fiber reinforcements. Wu's method uses a laser to heat a very small, localized region of the sample. The thermal expansion between the fiber and resin produces an acoustical emission, which can be measured. The stronger the interface, the lower the acoustical signal. The technique is simple to use, is non-destructive, and addresses one of the technical barriers to improved polymer composite processing identified by industry at two NIST workshops. For information, contact Wen-li Wu, B320 Polymer Bldg., NIST, Gaithersburg, Md. 20899, 301/975-6839.

Microstrip Patch Antenna Developed

NIST researchers have developed a small (20-cm-square) microstrip patch antenna that can be used as a standard transmitting and receiving antenna at frequencies below 500 MHz in an anechoic chamber. Up to now, well-characterized pyramidal horns and open-ended waveguides have been used, but at frequencies below 500 MHz, these instruments become very large and impractical. NIST researchers proved that the resonant frequency, driving point impedence, antenna radiation pattern, and radiated field strength of the microstrip patch antenna could be calculated theoretically from its geometry and are accurate to within 3 percent. Paper no. 2-91 describes the antenna in detail and is available from Jo Emery, Div. 104, NIST, Boulder, Colo. 80303, 303/497-3237.

"Expect" Automates Interactive Programs

"Expect," a software tool for automating interactive programs, is available from the NIST Manufacturing Engineering Laboratory. Originally designed to automatically log in computers in NIST's Automated Manufacturing Research Facility, Expect runs on UNIX systems but can also control non-UNIX computers and networks. Expect's creator, NIST scientist Don Libes, says the software "uses a script—much like a movie script—to simulate a human interacting with a computer. Expect scripts can describe alternatives and then 'play' differently each time as they adapt to the situation." Requests should be sent to Don Libes, A127 Metrology Bldg., NIST, Gaithersburg, Md. 20899 or library@cme.nist.gov.

America's Technology Opportunities

It's no secret that the U.S. position in the international marketplace has changed over the past two decades. U.S. business and industry dominated international trading from the period immediately after World War II until the late 1970s. By that time a reconstructed Europe and Japan, with U.S. help, were asserting themselves, and they began to acquire larger shares of the world market—sometimes taking aim directly at profitable U.S. markets in the process.

It seems obvious that the prospects for the future are for more and tougher competition. In the face of today's economic downturn, Commerce Secretary Robert A. Mosbacher points out that our exports are in fact doing very well. He feels exports are one key way to climb out of the downturn. Doing better with our high-tech products is one way to boost exports.

Researchers at the National Institute of Standards and Technology did the technical analysis for a report* the Commerce Department issued last spring that examined a series of emerging technologies and how the United States stacks up against the competition. The combined U.S. market potential alone for these technologies, 12 in four areas—advanced materials, electronics and information systems, manufacturing systems, and life sciences applications, is about $350 billion in annual product sales by the year 2000, and the world market approaches $1 trillion. Materials are far and away the largest market opportunity.

... these are weaknesses that this country and U.S. technology leaders are fully capable of correcting.

If current trends continue, the United States will lag behind Japan before the end of the century in most emerging technologies and will trail the European Community (EC) in several of them. When it comes to advanced materials, we don't foresee the United States gaining against the competition unless we take some new initiatives. In both research and development and new product introduction, the trend seems headed in just the wrong direction in our competition with the Japanese. However, we seem likely to hold our own compared with the EC.

In assessing the reasons for our relative decline in the global marketplace, most observers cite the high cost of capital, the short-term view of the financial markets, failures in managing technology, our competitors' trading practices, poorly trained workers, and the like.

My own specialty is technology, so let me discuss the challenges in managing technology.

We have general agreement that U.S. science is the best in the world—just witness the continuing stream of Nobel prizes to Americans and overseas interest in our university science base.

This article was excerpted from a speech made by John W. Lyons, director of NIST, to the Society of Manufacturing Engineers' Composites in Manufacturing 10 Conference in Anaheim, Calif., on Jan. 8, 1991.

**Editor's note: This report is available from the National Technical Information Service, Springfield, Va. 22161 for $17. Order by PB #90-216557.*

U.S. creativity remains strong, and our research and development laboratories continue to develop new technology at a competitive or better rate. Our major shortcoming is that we continue to fall behind in taking new technology into the marketplace and in reaping the resulting sales benefits.

The symptoms of the problem of going to market show up as problems in three areas: quality, cost of goods, and speed-to-market. We cannot expect to retain or gain market share if we are not the first with new product lines with the best quality and lowest cost.

If that's the bad news, it also is the good news. Because these are weaknesses that this country and U.S. technology leaders are fully capable of correcting.

First, quality. There are many techniques for improving the quality of our products. The question of quality can no longer be limited to physical and chemical attributes—for example, whether or not a product meets specifications. Instead we have to go back to the design stage and ask whether the product as designed is reliable, serviceable, and easy to manufacture, and whether it truly fulfills its intended function and satisfies the customer. In short, we need to design for quality.

At one end of the quality spectrum, a statistics-based discipline is emerging that seeks to achieve robustness of design through formal sensitivity analysis. This discipline recognizes that it is essential that a product not be sensitive to any small changes in any variable critical to quality. For most products, there are many critical variables and aspects of quality to be juggled, so a structured approach is needed. Fortunately, designing for quality is taking hold as an active field of research, and one in which industry can expect benefits in the near future.

Research physicists John Barker (left) and Susan Krueger insert a sample into NIST's 8-meter small-angle neutron scattering spectrometer at the NIST Cold Neutron Research Facility, a national user facility for materials research.

In a broader context, we are seeing a whole new movement to improve our companies under the banner of "total quality management." Companies are putting in place management systems that make quality considerations the basic starting point for business strategies and decision making, as well as for employee and customer involvement. Quality improvement is becoming serious business for business in America, and the efforts over the past few years are beginning to add up to a real cultural change for corporate America.

Cost is obviously one of the primary considerations that determine whether American technologies and companies make it in the international marketplace. Cost can be attacked by streamlining processes, by improving process measurements, and by using tighter process controls to reduce rejects. Often this is as simple as controlling the inventory of raw materials, components, and finished goods. For many processes, flexible automation techniques can and are bringing about economies of mass production in lot sizes as small as one unit. This is possible thanks to the extraordinary

advances that have taken place in microprocessors and their applications.

In many processes, while the control technology is well advanced, the process sensors are primitive and limiting. By failing to place a high enough priority on process technology, we are opting to lower short-term costs while ultimately driving up overall product costs.

Speed-to-market is the other critical factor that has been hurting U.S. technology-based developments. We've heard it over and over again: Technologies are given life in America and exploited by competitors who bring our ideas to market.

If you look at the evolution of any number of today's critical technologies, you often can identify a short period of time during which all factors were favorable. This is when a new business venture and the right product can reap large profits. And if there is one major difference between technological development in the 1980s and 1990s compared with earlier decades, it is the speed at which those technological "windows of opportunity" are opening and closing.

If American companies want to make it in the international marketplace in the years ahead, they will have to be much better prepared when those windows of opportunity present themselves.

That's why it is so encouraging to see American managers begin to focus on concepts of "concurrent or simultaneous engineering," "just-in-time manufacturing," and "lot sizes of one." Teams of designers, engineers, and production staff are putting together new products and processes in markedly reduced times. By automating major portions of the design and production processes, our industry leaders are improving quality and cost and offering the customer tailor-made products in less time.

... we need to pay more attention to how new technical approaches can improve—and are improving—our competitive situation.

If I sound upbeat, it's because I am. Instead of bemoaning our slide in key technology-based sectors of our economy, instead of worrying about what a tighter federal budget will mean for the portion of our economy that has traditionally relied on the defense sector, instead of complaining about what the competition is doing, we need to pay more attention to how new technical approaches can improve—and are improving—our competitive situation.

That is what we are trying to do at NIST. Working in partnership with industry and government, we have three main goals today: to support industry, to carry out selected programs in public health and safety and environmental improvement, and to support the science and engineering community through fundamental research. We are supporting industry by focusing on:

- generic, precompetitive technologies for both products and processes;
- emerging technologies, such as composites, that will be economically important in the future;
- quality management and quality improvement technologies and methods;
- expanding our cooperative efforts with partners in industry, government, and academe; and
- strengthening our outreach and technology transfer efforts.

Our work in composites reflects these priorities and shows how a federal laboratory can work productively with industry and government to ensure that America takes full advantage of technology opportunities.

We know that advanced materials, including composites, are a key technology of the future. At NIST we have been addressing scientific and measurement issues that are crucial to the successful applications of new materials. We have focused on the development of measurement methods, reference data, and materials to help relate the structure and properties of various materials to issues of design, processing, and performance. For composites, that information is vital since the pressure for rapid use of these materials has outstripped the development of a corresponding science and technology base in fabrication. We all know a major effort is needed to correct this problem.

NIST Joins with Automotive Consortium To Improve Polymer Composites Processing

NIST and the Automotive Composites Consortium (ACC) have agreed to a cooperative program to improve the processing of structural polymer composite materials.

The ACC partnership of Chrysler Corporation, Ford Motor Company, and General Motors Corporation is aimed at developing the technology industry needs for processing reliable, cost-effective structural polymer composite materials.

The cooperative project will focus on composites made by resin transfer molding (RTM) and structural reaction injection molding (SRIM). NIST researchers will develop and use computer models for both processing methods to simulate the fabrication of a complex demonstration part made by the ACC using the latest processing and performance technologies. The demonstration part is the front end structural member of a discontinued model of the Ford Escort constructed primarily of composite materials.

The RTM and SRIM processes involve injecting resins into a mold that has been filled with fiber reinforcements. By combining plastic resins with glass fibers, very versatile, lightweight, and high-strength materials can be made.

According to Donald L. Hunston, leader of the NIST polymers composites group, the challenge is to achieve the optimum flow of resin so that the mold is completely filled in minimum time and with minimum pressure while avoiding bubbles and voids.

The NIST computer models are designed to predict flow patterns and pressures during RTM and SRIM processing. Information from the simulations will be used by the ACC to optimize processing conditions and to improve mold design.

"This collaborative effort will offer NIST researchers an opportunity to compare model predictions with data from the fabrication of a part. The information also will be used to develop generic tools and procedures needed to establish RTM and SRIM processing as efficient routes for producing a variety of polymer composite parts," said Hunston.

Leading industry representatives at two NIST workshops indicated RTM and SRIM molding as among the most important processing methods for the next 5 to 15 years.

For further information, contact Donald L. Hunston, A209 Polymer Bldg., NIST, Gaithersburg, Md. 20899, 301/975-6837.

by Roger Rensberger
NIST Public Affairs Specialist

In recent years, our focus has turned increasingly toward improving the understanding of materials processing. Our goal is to assist industry to develop real-time, automated systems of process control—intelligent manufacturing, in short. Such systems are vital to improved product quality, production efficiency and cost, and speed-to-market, those factors critical to any commercially successful technology.

To ensure that our composites efforts are targeted on those aspects of the science base that will most directly help U.S. companies achieve cost-effective processing, we have held several workshops with industry. Recommendations about the most important processing methods, made during a 1987 session, helped us in planning a major expansion of our composites program.

Likewise, a second workshop held last year on technical barriers, helped to guide another expansion in our composites work.

Greater cooperation—among industry, university, and government—is absolutely vital if we are going to apply the resources needed to assure that the United States is competitive in the future—and that goes for composites as much as for any field. NIST has signed a cooperative

research and development agreement with the Automotive Composites Consortium put together by Chrysler, Ford, and General Motors. The project is intended to help improve the processing of structural polymer composite materials made by liquid molding. (See box on page 7.)

We are collaborating in other ways with industry and other government agencies to advance U.S. polymer composites capabilities. NIST has special facilities available to industry for proprietary and non-proprietary work. For instance, the world-class small-angle neutron scattering instrument at our research reactor has been used by industry to determine the molecular network structure in composite resins, and our small-angle x-ray scattering facility has been used to study microstructure in high-strength fibers.

At NIST we have been addressing scientific and measurement issues that are crucial to the successful applications of new materials.

At our Automated Manufacturing Research Facility, we are developing a workstation to improve fabrication by filament placement with thermoplastic composites. This method has great potential since it combines high speed with low cost.

In addition, we have several new extramural programs that can help U.S. composites manufacturers in their efforts to remain world-class competitors as this technology broadens to more far-ranging commercial applications.

Our regional Manufacturing Technology Centers program helps to transfer advanced manufacturing techniques—including techniques developed at our own NIST automation laboratories—to small and mid-sized companies. (See article on page 18.)

Operated by not-for-profit, non-federal organizations, the centers reach out to companies in the region and provide hands-on assistance and training opportunities. It would be entirely appropriate for these centers to serve the needs of composites manufacturers.

Our most recent external effort is the Advanced Technology Program, an industrial grants program intended to speed the development by industry of pre-competitive, generic technologies with high commercial potential. Both individual corporations and joint ventures are eligible for funding after undergoing a technical and business screening. The program is growing; we have received $36 million—which totals $72 million with the industry matching funds—for the next round of grants later this year. (See article on page 12.)

Perhaps our most successful new program relates directly back to quality: the Malcolm Baldrige National Quality Award. When you talk about culture changes that will help improve U.S. economic competitiveness, and what can be achieved through public-private sector cooperation, you probably can't find a better example. NIST manages the program, which was established by Congress just over 3 years ago, in close cooperation with the private sector. Only nine companies have been honored with this award after having made it through a tough screening process.

Just as importantly, the award criteria are being used extensively by U.S. firms to benchmark how they stack up against world competition and to improve their capabilities. If you aren't familiar with this program and the guidelines, I encourage you to contact us immediately. If your company can win the award, great. But if your organization follows the Quality Award guidelines, the increased awareness and action that result mean that you, your firms, American business, and our economy come out winners.

Our work at NIST will be but one of many factors in improving the health and competitiveness of the U.S. composites industry. By addressing the key factors of quality, cost, and speed-to-market, and by providing a forum for cooperative planning and research, we offer industry an opportunity to help meet America's technology challenges. This country has all the tools it needs to succeed in the competitive years ahead. Now we have to show that we are committed to using them.

1992 Budget Seeks Increase for NIST

President Bush's fiscal year (FY) 1992 budget request for the National Institute of Standards and Technology proposes total funding of $248 million, a 15-percent increase over the FY 91 appropriation of $215 million. The funding request includes $201.8 million for intramural projects and $46.2 million in extramural programs. The FY 92 budget strategy continues the effort begun in FY 91 to expand NIST's ability to develop generic technology and address a rapidly growing number of important standards and measurement issues. It is designed to strengthen NIST research programs in support of U.S. industry in the economically important areas of electronics, advanced materials, computers, communications, industrial chemical technology, and manufacturing.

"Collectively, these fields are a powerful driving force behind the U.S. civilian economic sector," said NIST Director John W. Lyons. "It is largely in these fields that technology advances are creating multibillion dollar markets for new products."

The $35.6-million increase for NIST intramural programs and facilities represents a 21.4-percent increase over FY 91 funding levels for these programs.

The $22-million increase proposed for FY 92 intramural research initiatives will support many new projects, including:

- accelerated development of measurement technology and standards for high-temperature superconductors, intelligent machines, advanced microwave and fiber optic communications systems, and intelligent materials processing;
- establishment of security criteria and evaluation measures for computer and telecommunications operating systems;
- collection of thermophysical property data needed to develop alternatives to chlorofluorocarbon refrigerants; and
- development of safety practices and construction standards to protect water, power, sewage, and other "lifeline" systems from damage during earthquakes.

The FY 92 budget request also includes $4 million to begin to address critically needed and overdue refurbishment of the Institute's 25- to 35-year-old laboratory facilities to correct safety and environmental problems and to initiate upgrades of inadequate heating, cooling, and electrical systems.

An additional $10.4 million is needed for adjustments to the FY 91 funding levels to account for inflation and to fund previously approved upgrades to the Institute's scientific computing system.

The budget proposal includes decreases totaling $750,000 in the intramural appropriation due to the completion of an upholstery ignition project, a decision not to support a non-energy-related inventions program, and changes in the building and fire laboratory.

While the extramural FY 92 request is $2.9 million less than that of FY 91, FY 92 program obligations will be increased slightly to $49.6 million due to carryover funding.

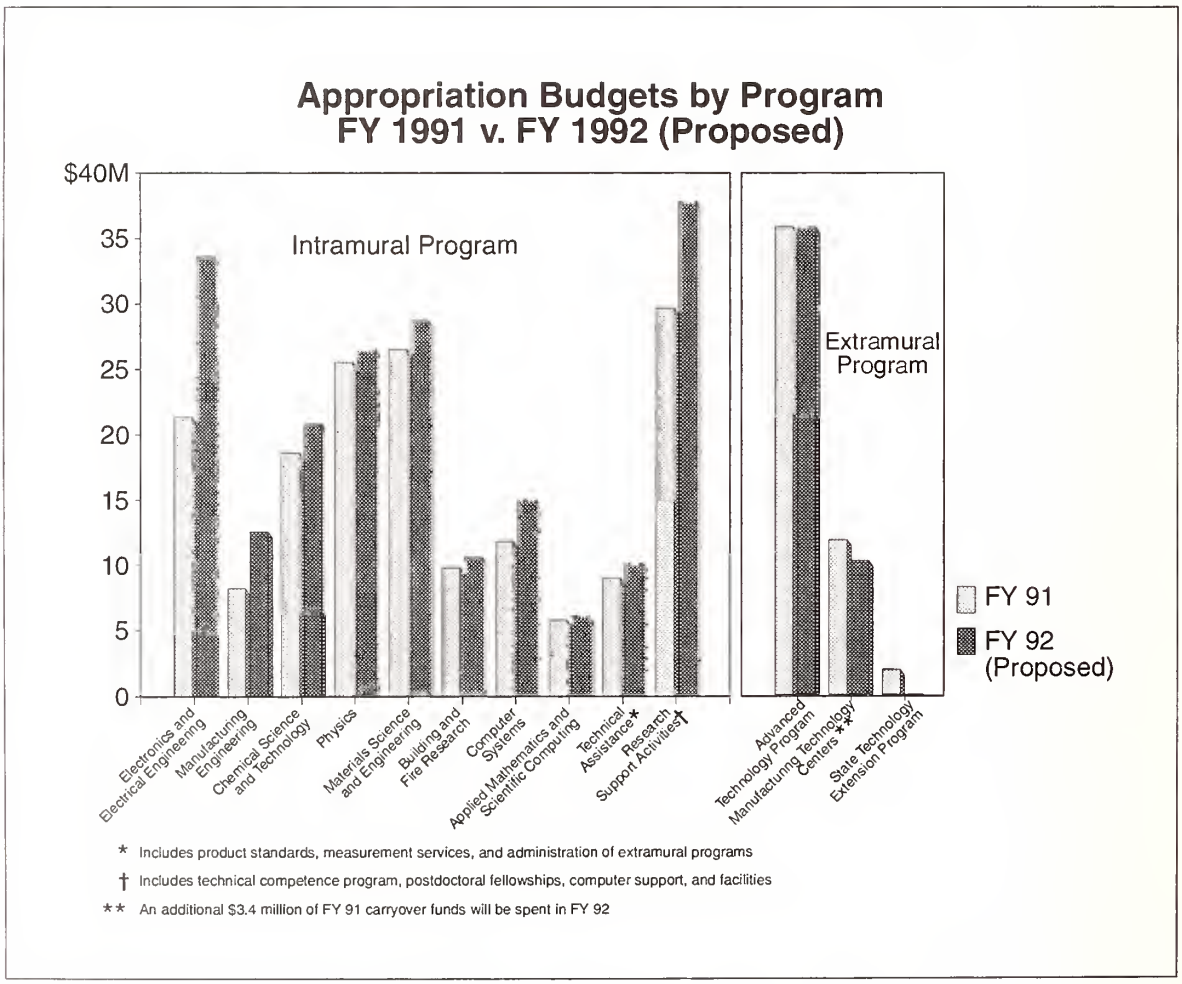
The FY 92 request of $35.9 million for the Advanced Technology Program (ATP) is equal to the level funded in FY 91. The ATP awards multiyear grants to U.S. businesses for the development of precompetitive, generic technologies.

The FY 92 appropriation of $10.3 million for the Manufacturing Technology Centers program will be added to $3.4 million in FY 92 carryover funding to support a total of six regional centers to transfer new and innovative manufacturing technology to small and medium-sized companies.

Decreases in the FY 92 extramural appropriation request include a $1.3-million decrease due to phasing out the State Technology Extension Program because its functions are being accomplished through other programs.

Overall NIST resources include the direct laboratory (intramural) appropriation; research funds from other federal agencies and non-federal sponsors; fees from reimbursable services, such as sales of standard reference materials and calibrations of equipment; "in-kind" loans or donations of staff and equipment; and the extramural appropriation.

Increased investment in NIST intramural research and its wide variety of technology-transfer mechanisms will help the Institute better meet industry's needs and will ensure that the resulting research advances reach their intended audience. At the same time, an expanded intramural research program complements the NIST extramural programs by ensuring that the agency has the depth and breath of in-house technical know-how needed to effectively manage its grants programs.



Making Good Contact

A broad-based method for making vastly improved electrical contacts to high-temperature superconductors is the subject of a patent issued to researchers at the National Institute of Standards and Technology and the Westinghouse Electric Corporation. NIST's Jack W. Ekin and Armand J. Panson and Betty A. Blankenship of the Westinghouse Science & Technology Center developed techniques for making ultra-low-resistivity contacts for various kinds of high-critical-temperature ceramic oxide superconductors. Contact resistivity using these methods is less than a billionth of that of conventional indium-solder contacts.

The work removes a serious obstacle to the commercial application of high-temperature superconductors in both large-scale and thin-film devices.

Intense, worldwide research efforts have focused on new ceramic materials that become superconductors at temperatures far higher than metallic superconductors. These ceramics are generally copper oxide compounds containing certain proportions of other elements such as yttrium, bismuth, thallium, lead, strontium, calcium, and barium. While metallic superconductors commonly must be cooled to less than 10 kelvins (less than 10 °C above absolute zero) and require liquid-helium cooling, many high-critical-temperature superconductors can operate at more than 77 K and use much cheaper liquid-nitrogen cooling.

Several scientific and engineering obstacles block wide commercial exploitation of the new materials, including the difficulty of making good electrical contact at the point where the superconductor must meet conventional electronic circuitry. Poor contacts have high resistance, generating heat and voltage, which in turn limit the amount of current the superconductor can carry, making them unsuitable for most applications.

The work removes a serious obstacle to the commercial application of high-temperature superconductors. ...

A key factor in the problem, the researchers found, is the electrical degradation of the superconductor surface where it is exposed to air—especially moisture in the air. The newly patented methods include etching the superconductor surface to achieve a non-degraded state, or maintaining the non-degraded state by excluding air after fabrication of the superconductor until a noble metal contact pad is deposited on the surface by sputtering or evaporation.

The methods have been applied successfully to the main yttrium-, bismuth-, and thallium-based high-temperature superconductor compounds in both bulk and thin-film forms. The patent covers contacts with contact resistivities below a milli-ohm-square centimeter. Resistivities below a nano-ohm-square centimeter, however, have been achieved using the method.

For licensing information on U.S. patent number 4,963,523, High-T_c Superconducting Unit Having Low Contact Surface Resistivity and Method of Making, contact Bruce Mattson, A343 Physics Bldg., NIST, Gaithersburg, Md. 20899, 301/975-3084; or Mike Lynch, Westinghouse Science & Technology Center, 1310 Beulah Rd., Pittsburgh, Pa. 15235, 412/256-5241. Order reprints of papers describing the techniques from Jack Ekin, Div. 724.05, NIST, Boulder, Colo. 80303.

by Collier Smith
NIST Public Affairs Specialist

Grants To Advance Key Industrial Technologies

Commerce Secretary Robert A. Mosbacher announced on March 5 selections for the first awards under the Commerce Department's new Advanced Technology Program (ATP), which he said could lead to the birth of revolutionary products and processes in key U.S. industries and help boost the country's trade and competitiveness.

Eleven new research and development programs (see pages 14–17 for program descriptions) have been selected for funding under the ATP in fundamental industrial technologies, including improved manufacturing techniques for electronics (such as x-ray lithography); optical recording; a variety of hardware and software technology for computers; high-temperature superconductivity; machine tool control; and novel laser designs.

Mosbacher said, "Nearly half of these projects are proposed by industrial consortia—partnerships between large and small companies that were formed to work on solutions to key technological barriers in their industries. The remainder of the proposals are from individual corporations.

"This demonstrates the new spirit of cooperation that I see between industry and government, between industry and academia, and within industry itself—a spirit that the ATP was designed to foster."

"... grants have the potential to spawn revolutionary new products and processes in several key industries."

The awards will provide approximately $9 million in first-year grants to initiate nearly $100 million in research and development programs over the next 5 years. More than half of the cost will be paid by sponsoring firms.

"The programs we have selected for this round of ATP grants have the potential to spawn revolutionary new products and processes in several key industries," Mosbacher said.

"Driven by industry's insight into the international marketplace, tools like the Advanced Technology Program offer an appropriate and powerful framework to achieve our common goal: developing the leading technologies that the world has come to expect from U.S. companies. We feel we've made a very good beginning on a program that promises to be an important tool for boosting U.S. competitiveness and trade."

Administered by the National Institute of Standards and Technology, the Advanced Technology Program provides grants to private industry to support the development of precompetitive,

generic technologies with significant commercial promise. The program provides incentives for research and development on fundamental technologies that underlie a broad range of potentially important commercial products, but does not support the development of actual products.

In the ATP, precompetitive means research and development activities up to the stage where technical uncertainties are sufficiently resolved to permit assessment of commercial potential, and prior to development of application-specific commercial prototypes. The ATP will support development of laboratory prototypes and proof of technical feasibility but not commercial prototypes or proof of commercial feasibility. At this stage, results can be shared within a consortium that includes potential competitors without reducing the incentives for the individual firms to develop and market commercial products or processes.

Generic technology means concepts, components, or processes, or scientific investigations that potentially could be applied to a broad range of products or processes.

Any business, independent research organization, or industrial joint venture may apply for an ATP grant. No direct funding will be provided to universities or government organizations, but they may participate as members of a joint venture. Universities may receive funding only through participation in an industry-led project.

Awards to individual firms are limited to $2 million over 3 years and can be used only for direct research and development costs. Awards to joint ventures can be for up to 5 years and are limited only by available funds. NIST funding to joint ventures must represent less than 50 percent of the total research and development cost.

The next solicitation for ATP proposals is expected in the late spring. The program has $35.9 million available for awards in fiscal year 1991.

Projects are selected for funding through a multistage evaluation process. Proposals are first screened for compliance with the basic requirements of the program. Technical experts then evaluate each proposal for scientific and technical merit. Those rated highest for scientific and technical merit are then rated for four additional criteria:

- the potential broad-based benefits of the proposal;
- the technology-transfer benefits of the proposal;
- the experience and qualifications of the proposing organization; and
- the proposer's level of commitment and organizational structure.

A small group of "semi-finalists" are asked to make oral presentations at NIST and, in some cases, site visits may be made to assess special facilities. Final decisions will be based upon:

- assuring an appropriate distribution of funds among technologies and their applications;
- the rank order of the applications on the basis of all selection criteria; and
- the availability of funds.

NIST publishes announcements calling for ATP proposals in the *Federal Register* and *Commerce Business Daily* at intervals that depend on available funding. The next solicitation for ATP proposals is expected in the late spring. The program has $35.9 million available for awards in fiscal year 1991.

Proposer's kits containing proposal preparation instructions and the forms required for proposal submission will be provided upon request. Only proposals meeting the criteria outlined in the proposer's kit will be accepted, and proposals will be accepted only during the solicitation periods noted in the program announcements. Interested parties may request that their names and addresses be added to the ATP mailing list. For information, write or call the Advanced Technology Program, B110 Technology Bldg., NIST, Gaithersburg, Md. 20899, 301/975-3972.

by Michael Baum
NIST Public Affairs Specialist

Advanced Thallium Superconductor Technology

E.I. du Pont de Nemours & Company

High-critical-temperature (HT_c) superconductors have potentially important applications in many electronic and electrical devices because they bring all the advantages of superconductivity within the range of relatively simple liquid-nitrogen cooling. Present applications are limited in part by the need for commercially viable thin-film processes to produce HT_c components. This proposal is to adapt and develop thin-film fabrication technologies for a relatively new and complex thallium/lead HT_c superconductor developed and patented by Du Pont. The project will develop two fabrication processes—a two-step approach using RF sputtering and post-annealing, and one in which sputtering and annealing are done simultaneously. Photolithographic and ion-milling techniques will be used to pattern the films, and a variety of basic electronic devices will be fabricated to demonstrate the new technology.

Technologies: Materials, superconductivity
Project length: 3 years
First-year request: $370 K
Total request: $1,590 K
Cost-sharing funds: $784 K
Contact: Alan Lauder, 302/695-9230

Solid-State Laser Technology for Point-Source X-Ray Lithography

Hampshire Instruments, Inc., McDonnell Douglas Electronic Systems Co.

The next generation of microlithography equipment needed to produce dense, high-performance integrated circuits will require commercially practical x-ray sources. A possible alternative to large, very expensive electron storage rings is a compact x-ray point source in which a rapidly pulsed, high-energy laser is used to excite an x-ray-emitting target. Until recently, this technology was limited by the lack of good laser materials able to cycle rapidly at high energy levels, but it is now possible to grow crystals of neodymium-doped gadolinium gallium garnet (Nd:GGG) with the required properties in commercially useful quantities. Hampshire Instruments and MDESC propose a joint venture to attack the next obstacle—the development of large-scale laser diode arrays to "pump" the crystalline laser host. The key problem is precise control of the energy produced by the diode array to satisfy the narrow absorption requirements of the crystal. Successful development would make possible a relatively low-cost, high-performance x-ray workstation of enormous value to the entire U.S. semiconductor industry.

Technologies: Semiconductors, x-ray lithography
Project length: 1 year
First-year request: $1,090 K
Total request: $1,090 K
Matching funds: $1,094 K
Contact: James Forsyth, 716/482-4070

Nonvolatile Magnetoresistive Semiconductor Technology

Nonvolatile Electronics, Inc. (NVE)

An important limitation of main computer memory is that it is "volatile"—the data disappear as soon as the power is shut off. Some specialized semiconductor memories—so-called "EEPROMS"—are limited in the number of read/write cycles they can handle before wearing out, and more permanent storage devices such as disk or tape drives are slow and have complex, mechanical parts subject to wear. The design of the entire range of modern computers from microcomputers in automobile control systems to supercomputers would be affected by the development of a fast, dense, non-volatile memory capable of unlimited read/write cycles. NVE proposes to develop that technology, based on a unique magnetoresistive memory (MRAM) patented by Honeywell Inc. and planned for use in space and avionics applications. NVE has an exclusive license to develop non-space/avionics applications of MRAM technology. NVE proposes to improve significantly the device speeds, density, and production yields in order to compete with conventional DRAMs (dynamic random-access memory) in a broad range of commercial applications.

Technologies: Computers
Project length: 3 years

First-year request: $599 K
Total request: $1,738 K
Cost-sharing funds: $869 K
Contact: James M. Daughton, 612/550-0913

New User-Interface for Computers Based on On-Line Recognition of Natural Handwriting

Communication Intelligence Corporation (CIC)

In 1990, the value of computers and peripherals produced in the United States came to more than $63 billion, yet studies have shown that no more than about 5 percent of the population uses computers at even the most elementary level. A system that allows people to interact with computers using their own "natural" (cursive) handwriting should significantly expand this important market. Handwriting input also offers significant advantages over all other data input technologies for applications like text editing and filling standard forms. CIC's research plan is to create a large database of cursive handwriting for evaluating such systems, test and improve current handwriting recognition algorithms and extend them to European languages, evaluate the potential of new approaches to handwriting recognition, and merge these approaches in a robust handwriting-recognition system that is independent of the user—that is, one that does not require "training" the computer to recognize each individual user's handwriting.

Technologies: Computing
Project length: 2 years
First-year request: $671 K
Total request: $1,264 K
Cost-sharing funds: $912 K
Contact: Francis V. Dane, 415/328-1311

Short-Wavelength Sources for Optical Recording

National Storage Industry Consortium (NSIC)

Data storage devices are a $50-billion-a-year industry, largely controlled by U.S. (64 percent) and Japanese (34 percent) firms. Although currently only a small portion of that market, the most promising new technology in this field is optical recording such as is used for compact discs, a market largely controlled by Japanese (80 percent) firms. NSIC members—Applied Magnetics Corporation, Bernoulli Optical Systems Company, Eastman Kodak Company, International Business Machines Inc., Maxoptix Corporation, and Optical Data Storage Center (University of Arizona)—propose to develop an integrated, short-wavelength laser source for optical recording. Multiple lasers (for multichannel recording), solid-state components to increase frequency, and a non-mechanical scanning system for tracking the beams will be fabricated in a single device. Besides greatly advancing the art of diode laser sources and optical modeling, these new heads would revolutionize the industry—data storage four times as dense, data read and write speeds twice as fast or better, in smaller, more rugged devices.

Technologies: Optics, electronics, computers, data storage
Project length: 5+ years
First-year request: $50 K*
Total request: $5,421 K
Matching funds: $9,200 K
Contact: John L. Simonds, 619/558-6835

*Preliminary grant contingent on further development of the consortium.

Advanced Manufacturing Technology for Low-Cost Flat-Panel Displays

Advanced Display Manufacturers of America Research Consortium (ADMARC)

The trend in the multibillion-dollar display industry for computers, television, and other commercially important products is toward larger and higher-resolution "flat-panel" displays. Beyond the development of the display technology itself, successful commercialization of low-cost, high-quality flat-panel displays will require important advances in testing and repair equipment, as well as better connection and packaging technologies. ADMARC, a joint venture of relatively small U.S. producers of flat-panel displays, proposes a linked series of research programs to develop automated inspection and repair technology and advance two generic technologies for interconnections (the electronic links between the

display panel and the microchips that drive the display) and packaging: "flip-chip-on-glass" and polysilicon ICs-on-glass. The results will be applicable to the design, production, testing, and manufacture of any type of flat-panel displays. The companies that will direct the major research tasks are Optical Imaging Systems, Inc. (Troy, Mich.), Photonics Imaging (Northwood, Ohio), and Planar Systems, Inc. (Beaverton, Ore.). Seven other companies will participate in the research.

Technologies: Electronics, computers, television
Project length: 5 years
First-year request: $1,251 K
Total request: $7,305 K
Matching funds: $7,604 K
Contact: Peter S. Friedman, 419/666-1024

Fabrication and Testing of Precision Optics for Soft X-Ray Projection Lithography

AT&T Bell Laboratories

Projection x-ray lithography is a key enabling technology for future generations of extremely dense, compact microelectronic circuits. Producing ICs with critical dimensions six times smaller than today's state of the art, it will lead to significant improvements in a vast range of commercial products. X-ray mirrors, used to image patterns from mask to wafer, are the most important optical elements in such a system. The technology is severely limited by our inability to measure directly and hence control the surface quality of these mirrors. This proposal is to develop the technology to test, fabricate, assemble, and align aspherical x-ray mirrors in an imaging system with resolution limited only by the diffraction of the x-rays. In addition to benefiting the electronics and semiconductor industries, the technology would have important applications in high-density plasma research, x-ray lasers and microscopy, and space optics.

Technologies: Electronics, manufacturing, x-ray
Project length: 3 years
First-year request: $955 K
Total request: $2,000 K
Cost-sharing funds: $3,525 K
Contact: John E. Bjorkholm, 908/949-3050

Printed Wiring Board Interconnect Systems

National Center for Manufacturing Sciences (NCMS)

Printed wiring boards (PWBs) are often overlooked in discussions of microchips and other advanced electronic components, but they form the backbone of virtually every electronic product, providing connections between individual electronic devices. PWB technology is approaching fundamental limits in materials and processes that must be overcome if the U.S. industry is to maintain a competitive position. (The U.S. share of the $25 billion world market dropped from 42 to 29 percent in 3 years.) Four members of the NCMS consortium—AT&T, Texas Instruments, Digital Equipment Corporation, and Hamilton Standard Interconnect Inc.—will work with Sandia National Laboratories to develop a more consistent epoxy glass material with improved mechanical characteristics for PWBs, improved processes and process-control techniques to produce more reliable solder connections, improved methods and technologies for fine-line imaging on the boards, and a better technical understanding of the chemistry underlying key copper-plating processes.

Technologies: Electronics manufacturing
Project length: 5 years
First-year request: $2,370 K
Total request: $13,783 K
Matching funds: $14,674 K
Contact: Gene Allen, 703/281-7326

Volume Holographic Mass Storage Subsystem

Microelectronics & Computer Technology Corporation (MCC)

One of the principal bottlenecks in the mass processing of large amounts of computerized information is the relative slowness of mass data storage systems, such as disk drives. Mass storage systems are about 100,000 times slower than typical microprocessor CPUs. This joint venture proposes to develop the next generation of computer mass memory using holographic recording to store information in photorefractive crystals.

Such a device would respond in microseconds rather than milliseconds and have applications across the entire range of computer technology, from personal computers to supercomputers. MCC has already developed and demonstrated the basic concept. This project will develop the support technology required to supply the electro-optical components of the system, develop low-cost designs and processes for producing the crystal arrays which form the storage medium, and build a prototype 2-gigabyte memory.

Technologies: Computers
Project length: 5 years
First-year request: $823 K
Total request: $10,331 K
Matching funds: $12,700 K
Contact: Cynthia Williams, 512/338-3512

Tunable Deep UV and VUV Solid-State Laser Source

Light Age, Inc.

Commercial lasers are a $1 billion market and growing, fueled by applications in photolithography for the semiconductor industry, materials processing, and medical and scientific instrumentation. Short-wavelength light sources in the ultraviolet (uv) or vacuum ultraviolet (vuv) ranges are particularly desirable, but today such sources are restricted to large, expensive synchrotrons, excimer-pumped lasers, or dye lasers that have been inefficiently "frequency upconverted." The latter two require facilities for dealing with toxic and mutagenic gases or liquids. Light Age proposes to develop two comparatively new laser technologies to produce a broadly tunable, solid-state laser light source for the uv and vuv. The new source will be based on a marriage of tunable alexandrite lasers and recently developed techniques for shifting laser frequencies using novel non-linear crystals. This approach could provide researchers, doctors, and engineers with high-average-power uv lasers that are cheaper, safer, more compact, more efficient, and more reliable than any now on the market.

Technologies: Lasers, photolithography, medical devices
Project length: 1.5 years
First-year request: $627 K
Total request: $701 K
Cost-sharing funds: $254 K
Contact: Georgia J. Fisanick, 908/563-0600

Advanced Compensation Techniques for Enhancing Machine-Tool Accuracy

Saginaw Machine Systems, Inc.

The ability to shape parts to the very high tolerances demanded by aerospace and other applications is a key sales point in the machine-tool industry; any technology that can significantly enhance machine-tool accuracy at a modest increase in cost can have a major impact on this important industrial sector. Thermal errors, caused by the expansion or contraction of various parts of the machine tool due to temperature changes, present one of the most recalcitrant problems in high-precision machining. Laboratory systems have been demonstrated that use thermal sensors and computers to correct for this, but existing techniques require detailed measurements to be made on each individual machine. Working with the University of Michigan, Saginaw proposes to develop a generic mathematical model of thermal errors and the sensor and computer-control systems necessary to give machine-tool manufacturers an easily adaptable thermal-error correction technology that can enhance the accuracy of their products four to five times at reasonable cost.

Technologies: Manufacturing
Project length: 2 years
First-year request: $266 K
Total request: $540 K
Cost-sharing funds: $168 K
Contact: Gerald J. Romito, 517/753-8465

Helping Companies Up the Technology Ladder

The United States is home to more than 350,000 manufacturing companies with fewer than 500 people on the payroll. These companies make everything from massive tree stump crushers to kitchen countertops. They produce over half the value added by all U.S. manufacturing and supply many of the components required by large manufacturers. They are, as one manufacturing expert recently commented, "the bottom end of the industrial food chain." And when they are suffering through hard times, the U.S. economy suffers with them.

A relatively new program at the National Institute of Standards and Technology aims to help such small companies compete by utilizing appropriate levels of advanced manufacturing technology. Computer-aided design and manufacturing (CAD/CAM), "just-in-time" inventory systems, automated inspection, total quality management—improving quality and efficiency by incorporating such fundamentally new approaches to manufacturing is both a necessary and daunting task for many small companies.

Established in 1988 through the Omnibus Trade and Competitiveness Act, the Manufacturing Technology Centers (MTC) program currently includes three operating centers in Cleveland, Ohio; Troy, N.Y.; and Columbia, S.C., with centers in Kansas City, Kan., and Ann Arbor, Mich., expected to open within several months. (See box.) Their mission is to help smaller U.S. companies take advantage of more advanced technologies to help improve their competitiveness.

Their mission is to help smaller U.S. companies take advantage of more advanced technologies to help improve their competitiveness.

The situation for Kintz Plastics in Howes Cave, N.Y., is typical. The company uses a vacuum molding process to make plastic parts for a large variety of custom applications, ranging from plastic "clouds" for airport ceilings to housings for medical instruments and protective covers for infrared sensors. Wynn Kintz, president of the company, contacted the NIST Northeast Manufacturing Technology Center (NEMTC) in Troy, N.Y., and asked for help. He was interested in speeding up the process for producing the steel or aluminum molds used in shaping custom plastic parts and in reducing the "down time" for programming the company's computer-controlled machine tools. He had already spent several months investigating the problems, but was making little headway. There were just too many options to consider and not enough time or information available to make the decisions best for his business.

NEMTC sent CAD/CAM experts to the company's plant to assess the firm's needs and to recommend solutions. Within

Kansas, Michigan Named Sites of Technology Transfer Centers

Commerce Secretary Robert A. Mosbacher announced on March 7 the selection of two organizations to establish regional manufacturing technology transfer centers in Michigan and Kansas to aid small and medium-sized businesses.

The Industrial Technology Institute in Ann Arbor, Mich., and the Kansas Technology Enterprise Corporation of Topeka, Kan., were selected by NIST. The institutions now will negotiate cooperative agreements with NIST for approximately $1.5 million each for the first year, which they will match.

"The establishment of Michigan and Kansas centers means that small and medium-sized businesses in the two areas soon will have improved access to the advanced manufacturing technology and processes they need to compete and prosper," Mosbacher said. "The new centers complement the efforts of centers in Ohio, South Carolina, and New York, which are already working with the Commerce Department to modernize America's industrial sector through technology transfer."

Twenty non-profit institutions from 18 states representing various segments of state and local government and the academic world competed for the federal support. NIST selected the two organizations after a National Research Council panel reviewed all applications for technical merit and NIST representatives visited the finalists.

The new centers will assist local companies to gain expertise with technologies that include sensors, computer networks and communications systems, inspection scheduling, computer-aided design and manufacturing, quality control, and intelligent machines and robots.

With NIST assistance, the Industrial Technology Institute will create a center in Ann Arbor. The center will focus its initial efforts on approximately 8,000 machine tool, tooling, metal-forming, and plastic processing firms that supply the automotive and office furniture industries—the state's principal employers.

The center will seek its first clients in an area bounded by metropolitan Detroit, Ann Arbor, Jackson, Battle Creek, Kalamazoo, Grand Rapids, Saginaw, Bay City, and Flint. For information, write or call: Bill Hetzner, Acting Director, Industrial Technology Institute, 2901 Hubbard Rd., Ann Arbor, Mich. 48106, 313/769-4580.

The Kansas Technology Enterprise Corporation will establish the Mid-American Manufacturing Technology Center in Overland Park, a suburb of Kansas City, Kan. Its service area will eventually be expanded to include western Missouri; northern Oklahoma, including Oklahoma City and Tulsa; and eastern Nebraska, especially greater Omaha. Information on the center is available from William Brundage, Acting Director, Kansas Technology Enterprise Corporation, 112 S.W. 6th Ave., Suite 400, Topeka, Kan. 66603, 913/296-5272.

by John Blair
NIST Public Affairs Specialist

12 months Kintz Plastics had purchased the automation equipment the company needed, trained employees, and cut mold production time from 8 weeks to 8 days. The result was increased profitability and increased capacity for new business with the potential to improve profitability even more.

AccuSpray Inc. had similar problems. The 30-person company manufactures special paint spraying equipment that reduces hazardous emissions to the environment. AccuSpray president Ken Marg turned to the NIST Great Lakes Manufacturing Technology Center (GLMTC) in Cleveland to help him make significant redesigns of both his product and its production method. "The world of manufacturing is changing

The Great Lakes Manufacturing Technology Center helped AccuSpray Inc. redesign its product and production method. Here, an AccuSpray employee demonstrates the special paint spraying equipment, which uses half the paint of conventional methods.

pretty rapidly," says Marg. With help from GLMTC and its affiliated group, the Cleveland Advanced Manufacturing Program, he says, "We made much more intelligent decisions than we would have otherwise."

The Cleveland center's monthly luncheon forums for small businesses and regular training seminars are also very helpful, Marg adds. "You learn that there are other ways that things can be done and it's a tremendous source of new ideas."

The assistance available through the MTCs can be critical for companies at certain stages in their development. "We're at a point where we're making a turnaround and resources are hard to come by," says Tom DiCarrado, vice-president for operations for Macbeth, which has worked extensively with the Northeast center. Forty-five percent of Macbeth's products, spectrophotometers used in judging the color of paints and papers, are exported. Since many other countries provide government support to their high-tech industries, says DiCarrado, "we would really be hurting without these kinds of programs. It really keeps us even."

Individual Approaches

Each of the three existing centers has a unique system and style of operation in reaching out to its client companies, explains Phil Nanzetta, who directs the MTC program for NIST.

The individual programs reflect the diversity of companies in the regions of the Midwest, Northeast, and Southeast United States. In addition, all three centers offer a wide range of assistance, including free advice answering specific questions over the telephone, free demonstrations of computer software and machine-shop hardware, seminars and training courses tailored to small businesses, and extended projects lasting from several days to a year, in which new technology is incorporated into a company's manufacturing process.

All of the centers are operated by non-profit organizations and receive up to 50 percent of their funds, to a maximum of $3 million annually, from NIST for the first 3 years, with declining government support for a maximum of 3 additional years.

■ **Great Lakes Manufacturing Technology Center**—This center is operated by the Cleveland Advanced Manufacturing Program, which is one of Ohio's Thomas Edison Technology Centers. With 30 full-time staff members, it provides training, workshops, and shop floor demonstrations of CAD/CAM and other equipment and tailors commercially available technology to the needs of small companies. Frequent special events, such as the luncheon forums described above, reach a large number of the more than 6,000 small manufacturing companies in the immediate Cleveland area.

Contact: George Sutherland, Director, Great Lakes Manufacturing Technology Center, Cleveland Advanced Manufacturing Program, 2415 Woodland Ave., Cleveland, Ohio 44115, 216/987-3200.

■ **Northeast Manufacturing Technology Center**—Located within the Center for Manufacturing Productivity and Technology Transfer at Rensselaer Polytechnic Institute, this center employs a full-time staff of nine, plus 16 part-time staff at Rensselaer and other universities and colleges and 19 student interns. It also utilizes a network of 18 technology extension agents affiliated with the New York State Science and Technology Foundation. According to an October 1990 report on the MTCs by the NIST Visiting Committee on Advanced Technology, many of the clients served by the Northeast center tend to be "more technologically sophisticated on average."
Contact: Gene Simons, Director, Northeast Manufacturing Technology Center, Rensselaer Polytechnic Institute, CII-9009, Troy, N.Y. 12180-3590, 518/276-6682.

■ **Southeast Manufacturing Technology Center**—A newly established program headquartered at the University of South Carolina, the Southeast center is affiliated with several state technology transfer organizations and serves a largely rural clientele with a full-time staff of 64, most of whom are located at 2-year technical colleges. The majority of its contacts are with small metals-processing companies who need help in a wide range of manufacturing practices from basic shop floor techniques to robotics technology.
Contact: Steven Eisele, Assistant Director, Southeast Manufacturing Technology Center, University of South Carolina, Swearingen Engineering Center, Columbia, S.C. 29208, 803/777-9595.

Total Quality Management

An important theme for the manufacturing technology centers is transferring the concept of "total quality management" to small manufacturers. Total quality management, explains William Ranson, director of the Southeast Manufacturing Technology Center (SMTC), involves engaging employees at all levels of a manufacturing company in the task of improving product quality.

SMTC is using its experience with RECO Industries Inc.—a Columbia, S.C., manufacturer of large steel pressure vessels—as a case study in how to work with an individual company to establish total quality management. "We went in with a team of eight people and formed a committee with eight RECO people," says Ranson. The changes initiated by the committee included improving the company's welding process, better materials planning, installing a new CAD/CAM system, and drawing up a plan for employee education and training. The project began in November and is ongoing.

"The long-term positive benefits of this committee's action will substantially contribute to RECO's well-being and competitiveness in the coming year," commented Stuart Point, the company's executive vice president.

The Technological Ladder

"What we're attempting to do with these companies is move them up the technological ladder," says Gene Simons, director of the Northeast manufacturing center. "The bottom rung is the totally manual shop. The first rung may have a numerically controlled machine tool, and the next rung would be a shop that has a computer-aided design system to go with the numerically controlled tool. And so on up the ladder until hopefully they're into a complete computer-integrated manufacturing system."

The bottom line, adds George Sutherland, director of the Great Lakes center, is "to do whatever it takes to help improve the competitiveness of these small companies. These companies very much appreciate what's being done for them through the MTCs. There's a void out there and this program is filling that void."

General information on the Manufacturing Technology Centers program is available by writing or calling Phil Nanzetta, B124 Metrology Bldg., NIST, Gaithersburg, Md. 20899, 301/975-3414.

by Gail Porter
NIST Public Affairs Specialist

New Instrument Promises Improved Tracking of Drugs

The idea has been around for a while. Scientists have known for some time that it is possible to create a system that can dependably detect drugs, pollutants, bacteria, and viruses in humans by using chemical components of the body's immune system. But the challenge to date has been to combine the biochemical components that make the process work with repeatability and a reliable method for gauging the component being measured.

Researchers at the National Institute of Standards and Technology have now developed such a device that has, for example, possible future applications in doctors' offices and other clinical settings. Based on immunoassay technology—which uses antibodies like those found in the human body to seek out and latch onto the substances being measured—the system is automated, fast, and reusable. It also can be calibrated easily to ensure accuracy and consistent results—"a significant advantage," says chemist William MacCrehan, who manages the project.

Dubbed the liposome-based flow injection immunoassay (LipoFIIA) system, the device's key benefit lies in its ability to pick out and quantify in minutes the amount of a specific chemical compound or other component from a complex mixture such as blood or urine. Other methods require hours or even days.

Having seen excellent results with in-house trials of the device, NIST researchers have also received high marks from tests of the instrument held recently at the National Institutes of Health's Clinical Chemistry Laboratory in Bethesda, Md. NIST has applied to patent the system.

The device had its beginnings in 1985. "We saw immunoassays then as a wide-open field that was about to take off," says MacCrehan. "We knew that there would soon be a need for analytical methods and calibrations. So we decided to develop our own generic system that could be adapted to serve these purposes and act as a prototype for a liposome-based system."

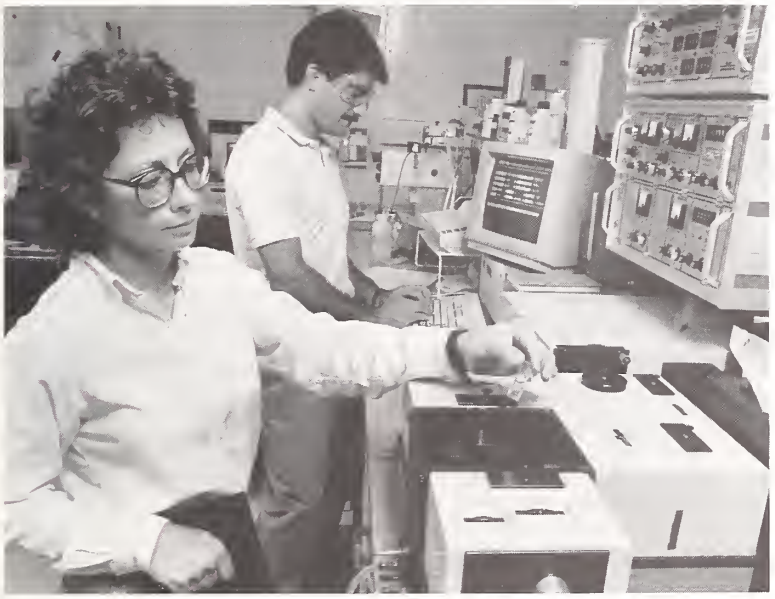
While they emphasize the LipoFIIA system's medical promise, NIST scientists envision other applications of the system, including environmental pollution monitoring and chemical process control.

The device's key benefit lies in its ability to pick out and quantify in minutes the amount of a specific chemical compound or other component from a complex mixture such as blood or urine.

For now, however, researchers are focusing on the system's use as a clinical laboratory analysis instrument.

The NIST device can, for instance, check blood levels of therapeutic drugs. Because it

works quickly—in about 12 minutes in most cases—an instrument of its design could be a boon to doctors monitoring patient levels of certain drugs that might be toxic, even lethal, at proportions only a fraction above their effective concentrations. Such an analysis could be performed in the doctor's office while the patient waits. Further revisions now in the works may make the instrument even quicker.



Biochemist Anne Plant, a collaborator on the LipoFIIA system, prepares a sample in the NIST laboratory where the system was developed. In the background is analytical chemist Steve Choquette.

The LipoFIIA system has advantages not found in other instruments on the market. Conventional analysis techniques—high-performance liquid chromatography, for example—require time-consuming, labor-intensive, and potentially costly steps to separate and identify the substance being analyzed. Another method known as radioimmunoassay uses antibodies like the NIST system, but it requires "tracers" made of radioactive materials that must be properly discarded.

Still other immunoassay systems work by using enzymes, which react with the component of interest to create a measurable product. But they are cumbersome and require chemical processing agents that cannot be reused.

The NIST system employs liposomes—submicroscopic, balloon-like globules made partially of cholesterol—to do much of its work. Because liposomes can be used to amplify detection of a substance, the LipoFIIA system can analyze components as low as parts per billion in concentration, making it more sensitive than enzyme methods. Also, liposomes can be stored for at least a year at room temperature, whereas enzymes require refrigeration.

Additionally, the LipoFIIA system incorporates flow injection technology into its design, a feature that allows the device to be used repeatedly for a batch of analyses. In a flow injection system, samples are introduced into a continuous stream where they undergo controlled dispersion and can be chemically or physically treated with appropriate processing agents.

The LipoFIIA system begins by using monoclonal antibodies to recognize the target substance. These antibodies, the same kind of proteins that are the human body's natural detectors of foreign substances, are the system's biochemical "arms" that identify and latch onto the target substances, which may be only one of many components in an actual sample (a blood specimen, for example). Liposomes are coated with a chemical look-alike of the target substance, which the antibodies recognize.

At the heart of the device is a regenerable immunoreactor column in which biochemical reactions between antibodies, liposomes, and the target substance being analyzed occur. Antibodies—available commercially for many drugs, viruses,

and bacteria—are immobilized by chemical bonding onto glass beads and placed into the immunoreactor column. When a sample containing the target substance is introduced into the immunoreactor, liposomes also are introduced. Antibodies in the immunoreactor column bind with the target substance and also with the liposomes.

NIST researchers have used antigens of the asthma therapeutic drug theophylline extensively to demonstrate the LipoFIIA system. They often have "spiked" blood serum with theophylline to simulate an actual blood sample with an unknown quantity of the drug. Like theophylline in the serum sample, liposomes coated with theophylline are drawn to the antibodies, which see the two components as the same thing. Both theophylline and liposomes then enter a competition to win residency with the antibodies, each of which finally ends up harboring either theophylline or theophylline-coated liposomes. The "loser" liposomes, still coated with theophylline, and the rest of the sample, flow out of the system. The "winner" liposomes remain behind, held tightly by the antibodies in the immunoreactor column.

Because the liposomes each contain either electrochemical or fluorescent "marker molecules," chemists can use a detergent to explode the liposomes, releasing the markers and allowing a signal from those molecules to be measured by a detector. The number of liposomes and antibodies in the system is always constant, so after measuring the signal associated with spiked samples containing different known concentrations of theophylline, the signal from real unknown samples allows researchers to determine how much theophylline is in the blood sample. If there is a high concentration of the drug in the sample, then a small number of liposomes will bind to the antibodies, and a small signal will be measured. Conversely, a large signal means there are many liposomes held by antibodies, therefore indicating a low drug concentration.

The NIST device can, for instance, check blood levels of therapeutic drugs.

NIST researchers have seen excellent results when analyzing theophylline in blood serum. Laurie Locascio-Brown, a NIST biomedical engineer, recalls a recent instance when the LipoFIIA system was tested for its ability to differentiate between two compounds that are nearly carbon copies of each other. "We used a sample containing theophylline and caffeine, which are very similar chemically," she says, "and we were pleased to find that the system effectively measured the theophylline concentration in the sample."

NIST research has shown that antibodies chemically bonded to the glass beads in the immunoreactor column can be reused hundreds of times, remaining effective for at least 3 months. This is an important plus since antibodies can be expensive and time-consuming to replace.

On the agenda next are tests of the device's value in measuring environmental trace organic pollutants and in controlling the creation of fermentation products within a bioreactor.

But for the moment, NIST researchers have seen the NIH trials as a sign that the LipoFIIA system is a success. "We tested 100 (blood) serum samples containing different components," Locascio-Brown says. "The great advantage of doing this at NIH is that we used actual samples from a variety of patients, so we were able to examine performance in a real-world setting beyond our own laboratories. It was the ideal test."

by John Henkel
NIST Public Affairs Specialist

Call of the Future

The 21st century is calling and if you answer the phone, chances are you will not only talk to but also see the person on the other end and, at the same time, be able to send information—a sales report, product design, or even a grandchild's drawing. A new telecommunications technology, Integrated Services Digital Network (ISDN), is being heralded by many as the basis for information networks that will make this possible.

While some ISDN networks are being used now, they are proprietary and exist only as "islands," says Shukri Wakid, chief of the Advanced Systems Division at the National Institute of Standards and Technology. Before the technology can grow and become, in Wakid's words, "ubiquitous," obstacles must be overcome.

One of the biggest is compatibility of products. Standards for ISDN on everything from how information should be formatted to how fast it should be transmitted are emerging from national and international standards organizations. But, standards don't always ensure compatibility.

"Standards are designed to meet many requirements," says Wakid, "so they have many options and even some ambiguities." The result: Products from different vendors will not work together.

To help overcome this obstacle, NIST, together with private industry—manufacturers, service providers, and prospective users of ISDN technology—formed a new organization called the North American ISDN Users' Forum (NIU Forum). The forum brings together potential users of the technology with the manufacturers and service providers who will be providing the products.

"Both users and vendors are going to come out winners."

The aim of the forum is to define potential applications of ISDN and the features that may be required and then to make the detailed technical decisions needed to produce multivendor products and services that meet users' needs. "The forum really puts the users in the driver's seat and gives them a chance to make ISDN a competitive tool for their industry," says Wakid, who chairs the forum. "Both users and vendors are going to come out winners," he says.

In addition to NIST, the other founding organizations of the forum are Ameritech Services, the Association of Data Communications Users, Bell Atlantic, Bell Communications Research, International Computers Ltd., NYNEX, and Southwestern Bell. More than 300 participants attend the forum, which meets regularly.

What Is ISDN?

ISDN is a telecommunications technology that makes it possible to send and receive data, voice, and images simultaneously over existing telephone networks. Part of the reason ISDN technology is so powerful is that it uses digital networks, which are able to break information up into bits of data that can be fed directly to computers for processing.

Digital networks are steadily taking the place of older analog communications systems. According to the U.S. Commerce Department's *U.S. Industrial Outlook 1990,* about 30 percent of public-switched telephone networks in the United States are digital. In contrast, France has converted about 60 percent of its switching and transmission to digital technology, and Japan about 45 percent.

Instead of separate lines for telephones, computers, facsimile machines, and video displays, only one line is needed for

sending and receiving all types of information. This convergence of computers and communications technology can speed data transmission and gives users more control over information.

Competition for World Markets

The agreements reached in the forum also will put U.S. telecommunications suppliers in a stronger position to compete for world markets. Around the world, telecommunications is seen as important for economic growth and improved productivity. According to James Martin Associates, consultants on information systems development, the European Community is actively involved in promoting ISDN, and telecommunications services in general, in each of its member countries. In Japan, ISDN is part of a government-sponsored national technology project called the Information Network System.

Both the European and Japanese communities recently established ISDN users' forums very similar to the NIU Forum.

What Has the Forum Accomplished?

Since the forum began in February 1988, more than 500 organizations have participated in 11 workshops held nationwide. More than 100 ISDN applications have been defined, and the first set of implementors' agreements are to be published by mid-1991. The agreements outline how vendors will implement ISDN standards to ensure that products and applications will work together. "This is a major milestone," says Wakid, "and reflects the substantial work going on in the forum." In addition, some of the conformance tests developed by the forum have been contributed to the International Telephone and Telegraph Consultative Committee, an international standards-development body, as a U.S. position on testing.

Is the forum living up to participants' expectations? Scott Beale, of ARINC, and Bob Sherry, of AT&T Bell Laboratories, believe it is. In a recent paper, Beale and Sherry, who chair working groups in the forum, say, "Many users are no longer asking whether the technology is real or not, instead they are concerned with the real world aspects of implementing ISDN. The formation of the NIU Forum has increased user involvement in ISDN implementation and fueled the growth of ISDN in North America."

The forum is considering a demonstration of the standard ISDN technology for October 1991 to be held in conjunction with two large telecommunications trade shows. The demonstration will show that specifications developed by the NIU Forum will result in compatible products. ISDN networks showing that products and services can work together will be set up around the country and, possibly, the world.

What Else Is Needed?

After implementation agreements are reached and products are developed according to the agreed-upon specifications, the final stage is testing. "Even if a vendor follows the specifications, assurance is needed that they've been implemented correctly in the product and that, indeed, vendor X's products will interoperate with vendor Y's," says Wakid. NIST has made significant technical contributions to the ISDN conformance testing working group of the NIU Forum.

In addition, the forum is working with the long-running NIST Workshop for Implementors of OSI (Open Systems Interconnection). The OSI workshop was established in 1983 for the same reason as the ISDN forum: to bring users and manufacturers together to develop implementation agreements of OSI protocols.

The OSI standards provide a set of rules, known as protocols, for computer-to-computer transmissions of data between computer products from different manufacturers through a variety of communications technologies, including ISDN. But, as is the case with ISDN, the standards provide many options. The OSI workshops have had a successful track record in developing technical agreements that are being implemented in products.

In 1989, NIST, the U.S. Air Force, AT&T, and five other companies conducted a successful trial run of products implementing OSI protocols using ISDN as the communications technology.

Users, software developers, system integrators, service providers, and manufacturers are invited to join the ISDN users' forum. For further information, contact Dawn Hoffman, A224 Technology Bldg., NIST, Gaithersburg, Md. 20899, 301/975-2937.

by Jan Kosko
NIST Public Affairs Specialist

A New Generation of Materials?

Composites made by mixing powdered ceramic superconducting materials with a polymer may be a practical way to fabricate a new generation of materials with the magnetic levitation properties of superconductors—even though they do not conduct electric current, say researchers at the National Institute of Standards and Technology. Having developed just such a new superconductor-polymer composite, Aime S. DeReggi, Chwan-Kang Chiang, and George T. Davis, scientists at NIST, have received a patent for the innovation.

Even though the new composites do not conduct an electric current, work in the laboratory has demonstrated that a ceramic superconductor placed in a matrix of polyvinylidene fluoride displays the magnetic levitation properties of a superconductor. When a magnetic field is applied to the composite at superconducting temperatures, an electric current flows around the surface of each particle, creating a counter-magnetic field which gives the composite its levitating properties.

The NIST scientists report that the polymer acts as a binder and shields the particles from exposure to moisture and other chemically active substances that can destroy superconductivity in the unprotected superconductor. The composite material also has thermal and mechanical properties that permit repeated cooling and warming between room temperature and cryogenic temperatures without loss of physical integrity.

The new composites have magnetic properties that are intermediate between non-magnetic materials and superconductors.

In addition, the new composites have magnetic properties that are intermediate between non-magnetic materials and superconductors. Measurements to examine the dependence of these properties on the quantity of superconductor particles in the polymer matrix were made in collaboration with Lydon J. Swartzendruber of the NIST magnetic materials group.

Magnetic measurements were conducted on bar-shaped, centimeter-sized samples of composite materials containing varying amounts of finely ground superconducting particles. Chiang and DeReggi prepared the polymer test specimens by conventional molding techniques using the yttrium-barium-copper-oxygen superconductors. Magnetic susceptibility was measured from room temperature down to 10 kelvins.

According to the scientists, because only a small amount of polymer is required to act as a binder, there can be little loss of magnetic levitating properties in the composite compared to an undiluted superconductor material.

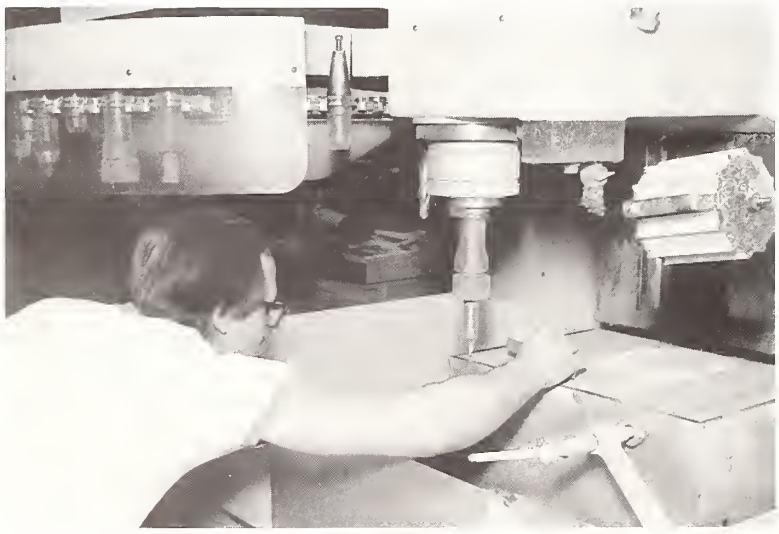
The new superconductor-polymer composites were developed as part of the NIST polymer research program. It is designed to support U.S. companies that produce, process, or use synthetic polymers, and to strengthen the scientific foundation that supports this important class of materials.

For information, contact Aime S. DeReggi, B320 Polymer Bldg., NIST, Gaithersburg, Md. 20899, 301/975-6725. *R.R.*

Manufacturers, Skiers Gain Competitive Edge

Six computer software and hardware companies and a sports helmet firm have combined forces at the National Institute of Standards and Technology to give America's top speed skiers and small machine shop operators a competitive edge. The companies used NIST's "Shop of the 90s" facility and equipment to design an aerodynamic helmet for athletes who flash down slopes at speeds up to 224 kilometers (139 miles) per hour. The facility is used to research and demonstrate how small machine shops can rapidly produce sophisticated, competitive products with commercially available technology.

John Simpson, director of NIST's Manufacturing Engineering Laboratory, recently presented the product of the cooperative effort, a mold for a Darth Vader-like helmet—and a diskette containing a computerized version of the mold, to Tom Westenburg, head of the United States Olympic Committee (USOC) engineering and technology department.



A NIST technician cuts the mold for the speed-ski helmet out of an epoxy-based resin in NIST's Shop of the 90s.

"NIST's concern is technology development and transfer."

"NIST's concern is technology development and transfer. We're not in the helmet business, and others must speak to the ultimate safety of the helmet our industrial partners designed for this extraordinarily exciting new sport of speed skiing," Simpson said. "We can say with certainty, however, that the head gear made from this mold will illustrate that the more than 127,000 small machine shops across the country can use off-the-shelf, computer-based technology to quickly produce world-class, top-quality items," said Simpson.

The United States Performance Engineering Program (US PEP), a not-for-profit Carlsbad, Calif., organization dedicated to applying technology to sports competition equipment, approached NIST about the project last fall. Steve Gubelmann, chief executive officer, said, "We have built our research and development capabilities around microprocessor-based technology. NIST's Shop of the 90s also uses commercially available computer-aided design and manufacturing (CAD/CAM) technology to help small machine shops modernize and compete. We both believe that existing, cost-effective technology can help win the gold for America."

Gubelmann assembled a team of industrial partners, many of which already were working with the Shop of the 90s. They met at NIST Dec. 17–21, 1990, to design the helmet, which is to be worn by members of the U.S. speed-skiing team at the sport's world cup competition May 12–17, 1991, at Mt. Bachelor, Wash. They are the only North American world cup races before speed skiing's debut as a demonstration sport in the 1992 Winter Olympics in Albertville, France. The resulting technology, including engineering data, is also to be provided at no charge to the United States Skiing Association and to the USOC.

The firms that donated material and personnel to the helmet project under a cooperative research agreement with NIST are Zenith Data Systems (Vienna, Va.), Brown & Sharpe (North Kingstown, R.I.), CADKEY (Manchester, Conn.), FastCut Numerical Control (Carson, Calif.), CNC Software Inc. (Tolland, Conn.), and Bell Helmets (Norwalk, Calif.). The work took place at NIST.

"NIST's Shop of the 90s also uses commercially available computer-aided design and manufacturing technology to help small machine shops modernize and compete."

All the CAD/CAM software was loaded on a high-performance microcomputer. US PEP used a coordinate measuring machine to convert measurements from a handbuilt helmet prototype into three-dimensional visual design data. The geometric data obtained from the reverse engineering effort were further refined so that CAM software could create numerically controlled tool paths for machining the final helmet mold. A three-axis milling machine was used to cut the mold out of an epoxy-based resin.

Bell Helmets will use the mold to manufacture the speed-skiing team's new head gear.

"Machine shop operators across the country can learn a great deal from this cooperative effort," said Adrian Moll, Shop of the 90s chief. "The speed-skiing helmet project offered NIST and its research partners an opportunity to demonstrate that small machine shops can move quickly from an idea to finished product. Small machine shops can compete nationally and internationally if they take existing technology seriously." *J.B.*

A member of the U.S. speed-skiing team models the helmet produced in a collaborative effort between NIST and a team of industrial partners.

Microwaves on a Chip

NIST Gauges Measurement Needs of Growing Industry

Fancy a cheap, on-board radar for your car to help avoid collisions? How about a low-cost TV satellite antenna about the size of a salad bowl to replace today's obtrusive, expensive "dishes"? Electronics engineers envision those and many more potential products as the result of new monolithic microwave integrated circuit (MMIC) technology now taking shape in government and industrial labs. But before these miracle devices can be successfully developed commercially, there are numerous obstacles—largely measurement related—to overcome. Researchers at the National Institute of Standards and Technology are tackling many of these problems through existing in-house programs and through team projects with outside organizations.

The impact of MMIC technology promises to be comparable to that of conventional integrated circuits (ICs), which in the recent past made possible small, inexpensive electronic devices of great power and complexity—high-speed laptop computers, for example. MMIC technology promises to do similar things by fostering the creation of products such as an intelligent traffic-light control system that can adjust the timing of whole networks of lights in response to changing traffic conditions.

The impact of MMIC technology promises to be comparable to that of conventional integrated circuits. ...

Currently, microwaves are used widely in communications, radar, and remote sensing devices, as well as in ovens. Present-day technology is built on comparatively large, discrete components such as antennas, amplifiers, mixers, and oscillators. It is in a state roughly akin to the days when computers were large, expensive assemblies of transistors, capacitors, and other components.

"MMIC technology can't use wires for interconnections. The microwave systems need special, precision-engineered components to guide the waves. Everything involved is very expensive," says Dylan Williams, a NIST electrical engineer. "However, it's now possible to build all of this on a chip, much like a lower-frequency integrated circuit."

Joining Forces with Industry

Early MMIC devices used silicon as the base material, limiting the usable frequency range. Now gallium arsenide, more useful but difficult to work with, has extended the frequency range and improved performance.

Still, there are key issues in standardization and measurement that must be resolved to ensure that MMIC devices from different companies can be integrated into working systems. In mid-1989 NIST began a MMIC measurement program and formed an industry-government consortium to establish national standards and provide traceability for critical measurements.

Members of the consortium include Cascade Microtech Inc.; ITT Defense and Gallium Arsenide Center; TRW Electronic System Group; and laboratories belonging to the U.S. Army Laboratory Command, Wright-Patterson Air Force Base, and Rome Air Development Center.

"We're pioneering in solving some of the important measurement problems that industry needs to address before MMIC can be a commercial technology," says Dennis Friday, assistant chief of the NIST Electromagnetic Fields Division. "Making conventional ICs is fairly well understood, but at microwave frequencies, very different problems arise. Just connecting two MMIC devices together without losing or degrading the signal through reflections is difficult. Working with the consortium, we've attacked several very serious problems in MMIC that became apparent when companies started producing these chips and trying to put them into systems."

One of these problems is temperature, which determines many of a circuit's electrical characteristics. Circuits may have a diminished lifetime, or may fail altogether, if they get too hot. Thus, it is critical for MMIC developers to have temperature-gauging capabilities, as well as a measuring system everyone can agree on. Presently there are no proven methods for measuring the temperature of many MMIC circuits because of the small size of many components, some with dimensions less than one-fifth the diameter of a human blood cell.

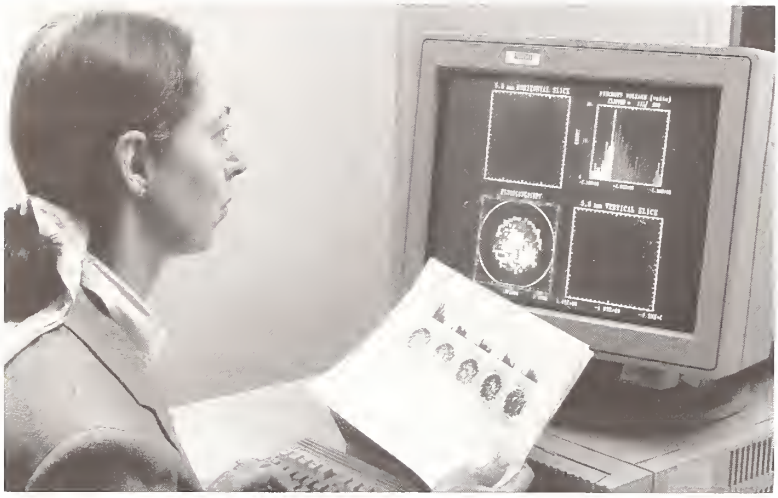
NIST electronics engineer David L. Blackburn is addressing these measurement needs by evaluating several existing temperature-gauging techniques and researching possible new ones. Among the methods being examined are infrared microradiometry (using the amount of infrared radiation naturally emitted by all warm bodies as a measure of circuit temperature), liquid crystals (a clear liquid-like material that becomes opaque to certain light at a very precise temperature), and computer modeling.

Ensuring MMIC Compatibility

Because of the infinitesimal size of MMIC devices, microwave characteristics must be measured to promote quality control and to ensure that final specifications will be met. With the aid of a microscope, microminiature "wafer probes" are used to make electrical contact with the circuit. Signals are injected and sensed by the probes at critical points in the circuit in order to determine its operating properties.

Product uniformity and interconnectibility are essential if U.S. manufacturers are to have a competitive edge in the international market. "Right now we do not

NIST electrical engineer Dylan Williams examines a microwave chip at one of NIST's wafer probe workstations.



Wafer maps are used by NIST engineer Constance Schuster to analyze test structure data. Various shades on the maps represent different data values.

have a clear understanding of the measurements we are making, and manufacturers use a variety of different calibration techniques. This makes it difficult to predict accurately how two microwave chips from different manufacturers—or sometimes even from the same manufacturer—will operate when connected together or to an antenna," says Williams. Working with the consortium, NIST is developing improved methods and integrated circuit standards to calibrate or characterize the probes industry is presently using.

"Since rapid technology transfer is essential to the success of this work, we hope to have consortium members utilizing new measurement methods a few months after they have been developed and verified by NIST," Williams says. The techniques will be transferred to the consortium members by distribution of computer software and standard intercomparison integrated circuit elements deposited on thin wafers.

Ball Aerospace Company of Boulder, Colo., will construct the initial NIST standards under a contract sponsored by the Defense Advanced Research Projects Agency (DARPA). "Within 2 years we hope to be able to fabricate our own standards in-house with better control over the tolerances and electrical characteristics," Williams says. At present, however, NIST intends to get improved measurement technology into the hands of consortium members as quickly as possible.

"Right now we cannot say with certainty—even when each chip has been measured carefully by its manufacturer—that an assembled system will work exactly as expected," Williams says. The eventual goal of the project is to ensure that every MMIC chip manufactured in this country can have transitions (electrical input and output terminals) that are well characterized and compatible.

Giving Meaning to Data

While much of the NIST research has potential consumer and mass-marketing applications, a significant slice has military applications. Under another cooperative agreement with DARPA, NIST electronics researchers are working with the U.S. Air Force's Wright Research and Development Center (WRDC). In support of the DARPA goal to provide manufacturing capabilities that produce affordable MMICs, NIST and WRDC are developing test and data analysis methods to show how the materials and processing used to fabricate MMICs affect their performance in a system. To do this, microelectronic test structures are produced on the same semiconductor wafer at the same time as MMICs themselves. Automated probing systems are used to measure both test structure parameters and MMIC performance, which are then correlated using data analysis techniques.

NIST is developing improved methods and integrated circuit standards to calibrate or characterize the probes industry is presently using.

The DARPA program needs a yardstick—a method that is economical, accurate, and reproducible—so the manufacturers know what they are producing and customers know what they are buying. Getting people to use standard test structures and test methods has been fairly easy, but that's only part of what's needed for correlations and comparisons to be meaningful," says NIST engineer Constance E. Schuster.

With each wafer providing over 30,000 data points that represent over 100 characteristics, this program is pursuing one of the most comprehensive test structure data analysis efforts ever. NIST and WRDC researchers have a considerable challenge to develop methods for simplifying data interpretation. Typically, test structure data analysis is done using "wafer maps," which resemble color-enhanced aerial photographs, where various colors represent different data values. Analysts reading these maps need expertise in MMIC materials, processing, and devices, as well as a keen eye for pattern recognition.

"To their credit, analysts are spending hours every day looking at wafer maps, knowing they will find things that will help them make better circuits," says Schuster. "But this is a slow, error-prone and analyst-dependent process. They need a better way, especially for the production environment they must eventually support."

As one way to make testing and data analysis more reliable and efficient for the production environment, NIST researchers are considering the applicability of computer-based pattern-recognition methods.

MMIC technology promises to revolutionize consumer and military electronics.

"From previous experience, we know such methods are a big help in identifying the most critical pieces in a pile of data so analysts can more easily diagnose problems. Such methods should also help streamline the amount of test data that needs to be collected in a production environment. This would be the real payoff for DARPA people," Schuster says.

Whether they are developing tests for MMIC chips or examining measurement standards, NIST researchers agree that MMIC technology promises to revolutionize consumer and military electronics. "The potential here is not just for reducing the size and lowering the cost of microwave devices," says Friday. "MMIC should open up a whole new communications spectrum that's not being used now—from 50 gigahertz right up to infrared frequencies. When that technology arrives there are going to be opportunities for new products that will sound like science fiction, products we can't even guess at."

by Fred McGehan and
John Henkel
NIST Public Affairs Specialists

New Publications

Standardization Activities of Organizations in the United States

Toth, R.B., editor, Natl. Inst. Stand. & Tech. (U.S.), NIST Spec. Pub. 806, 736 pages (February 1991). Order by stock no. 003-003-03070-8 from GPO, $31 prepaid ($38.75 foreign).

This directory summarizes the standards activities of more than 750 organizations in the United States, including federal agencies and approximately 425 private-sector groups. The largest section contains an alphabetical listing of 637 non-government organizations that develop standards or contribute to the standardization process by working with other organizations, or are sources of documents and information. The format provides quick access to information on the type of organization, scope of activities, whether standards are voluntary or mandatory, availability, and key words. Entries for 77 federal agencies, departments, and other organizational components that develop standards are included, as well as sources for information, subject index, acronyms and initials, and former names of organizations.

Manufacturing Technology Centers Program

NIST Visiting Committee on Advanced Technology, 27 pages (October 1990). Order from Dale E. Hall, A527 Administration Bldg., NIST, Gaithersburg, Md. 20899, 301/975-2158.

NIST's Manufacturing Technology Centers program is off to a promising start toward improving the technological competitiveness of small and mid-sized businesses, the NIST Visiting Committee on Advanced Technology said in this report to Commerce Secretary Robert A. Mosbacher. The centers are intended to bridge the gap between sources of manufacturing technology and the companies that need it. The nine-member committee praised the technology-transfer efforts of the New York, Ohio, and South Carolina centers, noting local business support for such efforts as direct project assistance, technical training courses, and demonstrations of hardware and software. The report looks at program strategies, operations, and financial support of the centers.

Polymer Composite Processing—Second Industry Workshop

Johnson, C., Chang, S.S., and Hunston, D., Natl. Inst. Stand. & Tech. (U.S.), NISTIR 4461, 86 pages (December 1990). Order by sending a self-addressed mailing label to A209 Polymer Bldg., NIST, Gaithersburg, Md. 20899, 301/975-6837.

The most important technical barrier to improved polymer composite processing for the next 5 to 15 years is industry's inability to control resin flow and fiber orientation, said a group of 24 leading composite users, suppliers, and fabricators in a 1990 workshop at NIST. Their findings are given in this report. The workshop was the second meeting at NIST in which representatives from industry were asked to target the most critical scientific and technical barriers in composite processing and to identify the serious performance issues that producers must address to meet increasing international competition. The industry group strongly supported conclusions from an earlier meeting, which ranked pressure molding and liquid molding as the two most important polymer processing methods for the future. Process monitoring and the measurement and control of fiber-matrix adhesion also were given high priority. Impact damage and environmental attack were selected as critical performance issues for all industry sectors.

U.S. Assessment of the New Diamond Technology in Japan

Feldman, A. and Schwartz, L.H., editors, Natl. Inst. Stand. & Tech. (U.S.), NIST Spec. Pub. 807, 96 pages (January 1991). Order by sending a self-addressed mailing label to Albert Feldman, A329 Materials Bldg., NIST, Gaithersburg, Md. 20899, 301/975-5740.

After visiting 21 Japanese companies, universities, and government agencies engaged in diamond research and development, a team of U.S. materials experts reports that the Japanese are leading in new synthetic diamond technology. In this report, the experts concluded that while no specific application of diamond technologies could be identified in which Japan has a dramatic advantage, there was a general impression that Japanese laboratories are ahead of the United States in high-rate deposition methods, but probably behind in understanding the fundamentals of the process.

Bibliography of Selected Computer Security Publications January 1980–October 1989

Bassham, L.E., III, editor, Natl. Inst. Stand. & Tech. (U.S.), NIST Spec. Pub. 800/1, 200 pages (December 1990). Order by stock no. 003-003-03060-1 from GPO, $11 prepaid.

This bibliography serves as an excellent resource for individuals interested in computer security issues. Citations are listed under 10 categories: general, management, foundations, access control, trusted systems, database security, communication and network security, cryptography, privacy and pre-1980 publications. Included are appendices with the addresses of all journals and magazines referenced in the bibliography and a list of key words.

Multimedia Courseware in an Open Systems Environment: A Federal Strategy

Moline, J., Hankinson, A.L., and Welsch, L.A., Natl. Inst. Stand. & Tech. (U.S.), NISTIR 4484, 53 pages (December 1990). Order by stock no. PB #91-143362 from NTIS, $17 prepaid

The federal government and other U.S. organizations are likely to invest billions of dollars to develop multimedia training materials for use in computer-based interactive training systems. This publication discusses the federal strategy for creating an environment in which high-quality portable courseware is available as commercial off-the-shelf products competitively supplied by vendors. The strategy comes from the Department of Defense Portable Courseware Project, which requires standard software interfaces.

NIST Standard Reference Data Products 1991 Catalog

Chase, M.W., Jr., and Sauerwein, J.C., editors, Natl. Inst. Stand. & Tech. (U.S.), NIST Spec. Pub. 782, 1991 Ed., 52 pages (February 1991). Order by sending a self-addressed mailing label to Standard Reference Data Program, A320 Physics Bldg., NIST, Gaithersburg, Md. 20899, 301/975-2208.

Scientists and design engineers will be interested in this catalog, which provides the latest information on the data computations, publications, and computerized databases available from the NIST Standard Reference Data Program and other sources. Critically evaluated data compilations are available in the following areas: analytical chemistry, atomic physics, chemical kinetics, materials properties, molecular structure and spectroscopy, thermodynamics and thermochemistry, and the thermophysical properties of fluids.

1989 Computer Security and Privacy Plans (CSPP) Review Project: A First-Year Federal Response to the Computer Security Act of 1987 (Final Report)

Gilbert, D.M., report coordinator, Natl. Inst. Stand. & Tech. (U.S.), NISTIR 4409, 189 pages (September 1990). Order by stock no. PB #91-107540 from NTIS, $23 prepaid.

This report describes the computer security and privacy plan review effort conducted jointly by NIST and the National Security Agency's National Computer Security Center in response to the Computer Security Act of 1987 (Public Law 100-235). The act requires federal agencies to prepare and submit to NIST and NSA—for review and comment—security plans for all computer systems that contain sensitive information. The report also discusses future directions for implementing the act. The goal of the act is to prompt federal agencies to take measures to improve the security and privacy of sensitive information in federal computer systems.

Directory of Federal Government Laboratory Accreditation/ Designation Programs

Breitenberg, M., editor, Natl. Inst. Stand. & Tech. (U.S.), NIST Spec. Pub. 808, 105 pages (February 1991). Order by sending a self-addressed mailing label to the Standards Code and Information Program, A633 Administration Bldg., NIST, Gaithersburg, Md. 20899, 301/975-4031.

This publication is designed to help federal, state, and local government officials, exporters, manufacturers, and others in commerce and industry locate federal laboratory accreditation programs and the organizations designated by the agencies to assist them in carrying out their responsibilities for testing products and services. Thirty-one lab accreditation programs are listed, as well as 13 federal programs with limited types of assessment. Entries are organized by agency, department, or independent commission. Each entry contains a program description, date initiated, authority, fields of testing accredited or designated, products affected, program requirements, availability of publications, and information on accreditation criteria.

Time and Frequency Users Manual

Kamas, G., and Lombardi, M.A., Natl. Inst. Stand. & Tech. (U.S.), NIST Spec. Pub. 559, 160 pages (September 1990). Order by stock no. 003-003-03050-3 from GPO, $8.50 prepaid.

NIST's popular time and frequency users' manual is written for readers at all levels of understanding. This revised edition contains updated information about time and frequency services available from NIST, other federal agencies, and other countries. The carefully indexed publication will be useful to technicians, experimenters, calibration laboratories, and scientists since it covers most aspects of receiving and using time and frequency calibration signals, the history of time services, foreign transmitters, satellite services, and calibration methods.

Ordering Information

To order publications from NTIS, send the request with payment to: National Technical Information Service, Springfield, Va. 22161. Publications can be ordered from GPO by mailing the order with payment to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Conference Calendar

June 4–5, 1991

Applications of Cold Neutron Spectroscopy in Chemistry, Biology, and Physics

NIST, Gaithersburg, Md.

Purpose: To explore the scientific opportunities offered by four new instruments at NIST's cold neutron research facility, which will permit the spectroscopy of chemical, physical, and biological processes across a very wide energy range.
Selected Topics: Chemical spectroscopy with neutrons, neutron spectroscopy of polymer dynamics, tunneling motions in molecular solids, neutron scattering from biological systems, time-of-flight spectroscopy, user policies at the cold neutron research facility.
Format: Workshop.
Audience: Physicists, chemists, biologists.
Sponsor: NIST.
Contact: William A. Kamitakahara, E151 Reactor Bldg., NIST, Gaithersburg, Md. 20899, 301/975-6878.

June [illegible]–21, 1991

North American ISDN Users' Forum (NIU-Forum)

Regal Constellation, Toronto, Canada

Purpose: To develop user-defined applications, implementation agreements for existing standards, and tests needed for a transparent, ubiquitous, and user-driven integrated services digital network (ISDN).
Topics: ISDN-related subjects.
Format: Tutorials, users' and implementors' workshops, working group meetings.
Audience: ISDN users, implementors, and service providers.
Sponsor: NIST.
Contact: Dawn Hoffman, B364 Materials Bldg., NIST, Gaithersburg, Md. 20899, 301/975-2937.

July 15–18, 1991

Fifth International Conference on Liquid Atomization and Spray Systems (ICLASS '91)

NIST, Gaithersburg, Md.

Purpose: To present the state of the art in experimental and computational techniques related to atomization processes and sprays used in industrial, transportation, and agricultural systems.
Selected Topics: Spray formation; instrumentation techniques; modeling of sprays and spray flames; atomization processes in gas turbines, internal combustion engines, and furnaces/boilers.
Format: Plenary lecture, invited and contributed papers, poster session, instrumentation and equipment exhibits.
Audience: International representatives of industry, academia, and other government agencies.
Sponsors: NIST and ILASS-Americas (Institute of Liquid Atomization and Spray Systems).
Contact: Hratch Semerjian, B312 Physics Bldg., NIST, Gaithersburg, Md. 20899, 301/975-2609.

July [illegible]–31, 1991

Joint U.S./German Conference on New Directions for Operations Research in Manufacturing

NIST, Gaithersburg, Md.

Purpose: To provide a forum for participants to discuss new directions for operations research in manufacturing.
Selected Topics: Distributed real-time scheduling, hierarchical and heterarchical control systems, integrated algorithms for design, process planning, and equipment level programming.
Format: Open forum.
Audience: Universities and manufacturers.
Sponsors: NIST, Operations Research Society of America Special Interest Group on Manufacturing, German Operations Research Society, and National Science Foundation.
Contact: Al Jones, A319 Metrology Bldg., NIST, Gaithersburg, Md. 20899, 301/975-3554.

October 14–18, 1991

Third International Symposium on ESR Dosimetry and Applications

NIST, Gaithersburg, Md.

Purpose: To focus on current applications of electron spin resonance (ESR) spectroscopy.
Selected Topics: Ionizing radiation dosimetry, including reference and transfer dosimetry, archeological dating, geology, solid-state effects, instrumentation, imaging, medical applications.
Format: Symposium.
Audience: Archaeologists, anthropologists, geologists, radiation scientists.
Sponsors: NIST, Department of Energy, China University of Science and Technology, and International Atomic Energy Agency.
Contact: Marc F. Desrosiers, C214 Radiation Physics Bldg., NIST, Gaithersburg, Md. 20899, 301/975-5639.

October 22–24, 1991

Gage Block Calibration

NIST, Gaithersburg, Md.

Purpose: To emphasize the concepts, techniques, and apparatus used in gage block calibration.
Selected Topics: Statistics, process control, gage block comparators, interferometry.
Format: Short instructional course.
Audience: Metrology laboratory managers and technicians.
Sponsor: NIST.
Contact: John Stoup, A107 Metrology Bldg., NIST, Gaithersburg, Md. 20899, 301/975-3471.

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