Proceedings of the
LLNL Technical Women's Symposium

May 6–7, 1993

The Lafayette Park Hotel
Lafayette, California

Erica von Holtz, Scientific Editor

Sponsored by the Women's Issues Program
Lawrence Livermore National Laboratory
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May 6, 1993

Women in Technology Symposium
c/o Lawrence Livermore National Laboratory
P.O. Box 808
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Dear Friends:

My warmest greetings to you as you gather for the Women in Technology Symposium.

Although I cannot be with you, I am very pleased that you have come together to network and discuss the many challenges that you face in your careers. I applaud Lawrence Livermore National Laboratory and the Women's Issues Program for providing a forum to exchange information and ideas.

In recent years, women have made many strides both professionally and politically. However, there is so much left for us to accomplish. One of our most important goals must be to inspire young women to realize their tremendous potential. As women who have succeeded in technological fields, you are role models for future leaders. Through your success they will be inspired to overcome obstacles and take their rightful place as engineers, as astronauts, as chemists.

My best wishes to all of you as you complete your symposium. I hope that you leave with a sense of accomplishment and purpose.

Sincerely,

Barbara

Barbara Boxer
United States Senator

BB\rk

Contents

The LLNL Technical Women's Symposium

Lawrence Livermore National Laboratory's first Technical Women's Symposium took place on May 6 and 7, 1993, at the Lafayette Park Hotel, Lafayette, California. The symposium was attended by 229 LLNL employees, most of them women working in science, engineering, and other technical fields.

The theme of the symposium—"Women in Technology: Today's Teamwork Meeting Tomorrow's Challenges"—was reflected in the focus on science and technology during the first day. Following opening remarks by Director John Nuckolls, Associate Director Philip Coyle introduced keynote speaker Tamara Jernigan, who enthralled the audience with her experiences as a NASA astronaut. Later that day, technical speaker Claire Max, an LLNL astrophysicist, reviewed progress on the Laser Guide Star Project, which she directs.

Technical sessions throughout the day featured LLNL women presenting their technical accomplishments and describing their involvement in a variety of research activities. Fifty-two women gave presentations on their work, and another fourteen exhibited posters on their technical projects. Abstracts of the technical presentations begin on page 13.

The second day of the symposium was devoted to personal and professional development. Participants chose among workshops on self assessment, mentoring, balancing personal and professional needs, male–female communication, conflict management, and networking. Later sessions featured a panel of LLNL women describing their keys to

Lunchtime networking at the LLNL Technical Women's Symposium.

Erica von Holtz and James Evans.

success and a workshop on proposal writing. Summaries of the professional development sessions begin on page 48.

The professional development sessions culminated in an energizing talk by psychologist and author Cynthia Scott, who described the process of personal and organizational change and how to cope with it. The symposium was closed by James Evans, Deputy Associate Director for Diversity and Equal Opportunity and symposium sponsor.

The inspiration for this symposium came from a small group of LLNL women engineers—Erna Grasz, Monya Lane, Johanna Swan, Erica von Holtz—who heard of similar events at NASA Ames and Hewlett-Packard and resolved to organize such a symposium at the Laboratory. They solicited the help of other LLNL technical women (see the acknowledgments on page 59), and, after months of hard work, brought the Technical Women's Symposium into reality. Erica von Holtz, in her capacity as Women's Issues Program manager, coordinated the organizing effort and presided during the two days' proceedings.

The consensus among participants is that the symposium was highly successful in every respect. In addition to serving as a showcase for the scientific, engineering, and other technical contributions of LLNL women, it presented a rare opportunity to learn about research projects from all corners of the Laboratory and to exchange ideas with technical women in other directorates. Many attendees commented that this gathering of LLNL women scientists, engineers, and technicians made them feel less isolated. Most of the women also felt they benefited from the insights and experience other women offered during the professional development workshops.

The general feeling at the end of the symposium approached euphoria: most participants felt energized, validated, and able to resume their work with renewed enthusiasm. The 32 percent who completed symposium evaluation forms gave it an overall rating of nine out of ten and strongly recommended that it be repeated at a future date.

Opening Remarks
Director John H. Nuckolls

Several themes of the Technical Women's Symposium strongly reflect his own vision for the Laboratory, Director John Nuckolls told attendees in his opening remarks on the morning of the first day. "As you know, we are all very interested in what you are doing," he said. "I personally am strongly committed to making the Laboratory a place where everybody who can excel will excel, and we'll help you do that."

During his address, the Director frequently referred to his recently distributed memo on the issues raised by last year's Workforce 2000 conference: networking and mentoring; ensuring that every employee has the opportunity to excel; the responsibility of managers to guide employee development; career-long education; and the dual ladder for career advancement.

The Director pointed out that his memo not only expressed his commitment to these ideas but provided metrics and took the additional step of holding Laboratory managers accountable for implementing them.

"The first responsibility of every technical manager is to achieve technical excellence," the Director told the audience. "But that's not enough. All supervisors also have a responsibility to help every employee who reports to them to develop. It's time that all Laboratory supervisors realize that they have that dual responsibility." Managers also have a responsibility for developing themselves, he said.

Director Nuckolls raised the issues of compensation, ranking, promotions, and the "glass ceiling," saying he has been struggling with all of them. In connection with the glass ceiling issue, he recounted an incident from his recent meeting in Albuquerque with Secretary of Energy Hazel O'Leary: "The word that her staff sent ahead was, 'I don't want to sit in a room with a lot of white males!' "

Director Nuckolls described the Secretary as a leader who provides a broad vision and then expects people in her organization to fill in the details and to realize the vision. "When she met with the lab directors," he recalled, "she walked up to her flip chart and outlined her vision for the Department of Energy. And then she assigned all of us 18 laboratory directors to go to work. She came back at four o'clock and said, 'What have you come up with, and what do you want me to do?' "

The next steps toward the Director's vision for the Laboratory include a second meeting similar to the Workforce 2000 conference; extending the pilot programs being conducted in Engineering to the rest of the Laboratory; and fostering more mentoring and networking. He complimented the LLNL Women's Association for "a really outstanding job in becoming proactive in giving scholarships to promote self-development and education," and said he was encouraging the Women's Association to move forward with mentoring.

The Director's vision also includes an effective dual career ladder. "It's the people on the technical side of the dual ladder that really make the Laboratory great," he said. "I don't want to minimize the contributions of managers, but the fact is, it's the people who are out there

making the technical contributions that make the Laboratory the outstanding research institution it is." Even if we break the glass ceiling, he said, only about one out of five employees will go into management. "It's important to make the Laboratory a place where you can become a manager if you really want to and excel at it, but in case you don't, you should be able to excel and have a very satisfying and productive career as a technical worker," he said. "And you should be compensated fairly for it."

Director Nuckolls noted the complexities of establishing a dual ladder system and said he had solicited advice on that issue from people inside and outside the Laboratory. "That's something I don't think Livermore does enough of, and I think one thing that's good about this symposium is that you are bringing in other people and learning from them. That's important to do."

The Director referred to Peter Drucker's assertion that American society is moving from capitalism with its emphasis on money to a post-capitalist world that will place greater value on knowledge. "You're becoming knowledge employees, and you will function both as intellectuals and as managers. So I'm trying to find out how the Laboratory can assist you to do this." He emphasized the need for career-long education for every employee. "My vision is that we set up an account number for each employee to support so many hours of course work per year, and each person can charge that account number for self development."

In closing, Director Nuckolls told the audience, "I'm really pleased the Laboratory can assist you in doing this. I'm very happy you invited me and these other males to come and share this symposium with you."

Director John Nuckolls.

Keynote Address

Dr. Tamara Jernigan, NASA Astronaut

In her keynote address to a spellbound audience at the Technical Women's Symposium, astronaut Tamara Jernigan described the rigors of astronaut training, the procedures for launching and landing a space shuttle, and her work in space during her second mission. Her technical discussion, leavened by charm and humor, was much appreciated by her audience.

Jernigan's scientific credentials include a B.S. in physics and an M.S. in engineering science from Stanford University, an M.S. in astronomy from the University of California, Berkeley, and a Ph.D. in space physics and astronomy from Rice University. Since becoming an astronaut in 1986, she has logged over 455 hours in space and a total of 305 Earth orbits during her two flights: a nine-day mission in June 1991 dedicated to life science experiments; and a ten-day mission in October 1992 that included deployment of a satellite intended to measure movements in the Earth's crust.

Astronaut Training

Early in her training Jernigan had to learn to pilot a small, supersonic jet trainer, the T-38. Her instructor told her scientists were usually a little shy about taking command of the plane. When her time came to learn aileron rolls—rotations around the long axis of the plane—Jernigan slammed the stick so decisively to one side that the T-38 spun into a 720° per second roll, flinging both astronaut and instructor against the jet's canopy. "He never, ever said anything more about timid scientists," she recalled.

Her training progressed from jet piloting to land and water survival after ejection from a plane. The 500-foot drops into the ocean and helicopter rescues from a life raft were easier, she said, than having to make a fire without matches during land survival training.

To prepare for the weightlessness of space, she and her fellow trainees were flown in a KC-135 aircraft that circled repeatedly in a parabolic trajectory to produce brief periods of weightlessness. Despite the plane's effect on the neophyte astronauts—they called it the "vomit comet"—they were able to practice doing experiments in short segments while weightless.

Not all the training was physical. A large portion of the astronauts' time was spent in lectures and in learning to operate and respond to simulated problems in the space orbiter's many systems. Jernigan trained as a mission specialist astronaut and as such was qualified for space walks, for deploying satellites, and for operating various experiments with a robot arm.

After about a year of training, the astronauts were assigned to a crew. Jernigan's first crew included two other women and two men. She was the only woman on her second crew, which she said was very

NASA astronaut Tamara Jernigan.

compatible. The work was so absorbing there was no time for friction or problems arising because the crews included both men and women.

Preparing for Launch

Jernigan showed slides and described the complex procedures for launching a space shuttle, or orbiter. She explained that the 200,000-pound orbiters landing at Edwards Airforce Base are ferried to Kennedy Space Center atop a 747 plane. After a flight, a shuttle is taken to the orbiter processing facility at Kennedy for refurbishment for its next trip into space. When refurbished, the orbiter is moved to the 580-foot-tall vertical assembly building at Kennedy, where it is bolted to a new set of solid rocket boosters. The boosters and shuttle engines exert 6.9 million pounds of thrust to raise the 4.5-million-pound shuttle. Once "stacked," the boosters and shuttle are transported 4 miles to the launch pad on a giant crawler. Jernigan also pointed out the undercoat-orange base of the booster's fuel tank in one of her slides, saying that 1,000 pounds of weight had been saved by stripping off the original white paint.

Lift Off

As launch time approaches, the astronauts don their pressure suits and ride to the launch pad in a small van. Wearing the 80-pound suits, they lie on their backs in the orbiter for about three hours before lift off.

"You're very anxious for the moment when the main engines light, and about 6.5 seconds later the solid rocket boosters light," said Jernigan. "There's an incredible sense of power beneath you, and it's clear you're going on a ride!"

About two minutes into the flight the solid propellant is expended and the rockets separate from the orbiter. A few minutes later the main engines cut off. Jernigan referred to these steps as "SRB-sep" and "MICO." "You go from 1 G to 3 G at SRB-sep, then at MICO you go weightless. So you feel like there's a gorilla sitting on your chest, then you're weightless. There's quite a transition!"

When the mission is over, orbital maneuvering system engines are fired to slow the shuttle so it will fall back to earth in a controlled fashion. When it lands, the shuttle is essentially unpowered and is acting like a glider with a very low lift-to-drag ratio of four, said Jernigan. "The pilot gets one chance to land this thing—and we wish him well!"

Working in Space

All work in space is done in very tight quarters, said Jernigan, showing film taken during her second mission. The work "day" is a minimum of 16 hours, most of it tightly scheduled to follow detailed procedures. Several of the experiments aboard this mission, including the deployment of a satellite, required use of the robot arm. At deployment, the satellite served as a "target" for pointing and tracking experiments to test a space-vision system that might be used in building a future space station.

Despite the heavy work load, the astronauts had time to admire the scenery. There was a sunrise or sunset every 45 minutes. Jernigan's space flights gave her new appreciation for the Earth; the sight of smoke from the burning Kuwaiti oil fields during her second mission angered her and her fellow astronauts.

In summing up her work and experiences as a NASA astronaut, Jernigan told the audience, "I truly believe that exploration is part of what makes life wonderful. Expanding the bounds of knowledge increases the quality of human life. We're not here just to eat and sleep. We're here to explore and to think and to wonder, and I feel the Space Program is an important part of that."

Technical Address

Dr. Claire E. Max, LLNL Astrophysicist

Claire Max, founding director of the Laboratory's Institute of Geophysics and Planetary Physics, was recently appointed Director of Institutes by the LLNL Physical Sciences Department. She holds an A.B., *magna cum laude*, in astronomy from Radcliffe College and was the first woman to earn a Ph.D. in astrophysical sciences from Princeton University. Dr. Max is also principal investigator for the Laboratory's Laser Guide Star Project, which she described, adding some observations about what it is like to be a woman doing science, to a highly receptive symposium audience.

LLNL astrophysicist Claire Max.

Max began by noting that her current research is a collaborative project between the Physical Sciences Department, the Laser Program, and Engineering—one of the few Laboratory Directed Research and Development Director's Initiatives that crosses directorate boundaries. Running a project involving three LLNL directorates is a bit like international diplomacy, she said. "The thought occurred to me that, as we get more women into management, we'll see more collaborations like this that go across different people's turfs. I think in the 'Lab of the future' that John Nuckolls talks about that's going to be crucial. Many new technical challenges facing the country are cross disciplinary, and if everybody's always worried about having to own all the people working on anything in an area, we're not going to get where we need to go."

Max recalled a personality test she took in an LLNL training course. Her physicist's interest in precision and quantification put her in one category, but her liking for working with people and getting things done collaboratively put her in another. Because so few women scientists had taken the test, there was no precedent for Max's combination of traits. "I was told that I didn't exist, that this result was basically impossible!" she said. "Something I think women scientists, engineers, and technicians can bring to the table is to try to do top-notch technical work with other people in a way that perhaps can be more synergistic than what has been the norm in the past."

Adaptive Optics

Moving to her research interests, Max explained that a basic problem in astronomy is that the Earth's atmosphere blurs the light from stars, obscuring the details astronomers want to examine. The blurring

cannot be corrected by increasing the size of telescopes beyond about 8 inches, the scale at which starlight becomes incoherent. The two possible ways to solve this problem are to get above the atmosphere, which the Hubble Space Telescope has done at a cost of over $2 billion, or to correct for atmospheric distortions, which Max thinks could be done for $10 million or less by retrofitting ground-based telescopes.

The technology that may make this possible is adaptive optics: extremely thin glass mirrors backed by many small, articulated actuators that deform the mirror surface in a controlled way in response to electronic signals. Atmospheric turbulence can be measured in real time (hundreds of times a second) by special detectors that analyze the light from a nearby, well-characterized reference star. The data can then be fed to the actuators behind the mirror, which adapt it appropriately to correct the blur in light from other, less understood stars, galaxies, and nebulae.

Adaptive optics have been developed in the Laboratory's AVLIS Program, and Max's group is now building a system that has 127 actuators. Large telescopes would need mirrors with hundreds of actuators.

Artificial Reference Stars

Adaptive optics technology is feasible for studying celestial bodies close to good reference stars, she said, but what about studying objects in parts of the sky that lack reference stars? Atmospheric turbulence varies greatly from place to place, and corrections cannot be transferred from one part of the sky to another. The solution to this problem, said Max, is an artificial reference star that can be used in any area of the sky.

About 60 miles above the Earth is a layer of sodium atoms, the remains of incinerated micrometeorites. A laser beam exactly tuned to the resonance lines of sodium and pointed into the sky will make those atoms glow. The glowing spot in the sky serves very well as an artificial wavefront reference, or guide star.

Max's group has demonstrated the guide star effect with a laser, and they are about to fit the laser with a beam director. This summer they will assemble two different adaptive optics systems to actually correct for atmospheric turbulence, one at LLNL and another at Lick Observatory on Mt. Hamilton. Next year they will install a 10-watt laser at Lick, and negotiations are under way to put a laser–adaptive optics system on the world's largest optical telescope at the Keck Observatory in Hawaii.

With conventional telescopes operating in ideal conditions, a point source such as a star appears to have an angular size of one-third of an arc second. But if astronomers could use adaptive optics to eliminate the blurring, said Max, the resolution with a 10-meter telescope could be improved by as much as a factor of 100.

Doing Work That Matters

Max said she believes adaptive optics will revolutionize astronomy, although she admitted having had some hesitation before making this statement. Reflecting on her work with adaptive optics and the Guide Star Project, she expressed to the audience her feelings about meaningful work. "I guess what I've learned from doing physics for twenty years is that I'm happiest when I'm working on projects I feel are really important to somebody, somewhere," she said. "This is sort of an extreme case—maybe overstated in the end—but if the work you're doing right now doesn't have broad implications for somebody, somewhere, for some community—it doesn't have to be earth shaking like this—if you

think it's not important to you or to somebody else, think about doing something that is. Maybe it's a little change, maybe it's a big change in your career but, heck, if what you're doing isn't important, it's probably not going to be gratifying in the long run."

Professional Development Address

Dr. Cynthia D. Scott, Organizational Psychologist

Cynthia Scott, a licensed clinical psychologist and co-founder of the San Francisco-based organizational development firm HeartWork, Inc., is a recognized leader in the fields of strategic planning for human capital management, organizational change, and visionary leadership. Dr. Scott holds degrees in anthropology, health planning and administration, and clinical psychology. She has authored nine books, including *Take This Job and Love It; Managing Organizational Change;* and *Self Renewal: Achieving High Performance in a High Stress Environment.*

Changing Employee Expectations

Scott told attendees at a general session of the symposium that the workplace is undergoing changes that will profoundly affect their lives and work, even if the changes are not yet apparent in all organizations. Referring to a series of articles in the *New York Times* (January 1993) on the underrepresentation of women and minorities in science and engineering, she quoted a headline that read, "Enter the Lab and Relive the Fifties." Organizations that resist change will not be able to attract and retain the valuable human capital they want. "In the fifties, you came to work because you had a job," Scott said. "Now you, as talented, capable people, have choices in where you're going to work."

Organizations are beginning to understand that having a healthy, highly motivated work force is a competitive advantage. To meet the changing requirements of their employees, organizations will have to provide an environment in which there is sharing of information and continuous improvement, where managers value what employees have to say and encourage them to increase their competencies. In lieu of offering lifetime employment, organizations will have to help people become more employable.

The concept of empowerment is not going away, Scott said. She noted research at the Karolinska Institutet in Sweden showing that employees who share power and control over their work had 25% less heart disease than micro-managed employees. She also cited research that demonstrated a slowing of brain wave activity in subjects being criticized. Empowerment is the only way organizations can compete or that quality initiatives can really work, she maintained.

From Pyramid to Cluster

In the past, she said, organizations were hierarchical. Leadership flowed down from the top of the pyramid, and information sent upward was viewed as insubordination. People worked within job descriptions

and knew their roles. This structure was efficient and stable until organizations became so self-absorbed they forgot about their customers. Pyramidal organizations are not good at responding quickly to changing customer needs.

Successful organizations are adapting their structures so they can respond more flexibly to customer demands, Scott said. The customer-focused organization is a "cluster," or network, with dispersed leadership and communication in all directions. Groups form around core competencies, and the emphasis is on being able to shift quickly to regain organizational equilibrium.

This structural change is necessary for companies, she said, but what does it do to individuals caught up in it? In the past, especially in unionized environments, the job was defined, no one had to do anyone else's job, there was a single boss, and employees felt comfortable and safe. In the new cluster environments, employees get feedback from many others, including customers, and they're expected to be self-managing and accountable for results. "This is a renegotiation of the psychological contract in the workplace," she said. "This is not an easy shift."

How People Experience Change

Scott cited her work with employees at AT&T in the mid-1980s when it was undergoing divestiture. From her interviews with them, she developed a psychological model for employees' experience of organizational change. She found they went through four phases:

(1) Denial. While it is necessary to deny the pain of change in order to initiate it, people who initiate the change move through it faster than people who have change forced upon them.

Organizational psychologist Cynthia Scott.

(2) Resistance. People miss familiar patterns and resist new ones.
(3) Exploration. People start to think about how to deal with the new situation.
(4) Commitment. People accept and function in the new structure.

People forced into change go through a grieving process, Scott observed, and they need time to finish grieving. Organizations that do not allow for emotional processes create problems for themselves. "There are high correlations between change and workers' compensation claims, illness, and sabotage," she said.

Surviving the Transition

In the transition to the new structure, where jobs and titles are less defined, employees accustomed to the traditional structure may feel their sense of identity threatened. But the looser structure is fairly familiar to women, said Scott. They are more comfortable in it, and they have accelerated the paradigm shift dramatically. Women in management want to move in this direction and are teaching organizations more effective ways to operate.

Organizational change is unavoidable, but transitions can be made less traumatic. Drawing on research during the AT&T divestiture and the Alameda County Study on Longevity, she offered four ways to stay healthier and happier during transitions:

(1) Make sure you understand "the big picture" and *why* the change is occurring.
(2) See the change as a challenge or opportunity rather than a threat.
(3) Take control of those things you can control, such as your personal health; do not let yourself feel helpless.
(4) Establish close relationships so you can have genuine communication with at least one other person.

In closing, Scott emphasized that people resist change less if they are involved in the process. Organizations should clearly communicate the reasons and expected results of change and provide channels for employee feedback and communication. People who love their work do so because of their work environment and the relationships in the workplace more than because of the work itself, she said.

Technical Session I

Future Directions in Computing

Chair: Jean Shuler *(National Energy Research Supercomputer Center)*

Are You Ready for the Massive One?

Tammy Welcome *(National Energy Research Supercomputer Center)*

Experts at LLNL have been predicting massively parallel processing (MPP) for years. Recently gathered data indicate that MPP is inevitable in our production environments in the near future. What magnitude MPP can we expect and when? What can you do right now to prepare yourself? What can you expect during and in the aftermath of MPP? What services and tools can your computer center and vendor communities provide? This presentation addresses these questions.

Update on the National Storage Laboratory

Loellyn Cassel *(Applications Development Organization)*

The National Storage Laboratory (NSL) is an LLNL collaboration with industry to build a high performance storage test bed. It is sited at the National Energy Research Supercomputer Center. The creation of the NSL was motivated by the grand challenge problems of science and industry, which have created corresponding challenges in information storage and retrieval. The overall objectives of the NSL are to investigate and commercialize key enabling technologies to help remove network computing bottlenecks and to provide needed functionality in storage systems. The impact of the NSL will be to help meet requirements of critical DOE and U.S. industry applications with new storage system functionality, to help commercial vendors find new methods of effectively utilizing storage hardware and software, and to guide national storage system standards efforts.

This talk will describe the specific technical and commercial objectives of the NSL and give its current status. The talk will also discuss the key enabling technologies and how these are being integrated at the NSL; the test bed participants and their contributions; the applications targeted to run on the NSL; and the status of equipment integration, software development, and applications enablement.

Tackling the Challenge of Telecommuting: Working with Others Remotely

K. Lori Wong *(National Energy Research Supercomputer Center)*

Telecommuting offers unique advantages but also poses challenges to working in a team environment. Some of the advantages to telecommuting include a flexible work schedule and an environment that can foster creativity and productivity. Challenges are encountered from things as little as bad phone lines and computer network difficulties to conducting effective communication exchanges through e-mail.

The experiences and challenges of working in a telecommuting environment for the User Information Systems Group at the National Energy Research Supercomputer Center will be discussed. Some recommendations for others who might contemplate this type of work arrangement will be presented.

New Directions in Software Development and Testing—The Great Usability Revolution

Nancy A. Storch *(Applications Development Organization)*

In the 1990s the success and survival of our computer applications (and probably the organizations that produce them) will depend on careful attention to two basic issues: (1) worker productivity and (2) quality of product. The cost of development and the productivity of the developers, as well as the customers' acceptance and satisfaction with the end product, become critical factors. The customer judges the product by how easy it is to set up, learn, and use, and how much more productive the users are in doing their work. Competition has led companies developing computer applications and systems to rely on usability engineering for quality user interfaces.

The application of human factors through tests on prototypes of the product yields early important information to developers and managers. These tests measure user performance in doing work-related tasks and the frequency of errors. Interpretation identifies the problem areas. Big cost savings can be achieved in early correction of problems. Usability testing is the best way to identify the big problems users will have with user-interface related problems. Repeated testing allows refinements and measurements of product improvement in usability.

An iterative approach to design and development of the software system best supports development of a quality product with usability testing. The iterative methodology repeats cycles of planning, implementing, measuring, and learning until the user interface is sufficiently tailored to the customer's needs to be acceptable. The project plan should reflect the iterative methodology.

Usability engineering adds a number of human factors activities to the software development process. These fall into the main categories of software development: scoping, functional specifications, design, development, and testing/installation. Depending on the activity and training of the software project team in human factors, a usability engineering activity can be performed either by the team or by human factors specialists.

New Generation Business Information Systems

Sandra L. Sparks *(Administrative Information Systems)*

The information systems (IS) field has led the computer industry in employment of women in technical roles. IS is as technically challenging as any computer applications development area and may have blazed the trail for women moving into scientific applications development areas.

Rather than focusing on any particular woman's success, this talk will highlight the accomplishments of many women in Administrative Information Systems. It will cover their roles and accomplishments in utilizing leading edge information systems technologies for Laboratory business information systems.

Environmental Technology: Correcting the Past and Protecting the Future

***Chair: Charlene Grandfield** (Environmental Protection Department)*

Ground Water Remediation at Lawrence Livermore National Laboratory: Treatment Facility Design and Construction

***Sally M. Bahowick** (Environmental Protection Department)*

The LLNL site was placed on the U.S. Environmental Protection Agency's National Priorities List in 1987 because volatile organic compounds (VOCs) are present in the ground water on Laboratory property and off site in excess of maximum contaminant levels. Under the negotiated Federal Facility Agreement and the National Contingency Plan, the Laboratory must commence remediation of underlying ground water within a schedule and budget jointly agreed on by DOE/LLNL and the regulatory agencies—the U.S. Environmental Protection Agency, the California Regional Water Quality Control Board, and the California Department of Toxic Substances Control. A series of seven treatment facilities, A through G, are being designed and constructed to clean up and/or contain the VOCs within the LLNL borders. Treatment facility design includes (1) applying the appropriate chemical processes to eradicate, and/or capture for removal, the VOCs; (2) designing a system-wide control and interlock scheme for process control and safety; and (3) applying the appropriate quality control checks and monitors to ensure the effluent (treated) ground water is within the required discharge specifications. The fundamentals of treatment facility design and construction will be presented.

Biotransformation Potential of Indigenous Microorganisms from a Gasoline Spill

***Paula W. Krauter, Roger Martinelli, and Linda M. Medeiros** (Environmental Protection Department)*

At LLNL, a records inspection in 1979 indicated approximately 17,500 gallons of gasoline had leaked into the soil from an underground fuel tank. The ongoing gasoline spill clean-up effort provides us with an opportunity to study the indigenous microbial communities. Subsurface sediment ecology is so unexplored that no one knows how many microbial species exist, their population dynamics, or the effects of contamination.

Characterization studies show that the metabolically active bacteria populations and the total microorganism population from several exploratory boreholes vary throughout the subsurface profile. The presence of gasoline reduced the numbers of metabolically active bacteria, and a negative correlation of bacterial number to gasoline concentration is found throughout the site. However, a portion of the microbial community was capable of gasoline biotransformations because of specific intracellular enzymes. Our results show that sediment samples with bacteria capable of biotransformation were not necessarily associated with the largest bacterial populations.

We conducted a series of experiments to determine benzene, ethyl benzene, toluene, and xylene transformation rates and consumption

preference of indigenous microorganisms. The degradation rates of acclimated microorganisms varied from species to species, and the gasoline compounds were consumed in various preference orders.

Many factors affect microbial contaminant biotransformations, such as structure, concentration, and toxicity. Additional factors that affect the microorganisms are temperature, soil moisture, availability of micronutrients, and electron donors and acceptors. From testing the effects of several nutrients on microbial growth, we have learned that oxygen and nitrogen are necessary to enhance biotransformations at this gasoline spill.

We have isolated microorganisms from the gasoline spill site that have not been classified or named. Each organism has been shaped by countless acts of natural selection. The loss of microbial diversity may lead to a less stable ecosystem in the long term. We need to develop remediation techniques that enhance natural biotransformations and preserve biodiversity.

Quality Evaluation for Dismantlement

Judy Steenhoven *(Environmental Protection Department);* ***Cathryn Teasdale*** *(Hazards Control);* ***and Erica von Holtz*** *(Chemistry and Materials Science)*

In response to rapidly changing world events, the United States has embarked upon an escalated schedule of retiring nuclear weapons from the stockpile. Enormous technical challenges are faced in addition to the expectation that all relevant environmental, safety, and health requirements will be met. DOE is committed to meeting these challenges and is working closely with its contractors to ensure the safe, compliant, and technically sound dismantlement of nuclear weapons. One method being used to ensure that these commitments are met is the Quality Evaluation for Dismantlement process.

As one of the primary design agencies, LLNL has set up dismantlement teams made up of weapons design experts as well as environmental, safety, and health specialists. Their task is to provide design information and to review work performed by production facilities such as Pantex to insure that all of the above goals are met. Three LLNL women supporting this effort are: Erica von Holtz, a high explosives formulations engineer; Cathryn Teasdale, a health physicist; and Judy Steenhoven, an environmental protection/waste management specialist. Erica is evaluating the high explosives handling aspects of dismantlement, including the removal, transport, and eventually the final disposition of explosive parts. Cathryn is looking at potential radiation exposures to workers through the entire sequence of events and recommending methods to reduce these exposures. Judy is looking at how wastes are generated to evaluate potential waste minimization opportunities and proper management of the waste once it has been generated.

To date, each team member has reviewed operational procedures for three weapon systems currently undergoing dismantlement. This has entailed physically visiting the dismantlement facility, viewing the dismantlement process, and evaluating how safely and effectively procedures are being followed. On the basis of the entire team's observations, recommendations were made for process improvements.

Ecological Risks: Beyond Hazardous Chemicals. The Vulnerability and Persistence of Rare and Endangered Species.

Tina M. Carlsen *(Environmental Restoration Division)*

In the regulatory arena, "ecological risk" has primarily meant the risk to species from hazardous chemicals. However, biologists and ecologists have long recognized that a primary risk to many species is the accelerating rate of species extinctions. Causal factors in species extinction include habitat loss or degradation, competitive pressures from exotic species, or stochastic processes. Federal sites (i.e., DOE and DOD facilities), which are usually large and sparsely developed, often support rich biological resources. These sites have become "refugia" for species that have been forced off surrounding land. Often, facility management actually encourages the persistence of rare or endangered species. LLNL's Site 300 is an 11 square mile site in the rugged Altamont Hills 50 miles east of San Francisco, California. There, several rare plant species exist. The native perennial bunch grasses, *Poa scabrella* and *Stipa pulchra*, exist in large numbers at the site, but are rare on surrounding land occupied almost entirely by exotic annual grasses. Also, until very recently, Site 300 was the only known location for *Amsinckia grandiflora*, an endangered species of fiddleneck.

These species have declined throughout their historic range, largely because of poor competition with annual grasses, intense grazing pressure, and land development. The perennial bunch grasses are thriving at Site 300 as a result of the elimination of grazing for the past 40 years, and the management practice of annually burning large areas of the site as a means of fire control. This burning has reduced the competitive pressure from the annual grasses, allowing the perennial grasses to increase in number. The fiddleneck, on the other hand, exists outside the controlled burn area and has had no active management. The numbers of individual plants have precipitously dropped from several thousand in the late 1960s, to a low of 28 plants in the early 1980s. Although Site 300 populations currently contain around 400 plants, at such low numbers these populations are vulnerable to stochastic extinction. Management techniques being considered to reduce the potential of extinction include control of annual grasses through fall burning or herbicide treatment, and establishment of a population within a perennial bunch grass matrix.

Defense and Space

Chair: Karena McKinley *(Mechanical Engineering)*

A Brief Overview of the High Explosives Applications Facility

Rochelle E. Clements *(Defense Systems/Nuclear Design Program)*

The High Explosives Applications Facility (HEAF) was designed and built to enhance the capability to develop high explosives with greater performance, less sensitivity, and engineering characteristics that can be directed toward a specific application. HEAF was constructed and is operated in a fashion that guarantees that this research can be

carried out with maximum safety to the people involved in the research, the Livermore community, and the environment.

Completed in 1989, HEAF has 108,000 square feet of laboratory and office space. There is a chemical synthesis lab, a formulation lab, and five experimental tanks to allow researchers to conduct tests involving as much as 10 kg of high explosive, with two more tanks coming on line soon. There are many exotic diagnostic tools available—lasers, Fabry–Perot, high-speed cameras, an x-ray accelerator, and holograms—that experimentors can utilize within this facility.

Modal Analysis of a Lightweight Spacecraft

Patricia A. Manning *(Engineering Sciences Division)*

LLNL is engaged in a technology development project that includes designing a lightweight, autonomous, highly maneuverable space vehicle, commonly referred to as a probe. The current probe design includes a guidance and control system that requires complete information on the dynamic response of the probe during operation. A finite element model of the probe was constructed to provide analytical information on the dynamic response to specific operational inputs. In order to verify the assumptions made in the model, a mass mock-up of the probe was constructed at LLNL, and an experimental model survey was performed to determine the frequencies, damping values, and deflection shapes for each natural mode of the mock-up. The experimental modal parameters were compared with the parameters obtained through modal analysis of the finite element model to provide a measure of the correlation between the model and the actual structure. This report describes the experimental modal testing and analysis of the mass mock-up and compares the experimental results with the finite element results.

Structure and Reactivity of Energetic Materials

M. Frances Foltz *(Chemistry and Materials Science)*

The dynamics of fast chemical reactions in the hostile environment of explosions is poorly understood, yet needs to be investigated to better tailor the design of new insensitive, high-yield explosives. Attempts to quantify the chemistry of the hot reaction zone in large-scale shock experiments have so far met with insurmountable technical problems. As a result, interest has turned to the small-scale (<1 mg), static, high-pressure testing regime afforded by the diamond anvil cell. In the work discussed, the unique use of laser ignition of a high-explosive sample confined under pressure in the diamond anvil cell is coupled with the measurement of the burn rate by fast streak-camera imaging of the reaction zone. The burn rate of the different high explosives studied varies not only as a function of pressure for a given compound but also from one compound to the next. Sensitivity to the laser-ignition threshold has also been observed to change over pressure regimes where burn rates vary abruptly. In this way, burn-rate measurements act as a reactivity fingerprint for energetic compounds of vastly different bulk performance and sensitivity behavior. This discussion includes the possible role of pressure-induced conformational changes or phase transitions in affecting the availability of reaction pathways and ultimately influencing the observed reaction (burn) rates.

The Mechanical Designer's Role in Experimental Physics at LLNL

Frances Ann Foy *(Nuclear Test Engineering Division)*

A mechanical designer is involved in physics experiments from conception to realization. Working with physicists and engineers, the mechanical designer transfers the experiment concept onto paper to produce precisely what the physicists and engineers require. To accomplish this, it is necessary to consult with experts in many different technical fields: materials, electronics, mechanisms, vacuum systems—whatever is called for by the nature of the experiment. The end product of this effort is a visual representation of the experiment design that leads to production drawings or computer data bases for the hardware fabricators and to assembly drawings for the technicians who complete and test it.

Two types of drawings are produced: a layout—a model of the desired experiment—and detail drawings, which include orthographic projections, dimensions, cross sections, tolerances, notes about materials, etc., for the fabricator, and document notes for the field engineer. The Bristol nuclear test, for example, required 990 detail drawings. On a small project, the mechanical designer may be a one-person shop. On a larger project, the mechanical designer functions as the project manager for the team of drafters and designers. All drawings must conform to the standard requirements of the American National Standards Institute and be reviewed for form, fit, function, and accuracy.

The mechanical designer must have a background in mathematics, fabrication practices, basic engineering and physics principles, and be an expert user of computer-aided drafting software. State-of-the-art software can handle complex problems with more flexibility, produce clear visual representations of the design, and produce an accurate data base for computer-aided manufacturing software, engineering stress analysis, and physics analysis codes. The lead designer's job requires excellent communication and interpersonal skills. Frequent consultations between the mechanical designer, the physicist, and the engineer, along with a smoothly functioning design team, are essential to complete the project on schedule and within budget.

Reinforcing Ground Combat: Helicopter or Tiltrotor Aircraft?

Dolores U. Olness *(Chemistry and Materials Science);* ***Arnold S. Warshawsky*** *(D-Division);* ***and Jeffrey E. Pimper, Michael J. Uzelac, and Joseph Wilson*** *(Computation Directorate)*

The work reported here provides a quantitative answer to the question "What difference does increased payload, speed, range, and hardness make in supporting Marine Corps amphibious assault and reinforcement missions?" Past studies have examined the ability of various aircraft to transport troops and equipment to combat areas and have measured the corresponding force build-up rates. However, none have examined how those build-up rates affect battle outcome in a high-resolution, force-on-force simulation.

We used the Janus combat simulation to compare the relative effectiveness of alternative aircraft fleets—a fleet composed of V-22 tiltrotors and CH-53E helicopters, or a fleet of CH-60(S) and CH-53E helicopters. The hypothetical scenario postulated for this study stresses time urgency; in other words, the different capabilities of alternative

aircraft mixes make significant differences in how the ground battle proceeds. In the scenario, amphibious assault forces reinforce the ground force. The aircraft must negotiate an air defense threat of moderate intensity.

During the simulated battles examined for this study, the V-22 tiltrotor/CH-53E helicopter fleet delivered the reinforcements more than twice as fast as the all-helicopter fleet. The earlier arrival of combat power delivered by the V-22 tiltrotor/CH-53E helicopter fleet permits better utilization of forces leading to defeat of the opponent while preserving a larger residual force than in the all-helicopter case. V-22 losses to ground-based air defenses are less than one-tenth the corresponding losses of the two other aircraft examined in this simulation. [This work was sponsored by the Bell/Boeing Joint Program Office under the provisions of a DOE Work for Others project.]

Nova Inertial Confinement Fusion Target Physics

Chair: Vicki Miller *(Laser Engineering Division, Electronics Engineering Department)*

Modeling of Capsule Symmetry Measurements in Nova Hohlraums

Linda V. Powers, Laurance J. Suter, and Peter Amendt *(X-Divison);* ***David B. Ress*** *(Y-Division);* ***and A. A. Hauer and N. D. Delamater*** *(Los Alamos National Laboratory)*

Recent Nova hohlraum experiments have used x-ray imaging of self-emission from capsule implosions to test the effects of intentionally detuning hohlraum drive symmetry. The observed image distortion provides a measure of the time-averaged drive asymmetry on a capsule. We have measured image distortion as a function of laser beam pointing for (1 ns) flat-topped and shaped laser pulses. We present comparisons of the measured image distortions and capsule performance data from these experiments with LASNEX modeling. Our modeling accurately predicts the beam position corresponding to best symmetry for all the pulse shapes we studied. The variations in image distortion and capsule performance data with beam pointing shifts away from best symmetry are also in good agreement with modeling.

We are also investigating time-dependent drive symmetry by imaging implosions produced by flat-topped laser pulses varying in length from 450 ps to 1 ns. The variation in capsule shape as a function of pulse length is indicative of temporal variations in drive symmetry. We present comparisons of measured vs calculated image distortion as a function of laser pulse length for flat-topped pulses ranging from 450 ps to 1 ns in length. This technique for measuring time-dependent hohlraum drive symmetry will soon be applied to shaped pulses of longer duration.

Effect of Beam Smoothing on Filamentation

Barbara F. Lasinski, Richard L. Berger, A. Bruce Langdon, Edward A. Williams, and William L. Kruer *(X-Division);* ***and Thomas B. Kaiser and Bruce I. Cohen*** *(Energy Directorate)*

We use our three-dimensional filamentation code to study the effect of beam smoothing techniques on filamentation instabilities for param-

eters of interest to current experiments. Our simulations support the scaling of the analytic result that ponderomotive filamentation is stabilized when

$$\frac{1}{f^2} \geq \frac{n}{n_c} \bullet \frac{\overline{v_o^2}}{v_e^2},$$

where f is the f-number associated with the incident laser beam. This may be understood as a specific case of the general consideration that both ponderomotive and thermal filamentation are stabilized when the speckle length characteristic of the beam-smoothing method is smaller than the filamentation spatial growth length. At laser intensities above 10^{15} W/cm^2 and temperatures above 2 keV, the contribution from nonlocal thermal effects is small. Thus, this formula can be used in this regime without thermal modifications.

Laser-Driven Hydrodynamic Instability Experiments on Nova

S. Gail Glendinning, Shamasundar N. Dixit, Mark A. Henesian, Joseph D. Kilkenny, and Howard T. Powell *(Y-Division);* ***Stephen V. Weber*** *(X-Division);* ***Russell J. Wallace*** *(Chemistry and Materials Science);* ***and J. P. Knauer and C. P. Verdon*** *(University of Rochester, Laboratory for Laser Energetics)*

We have performed a series of experiments on hydrodynamic (Rayleigh–Taylor) instabilities seeded by drive modulations in planar foils on the Nova laser at LLNL. For these experiments, we have used a drive laser beam smoothed by a random phase plate and by spectral dispersion with variable bandwidth. We have measured the laser far-field image both time integrated and time resolved. The samples (flat polyethylene foils 20 μm thick and 700 μm in diameter) are driven with ~1 x 10^{14} W/cm^2 of 0.53-μm laser light for 3 ns. The targets are radiographed during acceleration using a multiple frame gated x-ray pinhole camera (gate time ~100 ps). The x-ray backlighter target is uranium and is illuminated by a second laser beam. The time-resolved measurement of the laser far-field agrees quantitatively with modeling. We have observed systematic behavior of the measured modulations in optical depth that agrees qualitatively with anticipated behavior.

Characterization of Plasmas by Microdot Spectroscopy

Christina A. Back and Robert L. Kauffman *(Y-Division)*

Spectroscopy involves the analysis of line intensity ratios and line widths in a spectrum to determine electron densities and temperatures. Spectra from laser-produced plasmas are typically in the x-ray wavelength regime of 1 to 100 Å. Complex plasma models have been developed and have proven successful in analyzing data from such plasmas. The application to current inertial confinement fusion designs requires a reanalysis of these techniques to choose meaningful diagnostics. In this work, targets are fabricated using multilayer microdots. A microdot is a tracer layer of material that can serve as a monitor of the local plasma conditions. Because the spectrum of the tracer is different from that of the surrounding material, the signal can be identified and analyzed. The Nova laser has ten beams that can each deliver on target up to 2.5 kJ of energy in 1 ns at a wavelength of 0.35 μm. Time-resolved data from experiments using one beam will be discussed.

The Role of Resonance Absorption in Inertial Confinement Fusion

Denise E. Hinkel-Lipsker *(X-Division)*

In inertial confinement fusion, a laser heats a solid target, forming plasma on the surface. In the plasma, laser energy is absorbed and conducted inward toward high-density regions; more of the target is then heated, and it expands outward. Conservation of momentum causes the cold remainder of the target to recoil inward. An important issue is the absorption efficiency of the laser energy by the plasma. Resonance absorption is one such laser–plasma coupling mechanism. In resonance absorption, an electromagnetic wave with vacuum wave vector k and frequency ω inclined at an angle θ with the plasma density gradient propagates in the direction of increasing density. It encounters a cut-off at $\omega_p(z) = [4\pi n(z)e^2/m]^{1/2} = \omega\cos(\theta)$, where $\omega_p(z)$ is the local electron plasma frequency, $n(z)$ is the electron plasma density, and m is the electron mass. A portion of the wave is reflected at the electromagnetic cut-off; the remainder tunnels to the critical layer, $\omega = \omega_p(z)$, where it drives a Langmuir wave that is damped by the plasma, thereby transferring energy from the incident wave to the plasma. For an unmagnetized plasma with a linear density profile, the energy flux conversion coefficient, a measure of the fraction of energy converted from laser to plasma thermal energy, can be analytically expressed in terms of Airy functions by utilizing a source approximation that is valid when the electromagnetic field scale length is large compared to that of the Langmuir wave. The energy flux conversion coefficient is independent of electron temperature, T, and the collision frequency. It depends on the angle of incidence θ and the vacuum scale length $\omega L/c$, and for $T/mc^2 << 1$, agrees with earlier, numerical calculations.

Technical Communication

Chair: Eleanor M. O'Neal *(Communications Resources Office, Technical Information Department)*

Electronic Information Resources: Virtual Libraries at LLNL

Hilary D. Burton *(Information Systems and Services, Technical Information Department Library)*

In this time of information infrastructures and virtual realities, the extent of electronic information resources is expanding almost exponentially. Daily, new systems and services are available on the Internet; relevant new bulletin boards and listservers come on-line; cd-roms are released which offer one more previously print publication in electronic form; and new standards for intersystem retrieval and information sharing are extended.

Within the Laboratory, with its diversity of scientific and technical disciplines and changes in its charter due to the cessation of the cold war, there is a strong need to take advantage of as well as contribute to this rapidly developing world of information resources. Resource sharing is facilitated by flexible, high-capacity electronic communication channels. The Laboratory already has access to extensive resources located within the University and State of California systems available through MELVYL. Furthermore, access to resources such as *Chemical*

Abstracts, *Inspec*, and *Engineering Index* have been available and utilized on-line since the early 1970s when companies such as Lockheed's DIALOG and System Development Corporation's ORBIT systems were offered commercially.

However, the Laboratory is not simply a consumer of resources. Development of specialized software to facilitate access and analysis of textual information has been underway here for more than twenty years and the Technology Information Systems program has been involved in the integration and networking of disparate information systems since 1978. Within the Library, work is underway to make the Laboratory's journal collection available through the MELVYL system and to make the full text of the unclassified technical report collection available, first to our sister labs at Los Alamos and Berkeley, and subsequently, to qualified Internet users. Networking of cd-rom resources, including services such as the full text of the journals, standards, and conference publications, is also underway.

The overall effect of these efforts will be the creation of "virtual libraries" where individuals will have access to that subset of information resources which best supports their particular needs. No longer will information services be constrained by a physical library collection, rather access to electronic resources will provide each user with far more comprehensive coverage than was ever previously available even in a system as outstanding as UC's. In this time of diminishing and redirected budgets, such electronic access will provide the means for less to do more. And standards and software to facilitate sharing of resources will result in an electronic highway that will allow users to effectively and efficiently reach their destinations.

Evolution of the Technical Communication Profession

Shirley Ann Owen *(Editorial Division, Technical Information Department)*

The profession of technical communiation is now about 50 years old. Over its first 30 years the profession progressively defined and validated itself in response to several movements in Western cultural history: the explosive proliferation of technologies; the growing body of research on the psychology of perception, linguistics, sociolinguistics, information theory, reading skills, the nature of on-the-job reading, and new theories of rhetoric; the advent of computers as a major industry, and later as a common work tool; and, last but not least, the changing roles of women in the workplace.

During this period, into the late '70s, many different types of niches developed for technical communicators in different types of industries, and there was much argument among communicators about the "true" nature of the profession and, indeed, whether it was a profession. This struggle towards a recognizable professional image, even a coherent self-image, can be traced through the evolution of the publications of the Society for Technical Communication and of the topics addressed at the society's annual conferences.

During the '80s the profession "arrived." We have gradually recognized that the "true" heart of the profession is the focus of the technical communicator upon orienting and scoping information to fill the needs of a specific reader (or user) and of bridging gaps between the author/designer and the reader/user—gaps that may be of expertise, or of sociolinguistic habit, but always of perspective. With that expertise goes a lot of technical knowledge about techniques, procedures, and ever-

increasing electronic resources. Today, we comfortably recognize many subspecialties within the profession: e.g., on-line documentation; marketing communications; multimedia; risk communications; and the teaching of technical communications in colleges and universities. There are now recognized educational paths to a degree—even an advanced degree—in technical communication.

Of particular interest to this symposium, this is a field to which women, with the communication skills developed in their traditional roles, came already primed to make a significant contribution. The field being new and expanding, it has been relatively open to women, offering them technical careers with paths to management success and to independent business ownership. Seizing the opportunity, women now fill about two-thirds of all technical communication jobs in the U.S.

Today there is no lack of opportunity or challenge in the technical communications field. The goal of achieving better communication is a moving target in a world of technology that is constantly changing. And somewhat ironically in this "information age," there is one remaining battle to fight: to persuade the technical drivers that communication is *fundamentally*, not peripherally, important to the success of a project or a product.

Communicating Science to the Public

Ann Parker *(Communications Resources Office, Technical Information Department)*

Think of it as a problem to be solved: How do you effectively communicate technical or scientific information to the wider, public audiences beyond your scientific or technical peers? The solution usually involves a specialist in the field of communication. Such communication specialists collaborate with the technical expert to "build bridges" to the wider world. They provide the translation skills necessary to turn highly technical information into the words and images appropriate to the technical level of the audience. This is true whether the scientist or engineer is writing an article for *Mechanical Engineering*, *Physics Today*, or *Scientific American*; being interviewed by a writer/reporter for *Nature*, *Business Week*, or the local newspaper; or being interviewed for *Nova*, the nightly TV news, or a radio "call-in" show.

These communication experts often straddle two worlds: the world of technology and science, and the world of their audiences. In order to get the best results, a technical person should approach the expert with the attitude that she will be a help to the process, not a hindrance. Just as the technical person has expertise in her particular field, the communications person is an expert at determining the best ways and means of delivering clear, concise, and understandable information to a particular public audience. That audience may have technical expertise in a variety of fields, or no technical expertise at all. Understanding the partnership between technical and communication experts and the "rules of the game" will increase the odds of successfully getting that information across the bridge from the technical world to the public world.

Managing Communications in a Technical Organization

M. Louise Rufer *(Editorial Division, Technical Information Department)*

Today's scientific management team boasts a broad cast of characters. It is common nowadays to see scientists from several disciplines,

financial specialists, contract administrators, project managers, and health and safety specialists all sitting at the same management table, each contributing to the technical agenda of any organization. Thus, it is no surprise that the communications professional also plays a leading role in guiding a scientific management team.

The successful scientific manager recognizes that continued funding directly depends on targeted and timely reporting of technical plans and progress. Likewise, public acceptance and backing as well as key community alliances are now crucial to the life of any technical program. This manager also knows the necessity of collaborations with industrial partners, with educational institutions, and with government agencies. Today's research programs must continually justify their existence, must undergo frequent cost/benefit analyses, and must present a positive and dynamic stance to technical decision-makers. The strong communications manager plays this role.

With knowledge of a program's goals and its role in the national scientific agenda, the communications professional develops policies and plans addressing the communication needs of the organization. Internal and external audiences are identified and analyzed, contacts are made, schedules are developed, and various materials are written to communicate the proper information in the appropriate media to the correct audience. Thus, either within or outside the scientific community, to funding and regulatory agencies, from proposals to periodic milestone reports, from marketing brochures to detailed technical specifications, the communications specialist plans and implements strategies to distribute information to the right place at the right time.

The communications planner also maximizes each organization's resources. Internal contacts and decision-makers are integrated into the publishing process. Programmatic and specialized personnel assist in developing consistent and easily retrievable programmatic information in a format and style compatible with automated publishing standards. Information data bases provide the electronic network linking key participants.

The communications professional is thus a critical team player in today's scientific program, providing a necessary link between managers, scientists, and decision makers. Well managed communications can make the difference between a good technical program and a fully funded technical program.

Technical Session II

Computational Physics

Chair: Evi Dube *(Defense Science Applications Division, Computation Directorate)*

Visualizations of Tokamak Plasma Turbulence

Alice E. Koniges and Gary Craddock *(National Energy Research Supercomputer Center);* ***and James A. Crotinger*** *(Energy Directorate)*

Computer-generated movies are used to characterize coherent structures (akin to vortices in a fluid) and other flow characteristics in tokamak plasma turbulence. Results from the movies and the simulations are used to describe "anomalous transport," the understanding of which is crucial to making the tokamak a viable fusion energy source. In addition, the movies are used to design experimental diagnostic techniques for tokamak experiments. We discuss the codes and techniques used for making the movies, as well as give a brief introduction to the problem of tokamak transport.

Computational Diagnostics for the Determination of Phase Transitions During Nanoindentation

Carol G. Hoover *(National Energy Research Supercomputer Center);* ***Susanne M. Lee*** *(Physics Department);* ***Jeffrey S. Kallman and Anthony J. De Groot*** *(Electrical Engineering Department);* ***and William G. Hoover and Frederick Wooten*** *(Department of Applied Science, University of California at Davis/Livermore and LLNL)*

We have developed several diagnostics, applicable to a wide variety of atomistic systems, to characterize structural phase transformations in computational models of silicon. We emphasize an understanding of the brittle-to-ductile flow transition in the nanomachining of high-quality ceramic mirrors. The Stillinger-Weber potential was used in our molecular dynamics simulations and the computational solids modeled with more than one million atoms. We used massively parallel computers to simulate x-ray and electron diffraction patterns, radial distribution functions, and ring-size statistics. We also used a digital microtome technique to analyze computational nanoindentations at a variety of indentation rates and temperatures. We observed a diamond-cubic to metastable amorphous phase transformation during and following indentation of the diamond cubic workpiece.

Simulation of Turbulent Flow Around Buildings

Rose C. McCallen *(Nuclear Test Engineering Division, Mechanical Engineering Department)*

The goal of this research project is to accurately simulate the flow around buildings or other wind disturbing structures to predict the dispersion of airborne pollutants in the near field. The prediction of the

dispersion of pollutants from stacks and ground spills in urban areas is important to the government and private organizations involved in the use, generation, handling, or disposal of hazardous materials.

The wind flow around buildings is very complex and dependent on the building geometry, orientation, and proximity to other flow obstacles. Streamwise vortices are generated by flow obstacles and will shed and propagate downstream, which results in an unsteady, flapping wake. In predicting the dispersion of airborne pollutants around buildings, the critical and most difficult physics to model is the wind flow. The wind flow around buildings cannot be directly simulated because the computational requirements exceed the limits of present day computers. Instead approximations must be introduced to represent the turbulent flow (i.e., turbulence models).

This project has been a joint effort between Electronics Engineering, Mechanical Engineering, and Atmospheric and Geophysical Sciences Division (G-Division). Electronics Engineering's Bryan Lawver has developed a stand-alone, real-time emergency response system to predict the off-site dispersion of particulate releases. The system's wind field model is most effective at a significant distance from the source (e.g., for 1 km or beyond). For emission estimates in the proximity of source releases, more sophisticated models are needed. Two advanced modeling efforts are being developed at LLNL. Robert Lee of G-Division is developing a k-e turbulence model, and I am developing a large-eddy simulation (LES) model. The LES research effort has served the dual purposes of satisfying the above described project needs and supporting my Ph.D. research.

Numerical Comparison of Grid ReGeneration Methods for Three-Dimensional, Unstructured ALE Hydrodynamics

Evi Dube *(Defense Sciences Applications Division, Computation Directorate)* ***and Garry Rodrigue*** *(Department of Applied Sciences, University of California, Davis/Livermore)*

An ALE (arbitrary Lagrangian–Eulerian) method consists of two steps: first the complete Lagrangian calculation and then a modified Eulerian, or advection step. When going from the moving Lagrangian step to the advection step, the mesh is regenerated, or relaxed, to alleviate any tangling from the Lagrangian calculation. This new mesh needs to be smooth, with no bow-ties or distorted elements and no drastic changes in zone size.

Grid generation has been studied extensively for two-dimensional, structured, finite difference meshes. The more popular techniques include the Winslow-Crowley[1] and the Thompson-Thames-Mastin[2] methods. More recent work includes using the variational principle to derive grid-generation algorithms. The more robust algorithms result in elliptic grid generators that have several unique properties, such as a high degree of differentiability of interior nodes and an independence of interior nodes to boundary nodes.

We investigate the use of several different elliptic-grid generation methods for regenerating the mesh of a three-dimensional, unstructured, finite-element grid. We use the variational principle to derive these methods: (1) Laplace's equation; (2) weighted "Laplace's" equation,[3] where an arbitrary weight function such as regional weighting or pressure weighting is introduced; (3) weighted AO (area-orthogonality) Grid Generator[4]; and (4) geometric weighted "Laplace's" equation, in

which the finite element analysis is done over the nodes, not over the zones as is done in method (2).

We test the regridding algorithms on two problems. The first one consists of a cube of material surrounded by a semicircle of more material. As the problem runs, nodes are allowed to relax, and difficulties occur with overlapping elements at the relaxed boundary located between the non-relaxed nodes and the relaxed nodes. The second problem involves a bubble forming at one end of a material. Here, unwanted mesh lines migrate from the thin section of the problem into the thicker region.

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[1]A. M. Winslow, *J. Comput. Phys.* **2,** 149 (1967).
[2]J. F. Thompson, F. Thames, and C. Mastin, *J. Comput. Phys.* **15,** 299 (1974).
[3]R. E. Tipton, "Grid Optimization by Equipotential Relaxation," Lawrence Livermore National Laboratory, 1992 (unpublished).
[4]P. M. Knupp, *J. Comput. Phys.* **100,** 409 (1992).

Automation and Robotics

Chair: Erna Grasz *(Robotics and Automation Group, Environmental Restoration and Waste Management Program)*

Modular Robotics

Dawn R. Fairley *(Automation and Robotics Section, Environmental Restoration and Waste Management Program)*

To provide the DOE complex and eventually U.S. industry with both high-precision and high-payload-capacity robots, the Automation and Robotics Section at LLNL has been working on the development of modular robots. These hybrid robotics systems are designed to combine both hydraulic and electrically actuated joints that are interchangeable, depending on the kinematics and payload requirements, and that will offer low associated maintenance costs because of their modularity, thus increasing manufacturing flexibility and efficiency.

This technology is directly applicable to hazardous and radioactive materials processing systems and is also beneficial in industrial manufacturing work cells where operational downtime must be minimized. In addition, the modularity will allow systems to be reconfigured, extending system life as applications change in more flexible production systems of the future.

The work that the Automation and Robotics Section is undertaking to fill this need will be discussed. This work currently includes a modular arm joint and a modular mobile platform.

Waste Stream Robotics

Loretta A. Huber *(Automation and Robotics Section, Environmental Restoration and Waste Management Program)*

The Mixed Waste Management Facility (MWMF) is a proposed pilot plant at LLNL. The focus of this facility is to address the neutralizing and disposing of hazardous waste through alternative processes other than the traditional incineration method. Waste minimization and environmental concerns are driving the MWMF Project toward a fully automated facility. The software development is a necessary aspect of this facility for supervisory control as well as the control and monitoring of the chemical processes. The integration of currently available tech-

nologies and advanced technologies under development dictate the need for a formal software engineering development environment. The automation and robotics technologies used to sort, characterize, analyze, transport, and process the mixed waste stream are also highly dependent on the supervisory control capability. The technology developments completed for this facility will actively be transferred to private industries and duplicated for other DOE sites. This presentation will highlight the overall objectives of the MWMF while detailing the automation and robotics requirements as well as the software development and implementation plan.

The Development of Control Technologies Applied to Waste Processing Operations

Erna Grasz, Stanley Baker, Scott Couture, David Dennison, Maynard Holliday, Randall Hurd, Brett Kettering, Ray Merrill, Karl Wilhelmson *(Robotics and Automation Section, Environmental Restoration and Waste Management Program)*

Typical waste and residue processes involve some level of human interaction. The risk of exposure to unknown hazardous materials and the potential for radiation contamination provide the impetus for physically separating or removing operators from such processing steps. Technologies that facilitate separation of the operator from potential contamination include glove box robotics; modular systems for remote and automated servicing; and interactive controls that minimize human intervention. LLNL is developing an automated system which by design will supplant the operator for glove box tasks, thus affording protection from the risk of radiation exposure and minimizing operator associated waste. Although most waste processing tasks can be automated with minimal human interaction, some do require intelligent intervention to assure adaptation to unexpected circumstances and events. These particular tasks require operator interaction with the process by means of remote, robotic control. The automated robotic workcell fuses multisensor feedback with supervisory robot control to provide the operator with an effective means of controlling the robot in a potentially unknown environment. This presentation describes recent accomplishments in technology development and integration, and outlines the future goals at LLNL for achieving this integrated, interactive control capability.

Tools and Techniques for Biology in the 1990s

Chair: Linda K. Ashworth

An Overview of the Human Genome Project at Lawrence Livermore National Laboratory

Linda K. Ashworth *(Human Genome Center, Biology and Biotechnology Research Program)*

An interdisciplinary team has been working for four years on the Human Genome Project. The broad goals of the project are to: (1) evaluate DNA mapping and sequencing strategies; (2) use these strategies to construct ordered clone maps, initially for chromosome 19; (3) develop biological and physical resources useful to the genome

research community; and (4) use the map and sequence information to study genome organization and variation.

A foundation physical map has been generated from the analysis of over 12,000 clones, each containing ~40,000 bp of human chromosome 19 DNA. The clones were each cut with a battery of five restriction enzymes, and fragments were simultaneously labeled with a fluorescent dye. Sizes were determined by laser excitation of the fluorochrome attached to the fragments. These "fingerprints" of clones have been used to assemble more than 900 contigs using a log-likelihood probability algorithm. The contigs span approximately 90 percent of the chromosome.

Order and orientation of the contigs is being determined by fluorescence *in situ* hybridization (FISH) mapping. To date, clones from 232 contigs (and 101 other "orphan" clones) have been FISH mapped to prometaphase chromosomes. These mapped elements span approximately 50 percent of the chromosome.

We are collaborating with researchers worldwide to place markers from the genetic map of chromosome 19 onto our assembled cosmids. To date, 165 genes or genetic markers have been localized to contigs by hybridization. High resolution mapping is being done in several gene regions including myotonic dystrophy, three DNA repair genes, the carcino-embryonic antigen family, and others. Complete sequence has recently been determined for the XRCC1 gene in both the human and the mouse equivalent.

All data from raw waveform signals to assembled contigs along with associated biological and/or genetic attributes are stored in a database, currently over 1.1 Gb in size. Data is accessible through direct SQL queries or through Browser, a LLNL-designed graphical interface used for display of genomics data.

We are currently focusing our efforts on closure of gaps between contigs, the integration of the physical and genetic maps, and identification of additional chromosome 19 genes.

Structure and Evolution of a Gene Family on Human Chromosome 19

Susan M. G. Hoffman *(Human Genome Center, Biology and Biotechnology Research Program)*

A large proportion of the human genome consists of repetitive DNA, short stretches of DNA that are present as multiple identical or nearly identical copies. The most repeats, the Alu and LINE elements, have tens of thousands of inexact copies that together make up almost 20 percent of the total human genome. Though most repeats consist of non-coding DNA, there are multiple copies of coding sequences known as gene families. I have been studying the distribution and organization of gene families on human chromosome 19 in an attempt to understand the evolution of gene families and the mechanisms that create repeat elements.

Gene families, defined as groups of genes that are both structurally and functinally related, encompass perhaps 5 to 10 percent of known loci. Human chromosome 19 appears to be particularly rich in gene families. I have focused on a gene family group from the cytochrome P450 superfamily of mono-oxygenases. The proteins produced by these genes are of central importance in the metabolism of xenobiotic compounds, including drugs, pollutants, and plant metabolites. More than 110 mammalian CYP-P450 genes are grouped into subfamilies by levels

of sequence identity. In all known cases, the genes within each subfamily are clustered, but the clusters are scattered throughout the human genome. Three of these subfamilies, CYP2A, CYP2B, and CYP2F, were previously known to be on chromosome 19q.

I have characterized the number and arrangement of the CYP genes in each of these subfamilies by screening a chromosome-19–enriched cosmid library. Cosmids were analyzed by means of a fingerprinting strategy and assembled into contigs. At present, all of the CYP genes on chromosome 19 are in two contigs on 19q13.2; these contigs span 137 and 210 kb, separated by a gap.

Cosmids positive for any of the CYP probes were further analyzed by restriction enzyme digestion and Southern blotting. The region contained nine full-sized genes, including five CYP2A, two CYP2B, and two CYP2F loci; in addition, at least one B locus and one F locus were incomplete pseudogenes. The genes are arranged in a complex fashion, with the A and F loci intermingled; the evolution of this unusual arrangement can be explained by a tandem duplication of the ancestral A and F loci as a unit. The orientations of most of the full-sized genes have also been established. Two of the A genes appear to be the product of a recent tandem duplication, since they are within contiguous blocks of ~20 kb that have nearly identical distributions of sites for several restriction enzymes.

We are currently screening additional libraries to find larger clones that can span the gap between the contigs. The sequence of the CYP gene region on 19q is being determined in a collaborative effort to identify regulatory elements of the extensive CYP2 gene family.

Chromosome Painting: A New Method for Detecting Environmentally Caused Chromosome Damage

Denise A. Lee *(Biology and Biotechnology Research Program)*

Chromosomes are packages of genes carried in the cells of the body and are subject to damage by radiation or chemicals. The amount of chromosome damage can be related to the amount of exposure, making chromosomes a very good biodosimeter. A biodosimeter is a biological means of quantifying adverse environmental exposure. Conventional cytogenetic methods of performing biodosimetry are time-consuming, costly, and relatively insensitive. The development of a new method called "chromosome painting" avoids these problems. Chromosome painting involves preferential staining in one color of some of the chromosomes in a cell while the rest of the chromosomes are stained in another color. Rearrangements between painted and unpainted chromosomes are revealed as bicolored chromosomes. Painting has proven to be extremely sensitive and capable of revealing chromosome abnormalities that would otherwise be missed by conventional methods. By painting, we are able to detect levels of occupational exposure to radiation and accidental radiation exposure such as occurred at Chernobyl. We are also working to understand long-term consequences of exposure to chemicals such as cigarette smoke and carcinogens known to exist in cooked food.

Computer-Assisted Detection of Microcalcifications in Digitized Mammograms

Laura N. Mascio *(Engineering Research Division/Biology and Biotechnology Research Program)*

Breast cancer is a problem of national importance because it affects one in every eight women in the United States, and kills more than 45,000 women every year. There is no known cure for the disease, but it is widely known that early detection of the cancer greatly increases a woman's chances of survival. One early warning sign of breast cancer is the presence of tiny mineral deposits called microcalcifications, currently detectable only by x-ray mammography. While microcalcifications can be a warning sign for cancer, they may also be harmless, formed in response to some minor irritation. It is very important, but difficult, for experienced mammographers to first find the tiny and subtle microcalcifications on an x-ray film and then to distinguish between malignant and benign microcalcifications. The current technique requires an experienced mammographer to visually scan back and forth along a back-lighted film with a magnifying glass. This manual technique is tedious and introduces several problems that make the diagnosis prone to error. In fact, it is estimated that 20 percent of negative diagnoses are incorrect.

We've developed a computerized method whereby mammograms can be automatically scanned and presented to the mammographer with suspicious areas highlighted. In this way, the mammographer can focus attention on all of the areas of the mammogram which have some suspicious characteristics without missing any regions. The resources at this Laboratory allow us to digitize film mammograms at the highest resolution available for maximum detection capability of the tiny microcalcifications. Once digitized, mammograms are processed computationally. Our detection scheme is based on morphological and arithmetic image processing methods that yield high-frequency information from the mammogram. This algorithm provides a sound platform for detecting all microcalcifications. In order to better distinguish between the malignant and benign microcalcifictions, we are developing an object classifier. This work is done in conjunction with two mammographers who are evaluating our results.

Physics

Chair: Luisa Hansen *(N-Division, Physical Sciences Department)*

A Basic Enhancement for Nuclear Reactor Safety: The Intrinsically Thermostated Reactor

Muriel Y. Ishikawa *[Special Studies ("0") Program, Physical Sciences Department]*

Nuclear chain reactors are devices in which neutron-induced fission reactions occur, typically on a large scale, with resultant evolution of energy from nuclear binding energy shifts. The neutron-carried chaining nature of the reaction implies that the neutron population can exponentially grow in time until fuel exhaustion supervenes. An approach is pesented that could absolutely preclude appropriately designed nuclear reactors from experiencing short time-scale thermal runaway, a condition in which the temperature of the fissile fuel of the reactor

increases rapidly until fuel containment failure occurs as a result of nuclear fission power generation exceeding heat removal for a significant interval. This type of failure was illustrated memorably by the thermal explosion of Reactor 3 at Chernobyl, the long-lasting effects on the environment and the human condition in the Chernobyl region of which are still being realized.

Eliminating the possibility of such prompt thermal runaway conditions requires preventing the reactor's fuel from ever "overheating." The neutron energy dependence below 1 eV of the absorption cross sections of selected chemical elements, such as samarium and europium, suggests a mechanism that may be implementable in a practical fashion to guarantee a reactor's freedom from prompt thermal runaway behavior in a manner based directly on fundamental physics. These elements have epithermal neutron absorption resonances that may be exploited to upper-bound the effective temperature of the neutron population "seen" by a reactor's fuel elements. Providing adequately close coupling between the peak temperature of the fuel elements and the temperature of the reactor's moderator closes the "thermostating control loop" that implements this concept.

A nuclear reactor embedding such design principles would intrinsically "self-regulate" its own internal *temperatures* against a designed-in upper bound while still being subject to *power* control by conventional means. As long as such a reactor is capable of passively self cooling against its afterheat thermal power generation, e.g., a reactor system that has a designed-in significant thermal radiative or conduction "leak," an absolute guarantee can be given that the reactor will never overheat.

Klyuchevskoy Volcano: Insights into Understanding Island Arc Volcanism

Annie Kersting *(Earth Science Department and Institute of Geophysics and Planetary Physics)*

More than 75 percent of the volcanoes that erupt above sea level occur parallel to deep oceanic trenches where cold oceanic material descends into the Earth's interior (areas called subduction zones). Understanding the interplay between the subduction of the oceanic material, melting, magma ascent, and eruption in island arc environments is essential to quantifying the mass transfer between the subducting slab, mantle, hydrosphere, and atmosphere of the Earth. As such, island arcs represent a key area of focus for investigations aimed at understanding global recycling, continental growth, crustal differentiation, and evolution of the Earth's interior.

Klyuchevskoy volcano, Kamchatka, Russia, is the world's most active island arc volcano. It is located 200 km inland from the intersection of the Kurile–Kamchatka trench and the Aleutian transform fault–trench system. A detailed petrographic and isotopic investigation of Klyuchevskoy volcano has been used to distinguish between different source materials involved in its generation. New high-resolution, radiogenic Pb isotopic values were measured on the same rocks that were previously analyzed for $^{87/86}Sr$ and $^{143/144}Nd$. The Pb values of the Klyuchevskoy basalts overlap with East Pacific Mid-Ocean Ridge Basalts values and are the least radiogenic island arc basalts to date.

These new data support the conclusion that the Klyuchevskoy basalts are slightly modified primary melts generated above the subducting slab, most likely through melting of the fluid-fluxed mantle wedge. Water released from the dehydration of the subducting material ascends

into the overlying asthenosphere, where it induces melting. This material eventually migrates to the surface, producing island arc volcanoes. The hypothesis of whole scale melting of the subducting slab plus or minus sediments is not supported by these data. The erupted Klyuchevskoy rocks present a valuable glimpse into the dynamics of a chemically evolving magma chamber within an island arc setting.

The Mass, Charge, and Energy Selectivity of a Traveling Electric Potential Wave

Lou Ann Schwager *(Plasma Physics Research Institute, Physics Department)*

A solitary electric potential wave has been used to accelerate ions with a selected mass from a beam extracted from a source of mixed masses. The selectivity theory[1] that fostered this experiment is presented and is shown to be confirmed by the experiment and by a time-dependent particle-in-cell computer simulation. Results show that monoenergetic ions with the particular mass of choice are accelerated by controlling the wave potential and the wave velocity. The wave velocity is typically 20 to 30 percent faster than the ions to be accelerated. The ability of the wave to pick up a particular mass uses the fact that small velocity differences in the lab frame appear much larger in the moving wave frame. Ions will gain energy from the approaching wave if their relative energy in the moving wave frame is less than the peak potential of the wave. The final energy of these accelerated ions is two to three times the source energy, which facilitates energy filtering for mass purification. Choosing the appropriate wave potential and energy filter voltage will isolate ions with the lightest, heaviest, or intermediate mass.

In studying the theory, one can see that, in addition to mass selectivity, the Solitron concept can also be applied to the filtration of an ion beam according to ionic charge or energy. Because of this variety of properties, the Solitron is envisioned to have broad applications. Present visions include a device for enhancing the separation of masses in the cyclotron production of radiopharmaceuticals, mass analysis of unknown gases, isolating charge states to produce negative ion beams for fusion, removing unwanted charge states for accelerator beam clean-up, and accelerating the high energy tail in a beam or plasma with a velocity distribution.

[1]R. F. Post, "A Method for Discriminative Particle Selection," Patent #5140158, issued August 18, 1992.

Hydrodynamic Mix Experiments on Nova

Deborah A. Wojtowicz, Paul Miller, Theodore Perry, Thomas Peyser, Alan Spero, and Peter Stry *(A-Division);* ***Donald L. Griswold*** *(B-Division);* ***and Bruce A. Hammel*** *(Y-Division)*

A series of Nova experiments are planned to investigate hydrodynamic mixing at strongly shocked density interfaces (i.e., Richtmyer–Meshkov mixing). These shocks are generated by laser drive from the Nova laser. The objective of this series is to determine the behavior of the mixed region width at a strongly shocked density interface as a function of the Atwood number (related to the density discontinuity), shock strength, and interface roughness. Shot planning, target fabrication, and diagnostic development will be discussed. Some results from the initial experiments of radiatively driven shocks in planar packages will be presented, with comparisons to computer simulations of these experiments.

Technical Session III

Software Applications

Chair: Jo E. Sander *(Advanced Technology Program, Physical Sciences Directorate)*

Software Safety and Reliability Issues in Safety-Related Systems

Lin Zucconi *(Software Technology Center)*

The increasing number of accidents attributed to computer-based systems is causing growing public awareness of the risk associated with the use of these systems in safety-related applications. Examples include the Therac-25 medical LINAC deaths, the growing number of Airbus A320 crashes, the AT&T Long-Lines disaster on Martin Luther King Day in 1990, the spate of regional telephone outages of the summer of 1991, and many more. How do safety and reliability sometimes conflict? What practical computer system and software development technologies and processes can be applied to increase the safety and reliability of computer systems? What are the technical and managerial issues contributing to the construction of less-than-safe computer-based systems? How can systems engineers and software engineers work together to address the issues related to safety and reliability of computer systems? This presentation addresses these topics and includes an assessment of the best state-of-the-practice and upcoming technologies that will carry us into the 21st century.

Climate Modeling from a Computations Perspective

Lisa C. Corsetti *(Scientific Software Division)*

The issue of global climate change due to increased concentrations of greenhouse gases has drawn much attention from government agencies, the media, and many private interest groups. Global climate models have shown promise as valuable tools for understanding and predicting the climate response. However, there is significant disagreement among various models in simulations of greenhouse-gas-induced climate change, thus highlighting the need for better understanding of the models themselves. A program of comparative model experimentation, diagnosis, and intercomparison is supported at LLNL by the Department of Energy: the Program for Climate Model Diagnosis and Intercomparison (PCMDI). The research staff consists of eleven scientists supported by a programming staff of nine. One of the climate models being studied is the European Centre for Medium Range Weather Forecasts' Atmospheric General Circulation Model. The maintenance and development of post-processing software for this model and the climate simulations performed at the National Energy Research Supercomputer Center will be discussed. In addition, some results from an Atmospheric Model Intercomparison Project that is being led by PCMDI will be presented.

Autonomous Tracking and Exposure Control During An Asteroid Flyby

Linda L. Ott *(Phenomenology Project, Advanced Technology Program, Physical Sciences Directorate)*

The Deep Space Program Science Experiment's Clementine spacecraft is planned to fly by Geographos, a ~2-km-diameter asteroid, at a distance of 100 ± 20 km and a closing velocity of 10.5 km/s. Under these conditions, the spacecraft's imaging cameras will resolve the asteroid only during the 100 seconds around closest approach. Errors in the ground-based range and expected flyby distance of the two objects make it difficult to pre-program the spacecraft's slewing maneuver with enough accuracy to keep the asteroid in the field of view of the imaging cameras. Therefore the spacecraft will carry computer software that uses real-time information from the imaging sensors to direct the slewing maneuver.

Details of the autonomous tracking system will be discussed. These include the image processing algorithm that extracts target centroids and brightness; the exposure control algorithm for setting proper sensor exposure; the Kalman tracking filter, which uses the centroids and attitude estimates to update a model of the range and velocity vectors; and details of the high-fidelity image simulator used for software development.

Flyer: The Integration of Multiple Monitoring Systems

Judy Thomas *(Safeguards and Security Engineering/Computation)*

The Flyer system is designed to receive device state information from multiple monitoring systems and pass this information to a map-driven graphical user interface called the console. Device information is generated by such systems as fire, continuous air flow, radiation level detection, and power monitors. All components of the Flyer system, such as the programmable logic controllers and the computers that host the Flyer processes, run in a redundant mode to ensure that down time will be at a minimum.

One or more workstations can run the console. For each device of a given system, an icon will appear on the map and reflect by color the state of that device. The console process will be connected to only one of the redundant Flyer hosts at a time. The processes on the Flyer hosts will be in communication with one or more programmable logic controllers (PLCs) on the network. The PLCs also are in a redundant configuration. The monitoring systems are wired to ten racks that the PLCs scan periodically.

The PLCs determine if a given device is in a noteworthy or alarm state. If so, the PLC puts the device information on an alarm queue to be read by the Flyer processes. The Flyer alarm process running on the host, in turn, sends this information to the console, and the icon on the map for that particular device will change state color.

Flyer also monitors hardware failure for ten racks and PLCs. This information is also sent to the console to inform the operator that there is a problem. Also, the console monitors the health of the host computer and Flyer processes. In this way, an operator is apprised not only of the state of the monitoring devices, but also of the health of the Flyer system itself. In this way, an operator can be assured that all device information displayed by the console is current.

The Flyer system allows a facility to integrate all of its critical

monitoring systems, thus allowing users to view the state of an entire facility on a single user interface. Because of the redundancy of the Flyer system on various levels, operators and coordinators of critical facilities have a high degree of assurance that all device states will be current.

Materials Science

Chair: Jean H. de Pruneda *(Chemistry and Materials Science)*

Computer Studies of Low-Density Materials

Elaine A. Chandler *(A-Division);* ***Daniel Calef*** *(Chemistry and Materials Science);* ***and Anthony J. C. Ladd*** *(Physics Directorate)*

Many low-density materials such as aerogels and foams are made and used at LLNL. This talk will outline the Laboratory's efforts to model these materials on the computer and to study their physical and transport properties. The long-term goal of this project is to build a range of simulation software that can be utilized in optimizing materials for specific applications.

The Fabrication of High-Voltage, GaAs-Based, Transient Recorders

Lan Thi Nguyen *(Engineering Research Division)*

Until recently, either commercially available or newly developed (by Y-Program) silicon-based, electrical-transient recorders have been used for laser diagnostic applications. The limitation of silicon devices (6-GHz bandwidth, 2-ns record length) and their high cost have prompted the research and development of GaAs-based transient recorders. Two particular devices that were selected for development are the diode sampling bridge and the high-voltage, nonlinear transmission line (NLTL). This presentation covers the fabrication of the NLTL.

The goal of this project was to fabricate an integrated device that would function at high voltage: up to 120-V reverse breakdown voltage. The designed active epitaxial layers were grown on GaAs substrates using our molecular beam epitaxy machine. Aside from the initial designs and calculations, the physical aspects of building the devices included the use of thick and thin films of photoresist, polyimide, and metals (Cr, Ti, AuGe, Au). Also, the chemistry of the solutions used in the processes were emphasized.

The presentation discussed the processes that were used in the fabrication of the NLTL, problems encountered, and solutions developed to correct the problems during the fabrication of the devices. [This project is led by Greg Cooper, electrical engineer, Electronics Engineering Research Division.]

Comments on Transformational Superplasticity: An Example from a Non-Metal, Ammonium Nitrate

Annemarie Meike *(Earth Sciences Department)*

A number of materials, primarily metals, are known to become anomalously weak while undergoing a solid-state phase transformation. Such "transformational superplasticity" may have a major impact on the fabrication and wear of synthesized materials. In the Earth, it may have a profound influence on the dynamic behavior of the mantle and crust.

However, the ability to predict the effects of transformational superplasticity requires an understanding of fundamental solid-state processes that is still incomplete. Two complementary compressive creep experiments have been used to investigate potential transformational superplastic effects in polycrystalline ammonium nitrate (NH_4NO_3): a microdeformation apparatus for *in situ* observation during deformation under an optical microscope and a bulk specimen creep apparatus for temperature gradient experiments.

The results indicate that more than one experimental effect has been interpreted in the past as transformational superplasticity. We have isolated three effects that produce "anomalous weakening" that can be associated with both displacive and reconstructive transformations: thermal weakening, volume change, and strain hardening. In addition, however, other effects unique to displacive or reconstructive transformations may operate. These multiple and possibly interdependent mechanisms suggest that transformational superplasticity operates according to a more complex constitutive flow law than has been recognized in the past.

Intergranular Fracture in Ordered Intermetallics

Patricia E. Johnson *(Chemistry and Materials Science)*

Intermetallics are compounds in which dissimilar metal atoms arrange themselves in a regular manner with respect to each other. The resulting crystal structure and its mechanical behavior are unlike those of either of the constituents in their pure form. At elevated temperatures, intermetallic compounds tend to have strengths beyond what can usually be achieved in conventional metallic alloys. Since the efficiency of many engineering systems is limited by the maximum temperature the material can tolerate, interest has surged in recent years toward development of intermetallics for use at high temperature. The main challenge for materials scientists lies in finding a means to promote ductility (suppress brittle fracture) without sacrificing high temperature strength. The ability of low levels of boron to improve the ductility of Ni_3Al by strengthening the grain boundaries has been known for over a decade. However, the specific modification to local bonding as a function of the atomic structure at the boundaries is not yet understood, and this lack of understanding has made it difficult to identify potential additions for use in other intermetallic compounds. Specialized mechanical testing, structure and composition characterization, and theoretical calculations are being used to study these issues in individual grain boundaries of Ni_3Al.

Atomic Vapor Laser Isotope Separation

Chair: Johanna M. Swan *(Atomic Vapor Laser Isotope Separation Program)*

High-Power Copper Laser Head Engineering Development

Monya A. Lane *(Uranium Atomic Vapor Laser Isotope Separation Program/Mechanical Engineering)*

Copper lasers drive the tunable dye lasers used in uranium atomic vapor isotope separation. But copper lasers built to the size needed for

production-scale processing suffered from a loss of effective gain due to the overheating of the center of the discharge and the resulting thermal population of the lower copper laser states. We have accomplished the engineering development of a high-power copper laser amplifier head with a unique concept for lowering peak gas temperature in the laser—a septum that extends axially through the center of the plasma tube to radiatively reduce the center gas temperature and thereby increase output power. This design provides a 25 percent output power improvement over preceding designs with little added cost and has been subjected to extensive testing in the LLNL Laser Demonstration Facility. This talk outlines the copper laser head thermal and mechanical design requirements, electrical and chemical compatability issues, and septum complications. In addition, operational solutions and results of around-the-clock reliability testing are discussed.

Vibrational Control in Distributed Optical Systems

Johanna M. Swan, Donald Bender, and Thomas Kuklo *(Atomic Vapor Laser Isotope Separation Program)*

The Atomic Vapor Laser Isotope Separation Program at LLNL employs large, distributed optical systems with stringent beam pointing and stability requirements. Vibration of the optical system is one of the largest contributors to beam motion and instabilities. These vibrations manifest from multiple sources and have been well characterized and correlated to system performance. Several methods have been employed to alleviate the impact of vibrations on the optical system. These include: tolerating large excursions in benign modes, tunable dampers, and high-bandwidth beam steering mirrors. The design approaches and relative success of the techniques employed at LLNL are discussed.

The Use of Laser Diodes for Control of Uranium Vaporization Rates

Karla Hagans *(Atomic Vapor Laser Isotope Separation Program)*

Within the Atomic Vapor Laser Isotope Separation (AVLIS) Program we have successfully used the laser absorption spectroscopy technique (LAS) to diagnose process physics performance and to control vapor rate. In the LAS technique, a narrow-linewidth laser is tuned to an absorption line of the species to be measured. The laser light that is propagated through the sample is measured, and from this data the density of the species can be calculated. These laser systems have consisted almost exclusively of argon-ion-pumped, ring dye lasers, which are expensive, cumbersome, and difficult to maintain. While the wavelength flexibility of dye lasers is very useful in a laboratory environment, these laser systems are not well suited for the industrial process-control system under development for an AVLIS plant. Diode lasers offer lower system costs, reduced manpower requirements, reduced space requirements, higher system availability, and improved operator safety. We report the successful deployment and test of a prototype laser-diode based, uranium vapor rate control system. Diode-laser generated LAS data was used to control the uranium vaporization rate in a hands-off mode for greater than 50 hours. With one minor adjustment the system successfully controlled the vaporization rate for greater than 120 hours. We report excellent agreement with ring dye laser diagnostics and uranium weigh-back measurements.

Computer Programs for Real-Time Monitoring of Laser Signals

Rita C. Seng *(Computation Directorate/Uranium Atomic Vapor Laser Isotope Separation Program)*

In the Uranium Atomic Vapor Laser Isotope Separation Program, the isotopic density of various elements in a vapor cloud are measured by laser absorption spectroscopy. In this method, low-powered laser light is tuned to a specific wavelength that corresponds to a transition between orbits (or energy levels) of the outer electrons of the isotopes being measured. These discrete orbits are nearly unique for each isotope; therefore, energy absorbed at a specific frequency uniquely identifies the presence of a particular isotope. The computer system that monitors these laser signals provides real-time data acquisition and analysis to determine the densities of multiple and various isotopes. The system is completely configurable with respect to the number of input channels; the laser and other related process inputs; and the isotopes being measured. The data acquisition subsystem controls scanning of the lasers about the tuned, resonant frequency and synchronizes the collection of 1,024 samples per channel over the quarter-second scan. The calculated densities are output to the vapor control system for closed-loop control of the vapor rate. Using client/server communications software, data is also transferred over ethernet to remote systems for plotting and/or additional analysis. Both raw signals and analysis results are archived. In post-run, a software switch allows selection of the raw data archive as the input source so that more CPU-intensive analysis, such as curve fitting, can be done.

Technology Transfer

Overview of the DOE Industrial Integration Program: DOE/EM's Perspective on CRADAs and Funding

Susan Prestwich *(Director, Office of Technology Integration and Environmental Education, DOE)*

Bridging the Gap: Technology Transfer at LLNL

Julia Giller *(Technology Transfer Initiatives Program)*

[No abstracts submitted for these presentations.]

Poster Session

Coordinator: Danette Steele

How to Handle 5 GBytes a Night and Not Get Swamped

Roberta A. Allsman *(Scientific Software Division, Computations Directorate)*

The Macho Project has undertaken a five-year effort to search for dark matter in the halo of our galaxy by scanning the Magellanic Clouds for micro-lensing events. Each evening's raw image data will be reduced in real-time into the observed stars' photometric measurements. The actual search for micro-lensing events will be a post-processing operation.

The theoretical prediction of the rate of such events necessitates the collection of a large number of repeated exposures. The project-designed camera subsystem delivers 72 Mb per exposure with exposures occurring up to every 300 seconds. An ideal evening's observing will provide 5 Gb of raw image data and 20 Mb of reduced photometry data. Recognizing the difficulty of digging out from a snowballing cascade of raw data, the project requires the real-time reduction of each evening's data. The software team's implementation strategy centered on this non-negotiable mandate.

Accepting the reality that two FTEs needed to implement the core real-time control and data-management system within six months, we explored off-the-shelf vendor components to provide quick solutions to the classic needs for file management, data management, and process control. Where vendor solutions were lacking, state-of-the-art models were used for hand tailored subsystems. In particular, petri nets manage process control, and object-oriented databases provide data management; both are implemented in C++.

The differences between the implementation strategy and the final implementation reality will be presented. The necessity of validating vendor product claims will be explored. Both the successful and hindsight decisions enabling the collection and processing of the nightly data barrage will be reviewed.

[The Macho Project is a collaboration between the Institute for Geophysics and Planetary Physics, LLNL (C. Alcock, T. Axelrod, D. Bennett, K. Cook, H.-S. Park); the Center for Particle Astrophysics, University of California (K. Griest, S. Perlmutter, C. Stubbs, W. Sutherland); and Mt. Stromlo and Siding Spring Observatories, Australian National University (K. Freeman, B. Peterson, P. Quinn, A. Rodgers).]

Wastewater: Where Does It Go From Here?

Shari Brigdon *(Environmental Monitoring and Analysis Division, Environmental Protection Department)*

Every employee at LLNL contributes to the production of the wastewater that is discharged to the local treatment works. Proper control

measures for wastewater discharge are essential for the health and welfare of personnel and the environment and to maintain compliance with regulations. This poster will discuss the regulatory drivers and options for proper wastewater disposal. Topics covered will include sampling and analysis of the wastestream as well as the various disposal options for wastewater from LLNL's 47 retention tank systems. Data will be presented to show the importace of keeping prohibited contaminants out of the sanitary wastestream.

Somatic Mutation: Sequence Analysis of the HPRT Gene in Mutant Human Lymphocytes

Karolyn Burkhart-Schultz, Cynthia B. Thomas, Cheryl L. Strout, and Irene M. Jones *(Biology and Biotechnology Research Program);* ***and Claudia Thompson*** *(National Institute of Environmental and Health Sciences, Research Triangle Park, North Carolina)*

Somatic mutations, changes in the DNA of cells other than sperm and ova, have been found in tumor cells and are believed to be at least part of the reason that cells become cancerous. Understanding the significance of somatic mutation in human populations that are potentially exposed to toxins requires knowledge of the events that occur in normal unexposed populations, as well as changes associated with exposure. To this end we are collecting data on the frequency and character of mutations at the hypoxanthine phosphoribosyltransferase (HPRT) gene of lymphocytes of persons with and without a smoking history.

Our population consists of about 200 healthy, male and female, smoking and non-smoking individuals. Smoking is one of the factors that has an influence on the mutant frequency (total number of mutant cells per million cells). HPRT mutant frequency increases with age and for some smokers even more so with years of smoking. Currently, single clones from 63 donors have been analyzed: 34 from smokers (average of one pack per day for ten years) and 29 from non-smokers.

To obtain data, T lymphocytes from a blood sample are grown in culture under conditions that select for the growth of mutant cells possessing a non-functional HPRT enzyme (the protein product of the HPRT gene). Each selected mutant cell forms many cells (a clone) that are used to analyze mRNA/cDNA and genomic DNA, by polymerase chain reaction and sequencing, to determine the molecular basis for the mutant phenotype.

A wide variety of mutations in the gene have been detected in this group of clones. Slightly less than half of the mutations are base substitutions, predominantly at GC base pairs. The remainder of the mutations are deletions or insertions, ranging from one base pair to complete loss of the locus. Deletions, small and multiexonic combined, are responsible for about half of the cases of misspliced mRNA. There are hints of smoking-associated shifts in mutation spectrum. Different mutations at the same site reveal features of the HPRT polypeptide that may limit or define mutation spectrum. Identical mutations indicate that there may be "hot spots." Mutations not previously reported have been detected, indicating that the mutation "spectrum" is only partly defined. Comparison of this and other mutation spectra will help determine the relative contributions of endogenous and exposure-dependent mechanisms of mutation.

Longitudinal Beam Dynamics in Heavy-Ion Fusion Driver Beams

Debra A. Callahan, A. Bruce Langdon, and Alex Friedman
(Heavy-Ion Fusion Project)

Focusing a heavy-ion beam onto an inertial confinement fusion target requires that the amount of longitudinal momentum spread in the beam be kept small. One cause of longitudinal momentum spread is errors in the external electric fields needed to confine the beam axially ("ear" fields). These errors can be amplified by a longitudinal instability that is based on the same principle as "resistive wall" amplifiers. In a heavy-ion fusion driver, the impedance that drives this instability comes from the induction acceleration modules. We are using the electrostatic, axisymmetric, WARPrz particle-in-cell code to study longitudinal dynamics of these beams. In WARPrz, we model the impedance of the closely spaced modules as a continuum of resistors and capacitors in parallel. We are using this code to study perturbations due to errors in the acceleration and ear fields and the growth of these perturbations due to the instability.

Ecological Risks: Beyond Hazardous Chemicals. The Vulnerability and Persistence of Rare and Endangered Species

Tina M. Carlsen *(Environmental Restoration Division)*

See abstract on page 17.

Digital Computer Controls for Air Conditioning and Energy Management

Bonnie L. Carpenter *(Air Conditioning Shop, Plant Engineering)*

Computers are being used here at the Laboratory to monitor and control air conditioning equipment. Through the use of alarms and graphic screens, an air conditioning mechanic has the ability to discover and solve problems sooner, frequently before the space occupants are aware there is a problem. By utilizing a laptop computer and modem, it is possible for a mechanic to correct the problem from his/her home if there is an equipment malfunction or failure after normal working hours.

Temperature, humidity, and static pressure sensors are installed in the air ducts to transmit the temperature of the air, the moisture content, and how much air is being supplied through the duct. Amperage sensors can transmit the amount of current being used by any device. By comparing the actual amperage draw to the normal running amperage, the mechanic can determine if the motor is running and under what conditions. Temperature sensors can be installed in motor windings to track motor temperatures, which is useful for predicting failures before they occur.

The same system can be used to reduce energy consumption by determining and utilizing the most efficient source of heating and cooling at a particular time. For example, in the morning when the outside air is still cool, outside air dampers can be opened to take advantage of the "free cooling" instead of using mechanical cooling. Heat can be reclaimed from equipment mechanical heat and used as heat for the space. Thermal storage and load shedding programs are currently being considered to reduce energy costs. By using the latest computer technology, we are able to operate our HVAC equipment more efficiently,

which results in lower energy costs, longer equipment life, and greater personnel comfort.

The Mechanical Designer's Role in Experimental Physics at LLNL

Frances Ann Foy *(Nuclear Test Engineering Division)*

See abstract on page 19.

Oscillator Design for the Atomic Vapor Laser

Carolyn Henderson *(Energy Systems Engineering Division, Mechanical Engineering Department)*

This oscillator is the initial power for the lasers in operation in the Atomic Vapor Laser Isotope Separation Program. The oscillator is the beginning of a chain of laser tubes that create the beam that enriches uranium by separating its isotopes. The laser beam begins here by neon gas and the vapor of copper. The optics in the oscillator generate a strong beam that converges into an amplifier to intensify the power.

A new oscillator is necessary to produce a higher output of power. Along with the engineers, the designers, drafters, and technicians were able to produce a new design that is more efficient. Teamwork is the difference between success and failure.

The mechanical designer's position in the design process is an important one. The designer takes the idea of the engineer and physicist and designs a product, using skills in fabrication processes, cost of materials, computer-assisted design systems, communication, mathematics, physics, and the knowledge of the specific function of the product, and communicates them into a technical drawing that is a graphic language. This communication begins with the engineer and doesn't end until the product is complete.

Radiocarbon Dating in the Coastal Marine Environment

Michaele Kashgarian *(Nuclear Chemistry Division/Center for Accelerator Mass Spectrometry)*

The general focus of my research at LLNL is to measure the radiocarbon activity of mollusk shells and foraminifera in order to observe and date climate changes that affect the marine environment. The measurement of radiocarbon in mollusk shells by accelerator mass spectrometry will fill in important gaps in global ocean climate records, particularly in high latitude and coastal oceans.

There is a characteristic radiocarbon age difference between contemporaneous atmospheric CO_2 and dissolved inorganic carbon in surface seawater. Since carbonate depositing organisms such as corals, mollusks, and foraminifera have been shown to record the carbon isotopic composition of the water in which they are growing, it is necessary to determine this age difference (reservoir age) in order to obtain accurate radiocarbon dates on carbonate material from marine sediment cores and coastal archaeological sites. Variations in the reservoir age at a certain locality over time are typically caused by fluctuations in local ocean circulation in response to global climate changes. I have used mollusk shells of known calendar age from museum collections to determine baseline reservoir ages for high latitude

coastal sites throughout the global ocean. I have also looked for changes in upwelling in coastal waters over time by comparing radiocarbon ages in the growth bands of bivalve mollusks with contemporaneous radiocarbon measurements from the growth bands of corals and trees.

I am also measuring radiocarbon of coexisting planktonic and benthic foraminifera in marine sediment cores from the eastern Pacific continental shelf and Indonesian seas. I am using the differences in radiocarbon and stable oxygen and carbon isotopes between surface and deep water species to look at changes in deep water formation and global ocean circulation.

Geophysical Monitoring of Active Thermal and Hydrologic Processes

Robin L. Newmark *(Earth Sciences Department)* ***and the Dynamic Underground Stripping Project Monitoring Team: Duane Chesnut, Steve Jarpe, Abelardo Ramirez, and John J. Zucca*** *(Earth Sciences Department, Geosciences and Environmental Research Program);* ***William Daily, Shin-Yee Lu, Earle Owen, Clifford Schenkel, and Michael Wilt*** *(Electronics Engineering Department);* ***Edith Chang, Craig Chung, and Ron Goldman*** *(University of California, Berkeley);* ***Ernie Majer and John Peterson*** *(Lawrence Berkeley Laboratory);* ***and Douglas LaBrecque*** *(University of Arizona)*

LLNL, in collaboration with the University of California, Berkeley, is conducting the Dynamic Underground Stripping Project (DUSP), an integrated project demonstrating the use of active thermal techniques to remove subsurface organic contamination. A number of environmental restoration problems are addressed by complementary techniques: (1) steam flooding, which strips organic contaminants from permeable zones; (2) electrical heating, which then drives contaminants from less permeable zones into the more permeable zones from which they can be extracted; and (3) geophysical monitoring, which tracks and images the progress of the thermal fronts, providing feedback and control of the active processes. The first DUSP phase involved combined steam injection and vapor extraction in a "clean" site in the Livermore Valley consisting of unconsolidated alluvial interbeds of clays, sands, and gravels. Steam passed rapidly through a high-permeability gravel, with *in situ* temperatures reaching 117°C. In November 1992 we began cleaning up the LLNL gasoline spill.

As part of the Clean Site Demonstration, we fielded an integrated program of geophysical techniques to monitor the *in situ* formation changes during steam flooding. The objectives of the clean site monitoring effort were: (1) to image and provide real-time feedback control and monitoring of the remediation processes; (2) to determine the nature and extent of the active processes and how they affect the formation; and (3) to evaluate the potential of these technologies for monitoring the active processes on different scales. Monitoring techniques include cross-borehole electrical resistance tomography, seismic and electromagnetic induction tomography, passive seismic monitoring, a variety of temperature measurement techniques, conventional geophysical well logging, and a signal-response tiltmeter survey. Many of these techniques are being utilized at the LLNL gasoline spill site. The wealth of information collected provides a unique understanding of the subsurface response to the active thermal processes.

Solving the Structural, Chemical, and Electronic Properties of Nanomaterials with Transmission Electron Microscopy

Margaret L. S. Olsen *(Chemistry and Materials Science Department)*

Transmission electron microscopy is a unique research tool in that regions of interest as small as 2 nm in diameter can be characterized for crystal nature, chemical content, and electronic state. For example, the structure of low-density, ceramic aerogels fabricated in the Chemistry and Materials Science Department was thought to be amorphous; however, upon examination by phase-contrast, high-resolution electron microscopy, the aerogels were found to consist of nanocrystals. As another example, the analytical capabilities of the transmission electron microscope were used to determine the phase distribution of uranium-containing precipitates and the second phases of incinerator fly ashes from the Rocky Flats Fluidized Bed environmental project. From the same areas used for the microchemical analysis, the crystal structure of the nanocrystalline precipitates was examined using the diffraction capabilities of the microscope so that relationships between the fly-ash matrix and the uranium-containing phase were obtained. One final example of the uses of transmission electron microscopy involves the determination of the electronic state of silicon in materials developed by O-Division and formed by explosive crystallization during laser irradiation. By collecting the characteristic inelastically scattered electrons from small areas of the silicon material, the fabrication of nanolayers of SiC, SiO, or SiO_2 by this process was verified.

Visualizing Scientific Images with Creativity

Marcia A. Pollock *(Graphics Division, Technical Information Department)* ***and Jacqueline McBride*** *(Communication Resources Office, Technical Information Department)*

Technical photography is a specialty that combines skills and formal education in both technology and art. In addition to the usual photographic methods, technical photographers employ such techniques as photomicroscopy, schlieren, holographic, infrared, ultraviolet, high-speed, and underwater photography. Technical photographers must often cope with scientific subjects that exist in challenging conditions such as severe heat or cold, that move very fast, that are microscopic in size, or that are extremely ephemeral. LLNL technical photographers are also called upon to capture the human side of science in photos of people in their work environment. This poster displays a sample of the on-site work of two LLNL technical photographers.

Development of a Method to Detect the Induction of Aneuploidy in Sperm of Men exposed to Occupational, Lifestyle, and Environmental Toxicants

Wendie A. Robbins *(Biology and Biotechnology Research Program)*

The purpose of this research is to develop, evaluate, and apply a new method for detecting aneuploidy in sperm of men exposed to occupational, lifestyle, or environmental toxicants. An abnormal number of chromosomes is referred to as aneuploidy, and it is responsible for such commonly known conditions as Down's, Klinefelter's, and Turner's syndromes. The paternal contribution to these and other chromosomally abnormal offspring may result from fertilization with an aneuploid

sperm. Because sperm chromatin are densely packed, past studies of aneuploidy in human sperm have been difficult and have had little power to detect induced toxicant effects.

To address this problem, we decondensed human sperm with a chromatin pretreatment procedure and then used fluorescence *in situ* hybridization with DNA probes to detect aneuploid sperm cells. We used up to three color strategies to recognize repetitive-sequence targets on human chromosomes 1, X, 8, and Y in order to identify sperm cells hyperhaploid for these chromosomes. We tested the validity of this method by using semen from healthy donors for whom sperm aneuploidy data had previously been obtained by the human-sperm/hamster-egg cytogenetic technique. There were no statistical differences between the two methods in numbers of hyperhaploid sperm detected. We were able to demonstrate the reliability of the hybridization methodology by analyzing repeated specimens donated over a two-year period. Donor differences were noted in baseline frequencies of sperm aneuploid for chromosomes 1 and Y but not for other chromosomes tested. We now plan to apply this methodology to men exposed to three levels of cigarette smoke (active, passive, and control as measured by saliva and semen cotinine) to determine whether exposure to mutagenic agents in cigarette smoke is capable of inducing aneuploidy in human sperm.

Graphical User Interface for AMOS and POISSON

Teresa L. Swatloski *(Computational Engineering Group, Applications Systems Division, Computations Directorate)*

A graphical user interface (GUI) exists for building model geometry for the time-domain field code, AMOS. This GUI has recently been modified to build models and display the results of the POISSON electrostatic solver maintained by the Los Alamos Accelerator Code Group. Included in the GUI is a two-dimensional graphic editor that allows interactive construction of the model geometry. Polygons can be created by entering points with the mouse, with text input, or by reading coordinates from a file. Circular arcs have recently been added. Once polygons are entered, points can be inserted, moved, or deleted. Materials can be assigned to polygons and are represented by different colors. The unit scale can be adjusted as well as the viewport. A rectangular mesh can be generated for AMOS or a triangular mesh for POISSON. Potentials from POISSON are represented with a contour plot, and the user is able to mouse click anywhere on the model to display the potential value at that location. This feature was developed for the X-windowing system, using the Motif look and feel.

Professional Development Workshops

Self Assessment: What Turns You On?

Michelene Ottery, *Human Resources Specialist*

What do you need to know about yourself so you can steer your career and professional development more effectively? What motivates you when you think and act on career decisions? These questions were enthusiastically explored by seventy Symposium attendees in a workshop led by Michelene Ottery, manager of the LLNL Human Resources' Career Action Program. Ottery holds a B.A. and M.A. in speech communication and a certificate in organizational communication.

Values, interests, and motivated skills are developed at an early age, said Ottery, but people sometimes follow career paths that take them in a different direction than they had originally intended. Self assessment is a way of reviewing one's basic values and interests to gain insights that can be used in ongoing career decisions.

The heart of the workshop was a self-assessment exercise in which attendees completed a questionnaire, then broke into small groups to discuss the results and how to apply them. Of the many widely used self-assessment tools available (e.g., the Myers–Briggs Type Indicator and the Strong Interest Inventory), Ottery chose to use a questionnaire developed by the Novations company in the exercise.

The Novations questionnaire is designed to reveal an individual's enduring motives, values, and expectations regarding work and career. The questionnaire identifies five career orientations, along with their positive and negative characteristics:

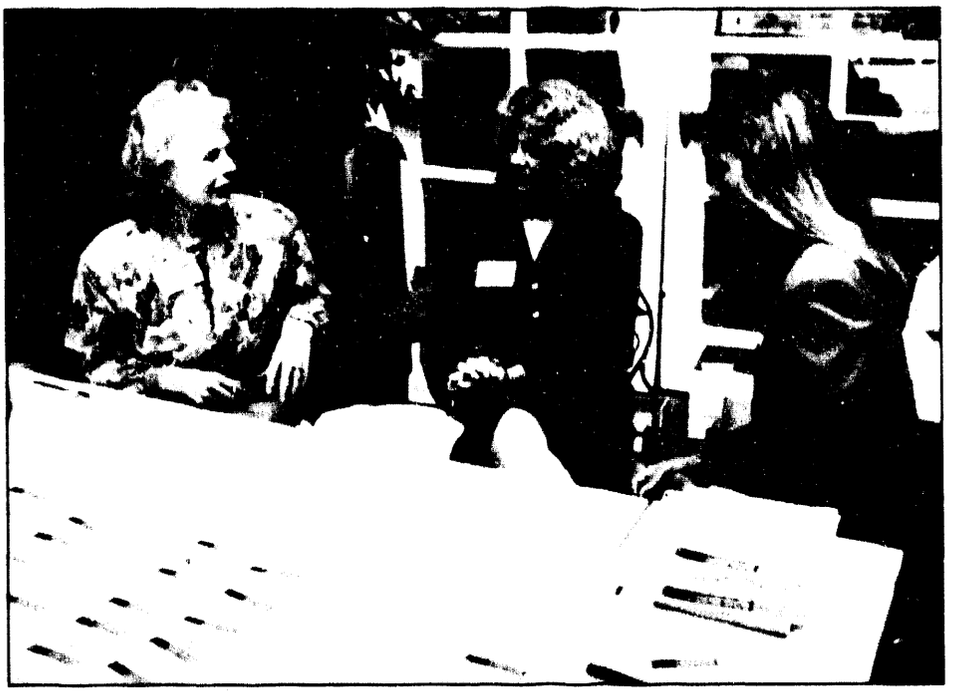
(1) Getting Ahead. For these people, up is the only way to go. They want visibility, and they pride themselves on getting the job done. However, they are sometimes perceived as being too pushy or insensitive to others.

(2) Getting Secure. These people are the backbone of an organization. They value recognition, job security, and respect. Their weakness is that they can become too comfortable with the *status quo*.

(3) Getting High. For these people, the work is its own reward. This group includes ideological, entrepreneurial, adventuresome, and technical types. They value challenge, excitement, and adventure on the job, but they can become impatient with routines and details.

(4) Getting Free. This group values autonomy and control over their own work. They want less structure—to be given a goal and then left alone. They can sometimes seem uncooperative and difficult to manage.

(5) Getting Balanced. These people are striving for meaningful balance between work, relationships, and self development. They want flexibility. They may appear to lack commitment to their careers or organizations.



Human Resources Specialist Michelene Ottery (center) at the symposium registration table with Betita Gamble and Erica von Holtz.

When the workshop groups had discussed the results of the self assessment, Ottery explained that career orientation can change over time and that no one is fully described by one orientation. Some people never develop an orientation. A flat career orientation profile usually means the individual could be satisfied in a number of work situations.

People in all five career orientations can be valuable contributors in an organization. In fact, a diverse mix of people with different profiles is likely to produce the greatest synergy.

Ottery encouraged the workshop participants to use the questionnaire results to help them recognize their strengths and blind spots, to make better career decisions, and to understand and value coworkers who have different career orientations.

The Magic of Mentoring

***Linda Donald,** Human Resources Consultant*

Mentoring can be magical if the relationship is one that benefits the mentor and the protégé, but it doesn't take magic to establish a mentoring relationship—it takes deliberate action. In a workshop led by Linda Donald, Symposium participants learned to distinguish mentoring from networking, sponsoring, and role modeling, and explored strategies for developing a satisfying mentoring relationship. Donald, who holds an M.S. in counseling with emphasis in organization development, recently assisted the Electronics Engineering Department to establish a pilot facilitated mentoring program for engineers. Many workshop participants voiced their interest in the Engineering pilot program.

Alluding to the theme of the Symposium, Donald said mentoring is a developmental tool that uses teamwork to meet tomorrow's challenges. She encouraged participants to take steps to establish a mentoring relationship.

Mentoring involves a formal or informal partnership between a person with greater experience (the mentor) and a less experienced employee (the protégé). The mentor counsels, guides, and helps the protégé to develop professionally and personally.

The mentor's role is to coach the protégé in areas that add experience and skill development, e.g., technical work, Laboratory culture and politics, management, interpersonal matters, and career development. The mentor gives feedback on the protégé's performance and behavior, provides support in times of personal crisis, and acts as a source of information on the philosophy, mission, and goals of the organization.

A good mentor must have strong interpersonal skills, leadership skills, knowledge of the organization, and technical competence. The mentor should also be someone respected in the organization. He or she must be willing to assume responsibility and accountability, to share credit, and have the patience to know when to let a protégé muddle through and when to give support.

A good protégé must be willing to assume responsibility for her or his own growth and development. The protégé should be ready to develop different or greater competencies, be willing to take risks, and be open to new ideas and work styles. Receptiveness to feedback and coaching is another characteristic of a good protégé, she said.

Donald presented a model describing the characteristics of several mentoring structures: open versus closed, reactive versus proactive, and mentor-initiated versus protégé-initiated. Participants were then given a worksheet and invited to sort through their own thoughts on being a mentor or protégé and to list personal action items. Mentoring takes deliberate action, she emphasized, and it is critical that both mentor and protégé clarify what they want from the relationship at the beginning. Donald mentioned a study on mentoring conducted at the Laboratory by the Women's Association. The study showed that many more women think of themselves as protégés than as mentors. Women have skills and experience to pass on and should seriously consider being mentors as well as protégés, she said.

Donald ended the workshop by briefly introducing some new mentoring trends for the '90s: Facilitated Mentoring, a structured process to select, match, train, and monitor protégés and mentors; Quad Mentoring, in which a high-level mentor is matched with three employees; and Circle Mentoring, a group of eight people that includes two high-level managers

The Balancing Act: Fulfilling Your Professional and Personal Life

Marianne Clark, Human Resources Consultant

Balancing your life is not about time management—it is about knowing your values and the quality of life you want. Workshop leader Marianne Clark helped participants examine their values in relation to the many different and sometimes competing parts of their lives. Participants then explored ways to make activities and life events congruent with their personal values. Clark has worked in the areas of stress management, career/life planning, interpersonal problem solving, and team building at the Laboratory. She holds an M.A. degree in counseling.

Values are the ballast that keeps our lives in balance, said Clark. If

parts of life—work, family, personal needs—seem to be in conflict, it is advisable to refer to our basic values as a guide to resolving the conflict.

Values are more than beliefs or attitudes, she said. They are the guidelines for making life's decisions. Distributing a list of common values, Clark asked participants to clarify their own values by selecting the ten they considered most important and then to put those ten in order of priority. The list included such diverse values as excellence, recognition, love, freedom, helping others, health, integrity, family, inner harmony, equal opportunity, and status.

Participants were next invited to consider three areas of their lives—personal, home/family, and professional—and to list what they considered essential in each. Personal time, for instance, might include education, physical activity, spiritual and intellectual development, and community involvement. They were also asked to list their personal values in relation to each area.

Clark next suggested that each participant develop an action plan for realizing the goals or activities congruent with her or his most cherished values. Clark then offered a long list of activities or behaviors that could fit in an action plan for regaining and maintaining balance in life:

- Keep consulting your fundamental values.
- Keep a positive attitude. Your body is affected by your mental state.
- Boost energy by alternating activities; pay attention to nutrition, sleep, and exercise.
- Make choices about your priorities and be prepared to relinquish some things.
- Keep your mind exercised by exploring new ideas, especially ones that challenge you mentally.
- Let go of things you can't change.
- Make time for yourself alone.
- Seek opportunities for laughter; it can have a therapeutic effect on the body.
- Reduce stress; practice visioning a state of relaxation or a condition you want to achieve.
- Focus on what you are doing and where you are in the present.
- Establish intimacy with at least one other person.
- Provide time for spiritual growth, whether through religion, meditation, appreciation of the beauty of nature, or other means.

After workshop participants had each developed an action plan, Clark closed by recommending several publications for those wanting more information on ways to keep life in balance, including: Ann McGee-Cooper's *You Don't Have to Go Home From Work Exhausted* (Bantam Books); Pam Conrad's *Balancing Home and Career: Skills for Successful Life Management* (Crisp Publications, Los Altos, CA); and Stephen Covey's *Seven Habits of Highly Effective People* (Simon and Schuster).

Ms-communicated and Ms-understood

Rosalyn Taylor O'Neale, Diversity Consultant

Communicating, listening, and understanding can have different meanings for women and men. Workshop leader Rosalyn Taylor O'Neale helped participants explore the difficulties and strategies in cross-gender communication. Founder and head of a diversity consult-

ing firm, O'Neale received her M.S.W. from the University of Louisville and is now pursuing her doctorate in human organization systems.

O'Neale began her presentation with a premise she credited to linguist Deborah Tannen: men and women belong to different cultures because they have been taught different habits and patterns of behavior. Consequently, their verbal exchanges constitute cross-cultural communication with all its attendant difficulties and misinterpretations. It is important, she said, for both men and women to understand the origins of their respective social habits to achieve real communication.

As examples of how men and women are socialized differently, O'Neale cited children's play. Girls play games that are inclusive and build social relationships. They tell stories and gossip. Boys play competitive games with the objective of defeating the opponent, they indulge in boasting and bragging, and they are concerned with who is the best player. Girls bond with only one or two close friends, and maintaining the friendship is more important than what they do. They learn conflict-management skills, how to empathize, to care, and to negotiate. Boys form teams built on accomplishing some objective (winning a game) rather than on personal relationships. They learn rules, hierarchy, organization, cooperation, delegation, and how to accomplish an objective.

The differences in how the sexes are socialized, O'Neale said, lead to different adult behavior. In a work situation, women are conditioned to hold back, to wait their turn, to put high value on relationships, to be fair, and to "play nice." Men are conditioned to assert themselves, to assume power and always have an answer, to be leaders, to speak up, and to win.

"We are taught to be fair, and men are taught to win," O'Neale asserted. "The 'nice' behavior can't compete against the 'win-oriented' behavior. Perhaps we need to give up being so nice! Focus on winning!"

A short brainstorming session produced suggestions on how to win from the audience: Learn to banter and don't take insults personally. Be assertive, be a good team player. Learn to value your suggestions. Be forceful rather than aggressive. Forget personalities and concentrate on work objectives. Don't be afraid to make mistakes. Don't always ask permission. Remember that competition is real and accept it.

The male focus on the "best player" often surfaces when hiring or promotion decisions are being made, said O'Neale. Male managers often take a narrow view of what qualities make a candidate the best player, whereas they should take broader social values into consideration in deciding who is best qualified to do a job.

Communication involves a sender and a receiver, O'Neale said, and the sender sends two kinds of messages: the literal verbal message and a "meta-message" consisting of all the behaviors surrounding the literal message (e.g., voice intonation and body language). Meta-messages are especially subject to cultural interpretation. Men tend to focus on the literal message, but women pay more attention to the meta-message. Women must learn to reach men in verbal exchanges by giving more straight messages, and men should be aware that there is more to communication than the bare words, she said.

In closing, O'Neale pointed out that both sexes have social qualities that are valuable to an organization, and that these qualities should be retained. "We don't want to lose the team work men understand or the sense of sharing and collaboration women understand. What we need to do is to teach one another how to communicate more effectively."

Diversity consultant Rosalyn Taylor O'Neale.

Conflict Management: Skills for Work and Beyond

Donna Dare Carvalho,
Principal Human Resources Specialist

What are the nature and sources of conflict? What are some of the human dynamics that can lead to conflict? And how can we address and work through those conflicts with others? In this workshop Donna Dare Carvalho led participants in exploring these questions and learning specific techniques for resolving a conflict with another individual. Carvalho holds a B.A. in communication and public policy and is pursuing an M.S. in organizational behavior and counseling.

Most people are uncomfortable with conflict and confrontation, but conflict is a normal, natural, and inevitable consequence of human interaction, Carvalho told the audience. It is unrealistic to think

conflict can be eliminated (or even that it should be eliminated), but it *can* be handled constructively.

Individuals feel needs to survive, to be satisfied or happy, or to reach some other valued goal, and their behavior is directed to fulfill those needs, said Carvalho. When a person's goal-directed behavior interferes with another person's needs or behavior, there is bound to be conflict, even though each individual intended some positive outcome. People rarely engage in conflict just to be destructive, she said, and they tend to view any damage as accidental.

All conflict arises out of interdependence. A person living alone on a desert island would never experience conflict, said Carvalho, but when people need something from other people, there is the potential for confrontation. The greater the interdependence, the greater the likelihood that disagreements will occur. In a complex, multi-layered organization like the Laboratory, there are many levels on which conflict may develop, e.g., interpersonal relations, management processes, communication and information flow, roles and responsibilities, and decision-making processes.

People have a need to explain behavior, even—or especially—in the absence of information. When in conflict, people tend to attribute motives to the other person that may have no basis in fact, and attribution can get in the way of conflict resolution. When you find yourself in this situation, Carvalho advised, try to think of a different reason for the other person's behavior. Also, she said, consider the context of the conflict: it may be due to the organization or the process you are both involved in rather than the other person.

There are several ways people deal with conflict, Carvalho said. In *compromising*, both parties give up something, and neither is satisfied. In *forcing*, one party attempts to steamroller the other. In *accommodating*, one party just gives in or goes away. Better than any of these is *collaborating*, the win–win mode of handling conflict.

She advised following these steps to handle conflict positively:

- Acknowledge the other person's position as legitimate.
- Differentiate the other person's position from your own.
- Check to see if you are hearing each other clearly (listen, clarify, paraphrase).
- Accept the feelings aroused (anger, hostility, hurt, etc.).
- Don't try to solve the problem until the differences have been fully discussed.
- Ask the other person to state his/her preferred solution(s); be prepared to state yours; brainstorm together.
- Practice problem solving rather than criticism or attack.

Carvalho concluded by reminding the audience that an unresolved conflict will last longer and be more painful than one that is addressed promptly and directly.

The "Old Girls" Network

Becky Failor, *Chemist*
Lori Jensen, *Systems Analyst*
Cynthia Palmer, *Chemist*
Eileen Vergino, *Seismologist*

How do some people manage to be at the right place at the right time for career opportunities? Have you gotten a promotion and then

felt you have not received support from the very people who helped you reach success? How do you recognize the real opportunities? If you are asking questions like these, you might do well to join a network, four LLNL technical women told Symposium participants. The four women (plus a fifth, Trish Baisden, who could not be present) have formed a network for mutual assistance in professional and career enhancement.

Wearing identical purple tee shirts with "Pushy Broad" emblazoned across the front, the women discussed several variants of networks and explained how their own had come about. The Pushy Broads coalesced into a formal network after all five attended the first DOE conference on women's programs, held at Argonne Laboratory in 1990. They were also brought together by a common interest and activism in science education, particularly for young women; all have worked with Expanding Your Horizons conferences.

The Pushy Broads believe that the "old boys" network is alive and well, that women are still not fully included in the information exchanges so important to career advancement, and that technical excellence is necessary but not sufficient to get ahead in a technical career. Their network helps to level the playing field, they said.

The Pushy Broads network is founded on mutual respect, honesty, trust, directness, and the belief that five heads are better than one. Although all technical, the Pushy Broads come from several disciplines and work in different Laboratory programs.

Their network serves as an information exchange, a place to test ideas, to warn one another about "mine fields," and to alert one another about opportunities. As a group, Pushy Broads has no regular meetings or rules; interactions are impromptu, informal, and humorous. Only when they feel the need to "plot strategy" do the members become more focused and formal.

Pushy Broads represents only one of several types of networks, the women said. There is now a large body of literature and research on networks and networking, and it has become an effective tool for women seeking career and professional growth.

The speakers mentioned several larger networks for women, including SYSTERS, an electronic bulletin board for computer scientists, and the exclusive "Chicago 100," which accepts members by invitation only. The speakers also distributed a long list of networks for women scientists and engineers that included such organizations as the Math/Science Network, Nuclear Energy Women, the Association for Women in Computing, and the Society of Women Engineers.

For those wanting to learn more about networks, the list also recommended Mary Scott Welch's *Networking: The Great New Way for Women to Get Ahead* (Harcourt, Brace, Jovanovich); Carol Kleiman's *Women's Networks: The Complete Guide to Getting a Better Job, Advancing Your Career, and Feeling Great as a Woman Through Networking* (Lippincott and Crowell); and Barbara Stern's *Networking: The Corporate Woman's Guide to Survival* (Prentice Hall).

As an example of how networking can help boost a woman to the top, the speakers distributed an article detailing the nearly endless string of contacts accrued by Secretary of Energy Hazel O'Leary (*The Washington Times*, February 4, 1993). It was through her far-flung network, says the article, that O'Leary came to the attention of President Clinton.

The Pushy Broads advised women wanting to form a network to clarify their expectations. Professional competence is a prerequisite, they said, and a network will not eliminate the requirement to compete professionally. They also believe other networks similar to theirs are flourishing at the Laboratory.

Keys to Success

Peggy Poggio, *Moderator*
Judy Chazel, *Plant Facilities Maintenance Coordinator*
Susi Jackson, *Engineer*
Janet Johnson, *Electronic Technologist*
Marcey Kelley, *Computer Scientist*
Karena McKinley, *Mechanical Engineer*
Ann Orel Woodin, *Chemist*

What are the keys to success? A panel of six LLNL technical women reflected on their own careers and identified factors that helped them achieve success. The panel also explored ways individuals can surmount obstacles and make the most of opportunities when they appear. Electronics engineer Peggy Poggio organized the panel and served as moderator at the Symposium.

The discussion made it clear that success has a different meaning for each individual. Panel members' definitions of success included: "being who I am," "feeling good about where I am," "living a balanced and rewarding life," "a successful family life," "a combination of math and science along with people skills," and "having opportunities to grow."

The women listed a variety of personal qualities and attitudes that led to their achievements. Judy Chazel said her keys to success are humor and tolerance for the views of others. "Attitude is everything," said Chazel. Tenacity is also important to her. As a maintenance mechanic apprentice, she learned to "stay with it 'til it runs."

Susi Jackson credited her success to learning early to work hard, to careful listening, and to caring about her work and her associates. Having high standards for herself and being committed are important to her, she noted. Jackson counts as success her contributions to helping others succeed as well.

The concept of success continues to change for engineer Karena McKinley. She recalled moving from a "school model" of academic

LLNL technical women describe their keys to success.

success to learning the importance of interacting with people and of being aggressive in presenting her ideas. "Leadership is an acquired skill," she said. For McKinley, success also includes making a contribution and being appreciated for it, having the opportunity to grow, and leading a balanced life.

Computer scientist Marcey Kelley (who worked part time for five years then spent two years on a Lab scholarship to earn a college degree while a single mother) attributed her professional success to being committed to goals and to overcoming obstacles through personal determination. She could not have done this, she said, without long-range planning and careful setting of priorities. She related how she prepared for several years to "get in line" for the scholarship. Her advice to others: "There will always be people who tell you what you can't do—don't listen to them!"

After earning a Ph.D. in chemistry, Ann Orel Woodin began a long search for the right niche and found it in a split assignment between the U.C. Davis Department of Applied Science and the Lab's V Division. Her definition of success includes her two young daughters and her husband. Among her strategies for success are searching until the right career situation presents itself and having a husband who is part of the family support structure.

For former U.S. Marine Janet Johnson, a key to success is to visualize where you would like to be in the future and be prepared. "When you're prepared, opportunity will come," she said. Johnson also numbered among her keys to success being a role model and mentor, having convictions about her purpose, having a support system, and maintaining balance.

Varied as their careers and backgrounds are, the technical women on the panel repeatedly mentioned the importance of determination, commitment, balance, and their families as keys to their personal and professional success.

Writing Effective Technical Proposals

Ann Freudendahl, *Deputy Program Leader for Technology Transfer*
Jean H. de Pruneda, *Materials Technical Area Coordinating Team*
Kathy Kaufman, *Communications Specialist for Technology Transfer*
Ruby M. Tebelak, *Contract Editor for TID Editorial Division*

As technology transfer becomes more central to the Lab's mission, effective proposals will be a critical link between scientists and private industry. Presenters in this session offered practical information on how to move technology from the Laboratory into the American economic mainstream.

Ann Freudendahl gave an overview of the technology transfer process. She pointed out that the process is still evolving and that it remains a challenge to achieve smooth interfaces between government, the national laboratories, and industry. Freudendahl summarized the history of technology transfer enabling legislation and briefly discussed

the DOE administrative structure that oversees technology transfer. Technology Transfer Program Leaders from each of the DOE Defense Program laboratories sit on a Laboratory Coordinating Board (LCB). Their responsibilities include recommending proposals for funding by various mechanisms, such as Cooperative Research and Development Agreements.

Before proposals are ranked and presented to the LCB, however, they should receive an internal LLNL review and a formal peer review by a Technical Area Coordinating Team (TACT) composed of scientists from the four defense labs. Jean H. de Pruneda, one of LLNL's Chemistry and Materials Science Department TACT representatives, explained the process further and gave practical advice from the perspective of a proposal reviewer. She stressed the importance of adhering to DOE guidelines and format when submitting a proposal. Of the 130 points the reviewers must consider, only 40 relate to technical merit, she said. The letter of intent from the industrial partner and a realistic approach to the amount of funding are especially important. She also strongly advised proposal writers to stay current with what other Lab researchers are doing in their technical area, to get assistance from the Technology Transfer Office, and to work with a technical editor.

Kathy Kaufman and Ruby Tebelak, both technical communication professionals, discussed the connection between the way a proposal is written and its success in winning funding. Tebelak, formerly proposal group manager at Northrop, emphasized that in a technical proposal every word counts because reviewers have only the words by which to judge the technology.

A proposal is first and foremost a sales document, and as such it must convince the reviewers/buyers that the technology will have some benefit for them. Customers don't buy products, she said, they buy what the product can do for them.

Tebelak stressed that this approach is sometimes difficult for technical people because they are accustomed to thinking in terms of technical reports, not selling a product. A technical report emphasizes features and provides data to verify performance, whereas a proposal must show how the features will benefit the customer and use data to convince the evaluator of the worth of the benefits. Tebelak gave numerous practical tips for writing effective proposals, including these:

- Use a top-down strategy—put your conclusions first.
- Include both features and benefits—tell what the product is and tell why the evaluators need it.
- Remember you face two hurdles—you must convince the technical evaluators *and* the business decision makers.
- Write the executive summary with great care—it is your opportunity to convince the decision makers.
- Your proposal should have an underlying theme that your customers will remember after they have forgotten the details.

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Index of Presenters and Session Chairs

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