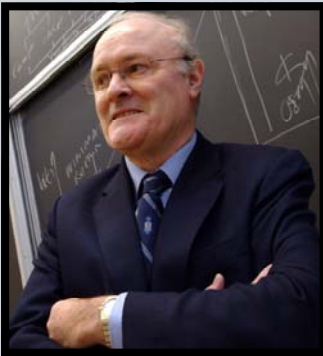




### Director

#### Michael Jong Kim

Mike Kim is the Director of C-MORE and a professor in the Department of Mechanical and Industrial Engineering at U of T.



### Founding Director

#### Andrew K.S. Jardine

Andrew K.S. Jardine is the Founding Director of C-MORE and Professor Emeritus in the Department of Mechanical and Industrial Engineering at U of T. He is the author of the classic textbook *Maintenance, Replacement, and Reliability: Theory and Applications* with A.H.C. Tsang.

## Industry-Guided Real-World Research for Optimal Asset Management

C-MORE's research is driven by close interactions with industry, in particular with our consortium members and researchers at universities world wide. Our focus is on real-world research in asset management in condition-based maintenance, spares management, inspection optimization—any reliability or maintenance problem based on industry data. Our strong industry connections benefit the companies we work with and our students who find work in maintenance divisions of industry leaders after graduation.

We apply our research with software tools that obtain valuable information from data found in corporate databases. EXAKT (the CBM Optimizer) and SMS (the Spares Optimizer) are commercially available, but are complimentary to Consortium members.

## Membership Benefits

- EXAKT software maximizes the value of your asset inspection data
- SMS software optimizes your critical spare parts decision-making
- Access to world leaders in Reliability and Maintenance Research
- Special access to post-doctoral fellows, and undergraduate and graduate students working on theses, internships, and applied projects
- Opportunity to drive direction of software/research development
- Company-wide membership
- Networking with companies at leading edge of maintenance practice
- Semi-annual meeting of consortium members

## History of the Consortium

C-MORE was founded in 1994 by Professor Andrew Jardine with the help of the Ontario Centres of Excellence Centre for Materials and Manufacturing. Its goal was to advance Professor Jardine's groundbreaking theoretical work on condition-based maintenance (CBM) optimization. Several companies were interested in his vision of a dedicated research centre involving industry, faculty, researchers, and graduate students. Major milestones include the development of C-MORE's CBM optimizer, EXAKT, and its spares optimization software, SMS.

## CONTACT US

<http://cmore.mie.utoronto.ca>

5 King's College Rd  
Toronto, ON M5S 3G8  
Fax: +1 416 946 5462

Director

Michael Jong Kim  
[mikekim@mie.utoronto.ca](mailto:mikekim@mie.utoronto.ca)  
+1 416 978 2710

Associate Director

Neil Montgomery  
[neilm@mie.utoronto.ca](mailto:neilm@mie.utoronto.ca)  
+1 416 978 2921

Founding Director

Andrew K. S. Jardine  
[jardine@mie.utoronto.ca](mailto:jardine@mie.utoronto.ca)  
+1 416 978 2921

# C-MORE Centre for Maintenance Optimization & Reliability Engineering

## Research Focus Areas

### Condition-Based Maintenance

For expensive long-lived assets that are subject to condition monitoring or process measurements.

### Key Issues

Diagnosing a complex asset's state of health.  
  
Providing a prognosis of its remaining useful life (RUL).

### Our Approach

Proportional hazards model finds key risk factors, which are blended with economics to provide an optimal CBM decision—gives system and component maintenance recommendations, estimates RUL and interval failure probability.

### Applications

Diesel engines  
Transmissions  
Gearboxes  
Hydraulic systems  
Water Pumps  
Pulp process pumps  
Reactor seals  
...*your* facility's equipment?

### Capital Spares and Emergency Spares

Stock sizing and ordering policies for parts that are critical to availability.

### Key Issues

Stock size and time horizon planning for critical spares.

### Our Approach

Optimization Criteria: instant reliability, interval reliability, cost minimization, availability for repairable and non-repairable parts.

### Applications

Repairable motors  
Steel mill processes  
Radar Systems  
...*your* spare part needs?

### Protective Devices

Ensure reliability for systems that safeguard health, safety, and the environment.

### Key Issues

Optimal inspection/repair/replacement policy

### Our Approach

Maximize the expected interval reliability over a specified period of time.

### Applications

Safety valves in a refinery  
...*your* protective device needs?

### Data Quality Assessment

Aligning data collection with business objectives—assess, benchmark, measure improvement in your data.

### Maintenance Scheduling

Focusing on meta-heuristic algorithms for complex maintenance scheduling and allocation problems.

### Reliability Growth

Are your assets getting healthier over time, or not? Assess the utility of your maintenance program.

### Human Reliability

Determining the impact of human-related factors, such as skill and motivation, on the reliability of a system.

C-MORE Software



## Consortium Members

## C-MORE Team



Funding Partners



### Director

Prof. Michael Jong Kim

### Associate Director

Neil Montgomery

### Founding Director

Prof. Andrew K. S. Jardine

### Research Staff

Dr. Dragan Banjevic (Project Director)  
Dr. Ali Zuashkiani  
Dr. Elizabeth Thompson

### Research Fellows

Dr. Maliheh Aramon  
Dr. Ricky Roet-Green  
Dr. Turuna Seecharan  
Dr. Payam Rahimi-Vahed

### Research Students

Janet Lam  
Xin Yuan Zhang  
Soroush Sharifi  
Ya-Tang Chuang  
Nasif Addnan