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TITLE: Creation of an Integrated Research Plan for Computer Integrated Manufacturing Technology for the Textile-Apparel Complex

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CODE: S94-12

GOALS: To create an overall strategic plan aimed at integrating and leveraging CIM research related to textile and apparel manufacturing. Establish an active academic network with broad participation, i.e. researchers not only from the four NTC universities. A successful integration of our research efforts will magnify the collective impact of our work without losing each individual initiative and strength, and accelerate movement toward our common goal - technologically advanced and competitive textile and apparel industry.

ABSTRACT: This project was initiated in March 1994 and is in the early stages of implementation. Most of the efforts have been focused on establishing an active network of textile researchers, working in CIM, interested in collaboration. Planning the integration activities has been one of the most important activities, the result of which is a three year NTC proposal for joint research between NCSU and USL (University of Southwestern Louisiana).

ACTIVE NETWORK:

The first initiative to establish the group of investigators interested in integration of CIM in the FTAR complex research was an informal meeting during the Second Annual NTC conference. It was a good time for networking and planning, because the conference exhibitions and seminars helped everyone to become familiar with one another's work and discover new possibilities for joint research. Here are some of the meeting issues:

* ***Research Content and Strategy:*** where are the CIM projects going; how do we identify where the gaps of knowledge are and develop a plan of research (e.g. scheduling is an increasingly difficult task, especially in dyeing and finishing, and apparel manufacturing); most of our work generates a static picture of one part of the textile chain - how do we integrate these pieces and make the whole system dynamic; can we create an integrated CIM structure that can be implemented in pieces one step at a time; how do we overcome the fragmented communication links caused by the diversity of function and size in the textile complex; how do we insure that the results of our work are useful and affordable for small companies, especially at the apparel end of the chain, etc.

* ***Researcher Interactions:*** how do we link with AMTEX (DAMA) to insure consistent standards for delivery and implementation; while expanding this group beyond the NTC universities, how do we make it international in character; how do we develop ways to interact so that we can get past generalities to specifics; should we develop a NATO-type meeting where researchers spend a week discussing an area of knowledge; how do we use electronic systems for ongoing interaction (e.g. Internet bulletin board); what is the right frequency for this group to meet.

* ***Research Funding:*** how do we work as a group to meet critical timing on requests for proposals; explore different funding sources.

* ***Technology Transfer:*** how do we find an adequate refereed journal for publishing our work, etc..

Another networking activity was a four-day trip to the A-CIM center at the University of Southwestern Louisiana (USL) with the purpose of exploring resources and potentials for joint research. The following resources are currently available:

* NCSU is on the manufacturing side with capabilities to experiment in a "real" production environment, collect on-line data from the machines, change parameters and measure variables (the Model Manufacturing and CIM Labs at the College of Textiles). Existing NTC CIM project can help the future research, i.e. the idea is to make use of already developed models of some textile operations.

* USL has expertise in Computer Science and Engineering, which can be utilized in two ways: (1) research - help NCSU from a computer science perspective by designing and implementing a system, based on information technologies, to convert data into useful knowledge, i.e. automate understanding; (2) software design, i.e. create "computer environment", as well as additions/enhancements to existing software, to answer specific questions and meet NCSU research needs.

Some areas of interest, with the potential for joint research, were identified:

* Computer integrated manufacturing, where USL has the computer expertise and NCSU has manufacturing competency;

* Information technology: simulation, scheduling, reactive (dynamic) planning and control, re-engineering and performance evaluation, real-time database design for new technologies/equipment (at the machine level), optimization, etc.. USL is interested in simulation and dynamic scheduling of processes in the textile part of the value-added chain, in a similar fashion to solving apparel problems using PPN for performance evaluation (which they have explored already).

A specific information technology problem was analyzed as an example for joint proposal - the application of process improvement by improved utilization of available information. The challenge in this project is the depth of both industry information and information technology knowledge that is required. This project will require both universities to provide each other with a lot of information. The point of the project will be to model some part of the industry in sufficient dynamic detail so that a process change can be reflected in the model clearly enough for performance evaluation of the changed system that can be used for comparison, and also to indicate difficulties in implementing the proposed change. We expect that process changes will be indicated merely by utilizing information that is already available within the system modeled or possibly by making available, within the system, information existing outside the system.
A serious consideration on modeling methodology is that the system used must be easy to create and understand, and at the same time must be capable of analysis for performance evaluation and for correctness (buffers being bounded, capacity constraints maintained, reversibility of errors, potential of work stoppage, etc.). The current choice is to combine IDEF and Petri net methodologies. USL has the technology when it comes to Petri nets, building their own software for simulation and analysis of PN models. The present stage of IDEF modeling is so close to the industry knowledge that developing IDEF models will require a lot of detailed input from NCSU students and faculty. IDEF models are also easier for many people to produce and understand. There exists some homomorphism (mapping) between IDEF (static hierarchical) models and PN (dynamic hierarchical) models. It is probably useful to think of this project in terms of a

dissertation/thesis time frame, probably two or three years. What is useful about modeling and performance evaluation activity is not the model itself (no industry will pay to acquire a model of their operations). The model is only the necessary step that must be gone through to validate and verify performance evaluations. In our case the systems to be evaluated include the AS-IS and the TO-BE systems, where the TO-BE system is better information integrated. However, industry will be very interested in the results of a system that allows them to say, beforehand, how a process re-engineering improves performance, and by how much. A student link between USL and NCSU will be the most effective way to ensure regular communication and update, and will naturally produce valuable thesis/dissertation.

The culmination of the integration and planning attempts was a "future search" three-day conference, focused on integration of the current efforts on CIM technology implementation in the FTAR (Fiber-Textile-Apparel-Retail) complex.

* ***Purpose:*** to bring together the diverse viewpoints and research efforts, represented by participants from various universities, with the intent of discovering a common vision and strategy for integration and implementation of CIM concepts in the FTAR complex.

* ***Participation:*** Dr. Padmini Srinivasan *(USL)*, Dr. Sundaresan Jayaraman *(Georgia Institute of Technology)*, Dr. John Peck *(Clemson University)*, Mr. Joe Off and Robert Fulenwider *(Textile/Clothing Technology Corporation)*, Mr. Lee Cheatham *(Battelle Pacific Northwest Lab)*, Mr. Steve Freudenthal *(Milliken)*, Dr. Sam Winchester, George Hodge, Perry Grady, Gordon Berkstresser, Mansour Mohamed and John Cuculo *(North Carolina State University)*.

After presentation of every participant's current research in CIM (individuals and teams), and two intense brainstorming sessions on important issues regarding CIM, the participants arrived to a list of actionable concepts. Each actionable concept was presented in detail by an assigned group member and discussed thoroughly in the group. They were organized in order of importance to the group as follows (a low Roman numerical indicates higher priority):

Category I:

1.) Joint NTC/DAMA Review - presented by Lee Cheatham;

2.) Make a clear picture of who we are - George Hodge;

3.) Give one view of what we are planning to do - Padmini Srinivasan;

4.) Common definition of architecture and modeling of the industry - Sundaresan Jayaraman;

Category II:

1.) Strategy for reaching the end-goal of the present group/team - Ekaterina Popdimitrova (NCSU);

2.) How to measure our performance - David Sigmon (NCSU);

3.) Skills and Capabilities Inventory - Sam Moore (NCSU);

4.) Providing access to new technology resources for education purposes - Lee Cheatham;

Category III:

1.) Establish a "virtual" Institute, in a fuzzy way, which serves as a focus point for R&D on CIM in the FTARC complex - Sam Winchester and Perry Grady;

2.) Clearing House Keeper(s) - Robert Fulenwider (TC^2);

3.) Lab for demonstrations/pilots - the non-virtual aspect of the Institute -John Peck;

* ***Accomplishments:*** An electronic mail distribution list (on Internet) was created for the purpose of sending messages to everyone from the newly formed working group. The address of this mailing list is: ***humble@tx.ncsu.edu***

We have now agreed to work on a proposal through the large group, in a meeting or electronically. The required funding for the new proposed project has been narrowed down to cover only NCSU and USL expenses. The reasons for that are as follow:

- the research interests of both parties are focused on manufacturing operations' perspective in textiles and apparel;

- all CIM researchers at the other participating universities are fully funded.

Therefore, the future research proposals will come out from NCSU with the USL team included.

STRATEGIC PLANNING:

The first step is to develop regular communication within the group through Internet exploring the advantages of an electronic working environment, i.e. create a working, "virtual" research group to overcome the lack of geographic proximity.

We have created a three year NTC proposal for joint research between NCSU and USL (as a contractor), supported by voluntary technical consultations from members of the newly formed CIM academic group (e.g. J. Peck - Clemson, S. Jayaraman - GaTech, E. Branon - Auburn).

The overall objective of the project is to develop and test approaches for information integration of the textile industry for more effective computer integrated manufacturing (CIM). The approaches are to be applied in modeling the interlinked material, business and information processes, with main focus on the manufacturing operations within a textile enterprise. The project has two parallel but integrated strategies: (1) develop a rationalized, dynamic, plant level integrated model of the textile manufacturing value-added chain, which will consist of coherent models based on machine and material flow processes. The viewpoint for these models would be that of a plant manager, so that they can be used as inputs to CEO/Enterprise models (NTC S92C11), industry/enterprise models being developed by DAMA, and development of standards by USL A-CIM Lab.

We have also planned the resources required for the proposed research, the industry outreach, and partnerships. First year goals have been defined, and some of the following years objectives have been established.

For the purpose of clarifying the reality of the existing and proposed CIM research we have created a picture - see Figure 1 "TEXTILE INFORMATION SCIENCE COMPONENTS".
The figure is a mechanism for mapping relationships between NTC research activities. For example: (1) the new NTC proposal covers the creation of CIM based information models of fiber through fabrics which are rationalized and integrated into adaptive, dynamic systems, (2) DAMA represents a computer integrated industry model focusing on the apparel to fiber chain, and (3) Berkstresser et al represents a market-driven enterprise model. These approaches are all required to enhance the competitiveness of the textile and apparel industry.

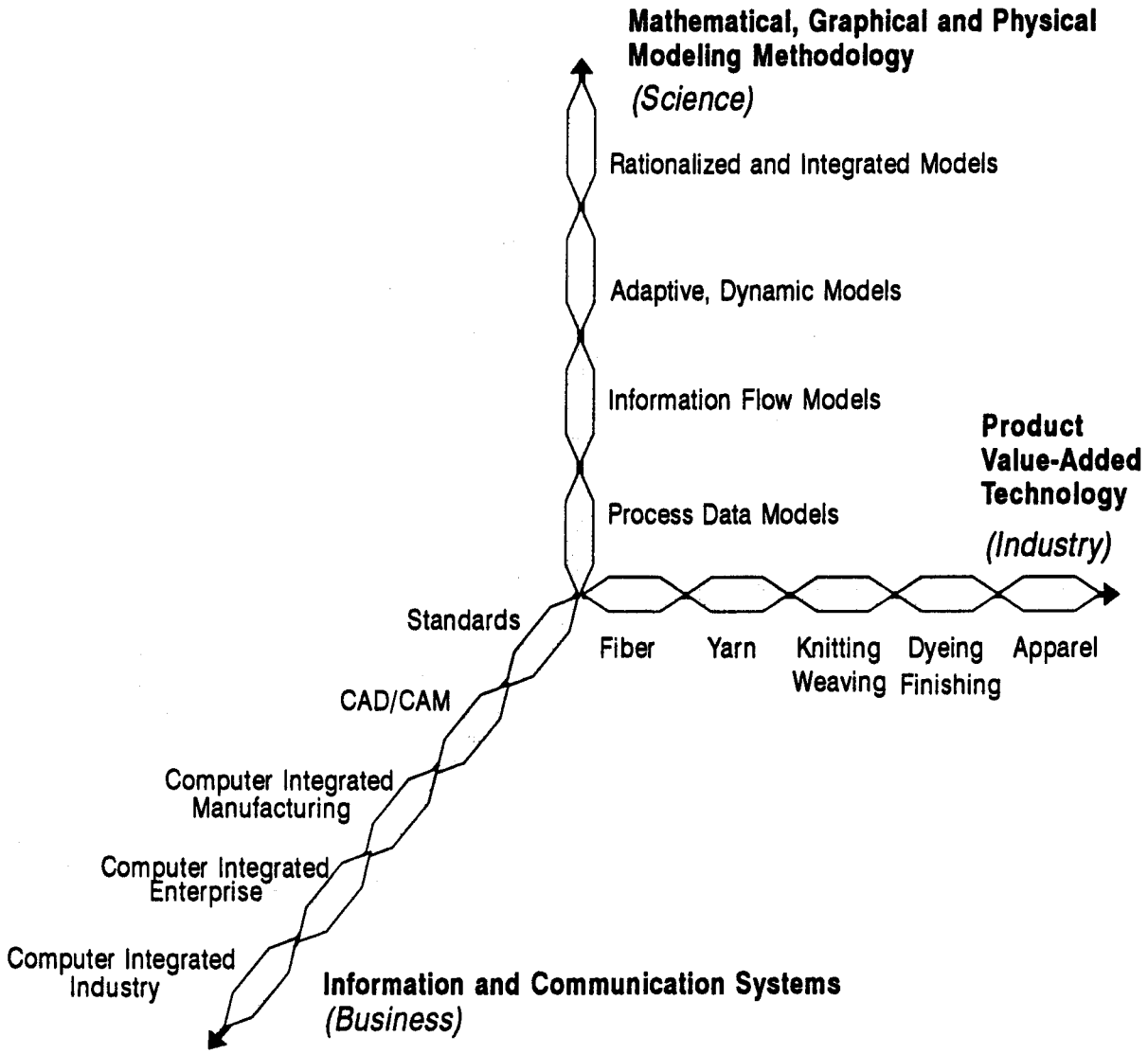

FIGURE 1. TEXTILE INFORMATION SCIENCE COMPONENTS

The next step is to identify all elements of need to develop a status plan for the CIM academic group.