CENTRE FOR MAINTENANCE OPTIMIZATION AND RELIABILITY ENGINEERING

CONSORTIUM MEETING AGENDA

December 6, 2011: 9:00am–4:00pm, Hydro One, Toronto

WELCOME 10 minutes	Andrew Jardine, C-MORE Director
EXECUTIVE SUMMARY 20 minutes	Andrew Jardine, C-MORE
NEW MEMBER PRESENTATION: GTAA 25 minutes	Tim Nevins, GTAA Mike Riseborough, Henry Oberholster
BARRICK'S MAINTENANCE JOURNEY 25 minutes	Robert Cronin, Barrick Joseph Ashun, Barrick
STUDY TO DISCOVER ABNORMAL OPERATIONS OF PROTECTING DEVICES 20 minutes	Adam McDonald, Hydro One
WHEEL MOTOR SPARE PROBLEM AT TECK 20 minutes	Robert Kalwarowsky, TECK Robert Svaluto, C-MORE
COLLABORATIONS WITH CONSORTIUM MEMBERS AND BEYOND 90 minutes	
Ministry of Defence, UK, Various – with Tim Jefferis UK MOD Gearbox CBM – with Tim Jefferis Teck: Spares availability analysis – with David Williams	Neil Montgomery, C-MORE
GTAA: Preliminary analysis of Low-Vis Lighting System data	Hossein Mohammadian, C-MORE
OCWA: Preliminary analysis of centrifuge vibration data	Janet Sung, C-MORE
LUNCH	

SOFTWARE DEVELOPMENT: SPARES SIMULATION 20 minutes	Neil Montgomery, C-MORE Robert Svaluto, C-MORE
MAINTENANCE SCHEDULING PROJECT WITH BOMBARDIER 20 minutes	Nima Safaei, C-MORE
COLLABORATIVE HEALTH RESEARCH PROJECT (CHRP) PROGRAM – PROGRESS 20 minutes	Sharareh Taghipour, C-MORE
DEVELOPING RESEARCH INTERESTS WITH STUDENTS 15 minutes	
Integration of maintenance and production scheduling	Maliheh Aramon, C-MORE
C-MORE EDUCATIONAL PROGRAMS 15 minutes	Ali Zuashkiani, C-MORE
ANY OTHER BUSINESS	Andrew Jardine, C-MORE

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 7, 2011, meeting.

WELCOME TO NEW MEMBERS

It is a pleasure to welcome to this Consortium meeting two new members: Greater Toronto Airports Authority (GTAA) and Iron Ore Canada (IOC)

GREATER TORONTO AIRPORTS AUTHORITY (GTAA)

GTAA has been in charge of the management, operation, and maintenance of Toronto Pearson – Canada's largest and busiest airport - since 1996. Over the past decade, GTAA has ushered in a number of improvements, expanding the existing infrastructure to include a state-of-the-art baggage system, a world class de-icing facility, and many other new airport innovations. Full details can be found at www.torontopearson.com.

IRON ORE CANADA (IOC)

IOC is Canada's largest iron ore producer and a leading global supplier of iron ore pellets and concentrates. IOC is a key employer in the communities in which it operates, employing almost 1900 people in the provinces of Newfoundland and Labrador and Quebec. IOC operates within the Rio Tinto Iron Ore group and maintains its head office in Montreal. Full details are available at www.ironore.ca

NEW RESEARCH FUNDING

I am pleased to report that we have obtained the following funding to support our research agenda.

NSERC CRD

This grant on Spare Parts: *Advanced Critical Spare Parts Provisioning Models* will further C-MORE's work on spare part procurement decisions, developing new models for single and multiple types of parts, stored at single and multiple locations. The project will incorporate preventative maintenance policies, including condition-based maintenance, into the spare parts provisioning decision. This submission would not have been possible without the support of Hydro One, Barrick Gold, and ABB. Total funding received from NSERC: $88,048 per year for three years.

NSERC ENGAGE

The NSERC Engage grant ($25,000) is in support of collaboration with Maintenance Assistant Inc. for the project titled *A framework to transform a web-based computerized maintenance management system into an evidence based asset management decision tool*. Full details of Maintenance Assistant can be found at www.maintenanceassistant.com

RESEARCH GRANT APPLICATON: AUTO 21

In partnership with HEC Montreal, Virage Simulation of Montreal, Fleet Challenge Ontario and colleague Professor Birsen Donmez we have submitted a full proposal to AUTO21, a federal funding program for sustainability initiatives in the automotive industry. Decisions will be announced in January. Without the support and guidance of doctoral student Corey Kiassat this application would not have been possible.

C-MORE STAFF AND STUDENTS

NEW STAFF

We welcome back Dr. Daming Lin as Research Associate. Daming will initially be working on the NSERC ENGAGE collaboration with Maintenance Assistant.

STUDENTS

We welcome three students:

- Mohammadreza (Soroush) Sharifi is a research student (currently MASc) who joins us from his Master's of Management in Operations Research degree from the University of British Columbia. It is expected that Soroush will specialise in some aspect of whole life costing of physical assets

- Xinbo Qian is a visiting doctoral student from Huazhong University of Science and Technology, China; she will be with us for three months in the first instance and may stay longer.

- Andriana Barisic a graduate student in epidemiology will be working with Dr. Sharareh Taghipour on our breast cancer screening study funded by the new grant: CHRP.

Three graduate students will present today:

- Janet Sung: OCWA: Preliminary Analysis of Centrifuge Vibration Data
- Maliheh Aramon: Integration of Maintenance and Production Scheduling
- Robert Svaluto: Wheel Motor Spare Problem at Teck

C-MORE LAB STAFF AND POST DOCTORAL FELLOWS (PDF)

Our Project Director, Dr. Dragan Banjevic, continued collaboration with Manitoba Hydro on CBM for power transformers. The main focus is now on analyzing data on TR maintenance in connection with the data on DGA. He has also collaborated with all members of the C-MORE Lab, and in particular with Sharareh on CHRP, Janet on inspection intervals, Nima and Maliheh on scheduling problems, Tanya on FFI, and Neil on case studies.

Neil Montgomery has continued to be essential to ongoing collaborations with Consortium members: Teck, MOD, GTAA, OCWA. Neil continued to provide general support to C-MORE graduate students working on their research projects and developing new research grant proposals.

Dr. Daming Lin started working at C-MORE in October, primarily on an NSERC Engage program to collaborate with Maintenance Assistant (MA). Daming has also been investigating and getting familiar with the SMS code as a preparation for new development.

Dr. Ali Zuashkiani Ali has been primarily involved in educational programs. Along with Dr. Nima Safaei have been working on a paper which deals with forecasting future O&M costs of a fleet of transformers.

PDF Dr. Nima Safaei continues his collaborative project entitled "Resource Planning to Schedule the Maintenance Tasks in Bombardier". Currently, Nima is developing optimization algorithms to solve the "Aircraft Maintenance Routing" problem considering the detailed maintenance program mandated by manufacturer as well as the airline's flight schedule

PDF Dr. Hossein Mohammadian he has been involved in the GTAA projects. As a part of a project, called low-visibility lighting system inspection interval, he created a software tool in order to create a database management system for the lights, inspections and faults. Congratulations to Hossein on obtaining his PEng license.

PDF Dr. Sharareh Taghipour continued her work on the project entitled "Risk factors and optimization model for breast cancer screening". Initial results of her analysis were reported in a paper titled "Analysis of cumulative incidence functions for invasive breast cancer and the competing mortalities in the Canadian national breast screening study" presented at the "Risk Assessment and Evaluation of Predictions" conference, 12-14 Oct 2011 at Silver Spring, USA.

SOFTWARE (SMS)

Extensions to SMS, our Spares optimization software, will be presented at this meeting: development of simulation procedures for computationally intractable models in SMS.

C-MORE ACTIVITIES

Since July 2011, C-MORE lab members have been working on research, participating in conferences, and meeting with consortium members. C-MORE is currently involved in the following projects with industry partners.

- **ABB**: Supported the successful NSERC CRD proposal on Spare Parts Provisioning.

- **Barrick Gold**: Supported the successful NSERC CRD proposal on Spare Parts Provisioning.

- **Hydro One Networks**: Supported the NSERC CRD proposal on Spare Parts Provisioning. Research student Will Luff completed a project related to his Master's thesis "Maintenance Strategies for Linear Assets," applying his work in the case study of part of the distribution system of Hydro One Networks, and has produced some potentially valuable results.

- **Teck**: Neil Montgomery and Dragan Banjevic worked on a spares problem posed by David Williams, Teck's Corporate Reliability Engineer, in which demand for spares could come from a failure or an age-based replacement. Simulation software to calculate

the optimal number of spares to minimize cost and/or availability has been developed and will be presented at this meeting.

- **MOD UK**: Neil Montgomery completed a report on the gearbox CBM case study. Tim Jefferis of MOD and Neil decided on the format of the data to be used for predicting the health of a long term project and have begun building histories. Doctoral student Janet Sung will also be working on this project.

- **Manitoba Hydro:** Data analysis of Manitoba Hydro's power transformers continued in collaboration with Wendelin Schuhmann. Detailed analysis of measurement data (DGA and STD) continued. There is also continuing interest in reliability growth of power units.

- **Enmax:** Supporting the current CRD on condition-based maintenance models.

- **Ontario Clean Water Agency**: Continued collaboration on maintenance of centrifuges with doctoral student Janet Sung. Vibration records have been obtained and analysis is ongoing.

- **Ontario Power Generation**: Battery maintenance collaboration still to commence.

- **GTAA:** Dr. Hossein Mohammadian started working on a project on low-visibility lighting system inspection interval. He has already created a software tool in order to create a database management system for the lights, inspections and faults. The final objective is to obtain the optimized inspection interval.

C-MORE EDUCATIONAL PROGRAMS

Dr. Ali Zuashkiani has continued in his role as Director of Educational Programs with responsibility for developing various knowledge transfer activities through both new Physical Asset Management Certificate programs and our regular International Maintenance Excellence Conference (IMEC). The objective is to combine high quality content delivered by leading instructors with the academic rigour of the University of Toronto.

Notably, the most recent course, the 8-day Certificate program in Physical Asset Management program held in November was again a success with participants coming from all corners of Canada (Newfoundland & Labrador to British Columbia to the North West territories), the USA and Dubai. Industries represented were mining, utilities (gas and electricity), physical plant, consulting and aluminum smelting.

THE INTERNATIONAL MAINTENANCE EXCELLENCE CONFERENCE (IMEC): THE ASSET MANAGEMENT CONFERENCE – OCTOBER 5-7, 2011

The more than 80 participants came from Australia, Canada, Colombia, Chile, Germany, Hong Kong, The Netherlands, Sweden, and the United States. Some had hands-on backgrounds in industry; others were academics and researchers. This presented a unique opportunity for like-minded people from around the world to share insights from the perspectives of both industry and academia. Many thanks to consortium members who were speakers at the conference: Shamir Lhadani of Enmax, David Williams of Teck, Ken Sutton of OPG, Rob Cronin of Barrick Gold, Wendelin Schuhmann of Manitoba Hydro and Bo Ji of Hydro One Networks.

THE C-MORE TEAM

We continue to have an excellent team of C-MORE staff and students. All are excited about our ongoing and new research activities. We can't say it often enough: the continuation of such activities requires close collaboration and frequent contact with consortium members. We value what has been achieved and are confident that we can maintain the support of members through the hard work and dedication of our staff and students.

Andrew K.S. Jardine

November 29, 2011