CALS Technologies Applied to the Fiber/Textile/Apparel Industry

The fiber/textile/apparel industry is looking to EDI and STEP to improve efficiency through electronic commerce and life cycle integration.

by Howard T. Moncarz and Y. Tina Lee

The fiber/textile/apparel (FTA)[1] industry is one of America's largest manufacturing industries, shipping $128 billion of apparel and textile products in 1990 and providing over 10% of all manufacturing jobs, particularly for women and minorities. Women made up 77% of the FTA work force in 1989, compared with 33% for all manufacturing; minority workers had about double the representation in the FTA industry as in manufacturing as a whole.[1] The FTA industry's success is critical to the economic health of the country.

The FTA industry in the U.S. faces fierce competition from imported products. The percent market penetration for apparel imports has gone from 28% in 1980 to 66% in 1992.[2] Since 1980, 420,000 jobs have been lost in the FTA industry in the U.S. If the market penetration of apparel imports had not increased since 1980, the net job loss to the industry would have been **ZERO!**[2]

The industry has decided to use "time" as a strategic weapon to offset the import challenge. The time taken from initial fiber production to eventual apparel product on the retail shelf is about 66 weeks. Of those 66 weeks, 11 are for actual process time. The remaining 55 weeks are time waiting for processing or time in inventory. As illustrated in Figure 1, there is a $25 billion a year loss in the apparel pipeline due to stockouts, markdowns, and inventory cost—directly attributable to the long cycle time. It has been projected by Kurt Salmon Associates that savings of $12 billion are possible through improved efficiency in the apparel pipeline that leads to reduced cycle time.[2]

In addition to addressing the efficiency of the entire FTA complex as a single system, the apparel sector, in particular, requires special attention. The apparel sector is the least capital-intensive of the FTA sectors, and therefore at greatest risk from imports. The sector comprises 23,000 apparel manufacturers, averaging under 50 employees each. If the

Howard T. Moncarz
is an engineer at the National Institute of Standards and Technology (NIST). At NIST, he has served as project leader for the design and development of the Inspection Workstation, one of the workstations in the Automated Manufacturing Research Facility. Most recently, he has been working on the Apparel Product Data Exchange Standard (APDES) Project.

Yung-Tsun Tina Lee
is a computer scientist at NIST. She joined NIST in 1986, and is currently the project manager of the APDES Project. Previous to NIST, she worked at the Contel Networks & Systems and at the Sperry Corporation.

[1]In this article, we are using the term "FTA industry" to mean the manufacturing sectors of fiber, textile, and apparel. We are using the term "integrated textile industry" to mean the entire multi-sector, vertical and horizontal industry that includes the fiber, textile, and fabricated product (including apparel) sectors, the supplier sectors to the FTA industry, the retail sector, and finally, the consumer. We will only use this latter term when specifically discussing the integration of the entire complex.

[2]Source: American Textile Manufacturers Institute; the apparel import data includes finished garments and an estimated percentage of fabric and yarn imports that went into domestically produced apparel.

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domestic apparel market was considered as a compilation of many small niche markets, each satisfying the needs of a relatively small number of consumers, imagine the strength of many small apparel companies, each addressing the needs of different niche markets.

The development of "apparel design engineering" can be a second strategic weapon to enable the many small apparel companies to react quickly to fashion changes and produce high quality products, responsive to niche markets. In fact, other countries have adopted that strategy and have been very successful; one such country is Italy. In 1989, Italy's apparel and textile exports were close to five times its imports, whereas the U.S. apparel and textile exports were about one twelfth its imports, even though hourly wages were significantly higher in Italy than in the U.S.[3] Advancing the technology of apparel design engineering could enable America's apparel companies to compete more successfully in niche markets.[4]

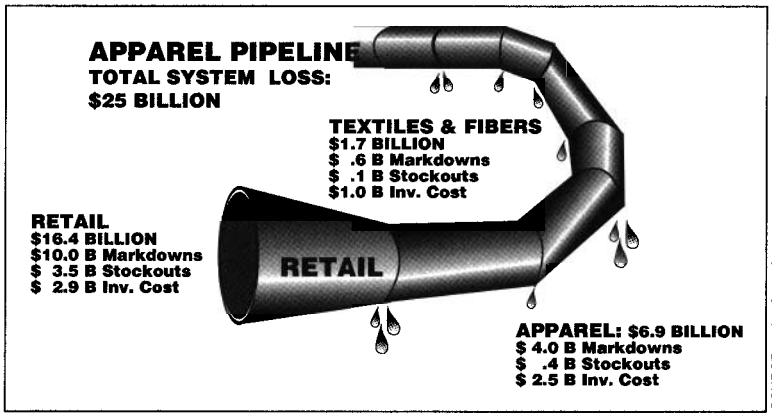

Figure 1. *The Apparel Pipeline.*

Key CALS technologies for electronic commerce—using the standard for Electronic Data Interchange (EDI)—and life cycle integration—using the Standard for the Exchange of Product Model Data (STEP)—can improve the efficiency of the entire FTA complex.[3] Furthermore, STEP can be used to specify apparel product data for sharing that information throughout the entire manufacturing life cycle. That capability is central to enabling apparel design engineering and integrating design information into the life cycle.

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ELECTRONIC COMMERCE FOR THE FTA INDUSTRY

The separate sectors of the integrated textile industry[4] must communicate effectively, both vertically and horizontally, to assure the most efficient operation of the entire multi-enterprise, multi-sector industry complex. For example, the operations and policies of an apparel manufacturer are heavily dependent on its suppliers and customers, and vice versa. The desire among the industry sectors to communicate more efficiently has led to the establishment of a number of trade organizations to foster those communications.

Industry Efforts

The Textile Apparel Linkage Council (TALC), the Sundries and Apparel Findings Linkage Council (SAFLINC), the Fabric and Suppliers Linkage Council (FASLINC), and the Voluntary Inter-industry Communications Standards (VICS) Committee are heavily involved in developing "Quick Response" for the integrated textile industry and developing the Electronic Data Interchange (EDI) standards necessary to accomplish it. The EDI standards are limited to data needed for business transactions, but that is sufficient to enable Quick Response and reduce the time required in the apparel pipeline.

Five percent of all U.S. manufacturers are using EDI; 12.5% of U.S. FTA manufacturers are using EDI—two and a half times the industry average.[5] The FTA industry is in the vanguard of electronic commerce.

New Initiative at the National Institute of Standards and Technology (NIST)

In recognition of the tremendous importance of electronic commerce to the future success of American industry, NIST is initiating a new program based specifically on electronic commerce. Business systems for procurement, inventory management, supplier bidding, accounting, etc. will be analyzed for their information technology requirements. Additionally, it is proposed that manufacturing systems be extended to interface with the above-mentioned business systems to build an overall enterprise environment. Another proposed effort is the harmonization between EDI, the business electronic exchange standard, and STEP, the manufacturing data interface standard. The goal will be to create a "seamless" interface to both types of information.

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[3]Expanding STEP to include product data for the FTA industry began with a NIST project, sponsored by the Defense Logistics Agency (DLA). The goal of the project was to develop an Apparel Product Data Exchange Standard (APDES), so that the military services could specify their uniform requirements electronically to apparel contractors. The APDES project and the DLA program are discussed later in this article.

[4]See footnote 1.

[5]The source of this information is the EDI Yellow Pages, as cited in reference [2].

The new NIST initiative will be broad-based across industry. However, another new program has been proposed for NIST—the Apparel Technology (ATEC) Program. We expect that the ATEC Program (discussed later in this article), will significantly leverage the results of the electronic commerce initiative. The idea that business transactions for the integrated textile industry will be predominantly electronic in the future is basically accepted. The new policies of several major companies have helped foster that belief. For example, Wal-Mart has told its suppliers and other business partners that they must ramp up their capabilities over the next several years to be able to do all of their business transactions with Wal-Mart electronically. The ATEC Program will bring together advanced technology, systems integration, product data exchange standards, and electronic commerce to help advance the technology of the integrated textile industry.

INTEGRATING FTA MANUFACTURING LIFE CYCLE

Two technology enablers are necessary for enterprise integration. The first is an enterprise framework that specifies the entire functionality of the industry's operation. The second is a set of manufacturing data standards that specifies the interfaces among these functions.

The APDES Project—Building Information Models For Apparel Product Data

At NIST, we have been working on a project to develop STEP Application Protocols (APs) for the apparel manufacturing life cycle (Figure 2). The project is named the Apparel Product Data Exchange Standard (APDES) Project, and is sponsored by the Defense Logistics Agency (DLA). The goal is to develop standard interfaces that will enable integration of the apparel manufacturing life cycle, in particular the activities that DLA is sponsoring as university research and development (R&D) projects.

As a first step in AP development, we decided to use the Apparel Manufacturing Architecture (AMA),[5] developed under DLA sponsorship by the Georgia Institute of Technology, as the enterprise activity model. We analyzed the AMA and identified a set of fifteen APs, shown in Table 1, that would fully support the information-exchange requirements contained within the AMA.[6]

***Table 1.** List of Candidate STEP Application Protocols for the Apparel Manufacturing Enterprise*

ready-to-wear pattern making	production scheduling
made-to-measure pattern making	packing and shipping
garment style development	material procurement
marker making and cutting	manufacturing resource maintenance
sewing and assembly	production resource allocation
cost estimation	sales and marketing
quality control	inventory maintenance
manufacturing planning	

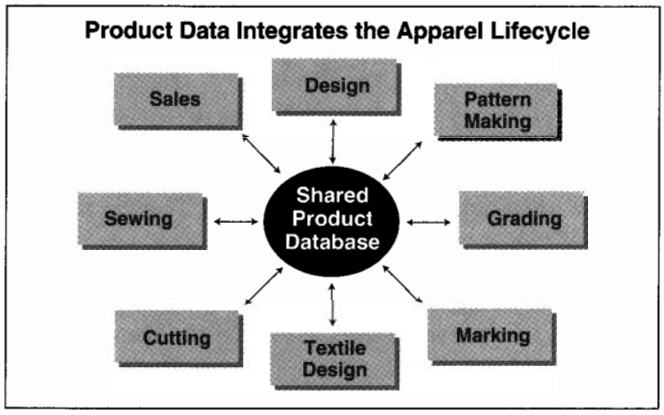

***Figure 2.** The Apparel Product Life Cycle.*

The goal of the APDES project is to bring the entire set of apparel APs through the International Organization for Standards (ISO) process. Because of the tight timeline required to integrate the DLA-sponsored research projects, a suite of "prototype" APs is being developed (in the short term) for the APDES project. These prototype APs will serve as straw-man APs to help in the development of formal STEP APs for the apparel industry. The formal STEP APs will be developed in full conformance with STEP standards, including the attainment of industry consensus as required by STEP procedures.

So far, we have completed one of the prototype APs we identified, "ready-to-wear pattern making."[7] This AP specifies the information necessary to represent two-dimensional flat patterns for the purpose of facilitating communication between apparel CAD/CAM, ready-to-wear, pattern making systems. The AP supports the capabilities of representing the base pattern geometry, the sizing data, and the grading rules which are based on traditional X-Y pattern-grading methods. Currently, we are working on a second AP, "made-to-measure pattern making." In the near future, we hope to engage a much wider participation from the industry to accelerate the AP development and improve the value that the APs developed will have to industry.

NATIONWIDE R&D EFFORTS

Over the last five years, a number of R&D programs have been established to benefit the FTA industry. Several of the notable efforts are described below.

DLA's Customer-Driven Uniform Manufacturing Program

The APDES project is part of an R&D program sponsored by DLA to improve apparel manufacturing technology. In addition to NIST, participants in the DLA program include universities, as well as apparel companies and their suppliers. The DLA program is advancing technology from traditional size-based methods (ready-to-wear) to methods that

use body measurements data directly (made-to-measure). Additionally, the program is advancing production methods from fixed procedures based on standard products to flexible, computer-integrated manufacturing using the standards developed in the APDES project. The new technologies developed are expected to lead to better fit, higher product quality, more economical unit-production methods, and quicker response. All told, the program is a broad evolution toward integrated enterprises, in which all phases of a product's life cycle are coordinated through a framework of standards, concurrent engineering practice, and supporting technology.

AAMA/ARC

According to the latest draft:

> *The mission of the Apparel Research Committee (ARC) [of the American Apparel Manufacturers Association (AAMA)] is to conduct, identify, support, influence and disseminate worldwide research and emerging technologies and philosophies that will enable the U.S. apparel industry to become more competitive in a global market environment.*

AAMA has been recognized by the American National Standards Institute (ANSI) as the standard's representative for the apparel industry, and is busily working on the development and ratification of computer integrated manufacturing (CIM) standards in the AAMA/ARC/CIM subcommittee. As a next step, the CIM subcommittee wants to take the ANSI-ratified apparel standards to the international level under the auspices of ISO.

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An important area to address in taking the standards to ISO will be the handling of conformance testing (CT), required for ISO standards. Discussions in the CIM subcommittee have recognized that it is likely that STEP will eventually be used for apparel CIM standards. The leveraging that is available from the extensive worldwide, multi-industry STEP effort may be a powerful inducement for the apparel industry to head towards STEP.

NTC

The National Textile Center (NTC) is a program established about two years ago by the Department of Commerce to fund collaborative university research for the entire integrated textile industry. So far, not much attention has been given to the apparel sector, but it is anticipated that will change in the future. The NTC program could be a valuable resource for helping to integrate the entire integrated textile industry.

[TC]^2

The Textile/Clothing Technology Corporation ([TC]^2) is a non-profit consortium established in 1979 to pursue more effective methods and more efficient machinery to carry the apparel industry into the future. Its mission includes demonstrations, education, and research and development. The Department of Commerce provides funding for its R&D program. The National Apparel Technology Center, located in Cary, NC, is the primary instrument of [TC]^2's real time demonstration and other programs.

ASTM/ISR

The Institute for Standards Research (ISR), a subsidiary of the American Society for Testing and Materials (ASTM), recently documented a comprehensive study of women's body measurements for use by the apparel industry. The study was coordinated by ISR and included about 7,000 women ages 55 and over. ISR is now developing an effort to do a new study for women ages 18 to 55. We have discussed working with ISR to possibly develop a STEP AP that could be used to disseminate the measurement information accumulated by them to the apparel industry.

AMTEX (American Textile Consortium)

The AMTEX Partnership™, initiated in mid-1992, is a collaboration of industry research consortia and academia working in conjunction with the U.S. Department of Energy (DOE) national laboratories, to provide assistance to the U.S. FTA industry to recover its domestic market share and enhance its global competitiveness. The project given the lion's share of funding for this, the first year, is the Demand Activated Manufacturing Architecture (DAMA) Project. Its main goal is to reduce by half the estimated $25 billion a year loss due to stockouts, inventory, and distressed pricing due to the unduly long cycle time. The CALS technologies are expected to be important in this effort.

NIPDE

The National Initiative for Product Data Exchange (NIPDE) is an organization involved in promoting and developing the idea of product data as central to life cycle integration across all manufacturing industries. We are working with NIPDE to develop a Capability Action Plan (CAP) for the FTA industry. A CAP lists the R&D activities that are in process or planned in a particular industry segment. We believe that a CAP for small apparel

companies, giving them a voice in the national arena, could be quite valuable.

MassTAC

The Massachusetts Textile/Apparel Consortium (MassTAC) is an organization of apparel and textile companies (mainly apparel) in Massachusetts who are banding together to share information and leverage their efforts to compete nationally and internationally. They include companies of medium size (about 1200 employees) to very small apparel companies. As such, they may prove to be a strong voice in representing small apparel company interests. In addition, they are planning a periodic newsletter to send to their members, and they anticipate that apparel product data standards, particularly APDES, will be an important part of the information they disseminate.

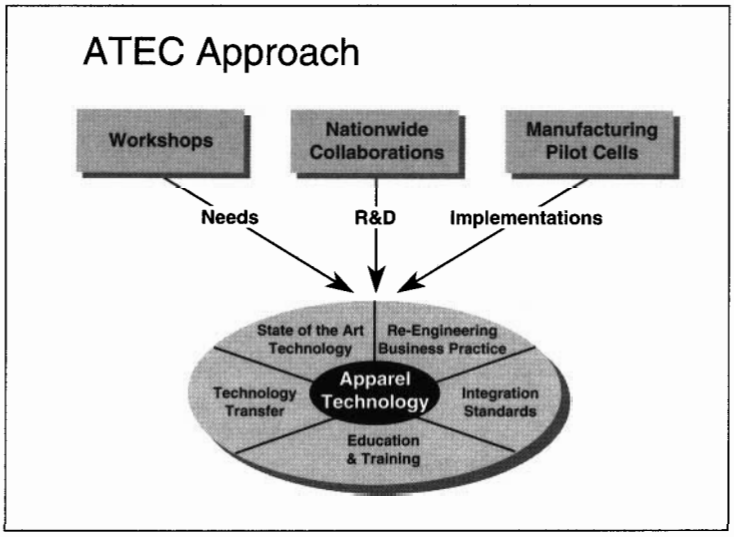

***Figure 3.** Apparel Technology (ATEC) Program Approach.*

Custom Footwear

Many of the technologies used for the apparel and footwear sectors are similar and can be leveraged to benefit each other. Recently, a workshop was co-hosted by NIST and the South Carolina Research Authority (SCRA) to discuss the possibility of initiating a nationwide R&D effort to advance the technology for manufacturing therapeutic footwear.[8] The conferees concluded that reducing the cost and improving the aesthetics are the main goals that must be accomplished for that effort. The CALS technologies are key to this program. The technologies needed exist, but must be properly integrated. Incorporating better aesthetics into a shoe design, so that the shoe would be functionally the same, requires improved design techniques that can be integrated within the manufacturing life cycle and are dependent on product data (STEP).

The ATEC Program will bring together advanced technology, systems integration, product data exchange standards, and electronic commerce.

It was suggested that custom footwear is the ideal product for describing CALS technologies in support of the life cycle of a product. A fuller discussion of this effort will have to wait for a future CALS article.

NIST'S NEW ATEC PROGRAM

Based on what we have learned over the last five years, directly and as a by-product of our APDES Project, we have determined that an expanded R&D program at NIST on behalf of the integrated textile industry is wanted by the industry and can benefit it. This expanded program builds upon the vision described in the paper, "Information Technology Vision for the U.S. Fiber/Textile/Apparel Industry."[4] Figure 3 shows the overall approach that we are planning for ATEC.

The objectives of ATEC, which we believe reflect the industry needs and NIST's strengths, are:

- to assist the development of standards in support of manufacturing data integration,
- to provide a voice to small businesses in the national arena, alongside the industry giants,
- to utilize NIST resources for technology development where appropriate, and
- to transfer technology from the nation's laboratories (including NIST) to industry.

R&D projects targeted as part of ATEC include:

- continuing the APDES Project,
- implementing an apparel pre-production manufacturing cell,
- developing the technology for nationwide apparel information dissemination,
- contributing to the development and maintenance of an anthropometric database,
- advancing the technology for computer-aided apparel design engineering, and
- implementing a custom footwear pre-manufacturing cell.

Our efforts will collaborate closely with nationwide R&D efforts across industry, universities, and other government agencies.

CONCLUSIONS

CALS' supporting technologies, in particular, EDI and STEP, are the perfect tonics for the FTA industry challenges. Both EDI and STEP will help integrate the activities across the whole industry complex.

EDI is already firmly established in the FTA industry. The idea that electronic commerce will be the method of doing business in the future is becoming accepted as inevitable.

STEP is in the early stages of penetration to the industry, but the interest nationwide in the endorsement of STEP is picking up strongly. We believe that the seeds have been planted to engage much greater industry participation over the next couple of years.

The merging of business transaction data and manufacturing product data will enable the best from both worlds to be leveraged for each other. We expect that the intelligent combination of EDI and STEP will be very beneficial to industry in general and will be a further major inducement for industry to embrace both EDI and STEP.

Finally, a number of substantial programs on behalf of the FTA industry are forming linkages. We believe that the activity models used to specify the scope of STEP APs can be used to clarify the vision of the integrated textile industry of the future, as well as provide a road map towards reaching it.

For more information about the application of CALS' technologies to the FTA industry, please call the authors at (301) 975-3548, or Jeane Ford, ATEC Program Manager, at (301) 975-3747.■

ACRONYMS

AAMA	American Apparel Manufacturers Association
AMA	Apparel Manufacturing Architecture
AMTEX	American Textile Consortium
ANSI	American National Standards Institute
AP	Application Protocol
APDES	Apparel Product Data Exchange Standard
ARC	Apparel Research Committee
ASTM	American Society for Testing and Materials
ATEC	Apparel Technology (proposed NIST program)
CALS	Continuous Acquisition and Life Cycle Support
CAP	Capability Action Plan
CIM	Computer Integrated Manufacturing
CT	Conformance Testing
DAMA	Demand Activated Manufacturing Architecture
DLA	Defense Logistics Agency
DoC	Department of Commerce
DoE	Department of Energy
EDI	Electronic Data Interchange
FASLINC	Fabric and Suppliers Linkage Council
FTA	Fiber/Textile/Apparel Industry
ISO	International Organization for Standards
ISR	Institute for Standards Research
MassTAC	Massachusetts Textile/Apparel Consortium
NIPDE	National Initiative for Product Data Exchange
NIST	National Institute of Standards and Technology
NTC	National Textile Center
SAFLINC	Sundries and Apparel Findings Linkage Council
STEP	Standard for the Exchange of Product Model Data
TALC	Textile-Apparel Linkage Council
$[TC]^2$	Textile/Apparel Technology Corporation
The AMTEX Partnership™	Collaborative effort among the DOE/National Labs & AMTEX
VICS	Voluntary Inter-industry Communications Standards Committee

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