

# Bell Labs News

AUGUST 4, 1992

## Redefinition Update: Mayo Maps Paths to Innovation

BY DAN VAN ATTA

Innovation, according to Webster's, is the introduction of something new: an idea, a method, or a device. For Bell Labs President John Mayo, customer-focused innovation — the perpetual search for new and better ideas and methods that lead to advanced products — is key to successfully redefining Bell Labs' support of a growing, global enterprise.

Mayo drove home this point in addressing this year's second "Bell Labs Update" on redefinition, broadcast live to all employees July 24 from the Holmdel Auditorium. Joining Mayo in the address were Group Technical Officers (GTOs) Joe Timko of Communications Products, Dan Stanzone of Network Systems, and John Davis of Communications Services. Together, Mayo and the GTOs outlined the goals and processes needed to make enhanced innovation a reality.

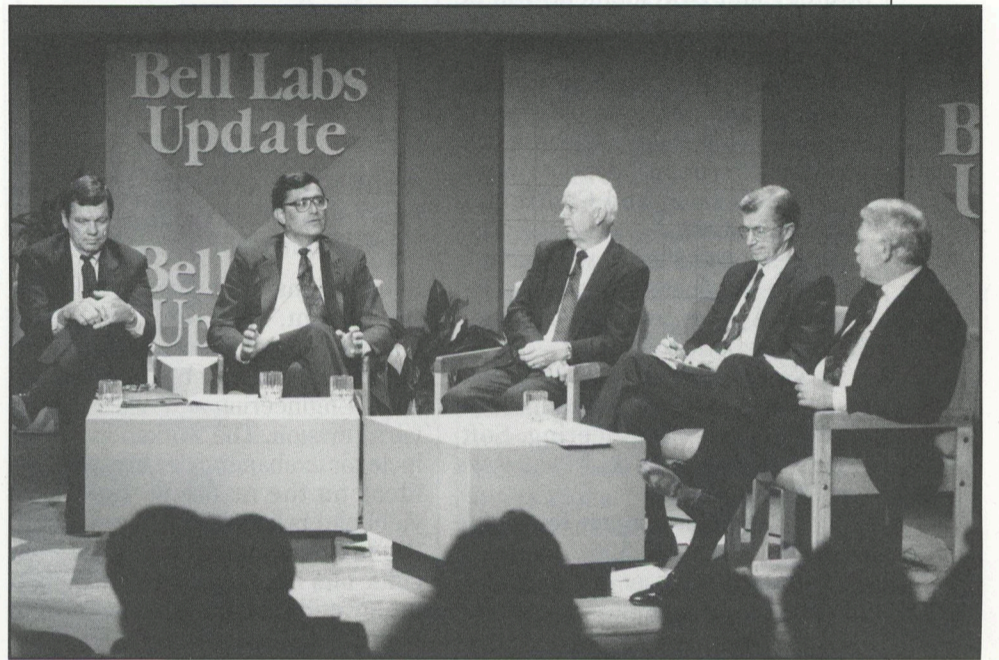
All of these goals and processes involve focus, vision, creativity and commitment, the officers said. Above all, however, they require a mindset that welcomes teamwork

and is receptive to ideas, from any source, that promise accelerated productivity.

Mayo began his talk by thanking employees for their support throughout the current period of transition. He ended his remarks with a reminder that the value of the Bell Labs brand depends on AT&T's success in the marketplace. "The best way to grow the value of Bell Labs is to grow its output, which, fortunately is what redefinition is all about," Mayo said.

In answer to an employee's question about the level of business unit support for the redefinition effort, Mayo confronted the mindset issue head on. "I hope we don't view this as one hand over the other hand," he said, "but, rather, as how we bring both pieces together to win over our competitors."

Mayo said the goals for realizing continuous innovation focus on a clearly defined strategic intent; a visionary plan needed to implement this intent over the long haul; a creative capacity to cut product intervals; a tenacious commitment to eliminate all unneeded costs; and,



President John Mayo, center, and Group Technical Officers, left to right, John Davis, Dan Stanzone, and Joe Timko answer employee questions posed by Public Relations Executive Director Dave Boyce during Bell Labs Update.

perhaps above all, a collective mindset that welcomes good new ideas — even those not invented here.

Among the processes that are being implemented to enhance innovation, Mayo cited:

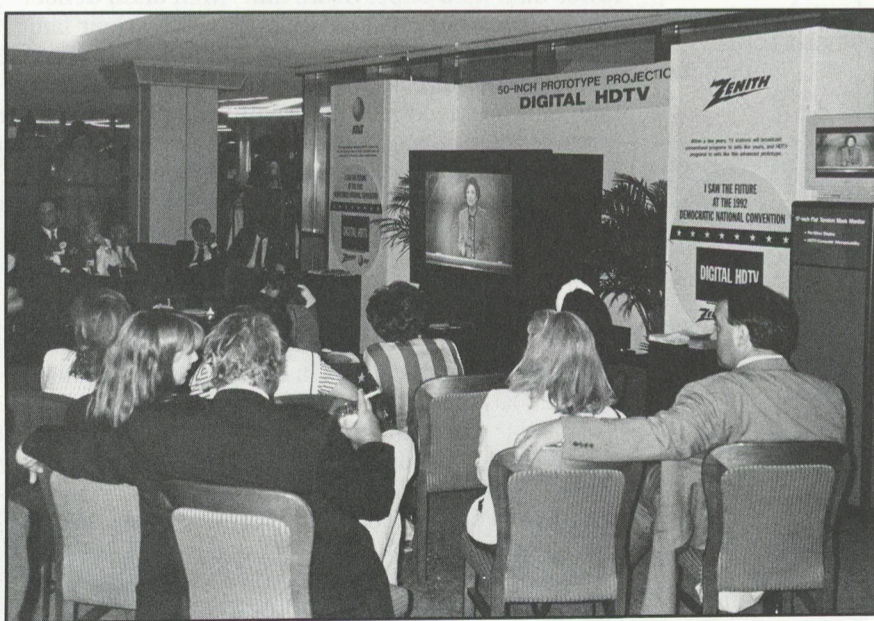
- Teaming research and development in tightly knit groups that speed applied research projects to market.
- Cross-business unit (GTO) oversight of exploratory develop-

ment, which was previously called forward-looking work.

- Long-term architecture and technology planning.
- Enhanced means of generating core products and processes.
- Extended use of best current practices.
- Use of metrics that measure R&D effectiveness and quality using external benchmarks.

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## HDTV Provides Clear View Of Garden Party



Those lucky enough to get into the VIP lounge at the Democratic National Convention got a better look at the proceedings than anyone anywhere — even the delegates a few hundred feet away in Madison Square Garden.

The arm-chair viewers watched the convention on prototype high-definition television sets supplied by AT&T and Zenith Electronics.

"Great picture" was the consensus of watchers who came armed with two questions — When will it be

available, and how much will it cost? The answers — 1995, and about \$1,000 above the cost of present high-end sets.

The demonstration, which will be repeated at the Republican showcase in Houston, is part of the effort by the two companies to earn Federal Communications Commission approval as the U.S. HDTV standard. The FCC is expected to name the winner of the five-entry race early in 1993. ■

## Alliance Aims to Break Transmission Bottlenecks

BY DONNA CUNNINGHAM

AT&T, General Electric, Honeywell, and IBM have formed a precompetitive industrial alliance — the Optoelectronic Technology Consortium (OETC) — to develop optical interconnections for high-speed data transmission in computers and telecommunications systems.

The OETC promises to break through the data processing "bottlenecks" that plague conventional copper-wired systems by transmitting data two to five times faster across optical highways.

The alliance, with \$8 million in funding from the Pentagon's Defense Advanced Research Projects Agency (DARPA), is expected to accelerate the already rapid pace of optoelectronic technology. "By pooling the

experience and programs of the four companies in optical interconnection, we believe we will advance the technology faster," explained Phil Anthony, head, Optoelectronic Device Department in Breinigsville, Pa. and Murray Hill. Anthony's department, along with optical interconnection experts in Indian Hill, Murray Hill and Whippany, will be responsible for the development of surface-emitting-laser transmitter and fiber-array interconnect technology.

Targeted applications include commercial and military signal/display processors for aviation and space systems, command-and-control systems, military image detection and tracking processors, high-speed parallel processors and multi-processors for workstation servers and controllers,

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## BULLETIN BOARD

**Second Annual AT&T Software Symposium**, Sept. 16-17, Holmdel and Indian Hill.

This symposium, sponsored by the Software Technology Center, Research and AT&T business units, has been organized to share ideas, work and experiences in research, development and use of software, with particular emphasis on improving quality and productivity.

The symposium will consist of invited and submitted talks, panel discussions, and workshops. On Sept. 16, Richard Bodman, AT&T senior vice president, Corporate Strategy and Development, will be the morning keynote speaker. He will address the topic, "Software as a Core AT&T Competency." Capers Jones, co-founder and chairman of Software Productivity Research, will give the afternoon keynote on the topic, "Assessing and Controlling Software Projects."

Sessions include presentations on Future Product Architectures, Reuse and Assets, Design Tools, and Process Experiences.

Workshops on Sept. 17 will include Object-Oriented Techniques, BCP Tutorials, Engineering, Software Technologies, and Processes and Platforms.

To register contact Josephine DiBella, MH 3C-526C, e-mail, [jpd@ulysses.att.com](mailto:jpd@ulysses.att.com), or fax, (908) 582-3063.

**AT&T Database Day**, Sept. 17, Holmdel.

This forum has been organized for the AT&T database community to exchange ideas about various aspects of databases, including research, design and implementation, experience, tools and needs. It will feature a series of presentations with lunchtime demonstrations.

Presentations will include: Knowledge Representation Support for Interactive Database Exploration; The Ode Object Database; DDB: An Object-Oriented Design Database for VLSI/CAD; DataShare and the Fourth Generation Language Cymbal; Generating Update Constraints from PRL5.0; Dynamic Hashing in the 5ESS switch; Carnot: Distributed Semantic Query Manager; Extending the UNIX Lock Types with SLEVE; Composite Event Specification & Detection in an Active Database; Integrating Efficient Large Object Support in a Persistent Language; and cql — Flat File Database Query Language.

Registration deadline is Sept. 1. To register, contact Josephine DiBella, MH 3C-526C, e-mail [jpd@ulysses.att.com](mailto:jpd@ulysses.att.com), or fax, (908) 582-3063.

**Sixth Yield and Reliability Improvement Workshop**, Nov. 5, Berkeley Heights, N.J.

Submissions are being solicited for this forum, sponsored by AT&T Quality, Management and Engineering and the Research, Materials Science, Engineering and Academic Affairs Division. The workshop is a vehicle for exchanging information and ideas on the materials aspects of yield and reliability improvement in the manufacture of integrated circuits, film integrated circuits, hybrid integrated circuits, printed wiring boards, semiconductor lasers and lightwave devices.

A title and 500-word abstract should be submitted to Niren C. Choudhury, AT&T QM&E, 650 Liberty Ave., Union, N.J. 07083. For more information, contact Choudhury on (908) 851-3581, or by e-mail, [homxb!ncc2](mailto:homxb!ncc2), or Bob Frankenthal on (908) 582-4032, or e-mail, [clockwise!rpfpr](mailto:clockwise!rpfpr).

## CONSORTIUM

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and telecommunications switching.

The consortium, which won the 30-month contract over several other groups competing for the award, plans to:

- Develop advanced optoelectronic components, including surface-emitting laser diode arrays, modulators, receivers, fibers, connectors, and polymer waveguides.

- Demonstrate data transfer through 32 parallel 500-megabit lines, at a total rate of 16 gigabits of data per second, between lightwave transmitters and receivers.

- Combine four 16-gigabit links in parallel to achieve a 64-gigabit data network. (High-capacity commercial telecommunications systems operate at up to 3.4 gigabits per second.)

The OETC's primary objective is to collaborate during the precompetitive development stage of optical interconnect technology for high-speed digital systems. Information developed in the program will be

shared with a users group made up of the consortium members and leading computer firms, semiconductor manufacturers, aerospace companies and government laboratories. The group will assist in identifying optical interconnect requirements for a broad set of future applications and will help establish time frames for the use of optoelectronic technology in future products.

Associates from leading universities and research laboratories will participate with the consortium to provide a conduit for advanced research projects that can complement and benefit the OETC program.

GE's Electronics Laboratory (Syracuse, N.Y.) will have overall OETC program management responsibility and will work on link design and modeling, testbed components and integration, and optical-interconnect testing and evaluation.

Honeywell will focus on modulation technology and optical sources. IBM will develop optical receiver arrays, and will perform link modeling and network analysis.

The next issue of the  
Bell Labs News  
will be published  
on August 24th.

## INDUSTRY WATCH

**Out in Front** Just a few years ago, U.S. companies didn't appear to have a future in high-definition TV. Yet, despite the technological prowess of Japan and the deep pockets in Europe, U.S. companies now lead the way in HDTV technology. They were spurred by the FCC, which in 1987 started a competition for the best system, and they were further helped by an unusual willingness to share technology. The U.S. researchers created, tinkered and tested until they invented path-breaking high-definition systems. Japan, meanwhile, is stuck with old-fashioned analog signals. (*The Wall Street Journal*, July 20).

**256-Megabit Chip Agreement** NEC and AT&T have agreed to cooperate in developing designs and production technology for 256-megabit dynamic random-access memory (DRAM) chips and other advanced integrated circuits. The aim of the tie-up, to be formalized in October, will be to develop designs and production technology capable of linewidths under 0.25 of a micron, believed necessary for production of 256-megabit DRAMS. NEC will use the technology to produce the advanced memory chips, while AT&T will concentrate on microprocessors and other logic integrated circuits. (*Nikkei Telecom*, July 14)

**Unique Flashcards** What's unique about AT&T Microelectronics' recently announced removable flash mass-storage cards is the fact that they can substitute directly for mechanical drives without the need to modify existing operating system standards, such as MS-DOS and BIOS. What's more, unlike Intel's memory cards, the AT&T cards used in a portable mass-storage system do not require a so-called flash file operating system. (*Electronics*, July 13)

**Hold that Stock** Edward Eyring, an analyst with Argus Research Corp., is gung-ho about AT&T's prospects because the economy will be improving. Telecommunications stocks typically lag behind in a recovery, so Eyring recommends that shares should be held at least until the stocks rebound six to nine months after the economy comes around. "What I like right now is AT&T's consumer division, which maintains a commanding presence in the cordless and corded telephone business, and answering machines as well," said Eyring, who is waiting to see how the VideoPhone 2500 will be received this year. "The company invests nicely in research and development and is being rewarded for it." (*New York Daily News*, July 19)

**Women Take Blame** Rutgers University researchers Nancy DiTomaso and George Farris found that women in research and development labs, unlike men, generally rated themselves lower than their supervisors did. "Men often deflect what doesn't go well, contending it wasn't their fault," agrees management consultant Richard Hallstein. "But women take more of the blame for things." Women may interpret feedback differently and play into stereotypes of themselves. "Women place a greater value on a sense of community and not the individual," says an AT&T spokesman; AT&T offers assertiveness-training classes and workshops for women. (*The Wall Street Journal*, July 21)

**On Safari in China** Hutchison-AT&T Network Systems (HANS) is taking personal communications in Hong Kong a step further with the launch of the Safari Personal Business Communicator, which the firm believes is the "world's first fully integrated cellular communications system." The system has been jointly developed by Hutchison Telecommunications, AT&T and NCR. It comprises an NCR 3170 Safari notebook, an AT&T cellular phone, and a host of on-board software. (*South China Morning Post*, July 21)

**Optical Lithography Study** Bell Labs will conduct a three-year comparison of X-ray and optical lithography techniques under a \$7.9 million award from the Defense Advanced Lithography Program. Bell Labs will print test CMOS devices using its Hampshire Instruments Model 5000P X-ray wafer stepper and a deep-ultraviolet XLS stepper from General Signal Corp. The devices are designed to have electrical performance related to the lithographic tolerances achieved in production, and will thus show whether X-ray's depth of focus and relative immunity to contamination translates into better device quality. (*Electronic News*, July 27)

# Voice Recognition System Makes Network Debut

BY CHRISTINE WARING

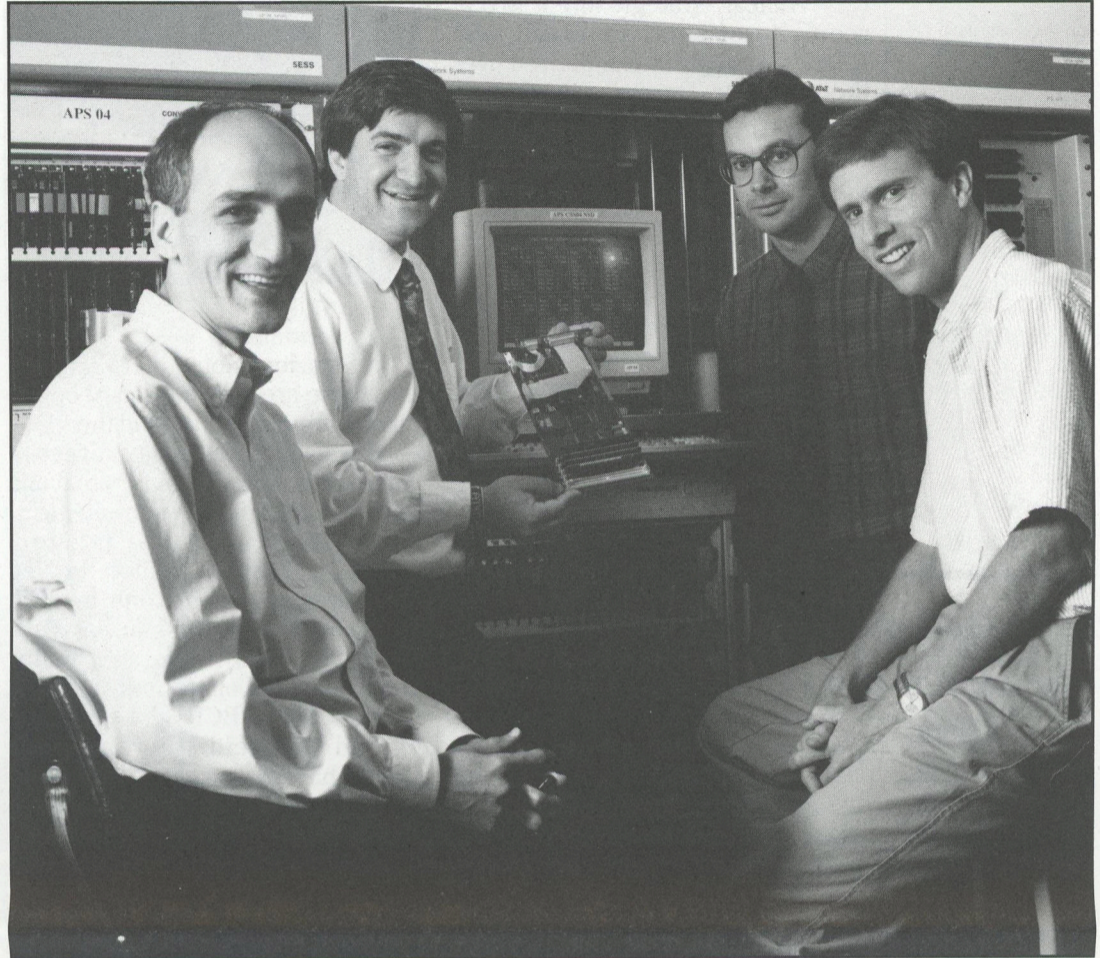
When AT&T customers in Jacksonville, Fla. and Seattle, Wash. make calling-card, collect, bill-to-third number, and person-to-person calls, chances are that their long-distance calls will be handled by AT&T's voice recognition service. Installed this summer, the Automated Voice Recognition Call Processing (VRCP) service will automate many non-directed long-distance calls originating from those areas. New Jersey Bell Telephone Company also installed the new AT&T technology in Camden, Cedar Knolls, Newark, New Brunswick and Rochelle Park, to handle its intra-LATA operator-handled traffic.

The VRCP service is built on the Conversant® Voice Information System (Conversant VIS), developed in Columbus for Business Communications Systems (BCSystems). For this application, a new processor called the MAP100C, which was designed for central-office use, was utilized. Also used were a switch interface, call-processing script, and support software developed at Indian Hill.

## 5ESS® Switch Adjunct

The combination of Conversant VIS with call-processing scripts and support software is called the Automated Position Cluster (AP Cluster), which serves as the main component of the VRCP service. Designed as an adjunct to the 5ESS switch, the Automated Position Cluster consists of a Cluster Support System and as many as 25 Automated Position Systems (APS), which are connected by a local area network. Each APS can handle as many as eight phone calls simultaneously, and each can support up to 200 calls at the same time.

When a caller places a collect, bill-to-third number, or person-to-person call, or, in some instances, a calling-card call, the switch routes the call to the APS. The APS lists call



Members of the Indian Hill Automated Voice Recognition Call Processing development team included, left to right, Gurol Akman, Hector Iurcovich, Scott Solenberger and Pete Danielsen.

early this year, as 6,000 management and non-management Operator Services employees may have to change jobs, which may require retraining. (AT&T's goal is to place all operators displaced by the new technology in other AT&T jobs.) But AT&T decided to implement voice-recognition technology because 95 percent of all long-distance calls and 80 percent of all calling-card calls are currently handled without operator assistance, and the number of operator-handled calls is declining by about eight percent a year.

## Ambitious Effort

The AT&T Network Services Division (NSD) and New Jersey Bell installations culminated an ambitious cooperative effort between developers in Columbus and switching designers in Indian Hill, according to Sam Salchenberger, technical supervisor, 5ESS Switch Product Management and Operator Services Position Systems (OSPS) Department, Indian Hill. The APS is tailored for use with the OSPS, a feature of the 5ESS switch that allows for operator assistance during calls.

Salchenberger said the idea for an APS began more than five years ago at AT&T, but development was not feasible at the time since it would have required a complex integration of new hardware and software into the 5ESS switch. Later in 1989, though, the idea resurfaced while systems engineers were examining possible new applications for the Conversant VIS.

"We thought that the Conver-

sant VIS could be helpful for automating the operator-assisted calls," Salchenberger recalled, "and the Switching Systems engineers and the Conversant VIS team put together a business case. We examined the feasibility, cost and implementation to prove that it could be done."

In early 1990, at about the same time that Switching Systems engineers and Conversant VIS team members were seeking funding for the project, NSD and New Jersey Bell expressed an interest in such a product. The Switching and Conversant teams were given the go-ahead to develop an AP Cluster for New Jersey Bell, while pursuing a parallel effort to provide NSD with another version.

"It was a fairly straightforward effort for the New Jersey Bell product, because the customer listed specific requirements up front, and then we worked to meet those requirements," Salchenberger explained. "But the NSD automated position product required what we call 'concurrent engineering': it was developed through an iterative process, as we shared ideas with NSD and received feedback on how to improve the product. This process continued between team members and NSD for more than a year."

"It was a challenge to work across business units while working for two customers with different requirements for the product," said Bill Longenbaker, supervisor, Voice Transaction Systems Department, Columbus, "but this development

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"It was a challenge to work across business units while working for two customers with different requirements for the product."

options and "spots" command words in the caller's speech, like "collect" or "person-to-person" even when they are used in a sentence or phrase with other words. After determining the type of call being placed, the system requests and accepts spoken information to process the call, and tells the switch how to bill the call.

The decision to use the system was the subject of some controversy

REDEFINITION

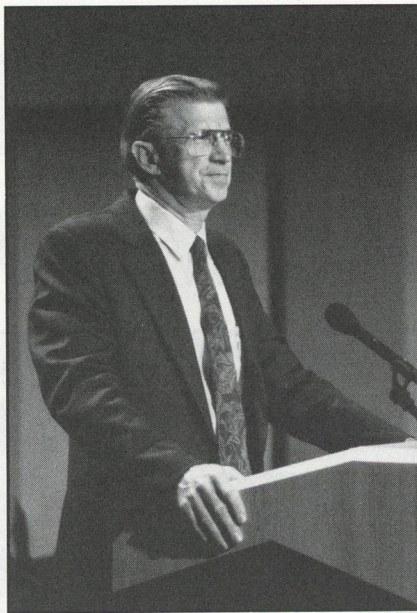
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- Creation of a chief technical officer matrix structure to coordinate technical responsibilities, including technology conversion, in a way that parallels the chief financial officer structure used throughout AT&T.

**Strategic Intent**

A clear strategic intent is one requisite of success. Mayo said AT&T's strategic intent, derived over the past year, "stresses the importance of technical coordination of platform, process, product and technology work that cuts across business units or groups." Six cross-group priority platforms already identified as a result of this ongoing process are voice processing; visual communications; data communications; wireless communications; messaging and scalable microprocessor-based computing.

Long-term technology planning, coordinated by the Bell Labs Council in accordance with the business-unit strategic plans, is also



Timko

Stanzione noted in his remarks that there are "extraordinary opportunities for growth around the globe — and that process competitiveness, coming from process innovation and improvement, is a requirement for success." He said the "gate-processes" being put in place in Network Systems will not only monitor process and provide financial discipline, but also serve as a major checkpoint and opportunity for feedback on BCPs. "BCPs also can be improved," he said. "Perhaps they should have been called 'Better Current Practices' from the start."

**Working Smarter**

Lower R&D and product service costs also are needed in an environment that's conducive to innovation. "Lower costs come largely from working smarter," Mayo said, "and particularly from killing unsuccessful projects early." Noting that much cost reduction has already been achieved, he added: "I'd like to reiterate the importance of squeezing every bit of cost out of our cost structure — that is, every unnecessary cost."

In Network Systems, Stanzione said productivity is key to competitiveness. While costs per person are being reduced to make the group more competitive, to be best in class also requires increases in output per person, and the value of that output. "It's here that innovation in meeting customer needs, and in providing value in the marketplace, is needed," he said.

In response to a question, Stanzione noted that payroll and some other support services for some 1,200 Bell Labs employees in Operations Systems were recently changed to conform with services provided to other employees in the unit. "The motivation was less getting goals aligned, and more getting processes and costs aligned," he said. "There were difficulties with dual administrative systems and processes in some cases, so this has helped a great deal."

Timko said the convergence of computing and traditional communications — together with developments in wireless, video telephony, speech recognition, and other advanced technologies — will transform the communications products businesses in the near future. "There will be major technology disruptions and, thus, major market opportunities," he said. "Our past concept of network architectures and services

needs to be expanded by orders of magnitude."

Redefinition will aid this effort by better leveraging technical resources, Timko said. Noting that his group's chief technical officers (CTOs) have been named, Timko said he will work with the CTOs — Alec Feiner in Business Communications Systems; Peter Ballantyne in Consumer Products; John Miller in Paradyne; Herb Burton in General Business Systems; and Bob Lauer in Federal Systems — to boost teamwork on core technologies and core products across all units.

"We're looking for increased collaboration on wireless technology, voice processing, visual communications, and messaging across multiple business units," he said. "We also want to work more closely with Research on selected applied research projects, to bring new technologies more rapidly to the marketplace."



Stanzione

Davis said that Communications Services Group (CSG) put an R&D transition management team in place in April to ensure orderly progress as the redefinition moves forward. He said the transition effort is assessing internal customer needs; developing and evaluating structural alternatives; identifying activities and programs aimed at addressing the "people issues" that relate to the transition; redesigning the infrastructure, including support services; and developing plans for supporting the role of the GTO.

"If you've chosen a career that's dedicated to innovation ... your day has arrived."

— John Davis

needed to carry out the strategic intent and enhance innovation. "Most business units foresee a long-term technology plan, or technology road map, as an integral part of their strategic planning process," Mayo said.

Dramatically reduced product and service development intervals, resulting from the beneficial use of accepted best current practices (BCPs), is a necessary element in forging innovation. "I expect the redefined Bell Laboratories will be less tolerant of nonconformance to best current practices," Mayo said.

In answer to a question about whether strict adherence to BCPs can conflict with innovation, Mayo said the BCPs should be used as a broad guideline, and not as an instruction manual. John Davis agreed, saying: "We must be tightly focused on quality, and BCPs are one part of that." But, Davis added, "There can be a conflict between innovative process, if you will, and that kind of discipline. In such cases, we have to work the issue in a way that will benefit the customer."



Davis

Redefinition will better leverage our technical resources.

— Joe Timko

A series of communications activities, including focus group sessions and a biweekly e-mail report, will update CSG R&D employees on progress as the transition moves forward this year, Davis said. "The transition will have fear, and anguish and frustration associated with it, as any change does," Davis said. "But I challenge you to couple that with the opportunity. If you've chosen a career that's dedicated to innovation and to finding ways of helping people around the world, as I'm sure most of you have, then your day has arrived." ■

## Mayo: "Alignment Changing, Not Membership"

Bell Labs President John Mayo also used the July 24 Update as an opportunity to restate the goals of Bell Labs' redefinition and to clarify a number of human resource issues raised since the Update broadcast in March.

Five principal goals of Bell Labs' redefinition, Mayo said, are:

- To bring R&D together with manufacturing, product management and marketing to create a single focus for the customer. "The very essence of Bell Labs has always been a high level of functional excellence, but our center of customer focus was limited to R&D," he said, adding: "Redefinition will not give up the excellence, but will enhance the focus."

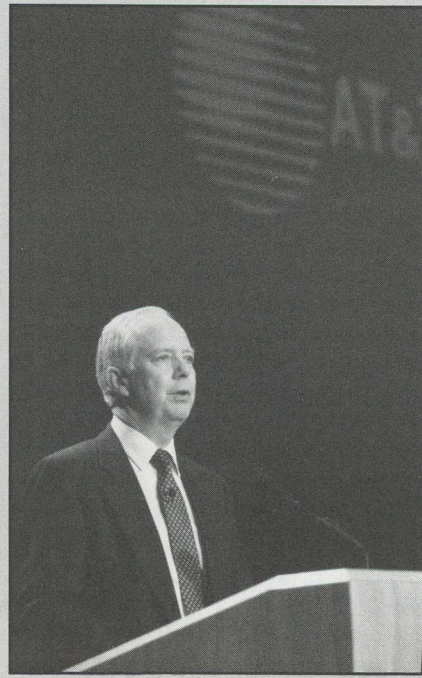
- To reduce the time it takes to bring new products to market. This will be achieved, in large part, by shortening development intervals. Key to this is the concept of core products and "a warehouse of reusable assets," he said. "We don't have to carry every job down to the level of individual transistors or individual lines of code."

- An increased number of innovations resulting from continued commitment to research and exploratory development. "The revitalization of applied research has already visibly helped the innovation process," he said. "We now have many applied projects that concurrently involve research, development, and, in some cases, manufacturing."

- More competitive costs, which are an outgrowth of shorter development intervals and increased innovations. "But we also have to manage every element of cost," he said, "to get out all costs that are not necessary."

- Making Bell Labs global, which will be the subject of a third redefinition broadcast later this year.

Mayo also updated employees on some of the human resources issues, including some of the most difficult questions raised by the re-



Mayo

definition, which were discussed March 10 together with AT&T Human Resources Senior Vice President Hal Burlingame.

Although human resources changes can be painful, Mayo said the alignment of development resources with customer-focused business units "is necessary to give us the customer focus that we must have to succeed in the competitive global marketplace." But, despite changes, Mayo said no one should lose his or her Bell Labs identity as a result of the redefinition. "We are changing the alignment," he said, "not the membership."

Later, at the conclusion of his remarks, Mayo revisited the question of identity in the context of discussing the value of the Bell Labs brand name. "Redefinition is about increasing the value of Bell Labs," he said, "and thereby increasing the meaning of being part of Bell Labs."

As the "glue" that holds AT&T together, however, Mayo said the human resources system serving the R&D function clearly needed to be aligned — in a way that's customizable to meet functional needs — with AT&T's total human resources system. "So, Bell Labs will be different from the rest of AT&T only in those areas where R&D needs to be different in order to be efficient and world-class," he said.

Some key areas that will be the

same throughout Bell Labs, after redefinition, include:

- Keeping common technical classifications (currently ATS, MTS-I, MTS, DMTS, etc.) for Bell Labs' people.

- Maintaining Bell Labs' identification.

- Continuing to use common performance and compensation practices and policies across Bell Labs, tied to competitive benchmarks. Some local customization will occur, however, especially as pertains to the merit award.

- Continuing support for technical education and training, along with leadership development.

- Continued support for cross-business unit force management, and management of force imbalances across the whole Bell Labs.

- Centrally managed university relations and recruiting practices, with a cross-business unit team of Bell Labs recruiters, aimed at attracting the best people at all levels.

- Maintenance of appropriate Bell Labs databases, such as those for information on personnel and on R&D operations.

An overriding goal for the human resources system, and all other administrative systems that support Bell Labs groups, is to be driven by user requirements, Mayo said, "without regard for entity boundaries." — D.V.

## Russian 'Invention Machine' Wins Over Skeptics

BY RICHARD Q. HOFACKER JR.

In May, a Russian scientist from Minsk faced a group of Bell Labs scientists in the Holmdel auditorium who wore expressions hinting at skepticism. Dr. Valery M. Tsourikov was giving a presentation on the Theory of Inventive Problem Solving (TIPS) and a Russian project, the INVENTION MACHINE™ software. The audience looked as if they expected something along the lines of "Tom Swift and His Electric Invention Machine."

But by the end of his talk, Dr. Tsourikov had persuaded a significant number of MTS attendees to give him their cards for further information — the first step in a successful sales program. And that's pretty much what the talk was — a scientific sales pitch.

"The INVENTION MACHINE is actually a tool to help the inventor solve a particular problem," explained Dr. Tsourikov. "When a given invention project runs into trouble, the INVENTION MACHINE system provides problem-solving input from the combined intellect of hundreds of problem solvers, using the power of our algorithm, physical effects, and inventive principles and laws. The inventor can engage in a

dialogue with the computer program, sometimes providing answers to the program's questions and sometimes asking questions that the program answers."

Dr. Tsourikov, who served four years as the head of the Intelligent Systems Laboratory at the Radio Engineering College in Minsk, is currently the chief scientist and director of the Invention Machine Corporation (IMCorp.), located in South Plainfield, N.J.

The first prototype of the INVENTION MACHINE software system was created in 1976 by Dr. Tsourikov, who has 15 years' experience in practical application of the Theory of Inventive Problem Solving. Tsourikov earned his Ph.D. in engineering and information theory from the Moscow Electrocommunications College and did post-doctoral research at the Imperial College of London.

The fundamentals of the INVENTION MACHINE program originated in the 1940s with a Russian scientist named G. S. Altshuller. He described his work in a book titled *Creativity as an Exact Science*, available in the Murray Hill library in a 1984 English language translation.

Tsourikov noted that engineers

and scientists often work with limited databases that restrict the effectiveness of their inventive work. The INVENTION MACHINE system, he says, dramatically expands the scope of problem-solving information available to the inventor, yet avoids overloading the researcher with excess information. Six information modules have been completed (in Russian, using the Prolog computer language), and work is underway on six more. Three of the original modules — Engineering Principles, Physical Effects and Engineering Standards — have been translated into English to date. The remaining three are Substance and Field Interactions, New Technologies and Value Engineering Analysis.

One example of the effectiveness of this approach, as cited by Dr. Tsourikov, involved two groups of engineers who were assigned the same project challenge. One group of 723 engineers was not trained in TIPS, while the second group of 637 engineers applied the TIPS concept. Of the non-TIPS engineers, 80 percent had the wrong answers to the problem and 20 percent had dubious solutions. Of the TIPS-trained engineers, 68 percent had the correct answers while 38 percent had dubious solutions.

"Our experiments have shown that an inventor working alone, without the INVENTION MACHINE system, could generate about seven new ideas an hour," said Dr. Tsourikov. "The same inventor produced 60 ideas in an hour, working with the IM system."

Greg Blonder, director, Materials and Technology Integration Research, says the INVENTION MACHINE is "an excellent tool to encourage 'out of box thinking.'" Blonder, along with several members of his organization, the Artificial Intelligence Principles Research Department, the Linguistics Research Department, and the Patent division recently took a closer look at the INVENTION MACHINE.

"The machine, which right now is restricted to mechanical inventions, is like an expert system in that it helps raise the level of the average user by suggesting other ways of doing things," Blonder commented. "It can help people get to an optimal answer quicker." He added that because much of the software is still to be translated, and restricted to mechanical principles, it would be premature to judge whether the INVENTION MACHINE could be of use to Bell Laboratories. ■

# Prototype Sonar System Shortens Cable Searches

BY RHEA LEWIS

AT&T last month announced that it had successfully tested a prototype sonar system that is able to locate and track communication cables and other materials suspended in mid-ocean or buried in sea beds. Called the Enhanced Bottom Sonar System (EBSS), the acoustic tracking device is based on Bell Labs' digital signal processing technology, and was developed to find AT&T's communication cables buried as much as one meter into the ocean floor. The prototype has been in operation on the TAT-7 undersea cable.

The EBSS was designed by Ron Earp, an MTS in the Signal Processing Engineering Division at the Guilford Center, N.C., in conjunction with Bob Bannon, senior engineer of marine operations at AT&T Submarine Systems, Inc., (AT&T-SSI) in Morristown, N.J.

"We knew we needed a sensor that could find our cables without magnetics."

Before developing the EBSS, AT&T primarily used ocean-bottom sensors that located and tracked cable locations via magnetic fields. "With a gradiometer, we can find cables that contain large amounts of steel," explains Earp, who provided the technical specifications for the magnetic sensors used by AT&T's SCARAB IV (Submersible Craft Assisting in Repairs and Burial). "This multi-axis 'metal detector' helps us locate the cable strictly by the mass of ferrous material around it." Another method uses a magnetometer, which detects the magnetic field of a 25-hz AC tone sent out from the shore-end of a wire cable. If a cable has been severed, technicians can find the break by following the magnetic field of the tone along the cable to where it ends at the cut.

"These methods work reason-

ably well in finding our older cables, which contain lots of steel and can carry the low-frequency tone," says Earp, "but not so well for some of the newer, fiber-optic cables, which contain little ferrous material and cannot transfer the tone."

With AT&T's international communications business dependent on the reliability of its undersea cable systems, it is imperative that the systems be quickly located and repaired when damaged or severed. One of the major menaces to cables is commercial fisherman, who often rake and rerake the ocean bottom, sometimes pulling the cables out of their trenches and dragging them miles from their original locations. As a result, cables can end up broken and snarled in large coils on the ocean floor. In arctic areas, shifting ice floes can damage a cable as they slide across it.

"We knew we needed a sensor that could find our cables without magnetics," Earp recalls. He told AT&T-SSI about his idea for a sonar detection system that would be acoustic, rather than magnetic. "Ron felt it would have a 50-50 chance of success and, after searching the commercial market for a solution, AT&T-SSI offered to fund his R&D effort," said Bannon. After about two years of work, the EBSS acoustic signature recognition system was created.

According to Bannon, the principal theory behind EBSS is that all objects have a distinct three-dimensional acoustic signature. The EBSS, which is mounted on a Remotely Operated Vehicle (ROV), utilizes a narrow beam sonar transducer to search for cables on the ocean bottom. If the system locates an object, indicated by its sonar return, the EBSS processes the data in real-time on the ROV, then uplinks the resulting signature information via fiber-optic link to a graphics processor on board the ship. The processor directs the ROV to the desired object via three-dimensional, real-time displays.

The EBSS software consists of a series of digital signal processing



Ron Earp sets the switches on the control card from the system's DSP-2 Digital Signal Processor.

programs written in the C language and tailored to the specific application of the system. In addition, explains Earp, the EBSS uses Artificial Intelligence algorithms to interpret the return signal and to instruct the ROV pilot in flying the vehicle during cable detection and tracking.

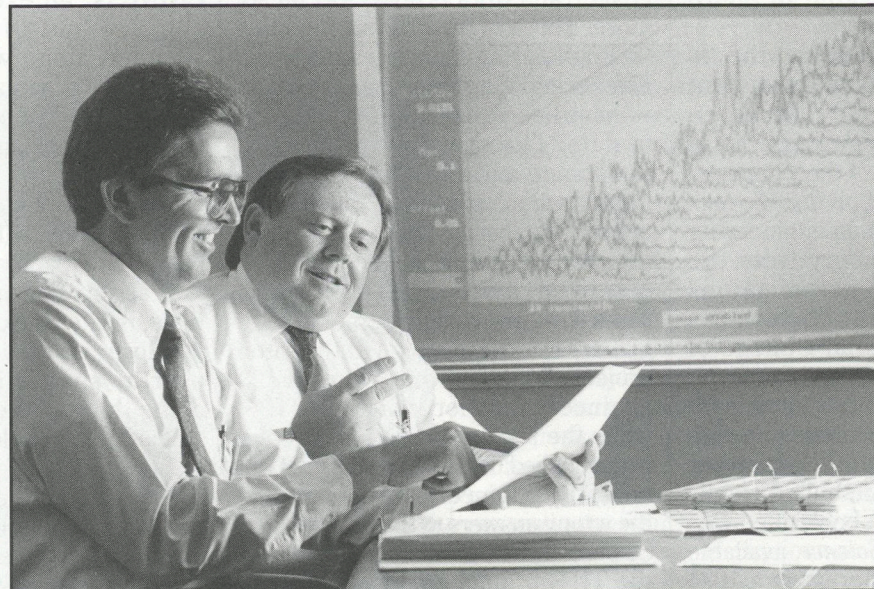
In July 1991, Earp, along with some members of the Baltimore-based SCARAB team, mounted the EBSS on the towfish Croaker. This small, towed submersible was used to test a prototype of the EBSS digital signal processor and the receiver.

Croaker was taken to the coast of North Carolina and towed from the Capricorn, a research ship on charter from the University of North Carolina. There, a series of tests was run on different sections of the prototype. The EBSS also was tested aboard the British ship Alert; the Canadian ship C.C.G.S. John Cabot; and the U.S. ships Performer and Sea Echo.

"There has been no other technology like this before," said Bannon, who designed the EBSS transducers and integration of the equipment on SCARAB IV and Pacific SCARAB I. "Before, to find cables, we had to rely on charts, magnetometers, grapnel devices and a certain amount of luck — it could take a full day. With the EBSS, the time will be cut in half."

It is expected that all the AT&T submersible tools, SCARAB II, SCARAB IV, Pacific SCARAB I, SEABED tractor and SEA plows, and others will be outfitted with an EBSS.

Although the device was specifically developed for AT&T's use, it has widespread application for the location and tracking of oil and gas pipelines, and artifacts, as well as for possible military use. ■



Bob Bannon, right, along with SCARAB Supervisor Tom Smith, review a graph depicting the sonar signature of an undersea cable.

VRCP DEBUT

*continued from page 3*

method made us fast on our feet.”

Longenbaker's organization was responsible for the automated position service platform, which was based on Conversant VIS. MTS Bill Erwin and Glen Taylor coordinated the Conversant VIS planning and development effort in Columbus. Supervisor Bob Perdue and MTS Roy Grubbe led a Columbus team that developed the speech recognition technology for the project.

After running basic platform tests, the Columbus team shipped the product to Indian Hill, where applications software was added. MTS Pete Danielsen, Gurol Akman and DMTS Gail Valentine led the development effort there, and complete systems integration tests were then performed with the 5ESS switch before the AP Clusters were deployed, in June and July, for New Jersey Bell and NSD by technical support personnel.

**Tickled Pink**

After months of daily calls and meetings during product design, development, and installation, Longenbaker said that most people involved in the project were “tickled pink” at the successful implementations at NSD and New Jersey Bell. “It's very exciting to be involved with a brand-new technology that is making history in the business,” he added.

“It also gave us satisfaction when New Jersey Bell quickly became comfortable with our product and proceeded uneventfully through an aggressive phased implementation throughout the state,” said Chander Sehgal, head, 5ESS Switch Deployment, Indian Hill. Sehgal added that the APS successes in NSD and New Jersey Bell can be attributed to a strong working partnership between the development team and the customers during the First Office Application (FOA) site testing.

The NSD and New Jersey Bell installations are important because the speech technology stakes are high, explained Ray Sojka, Indian Hill, a Network Systems engineering

manager who is responsible for product deployment and field support for Local Exchange Carrier (LEC) customers.

“The automated position product is being closely monitored by AT&T's other LEC customers,” Sojka said. Representatives from two other LECs visited the FOA site in Camden, N.J., while AT&T was still testing the product. Currently, the APS appears to be exceeding New Jersey Bell's expectations, and “this could be a springboard to other sales,” Sojka commented.

But, there is competition on the horizon. Northern Telecom offers a speech recognition system, and Texas Instruments has a network-based voice-response/speech recognition system planned. Nonetheless, AT&T hopes to sell the APS to companies that have AT&T OSPSPs, such as U S West and smaller regional companies, in the next year or so.

In the meantime, NSD plans to roll out the APS-based VRCP on a national basis after a marketing analysis of the Jacksonville and Seattle deployments. Long-distance customers in Seattle received a direct-mail brochure, informing them of the change and explaining the automated technology; customers in Jacksonville were not informed of the change. Marketing experts will compare reactions from customers who have been notified in advance of the new technology with those of customers who encountered it “cold.”

Later in the year, additional VRCP features will be available, and the service will be installed in Phoenix, Ariz. The service will be installed in other cities during the next two years, until AT&T reaches full deployment on its long-distance network in early 1994.

“Right now, we're proving the viability of the most sophisticated speech recognition system on the market,” said Dennis Morgan, head, Voice Transaction Systems, Columbus. “We're setting the stage for nationwide VRCP deployment, and we can't help but feel that the APS will have a profound impact on future speech recognition technology applications in telecommunications.” ■

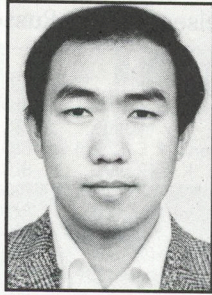


Columbus team members Roy Grubbe, top right, Glen Taylor, center, and Bill Erwin were responsible for Conversant VIS planning and development.

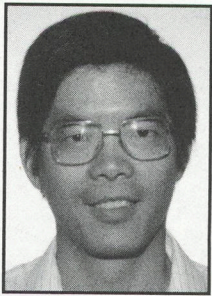
NEWSMAKERS



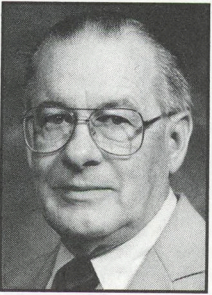
Hansen



Hsu



Yueh



Woome

**Ralph Hansen**, former Bell Labs supervisor and now president of Rave Consulting Associates, has been elected a Fellow of the Society of Plastics Engineers in recognition of his contributions to the plastics industry. Hansen retired from Bell Labs in 1981.

**Chin-Fei Hsu and Kang Yueh**, MTS in the Advanced Technology Applications Department at Holmdel and supervisor in the Wireless Systems Software Assets Department at Whippany, respectively, were honored by the Chinese American Academic and Professional Society for their outstanding service to the society. Hsu was recognized for his role as chairperson of the society's 1992 annual convention and Yueh for his efforts as the convention's 1991 chair.

**F. Nelson Woome Jr.**, MTS in the Federal Systems Planning and Control Department at Whippany, has been elected vice president of Administration for the Project Management Institute's New Jersey Chapter. He will be responsible for all administrative matters. He is also a member of the International Project Management Association, Internet.

Six members of the Advanced Technology Development and Optoelectronic Devices Department at Murray Hill are the recipients of the American Electroplaters and Surface Finishers Society's Best Paper Awards. They were honored for outstanding papers published in *Plating & Surface Finishing* during 1991. The winners of silver medals were **Joseph Abys, Igor Kadija, Edward Kudrak and Joseph Maisano** for their paper, “Wear Reliability of Gold-Flashed Palladium vs. Hard Gold on a High-Speed Digital Connector System,” and Abys, **Vijay Chinchankar, Kadija, and Heinrich Straschil** for their paper, “Hydrodynamically Controlled ‘Hull Cell.’” The awards were given on June 22 at the SUR/FIN '92 technical conference and exhibit in Atlanta.

*If you've won an award or received any other professional or civic honor, send the information along with a black-and-white photo to Jennifer Hammond, HL 1B-418.*

June 1992 Earnings Factors

	Long-Term Savings Plan For Management Employees		Long-Term Savings and Security Plan (Non-management)	
	Earnings Factors	Year-To- Date	Earnings Factors	Year-To- Date
AT&T Shares	1.0194	1.1149	1.0195	1.1163
Government Obligations	1.0121	1.0283	—	—
Diversified Equity Portfolio	.9805	1.0065	.9805	1.0066
Guaranteed Interest Fund	1.0065	1.0407	1.0065	1.0409
South Africa Restricted Fund	.9786	.9775	.9787	.9776
Employer Stock Fund	—	—	1.0196	1.1155

(Company match in LTSSP only, effective July 1990)

Earnings factors represent the change in value of the investments in each fund from the previous month. Thus, the current month's value of a fund may be approximated by multiplying the previous month's value by the current month's earnings factors.

PEOPLE

August Service Anniversaries



Ferrone



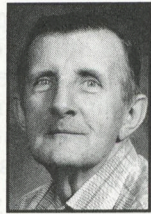
Pesci



Preiser



Russello



Quinn



Woormer

**Luke Ferrone**

Engineering Information, Standards and Art Department (131K10000), MT, Aug. 15, 35 years

**Paul Mielke**

1NCP Project Department (BLO55824), CB, Aug. 1, 35 years

**Louis Pesci**

Facilities Engineering, Planning and Design Department (BLO77813), MH, Aug. 19, 35 years

**Godfrey Preiser**

General Legal Matters (BLO1211), HL, Aug. 30, 35 years

**Vincent Russello**

Federal Systems DES Department (BLO46241) WH, Aug. 19, 35 years

**Donald Quinn**

Whippany Facilities Operations (BLO77812), WH, Aug. 11, 40 years

**F. Nelson Woormer**

FSAT Program Planning and Control Department (BLO46256), WH, 40 years

Morrow, E.M. (21st) ..... BLO79541

15 Years

Dunlop, A.E. (25th) ..... BLO11253  
 Gaulf, L.L. (22nd) ..... BLO45260  
 Bagley, J.D. (1st) ..... BLO45262  
 Anglade, E. (22nd) ..... BLO45317  
 Gahr, S.A. (1st) ..... BLO45424  
 Roberts, W.G. (29th) ..... BLO45424  
 Kim, B.S. (22nd) ..... BLO45431  
 Layendecker, R.A. (22nd) ..... BLO45431  
 Hallock, G.W. (29th) ..... BLO46229  
 Lurch, M.A. (5th) ..... BLO46234  
 Lagrotta, R.T. (29th) ..... BLO46238  
 Milovich, R.J. (1st) ..... BLO46238  
 Guhse, S.E. (5th) ..... BLO51236  
 Kaufman, R.L. (31st) ..... BLO51236  
 Sinha, L.P. (29th) ..... BLO51237  
 Schuster, R. (1st) ..... BLO52391  
 Alexander, D.L. (29th) ..... BLO52462  
 Globis, R.M. (1st) ..... BLO52462  
 Schwartz, S.N. (17th) ..... BLO52492  
 Cranor, B.D. (1st) ..... BLO52498  
 Smith, G.A. (1st) ..... BLO52893  
 Mueller, M.B. (22nd) ..... BLO54373  
 Tam, J.K. (24th) ..... BLO54421  
 Schotland, H.A. (12th) ..... BLO54424  
 Baxter, L.A. (1st) ..... BLO54524  
 Koehler, R.A. (2nd) ..... BLO54726  
 Cheng, C. (22nd) ..... BLO54796  
 Harrison, A.M. (22nd) ..... BLO554  
 Rusnak, J. Jr. (10th) ..... BLO55430  
 Teraslinna, K.T. (1st) ..... BLO55433  
 Huen, W.H. (20th) ..... BLO55518  
 Barclay, D.K. (15th) ..... BLO55546  
 Willett, N.J. (1st) ..... BLO55554  
 Thornton, S.E. (8th) ..... BLO55661  
 Martin, L.E. (8th) ..... BLO55663  
 Martyniuk, D.J. (22nd) ..... BLO55811  
 Westenkirchner, P.M. (15th) ..... BLO55813  
 Miller, M. (30th) ..... BLO55814  
 Ginzer, J.A. (1st) ..... BLO55824  
 Collins, J. (3rd) ..... BLO55832  
 Forsburg, A.S. (15th) ..... BLO55852  
 Johnson, D.R. (30th) ..... BLO55852  
 Pokropinski, J.H. (8th) ..... BLO55854  
 Ritchie, C.A. (31st) ..... BLO55865  
 Windecker, R.C. (22nd) ..... BLO59511  
 Huangfu, A.T. (15th) ..... BLO59622  
 Hicks, G.S. (15th) ..... BLO59712  
 Domangue, J.C. Jr. (22nd) ..... BLO59714  
 Deshazer, V.C. (9th) ..... 131A30000  
 Lynch, B.S. (9th) ..... 131A90000  
 Boucher, J.P. (1st) ..... 131E30000  
 Goetz, S.A. (9th) ..... 131N20000  
 Walsh, T.P. (1st) ..... 131P40000  
 Sullenberger, R.C. (10th) ..... 131W10000  
 DiPiazza, P.S. (22nd) ..... 120V90000  
 Dillon, J.Y. (3rd) ..... BLO77221  
 Matarazzo, L.K. (12th) ..... BLO77459  
 Patin, M.L. (15th) ..... BLO77474  
 Wright, W.F. (8th) ..... BLO77475  
 Binford, J. (29th) ..... BLO77801  
 Herb, P.A. (15th) ..... BLO77801  
 Grant, P.J. (15th) ..... BLO77812  
 Di Nizo, M. (29th) ..... BLO77816  
 Figueroa, E.E. (30th) ..... BLO77816  
 Circelli, C. (29th) ..... BLO77818  
 Serafin, W.J. (22nd) ..... BLO77818  
 Wiley, R. (29th) ..... BLO77818  
 Blackman, A.P. (1st) ..... BLO79594

25 Years

Tai, K.L. (1st) ..... BLO11553  
 Labianca, F.M. (28th) ..... BLO46223  
 Ross, P.C. (1st) ..... BLO46229  
 Smith, W.L. (14th) ..... BLO46256  
 Sears, R.W. Jr. (28th) ..... BLO46257  
 Winans, C.S. (12th) ..... BLO51142  
 Dishman, J.M. (14th) ..... BLO52465  
 Carey, R.E. (21st) ..... BLO52711  
 Butherus, A.D. (28th) ..... BLO52722  
 Manchon, D.D. Jr. (21st) ..... BLO52722  
 Lukasik, E.J. (8th) ..... BLO52824  
 Gleason, W.J. (2nd) ..... BLO54418  
 Shanks, W.L. (31st) ..... BLO54452  
 Fangmang, R.E. (7th) ..... BLO54595  
 Larsen, A.B. (2nd) ..... BLO54627  
 La Padula, C.A. (7th) ..... BLO55438  
 Feay, M.R. (22nd) ..... BLO55811  
 King, J.G. (28th) ..... BLO55821  
 Stankus, P.J. (1st) ..... BLO55853  
 Sims, W. (27th) ..... 2BOA11000  
 Grube, W.A. (7th) ..... BLO77192  
 Kulpinski, J.T. Jr. (14th) ..... BLO77192  
 Grant, G.E. (16th) ..... BLO7740  
 Schelke, J.A. (8th) ..... BLO77515  
 Off, H.B. Jr. (21st) ..... BLO77895  
 Apfelbaum, H.E. (7th) ..... BLO79258

20 Years

Trimble, L.E. (15th) ..... BLO11122  
 Lang, D.V. (28th) ..... BLO11115  
 Piz, F.C. (30th) ..... BLO11227  
 Milton, J.L. (1st) ..... BLO45266  
 Fawcett, R.L. (7th) ..... BLO46234  
 Berglund, R.N. (14th) ..... BLO46237  
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 Stampfle, J.P. (28th) ..... BLO51235  
 Canter, B.J. (31st) ..... BLO51441  
 Miller, J.H. (14th) ..... BLO54581  
 Abed, M.I. (1st) ..... BLO54614  
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 Freeman, G.E. (16th) ..... BLO55668  
 Bengtson, A.H. (22nd) ..... BLO55863  
 Sand, D.S. (9th) ..... BLO59640  
 Burns, M.L. (21st) ..... 131A20000  
 Baptist, D.S. (14th) ..... 131E40000  
 Darfler, G.L. (8th) ..... 131E50000  
 Wood, J.L. III (8th) ..... 131J40000  
 Beckman, J. (30th) ..... 120V60000  
 Dorsey, T. (16th) ..... 2BOA42000  
 Kirkland, R. (28th) ..... 2BOA00000  
 Schwill, A. (24th) ..... BLO77121  
 Monford, J.R. (18th) ..... BLO77457  
 Hennessy, J.M. (12th) ..... BLO77801  
 Kline, S.I. (19th) ..... BLO77801  
 Ross, A. (9th) ..... BLO77801  
 Jones, V.L. (15th) ..... BLO77814

10 Years

Higashi, G.S. (9th) ..... BLO11123  
 Lee, K.F. (31st) ..... BLO11126  
 Olsson, N.A. (16th) ..... BLO11153  
 Van Santen, J.P. (4th) ..... BLO11222  
 Koch, T.L. (2nd) ..... BLO11366  
 Fang, W. (9th) ..... BLO11535  
 Bowman, W.C. (2nd) ..... BLO11538  
 White, A.E. (16th) ..... BLO11547  
 Becker, R. (3rd) ..... BLO11551  
 Lau, M.Y. (23rd) ..... BLO11553  
 Cardoso, M.A. (16th) ..... BLO12381  
 Milewski, A.E. (16th) ..... BLO41321  
 Rosen, K.H. (27th) ..... BLO41321  
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 Prasanna, P.K. (25th) ..... BLO41333  
 Christie, C.A. (2nd) ..... BLO45260  
 Aboagye, T.B. (16th) ..... BLO45261  
 Graves, M.A. (9th) ..... BLO45261  
 Laramore, A.M. (16th) ..... BLO45261  
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 Rajaram, S. (27th) ..... BLO45425  
 Blumentstock, B.J. (17th) ..... BLO45431  
 Sweetman, E. (19th) ..... BLO45431  
 Tubbs, A.D. (16th) ..... BLO46234  
 Royster, D.L. (24th) ..... BLO46256  
 Santo, D.L. (16th) ..... BLO46256

King, S.B. (9th) ..... BLO46271  
 Zatloukal, C.R. (31st) ..... BLO46271  
 Farrell, P.A. (13th) ..... BLO51000  
 Schubert, R.E. (29th) ..... BLO51134  
 Fenton, K.L. (25th) ..... BLO51233  
 Chan, K.K. (16th) ..... BLO51273  
 Frauenthal, J.C. (18th) ..... BLO51281  
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 Hsu, D.K. (16th) ..... BLO54444  
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 West, C.L. (2nd) ..... BLO55517  
 Regalado, D.W. (16th) ..... BLO55518  
 Plummer, M.A. (23rd) ..... BLO55532  
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 Hartman, M. (9th) ..... BLO55536  
 McIntyre, L.G. (2nd) ..... BLO55536  
 Spanke, R.A. (30th) ..... BLO55536  
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 Ahmed, M. (25th) ..... BLO55546  
 Smart, M.L. (28th) ..... BLO55554  
 Yasdick, J. (9th) ..... BLO55554  
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 Whitt, S.R. (16th) ..... BLO55663  
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 Sanders, D.H. (4th) ..... 131A30000  
 Tam, S. (2nd) ..... 131E20000  
 Hodges, W.J. (16th) ..... 131K10000  
 Jeffery, D.C. (30th) ..... 131N10000  
 Larkin, M.S. (16th) ..... 131N40000  
 Petty, N.W. (25th) ..... 131N80000  
 Hwang, L.H. (2nd) ..... 131P20000  
 Baker, S.L. (16th) ..... 131P60000  
 Stasik, C. (16th) ..... 131P90000  
 Holder, M.L. (2nd) ..... 131P70000  
 Smith, R. (23rd) ..... BLO63162  
 Serra, A.S. (2nd) ..... 120700000  
 Thompson, J.L. (16th) ..... 120700000  
 Krischer, E.L. (9th) ..... 120V30000  
 Osei, B. (2nd) ..... 2BOA11000  
 Livingston, M. (8th) ..... 2BO930000  
 Corsi, D. (30th) ..... BLO77122  
 Antonik, W.J. (23rd) ..... BLO77191  
 Bello, R. (16th) ..... BLO77192  
 Chester, J. (2nd) ..... BLO77221  
 Valdespino, G. (24th) ..... BLO77222  
 Moore, B. (2nd) ..... BLO77223  
 Staats, G.C. (30th) ..... BLO77421  
 Gurdison, M.G. (9th) ..... BLO77422  
 Diaz, I.M. (2nd) ..... BLO77451  
 Spaulding, P.A. (5th) ..... BLO77474  
 Walker, A. (9th) ..... BLO77512  
 Richard, C.M. (2nd) ..... BLO77513  
 Loftus, D.P. (2nd) ..... BLO77515  
 Williams, C.A. (16th) ..... BLO77515  
 Blanton, W.B. (23rd) ..... BLO77800  
 Berberian, M. (2nd) ..... BLO77801  
 Cocuzzo, Y. (16th) ..... BLO77801  
 Drew, S.A. (16th) ..... BLO77801  
 Liang, Y.C. (16th) ..... BLO77801  
 Petlak, C.L. (9th) ..... BLO77801  
 Rush, A.T. (23rd) ..... BLO77801  
 Stone, S.M. (10th) ..... BLO77801

Rodgers, I. (22nd) ..... BLO77802  
 Dennis, A.D. (9th) ..... BLO77810  
 Cannon, S.C. (2nd) ..... BLO77811  
 Lane, R.G. (30th) ..... BLO77812  
 Runne, B. (30th) ..... BLO77812  
 Studier, B.H. (16th) ..... BLO77812  
 Deming, R.W. (30th) ..... BLO77813  
 Reilly, B.P. (16th) ..... BLO77814  
 Pagnoni, V.M. (16th) ..... BLO77817  
 Potter, R.J. (16th) ..... BLO77835  
 Binkley, M. (23rd) ..... BLO77836  
 Clever, S.F. (2nd) ..... BLO77896  
 Hobbs, A.L. (16th) ..... BLO79244

5 Years

Agazzi, O. (31st) ..... BLO11224  
 Doran, G.E. (24th) ..... BLO11346  
 Jaisingh, G.K. (17th) ..... BLO41111  
 Walker, C.E. (10th) ..... BLO41112  
 Marcus, N.Y. (5th) ..... BLO41321  
 Cho, G. (24th) ..... BLO45255  
 Bolden, F.A. (31st) ..... BLO45262  
 Core, M.P. (17th) ..... BLO45264  
 Ismail, A.M. (10th) ..... BLO45266  
 Long, A.L. (31st) ..... BLO45315  
 Rapposelli-Manzo, C. (10th) ..... BLO45317  
 Durdik, R.H. (31st) ..... BLO46221  
 Fenyk, W.D. II (31st) ..... BLO46221  
 Birnbaum, D.J. (31st) ..... BLO46222  
 Cox, R.M. (17th) ..... BLO46225  
 Powell, T.A. (24th) ..... BLO46234  
 Volent, R.F. (10th) ..... BLO46237  
 Richardson, R.W. (10th) ..... BLO46241  
 Goddard, D.E. (24th) ..... BLO46244  
 Israel, H.M. (3rd) ..... BLO46244  
 Riggins, M.D. (4th) ..... BLO46244  
 Smith-Thomas, B. (17th) ..... BLO46244  
 Cohen, J.L. (31st) ..... BLO46245  
 Faucher, D.W. (31st) ..... BLO46245  
 Costello, M.F. (10th) ..... BLO46255  
 Giroux, L.A. (17th) ..... BLO46256  
 Steigerwald, M. (28th) ..... BLO46274  
 Hoang, A.Q. (26th) ..... BLO51131  
 Ohm, J.Y. (3rd) ..... BLO51132  
 Young, W. (28th) ..... BLO51137  
 Duncan, V.J. (24th) ..... BLO51141  
 Khairandish, L. (31st) ..... BLO51151  
 Vasireddy, S.R. (24th) ..... BLO51151  
 Bondi, A.B. (17th) ..... BLO51153  
 Chanda, R. (31st) ..... BLO51153  
 Vaio, C.I. (10th) ..... BLO51153  
 Mani, S. (24th) ..... BLO51154  
 Franzese, G.R. (24th) ..... BLO51231  
 Kulzer, R.D. (10th) ..... BLO51231  
 Lin, F.N. (3rd) ..... BLO51231  
 Agraharam, S. (3rd) ..... BLO51233  
 Badey, R.R. (17th) ..... BLO51233  
 Kerns, P.G. (31st) ..... BLO51234  
 Robinson, C.D. (3rd) ..... BLO51234  
 Thimmappa, A.L. (17th) ..... BLO51234  
 Kong, T. (24th) ..... BLO51235  
 Cochran, R.D. (17th) ..... BLO51237  
 Lui, P.J. (10th) ..... BLO51238  
 Tsim, T. (17th) ..... BLO51238  
 Lenoble, J.S. (26th) ..... BLO51281  
 Greenman, M.S. (27th) ..... BLO51291  
 Fahs, A.A. (13th) ..... BLO51327  
 Wallace, M.D. (24th) ..... BLO51327  
 Pardo, A. (17th) ..... BLO51341  
 Donkin, M.A. (10th) ..... BLO51342  
 Taie, S.F. (31st) ..... BLO51342  
 Subramanian, V. (24th) ..... BLO51344  
 Tyle, N. (31st) ..... BLO51344  
 Taie, M.R. (31st) ..... BLO51346  
 Kocharlakota, R. (31st) ..... BLO51351  
 Lam, J.S. (11th) ..... BLO51351  
 Atluri, R.P. (17th) ..... BLO51352  
 Harris, C.B. (3rd) ..... BLO51352  
 Rodrigues, M. (3rd) ..... BLO51352  
 Shah, B. (3rd) ..... BLO51354  
 Chen, M.S. (31st) ..... BLO51411  
 Bhusri, G.S. (3rd) ..... BLO51413  
 Hauser, A.I. (31st) ..... BLO51413  
 Parrott, D.R. (24th) ..... BLO51431  
 Kapadia, R. (14th) ..... BLO51433  
 McGee, R.A. (31st) ..... BLO51433  
 Schwenk, M.A. (28th) ..... BLO51442  
 Wong, L. (3rd) ..... BLO51442  
 Juengling, W. (3rd) ..... BLO52814  
 Ambati, S. (10th) ..... BLO54327  
 Kuo, J. (10th) ..... BLO54415  
 Shah, N.R. (31st) ..... BLO54418  
 Gandhi, M. (31st) ..... BLO54421  
 Gascon, C. (15th) ..... BLO54422  
 Valle, C.A. (31st) ..... BLO54584  
 Haughton, L. (10th) ..... BLO54586  
 Eckstein, S. (31st) ..... BLO54615  
 Jeng, C.W. (7th) ..... BLO54625  
 Ku, A. (3rd) ..... BLO54625  
 Setlur, S.D. (17th) ..... BLO54625  
 Vasireddy, L.R. (31st) ..... BLO54628  
 Dalleggio, A. (20th) ..... BLO54633  
 Kohen, I. (24th) ..... BLO54711  
 Sturges, D.R. (31st) ..... BLO54711

Iyer, R.R. (3rd) ..... BLO54732  
 Huber, R.K. (17th) ..... BLO54735  
 Naumann, P.C. (31st) ..... BLO54735  
 Marcus, R.D. (17th) ..... BLO54798  
 Selig, G.W. (3rd) ..... BLO55512  
 Volpicelli, D. (24th) ..... BLO55512  
 Davis, N.R. (10th) ..... BLO55513  
 Lisonbee, P.K. (3rd) ..... BLO55513  
 Schlaman, J.E. (17th) ..... BLO55513  
 McFarland, P.W. (31st) ..... BLO55515  
 Heuer, T.C. (5th) ..... BLO55516  
 Pearson, H.E. (5th) ..... BLO55517  
 Burks, B. (24th) ..... BLO55519  
 Thielen, E. (11th) ..... BLO55519  
 Millison, K.A. (3rd) ..... BLO55523  
 Balice, M.J. (31st) ..... BLO55532  
 Schultz, S. (17th) ..... BLO55532

Zepeda-Godinez, J. (24th) ..... BLO55535  
 Calhoun, R.G. Jr. (3rd) ..... BLO55541  
 Fisher, G.F. (10th) ..... BLO55546  
 Menzies, B.A. (3rd) ..... BLO55551  
 Chan, O.S. (31st) ..... BLO55552  
 Kaloydis, K.H. (10th) ..... BLO55554  
 Nichols, H. (3rd) ..... BLO55554  
 Chapman, R.S. (27th) ..... BLO55631  
 Drake, L.A. (31st) ..... BLO55634  
 Cheung, M. (10th) ..... BLO55662  
 Ward, B. (17th) ..... BLO55661  
 Ho, G.N.M. (3rd) ..... BLO55663  
 Rittenberg, R. (17th) ..... BLO55663  
 Hoffstetter, C.A. (17th) ..... BLO55666  
 Shah, A.Y. (22nd) ..... BLO55669  
 Bergren, S.C. (31st) ..... BLO55686  
 Sun, W.W. (31st) ..... BLO55811  
 Hanmer, R.S. (12th) ..... BLO55812  
 Kuo, H. (10th) ..... BLO55812  
 Ellefson, T.S. (13th) ..... BLO55813  
 Kardaras, C.J. (31st) ..... BLO55813  
 Robins, J.D. II (24th) ..... BLO55813  
 Jackson, M. (10th) ..... BLO55814  
 Taghon, K.E. (3rd) ..... BLO55814  
 Armas, C.R. (3rd) ..... BLO55821  
 Savory, E.L. (24th) ..... BLO55822  
 Ballinger, K.K. (3rd) ..... BLO55823  
 Lee, A. (17th) ..... BLO55824  
 Rodriguez-Vargas, A. (17th) ..... BLO55824  
 Poll, P.D. (17th) ..... BLO55831  
 Su, T. (31st) ..... BLO55831  
 Huang, C.G. (24th) ..... BLO55832  
 Patwari, G. (31st) ..... BLO55853  
 Birney, D.S. (17th) ..... BLO55854  
 Scott, C.M. (31st) ..... BLO55854  
 Patterson, M.R. (24th) ..... BLO55863  
 Pathak, Y. (10th) ..... BLO59115  
 Zervos, C.R. (10th) ..... BLO59226  
 Scott, S.A. (17th) ..... BLO59227  
 Cheng, A. (3rd) ..... BLO59462  
 Lee, S.K. (10th) ..... BLO59462  
 Soo Hoo, L. (10th) ..... BLO59462  
 Tam, T. (3rd) ..... BLO59462  
 Wang, S. (3rd) ..... BLO59462  
 Delriccio, J.E. Jr. (31st) ..... BLO59468  
 Manos, M.A. (24th) ..... BLO59513  
 Wu, J.C. (3rd) ..... BLO59516  
 Sandjaby, A. (17th) ..... BLO59525  
 Williams, A.A. (24th) ..... BLO59525  
 Richards, J. (10th) ..... BLO59535  
 Atkins, J.M. (10th) ..... 131A10000  
 Anderson, J. (3rd) ..... 131K10000  
 Bonilla, L.M. (3rd) ..... 131K10000  
 Schneider, W. (31st) ..... 120V90000  
 Murtaugh, J. II (17th) ..... 131P20000  
 Ramaswami, S. (10th) ..... 140320000  
 Deolankar, S.P. (3rd) ..... 140350000  
 Fong, H. (17th) ..... 2BO920000  
 Poulin, M. (24th) ..... BLO07520  
 Voss, R. (3rd) ..... BLO77221  
 Brady, T.L. (24th) ..... BLO77451  
 Colarusso, K.A. (3rd) ..... BLO77451  
 Hizny, J.T. (3rd) ..... BLO77451  
 Myers, K.A. (3rd) ..... BLO77451  
 Wiley, M. (10th) ..... BLO77456  
 Cruz, A. (10th) ..... BLO77457  
 Parry, K.T. (10th) ..... BLO77476  
 Jackson, R.A. (17th) ..... BLO77511  
 Placide, C. (19th) ..... BLO77511  
 Sciancalepore, P. (3rd) ..... BLO77511  
 Bruscella, L.M. (31st) ..... BLO77801  
 Camacho, E.A. (24th) ..... BLO77801  
 Fauci, J.M. (31st) ..... BLO77801  
 Newman, L. (4th) ..... BLO77801  
 Perry, M. (31st) ..... BLO77801  
 Randazzo, J. (31st) ..... BLO77801  
 Traverso, W.A. (17th) ..... BLO77801  
 Zellman, C.A. (24th) ..... BLO77801  
 Principe, S.A. (24th) ..... BLO77802  
 Roman, A.A. (31st) ..... BLO77802  
 Fernandez, L.A. (3rd) ..... BLO77817  
 Braxton, V. (1st) ..... BLO77818  
 Ward, J.C. (24th) ..... BLO77842  
 Helfrich, D.R. (17th) ..... BLO77895  
 Myers, F.W. (17th) ..... BLO79245  
 Narasimhan, A. (17th) ..... BLO79541  
 Parker, E.T. (17th) ..... BLO79541