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**Pathway #1, Techniques/Methods to Minimize/Eliminate Variability
and Increase Paper Machine Efficiency**

QUARTERLY REPORT

Project # DE-FC36-99GO10416

**Improving Paper Machine
Efficiency Through On-Line Control of
Stock Delivery, Headbox and Forming Hydrodynamics**

Principal Investigator: Cyrus K. Aidun

Institute of Paper Science and Technology
Atlanta, GA 30318

Phone: 404-894-6645

Fax: 404-894-1496

e-mail: cyrus.aidun@ipst.edu

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1. Status of the Technical Scope of Work

The design for trial on the Thin-Channel Converflo headbox are in progress. The design for implementation of the microforming unit on the Type W and Symflo headboxes are planned for Summer and Fall of 2000.

According to the revised schedule, the on-line electronic control (ultrasonic and/or electromagnetic) system design will start during the first quarter of the second year. Various options for the design based on efficient control approaches have been evaluated including the use of 'smart material' in the control system. The practical aspects of these techniques are being evaluated.

2. Level of Completion:

The tasks in phase I of the Static Version are complete (see the schedule of tasks presented below). The remaining work is to extend the applicability of the static microforming system to Thin-Channel Converflo and Symflo headboxes.

The design and fabrication of the on-line control systems will start during the first quarter of the second year. The computational fluid dynamics analysis has been partly completed as the preliminary studies and evaluation of the methods.

3. Significant Program/Project Tests

Experiments are planned for evaluation of the laboratory headbox and flow loop constructed during the last two quarters. The diagnostics equipment including high-speed imaging and the Laser-Doppler Anemometer is being evaluated with the conventional headbox system prior to application to the new on-line control systems.

4. Upcoming conferences

There are no papers planned for upcoming conferences at this time.

5. Variances to cost or schedule

It has been proposed and accepted by the OIT Office in Washington to use part of the funding for the second year (~\$78.5K of the) for partial funding of the AF&PA project for commercial application of a microforming retrofit to the Escher Wyss headbox in Florence, SC. Per Ms. Valri Robinson, the OIT office has agreed to add the \$78.5K funding to this project above the previously funded budget for the fourth year of the project. Therefore, with this additional task, some of the other tasks will be postponed for a quarter, as reflected in the next section. The remaining part of the project is on schedule.

Summary of the additional task:

IPST has a major project with the Containerboard Group (CG) of AF&PA concerned with the Hydrodynamics of Forming directed by the current project PI. The CG

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project is a commercial demonstration of the 'swirl-tube' technology invented by Aidun and patented by IPST. Pilot trials in an AF&PA member company's pilot plant has been successfully completed in addition to the Voith Sulzer pilot plant in Germany at commercial speeds. There have been no glitches thus far and the potential benefits appear to be greater than first anticipated. The next step is a full scale commercial trial on a actual paper machine. The commercial trial, scheduled for first week of January 00, requires the manufacturing of a new full size tube block and tubes for the commercial machine. The total cost has been over \$550K most of which has been funded by AF&PA and the supplier companies involved with the project. An additional \$75K is required to complete the fabrication of the commercial tube block.

By co-funding this project, DOE-OIT will be associated with a full blown commercial trial that is expected to be a complete success. The AF&PA Containerboard member companies have welcomed the additional funding by DOE-OIT to expedite the project since they are anxious to have the technology available as soon as possible. And the results of the January trial would be known in a matter of months. The CG support of this project over the past two years is over \$470K. By adding the in-kind contributions from the supplier companies to this amount, the industry-government cost share ratio would be very favorable. There are plans for CG to continue the project through board testing and box making.

The tasks already planned in this project builds on the commercial trial added to the project, so the success of the January trials will considerably elevate the significance of the current DOE-OIT project in the eyes of the industry.

6. Updated Task Schedule for the Project:

The added tasks to the project will only influence the schedule of tasks for the on-line control system. The Schedule for the Development of the Static Microforming System remains unchanged.

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Schedule for the Development of the Static Microforming System:

Quarters→	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Phase I - CFD Analysis & Exp. verification																
Design Retrofit Concept	?															
CFD Evaluation of Concept	?	?		?				?								
LDA measurements and CFD Verification					?	?		?								
Phase II - Pilot Trials																
Retrofit Concept for Pilot Trials			?	?	?						?	?	?			
Laboratory Evaluation				?	?						?	?				
Pilot Machine Installation/Trials					?	?	?						?	?	?	
Phase III - Commercial Trials																
Commercial Retrofit Concept							?	?			?	?				
Laboratory Evaluation					?	?		?	?				?			
Fabrication						?	?		?	?			?	?		
Machine Installation/Trials							?	?		?	?	?		?	?	?
Commercial Trial/Escher-Wyss HB					?											
Report at each milestone		?		?		?		?		?		?		?		?

Schedule for the Development of the On-Line Field Control System:

TASKS	Quarters→	Year 1				Year 2				Year 3				Year 4			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Phase 1 – Laboratory Experiments:																	
Design Tubes for the Tube Bundle					√	√											
System Installation/Optimization						√	√	√									
CFD Characterization						√	√	√	√								
Laser-Doppler Turbulence Characterization								√	√								
Phase II – Pilot Trials:																	
Retrofit Concept for Pilot Trials										√	√						
Laboratory Evaluation										√	√						
Pilot Machine Installation/Trials											√	√	√				

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