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## AMTEX First Quarter FY96 Report

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# The AMTEX Partnership™



December 1995

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# The AMTEX Partnership™

## First Quarter Report Fiscal Year 1996

December 1995

MASTER

Issued by  
The AMTEX Program Office

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and

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## **EXECUTIVE SUMMARY**

The AMTEX Partnership™ is a collaborative research and development program among the U.S. Integrated Textile Industry, the Department of Energy (DOE), the national laboratories, other federal agencies and laboratories, and universities. The goal of AMTEX is to strengthen the competitiveness of this vital industry, thereby preserving and creating U.S. jobs.

### **Operations and Program Management**

The operations and program management of the AMTEX Partnership is provided by the Program Office. This report is produced by the Program Office on a quarterly basis and provides information on the progress, operations, and project management of the partnership.

### **Program Office Operations and Management**

The AMTEX Operating Committee meeting scheduled for December 1995 was changed to a meeting solely for the Industry Operating Board. The meeting was hosted by Fieldcrest Cannon at their headquarters in Kannapolis, North Carolina. The industry leaders expressed strong support for AMTEX and a desire to see it continue. Brief technical progress reports from the industry project directors were heard. In the face of insufficient funds to continue all activities, the industry board gave the program office the guidelines of priorities for allocation of the available FY96 funds.

Two workshops were held to continue with the development of an Option Agreement that would be suitable for multilaboratory CRADAs. A laboratory working group developed a draft document that was subsequently reviewed and refined by a group with representatives from the industry, DOE headquarters, DOE field offices, several laboratories and the AMTEX Program Office. A final draft of the Option Agreement was prepared for final approval.

## **Projects**

### **Computer-Aided Fabric Evaluation**

Budget uncertainties have had a major impact on the project over the past quarter. Efforts on all tasks have been slowed down at the laboratories and, in some cases, suspended (Knit Vision Inspection System) or eliminated (Greige Vision Inspection and Imaging Colorimetry). These actions have prompted the team to reevaluate the current project plan,

make changes, and redirect efforts when necessary. Although some tasks have suffered a reduction in activities, the project remains focused on delivering value-added systems for greige, knit, and color inspection.

**On-Line Greige Inspection System** - The laboratory team continues making progress towards the July 1996 deployment of the Beta fabric inspection and machine diagnostic system. The specific work includes designing and building the integrated CAFE inspection hardware architecture, designing and fabricating the mounting support frames for the fabric and machine diagnostic systems, developing the real-time operating system, redesigning and optimizing sensor designs, advancing the inspection and interrogation algorithms, and drafting the preliminary process flow diagrams and Business Event Model for Greige Inspection. In addition to this, the team is preparing for an April Beta test of the Linear Diode Array (LDA). This advanced LDA includes a coherent light source and new optics for front-lit capabilities and a reduced footprint and weight.

**Knitting System** - The task team completed a proof-of-principle test of the vision system in place of the Alpha test identified in the project plan. This test is to compensate for lost funds that resulted in the effort being eliminated from current activities. Other work during the quarter included an investigation into the feasibility of deploying three technologies specifically for knit machine diagnostics. All have promise, but have been suspended, with the exception of the LDA. The team has also completed the final draft of the Knit Functional Description and Requirements Document (FD/RD). A change in the project management structure has occurred as a result of budget impacts. Sandia National Laboratories (SNL) are now responsible for deploying the knit inspection system with support from Argonne National Laboratory (ANL) and Oak Ridge National Laboratory (ORNL).

**Color Print Pattern Goods (CPPG)** - During the past quarter, the Color Print Pattern Goods (CPPG) task team selected a vendor and a vendor affiliate and continued in its endeavors to design, fabricate, and deploy the CPPG Alpha Hardware/Software configuration targeted for June 1996. These efforts included developing the CPPG Alpha test plan, establishing the Alpha Site selection committee, implementing the real-time system software for the test, porting code to the hardware suite, enhancing the color print detection and classification algorithms, and developing a new feature extraction module for screen diagnostics. In addition, the CPPG team held a meeting to begin planning the Imaging Colorimetry Alpha test. Unfortunately this effort has been eliminated from current activities, due to budget reductions.

**Economic Model** - This quarter, three modules representing the Economic Model were completed and delivered to the Institute of Textile Technology (ITT) for evaluation and testing. These modules are the

1) Defect Analysis, which considers the class and category of defects and computes the cost of occurring defects; 2) Performance Module, which models the CAFE subsystem performance for sensors, signal conditioning, and processing; and the 3) Break-Even-Analysis (BEA), which predicts the capital cost and amortization data for a given break-even period. The BEA was used by ITT and Alexco to perform a product cost and market analysis for the Greige Inspection System.

**Material Marking** - This task was suspended, due to budget reductions. The team did manage to complete a marking industry survey and present the results to the CAFE industry partners. It was decided that an existing product could be used in the interim to identify and locate defects on the cloth.

### **Cotton Biotechnology**

Important advances were made in all three Cotton Biotechnology tasks this quarter. In the Fiber Development task, a method was found for determining the biological potential of a cultivar to develop the maximum number of fibers. The Molecular Markers task overcame previous technical difficulties and doubled the number of unique sequences with simple sequence repeats. The Database task developed a method for entry and display of results from a commonly used genetic mapping program.

Due to uncertainties, the following steps were planned: 1) The Database task will terminate in February or March, as previously scheduled; 2) the Molecular Markers task will be put on hold the end of January, until funding is available.

### **Demand Activated Manufacturing Architecture**

Highlights of major progress during the past quarter from each of the technical task areas are:

**Enterprise Modeling and Simulation** - A key milestone was met by demonstrating a complex analysis at the December Steering Committee meeting, and to three companies following the meeting. The Retail On-Shore/Off-Shore simulation was shown with several activity modules.

**Connectivity and Infrastructure** - Work focused on collaboration with the Cooperative Business Management task for the FY96 TEXNET framework pilot.

Two new C&I pilots were identified and initiated: Electronic Date Interchange (EDI) over the Internet and Intranets. Also, an industry survey was distributed to help identify topics for the National Information Infrastructure course preparation in FY96.

In November, Chip Hatfield, LLNL, briefed high-level executives at Ciba-Geigy on DAMA and the National Information Infrastructure.

**Cooperative Business Management** - Pilot planning for TEXNET began with a series of plant visits to help companies decide on their participation. A final draft of the TEXNET Pilot Requirements Document was completed.

In response to industry's evaluation of the Forecasting and Inventory Management Prototype #1, a Supply-Chain Integration Prototype effort was implemented and a list of high-level requirements finalized.

The NSDB incorporated the Garment Contractors Association database and the Cotton Incorporated directory into the pilot. A new version of the NSDB went on-line and is available through the DAMA Home Page, or directly at <http://avalon.epm.ornl.gov:80/Dama3/>.

**Education, Outreach, and Commercialization** - A DAMA video that was prepared and distributed received very positive feedback.

Work began on the design of floor space for the DAMA exhibit for the IQ 1996 Conference in Chicago, Illinois.

### **Electronic Embedded Fingerprints**

The EEF project successfully met its primary objective when the first-of-a-kind RF tag system was demonstrated at the Bobbin Show in Atlanta, Georgia last quarter. The unique features of the system are its ability to address multiple tags in at one time and to both read from and write to the tags. The development of these devices has matured to the point that the project will be transitioned to the industry partners to pursue commercialization. Laboratory work will conclude in mid-FY96. Work by the national laboratories this quarter focused primarily on writing the final technical report.

### **On-Line Process Control for Flexible Fiber Manufacturing**

The semi-annual meeting of the OPCon industry partners was held in October 1995. Technical results of the four tasks were reviewed, followed by breakout sessions where task progress and plans were discussed in more detail.

Good progress is being made at PNNL on the measurement of fiber cut and crimp. The emphasis is to develop a technique that will measure the 3-dimensional crimp shape, not just the peak-to-peak crimp spacing. A surface spectroscopy method has proven effective for monitoring oil films on moving fiber. Two optical birefringence techniques are being evaluated for determining fiber morphology and are showing promising results. Ultrasonic methods for determining polymer rheology are being investigated. Results differ depending on the polymer. In some cases, the ultrasonic measurements are not sensitive to changes in polymer viscosity, but the technique has been shown useful on a subset of polymer materials.

### **Rapid Cutting**

Effort this quarter concentrated on the directive of temporarily reassigning lab teams and minimizing expenditures, so that FY95 carryover funds could last through January 1996. Hence, task effort was reduced and a corresponding stretch in schedule was realized.

Despite this situation, some key deliverables and milestones were met. The next lot of blades for further industry partner testing was delivered to [TC]<sup>2</sup>. Full characterization tests were conducted on the electric linear driver for the multiple-ply cutter and a draft of the final, year-end report was completed and is now in review. The FY96 work scope package for intermetallic, coated, and amorphous blades was prepared, along with a fabrication and procurement package for laser diodes. As of the end of this quarter, work scope for the RCUT project was still unresolved.

### **Sensors for Agile Manufacturing**

The objective of this project is to develop sensors and feedback control methods that will improve the quality and productivity of the textile industry in the cutting and sewing processes associated with garment assembly. The first tasks in this project concentrate on the development of sensors for fabric edge detection and felled seam sensing. Prototype sensors were developed and delivered to industry partners for evaluation.

Work was in progress with the second task to develop advanced sewing sensors. Due to budget uncertainties, the work on this task has been postponed indefinitely.

### Textile Resource Conservation

A series of task team meetings were held in November and December, where technical progress was discussed and future plans further defined. The Recovery of Colorants task continues to provide salt recovery between 85% and 96%. This performance results in very favorable payback to the industry. Tests of the enhanced-flow membrane technology have shown a 5% to 10% increase in the flux through the membrane. Additionally, extractive recovery of dyes from spent dyebaths has been reasonably successful.

The Fibrous Solid Waste task made significant progress during the quarter in the chemical and biological conversion approaches. Without additional funding, work on this task will conclude in the next quarter.

Work on metals speciation has resulted in a method for the accurate determination of total metals and also an improved method for fractionation for labile versus non-labile metal complexes.

A field test of an air emissions sensor was performed on a tenter frame, printer dryer, and slashing range. Levels of formaldehyde were measured and compared. Work on the low-waste applications of chemicals is being refocused to concentrate on coating of yarn rather than fabric. The low-water washing system has advanced sufficiently to scale up to a 12-inch wide unit that will be suitable for additional laboratory and in-plant testing. Industry will begin the process of soliciting and selecting a vendor to participate in the scale-up process, and work with the team to commercialize this technology.

Work on the Environmental Decision Tools task is moving ahead and is benefiting from the \$300,000 of additional funding from the EPA. Selected software tools are being accumulated and evaluated. Selected pieces of software have been supplied to one of the TReC partners for evaluation during a major plant reconstruction, following a devastating fire.

The Slashing task was approved by the Industry Technical Advisory Committee with focus on investigating supercritical fluid approaches. Work will begin in the next quarter.

Alternative cleaning technologies work has been put on hold, since available funding has been spent at the DOE laboratories.

**Financial Summary (DOE \$ in thousands)**

	(A) Total FY95 Budget* (\$K)	(B) Quarter Cost	(C) FY95 Cost to Date	(D) Remaining Balance (A - C)	(E) % Spent of Budget (C / A)
Program Office	(TBD)	240	240		
DAMA	(TBD)	1,761	1,761		
CAFE	(TBD)	1,126	1,126		
TReC	(TBD)	722	722		
EEF	(TBD)	72	72		
Cutting	(TBD)	291	291		
Sensors	(TBD)	73	73		
Cotton Biotech	(TBD)	250	250		
OPCon	(TBD)	184	184		
TA Leaders	0	0	0		
Uncommitted	0	0	0		
Total	(TBD)	\$4,719	\$4,719		

\* Total FY96 Budget includes carryover from FY95.

## OPERATIONS AND PROGRAM MANAGEMENT

### Program Office Operations and Management

The Program Office provides management oversight of the daily operations and project activities of the AMTEX Partnership and is composed of an industry and a laboratory component. The following activities were conducted this quarter.

#### Intellectual Property and CRADA Meetings

Two workshops were held with laboratory, DOE, and industry representatives to continue the development of a multilaboratory Option Agreement and CRADA for AMTEX. Laboratory representatives met at the first workshop to work on issues and language in the Option Agreement relative to laboratory rights and royalty sharing. At a subsequent meeting with laboratory, industry, and DOE representatives, a final draft of the Option Agreement was created. Only minor revisions will be required to adapt the DOE-standard multilaboratory CRADA for use in AMTEX. Plans are to convert the DAMA, TReC, and CAFE projects to the multilaboratories' CRADAs during March, April, and May 1996.

### Operating Committee Activities and Actions for the Quarter

#### Industry Technical Advisory Committee

The Industry Technical Advisory Committee (ITAC) met on October 12, 1995 in Charlotte, North Carolina. The industry project directors presented summaries of progress to date and plans for FY96. Following the presentations, the ITAC developed a recommendation for allocating the FY96 DOE funding among the projects.

#### Operating Committee Meeting

The Operating Committee meeting scheduled for December 1995 was reduced in scope to include only the Industry Operating Board. That body met at the headquarters of Fieldcrest Cannon in Kannapolis, North Carolina. After hearing brief summaries of the projects, the group discussed their desires and strategies for the future of AMTEX. A strong sentiment was expressed to see AMTEX continue.

## PROJECT ACCOMPLISHMENTS

During the last quarter, accomplishments within the AMTEX Partnership™ have been numerous. A review of those accomplishments for each AMTEX project is contained in the following paragraphs.

### Computer-Aided Fabric Evaluation (CAFE)

The CAFE project is developing inspection systems that will provide U.S. textile manufacturers with a major leap forward in the assurance of high quality, consistent textiles.

Project Manager:

Glenn Allgood, ORNL / 615-574-5673

Project Director:

Mark Kametches, ITT / 803-595-0035

#### Performance Related to Milestones

##### On-Loom Greige Inspection System

1. Redesign the LDA housing and develop new optics and lighting system for deployment in March/April 1996 Beta test.
2. CAFE Management Information Systems Working Group Meeting to develop central inspection computer (CIC) needs and identify minimal configuration and requirements for the Greige Inspection System and Machine Diagnostics.
3. Draft Preliminary Process Flow Diagrams for the On-Line Greige Inspection System, Machine Diagnostics, and LDA.
4. Initiation of Wear Study at Glen Raven Mills.
5. Design and build the integrated CAFE inspection system hardware architecture for Beta test.
6. Redesign and fabricate two new sensor prototypes for Beta testing.
7. Redesign and fabricate a new flexible sensor for Beta testing.

##### CPPG Inspection System

The CPPG vendor partner was selected as the systems integrator for the Color/Printed Pattern Inspection System.

Alpha test requirements were established for the Imaging Tristimulus Colorimeter by the Colorimetry subgroup. Although work on the Colorimetry task was subsequently suspended, these requirements will help establish goals for potential future commercialization efforts.

Proposals were submitted to ITT by industry partners for selection of the Color Print Defect Alpha test site.

#### Knitting Inspection System

Revisions to the CAFE Knit Inspection System FD/RD (LBNL) were completed. Some final issues need to be resolved by the industry partners before the final draft is completed.

The integrated Knit Camera Vision Inspection System was successfully tested at Y-12 on knit fabrics.

#### Economic Model

Two components of the model, presented at the Chicago CAFE Quarterly meeting, were reconstructed into three modules: (1) Defect Analysis, which considers the class and category of defects and computes the cost of occurring defects; (2) Performance Module, which models the CAFE subsystem performance for sensors, signal conditioning, and processing; and (3) Break Even Analysis, which predicts the capital cost and amortization data for a given break-even period.

Visits were made to textile mills during this quarter to test the quantitative and qualitative aspects of the model.

#### Material Marking

A Material Marking meeting/workshop was held with the laboratory and industry partners. A proper definition for material marking needs was developed. A conceptual design was also presented.

### **Activities and Technical Accomplishments for the Quarter**

#### On-Loom Greige Inspection System (ANL, ORNL, SNL)

The project lost several of the task team members, due to budget uncertainties and work slowdowns. This situation forced the remaining team members to regroup and focus their attention on developing the process flow diagrams for the On-Line Greige System. These diagrams are used to identify critical states of operation for the system and how recovery from soft or hard failures is achieved. This work helps identify the level of autonomy required of each system (machine diagnostics, LDA, fabric inspection) in the weaving plant.

Documenting these states and their transitions for each system also provides a preliminary Users Operational Guide for the CAFE System at Beta.

The CIC team also met with ITT, Alexco, and the CAFE industry partners involved in the development of CIC to discuss the impacts the new budget will have on this effort. At this meeting, a plan identified a new structure for the work and a level of effort and expectations for CIC at Beta. This proposal has been accepted and submitted to the project.

Work has progressed in the redesign and packaging of the Alpha LDA. The Alpha version was based on transmitted light and a noncoherent light source projecting a large footprint. The current version has new optics and a coherent light source for a front-lit capability and has been repackaged to reduce weight and volume. The LDA will provide process and material parameters, as well as a capability for limited fabric defect detection. The base line configuration will provide a stand-alone unit providing these process and material properties.

Work continues on the development of the Machine Diagnostic sensor system configured for the Beta test. Hardware has been bought and work has begun on the integration of the system with the sensor arrays. In the final configuration, it will be integrated with the CAFE hardware inspection system being built at SNL. In the area of software development, the team is redesigning the Alpha code to include a periodic and exception reporting. In addition, the team is investigating the operational requirements of the system and its impact on the business infrastructure at a weaving plant. Issues being studied include level of autonomous operation, data reporting requirements, exception handling, data communication requirements, and alarms.

In a parallel effort, the team is enhancing the overall system concept by including fabric defect detection based on 1-dimensional signatures generated from the LDA. This capability should provide coverage of single and multiple pick defects, as well as mixed fill and patterns.

All efforts on the On-Line Greige Vision Inspection System and a second On-Line Greige Inspection System have been terminated due to budget reductions. The task team is currently completing documentation to hand off to ITT.

The design of a third system for Beta test has been reevaluated. This evaluation focuses on how to minimize the number of channels and maximize the inspection scanning speed. To meet the Beta test configuration of an 80-inch width, 8 channels are required. Based on the design of the Alpha test, the electronics for an 8-channel system have been developed and two prototypes fabricated. New features have

been added to the electronics. For example, an impedance matching device was used for improving the match between receivers and the processing electronics, a preamplifier was added to increase signal to noise (S/N) ratios, and better shielding was developed to reduce cross-talks. A total of 20 pairs of transducers for two systems and backups are being fabricated. These transducers were redesigned so that they are more compact and can fit into different looms to deliver more power at better S/N ratios. The design for a power amplifier was also completed and the required number of amplifiers was reduced from 8 to 2, decreasing the system cost by \$800 per system.

Progress continues in the development of the Beta version of a fourth inspection system. Prototype dc-coupled flexible sensor boards have been assembled and tested during the quarter. The sensors have been tested by scanning a greige defect sample over the sensor. Preliminary results indicate that this sensor holds potential for detecting warp defects without mechanical scanning. Additionally, the assembly of an on-loom sensor mount mock-up for fit testing was completed.

During the quarter, a formal wear test study was conducted on the kapton-coated flexible sensor boards. Four sensor samples were delivered to Glen Raven Mills and mounted on the loom in a manner consistent with the proposed automatic inspection configuration. The loom was a production loom producing a near micro-denier fabric. This test was intended to provide realistic wear data. Two samples have been returned after 500 and 1000 yard production runs, respectively. Preliminary results indicate the sensors exhibited no wear during those runs. Longer term wear tests are continuing.

In the embedded computing area, the Beta integrated inspection system has been assembled and lab tested. The system is ready for shipment to a Beta site for in-plant reliability testing. In the real-time software area, progress continues in the development of the Beta version software, including structured DSP code interfacing to any host program (DOS, Windows, or embedded).

#### CPPG Inspection System (SNL, LLNL, ORNL)

Terry Stalker of Sandia National Laboratories and Mark Kametches of ITT attended ITMA '95 in Milan, Italy. They were chartered with looking at automated inspection systems and reporting their findings. Terry concentrated on those having application to color print and unicolor inspection. Mark reported on automated inspection, as part of the presentation to ITT members on ITMA in November at ITT headquarters.

Representatives from CPPG, in conjunction with the Vendor Selection Committee, met at ITT in Spartanburg, South Carolina in October to hear presentations by two color system vendors. The presentations

outlined the strengths of the vendors in the technology areas, level of staffing and support, as well as their approach to the joint development effort. Two vendors proposed to commercialize both the Color Print Defect Detection and Imaging Colorimetry Subsystems presently under development.

A third vendor made a presentation to CPPG and members of the Vendors Selection Committee on November 1 at Spartan Mills. The presentation outlined their technical strengths, staffing plans, and approach to collaboration.

After these presentations by the prospective vendors, the Vendors Selection Committee, with input from the CPPG representatives, recommended to the industry partners the selection of a vendor as the systems integrator for the Color/Printed Pattern inspection system. This recommendation was ratified by the CAFE industry partners. A representative from the vendor will coordinate their efforts and will attend the industry partners meeting in Spartanburg on January 18, 1996.

The Colorimetry Subgroup held a meeting at ITT in Spartanburg in October to begin planning the Imaging Colorimeter Alpha test. The meeting was organized by David Sitter of ORNL and Patrick Chong of Spartan Mills. It was decided the Alpha test would be conducted at the ORNL web test bed. Many parameters for the test were established by the industry partners. In a follow-up meeting at Spartan Mills in November, the Industry Partners met to specify requirements for the Imaging Tristimulus Colorimeter Alpha test.

Subsequent to these meetings, the Color Printed Pattern Inspection System Team (laboratories, industry partners and project/program management) met to consider the impact of the reduced budgets on this activity. Based on the submitted budgets, the Inspection System team decided to complete all documentation, hold a final technical transfer meeting, and subsequently terminate all activities on this task.

The laboratory partners met at SNL in October to review the approaches and plans for implementing the real-time system for the Alpha test and establish time lines to achieve the June test date. The requirements for pre-Alpha in-plant testing were also reviewed in terms of the level of support required from the industry. The original estimate of multiple weeks of in-plant testing prior to the Alpha test was determined to be sufficiently realistic to provide a high level of confidence in fielding a successful system. The original estimate of 1000 yards of defective cloth was thought to be too conservative. The actual number is dependent on the number of actual defect classes tested. These results will be fed back to the industry partners who are interested in hosting the Alpha test.

Proposals from industry partners to host the Alpha test were submitted to ITT during this period. The proposals outlined the level of support that would be provided for the Alpha test. Presentations based on these proposals will be made at the next partners meeting (scheduled for January) so that an Alpha test site and an Alpha test chairman can be selected.

Progress continues at both SNL and LLNL on the real-time implementation and system software required for the Alpha test. Significant progress in the porting and testing of code on the real-time hardware continues to be made at SNL, including porting to the host and the DSP processors. In addition, the real-time hardware for the implementation of the color print detection and classification algorithms developed at SNL was ordered and the development of the real-time software modules for the Alpha test began. This software differs from both the nonreal-time workstation software tested earlier this year and the stripped down benchmark routines tested previously. Consolidation of the preprocessing software for developing exemplar information from CAD files into single software modules also began.

LLNL started developing a new feature extraction module for screen diagnostics that can extract RGB features in real-time. Modifications to the software for CAD file processing continued and testing began. LLNL rewrote portions of their feature extraction code to reduce the number of memory modules needed for the Alpha test. The new implementation significantly reduced the amount of image memory required in LLNL's planned implementation for the Alpha test. Progress also continues on implementing the real-time hardware for the Alpha test. Computing hardware has been configured and software ported to the host system for testing.

Multiple versions of the Color Printed Pattern program plan continued to be considered and their impact on schedule and performance was assessed in response to budget scenarios and actual budget numbers. These budget exercises were developed based on new information from various sources including, but not limited to, the AMTEX Program office, individual laboratories' technology transfer offices, and ITAC actions. These exercises continued throughout the month.

#### Knit Inspection System (ANL, LLNL, SNL)

LLNL completed identified revisions on the Knitting FD/RD. Some issues still remain to be resolved by the industry partners in order to finalize the document.

The Knit Inspection Vision team (LLNL, ORNL) completed their test of the integrated Knit Camera Vision Inspection System at the Y-12 knit test bed. The test consisted of successfully demonstrating a camera-based imaging system, interfacing between the imaging system

and data processing system, acquiring and storage of continuous data in real-time with different knit defects, and testing of the real-time inspection software. A representative from the knit industry partner team was present during the test.

During the first part of the quarter, Y-12 continued development of the housing for the LDA, which is being codeveloped for the On-Line Greige Inspection. An existing camera housing was stripped and the circuit boards replaced with the front-end electronics and circuitry for the LDA. Preliminary tests on the housing were conducted. Y-12 also began conducting feasibility studies on two other technologies that could possibly support machine diagnostics on the knitting machine.

At ANL, a 4-channel electronic system was designed and tested for the knitting inspection system. Different sizes of transducers and techniques were evaluated to make the system more compact and reduce costs. A DSP board was purchased and successfully tested with the detection algorithms.

At SNL, significant progress was made on the sensor system during the month of December. The knit sensor boards were manufactured by the SNL printed circuit board shops. These boards were designed specifically for knit inspection. They are capable of sampling data at a very high rate, which will enable them to obtain high resolution images on the knit machine. Specifically, a knit defect sample was scanned over the sensor at moderate speeds (3"/sec). Preliminary test results showed excellent course-flaw detectability. Additionally, the circuit exhibited low dc drift and provided improved wale-flaw imaging.

The camera imaging system developed at ORNL was successfully integrated with LLNL's real-time data acquisition and inspection system. The complete system was tested at Y-12. Real-time data with all the different types of defects was acquired and stored during the test. More than 117 Mb of data were collected. Samples of the collected data were converted to tif format and added to the CAFE electronic defect samples database at ORNL. In support of this activity, LLNL completed the hardware interface between the analog camera and a camera power supply unit. The software/hardware code needed to interface the camera with the analog signal board was developed. The team also developed, and integrated into the real-time system, algorithms that place a bounding box (rectangle) over areas flagged as defects from 1-dimensional projection arrays. This process provides information specifics about the defect(s) such as orientation, length, width, and area from the bounding box. It also eliminated the need for expensive blob labeling techniques. The LLNL team tested the real-time inspection algorithm at Y-12. This team also wrote the first draft of the statistical detection algorithm report, which discusses how the vision algorithm was implemented in real-time and how the

constraints associated with the real-time image processing hardware were used.

#### Economic Model

Because of budget uncertainties, work on the Economic Model was substantially delayed. However, the three main components of the model were completed during this period by LBNL and ORNL. The three component modules are: (1) Defect Analysis, which considers the class and category of defects and computes the cost of occurring defects; (2) Performance Module, which models the CAFE subsystem performance for sensors, signal conditioning, and processing; and (3) Break Even Analysis (BEA), which predicts the capital cost and amortization data for a given break-even period. Each module has been given to ITT for evaluation and comment. In particular, the BEA has been used by ITT and Alexco to perform a product cost and market analysis for the CAFE Greige Inspection System.

#### Material Marking

A Material Marking working meeting was held at ITT during this quarter. In attendance were the industry task leaders and representatives for greige and color print. A review of the results of the material marking industry survey was presented. The results showed that greige inspection is primarily interested in marking along the selvage. This mark should be detectable by the manufacturer and invisible to the customer. Industry representatives noted commercially available systems are now on the market; however, information on these systems indicate a system price approaching \$10,000—an order of magnitude above what would be cost effective for industry. They also mentioned that intelligent correlation of defect type and location on the product may not be useful to soft goods for several years.

A straw man design was presented that is responsive to the intelligent electronic defect map correlation to fiducials on the product selvage. One design concept, based on premarked warp beam yarn, emerged as a leading candidate.

#### **Issues, Major Problems, and Resolutions**

The uncertainty in funds and their allocation, along with the current level of funds available for use at each laboratory, has created significant problems in the flow of the project. All efforts have been reduced to provide continuity. In some instances, subtasks have been eliminated altogether. The Project Management team has developed a plan in agreement with the laboratory and industry task team leaders. Next quarter, meetings will be held with the Project team at large to

discuss the plan and the impacts from the reduced budget, and to reach a consensus on the path forward for each task.

### **Explanation of Variances**

#### On-Loom Greige Beta test

The On-Line Greige Inspection System Beta test has been moved to the June/July time frame due to the work slowdowns at laboratories necessary to conserve dollars and to provide continuity. The On-Line Greige Vision System task has been suspended, pending resolution of the CAFE budget.

#### Color Printed Pattern Alpha test

The imaging colorimetry system task has been suspended pending resolution of the CAFE budget.

#### Knit Inspection

The vision test conducted at Y-12 was not the same Alpha test configuration stated in the CAFE Project Plan. This change was due to the reduction in the CAFE Knit budget, which resulted in elimination of the vision system from the FY96 activities. The team continued with this pre-Alpha test to provide proof-of-concept and technology capabilities to ITT and the CAFE industry partners.

Two elements of the machine diagnostic task—magnetic flux and acoustic emissions—have been suspended until the final budget is resolved.

#### Economic Model

Work, financed by carry forward funds, continued on the BEA at LBNL throughout the quarter. Due to uncertainty of AMTEX funds, the ORNL Economic Model participation was severely reduced, and, at one point, frozen until December. This funding change has caused a slip in the integration of the three modules, resulting in two deliverable dates missed.

#### Material Marking

Due to budget limitations, the Material Marking task will be terminated, closing out all activities on this task. Currently the team is finishing the CAFE Material Marking Final Report, which will be submitted as the final delivery on the effort.

### Plans for Next Quarter

Given the current budget reductions on CAFE, the Project Management team has developed a path forward, in coordination with the industry and laboratory task leaders. In light of this, meetings will be held next quarter to resolve any issues associated with the revised Project Plan. Under the current scenario, CAFE will have deliverables on all tasks.

#### On-Loom Greige Inspection System

- Final determination of On-Line Greige Inspection System Beta test sites.
- Conduct meetings with ITT/Alexco/industry partners/laboratory team to finalize Beta test site requirements (January 1996).
- Complete final mounting designs for all fabric inspection, machine diagnostics, and LDA systems.
- Deliver working drawings to Alexco for building and fabrication of two LDA sensor subsystems for deployment to three site selections.
- Deliver CAFE integrated hardware architecture system to Beta site(s) for preliminary test and evaluation.
- Complete and document on-loom wear study.
- Complete Process Flow Diagrams for the On-Line Greige Inspection System and Machine Diagnostics, including LDA. Included in the documentation will be a complete data dictionary.
- Continue development of the Beta version real-time software.
- Design and submit for fabrication the 16" (64-channel) Beta version sensor.
- Design and submit for build and fabrication the Ultrasonic translation, transducer holder, and mounting device.
- Continue development of the machine diagnostic system, based on integrated system concept.
- Begin development and design of board level embedded system architecture.
- Conduct meetings with ITT/industry partners/laboratory task teams to consolidate efforts on the On-Line Greige task after resolution of the CAFE budget.

#### CPPG Inspection System

- Conduct meetings to establish Alpha CPPG test site selection and requirements.
- Continue development of codes and porting to CPPG hardware configuration.
- Conduct meetings with ITT/industry partners/laboratory task teams to consolidate efforts on the CPPG task after resolution of the CAFE budget.

#### Knit Inspection System

- Complete the Integrated Knit Camera Vision Inspection System (LLNL, ORNL) report.
- Complete and deliver the Statistical Detection Algorithm report.
- Conduct meetings with ITT/industry partners/laboratory task teams to consolidate efforts on the Knit task after resolution of the CAFE budget.
- Continue development of the sensors for Knit Alpha testing.

#### Economic Model

Complete the integration of the three economic model modules. This task will include the complete documentation, consisting of a narrative of structure and cell input, GUI, and computational flow diagram.

#### Material Marking

Delivery of CAFE Material Marking Final Report.

#### Invention Disclosures

- Machine Diagnostics for On-Line Greige
- Economic Model (LBNL, copyright working)

#### Publications/Presentations

None.

## Cotton Biotechnology

This visionary project in cotton biotechnology promises to provide revolutionary advancement in the qualities and performance of cotton fiber. By increasing the rate of progress 10-fold in gene description, this project will enable scientists to improve the strength, length, and uniformity of cotton. The improvements will add an array of new product features for consumers and a competitive edge for U.S. companies in the world market.

Project Manager: Ben Burr, BNL / 516-282-3396  
Project Director: Gay Jividen, Cotton, Inc. / 919-881-9874

### Performance Related to Milestones

Milestones for the cDNA task were not achieved because work on this task was not started.

### Activities and Technical Accomplishments for the Quarter

#### Molecular Markers

The goal of this task is to provide easy-to-use genetic markers that detect a high degree of polymorphism in cotton. Simple sequence repeats are used as the basis for these markers. Discovery of these sequences is the major objective of this task; that is, DNA sequencing after obtaining populations of clones that are enriched for the repeats.

Improvements in technology developed in the fourth quarter of FY95 resulted in doubling the unique sequence obtained since the end of the last quarter. However, a high proportion of redundant sequences were obtained. This problem was partially overcome by increasing the number of helper phage used to develop the single stranded secondary libraries. Impure single-stranded DNA led to a low recovery of positive clones. This difficulty was overcome by the use of alkaline gels to purify single-stranded phagemid DNA. Refinements in DNA sequence techniques resulted in longer, higher quality sequences. Refinements in the database have greatly benefited this task.

#### Fiber Development

This quarter has been a particularly fruitful one for the Fiber Development task. Previously, Jack van't Hof determined the point in time before flowering when fiber cell differentiation was initiated on developing ovules, and the organs that will give rise to seed upon

fertilization. He then developed a technique to count the number of fiber cells on the developing seed. This process allowed him to screen 65 cultivars to discover a 2-fold variation among common upland varieties for this property. He subsequently found that cotton grown under continuous light increased the number of fiber cells, which shows the biological potential of a variety. He now has the ability to obtain the following three parameters for a given cultivar:

1. The number of epidermal or surface cells on the ovule at the time of fiber cell initiation - the maximum number of potential fiber cells.
2. The actual number of fiber cells.
3. The number of fiber cells that could develop under the best environmental conditions.

The third parameter is an indication of the genetic potential of a cultivar to increase the number of fiber cells. For instance, one cultivar is able to convert nearly 85% of its epidermal cells to fiber, whereas another cultivar shows no ability to increase the number of fiber cells. The number of fiber cells is an important component of yield. Other experiments conducted indicate which varieties are good material for future breeding efforts.

#### Database

The major achievement of the Database task this quarter was the incorporation of results from MapMaker, a commonly used genetic mapping program, to display a genetic map related to the loci in the database. The map distinguishes between framework and nonframework markers, shows the level of confidence with which nonframework markers are mapped, and indicates their positions relative to the framework markers. This achievement is an important one for all databases using the AC Elegans Database (ACEDB) format.

#### **Issues, Major Problems, and Resolutions**

Funding uncertainty continues to be an issue affecting project performance and planning. Discussions are underway between the Program Office, DOE, and the industry partner to resolve this matter.

#### **Explanation of Variances**

Milestones related to the cDNA task were not achieved because this task was never started, due to incomplete funding.

### **Plans for Next Quarter**

#### Molecular Markers

The budget crisis will not permit the orderly shutdown of this project. Progress will be documented and primer orders for unique sequences currently in the database will be prepared.

#### Fiber Development

The plan is to attempt to relate fiber number in 3 cultivars with the number of epidermal cells 18 days before flowering and the number of fiber cells when the plants are grown under full light. Fiber numbers in parents of established genetic populations are being examined to see if important differences can be found, so that genetic determinants of this character can be mapped. Collaboration with a research partner is envisioned to measure fiber number in field grown plants to determine how useful it is as a predictor of yield.

#### Database

The final steps in this task will be to document scripts developed for loading the database and develop a mechanism for automated loading of digital information (molecular lengths of polymerase chain reaction products and allele scores) obtained from gels.

#### **Invention Disclosures**

None.

#### **Publications/Presentations**

None.

### **Demand Activated Manufacturing Architecture (DAMA)**

The objective of the DAMA project is to define, develop, integrate, and deliver an electronic marketplace system/structure that can be used by all elements of the U.S. textile industry. DAMA will enable companies to reduce process requests for apparel on demand, and establish new strategic alliances to create business opportunities. These

steps will enhance industry productivity and competitiveness in the world marketplace.

Project Manager: Leon Chapman, SNL / 505-845-8668  
Project Director: Jim Lovejoy, [TC]<sup>2</sup> / 919-380-2184

### **Performance Related to Milestones**

#### Enterprise Modeling and Simulation

**Milestone:** *Complete fashion item product line and complex analyses and simulation development.*

An information package, describing the product-line process, was prepared for industry members of the ladies' fashion item team.

Consumer Demand and Replenishment/Forecasting modules were completed for the retail On-Shore/Off-Shore scenario simulation. The simulation was demonstrated at the DAMA December Steering Committee meeting, and to other industry representatives.

#### Connectivity and Infrastructure

**Milestone:** *Develop four National Information Infrastructure (NII) courses and an Electronic Data Interchange (EDI) pilot.*

An industry survey was distributed to determine what NII courses are of most interest among DAMA partners. With this input, specific courses will be identified and planned in January.

#### Cooperative Business Management Tools

**Milestone:** *Initiate TEXNET pilot and complete National Sourcing Data Base (NSDB) pilot.*

Planning for the TEXNET pilot began with pilot team recruitment efforts and preliminary requirements definition.

Several new databases were incorporated into the NSDB pilot. Completion and commercialization of this DAMA product will become the primary focus of ORNL DAMA support during FY96.

**Milestone:** *Define requirements and prototype a supply-chain production and inventory tool.*

A list of high-level requirements was finalized, and a proposed plan for integrating the Supply Chain Integration Prototype with other CBM activities was created. The plan includes investigation of requirements for integration with TEXNET.

Education, Outreach, and Commercialization

**Milestone: *Plan and commercialize NSDB.***

Development of the commercialization plan is on hold, pending recruitment of a new task leader for the Education, Outreach, and Commercialization task.

Product Administration and Dual Use

**Milestone: *Conduct Technical Peer Review and demonstrate DAMA dual use.***

Preliminary planning began for the DAMA technical peer review, which is scheduled to be held in conjunction with the June Steering Committee meeting.

Planning efforts for dual-use applications are on hold, pending resolution of actual funding available to the DAMA project.

**Activities and Technical Accomplishments for the Quarter**

The following accomplishments are in addition to those previously reported and are provided according to DAMA task area.

Enterprise Modeling and Simulation

Three reports were drafted and are currently in review:

- *Development of the Process Step Models and Possible Extensions for Their Use*
- *Bedsheet Product Team Report*
- *Models to Improve Sales and Demand Response for Licensed Products*

The retail On-Shore/Off-Shore scenario simulation was demonstrated at the December Steering Committee meeting of DAMA, and also to Sara Lee Knit Products, Spartan Mills, and Milliken personnel. Modeling of Consumer Demand and Replenishment/Forecasting modules was completed in preparation for these demonstrations.

In cooperation with a freight forwarder, representative shipping costs for shipping containers were obtained in support of the On-Shore/Off-Shore modeling effort. Also, the capability to plot historical data, such as inventory level over time and consumer demand over time, was added to the simulation's Graphical User Interface (GUI).

#### Connectivity and Infrastructure

Most C&I effort involved supporting the TEXNET pilot in collaboration with the CBM task. Primary activities this quarter included:

- Meeting with industry members to encourage participation in the pilot.
- Researching commercial Secure-HTTP and X.500 products to be integrated into TEXNET.
- Developing a World-Wide-Web-based TEXNET demonstration.

A demonstration, titled "Doing Business on the Internet (a.k.a. Information Superhighway)," was published in the DAMA web site. The completed demonstration is accessible to DAMA members from the C&I home page of the DAMA web on <http://dama.tis.llnl.gov>.

Two new C&I pilots were identified and initiated in December:

1. *EDI over the Internet* will initially involve five DAMA industry participants who will use Internet e-mail to send and receive ANSI-X12 (EDI) transactions. The goal is to demonstrate increased efficiency, using the Internet to move EDI transactions versus using a commercial value-added network.
2. *Intranets* will involve three partners with the goal of demonstrating the benefits of using the World Wide Web within an enterprise to share internal information.

#### Cooperative Business Management

Planning for piloting TEXNET began in earnest this quarter. A series of plant visits was made to help companies decide on their participation, and a final draft of the TEXNET Pilot Requirements Document was completed.

The TEXNET Prototype #2 (P2) Demonstration Configuration is now available and accessible via the Internet. Anyone with a Netscape 1.1 (or higher) browser can view and demonstrate the prototype at <http://snowmass.inel.gov:3012>.

In response to industry's feedback at the August Forecasting and Inventory Management Prototype #1 (FIM P1) evaluation session, a *do more forecasting* (now called Forecasting Effort) was initiated. The team made contact with all DAMA retailers and started contacting manufacturers and others to help understand the complexities of forecasting.

Based upon input from the Advisory Committee and funding constraints, DAMA management has chosen to reduce the scope and to transition the ORNL forecasting work to LANL. With LANL working on the reduced-level forecasting effort, ORNL will be able to accelerate the NSDB work.

Also in response to industry's evaluation of FIM P1, a Supply Chain Integration Prototype (SCIP) effort was implemented and a list of high-level requirements was finalized this past quarter. In addition, a proposed plan for integrating SCIP with other CBM activities was created. The plan includes investigation of requirements for integration with TEXNET.

The NSDB incorporated the Garment Contractors Association database and the Cotton Incorporated directory into the pilot. A new version of the NSDB went on-line and is available through the DAMA home page, or directly at <http://avalon.epm.ornl.gov:80/Dama3/>.

Access statistics indicate the site is receiving significant use from non-laboratory visitors. Also, agreements were reached to include a suppliers' section in the NSDB.

The data assessment team held a successful meeting November 1 at JC Penney. The kind of data desired from business offices, the role of EDI standards, and the data glossary were discussed and reviewed.

Requirements for the Data Analysis and Modeling Effort (DAME) were completed.

#### Education, Outreach, and Commercialization

A DAMA videotape, featuring several industry executives, was prepared and widely distributed to DAMA and AMTEX participants for use in explaining the project. Feedback has been very positive from both industry and government viewers.

Fliers were developed for TEXNET, NSDB, Enterprise Modeling and Simulation, and Electronic Marketplace.

A 4-color DAMA brochure and presentation folder was approved, including text, photographs, design, and creative concepts for illustrations.

Work began on DAMA IQ 1996 conference participation with design of the floor space. The same general theme that was used at RISCon, *Get Plugged into DAMA*, will be used.

Transition of the C&I seminar "Hands on Internet Tools" to EO&C was initiated in December. Future seminars will be offered through [TC]<sup>2</sup>.

#### Product Administration and Dual Use

Progress continued on the multilaboratory CRADA for DAMA. The FY96 budget must be resolved before the CRADA can be completed and implemented. The CRADA should be in place by the end of February.

Most activity continued to revolve around support to the AMTEX Program Office on the budget situation. The AMTEX Program Office provided their expected final budget levels to the projects in early December. A final budget and subsequent release of funds to DAMA may not occur until February, however, due to continuing Technology Transfer Initiative funding issues within DOE/DP, SNL, LANL, and LLNL.

#### **Issues, Major Problems, and Resolutions**

The release of FY96 funding is needed at SNL, LLNL, and LANL to enable continued technical activity on the Connectivity and Infrastructure and Cooperative Business Management tasks. Full AMTEX level funding at these laboratories is not likely. The DAMA project office and task managers continue to work contingency plans, but the ability to resolve this issue falls outside DAMA and AMTEX.

In general, delays in finalization of AMTEX and DAMA budgets, due to reappropriation of TTI funds within DP laboratories, has created a very turbulent environment and major frustration for the project. The multilaboratory CRADA, ready since October pending final budget determination, cannot be implemented by February 1 as originally planned. This situation is being reviewed to determine how to keep the project active during this period. Efficient use of project resources has been severely compromised. Project moral is suffering and planning has become difficult, as it has for all AMTEX projects.

#### **Explanation of Variances**

None.

## Plans for Next Quarter

### Enterprise Modeling and Simulation

Synthesis of results from the first three product line investigations will begin.

Work will be completed on the On-Shore/Off-Shore analysis, and will begin on the Mass Customization scenario.

Jane Macfarlane will present session #LE3 at the IQ 1996 conference, titled "Strategic Report: Understanding the Constraints of the Integrated Textile Pipeline."

### Connectivity and Infrastructure

Support will continue on preparations for the TEXNET pilot. Further discussions with DAMA industry participants will lead to identification of TEXNET pilot teams.

Schedules for accomplishing the *EDI Over the Internet* and *Intranet* course pilots will be developed, along with a schedule of NII Education and Training courses.

### Cooperative Business Management

The TEXNET team will evaluate security and commercial X.500 packages, together with continued planning and pilot team identification.

Transition of the technical forecasting work from ORNL to LANL will occur, with the integration of LANL into other CBM activities.

The data activity will be restarted, after FY96 funds become available.

Ken Washington will present session #LE4 at the IQ 1996 conference, titled "Cooperative Business Management Strategies."

The Knitted Textile Association (KTA) directory will be added to the NSDB.

### Education, Outreach, and Commercialization

Development of the DAMA commercialization plan will begin.

DAMA will demonstrate TEXNET, NSDB, and the On-Shore/Off-Shore simulation analysis at the IQ 1996 conference in Chicago, Illinois.

Materials for beginning and intermediate DAMA seminars will be prepared.

Product Administration and Dual Use

- The multilaboratory CRADA will be implemented.
- The FY96 Project Plan will be finalized.
- The technical peer review will be planned.
- A DAMA dual-use plan will be developed.
- A 1995 DAMA Annual Report will be prepared.

**Invention Disclosures**

None.

**Publications/Presentations**

Publications:

- The DAMA overview videotape was prepared and distributed.
- A new brochure of DAMA was completed and is available.
- A complete list of DAMA publications is available through the DAMA project office at either [TC]<sup>2</sup> or SNL.

Key Presentations:

- Chip Hatfield, LLNL, delivered a briefing in November which described DAMA and the National Information Infrastructure to high-level executives at Ciba-Geigy.
- Jim Lovejoy, [TC]<sup>2</sup>, made DAMA overview presentations to the following organizations this quarter:
  - Associate Member Congress of the AAMA
  - Liz Claiborne
  - AT&T
  - Garment Industry Development Corporation
  - University of Southwestern Louisiana
  - Southern Equipment Supplier Inc.
- Pete Butenhoff, [TC]<sup>2</sup>, presented an overview of DAMA to UNITE, a major labor union.

## **Electronic Embedded Fingerprints (EEF)**

The Electronic Embedded Fingerprints project is developing miniature electronic devices as permanent identification and information markers for textiles and apparel.

Project Manager: Mike Riley, LLNL / 510-422-3045  
Project Director: Jim Caldwell, [TC]<sup>2</sup> / 919-380-2156

### **Performance Related to Milestones**

The major objective of this project has been achieved with the development and demonstration of the multiple-tag RF system at the recent Bobbin Show. The key features of the system that were demonstrated are the ability to address multiple tags at one time and to both read and write data to/from the tag. The Industry Technical Advisory Committee reviewed this project and determined the technology had matured to the point that it no longer required R&D work by the national laboratories. Therefore, the FY96 DOE funding for the project was designated for completion of a final technical report.

The future of the project will be determined by the industry partners under the leadership of [TC]<sup>2</sup>. If there is sufficient interest in the tags, vendors will be solicited to work with the industry to proceed with miniaturization and manufacturing of an appropriate RF tag for the textile/apparel industry. The final report will soon be completed.

### **Activities and Technical Accomplishments for the Quarter**

The final report will soon be completed.

### **Issues, Major Problems, and Resolutions**

None.

### **Explanation of Variances**

None.

### Plans for Next Quarter

- Complete final report
- Close out project

### Invention Disclosures

None.

### Publications/Presentations

Arden Dougan presented a briefing on EEF to George Miller, LLNL associate director.

## On-Line Process Control in Flexible Fiber Manufacturing (OPCon)

The OPCon project goal is to strengthen the worldwide competitive position of U.S. fiber manufacturers by identifying and developing technology that provides the means for: (1) faster transition between products, (2) efficient production of small lots, and (3) improved economics via elimination of off-quality production and off-line testing.

Project Manager: Marc Simpson, ORNL / 423-574-4171  
Project Director: Jack Scruggs, TRI / 803-627-8040

### Performance Related to Milestones

No milestones for this period.

### Activities and Technical Accomplishments this Quarter

The semiannual AMTEX OPCon Project Industry/Laboratory Meeting was held in the Hoescht Celanese Research Center in Charlotte, North Carolina, on October 27, 1995. A total of 31 attendees represented the 10 OPCon Industry partners and the four national laboratories participating in OPCon. The meeting began with an overview of the ITAC meeting and AMTEX funding activities, followed by a technical review of results-to-date for each task. Breakout sessions chaired by the laboratory and industry task leaders were then conducted for each task to review progress and plan FY96 activities. The meeting concluded with a presentation to the general group on conclusions from the breakout sessions. The next general OPCon meeting will be held

on April 18, 1996 at the Hoechst Celanese Research Center in Charlotte, North Carolina.

#### Fiber Cut and Crimp

Researchers at PNNL are making crimp-per-inch (CPI) measurements with a polyester tow sample mounted on a drum rotating at linear speeds up to 122m/min. (400 ft./min). A fixed sampling window of approximately 2.5 cm (1 in.) was used and measurements were made at about 0.5-m (1.6-ft) intervals along the tow length. Work also continues on the measurement of crimp shape on-line.

Results from literature searches by PNNL, TRI/others (Jack Scruggs), and several industry partners have now been reviewed and summaries of content compiled. Based on the reviewed publications, no on-line, near real-time instruments were found for measuring more than crimp frequency; thus, the emphasis on on-line crimp shape measurement chosen by the Crimp task team is unique.

#### Finish Oil and Moisture and Rapid Finish Measurement

A surface spectroscopy used for monitoring of oil films under clean room conditions has proven useful for rapid determination of customer finishes applied to final product. This method will allow fiber manufacturers to perform rapid, cost-effective certification of all material produced, which will facilitate improvements in product uniformity and timely diagnosis of equipment malfunction. Because of increasing customer expectations for tightened tolerances at the finish level, market pressures for cost control, and enhanced certification demands (such as ISO-9000 compliance), these measurements will play a key role in maintaining U.S. competitiveness in a major global market.

#### Chlorinated Solvent Use Reduction

Standard finish measurement protocols require laboratory extraction of finish from representative production samples using chlorinated solvents, such as perchloroethylene; the extracted finish is then measured gravimetrically or spectroscopically. This test method is time-consuming, expensive, and produces significant quantities of hazardous waste. New analytical methods developed in this project may drastically reduce the use of hazardous solvents by eliminating the need for extraction. Direct measurement of finish on fiber has been achieved in less than 10 seconds, and will allow these measurements to be performed without extraction. The exceptional speed of the new method significantly reduces analyses times, which should increase the impact of analytical data for control of product quality.

These early results, obtained during the first six months of the project, are providing the technical basis needed for development of rapid, versatile, and cost-effective on-line sensors by ORNL. These sensors will have immediate relevance in the synthetic fiber industry, as well as for a variety of energy- and defense-related missions. Monitoring and control of uniformity, reproducibility, composition, and stability are important, not only to the flexible manufacturing of synthetic fibers, but also to the safe and certifiable processing, storage, and destruction of hazardous waste, control of remediation systems, environmental monitoring, production and blending of fuels, energy efficient operation of production equipment, and the maintenance of strict controls during fabrication of weapons components.

#### Fiber Morphology

Two optical scattering techniques capable of measuring birefringence on-line and in real time have been demonstrated at PPPL. The first technique measures bulk birefringence and the second one measures a *surface birefringence* at different penetration depths. The second technique is presently being pursued and has two major advantages: (a) it can be used on materials of any shape and size and may also be applicable to dyed materials, (b) it has few accessibility constraints. Both techniques have been applied in the laboratory to moving PET filaments. Modeling and analytical tools are also being developed at PPPL for the measurement.

#### Polymer Rheology

After preliminary results indicating insensitivity of acoustic measurements to changes in polymer viscosity, researchers at LANL have demonstrated the usefulness of their acoustic technique to a subset of polymer materials. At the present, emphasis is extending the technique to a broader range of textile materials at elevated temperatures. Work at LANL is being pursued in the modeling and experimental verification of the techniques for on-line measurement of polymer properties.

#### **Issues, Major Problems, and Resolutions**

Because of no new FY96 funding for the OPCon principal investigators until as late as April, several of the task activities were cut back. Lack of funding will delay technical deliverables scheduled for this fiscal year.

### **Explanation of Variances**

None.

### **Plans for Next Quarter**

A combined industry/laboratory OPCon Project Meeting will be held on April 18, 1996 at the Hoechst Celanese Research Center in Charlotte, North Carolina. The meeting will provide a forum for information exchange between industry and Laboratory partners. Break-out sessions at the meeting will be chaired by the individual task principal investigators to review progress on the tasks and refine FY96 goals/activities in lieu of the present AMTEX budget constraints. The OPCon industry board is planning a teleconference for mid-January to discuss task progress and budgets. Finish, Crimp, Morphology, and Rheology task meetings are also planned before the April meeting.

Scheduled technical activities next quarter include a demonstration of static finish on product (FOP) measurements for the Finish Task meeting at AMOCO in January, and continued laboratory experiments using samples provided by industry in the Morphology, Polymer Rheology, and Fiber Cut and Crimp tasks. Projected FY96 deliverables for OPCon include: 1) a laboratory demonstration of sampled crimp shape measurements on a moving tow; 2) a demonstration of the replacement of off-line solution viscosity measurements with on-line acoustic techniques, and 3) pilot plant measurements of finish and morphology.

### **Invention Disclosures**

None.

### **Publications/Presentations**

None.

### **Rapid Cutting (RCUT)**

The Rapid Cutting (RCUT) project is developing a new generation of cutting systems and technological advancements in current systems that will improve cutting quality and efficiency. Such systems will enable true demand activated manufacturing of apparel. The Rapid Cutting project consists of six national laboratories, each with laser and optical

technologies appropriate for the mechanical cutting of textiles using new materials and photonics.

All teams were actively involved with their tasks during this quarter.

Project Manager: Craig Fong, LBNL / 510-486-5298  
Project Director: Jim Caldwell, [TC]<sup>2</sup> / 919-380-2156

### **Performance Related to Milestones**

More than 48 blades were fabricated and processed by the laboratories for industry testing.

A linear induction motor appropriate for multiple ply cutting was integrated with a control and drive system and operated under bench scale cutting conditions.

A final report was generated in draft form. This document is a compilation of all work performed throughout the RCUT project.

### **Activities and Technical Accomplishments for the Quarter**

In accordance with the guidance offered by the AMTEX program office, all task activity was slowed this quarter to conserve remaining laboratory FY95 funds through January, 1996--the point at which industry and DOE funding decisions would tentatively be resolved. Hence, the general approach was to complete pivotal work-in-progress, such as coated and intermetallic blades fabrication and testing by industry, and the consolidation of year-end report submissions from each of the laboratory and industry teams.

ORNL has initiated fabrication of more than 36 intermetallic blades. Approximately 20 of these blades have been delivered to Textile Clothing Technology Corporation, [TC]<sup>2</sup>, for industry test and evaluation. The remaining blades will be completed as FY95 funds for this task have been identified and placed in the task leader's account. LBNL has processed 12 coated blades, 10 of which have been provided to [TC]<sup>2</sup>. Tests at [TC]<sup>2</sup> will be performed on a multiple-ply Cartesian cutter operated under controlled parameters, such as a standard marker at standard acceleration profiles. Compared to stock blades, 10 blades of each type should provide statistically credible performance. Test results will be correlated by LANL and [TC]<sup>2</sup>.

At LBNL, a second linear induction motor was integrated to a fiber optic control system, waveform generator, and power supply. Fitted with a blade, the assembly was tested by cutting denim on a small, multiple-ply test stand. Drive stroke lengths up to 11.4 cm (0.375 ft) were achieved at 100 Hz. Peak frequencies approached 300 Hz. Acceptable blade velocities were attained, along with reduction in cutting head mass. A comprehensive report will be consolidated into the year-end report.

As a result of work completed early (prior to the laser cutting design review held in August), ANL, LANL, and LLNL focused their first quarter efforts on generating their individual contributions to the year-end report. A task plan for FY96 was drafted by LLNL, based on constructing a specific diode-pumped, solid-state laser source.

The project quarterly review was scheduled for October 27, 1995. Due to uncertainties associated with the FY96 budget, this meeting was put on hold until AMTEX funding was resolved. In lieu of that meeting, Jim Caldwell visited LBNL and LLNL to assess project progress.

#### **Issues, Major Problems, and Resolutions**

None, in light of the general guidance to conserve FY95 funds through January 1996.

#### **Explanation of Variances**

None.

#### **Plans for Next Quarter**

Based on the recommendations of the AOC and their meeting of December 14, 1995, all project activity has been either put on hold for blades tasks, or is being closed out, as in the case of laser cutting tasks. When the budget is completely reconciled, blade testing by industry and LANL will restart. Amorphous blade development will continue at LANL, and another iteration of intermetallic blades and diamond-like coatings will be fabricated by ORNL and LBNL, respectively. The year-end report will be published in final form.

#### **Invention Disclosures**

None.

### Publications/Presentations

None.

### Sensors for Agile Manufacturing (SFAM)

The Sensors for Agile Manufacturing (SFAM) project team is developing sensors that will allow the automation of sewing processes to improve product quality and process productivity in the apparel manufacturing sector of the U.S. textile industry.

Project Manager:

Kevin Widener, PNL / 509-375-2487

Project Director:

Jim Caldwell, [TC]<sup>2</sup> / 919-380-2156

### Performance Related to Milestones

Laboratory demonstrations of the fabric edge sensor were made. A statement of work and a task plan for the advanced sewing sensors task were generated.

### Activities and Technical Accomplishments for the Quarter

The team succeeded in getting the felled seam machine to work with the flexible sensor, and have a standard industrial PLC running as the processor. The PLC takes the sensor input and controls the motors on the machine to move fabric in and out. The results look very promising. Presently, a second generation felled seam sensor is underway. A sheet metal folder attachment to which the sensors will be laminated, has been designed and is being crafted. The unit manufactured by the shop craftsmen will be more refined than the original.

The SNL technical team also worked with Jim Caldwell to transfer the design and schematics for the edge detection sensor to an industry partner. They will make their own sensor, based on the SNL design, and will demonstrate it. Tom Weber, SNL task leader, will be acting as a consultant as they build their sensor, and will probably travel to their plant to help them.

Due to FY 1996 funding reductions, the advanced sewing sensors task was postponed indefinitely.

### **Issues, Major Problems, and Resolutions**

None.

### **Explanation of Variances**

None.

### **Plans for Next Quarter**

Continue the development of the fabric edge and second generation felled seam sensors at SNL. Document and file the work on the advanced sewing sensors so that it may be restarted at a future date, should funding be restored.

### **Invention Disclosures**

No invention disclosures were filed this quarter. An invention disclosure on felled seam sensing is currently pending at SNL.

### **Publications/Presentations**

The prototype of the fabric edge detector was demonstrated at the 1995 Bobbin Show in Atlanta, Georgia.

### **Textile Resource Conservation (TReC)**

The objective of the Textile Resource Conservation (TReC) project is to define, develop, integrate, and deliver processes, devices, and techniques to be used by all elements of the U.S. textile and soft goods product chain to enhance environmental quality and minimize the production of wastes.

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### **Performance Related to Milestones**

Performance related to milestones has been satisfactory during the quarter, with concern about future progress dependent upon the availability of funding. Most of the industry/laboratory task teams met during the months of November and December when the laboratory investigators reported their progress to the industry liaisons. Field tests

in Recovery of Colorants and Low Waste Chemical Application have been delayed, due to the necessity of bringing equipment/system manufacturers into the project. This integration of vendors is important for the successful transfer of technology from the laboratories and the commercialization of that technology for the benefit of the U.S. industry. Progress in developing a process for the recovery and recycle of solid fibrous wastes is continuing on schedule, with promising results being reported from PNNL and ANL.

The development of metals speciation analytical methods is proceeding according to schedule with the laboratories planning methods verification in cooperation with the industry partners, and integration of this effort with a joint Textile Industry/EPA program to evaluate and certify metals speciation techniques. Air Emissions Monitoring completed a successful field test of a sensor for formaldehyde at one of the partner's dyeing and finishing plants. The Alternative Cleaning Task has ceased all activities, due to a lack of funding, and project management is trying to obtain sufficient funds to produce final reports. All other tasks within the TReC Project are performing according to the project plan and did not have milestones during this quarter.

#### **Activities and Technical Accomplishments for the Quarter**

The AMTEX Textile Resource Conservation (TReC) project was active in all of its tasks during the quarter. A series of task team meetings was held during November and December between laboratory investigators and the industry partners.

Under the Recovery of Colorants task, salt recovery results have been consistently good as the experiments continue to determine the parameters necessary for the in-plant trial. Preliminary process economics show a payback of 0.6 to 1.2 years. Runs performed have shown 85% (one case) to 96% salt recovery. Long-term testing of the salt recovery system is underway to find any problems that could develop after several hundred hours of continuous operation.

Enhanced membrane flow tests, with a dispersed dye, showed about a 5% to 10% increase in flux through the membrane with the flow enhancement systems, compared to straight-through flow. Therefore, the combination of the enhancement system, coupled with a new flow distributor design developed at Argonne, can improve the separation performance. With polyvinyl alcohol, significant fouling on the membrane was seen during the ultrafiltration process. Membrane flow enhancement techniques had a decisive effect on the permeate flux and decreased the frequency of the cleaning cycle. Additionally, extractive recovery of dyes from spent dyebaths has been reasonably successful. Testing has been ongoing using a 2.5-cm (1in.-) diameter Karr column

at ANL and also a Schiebel column. The separation occurs counter-currently in the columns with some problems noted at high flow rates.

A brief field test in bioadsorption of dyes that has been completed at a partner's facility examined blue-green algae and a modified silk. The question was how to manipulate the physiochemical conditions to convert dye monomers aggregates. The investigators have explored the size of aggregates to recover the dye by filtration or settling. In-line filtration was used to test filters of different compositions and pore sizes on the separation. Aggregation conditions were determined more important than the filter characteristics. Certain aggregation agents were able to concentrate the dye about 20-fold and take removals up to the 99.5% to 99.96% range. Because these agents are used in milli-molar concentrations, they would appear to be quite economical for use in a plant-scale application.

The fibrous solid waste recovery task team has made considerable progress since the last quarter. The chemical conversion of blends (ANL) and the biological conversion of cotton (PNNL) are proceeding at a fast pace. While the work has concentrated on the recycling of reactive and dispersed dye blends, it was indicated by the partners that some experimentation should be performed with indigo/sulfur-dyed cotton. Pending the availability of funding, work in the following quarter will concentrate on improving the process performance of the two approaches, and thereby improving their economics.

Metal speciation work at ANL has determined a method for the accurate determination of total metals and also has improved the method for labile versus non-labile metal complexes. Remaining work, depending upon the availability of funding, is to determine the effect of sample volumes on the chromatographic separation, complete the analysis of selected waste water samples, and document the methods. Metals speciation work at SNL has proceeded, although the original principal investigator has left the laboratory to take a position in the private sector. Work has progressed on the development of the polarographic method for the analysis of dyes and other incoming raw materials. As soon as FY96 funding is available, work will progress in three areas; 1) Quality Control Library Development; 2) Criteria Development - develop criteria for the acceptance or rejection of incoming dyes and chemicals, based on comparisons of sample polarogram, and; 3) Method Validation for Waste and QC - provide statistically valid data for effluent analyses that ensures the developed QC methods can reliably screen dyes and chemicals.

Air emissions monitoring researchers are making progress in packaging their sensors for field testing. A field test was performed on a tenter frame dryer at a plant with the goal to sample all of the stacks on the unit. The final results would characterize the process, determine

emissions for different size formula combinations (two were different), and verify the instrument readings of the commercial instruments and check with samples put through a GC and an HPLC. This test was performed during the period July 17-20. All four stacks and the pre-dryer stack were sampled. A second field test was run from October 30 to November 3 at another partner's facility. A tenter frame, a print dryer, and a slashing range were sampled. The tenter frame dryer results from plant 2 were similar to those from plant 1 in that little formaldehyde was found in the pre-dryer stack. Moderate to high formaldehyde was found in the first two stacks and lower formaldehyde was found in the last stack. The levels of formaldehyde corresponded to the levels of the resin being used. Work on air-sensor development at LANL has also been proceeding. To overcome the disadvantages of the universal detector mode of operation for the sensing system, a new membrane with a helium carrier gas was used. The advantages of this modification are the ability to perform real-time, continuous monitoring, with a simple and robust unit sensitive to total volatile organic compound (VOC) concentration changes, and increased sensitivity for some species. The principal investigator expects to have a field test unit ready by the second quarter of 1996.

Low-waste chemical applications work is proceeding, although some difficulties were experienced in achieving the flow rates and evenness of coverage with the system being developed at ORNL. Based on these difficulties, it was decided that applications work at ORNL should concentrate on the coating of yarn and to cease all efforts on the coating of fabrics.

The low-water washing system under development at the LLNL has advanced far enough to support a decision to scale-up to a 30.5-cm (12-in.) wide unit for more laboratory and in-plant testing. A decision was made that TReC should go through the procedures necessary to obtain vendor participation, in order to advance the washing system toward commercialization.

Alternative Cleaning Technologies has put all activities on hold, due to the withdrawal of funding from work at the INEL and the depletion of small amounts of funding available at the PNNL and the ANL.

Samples of already existing software for Environmental Decision Tools have been accumulated by the Laboratory Task Coordinator at the PNNL. Selected pieces of this software have been forwarded to one of the partners for evaluation during a major plant reconstruction.

The Slashing Initiative approach was approved by the Industry Technical Advisory Committee. Pending the availability of funding, it is expected that some of this work will begin after January 1996.

### **Issues, Major Problems, and Resolutions**

Issues this quarter center primarily around the concerns for FY96 funding for continuation of tasks of interest and need by the industry. An additional issue, which has been presented to the industry partners for resolution, is the need to determine sites for upcoming in-plant tests of colorants recovery, and the arrangements for ensuring that needed in-plant test equipment will be available.

### **Explanation of Variances**

Variances in milestones and deliverables from the project plan are minor and have been due to a slight modification in some laboratory efforts, based on recommendations and continued contact between the textile industry teams and the principal investigators in order to better align national laboratory research efforts with textile industry needs.

### **Plans for Next Quarter**

During the next quarter, laboratory researchers will continue their programs with directions slightly modified, based on the TReC industry partner progress reviews. When the industry partners confirm sites for field testing, plans will be finalized for the recovery of colorants and advanced washing tests. Because plans for the following quarter are dependent upon the availability of funding, they are difficult to assess in detail.

### **Invention Disclosures**

An invention disclosure was filed at ANL on a "Method of Polymer Recovery in Aqueous Biphase Extraction Systems" by David Chaiko (ANL-IN-95-001).

### **Publications and Presentations**

None.

## **FINANCIAL SUMMARY**

Financial summary information will be included in the next quarterly report.

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