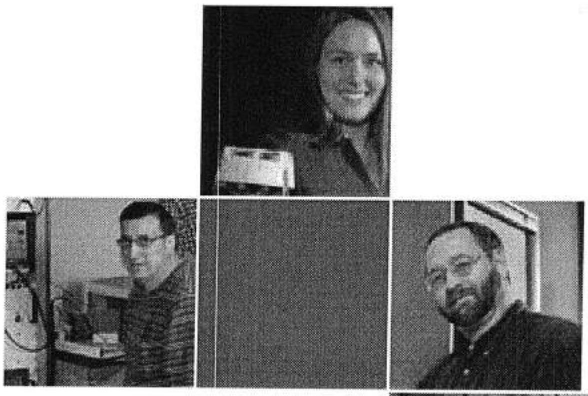
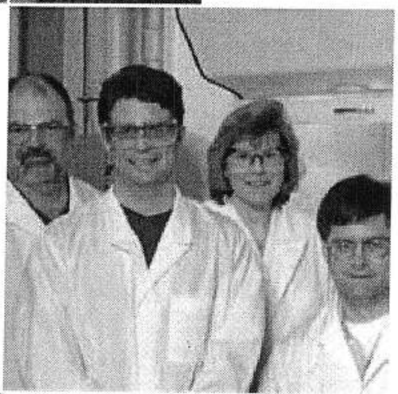
Kansas City Plant | Kirtland Operations



2005 Technical Achievements



The Kansas City Plant / Kirtland Operations is operated and managed by Honeywell Federal Manufacturing & Technologies, LLC, for the NNSA.

NNSA National Nuclear Security Administration

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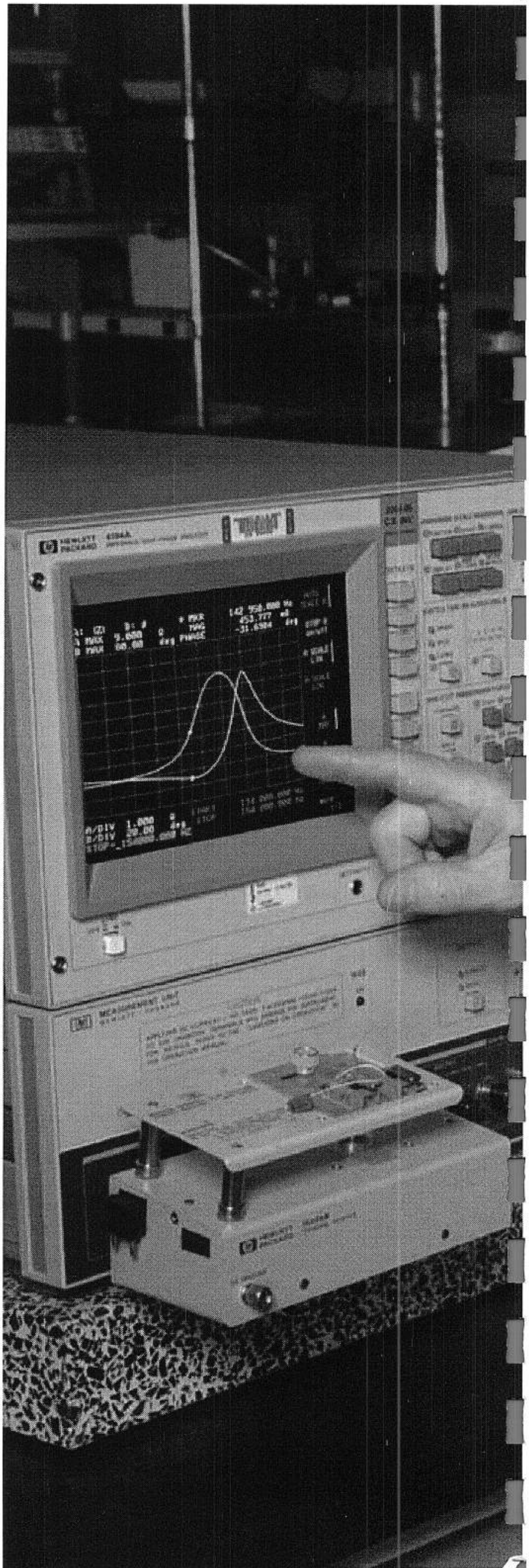


There is a need for a source of electrical energy to run the electrical systems in both conventional and nuclear weapon systems. The ability to generate this energy from the acceleration of firing or deceleration of impact is highly sought after as an alternative to batteries. Through simulation, the Kansas City Plant has invented and validated a novel design of a setback generator to solve this problem.

Although the forces generated from the launch or impact of a weapon can be very large, the forces are generated over a very small time period, and capturing the energy becomes difficult. Setback generators based on compressing a piezoelectric element under the weight of an accelerating mass have not been sucessful because of the large size and weight of the piezoelectric element and mass required to capture the energy in a short amount of time. Another approach has been to develop an oscillating system that generates energy over a longer period of time, but the mechanical energy losses in the system prohibit the ability to recover enough energy from the system. The Kansas City Plant developed a setback generator utilizing a piezoelectric element with a new proprietary mechanical design that generates the needed electrical energy within a small, lightweight and simple package. Finite element simulations were used to guide and validate the design.

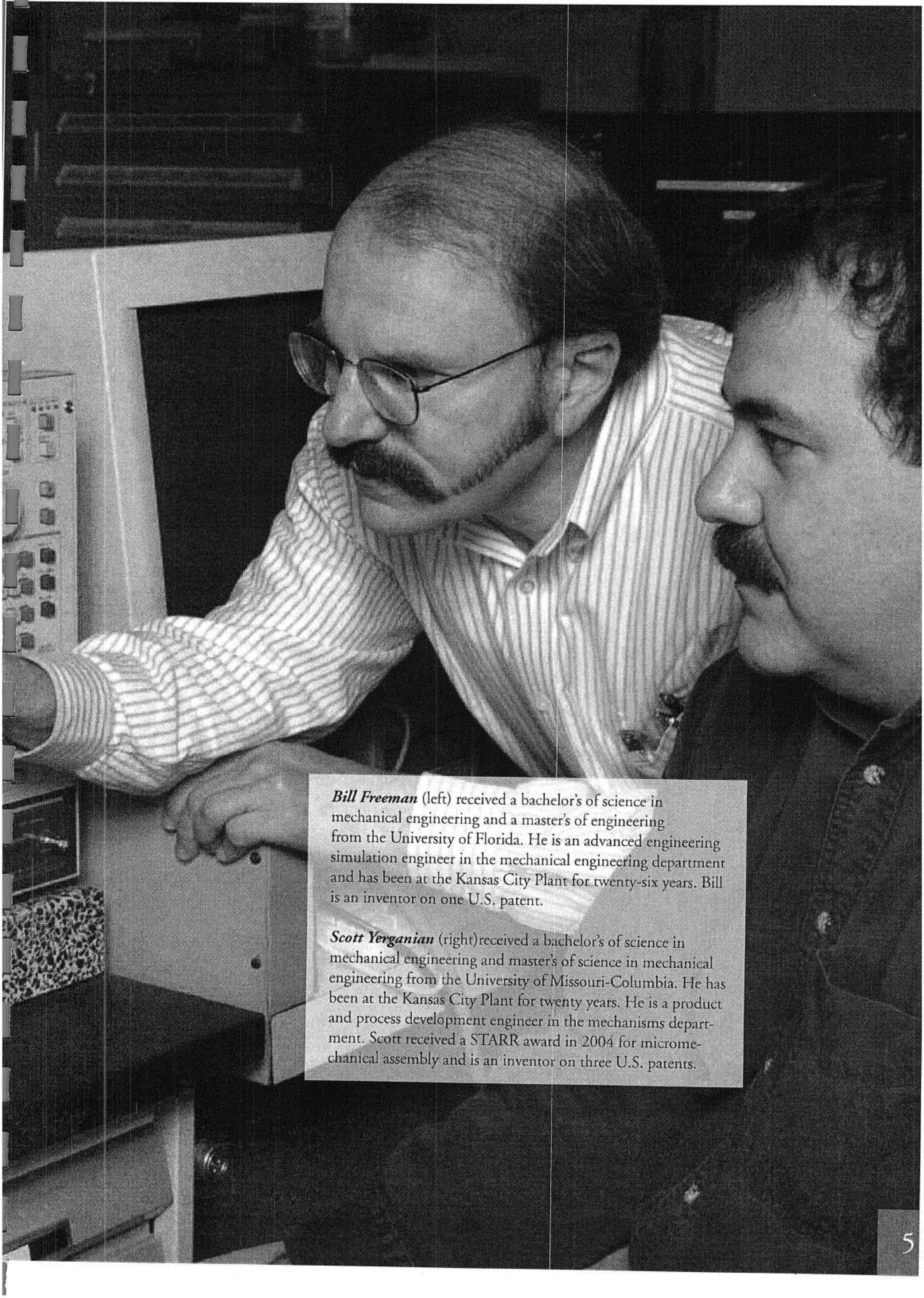
Benefits

This accomplishment may provide a method for producing electrical energy for a wide range of applications within the NNSA's national security mission. It solves the problems with the size and weight or high mechanical energy loss previously encountered with setback generator designs that rendered them infeasible. The simplicity of the design will enable the setback generators to be produced at a reasonable cost.

Other Uses

This technology may be applied to any application where short-term electrical power is required after an event with a large acceleration or deceleration. Examples include:

- Weapon systems (on launch or upon impact)
- Crash safety systems (airbag systems or seatbelt pre-tensioning devices)



Bill Freeman (left) received a bachelor's of science in mechanical engineering and a master's of engineering from the University of Florida. He is an advanced engineering simulation engineer in the mechanical engineering department and has been at the Kansas City Plant for twenty-six years. Bill is an inventor on one U.S. patent.

Scott Yerganian (right)received a bachelor's of science in mechanical engineering and master's of science in mechanical engineering from the University of Missouri-Columbia. He has been at the Kansas City Plant for twenty years. He is a product and process development engineer in the mechanisms department. Scott received a STARR award in 2004 for micromechanical assembly and is an inventor on three U.S. patents.

Materials
Engineering

Removable Epoxy Foam

When removable encapsulation and adhesive materials were needed for the W76 Life Extension Program (LEP), Sandia National Laboratories turned to the Kansas City Plant for help. Sandia had invented a suitable material, known as bismaleimide (BMI), but needed the Kansas City Plant to establish production processes for manufacturing this high-purity chemical on a much larger scale. The existing process definition was limited and on-time material delivery was considered fundamental to the success of the arming, fusing and firing system. A team of associates from the Kansas City Plant embarked upon the scale-up process challenge. The team used Six Sigma tools to fully define the process and product. In addition, they listened to the voice of the customer and optimized the process and logistics by applying define-measure-analyze-improve-control (DMAIC), Design For Six Sigma failure mode and effects analysis, measurement system evaluation, and design of experiments. As a result, the team successfully produced a robust, innovative and controlled process to deliver high-purity production quantities of the specialty bismaleimide chemical. Overall production costs were reduced by ninety-one percent and the project realized cost savings of more than $2.3 million over the life of the program.

Benefits

- Due to our innovative process improvements, the product's purity is higher than it was originally and manufacturing processes are more robust.
- Our processes are safer and cleaner for the environment. By minimizing solvent usage and implementing improved engineering controls, not only is worker exposure minimized, but it is better for the environment as well.
- The primary analytical method we used to determine the purity of our product, gel permeation chromatography (GPC) is less expensive to operate than Nuclear Magnetic Resonance (NMR). In addition, GPC is faster and it even identified impurities not observed by NMR.
- We are currently producing both four hydroxyphenylmaleimide (4HPM) and BMI. Our processes reduced overall production costs by ninety-one percent, realizing a cost savings of $2.3 million over the life of the program.
- During this project, we encountered two unexpected problems. The first problem was gel formation in the final BMI product solution. This issue was resolved by rapidly taking the product to dryness all in one step, rather than in separate steps. The second problem involved product degradation, which was solved through the use of better mixing and more thorough neutralization.
- The goal of the material we are supporting is to lower risk. The product we are making is used to manufacture removable epoxy coatings and foams. The fact that these materials can be removed reduces the risk that a failed electrical component will need to be thrown away, rather than repaired. Also, removing the coating or foam increases our ability to determine what caused the failure in the first place.
- This project was very technically challenging. Everyone in our polymer production facility is now recognized as an expert in chemical synthesis and scale-up. The engineering team that worked with the polymer production facility is also well-known for their scale-up experience.
- Sandia originally attempted to have a commercial fine chemical supplier produce the 4HPM, but that company failed to produce the desired material in the needed purity. So, not only can we deliver results faster, but we can deliver them when others have failed.
- As mentioned, a number of the problems encountered upon scale-up had never been observed before at the design agency. Our documentation of these issues and solutions are helpful to the entire complex.
- The polymer production facility is unique within the nuclear weapons complex and is one of the few places where fine chemicals and polymeric materials can be synthesized on scale.
- The polymer production facility aims to be flexible and adaptable and to provide whatever the customer needs.
- At the Kansas City Plant, we can take your bench top process and scale the process up from 15 L to 500 gal. with a well documented, highly reproducible and safe process.
- Our work on this project and our team's good showing in the Honeywell Quest for Excellence competition lead to corporate Honeywell's interest in traveling to Kansas City for a technology exchange. With our current Sandia customer and the materials community within the nuclear weapons complex, this project has lead to increased appreciation for materials production at the Kansas City Plant.

Inter-Complex Technology

The removable epoxy concept was developed by Sandia National Laboratories, but the process for scaling it up was developed wholly at the Kansas City Plant. These two equal halves go hand in hand to supply this technology to anyone in the nuclear weapons complex who might want to use it. This material is used extensively throughout the W76 LEP and to a lesser degree on the W80 LEP. As the benefits of this technology grow and our collective experience of how to use it grows, it is virtually certain the need to produce it will also grow.

Conference Papers / Presentations

Title: Scale-up Issues with Removable Epoxy Foam - Final Drying and Gel Formation
Authored / Presented By: Daniel Bowen III (author/presenter), Elizabeth Nail (co-author), Patricia Wilson (co-author), Robert Sedlacek (co-author), Ron Osborn (co-author)
Conference: 35th Annual PolyMAC Meeting at Y-12
Date: June 15, 2005

Summary: Removable epoxy resins are required as new encapsulation and coating materials for the W-76 arming, fuzing and firing system. In order to produce these materials, chemical synthesis of maleimideconstituents is required. The challenging task of managing the technology transfer and scale-up process is an important role of the Kansas City Plant's polymer production and material science department. A two-component kit is necessary for each foam (REF308, REF320, RSF200) and the conformal coating / adhesive (RCC200). Each Part A is a mixture of removable resins that are produced batchwise with tight controls and oversight in four steps. Each Part B contains commercial curing agents, which are mixed and repackaged by the Kansas City Plant. Production processes for all steps of the resin production have been completed at the Kansas City Plant including the challenging synthesis of two removable epoxy resin precursors, four hydroxyphenylmaleimide (4HPM) and RER bismaleimide. Significant hurdles where overcome to make progress in the optimization and scale-up of the resin materials.

A copy of the full conference paper / presentation is available upon request. *For more information, please see pages* 45 – 48.

Title: Removable Epoxy Production Scale-Up at KCP
Authored / Presented By: Elizabeth Nail (author), Patricia Wilson (co-author), Daniel Bowen III (co-author)
Conference: 34th Annual PolyMAC Meeting at Sandia National Laboratories, Albuquerque
Date: June 7, 2004

Summary: Significant progress has been made toward the Kansas City Plant's goal of scaling-up and producing the two critical chemical precursors enabling removable epoxy technology. This presentation describes our significant process improvements in the work-up and isolation of four hydroxyphenylmaleimide (4HPM). Specifically, we describe advances made to the crystallization and recrystallization process for isolating the 4HPM. We further describe progress made toward full scale production of the bismaleimide (BMI) component.

A copy of the full conference paper / presentation is available upon request. *For more information, please see pages* 45 – 48.

Title: Removable Epoxy Production Scale-Up at KCP
Authored / Presented By: Elizabeth Nail (author), Patricia (Tricia) Wilson (co-author), Daniel (Dan) Bowen III (co-author)
Conference: Foams Conference at Sandia National Laboratories in Livermore, California
Date: January 25, 2005

Summary: Both bismaleimide (BMI) and four hydroxyphenylmaleimide (4HPM) are critical noncommercial precursors enabling removable epoxy technology, including removable epoxy foam technology, which is required for the W-76 arming, fuzing and firing system. Materials engineering at the NNSA's Kansas City Plant has engaged in a significant effort to scale-up and produce both of these materials. Significant improvements in the process for synthesizing BMI are described. The elimination of residual moisture from all reactants and our move towards a closed reactor system are described.

A copy of the full conference paper / presentation is available upon request. *For more information, please see pages* 45 – 48.

STARR Awards

Dan Bowen, senior scientist in materials engineering and polymer production, developed and implemented significant process changes to overcome show-stopping obstacles encountered during scale-up to production of removable epoxy foam. Originally developed at Sandia, this material is critical for W76-1 arming, fuzing and firing production. The transfer and scale-up of this material was far more complicated than originally envisioned by Sandia National Laboratories and the Kansas City Plant. Dan's work allowed the chemistry to be better understood so that war reserve quality requirements for the material could be met. Numerous technical issues that threatened the synthesis of the BMI intermediate were overcome by Bowen's innovative process techniques. Purity and consistency of the BMI product were greatly improved by his extensive redesign of the manufacturing process, which implemented novel changes to minimize moisture throughout the synthesis process. The resulting process yields a highly consistent material that has a greater purity than that produced in the laboratory, the opposite of the result normally encountered during scale-up of chemical syntheses.

For more information on STARR awards, please see pages 49 – 50.

Elizabeth Nail earned a bachelor's in chemical engineering from the University of Missouri – Columbia. She has worked for the Kansas City Plant for approximately three years. As an engineer, she is responsible for materials engineering related to epoxies, including identifying areas where technical changes or new materials are required, providing technical expertise and problem solving for adhesive issues for varied applications with the organization, and managing new materials development projects. Elizabeth is certified as a Six Sigma Green Belt. She participated in the 2005 Honeywell Quest for Excellence event in Morristown, New Jersey this year.

(from left to right)
Ronald Osborn studied earth sciences at Northeastern State University of Oklahoma from 1974 to 1975 and Oklahoma State University from 1975 to1978. He has spent twenty-six years at the Kansas City Plant, working in materials engineering with primary responsibility for chemical synthesis of pilot plant operations. This includes equipment operation, material handling, maintenance and troubleshooting. Ron is recognized for his achievements in both quality and security at the Kansas City Plant. He is a certified Six Sigma Green Belt. Additionally, he participated in the Honeywell Quest for Excellence event in Morristown, New Jersey.

Daniel Bowen III received a bachelor's in chemistry from Loras College followed by a doctorate in inorganic chemistry from the University of Iowa. He has worked at the Kansas City Plant as a senior scientist for approximately two years. His wide span of responsibilities in this role include all aspects of materials chemistry for fine chemicals, polymers, encapsulants, sealants, adhesives, and elastomers, including synthesis, characterization, material properties evaluation, and scale-up. He is also responsible for all aspects of materials chemistry based root cause and failure analysis, formulation and reformulation, application based materials selection, and process evaluation, analysis, and optimization. Dan received a STARR Award for W76-1 removable epoxy foam and a Missouri Team Quality Award for the development and evaluation of LK3626 RTV foam. Additionally, Dan took place in the 2005 Honeywell Quest for Excellence event held in Morristown, New Jersey this year. He is a certified Six Sigma Green Belt.

Tricia Wilson received a bachelor's in plastics engineering from the University of Massachusetts – Lowell. She has been with the Kansas City Plant for seventeen years and currently works as a principle engineer with responsibility for operating the polymer production facility, which produces and repackages specialty materials for the nuclear weapons complex, the Department of Defense and the United Kingdom's Atomic Weapons Establishment. Tricia is a certified Six Sigma Green Belt and has been recognized for her expertise in material science. She also participated in the 2005 Honeywell Quest for Excellence event in Morristown, New Jersey.

Robert Sedlacek earned a bachelor's in distributed studies from Iowa State University, followed by a master's in business administration from the University of South Dakota. He has been with the Kansas City Plant for more than two years and currently works as an engineering technologist. In this role, Robert is responsible for process development and quality assurance testing. He was a participant in the 2005 Honeywell Quest for Excellence event held in Morristown, New Jersey.

RTV Foam Cushion

When the commercially-supplied room temperature vulcanized (RTV) silicone foam for the W76-1 Life Extension Program (LEP) stress cushions, compression pads and cots was taken off the market, a drop-in replacement RTV foam, LK3626, was developed in collaboration with Los Alamos National Laboratory (LANL).

As the design requirements for the stress cushion evolved, it was discovered that LK3626 could not consistently be used make cushions that met all the new requirements. LANL partnered with the Kansas City Plant in order to help them maintain schedules and develop a solution to the problem. This effort exceeded design agency expectations and garnered high praise from LANL and the NNSA. Additional experiments were conducted at the Kansas City Plant to characterize the part making process, resin compounding and the implications of formulation changes. While maintaining an aggressive schedule, Six Sigma tools were used in combination with our expertise in silicone foam technology, silicone material synthesis and analytical chemistry leading to a detailed understanding of the chemical structure/physical property relationships. This innovative analysis of the elastomer structure-property relationships linked the relationship of the chemical reactants to the material's ultimate properties. A visualization model based on this new understanding was developed and used to modify the original LK3626 formulation to meet the customer's design requirements for the cushions and to make significant improvements in the overall material processing.

The visualization model identified three new foam formulations that met all of the acceptance requirements for stress cushions. The formulations were then down-selected to the final formulation, SX358, and incorporated into stress cushion manufacturing. Without the implementation of these formulation changes, the W76-1 LEP stress cushions would not have consistently met the design requirements resulting in low yields and significant scrap. Our unique ability to develop customized materials and produce them in-house allows us to develop future custom materials with desired properties for current and future weapon designs.

Benefits

- In keeping with our focus on customers and the desire to excel in operations, high quality cushions for the W76-1 LEP can now be manufactured with the new formulation.
- This advancement led to the successful development of a robust, high quality product that meets all design requirments and can be manufactured with a sustainable, consitent producibility.
- During the development of the SX358 material, a large amount of knowledge was gained in the elastomer structure-property relationships of RTV silicone materials. By having this knowledge we now have the ability to tune a formulation and dial in on the desired mechanical properties of the foam. This unique ability to develop customized materials and produce them in-house allows us to develop custom materials with desired properties for future weapon designs and other potential foam applications.
- The development of the RTV silicone foam material represents a "captive" technology where almost every aspect of the formulation and raw materials are known and can be controlled. By having a "captive" technology, the quality and consistency of our cushions will benefit the nuclear weapons stockpile for many years.
- Under a very compressed schedule, three new formulations were discovered which yielded cushions that met all acceptance requirements. In fact, the modified foam was re-formulated in less than seven weeks!
- The Kansas City Plant is a one stop shop for the develoment of silicone cushions. We can develop the RTV silicone foam formulations that meet specific mechanical properties, characterize chemical properties of the foam, compound the resin, manufacture cushions and other parts, and complete aging studies on those parts.

Inter-Complex Technology

The ability to develop RTV silicone foam formulations in-house and manufacture high quality cushions of many shapes and sizes benefits the entire nuclear weapons complex. Specifically, the ability to develop new formulations with tunable properties is of great value for future weapon designs that use a RTV silicone foam parts.

Conference Papers / Presentations

Title: S5370 Silicone Foam Replacement Developments at KCP – Implications of Formulations Changes
Authored / Presented By: Dan Bowen
Conference: 35th Annual PolyMAC Conference in Oak Ridge, Tennessee
Date: June 14-16, 2005

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 45 – 48.

Title: S5370 Silicone Foam Replacement Developments at KCP – Characterization of Formulations Changes
Authored / Presented By: Eric Eastwood
Conference: 35th Annual PolyMAC Conference in Oak Ridge, Tennessee
Date: June 14-16, 2005

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 45 – 48.

Title: KCP Supported Aging Study Activities for the Newly Developed RTV Blown Foam Materials
Authored / Presented By: Jim Schneider
Conference: JOWOG (Joint Working Group) 28 Main Meeting in Las Vegas, Nevada
Date: November 14-18, 2005

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 45 – 48.

Title: Insights into the Mechanisms of Sn(II) Carboxylate Catalyzed RTV Blown Silicone Foam
Authored / Presented By: Dan Bowen
Conference: 35th Annual PolyMAC Conference in Oak Ridge, Tennessee
Date: June 14-16, 2005

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 45 – 48.

STARR Awards

Dr. Eric Eastwood was awarded a 2005 STARR award for playing a key role in the investigation and formulation of the chemical composition of a critical RTV silicone foam material. Through his understanding of chemistry and polymer processing, he was able to lead the customer (Los Alamos National Laboratory) and the Kansas City Plant to a detailed understanding of this material and its properties. This understanding led to changes in the formulation which allowed the successful manufacturing of silicone RTV foam stress cushions for the W76-1 life extension program. This effort exceeded design agency expectations and garnered high praise from Los Alamos National Laboratory and the NNSA. Eric's innovative analysis of elastomer structure-property relationships linked the relationship of the chemical reactants to the material's ultimate properties. One critical aspect of this work was the establishment of a design space from which the physical properties of the silicone foam were predicted from the molecular weights of the reactants. Eric also developed a novel approach to measure the extent of reaction by monitoring hydrogen evolution from the material as it cured. This also allowed the Kansas City Plant to assure that the new formulation met design requirements for long term performance. LANL product realization team members stated that Eric's work significantly elevated the nuclear weapons complex's knowledge of the science that governs silicone elastomer chemistry, processing and performance.

For more information on STARR awards, please see pages 49 – 50.

(clockwise from left)

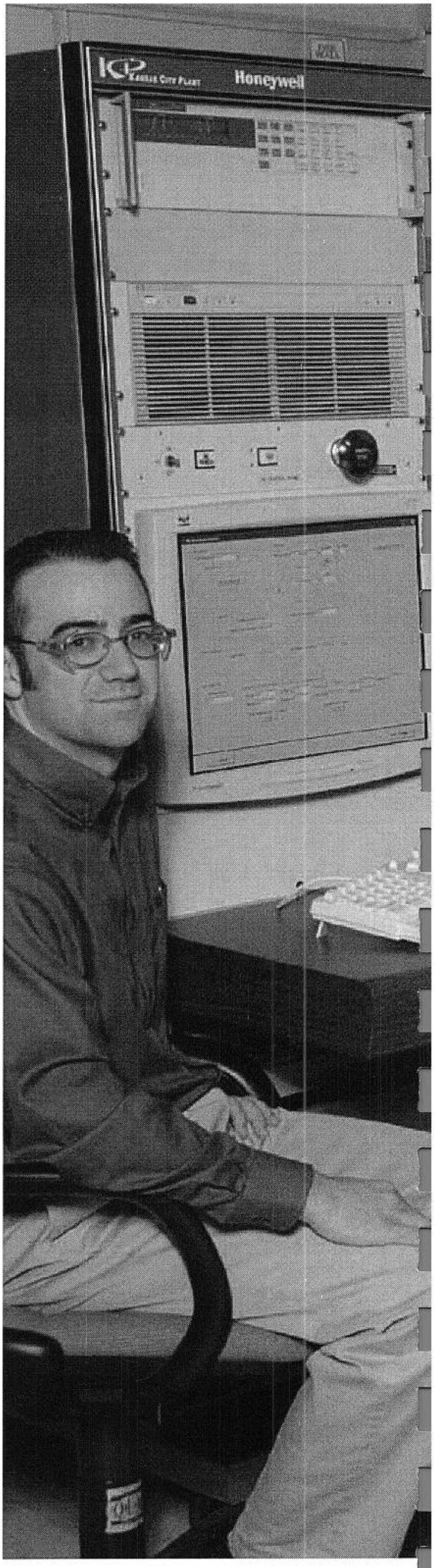
Eric Eastwood (far left) earned a bachelor's in chemistry from Pittsburg State University followed by a doctorate in polymer chemistry from the University of Tennessee. He has been working for the Kansas City Plant for approximately four years. As a scientist, Eric has material engineering responsibilities for RTV silicone materials, filled elastomers and many other polymeric materials. He serves as project leader for VCE (an ethylene vinyl acetate vinyl alcohol terpolymer) scale up and manufacturing. Eric was awarded the Honeywell Chairman's Award for Everyday Heroes for development of formulation changes for critical cushion components. He received a 2005 STARR Award for W76 RTV foam cushion. Furthermore, he was part of a team that received a 2005 Missouri Team Quality Award for the development, evaluation and optimization of LK3626 foam. In addition, Eric certified as a Six Sigma Green Belt.

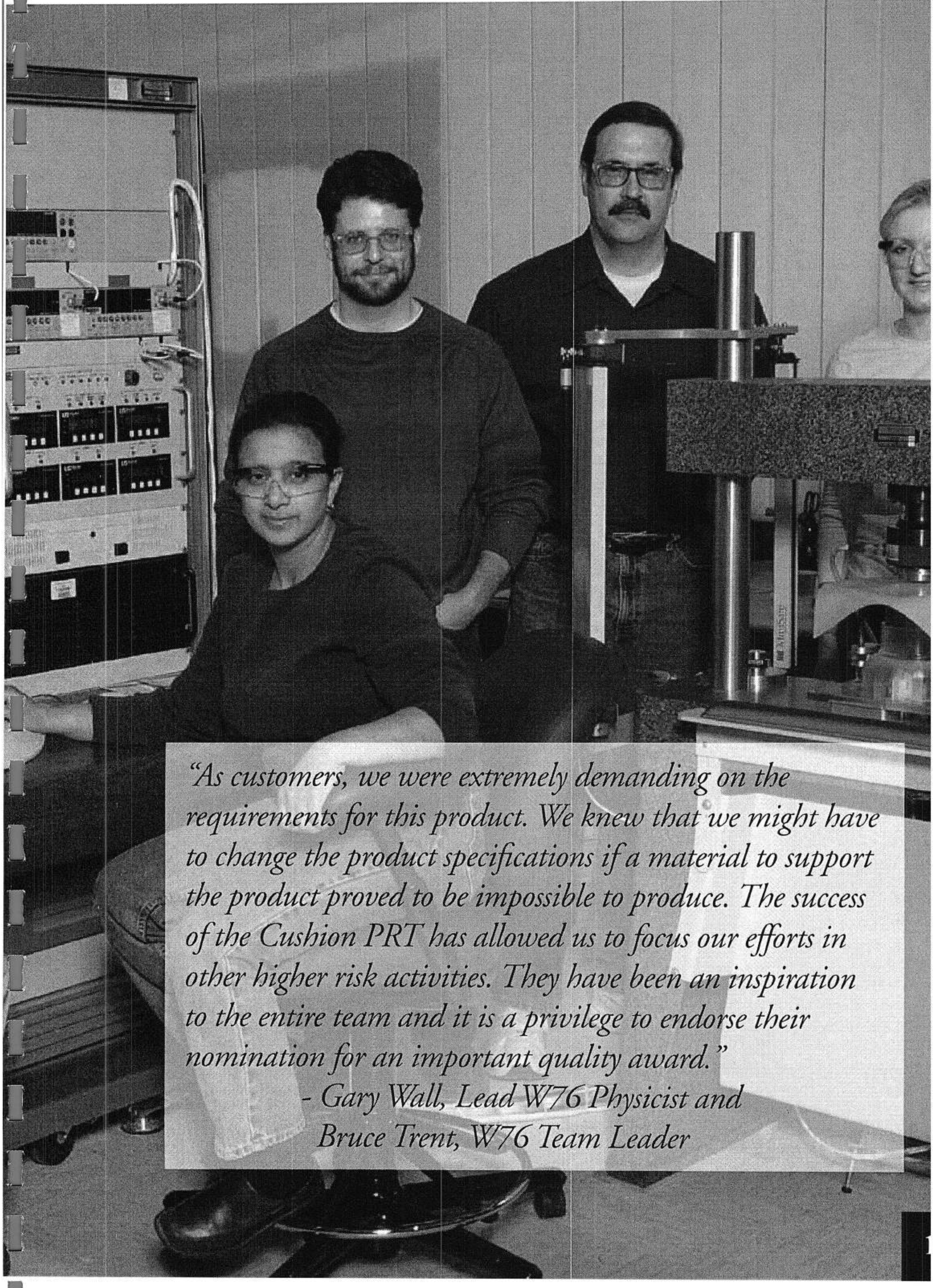
Vinita Chhabira (second from left) earned a bachelor's in chemical engineering from the University of California – Berkeley followed by a master's in chemical engineering from the New Jersey Institute of Technology. She has spent seven years at the Kansas City Plant. As a product / process engineer, Vinita is responsible for cellular silicone/ RTV foam and polyurethane foam products. Vinita is a certified Six Sigma Black Belt and is currently working toward a Lean Greenbelt certification. She was part of the team that received the 2005 Missouri Team Quality Award for the development, evaluation and optimization of LK3626 RTV foam.

Dan Bowen (middle) received a bachelor's in chemistry from Loras College followed by a doctorate in inorganic chemistry from the University of Iowa. Working as a senior scientist at the Kansas City Plant for approximately two years, he is responsible for all aspects of material science. Dan received a 2005 STARR (Significant Technical Achievement Recognition Reward) for W76 -1 removable epoxy foam; competed in the Honeywell Quest for Excellence finals in Morristown, New Jersey; and was a member of the team that won a 2005 Missouri Team Quality Award for the development, evaluation and optimization of LK3626 RTV foam. Additionally, Dan is a certified Six Sigma Green Belt.

Jim Schneider (second from right) received a bachelor's in chemical engineering from the University of Kansas. He has been with the Kansas City Plant for twenty-eight years and is certified as a Six Sigma Green Belt. As a principal engineer, he is responsible for material compounding and development along with part development and production. He is also responsible for implementing new aging study and continued testing of previously established aging tests for silicone materials. Jim received a 2004 STARR Award for development of a process to synthesize a silicone fluid processing aid. Additionally, Jim was part of a team that received a 2005 Missouri Team Quality Award for this project.

Jessica Zeman (far right) earned a bachelor's in chemical engineering from Iowa State University. She has worked for the Kansas City Plant for approximately two years as a product and process engineer. In this role, she is responsible for the production of RTV foam, solid RTV and cellular silicone. She received a 2005 Associate Recognition Award for performance enhancement in regards to a design manufacturing guide for cellular silicone. Jessica is a certified Six Sigma Green Belt. In addition, she was part of the team that received the 2005 Missouri Team Quality Award for the development, evaluation and optimization of LK3626 RTV foam.





"As customers, we were extremely demanding on the requirements for this product. We knew that we might have to change the product specifications if a material to support the product proved to be impossible to produce. The success of the Cushion PRT has allowed us to focus our efforts in other higher risk activities. They have been an inspiration to the entire team and it is a privilege to endorse their nomination for an important quality award."

- Gary Wall, Lead W76 Physicist and
Bruce Trent, W76 Team Leader

Ultra-Thin Solid Film Lubricant

In 2005, a critical need existed for thinner solid film lubricants at the Kansas City Plant. Commercially available, adhesively bound solid film lubricants in use were no longer acceptable because they were six to ten times thicker than the designers' (Sandia National Laboratories) requirements.

Very thin lubricant layers were needed because as weapon mechanisms get smaller and smaller, so too must the tolerances for clearances between parts. Traditional solid film lubricant coatings applied by liquid spray methods and then oven-cured were not designed to be applied or function at thicknesses of less than eight to ten microns. Lubricant layers that thick would interfere with proper operation of the new mechanisms being planned. Therefore, over a period of fourteen months, a Kansas City Plant team developed a unique new method for spray-applying a layer of molybdenum disulfide (MoS_2) that is one micron or thinner.

The ultra-thin solid film lubricant was intended for use in small mechanical devices such as bearings, pins and small gears for the W76 and W80 programs. The new method uses a small, inexpensive media blast unit to apply pure, dry, solid MoS_2 powder directly to a surface at elevated pressure in order to imbed and bond a very thin layer of the solid film lubricant to a substrate surface. Since the new method uses no adhesives but depends on chemical and mechanical bonding of the solid film lubricant itself to the surface, a much thinner and more lubricious coating can be achieved.

This innovative method has proven vastly successful in providing extremely thin and durable layers of solid film lubrication. Durability of this new coating is enhanced because it is chemically and mechanically bonded to substrate surfaces, will not migrate within the mechanism, and actually becomes a better lubricant as it is "run-in" or pressed into the surface being lubricated. Following development testing, it received the approval of Sandia National Laboratories for war reserve production applications. The resulting lubricant layer is so thin (0.8 microns thick) as to be insignificant to part tolerances. The lubricant layer provides a surface with a very low coefficient of friction (CoF). Typically a CoF of 0.1 is considered good, with lower being better. This process has provided some surfaces with a CoF as low as 0.03, a range where it is difficult to measure accurately.

Benefits

- Since the process uses no solvents or binders, it eliminates air emissions, known carcinogen solvents and hazardous waste associated with current liquid-sprayed solid film lubricant techniques.
- The process uses no binders or adhesives so that the lubricant layer is pure lubricant with no baking or further processing required. The process is thus very environmentally friendly, inexpensive, fast and readily adapted to production.
- The method has set a new standard for solid film lubricants for being easy to apply, thinner than any other solid lubricant available and essentially permanent, not migrating or degrading with time.

Inter-Complex Technology

The process will be used on the W76 and W80 life extension programs and is quickly finding use in other war reserve production programs. It is also being tested to fill the need for very thin solid film lubricants on many electromechanical and mechanical devices throughout the nuclear weapons complex.

The innovative process received widespread positive attention when it was publicized in the Kansas City Plant's Connections newsletter and Sandia Lab News.

Other Uses

The technology offers an extremely thin layer of lubrication that is negligible to part tolerances and provides lubrication that will not degrade or migrate with time. This process lends itself to new weapon designs that require or benefit from extremely thin permanent lubricants. This process is simple, inexpensive, fast, robust and non-polluting. The potential exists for significant new reimbursable business with the Department of Defense and other government agencies.

Development of the process brought in reimbursable business from Hill Air Force Base for FY05 and FY06 with much more planned over the next three years. The process will allow gyroscopes in Air Force guided weapons to remain viable in long-term storage.

Benchmarking

The Kansas City Plant applies many solid film lubricants, and many are available from the lubrication industry. Comparisons with these commercially available products by the Kansas City Plant and Sandia National Laboratories' tribology expert, Mike Dugger, indicated that this new process provided a superior lubricant and could be performed in-house quickly, cleanly and inexpensively.

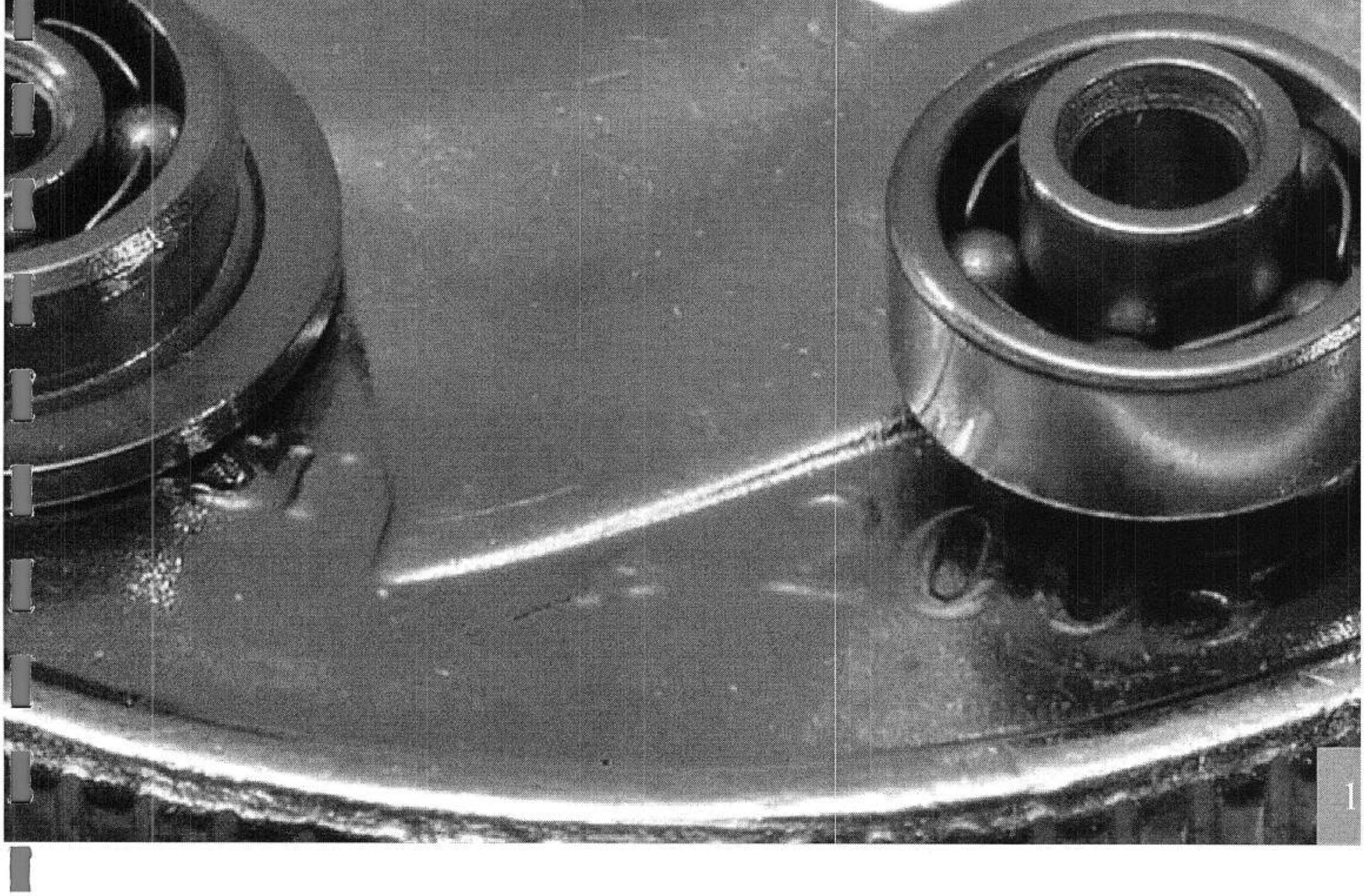
Mark D. Smith received a bachelor's in chemical engineering from Kansas State University. As a principal engineer in the materials engineering and polymer production department, he is responsible for paints, powder coating, plasma processing, solid film lubricants and cleaning solvents. Throughout the twenty-eight years he has been at the Kansas City Plant, Mark has received several awards in the areas of powder coating and plasma processing, including a 2002 STARR Award. He is a certified Six Sigma Black Belt.

Michael D. Hester is a senior engineering technologist in the materials engineering and polymer production department and has been with the Kansas City Plant for twenty-eight years. In his position, Mike works in the areas of paints, powder coating, plasma processing and solid film lubricants. During his career at the Kansas City Plant, Mike relocated and worked on the National Ignition Facility Program for two years at Lawrence Livermore National Laboratory. Mike was part of a team that won the Missouri Team Quality Award for a powder coating project in 2001. Additionally, he is a certified Six Sigma Green Belt.

Tom Hand spent time studying electronics technology and the Russian language at various colleges in the Kansas City area. He is a senior engineer in the mechanisms department and has been at the Kansas City Plant for twenty-five years. Tom has responsibility for precision cleaning processes associated with mechanisms and precision cleaning support for the plant. He has received several awards including a Governor's Award, a Federal Laboratory Consortium Award and a Silicon Prairie Technology of the Year Award. In addition, he has received three patents for his work in cleaning processes and cleaning agent formulations.

Randy Forbes earned a bachelor's in business and a bachelor's in mechanical engineering from the University of Kansas. He has been with the Kansas City Plant for more than two years. As an engineer in the mechanisms department, Randy has product and process responsibility for four assemblies on the W76 and W80 intent stronglink mechanisms. He is also a certified Six Sigma Green Belt.

Amanda Rafferty received a bachelor's in mechanical engineering from the University of Missouri-Rolla. As an engineer in the mechanisms department, she has product and process responsibility for the W80 trajectory stronglink. Amanda has been at the Kansas City Plant for two years and is certified as a Six Sigma Green Belt.



Mechanical
Products

Cleaning Line

To provide higher quality and more robust cleaning capabilities in the reservoir manufacturing department, a team of Kansas City Plant personnel worked together on various operational and technical features of the cleaning systems. New cleaning systems were purchased to increase the reservoir product cleaning capacity because old cleaning methods and technology adopted during reconfiguration activities of the mid-1990s were limited. Previous systems and rinse methods used with them wasted water and provided less than optimum rinse capabilities. By combining the talents of the reservoir manufacturing department system operators, the Kansas City Plant's particle monitoring team, various maintenance personnel, and engineering representatives, changes were made to the cleaning systems to provide higher purity rinse water and more consistency. Pumps were eliminated, water lines rerouted, solenoids changed, filters installed, and water flow during use was reduced and eliminated during off times. Additionally, monitoring of ancillary clean benches, the ambient air in the cleaning area, line nitrogen used for purging and drying, ultrasonic cleaning system effectiveness and final rinse water particle content was instituted.

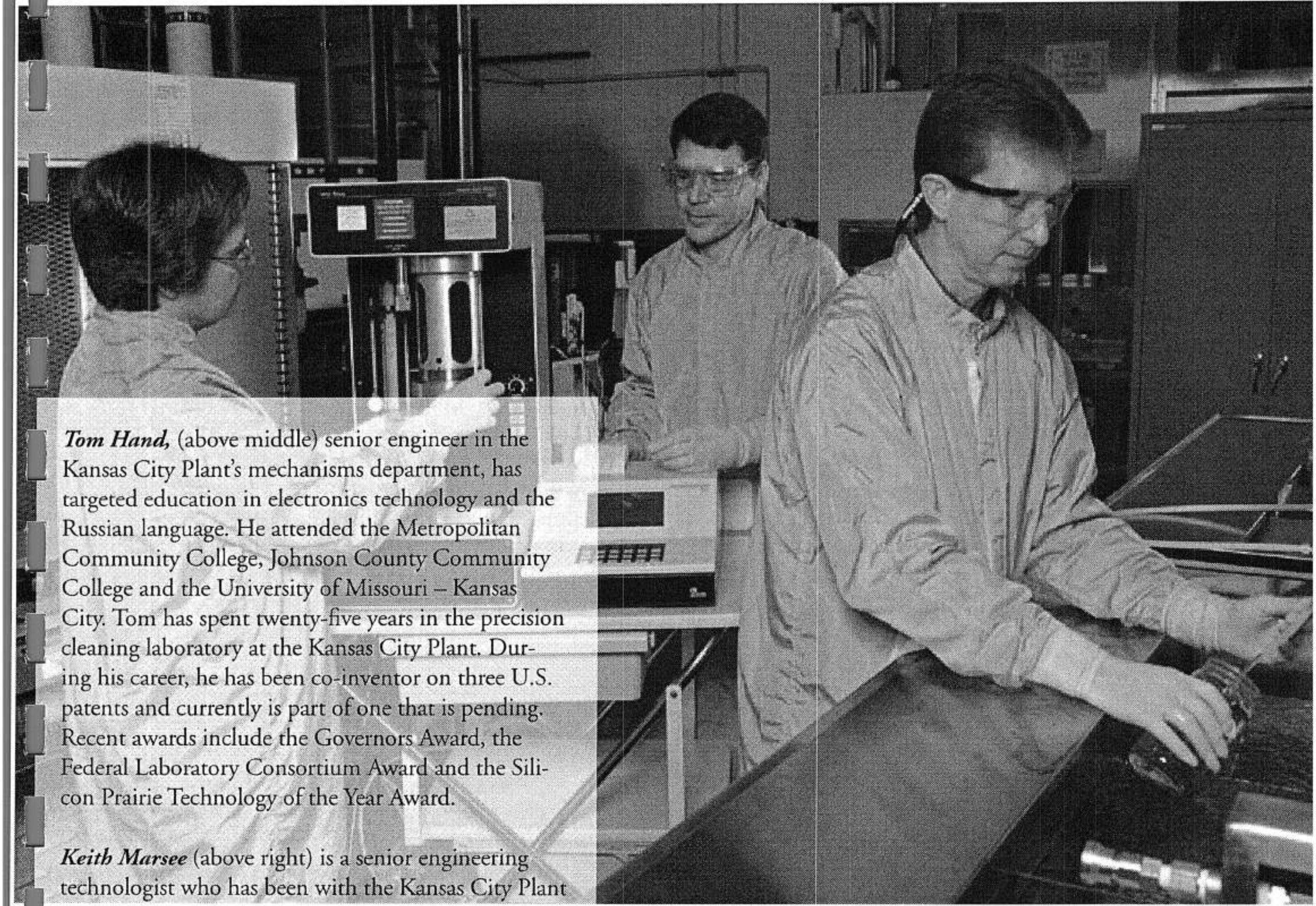
Benefits

This series of technical and operational changes to the reservoir manufacturing department's cleaning systems enabled the Kansas City Plant to drastically reduce the usage of heated and high purity deionized water. Changing the systems also improved the quality of the rinse water by increasing purity and reducing particle count. Routine monitoring of the area and systems will enable the reservoir manufacturing department's cleaning facility to operate within a characterized condition. The changes made to the systems were not expensive or difficult, but their effect is dramatic; potentially millions of gallons of heated, high purity deionized water and its disposal will now be prevented annually.

The changes made to systems in the reservoir manufacturing department led to significant improvments, but the following additional changes are also being considered. Close-looping and recirculating all of the high purity rinse water will save additional energy and minimize water usage. Part suppliers to the Kansas City Plant now use similar rinse systems to process parts that are ultimately used in the reservoir manufacturing department and other departments throughout the Kansas City Plant. These vendors also benefit from reduced water usage and higher purity rinse water.

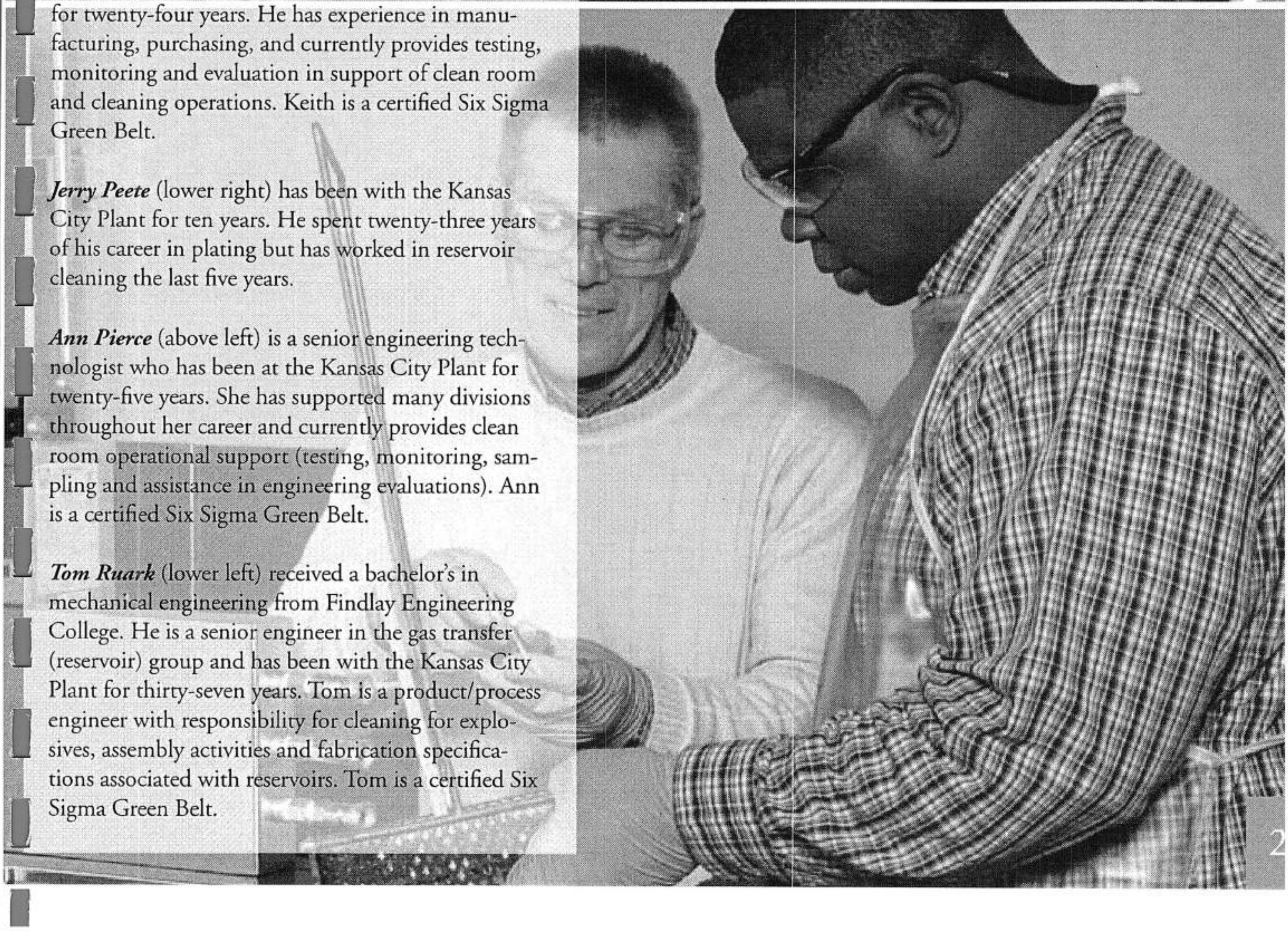
Other Uses

- Water rinse systems used in precision cleaning areas.
- Suppliers of aqueous cleaning systems. Suppliers of parts for the reservoir manufacturing department are currently using similar systems to save water, improve the quality and lower the cost of final rinsing operations.



Tom Hand, (above middle) senior engineer in the Kansas City Plant's mechanisms department, has targeted education in electronics technology and the Russian language. He attended the Metropolitan Community College, Johnson County Community College and the University of Missouri – Kansas City. Tom has spent twenty-five years in the precision cleaning laboratory at the Kansas City Plant. During his career, he has been co-inventor on three U.S. patents and currently is part of one that is pending. Recent awards include the Governors Award, the Federal Laboratory Consortium Award and the Silicon Prairie Technology of the Year Award.

Keith Marsee (above right) is a senior engineering technologist who has been with the Kansas City Plant for twenty-four years. He has experience in manufacturing, purchasing, and currently provides testing, monitoring and evaluation in support of clean room and cleaning operations. Keith is a certified Six Sigma Green Belt.



Jerry Peete (lower right) has been with the Kansas City Plant for ten years. He spent twenty-three years of his career in plating but has worked in reservoir cleaning the last five years.

Ann Pierce (above left) is a senior engineering technologist who has been at the Kansas City Plant for twenty-five years. She has supported many divisions throughout her career and currently provides clean room operational support (testing, monitoring, sampling and assistance in engineering evaluations). Ann is a certified Six Sigma Green Belt.

Tom Ruark (lower left) received a bachelor's in mechanical engineering from Findlay Engineering College. He is a senior engineer in the gas transfer (reservoir) group and has been with the Kansas City Plant for thirty-seven years. Tom is a product/process engineer with responsibility for cleaning for explosives, assembly activities and fabrication specifications associated with reservoirs. Tom is a certified Six Sigma Green Belt.

The Los Alamos High Explosive Radio Telemetry (HERT) project, an Enhanced Surveillance Campaign effort, uses fiber optic sensors to detect and measure mechanical shock wave propagation in high explosive detonation. Glass optical fibers that transmit light are anticipated to be used in replacement of an earlier Los Alamos National Laboratory (LANL) technique that was electrical based, using wires. Unlike wire, glass optical fibers are subject to breakage, and if broken prior to high explosive detonation, false signals are registered. When dealing with the Navy (the customer), LANL learned that fiber optic shock sensors would be acceptable for use on Navy flight tests only if it could be demonstrated just before use that the optical fibers were all intact. Only in this way would false signals be avoided.

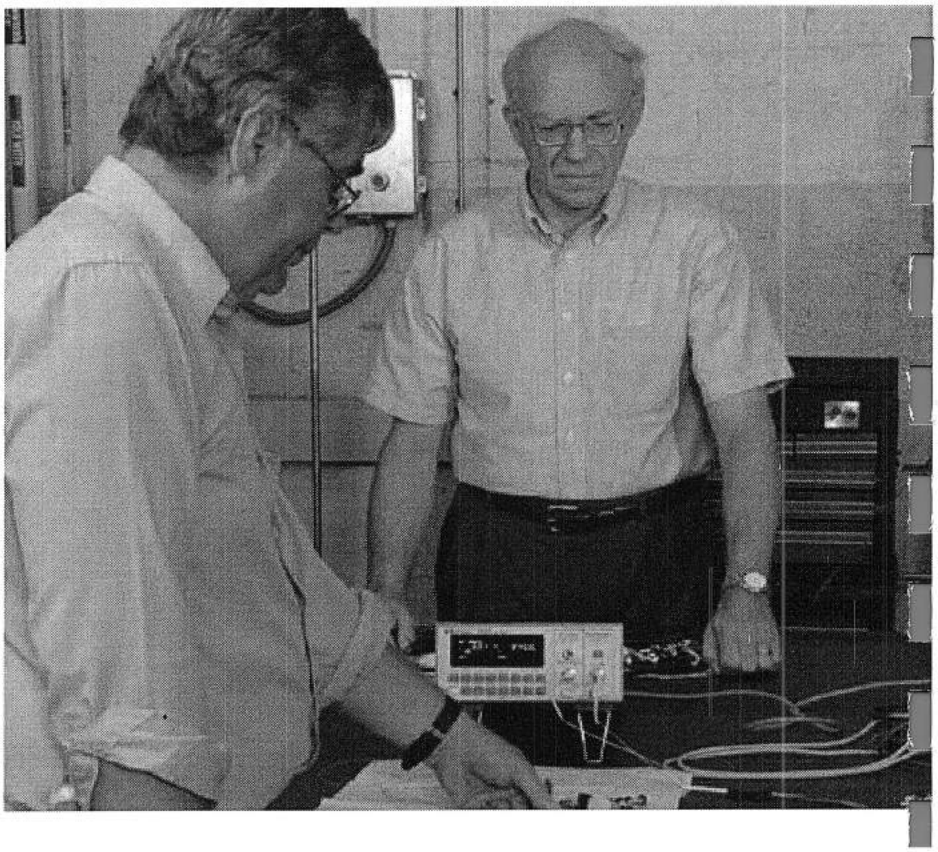
LANL asked the Kansas City Plant to find a means of verifying the integrity of the fibers just before use. In doing so, we fabricated fiber optic mechanical shock sensors that are placed on the high explosive. When detonated, the mechanical impulses received by the fiber tips of those sensors result in transmitted light that is used to measure advancement of the shock wave as it arrives at the various locations of the sensors. The preparation and coating of the fiber tips, which are used in the sensors to assess the integrity of the glass optical fibers just prior to detonation, has resulted in many great technical achievements for the Kansas City Plant. Each optical fiber sensor consists of a fiber approximately one to two meters long with one end, or tip, placed on the high explosive and the other end connected to the electronics of HERT for detection and measurement of light. The end, or tip, of the fiber in contact with the high explosive is the sensor, and it contains a reflective coating so that light can be sent down the fiber, reflected from the coating, and measured to verify that the fiber is intact, not broken, just before use. Prior to coating the tip of the fiber, the tip must be prepared by lapping and polishing it flat and smooth. This assures that the internal light reflected from the coating on the tip will be sufficient for detection in the HERT detector electronics. Upon detonation, the mechanical impulse received by the fiber tip generates light that is transmitted to the electronics for measurement of arrival time for the particular fiber tip located on the high explosive. To enhance the amount of light generated in the tip of the fiber when it is subjected to the mechanical shock wave from the high explosive detonation, the tip contains a small amount of shock sensitive powder.

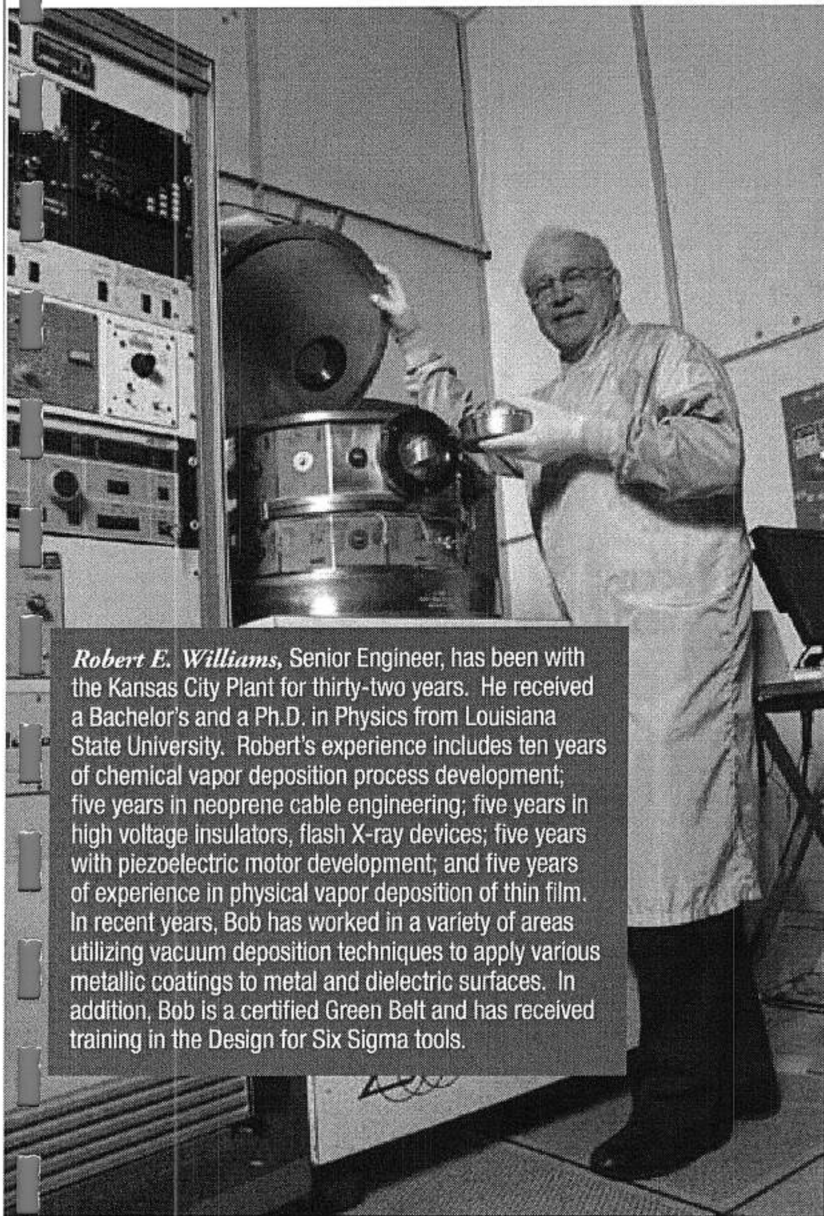
To avoid false data signals from optical fiber shock sensors, it is imperative to have a means of testing the fiber integrity, that is, whether the glass fibers are intact or broken prior to use. Three key features are necessary to provide a valid test. First, the fiber end must be polished sufficiently smooth so adequate levels of light will be reflected internally from a coating applied to the polished surface. Secondly, the polished end must be sufficiently

Fiber-optic Shock Sensors

Paul Klingsporn (right) received a bachelor's in education (physics) from Southwest Missouri State University, a master's in physics from Pittsburg State University, and a doctorate in physics from Oklahoma State University. He is a staff engineer and has been with the Kansas City Plant for thirty-six years. During the last fifteen years, he has worked on a wide variety of fiber optic applications. Paul is a member of the Network of Senior Scientists and Engineers and has a patent pending for an efficient method of coupling light from two or more optical fibers into a single fiber. In addition, Paul is certified as a Green Belt in Six Sigma.

Gary Couser (left) received a bachelor's in biology from the University of Missouri – Kansas City. He is a senior engineering technologist with twenty-two years of experience at the Kansas City Plant. During the last eleven years, Gary has worked with a variety of lapping and polishing techniques in the special preparation of optical fibers surfaces to meet the needs of many opto-electronic applications. In addition, he performs extensive testing of the optical fibers. Gary is a certified Six Sigma Green Belt.





Robert E. Williams, Senior Engineer, has been with the Kansas City Plant for thirty-two years. He received a Bachelor's and a Ph.D. in Physics from Louisiana State University. Robert's experience includes ten years of chemical vapor deposition process development; five years in neoprene cable engineering; five years in high voltage insulators, flash X-ray devices; five years with piezoelectric motor development; and five years of experience in physical vapor deposition of thin film. In recent years, Bob has worked in a variety of areas utilizing vacuum deposition techniques to apply various metallic coatings to metal and dielectric surfaces. In addition, Bob is a certified Green Belt and has received training in the Design for Six Sigma tools.

flat so that light reflected from it will return at angles within the fiber numerical aperture and thereby propagate back to the detectors. Finally, the reflective coating applied to the polished fiber end must be of high quality to assure the maximum level of reflectance in the fiber at the wavelength used to test the fiber integrity.

Techniques were developed to achieve the necessary smoothness (50 Angstroms rms) and flatness (1 micrometer) of polish on the small diameter (100 micrometers) fiber core. A sputtering process was developed to achieve the maximum reflectance at 850 nm, with a gold coating. In order for gold to adhere to the glass fiber end, a layer of either chromium or titanium must be applied first, followed by gold. However, if the adherence layer of chromium is too thick, then too much light will be absorbed before it reaches the gold, where the intended internal reflection occurs. On the other hand, if the chromium layer is too thin, the gold adherence will not be adequate. The chromium layer must be thick enough to provide gold adherence, but thin enough to allow adequate light to pass through it, be reflected from the gold, and then pass again through the chromium and into the fiber where it is transmitted at a high enough level to register at the detector used to indicate fiber integrity. A sputtering process was developed to achieve the proper chromium thickness (25 Angstroms) followed by 2 micrometers of gold that gave adequate retro-reflection in the fiber at the test wavelength of 850 nm.

After the fiber shock sensors have been fabricated and tested for light reflection, the Kansas City Plant ships them to LANL so that they can assemble the fiber sensor tips on the high explosive.

Benefits

A total of thirty-two fiber optic shock sensors were fabricated for the W76 Field Command Evaluation Test (FCET) 32 flight test. The flight test conducted by the Navy in November 2004 was successful.

These achievements provide the NNSA with added capability for fabricating fiber optic shock sensors that can be used in a variety of potential areas in which detonation shock characterizations are desired. In fact, potential applications of this technology exist within the Department of Defense. Moreover, the special capabilities developed for fiber polishing and application of highly reflective gold coatings are sure to have application to the overall NNSA mission in other opto-electronic areas.

A total of sixty-four fiber optic shock sensors were fabricated in preparation for a follow-on FCET 34 flight test, scheduled for 2005. These sensors passed all pre-tests and are currently being assembled by LANL for the FCET 34 test application.

Inter-Complex Technology

Arrival of the high explosive detonation shock wave at a given fiber sensor site results in mechanical shock-induced light in the fiber that is then transmitted to the corresponding detector in the HERT electronics package. Earlier work at Special Technologies Laboratories (STL), Santa Barbara, had shown that Lutetium Oxyorthosilicate, Cerium doped (LSO) generates light when it is subjected to mechanical shock. Preliminary tests at LANL using fiber sensors fabricated at the Kansas City Plant showed that shock-generated light enhancement occurred when a small quantity of LSO was applied to the fiber sensor tip. Because of this, the Kansas City Plant collaborated with STL to transfer the process for application of the LSO to the fiber sensor tips. All fiber shock sensors used on the successful W76 FCET 32 flight test conducted by the Navy contained the LSO for light enhancement.

Other Uses

Any opto-electronic system employing optical fibers can use the gold coated retro-reflection technique for in-situ assurance of fiber integrity.

The shock sensors have potential application for detonation wave shock analysis for the Department of Defense and other government agencies.

Lubrication Process

Kansas City Plant associates from the materials engineering department developed a relatively simple and robust lubrication process that involves a powdered lubricant, pure molybdenum disulfide ("moly disulfide") and a method by which it is to be applied. Another team of Kansas City Plant associates adapted the method to production operations. Amanda Raffurty and Randy Forbes developed the process and acquired equipment and a room for production lubrication of components for miniature mechanisms. Aaron Ison and Mike Dugger of Sandia National Laboratories provided assistance with the development in the form of torque testing for bearings and friction testing of piece parts.

This new lubrication process is very simple in that finely powdered molybdenum disulfide is introduced into a dry nitrogen stream and sprayed onto parts using a set time, flow rate and pressure. When molybdenum disulfide powder hits the surface of the part at high velocity, it breaks down and uniformly bonds to the surface. A portion of the lubricating material binds intimately with the metal part and the remainder of the material can then "slide" over itself and the binding component as the coated parts mesh or roll against each other. Gears, pawls, shafts, bearings and other miniature mechanism parts can be lubricated using this newly adapted process. The coating is extremely thin (less than one micron) and testing indicates the coefficient of friction is very low and the performance is repeatable. The Kansas City Plant's new moly disulfide spray (lubrication) process produces a coefficient of friction that is typically better than other lubrication processes commonly used, such as moly harperization, moly sputtering and commercially sprayed moly disulfide.

Benefits

Earlier lubricants used within the nuclear weapons complex were suspensions of fine particles of Teflon in CFC-113 solvents. Parts were coated by pouring the suspension on them and allowing the solvent to evaporate. As the CFC-113 portion evaporated from the parts, the Teflon particles adhered. This process was repeatable but wasteful in that only a portion of the lubricant was actually used and all of the solvent evaporated. CFC-113 was banned due to its ozone damaging properties eliminating this lubrication method as an option for stronglink components.

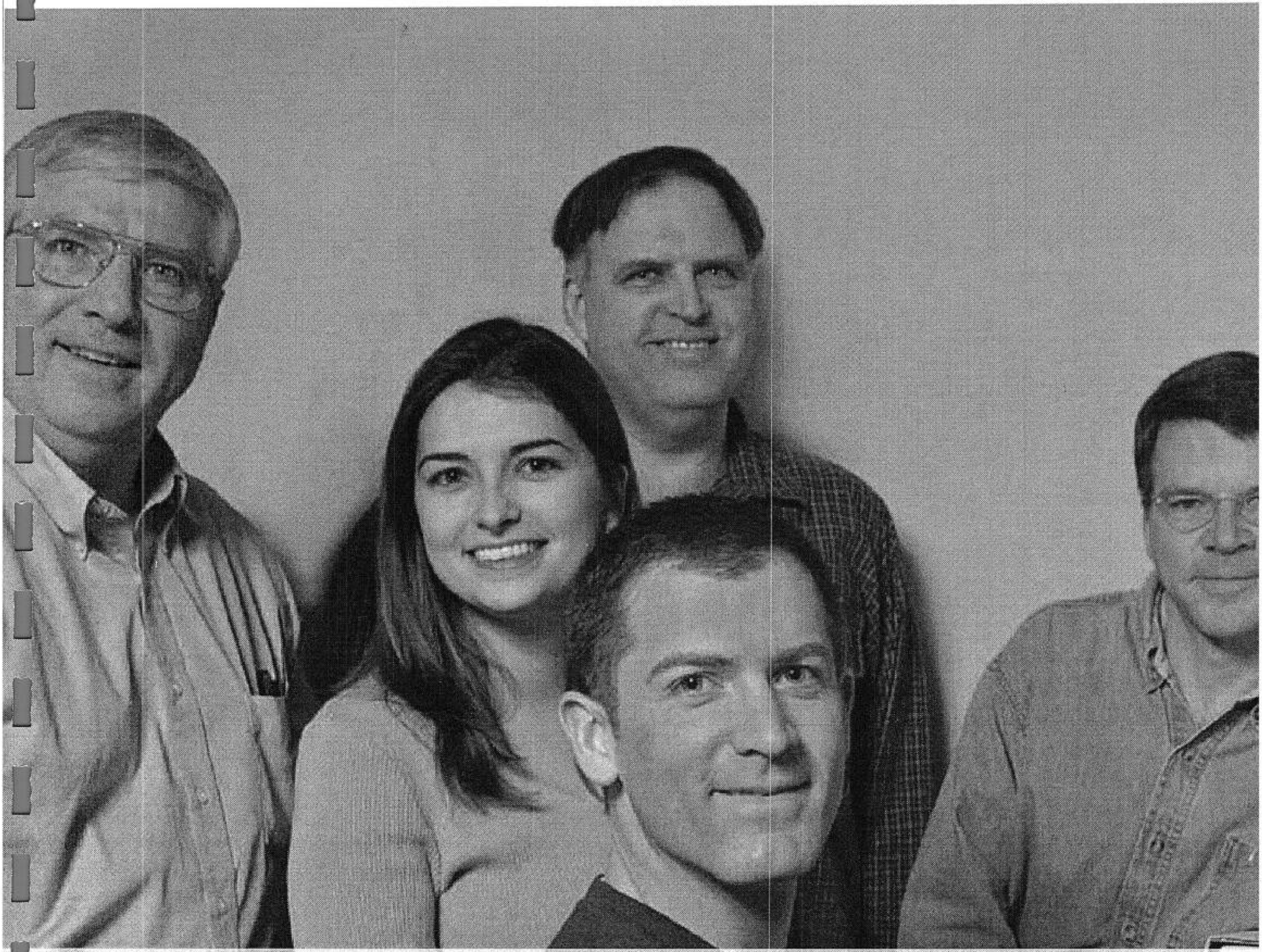
By using a lubricant, such as the powdered molybdenum disulfide, which has no binder or solvent that needs to evaporate, its properties can be predicted and controlled much more accurately. The waste is eliminated and its ease of application is improved. This newly adapted process requires no more than a simple "media-blasting" system, a dry nitrogen supply, a blow off nozzle and a relatively simple cleaning process.

Inter-Complex Technology

Additional components throughout the complex can be lubricated using this new method and material if the final assemblies are stored or used in relatively dry conditions and in somewhat controlled environments. By working with the design agency, Randy Forbes and Amanda Raffurty are strongly tied to designers and developers of other mechanisms that may use this novel process sometime in the future.

Other Uses

Current work by materials engineering personnel is underway to adapt the lubrication method and material to other defense industry components. So far, testing has indicated certain guided bomb components are candidates; a multi-year project is currently in work to further develop this potential.



Mark D. Smith (left) received a bachelor's in chemical engineering from Kansas State University. He is a principal engineer in materials engineering and polymer production and has been with the Kansas City Plant for twenty-eight years. Mark has materials engineering responsibility for paints, powder coating, plasma processing, solid film lubricants and cleaning solvents. He has received several awards in the areas of powder coating and plasma processing including a 2002 STARR Award. Additionally, he is a certified Six Sigma Black Belt.

Amanda Raffurty (center) received a bachelor's in mechanical engineering from the University of Missouri – Rolla. She has been with the Kansas City Plant for approximately two years. Amanda is a process and product engineer on mechanisms for the W80 life extension program. Additionally, she is certified as a Six Sigma Green Belt.

Randy Forbes (below center)earned a bachelor's in mechanical engineering and business from the University of Kansas. He has been with the Kansas City Plant for approximately three years. As a Six Sigma Green Belt-certified engineer, he is responsible for four assemblies on the W76 and W80 intent strong link mechanisms.

Tom Hand, (right) senior engineer in the Kansas City Plant's mechanisms department, has targeted education in electronics technology and the Russian language. He attended the Metropolitan Community College, Johnson County Community College and the University of Missouri – Kansas City. Tom has spent twenty-five years in the precision cleaning laboratory at the Kansas City Plant. During his career, he has been issued three U.S. patents and currently has one pending. Recent awards include the Governor's Award, the Federal Laboratory Consortium Award and the Silicon Prairie Technology of the Year Award.

Michael D. Hester (back center) is a senior engineering technologist in the materials engineering and polymer production department and has been with the Kansas City Plant for twenty-eight years. In his position, Mike works in the areas of paints, powder coating, plasma processing and solid film lubricants. During his career at the Kansas City Plant, Mike relocated and worked on the National Ignition Facility Program for two years at Lawrence Livermore National Laboratory. Mike was part of a team that won the Missouri Team Quality Award for a powder coating project in 2001. Additionally, he is a certified Six Sigma Green Belt.

Torque Testing System

A team of Kansas City Plant personnel designed, developed and assembled an automated, highly accurate and easy-to-use rotary device torque testing system. The system directly measures the output torque of solenoids used to drive stronglink (miniature electromechanical) mechanisms.

Previous measuring systems for output torque measurement consisted of cabling, pulleys, various adapters and an Instron system. The old systems required specialized and trained personnel to operate them. Variations in temperature and humidity reduced repeatability, as did different operators. The previous system was sometimes cumbersome and variations in the setup or data collection could alter the results. By integrating a stepper motor, angular encoder, computer controls, data generating and logging capacity with special fixturing, this new integrated torque measuring system has exceptional repeatability, is easy to use and it provides an accurate representation of the solenoid's output torque during actual working conditions.

Benefits

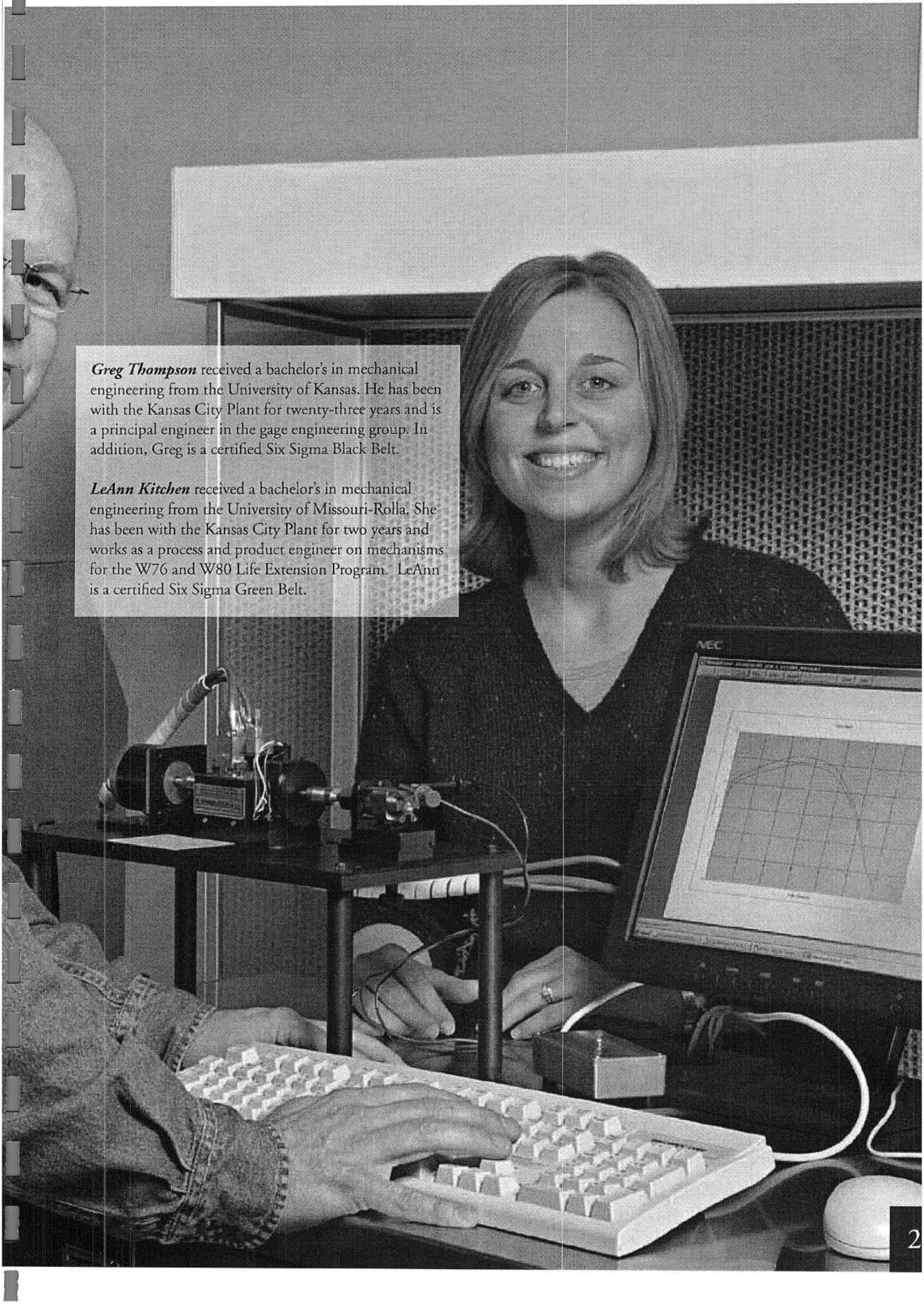
This innovative, automated torque testing system only requires a short time to set up. In addition, it has significantly reduced the actual operational testing time. The computerized data is provided in a repeatable mode and can be digitally distributed between the design agency and the production agency, which ultimately saves time. The computer also enables automatic data retention. The new system is easy to use and can be operated by a wide range of personnel. Along with ease of use, it provides a simple-to-interpret, go/no go capability. Most importantly, it provides a very accurate and direct correlation between the solenoid's angular displacement and the data displayed and recorded.

Inter-Complex Technology

The development team consisted of individuals from the Kansas City Plant and the design agency, Sandia National Laboratories. This joint development created a sense of trust and understanding within the natural teams and the product realization teams. It is expected that an interagency contract order (ICO) will be provided, asking the Kansas City Plant team to design and build another copy for Sandia National Laboratories.

Other Uses

Along with measuring the output torque generated by solenoids, this new system can measure the torque required to rotate the electrical contacts into their final location in the intent stronglink. It can also measure the torque loss through the escapement mechanism in various other stronglinks. Finally, the system has applications when monitoring rotary torque measurement is required.



Greg Thompson received a bachelor's in mechanical engineering from the University of Kansas. He has been with the Kansas City Plant for twenty-three years and is a principal engineer in the gage engineering group. In addition, Greg is a certified Six Sigma Black Belt.

LeAnn Kitchen received a bachelor's in mechanical engineering from the University of Missouri-Rolla. She has been with the Kansas City Plant for two years and works as a process and product engineer on mechanisms for the W76 and W80 Life Extension Program. LeAnn is a certified Six Sigma Green Belt.

Virtual Contact Measuring System

The Kansas City Plant created a computerized and easy-to-use virtual contact measuring and adjusting system for electromechanical mechanisms. This innovative system enables an assembler to comfortably and consistently monitor and adjust bi-furcated contacts (metallic connections needed for circuit closure) in order to achieve the required contact gap. The required contact gap, or distance between the two legs of the bi-furcated contact, is critical in controlling some of the operating characteristics of mechanisms.

The previous measuring system for adjusting these contacts required an optical comparator and holding stage, along with specially trained personnel. Multiple contacts could be adjusted without reorientation of the part; however, it was difficult for an operator to reach contacts to perform the adjustment. It also required a series of less-than-optimum, ergonomically challenging movements.

Many benefits have resulted from the creation of this computerized optical contact measuring and adjusting system. The computerized optical viewing system projects a virtual image on the screen, similar to the yellow line seen on a television screen during a football game that shows how close a team is to a first down, to enable an operator to immediately tell which way and how much the contacts need to be adjusted. This projected pair of concentric circles provides a visual, "go / no go" image that immediately tells an operator that the contacts need to be adjusted to a bigger or smaller gap setting. The viewing screen is located directly in front of the operator and eliminates the need for a series of movements previously required to see the comparator and its monitor/screen. The system has exceptional repeatability, is relatively easy to use, and provides a way to adjust all the contacts accurately and consistently.

Benefits

This optical contact adjustment system requires minimal preparation time, can be self calibrated and is ergonomically friendly. The processing time to adjust contacts has been reduced by approximately forty percent and the process itself simplified, resulting in an expected standard hour reduction of thirty percent for this process. The computerized viewing screen shows a visual image that is easy to calibrate. The system is calibrated prior to each group of parts to be adjusted. The computerized system also provides an easy-to-interpret, green and red "go / no go" display that tells the operator which contacts have been adjusted to the required gap. These individual displays offer a way to verify that all contacts are complete and adjusted correctly.

Inter-Complex Technology

Other agency and manufacturing facilities may be able to adapt similar virtual imaging calibration systems using equivalent technology.

Other Uses

Along with contact adjustment capability, this type of computerized virtual display projection system can be used for other applications such as clearance adjustments in escapement assemblies, contact parallelism in similar units and other measuring opportunities.

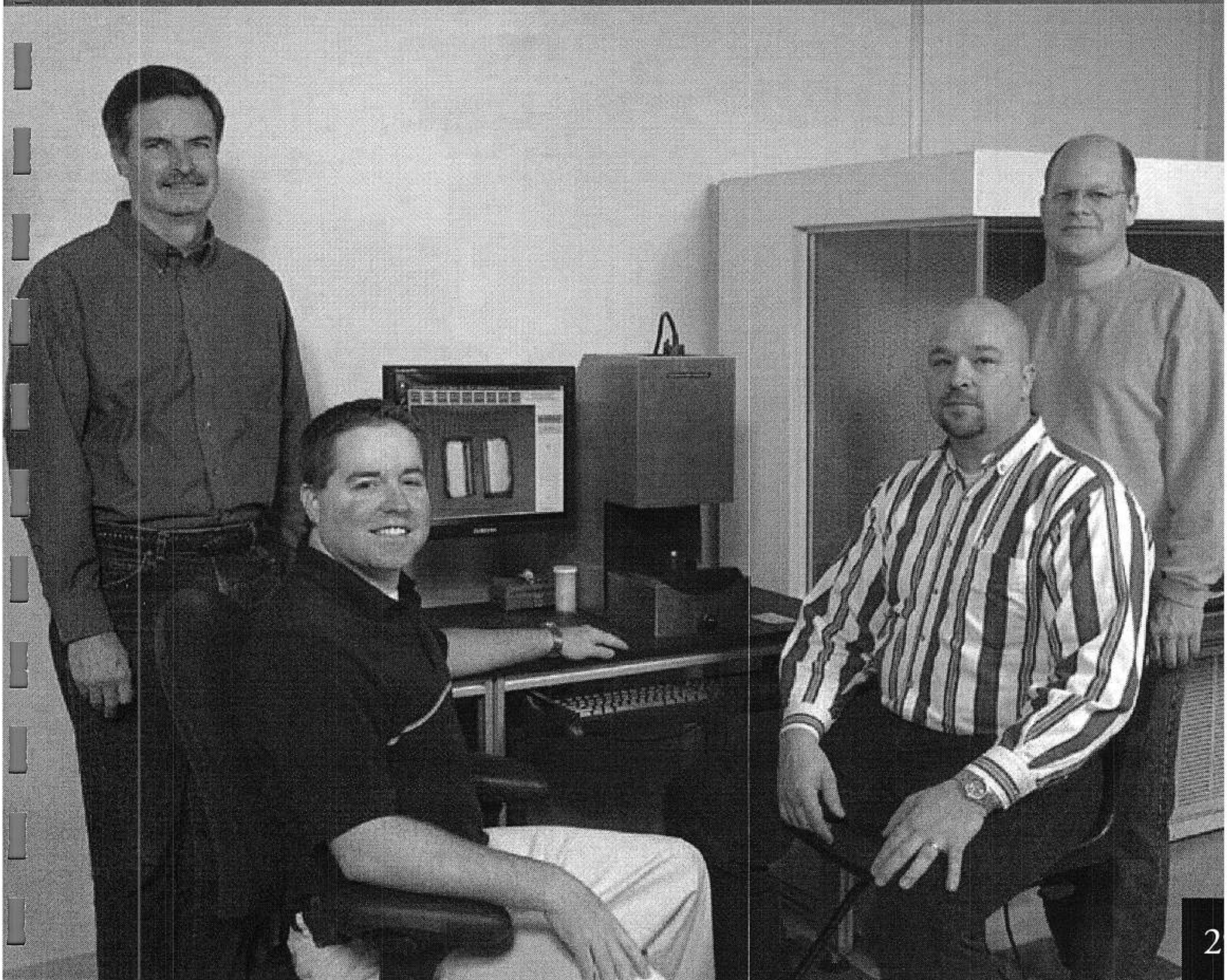
Tim Castillo (not pictured) received a bachelor's in electrical engineering from New Mexico State University. He has worked in the mechanisms department at the Kansas City Plant for nineteen years. As a product engineer, Tim is responsible for product, process and project leads for an inertial switch on the W76-1.

Craig Humphrey (left) earned a bachelor's in mechanical engineering from the University of Kansas. He has been at the Kansas City Plant for more than sixteen years with quality engineering responsibility – the last four of which have been in the mechanisms department. Craig is Green Belt certified.

Greg Thompson (right) received a bachelor's in mechanical engineering from the University of Kansas. He has spent twenty-three years at the Kansas City Plant, working as both a principal engineer and a gage engineer. Greg is a certified Six Sigma Black Belt.

Matt Willoughby (middle left) earned a bachelor's in industrial engineering and a bachelor's in manufacturing systems from Kansas State University. Currently, he is working on his master's in manufacturing engineering at the University of Missouri – Rolla. Matt is employed as a product / process engineer on the W76 launch accelerometer. He is also the product engineer for enhanced surveillance on environmental switching device switches. Matt is a certified Six Sigma Green Belt.

Kevin Schimpf (middle right) received a bachelor's in mechanical engineering from the University of Missouri - Rolla. He has worked for the Kansas City Plant for ten years, three of which were spent as a resident at Lawrence Livermore National Laboratory working for the National Ignition Facility. Kevin is a project lead engineer for an inertial switch used on the W87 fireset. He is also the product and process engineer for assemblies pertaining to the inertial switch. Kevin is a certified Six Sigma Green Belt.



Telemetry & Test Equipment

Cushion Test Systems

Cellular silicone material is used in the production of cushions and pads, which are critical components to weapon design and function. The cushions and pads are used to: 1) maintain position of surrounding parts by applying the appropriate force; 2) compensate for dimensional changes of adjacent components due to thermal variations; and 3) allow for tolerance stack-up in weapon assembly. The cellular silicone used in cushions and pads refers to an open-cell, flexible silicone material available in varying densities or porosities. The variety of densities or porosities results in various load deflection properties, allowing this material to be used in applications ranging from a thin cushion to a thick pad.

For approximately thirty years, these load deflection properties were tested at the Kansas City Plant using hydraulic-driven systems that have become outdated. In 2005, those systems were replaced with modern electromechanical systems.

Cushions and pads are now tested by placing the cushion material on a test platen that is raised until it contacts a load cell, which is a device that determines the force being exerted against it. The test system measures the thickness of the cushion and the corresponding force as the cushion is being compressed. This digitized data is then used for analysis/acceptance and plots.

Dramatic improvements in reliability, accuracy and repeatability of the new test systems are complemented by improvements in operator safety and ergonomics. These improvements include a new compact actuator design, a laser measurement and control system that actively monitors compression, a full light curtain for operator safety, and immediate graphical output of test results.

Benefits

Cushions and pads provide a vital element of nuclear safety, and it is paramount that they perform to their specifications. The cushion test systems ensure these parts meet specifications prior to shipment from the Kansas City Plant.

Converting from a hydraulic system to an electromechanical system was a major improvement. Purity of the hydraulic oil was so critical that the pumping station had to incessantly filter the oil, which was a source of constant noise in the area. The old system also had leaks resulting in oil waste and environmental safety and health concerns. The electromechanical systems are quieter and cleaner.

The new systems are also safer. They use a "light curtain" consisting of a light beam that bounces off mirrors located at the four corners of the load frame. If an inspector reaches toward a moving part, this beam is broken, stopping the actuator.

The new systems provide "load cell deflection compensation" resulting in more accurate readings. When a force is exerted against the load cell, the load cell itself deflects. This deflection can be up to 900 micro inches when force is applied. The software maintains a "load cell deflection" table to compensate for this movement, resulting in more accurate readings.

When they have not been used for awhile, load cells must be exercised, or conditioned prior to use. The load cell is conditioned by applying and removing a maximum force for five cycles. The new systems keep track of the load cell usage and automatically condition the load cell if a specified amount of time has elapsed without use.

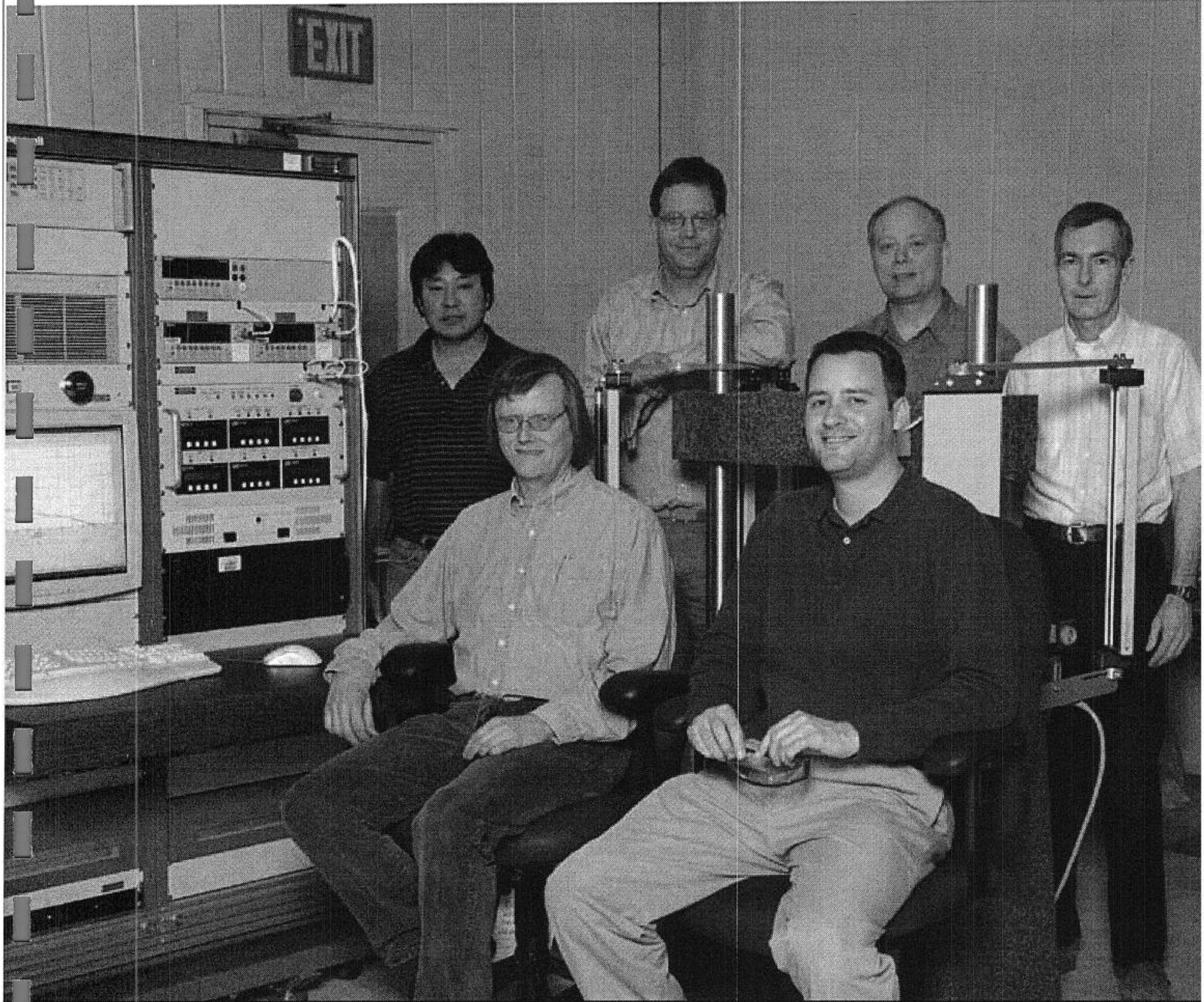
The old systems had a limit of two hundred different cushion types that could be defined at any one time. Once this limit was reached, a cushion type had to be removed before adding a new cushion type. On the new systems, testing of each type of cushion is driven by a parameter table in Microsoft Access with no such limitation.

Inter-Complex Technology

Engineers at Sandia National Laboratories, Los Alamos National Laboratory and Lawrence Livermore National Laboratory develop specifications for cushions and pads that are manufactured and tested at the Kansas City Plant. The new test systems will help ensure we provide timely and accurate data on the characteristics and acceptability of these cushions.

Other Uses

The cushion test systems may be used in other applications where it is desirable to take digitized force and thickness measurements as a product is being compressed. The built-in analysis and plots may then be used to examine results, or the digitized data can easily be imported into Microsoft Excel to perform custom analysis. There has already been one request to use the testers in this manner.



Kiwon Yoon (top left) received a bachelor's in electrical engineering from the University of Missouri – Rolla and a master's in electrical engineering from the University of Missouri – Columbia. He is a senior engineer and test equipment consultant with twenty-three years of experience at the Kansas City Plant. Kiwon used the new cushion test systems to earn his Design for Six Sigma certification.

Dan Brantley (second from top left) has an associate's from Longview College and a bachelor's in management from Baker University. He is an Engineer III who has been at the Kansas City Plant for seven years in the test equipment department. He recently received an NNSA Weapons Award of Excellence and has earned his Design for Six Sigma certification.

Bill Roberts (bottom left) received a bachelor's in computer science from Kansas State University. He is a principal engineer and has spent twenty-five years at the Kansas City Plant in the test equipment department. Bill recently earned his Design for Six Sigma certification.

Stephen Hatch (second from top right) has a bachelor's in mechanical engineering from Brigham Young University. He is a senior engineer in test equipment mechanical design with twenty-one years of experience and has earned his Design for Six Sigma certification.

Cole Young (bottom right) received an associate's in science from Kansas City Kansas Community College and a bachelor's in electronic engineering technology from Pittsburg State University. He is an Engineer III and has worked in the test equipment department for two years. He recently earned his Design for Six Sigma certification.

Larry Everly (top right) received an associate's in electronics from Central Technical Institute and a master's in management from Avila University. He is an electronic equipment technician and has worked in the test equipment department for thirty-six years.

Long Stroke **Shaker**

The Kansas City Plant's metrology department developed an enhanced test system for calibrating accelerometers. Accelerometers are sensing transducers that provide an electrical output proportional to the vibration and shock that occurs when a structure experiences motion. A precise calibration of the accelerometer used to control and monitor product as it is tested is necessary to meet the customer's test requirements for their product at different acceleration levels and frequencies.

The department's previous calibration system had a lower frequency limit of 10 Hz, which didn't support customer requirements for testing down to 5 Hz for the W76 life extension program or for testing transportation containers under the Work for Others program. By integrating a long stroke shaker and power amplifier with the existing system's vibration controller, the metrology department created a new system that is capable of calibrating accelerometers down to a frequency of 2 Hz with an uncertainty not exceeding ± 5 percent. The new system has the additional capability to provide 5-inch peak-to-peak sinusoidal displacement, which allows for accelerometer calibrations at higher acceleration levels for frequencies ranging from 2 Hz to 100 Hz. The prior system's 0.5-inch displacement limited the acceleration levels at frequencies from 10 Hz to 100 Hz.

As part of a Six Sigma project, software was also developed to automate the calibration process over the expanded frequency and displacement ranges. The automated process controls both the vibration controller and long stroke shaker, setting up the test at the appropriate acceleration levels and frequencies and providing data acquisition and analysis. Data acquisition involves measuring the electrical parameters at the specified acceleration levels and frequencies to perform data analysis to characterize the accelerometer sensitivity at each test condition.

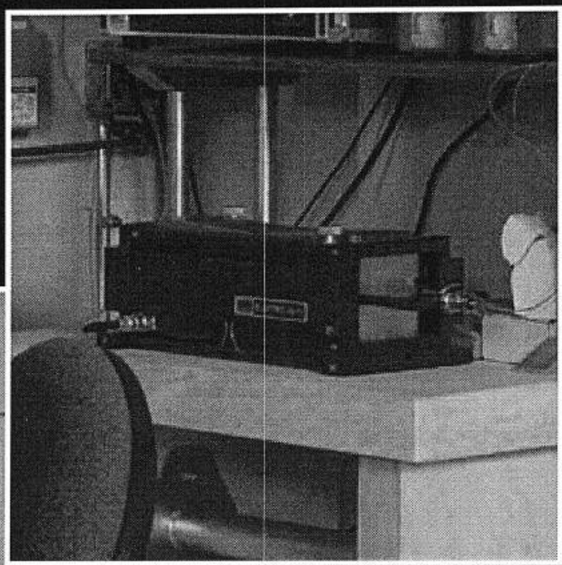
Benefits

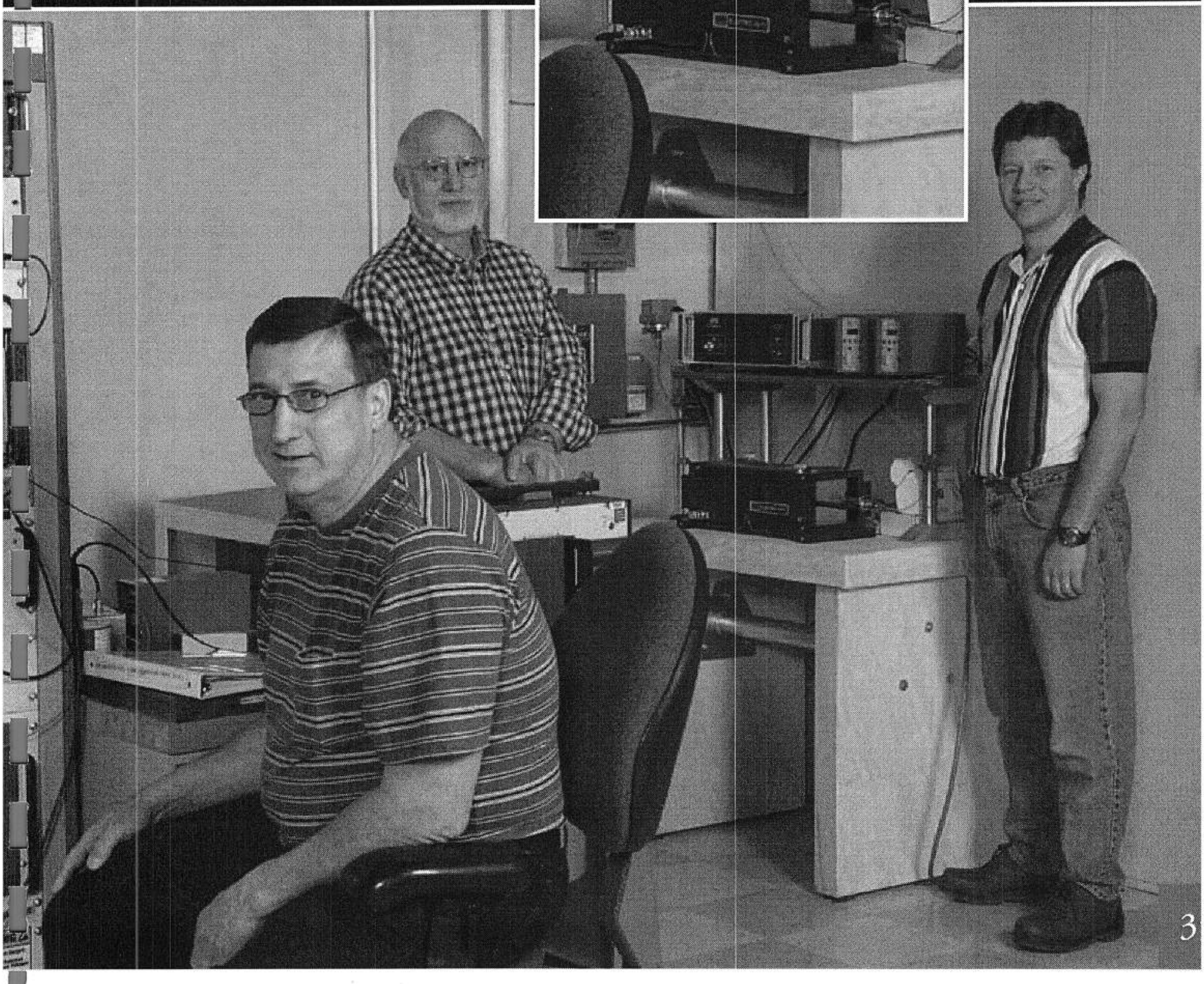
- System development has provided world-class accelerometer calibrations with minimal uncertainty using state-of-the-art equipment at low frequencies. This has been vital to the W76 life extension program and transportation-related new business. Now it is no longer necessary for customers to change their product specifications, and tests are not limited to a low frequency of 10 Hz.
- The new system is capable of determining an accelerometer's sensitivity at the time of test with an estimated uncertainty of ± 2.6 percent at 2 Hz and ± 1.9 percent at 5 Hz, thus exceeding customer requirements.

Bill Mosier is a senior engineering technologist and has been at the Kansas City Plant for twenty-eight years – fourteen years in the environmental and test labs and fourteen years in the metrology services department. In this position, Bill is responsible for calibration of accelerometers for shock and/or vibration at various frequencies, durations and amplitudes.

Ron Russell received a bachelor's in general engineering from the University of Missouri – Kansas City. He is a Six Sigma Green Belt-certified principal engineer and has been at the Kansas City Plant for thirty-nine years, where he has worked in metrology and advanced inspection development departments. In his position, Ron is responsible for shock and vibration calibrations. Ron received STARR awards in both 1998 and 2000.

Randy Herder earned a bachelor's in electrical engineering from Kansas State University. He is a principal engineer and has been at the Kansas City Plant for seventeen years in the metrology engineering department. In this position, Randy is responsible for radio frequency and microwave calibrations as well as time and frequency calibrations. He is certified as a Six Sigma Green Belt.





PT3300 to PT3800 Translator Program

The Kansas City Plant developed a translator program to convert hundreds of software instruction sets on the Product Tester (PT) PT3300 for use on the newer PT3800 (a PT performs acceptance testing on a product). Significant difficulties were expected as the existing files were in a loosely structured format, and the desired output was a highly structured, strictly validated extensible markup language (XML) file.

The original files were developed by more than thirty people over twenty years' time, and their design was a reflection of decades-old technology. For example, the files were designed so only the first two characters of file section and keyword values had any meaning. The remainder of these words was spelled in a variety of ways. This resulted in a vast number of permutations in the file contents that had to be recognized for conversion.

This file structure was acceptable for linearly "driving" the tester but was detrimental when attempting to convert the files to a new format. Therefore, regular expressions were used to examine the file contents at a broader level, and patterns were defined to capture large sections of data. This captured data could then be further examined by using sub-patterns until the underlying data was captured. This regular-expression approach simultaneously found the data and validated it. It then allowed a complete conversion of the existing data into XML format while providing inherent mistake-proofing of the captured data.

Benefits

The translator technology provides the NNSA with a number of benefits. The primary near-term benefit is confidence in the PT3800's ability to test product exactly as the PT3300 did. The Kansas City Plant's software provides higher quality, as it ensures all files were converted using the same decision-making process. This is particularly important because some aspects of the files could be translated in different ways and still be correct.

A manual conversion process would have required more resources, produced less consistent output files and heightened the risk of errors. The software translator approach, however, reduced variability, caught unexpected conditions, allowed for future changes and did not introduce manual errors. Further, as the PT3800 development process continues, the software automates changes in the structure of these files. This approach allows the entire set of files to be reconverted in a matter of hours.

This project's resulting XML files provide a long-term benefit for the NNSA. Today, computer hardware changes rapidly, requiring aging testers to be replaced more often than in the past. With this in mind, the XML structure was selected for the converted files because:

- Databases directly support XML for inserts and manipulation.
- The strictly structured, fully defined XML format provides syntax for conversion.
- The XML files will directly provide patterns for future regular expressions.

In addition, because processing captured data is often a pattern recognition process, the approach used to develop this technology will directly apply to future test equipment projects. The use of regular expressions and pattern matching will reduce the time needed to develop software for parsing and processing data. Further, it provides a better means to validate software, as the developed patterns can be easily checked and documented.

Finally, this regular expression approach decreases tester development time while increasing software quality. Specification changes could be handled simply by changing the underlying pattern definitions. This pattern approach also provides increased confidence that data manipulation yields desired results. Knowledge gained from this project is being shared with other developers to further increase its benefit to the NNSA.

Inter-Complex Technology

Fifteen copies of the PT3300 are currently in use. Fourteen of these testers are at the Kansas City Plant, and one is at Pantex. The PT3300 is the workhorse of the complex, testing nearly every product that leaves the Kansas City Plant as well as performing additional product testing at Pantex. It must be replaced, however, due to technology obsolescence, maintenance difficulties, parts unavailability and the loss of key personnel. The PT3800 will be functionally identical to the PT3300 in terms of the stimulus and measurement signals seen by a unit under test.

The inter-complex impact of this technology will primarily involve qualification activities for the PT3800. The sets of converted test instructions must be qualified to ensure that the PT3800's product analyses are consistent with those of the PT3300. The use of the software translator will provide qualification teams an opportunity to examine the conversion process for all converted files by examining the software. This approach will minimize the time and resource impact of the qualification process for the new PT3800 across the complex.

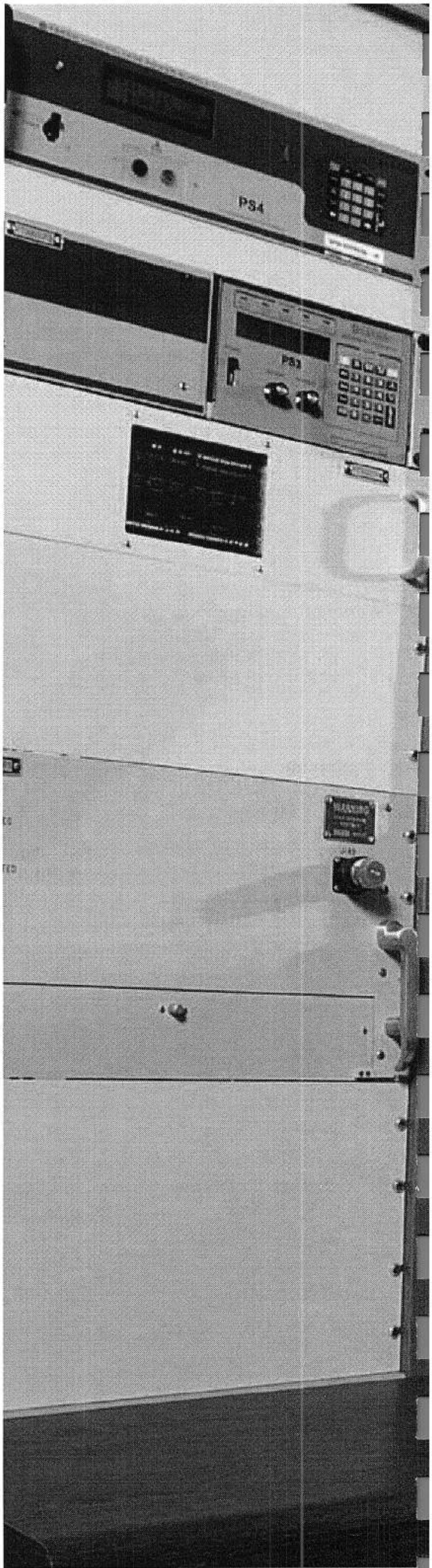
Other Uses

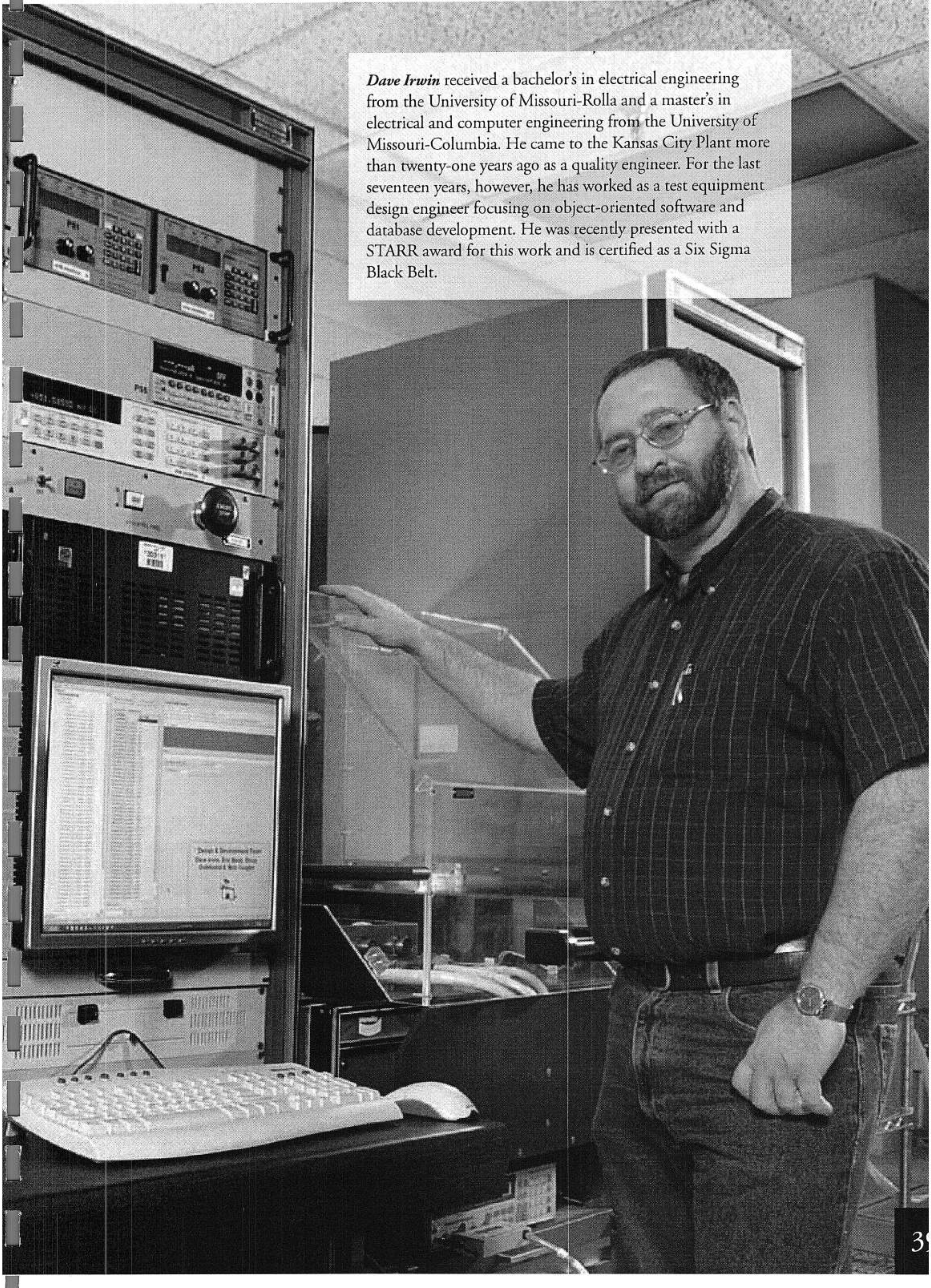
The regular-expression technology that underlies this translator is directly impacting other parts of the same project. The patterns used for the translator were also applicable to parts of the tester executive software. A test application "builder" software project is also being developed to allow new test files for the PT3800 to be generated quickly and easily with built-in validation. The same patterns developed for the translator were directly reusable in this application builder. Like the translator, the fact that the data being manipulated passes the regular-expression pattern provides direct validation of the data contents. Thus, mistake-proofing is built in for future test applications on the PT3800. Also, many of the regular expression patterns developed are generic enough to be used on other test systems developed in the future. Finally, general use of regular expressions will reduce the need for complex-customized parsing software in other test equipment development projects.

STARR Awards

A STARR award was presented to Dave Irwin on September 19, 2005, in recognition of this work. The translator program automated a process that is estimated at nearly 10,000 man-hours if performed manually. The magnitude of this effort would have required multiple people to accomplish it in a reasonable time. Using multiple people to interpret these complex files would have introduced undesirable differences in the actual conversion process. The software approach taken allows for changes to be made in the desired output format, and the files can be reconverted in a matter of hours. Further, the use of this technology process will have a positive impact on the qualification process for the replacement tester.

For more information on STARR awards, please see pages 49 – 50.





Dave Irwin received a bachelor's in electrical engineering from the University of Missouri-Rolla and a master's in electrical and computer engineering from the University of Missouri-Columbia. He came to the Kansas City Plant more than twenty-one years ago as a quality engineer. For the last seventeen years, however, he has worked as a test equipment design engineer focusing on object-oriented software and database development. He was recently presented with a STARR award for this work and is certified as a Six Sigma Black Belt.

Temperature Calibration

In 2004, a Six Sigma project was chartered to eliminate an excessive temperature calibration backlog. As a result, software was developed by the Kansas City Plant that dramatically improves both temperature calibration capability and capacity. The calibration of temperature instruments was manual in the past, requiring the operator to enter the data into conversion software by hand, and then record the result in a calibration worksheet. The newly developed software, which was implemented in January 2005, automatically determines when a reading is stable, collects data from those devices that have an interface, converts the data, and enters the resultant data in a document that meets the requirements for a calibration worksheet. Following data collection, the software automatically adjusts the oven or temperature bath for the next measurement point.

By allowing rapid data collection from multiple instruments and sensors, the software reduces errors due to temperature drift during data collection. All in-process data is displayed graphically for ease of use and troubleshooting.

Approximately fifty percent of the instruments cannot be interfaced to a computer. For these instruments, the software allows for manual input from the test instrument, automatic input from the reference instrument, and automatic control of the oven or temperature bath. This partial automation of the process results in a twenty-five percent reduction in calibration time. For those processes that are entirely automated, the calibration can be started at the end of the day and concluded over night. This is very valuable to processes that can require up to forty hours of work to complete. Processes that are completely automated have resulted in a reduction in calibration time of approximately fifty percent.

Currently, the software can be used on approximately three hundred temperature instruments calibrated in the temperature lab which is equivalent to approximately fifty percent of temperature related calibrations. Because new instruments being purchased today can interface with computers, the number of calibrations that can be used with this software is steadily increasing.

Capabilities / Features

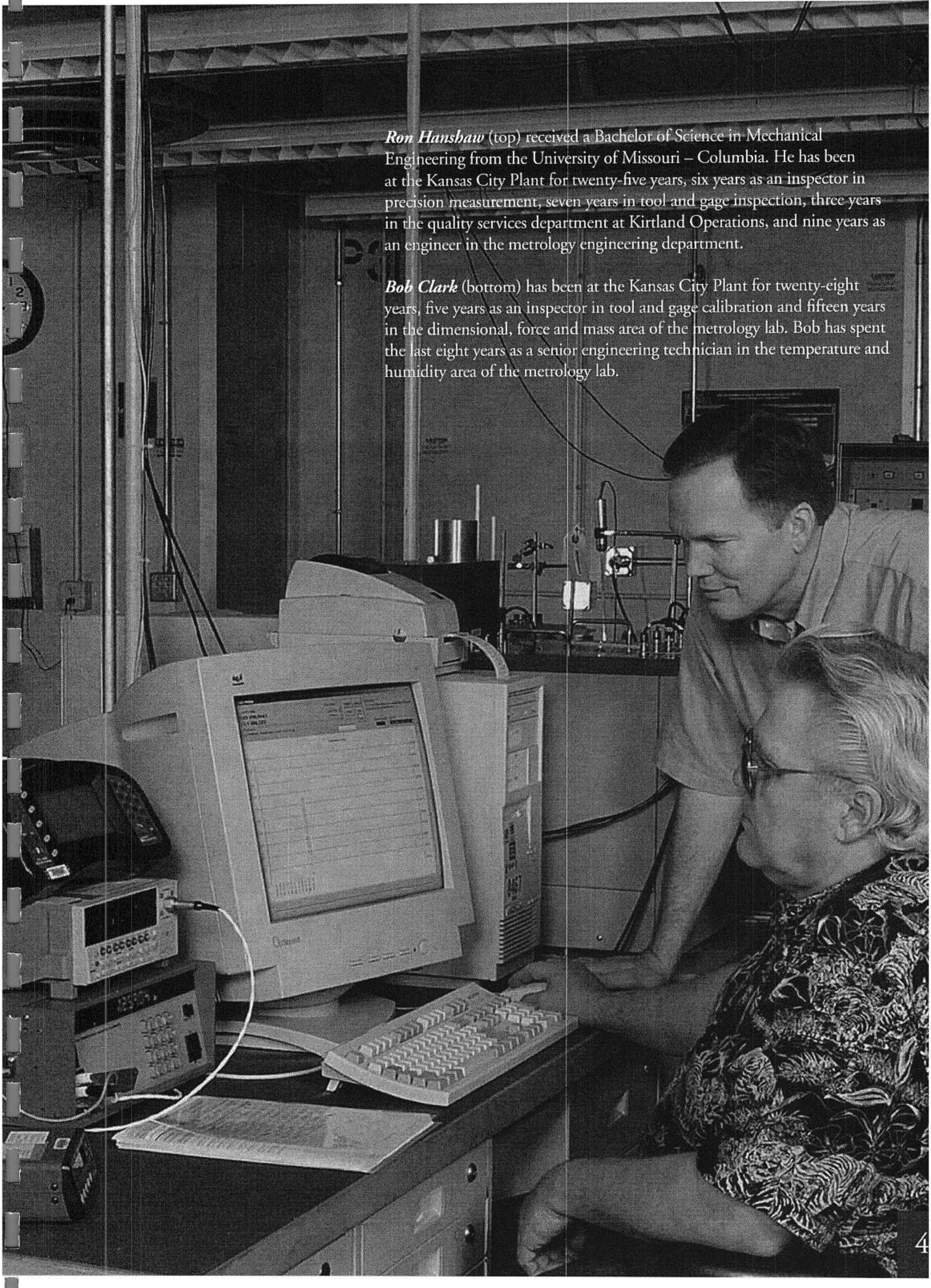
- Calibrating a variety of instruments including thermistor thermometers, thermocouples, resistance and standard platinum resistance thermometers, thermocouple readouts and thermocouple calibrators.
- Conducting as many as six calibrations concurrently.
- Completing a calibration with minimal human interaction.
- Automatically converting resistance or voltage into Celsius or Fahrenheit.
- Automatically placing data into a worksheet that meets the work instruction requirements for a calibration worksheet.
- Compatible with Windows 2000 and XP operating systems with a serial port and IEEE-488 interface installation.
- Easy-to-use graphical interface requiring less than two hours of training.
- Reducing calibration time by at least fifty percent.

Benefits

Before implementing the software, there were numerous hours of backlog in the temperature lab and workload was steadily increasing. Other departments' technicians were brought over to assist with the calibrations. The use of this automated temperature calibration software has resulted in a reduction of backlog in the temperature lab of greater than fifty percent and therefore, it is no longer necessary to recruit other technicians to assist. The software has almost completely eliminated operator input errors and significantly increased the consistency of calibrations. Additionally, the reduction in man hours per job has resulted in a cost savings of $14,500, with much greater cost savings expected in the future as more equipment is automated.

Other Uses

This software could also be used on humidity equipment as interfaceable humidity equipment becomes more prevalent.



Ron Hanshaw (top) received a Bachelor of Science in Mechanical Engineering from the University of Missouri – Columbia. He has been at the Kansas City Plant for twenty-five years, six years as an inspector in precision measurement, seven years in tool and gage inspection, three years in the quality services department at Kirtland Operations, and nine years as an engineer in the metrology engineering department.

Bob Clark (bottom) has been at the Kansas City Plant for twenty-eight years, five years as an inspector in tool and gage calibration and fifteen years in the dimensional, force and mass area of the metrology lab. Bob has spent the last eight years as a senior engineering technician in the temperature and humidity area of the metrology lab.

Transfer Software

At the request of Los Alamos National Laboratory (LANL), the Kansas City Plant designed and implemented software to transfer detonator test data and waveforms to a classified server for analysis by multiple engineers. A system at LANL tests and records waveform data for detonators classified at the Confidential Restricted Data (CRD) level. This information is stored on removable hard drives in the tester in the form of a Microsoft Access database and custom binary waveform files. An ActiveX.exe application was written for the tester to display and analyze this data and waveforms.

Two new applications were written and incorporated at LANL to:

- Transfer new data and waveforms to a CRD CD-ROM using a CRD system at LANL.
- Transfer the new data (waveform files and database records) from the CRD CD-ROM to an Secret Restricted Data (SRD) server at LANL that is accessible by the appropriate engineers.

Benefits

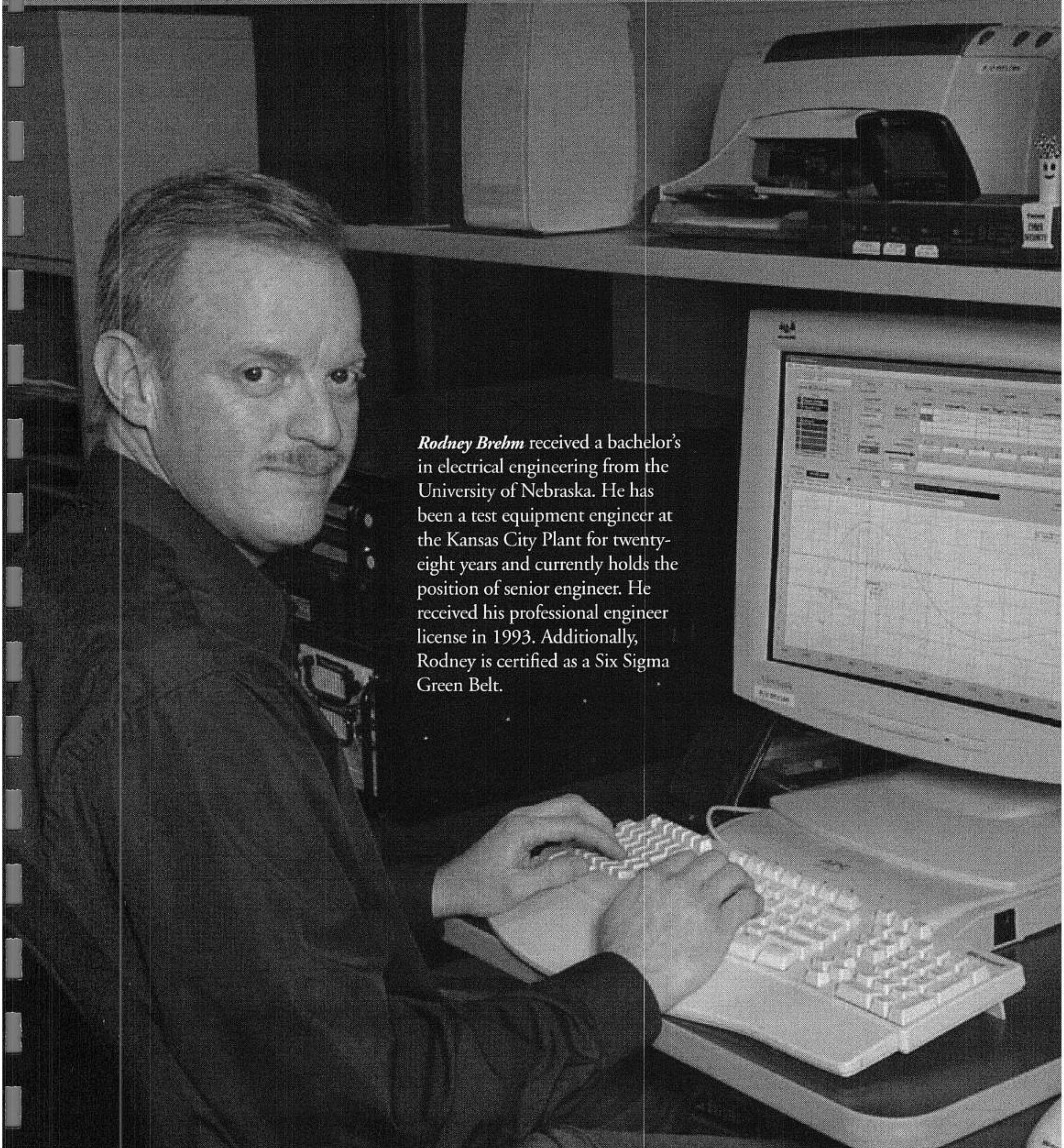
Having the test and waveform data available at each desk allows engineers to call up particular data that he/she is responsible for or has an interest in. Working at their own desk increases productivity and efficiency by letting them review the data at their convenience, rather than scheduling time on the tester (which is located in a different building). This also allows this particular test system to be used for testing while post testing analysis is being done on the engineer's computer.

LANL engineers have expressed their appreciation for having this tool at their disposal. The ability to apply filtering to the waveform data and to analyze timing information from their desk has been helpful in identifying specific characteristics, properties and trends of the detonators.

An additional benefit of having this test data on a server is that it is backed up on a regular basis, greatly reducing the risk of data being lost.

Inter-Complex Technology

Detonators are designed and used by multiple areas of the Nuclear Weapons Complex. The engineers at LANL work with these other areas in developing and testing detonators. Having the test data and waveforms available at individual desks allows engineers to support their customers in a more timely and convenient manner.



Rodney Brehm received a bachelor's in electrical engineering from the University of Nebraska. He has been a test equipment engineer at the Kansas City Plant for twenty-eight years and currently holds the position of senior engineer. He received his professional engineer license in 1993. Additionally, Rodney is certified as a Six Sigma Green Belt.

Conference **Papers**

Conference Papers / Presentations

At the Kansas City Plant, more than 200 technical publications were approved for public release in 2005. Two of the technologies found within this book, removable epoxy foam and the RTV foam cushion, have associated papers and presentations. We have highlighted each in a short-form list, followed by a more in-depth list that includes summaries.

Technology	Author/ Presentor	Date	Title of Paper/ Presentation	Conference	For more information, please see page:
Removable Epoxy Foam	Daniel Bowen III (author/ presenter), Elizabeth Nail (coauthor), Patricia Wilson (coauthor), Robert Sedlacek (coauthor), Ron Osborn (coauthor)	June 15, 2005	Scale-up Issues with Removable Epoxy Foam - Final Drying and Gel Formation	35th Annual PolyMAC Conference in Oak Ridge, Tennessee	10
Removable Epoxy Foam	Elizabeth Nail (author), Patricia Wilson (coauthor), Daniel Bowen III (coauthor)	June 7, 2004	Removable Epoxy Production Scale-Up at KCP	34th Annual PolyMAC Conference in Albuquerque, New Mexico	10
Removable Epoxy Foam	Elizabeth Nail (author), Patricia (Tricia) Wilson (coauthor), Daniel Bowen III (coauthor)	January 25, 2005	Removable Epoxy Production Scale-Up at KCP	Foams Conference at Sandia National Laboratories in Livermore, California	10
RTV Foam Cushion	Jim Schnieder	November 14-18, 2005	KCP Supported Aging Study Activities for the Newly Developed RTV Blown Foam Materials	JOWOG (Joint Working Group) 28 Main Meeting in Las Vegas, Nevada	13
RTV Foam Cushion	Daniel Bowen III	June 14 – 16, 2005	Insights into the Mechanisms of Sn(II) Carboxylate Catalyzed RTV Blown Silicone Foam	35th Annual PolyMAC Conference in Oak Ridge, Tennessee	13

Removable Epoxy Foam

Title: Scale-up Issues with Removable Epoxy Foam - Final Drying and Gel Formation
Authored / Presented By: Daniel Bowen III (author/presenter), Elizabeth Nail (coauthor), Patricia Wilson (coauthor), Robert Sedlacek (coauthor), Ron Osborn (coauthor)
Conference: 35th Annual PolyMAC Meeting at Y-12
Date: June 15, 2005

Summary: Removable epoxy resins are required as new encapsulation and coating materials for the W-76 arming, fuzing and firing system. In order to produce these materials, chemical synthesis of maleimideconstituents is required. The challenging task of managing the technology transfer and scale-up process is an important role of the Kansas City Plant's polymer production and material science department. A two-component kit is necessary for each foam (REF308, REF320, RSF200) and the conformal coating / adhesive (RCC200). Each Part A is a mixture of removable resins that are produced batchwise with tight controls and oversight in four steps. Each Part B contains commercial curing agents, which are mixed and repackaged by the Kansas City Plant. Production processes for all steps of the resin production have been completed at the Kansas City Plant including the challenging synthesis of two removable epoxy resin precursors, four hydroxyphenylmaleimide (4HPM) and RER bismaleimide. Significant hurdles where overcome to make progress in the optimization and scale-up of the resin materials.

A copy of the full conference paper / presentation is available upon request. *For more information, please see pages 8-11.*

Title: Removable Epoxy Production Scale-Up at KCP
Authored / Presented By: Elizabeth Nail (author), Patricia Wilson (coauthor), Daniel Bowen III (coauthor)
Conference: 34th Annual PolyMAC Meeting at Sandia National Laboratories, Albuquerque
Date: June 7, 2004

Summary: Significant progress has been made toward the Kansas City Plant's goal of scaling-up and producing the two critical chemical precursors enabling removable epoxy technology. This presentation describes our significant process improvements in the work-up and isolation of four hydroxyphenylmaleimide (4HPM). Specifically, we describe advances made to the crystallization and recrystallization process for isolating the 4HPM. We further describe progress made toward full scale production of the bismaleimide (BMI) component.

A copy of the full conference paper / presentation is available upon request. *For more information, please see pages 8-11.*

Title: Removable Epoxy Production Scale-Up at KCP
Authored / Presented By: Elizabeth Nail (author), Patricia (Tricia) Wilson (coauthor), Daniel Bowen III (coauthor)
Conference: Foams Conference at Sandia National Laboratories in Livermore, California
Date: January 25, 2005

Summary: Both bismaleimide (BMI) and four hydroxyphenylmaleimide (4HPM) are critical noncommercial precursors enabling removable epoxy technology, including removable epoxy foam technology, which is required for the W-76 arming, fuzing and firing system. Materials engineering at the NNSA's Kansas City Plant has engaged in a significant effort to scale-up and produce both of these materials. Significant improvements in the process for synthesizing BMI are described. The elimination of residual moisture from all reactants and our move towards a closed reactor system are described.

A copy of the full conference paper / presentation is available upon request. *For more information, please see pages 8-11.*

RTV Foam Cushion

Title: S5370 Silicone Foam Replacement Developments at KCP – Implications of Formulations Changes
Authored / Presented By: Daniel Bowen III
Conference: 35th Annual PolyMAC Conference in Oak Ridge, Tennessee
Date: June 14-16, 2005

Summary: Dow Corning's RTV silicone blown foam, S-5370, has been used in a variety of applications including stress cushions. Unfortunately, S-5370 went off the market in 1995 and is no longer commercially available. A replacement resin, LK3626, was developed by the Kansas City Plant and Los Alamos National Laboratory. The Kansas City Plant had difficulties meeting new load deflection requirements along with the part weight / density requirements for parts made with LK3626. By adjusting the LK3626 formulation, the cross-link density of the foam can be changed and thus the load. The formulation was adjusted by multiple methods to achieve the desired stress strain behavior. This presentation details the chemistry and presents a model to explain the resulting change in cross-link density.

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 12 - 15.

Title: S5370 Silicone Foam Replacement Developments at KCP – Characterization of Formulations Changes
Authored / Presented By: Eric Eastwood
Conference: 35th Annual PolyMAC Conference in Oak Ridge, Tennessee
Date: June 14-16, 2005

Summary: Dow Corning's RTV silicone blown foam, S-5370, has been used in a variety of applications including stress cushions. Unfortunately, S-5370 went off the market in 1995 and is no longer commercially available. A replacement resin, LK3626, was developed by the Kansas City Plant and Los Alamos National Laboratory. The Kansas City Plant had difficulties meeting new load deflection requirements along with the part weight / density requirements for parts made with LK3626. By adjusting the LK3626 formulation, the cross-link density of the foam can be changed and thus the load. The formulation was adjusted by multiple methods to achieve the desired stress strain behavior. This presentation presents the stress strain behavior for the multiple methods used to adjust the formulation and potential impacts.

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 12 - 15.

Title: KCP Supported Aging Study Activities for the Newly Developed RTV Blown Foam Materials
Authored / Presented By: Jim Schneider
Conference: JOWOG (Joint Working Group) 28 Main Meeting in Las Vegas, Nevada
Date: November 14-18, 2005

Summary: Los Alamos National Laboratory has established the foundation for the most comprehensive aging study to date concerning RTV silicone blown foam materials. The aging study has an estimated start date of January 2006 evaluating three different RTV formulations: SX358, SX462 and LK3626. This presentation will provide insight into Kansas City Plant activities supporting this aging study. These activities include multiple mechanical response tests and chemical analysis of crosslink density by solvent swelling. RTV samples of varying thickness and density from the three formulations will be exposed to varying temperatures and compressions. A limited number of RTV samples from the above conditions will also be exposed to environments of dry air and nitrogen during aging.

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 12 - 15.

Title: Insights into the Mechanisms of Sn(II) Carboxylate Catalyzed RTV Blown Silicone Foam
Authored / Presented By: Daniel Bowen III
Conference: 35th Annual PolyMAC Conference in Oak Ridge, Tennessee
Date: June 14-16, 2005

Summary: A lack of institutional knowledge regarding the specific role of the tin catalysts (Sn(II) 2-ethylhexanoate) in curing RTV silicones necessitated a review of the literature in this area. Based on the literature, two new mechanisms are proposed of specific interest to the W76 life extension program 5370 RTV blown silicone foam replacement containing diatomaceous earth. These two new mechanisms, based on similar reactions catalyzed by Sn(IV) bisalkyl carboxylate catalysts, are presented. A number of implications of the proposed mechanisms are highlighted as they impact certain practical aspects of S5370 RTV silicone foam replacement. The proposed mechanisms will be correlated with preliminary supporting data.

A copy of the full conference paper / presentation is available upon request. For more information, please see pages 12 - 15.

STARR Awards

STARR Awards

For the past eight years, the Kansas City Plant has used the Significant Technical Achievement Reward & Recognition (STARR) program to recognize associates for technical and innovative achievements in five categories. Technical peer review teams are involved in making the final selection of technology winners. In 2005, only eight individuals received a prestigious STARR Award. The following individuals (listed alphabetically by technology) were recipients of the award in 2005, as related to the technical achievements contained in this book.

Technology	Inventor	Date Received	Comments	For more information, please see page:
PT3300 to PT3800 Translator Program	Dave Irwin	09/2005	A STARR award was presented to Dave Irwin on September 19, 2005, in recognition of this work. The translator program automated a process that is estimated at nearly 10,000 man-hours if performed manually. The magnitude of this effort would have required multiple people to accomplish it in a reasonable time. Using multiple people to interpret these complex files would have introduced undesirable differences in the actual conversion process. The software approach taken allows for changes to be made in the desired output format, and the files can be reconverted in a matter of hours. Further, the use of this technology process will have a positive impact on the qualification process for the replacement tester.	38
Removable Epoxy Foam	Daniel Bowen III	09/2005	Dan Bowen, senior scientist in materials engineering and polymer production, developed and implemented significant process changes to overcome show-stopping obstacles encountered during scale-up to production of removable epoxy foam. Originally developed at Sandia, this material is critical for W76-1 arming, fuzing and firing production. The transfer and scale-up of this material was far more complicated than originally envisioned by Sandia National Laboratories and the Kansas City Plant. Dan's work allowed the chemistry to be better understood so that war reserve quality requirements for the material could be met. Numerous technical issues that threatened the synthesis of the BMI intermediate were overcome by Bowen's innovative process techniques. Purity and consistency of the BMI product were greatly improved by his extensive redesign of the manufacturing process, which implemented novel changes to minimize moisture throughout the synthesis process. The resulting process yields a highly consistent material that has a greater purity than that produced in the laboratory, the opposite of the result normally encountered during scale-up of chemical syntheses. Two invention disclosures resulted from work on this product by the entire project team.	10
RTV Foam Cushion	Eric Eastwood	09/2005	Dr. Eric Eastwood was awarded a 2005 STARR award for playing a key role in the investigation and formulation of the chemical composition of a critical RTV silicone foam material. Through his understanding of chemistry and polymer processing, he was able to lead the customer (Los Alamos National Laboratory) and the Kansas City Plant to a detailed understanding of this material and its properties. This understanding led to changes in the formulation which allowed the successful manufacturing of silicone RTV foam stress cushions for the W76-1 life extension program. This effort exceeded design agency expectations and garnered high praise from Los Alamos National Laboratory and the NNSA. Eric's innovative analysis of elastomer structure-property relationships linked the relationship of the chemical reactants to the material's ultimate properties. One critical aspect of this work was the establishment of a design space from which the physical properties of the silicone foam were predicted from the molecular weights of the reactants. Eric also developed a novel approach to measure the extent of reaction by monitoring hydrogen evolution from the material as it cured. This also allowed the Kansas City Plant to assure that the new formulation met design requirements for long term performance. LANL product realization team members stated that Eric's work significantly elevated the nuclear weapons complex's knowledge of the science that governs silicone elastomer chemistry, processing and performance.	13