
As per Marsha Gill I have answered the following questions.

1. What is the status of the technical scope of work? Answers to this question should be tailored to the tasks in the Statement of Work that are being performed.

   Answer: the project has ramped up to full speed. We have made good progress in starting the mill measurements and in designing the experimental apparatus.

2. What is the level of completion (percentage) for each task
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and/or subtask? Percentage completion rates should be provided for each task within the Statement of Work as reported in question 1.

**Answer:** we are about 40% complete on the tasks that are scheduled for the first year.

3. Are there any significant program/project tests or demonstrations scheduled in the next four months? This pertains to work outlined in the Statement of Work.

**Answer:** The main experimental work will begin in the second year, once we have fully established our experimental facilities and procedures.

4. Are there upcoming conferences at which papers will be presented? This pertains to work outlined in the Statement of Work.

**Answer:** I presented a review of the project to the AF&PA Agenda 2020-Capital Effectiveness team earlier this month. The project reviewed strong support.

5. If there are any variances to cost or schedule, what are the reasons for these? If the project schedule has changed submit an updated schedule with dates referring to each task.

**Answer:** There are no variances so far.
*Also, for purposes of verifying the project schedule, with the first Quarterly Report please submit an updated task schedule for the project period.

Answer: see the write-up below, or the handouts from my AF&PA talk.

Regards,

Dave Orloff


Quarterly Status Report for the period October 1999 through April 1999 on Project DE-FC36-99GO10384

D. I. Orloff
May 10, 1999

The purpose of this quarterly report is to provide an overview of the project including key tasks, schedules for completion of
tasks and to document accomplishments.

**Project Staff:** David Orloff is principle investigator of the project, while Jere Crouse, recently retired from Beloit Corp, and Fred Bloom, Northern Illinois University, are consultants. The IPST faculty and staff working on key aspects of the project are; Fred Ahrens, Tim Patterson, Hiroki Nanko, Seppo Karrila, and Yulin Deng

**Project Objective:** The objective of the project is to provide fundamental knowledge and diagnostic tools needed to design new technologies that will allow ultra high speed web transfer from press rolls and dryer cylinders.

**Deliverables:** The deliverable include; 1.) A database and understanding of the mechanisms of deposition of contaminants on roll surfaces, 2.) Experimental results that demonstrate how surface chemistry, surface topology and operating conditions influence the work of adhesion in transferring webs from roll surfaces, 3.) Verification of improved web transfer models at ultra high speeds, and 4.) Development of an improved roll surface conditioning technology.

**Benefits to Industry:** Benefits include; 1.) Improved paper machine runnability, resulting in less breaks per day, and increased uptime, 2.) Improved utilization of first dryer section that will improve machine efficiency, energy usage, and machine speed, and 3.) Improved paper sheet surface
properties as a result of reduced sheet picking.

**Fundamental Questions:** From a fundamental standpoint, we expect that roll surface performance depends on the composition of contaminants that deposit on these surfaces during use, as well as the materials and finishing techniques used in manufacturing these surfaces. We need to understand; the contamination process, the influence of contamination on work of adhesion, the roles of surface topology, film splitting, and process conditions on web transfer.

**Key Research Tasks:** Our research program may be separated into the accomplishment of six major tasks. These include;

Task 1.: Identify composition of contaminants and topology of press and dryer roll surfaces at commercial mills.
Task 2.: Develop facilities to simulate contaminant deposition process under controlled experimental conditions.
Task 3.: Develop facilities to simulate web transfer from contaminant surfaces and measure work of adhesion.
Task 4.: Develop models to predict contaminant deposition and work of adhesion.
Task 5.: Develop and verify models to predict web transfer at ultra high paper machine speeds.
Task 6.: Develop and demonstrate new roll surface conditioning technologies.

**Progress:** In this section we briefly summarize the progress that we have made on each of the key research tasks.
Task #1.
Identify composition of contaminants and topology of press and dryer roll surfaces at commercial mills. We are currently involved in the following subtasks; 1.1) development of techniques for measuring and quantifying surface topology of press and dryer roll surfaces, 1.2) development of procedures for measuring contaminants from press roll and dryer surfaces, 1.3) collect contaminants and surface replicas from mill surfaces. We expect these tasks to be completed by July of 1999. Once completed, we will 1.) use the results to design simulation experiment to be undertaken in year two of the project.

Progress on subtask 1.1 includes comparison of various resins as replicating materials and comparison of direct contact and non-contact profilometry techniques. Progress on subtask 1.2 and 1.3 includes completion of first mill visit during which we obtained contaminant samples and surface replicas from all press rolls and dryer rolls on a paper machine making coating base stock.

Task #2.
Develop facilities to simulate contaminant deposition process under controlled experimental conditions. Subtasks include; 2.1) development of a roll test stand where the roll surface can be made up of curved roll surface coupons, 2.2) preparation of the roll test stand, 2.3) development of a ring system to hold the coupons on the roll surface, 2.4) develop a system for
controlling the contaminant environment, and 2.5) system test and shakedown.

Progress on these subtasks includes the design completion of the design of the ring/coupon system. Machine component drawings are currently out for machine-shop bids. We expect that the test stand, rings and coupons will be ready for system shakedown by September of 1999.

**Task #3.**
Develop facilities to simulate web transfer from contaminant surfaces and measure work of adhesion. The subtasks of this project include; 3.1) defining the design targets of the apparatus, 3.2) design of the web adhesion simulator apparatus, 3.3) construction of the apparatus, 3.4) testing and debug.

Progress on these subtasks has included defining the design targets as; ability to utilize surface coupons from the roll test stand, ability to operate in ranges of temperature and dwell time representative of commercial presses and dryers, ability to simulate dual application pressure ranges (for both pressing and drying simulation), capacity to adjust web transfer speed and peel angle, capability to provide an accurate measurement of the peel force (tension) for use in the Mardon equation to calculate the experimental "work of adhesion".

We have also made good progress in designing the web adhesion simulator apparatus. The apparatus will allow us to measure the work of adhesion of dryer roll and press roll.
surface coupons as a function of: surface topology, surface materials, contaminants, paper characteristics, application pressure, interfacial temperature and interfacial moisture. We plan on debugging of the apparatus by the end of September 1999.

**Task #4.**
Develop models to predict work of adhesion from first principles. The subtasks associated with this task include: 4.1) literature survey, 4.2) development of models to relate measures of surface topology to the "work of adhesion" and web release, 4.3) use of these models as a background in defining how to measure the topology of mill surfaces, 4.4) development of models to predict contamination of roll surfaces, and 4.5) the use of these models in designing controlled contamination experiments on the roll test stand.

We have completed the literature search and have identified the measures of surface topology that are most likely to be important in correlating our "work of adhesion" data. We have begun a model to predict the temperature and moisture at the interface between the paper web and the dryer roll surface at the moment of web transfer. We will be using this model as a starting point in modeling the various modes of contamination from the paper web to roll surfaces. We expect that precipitation and liquid film splitting will play roles in the contamination process. The modeling effort will be completed by October 1, 1999.
Task #5.
Develop and verify models to predict web transfer at ultra high paper machine speeds. The subtasks of this task will begin in the second year of this project after we have full experimental capability. The subtasks include; 5.1) performing contamination experiments on the roll test stand utilizing coupons of relevant dryer and press roll surfaces, 5.2) performing "work of adhesion" experiments with contaminated coupons at various simulated dryer and press operating conditions, 5.3) correlating the resulting data, 5.4) incorporating the correlation into a web transfer model, and 5.5) evaluating the model on a pilot paper machine. We expect to complete these subtasks by October 1, 2000.

Task #6.
Develop and demonstrate new roll surface conditioning technologies. The subtasks associated with this task will begin during the third year of the project. These subtasks include; 6.1) development of contamination control options on the roll test stand, 6.2) development options for controlling roll surface topology on the roll test stand, 6.3) evaluate desirable options on the pilot paper machine. We expect that these subtasks will be completed by October 2001.