
**CENTRE FOR MAINTENANCE OPTIMIZATION AND RELIABILITY
ENGINEERING SEMIANNUAL CONSORTIUM MEETING**

**MAINTENANCE OPTIMIZATION
AND RELIABILITY ENGINEERING
CONDITION-BASED MAINTENANCE
AND BEYOND**

DIRECTOR
Professor Andrew K. S. Jardine

REPORT

Tuesday October 30, 2007
9:00 a.m.–4:00 p.m.

HILTON GARDEN INN
OAKVILLE, Ontario

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EXECUTIVE SUMMARY

ANDREW K. S. JARDINE, C-MORE DIRECTOR

INTRODUCTION

The following report summarizes work undertaken between Consortium members and C-MORE since the June 2007 meeting on the project *MORE (Maintenance Optimization and Reliability Engineering): CBM (Condition-Based Maintenance) and Beyond*.

We are delighted today to welcome Xerox's US operations as our newest Consortium member.

C-MORE

On July 24 we received approval from the Chair of the Department of Mechanical and Industrial Engineering, Professor Tony Sinclair, to rename our group "The Centre for Maintenance Optimization and Reliability Engineering (C-MORE)," in recognition of our expanded mandate. We are the second Centre within the Department, the other being the Centre for Advanced Coating Technologies.

Our new web site www.mie.utoronto.ca/cmored will be launched at today's meeting.

RESEARCH PROPOSALS

On August 1 confirmation was received from the Ontario Centres of Excellence Centre for Materials and Manufacturing (OCE-CMM) that they are funding our proposal titled, "MORE (Maintenance Optimization and Reliability Engineering): CBM (Condition-Based Maintenance) and Beyond," at the level of \$182,000 per year for a period of 3 years. It was clear that this support was influenced significantly by OCE-CMM's knowledge that Consortium members were highly supportive of the planned program.

The second research proposal titled, "Critical Spare Parts Provisioning: Models and their Application," which was being reviewed by the University last June, has been submitted to NSERC. It is under review and we look forward to a positive response in mid-November.

The support of all Consortium members in enabling us to finalize these submissions is greatly appreciated.

C-MORE STAFF AND STUDENTS

Since our June meeting Ali Zuashkiani and Darko Luit received their doctoral degrees at convocation on June 21 and Andrey Pak successfully defended his MSc thesis, "Maintenance and Repair Contracts: Modeling and Optimization" on September 6.

It was a pleasure to welcome our new Postdoctoral Research Fellow Nima Safaei earlier this month.

Diederik Lugtigheid (PhD candidate) will be defending his doctoral thesis titled, "Systems Subject to Repair and Maintenance Actions: Modeling and Optimization" on November 5.

One new graduate students joined us in September—Robert Svaluto. Robert joins Tanya Tang (PhD candidate), Sharareh Taghipour (PhD Candidate: Sharareh successfully was fast tracked to the PhD program in September), and Kelly Kinahan (MA Sc candidate). We also look forward to welcoming Lorna Wong as a doctoral student in January 2008. Also arriving in January will be a visiting doctoral student for a period of 3 months: Jan Block from Lulea University in Sweden. Jan is also Lead Computational Engineer, Logistics Analysis and Fleet Monitoring, Ground Support Services Division, Saab Aerotech.

Graduate student Peter Lewis who was due to join us in September has delayed his acceptance.

Our research associate, Dr. Daming Lin, continues work on the I2I project in collaboration with OMDEC that focused on EXAKT commercialization and has developed a new I2I proposal titled “Commercialization of Spare Management Software (SMS)” that was submitted to NSERC in October. A summary of the proposal is included in this report.

RESEARCH OUTPUT

As has been our practice in previous years, the end-of-year report provides a listing of all the research outputs of staff and students for the current year (2007) where it is reported that there were a total of 15 papers published, accepted for publication, or submitted for publication, along with one encyclopedia chapter. Eighteen presentations were made at conferences.

SOFTWARE

A new version (1.3) of SMS software for spare parts management optimization of emergency/critical spares will be delivered today to the Consortium members. The major enhancement over V1.2 is that an extended option for infinite calling population has been implemented, to provide more flexibility and user friendliness to the options in V1.2. This new option can be used conveniently when the fleet size (number of working units/components of the same type) is large, so that the demand rate for spares is practically constant. This approach does not require the arrival rate for individual units/components, but it requires the arrival rate at the workshop only, which is relatively easy to estimate. The option has been implemented for both non-repairable and repairable cases and different optimization criteria, which is not common in other software packages, particularly not for repairable systems.

C-MORE ACTIVITIES

C-MORE has been busy during the June–October 2007 period participating in conferences and meeting with consortium members, as evidenced by the listings in the sections, “Visits and Interactions with Consortium Members and Others” and “Publications and Presentations 2007.” C-MORE is currently involved in the following projects with our industry partners:

- Barrick Gold: Maintenance and repair contracts and right sizing of truck shop bays
- Dofasco Steel: Performance measurement and design of a reliability knowledge base
- Hydro One: Optimization of maintenance crew sizes
- Ministry of Defence UK: Optimizing CBM decisions for diesel engines (oil analysis) on frigates; gearboxes (vibration monitoring); diesel engines on armoured fighting vehicles (oil analysis and weather data); aircraft repair histories

- Syncrude: Use of on-line sensor data for CBM optimization. The dataset combines reliability data, oil analysis data collected every 250 operating hours, and process data collected by sensors on the order of hundreds of times per day.

COLLABORATIONS WITH CONSORTIUM MEMBERS

As always, it is a pleasure to see the presentations about C-MORE's collaborations with Consortium members at today's meeting, where we feature presentations related to our Barrick, MOD UK, and Syncrude work. In addition it is a pleasure to have Xerox introduce their work on "How Xerox uses reliability information and analysis." Due to the arrival of new students and new funding, Professor Jardine will be visiting all Consortium members with the goal of alerting colleagues of company representatives to C-MORE's activities and exploring possible new collaborations, including case study applications, in the focus areas of

1. Condition-based maintenance of expensive long-life assets subject to condition monitoring
2. Capital/emergency spare stock sizing for parts critical to plant availability
3. Protective devices reliability for health, safety and the environment

THE INTERNATIONAL MAINTENANCE EXCELLENCE CONFERENCE IMEC 2007: OCTOBER 31–NOVEMBER 2, 2007

As part of the Physical Asset Management Initiative at the University of Toronto, the University has organized IMEC 2007. Steve Allen has been representing Consortium members on the Advisory Committee and will brief Consortium members on the current development of the conference plans.

THE FUTURE

We continue to have an excellent team of C-MORE staff and students. All are excited about the future development of our research activities. As is always stressed, to continue such activities requires continuing close collaboration and contact with CBM consortium members. We value what has been achieved and are confident that we can maintain the support of members through the excellent staff and students committed to the research program funded by members, OCE and NSERC. I am particularly excited about our new name C-MORE, support from OCE, and our new graduate students and postdoc—all changes that augur well for the future of C-MORE.