PHM 2016
8th Annual Conference of the
Prognostics and Health Management Society

Denver, CO
October 3 – 6, 2016

www.phmconference.org

www.phmsociety.org
Welcome to Denver!

Welcome to beautiful Denver, Colorado, for the 2016 Annual Conference of the Prognostics and Health Management Society. This is the 8th annual conference of the PHM Society and we are thrilled to be here in Denver. We have an exciting program this year which builds on the success of our previous conferences. Those of you who attended the conference last year in San Diego, California, know that we have big (well small) flip flops to fill. Two years ago we met in Ft. Worth, TX. If you combine Texas and California, flip flops and cowboy boots, you get river sandals and hiking boots, laid back and high adrenaline. Welcome to Colorado.

Denver has world-class museums, unique downtown arts districts, and highly-varied urban architecture to explore. This includes the iconic Union Station, which serves not only as a transportation hub, but as a foodie mecca with a dozen chef-owned restaurants and bars. The 16th Street Mall, just two blocks away, is a mile-long pedestrian mall designed by the famous architect I.M. Pei, lined with restaurants and shops, and served by free shuttle busses. Other sites in Denver include the Denver Art Museum, the Museum of Nature and Science, the (Unsinkable) Molly Brown House Museum, the Denver Mint (maybe the easiest way to grow your PHM budget), and many other museums within walking distance of the conference hotel. Downtown Denver is also home to a vast number of craft- and micro-breweries; several, including “Wynkoop” and “Great Divide,” are right downtown and have late-afternoon and evening tours for anyone interested. If you are sticking around for the weekend, Denver is also home to the Great American Beer Festival, right across the street at the Colorado Convention Center this weekend.

The city is also a hub for various sporting activities. Perhaps we will see some of you out for an early-morning run this week! A great location is the Cherry Creek Trail along Cherry Creek just on the other side of the Convention Center from the hotel. If you prefer two wheels to two feet, you can rent bicycles from Denver B-Cycle kiosks located around town. Denver is also home to several professional sports teams, including the Rockies, Nuggets, Rapids, Spurs (look that one up), and the World Champion Denver Broncos. While the Rockies’ season is over, the Nuggets’ hasn’t started, and the Broncos don’t have a game while we are here, you will get a chance to see and tour Sports Authority Field at Mile High, the Broncos Stadium, where we will have this year’s conference banquet.

Last, but certainly not least, Colorado is a worldwide destination for outdoor enthusiasts. Whether you hike, bike, run, climb, ski, or just enjoy the view, Colorado has just about every type of outdoor attraction you can think of. Colorado is home to Rocky Mountain, Mesa Verde, Black Canyon of the Gunnison, and Great Sand Dunes National Parks, and this year is the 100th anniversary of the United States National Park Service. Denver sits on what is known as the front range of the Rockies—this is where the Rocky Mountains start! We are hoping for nice, sunny weather while we are here this week, but it won’t be too long until the mountains to the west are covered with snow and beckoning skiers to come and play.

We hope that you have a great week here at the PHM Conference and also get a chance to explore downtown Denver and possibly even more of Colorado. If not, we’re sure that they would welcome you back. While neither Dave nor Karl are from Colorado, we’ve both enjoyed visiting here in the past and it’s one of our favorite destinations for work and play. We predict that you will have a wonderful time this week.

David Larsen and Karl Reichard

2016 Conference Co-Chairs

Come Visit the Following Sponsors
(3rd Floor Crystal Ballroom Foyer)

Get details of the Conference using the free Whova mobile app on your phone or tablet. See page 4 for details.
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<th>Event Details</th>
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<tr>
<td>8 AM – 5 PM</td>
<td>Crystal Ballroom AB</td>
<td>PHM Fundamentals Short Course</td>
<td>Reservation Location: Crystal Ballroom AB</td>
<td>8 AM – 5 PM</td>
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<td>PHM Fundamentals Short Course</td>
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<td>PHM Fundamentals Short Course</td>
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<tr>
<td>12 PM – 5 PM</td>
<td>Crystal Ballroom AB</td>
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<td>5:00 – 8:30</td>
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<td>Reserved for PHM Conference</td>
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<td>5:00 – 8:30</td>
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**Optional Short Course Agenda**  
(See Page 12 for Details)

**Saturday, October 1, 2016**
- 8:00 – 10:20 Session 1: Welcome and Introductions
- 10:40 – 12:00 Session 2: Diagnostics Methods
- 12:00 – 1:00 Lunch (provided)
- 1:00 – 3:20 Session 3: Prognostics
- 3:40 – 5:15 Session 4: Sensors and Data Processing
- 8:00 – 5:15 Non-hosted dinner with all participants

**Sunday, October 2, 2016**
- 8:30 – 10:30 Session 5: CBM+ Technologies
- 10:45 – 12:30 Session 6: Reliability and Life Cycle Management
- 12:30 – 1:30 Lunch (provided with evaluation forms)
- 1:30 – 3:20 Session 7: Fielded Systems Case Studies – 2
- 3:40 – 4:15 Session 8: Way Forward

**Additional Information**
- Registration Location: Crystal Ballroom AB
- PHM Conference Dinner
- Doctoral Symposium Dinner
<table>
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<tr>
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</table>
| 1:15 – 1:30 | Doctoral Symposium Welcome  
Jamie Coble                                    |
| 1:30 – 1:40 | Presentation #1: Circuit Breaker Health and Reliability Monitoring:  
The Key to Realizing a Smarter Electricity Grid  
Payman Dehghanian, Texas A&M University        |
| 1:40 – 2:00 | Panelist Feedback & Audience Q/A                                     |
| 2:00 – 2:10 | Presentation #2: Algorithms for Hybrid  
Diagnostics of Nonlinear Systems  
Turki Haj Mohamad, Villanova University         |
| 2:10 – 2:30 | Panelist Feedback & Audience Q/A                                     |
| 2:30 – 2:40 | Presentation #3: Fault-Tolerant Supervisory  
Control Mechanism for Chiller Plants  
Khushboo Mittal, University of Connecticut     |
| 2:40 – 3:00 | Panelist Feedback & Audience Q/A                                     |
| 3:00 – 3:30 | Break                                                                 |
| 3:30 – 3:40 | Presentation #4: Bayesian Cramér-Rao Bounds for  
Time-of-Failure Probability Mass Function Estimation  
David Acuña, University of Chile                |
| 3:40 – 4:00 | Panelist Feedback & Audience Q/A                                     |
| 4:00 – 4:10 | Presentation #5: Development of Deep Learning Based Approaches  
for Rotating Machinery Fault Diagnosis with Big Data  
Miao He, University of Illinois at Chicago      |
| 4:10 – 4:30 | Panelist Feedback & Audience Q/A                                     |
| 4:30 – 4:40 | Presentation #6: Model-Based Failure Prognosis Approach for  
Complex Systems to Support Asset Management  
Olivier Blancke, École de Technologie Supérieure |
| 4:40 – 5:00 | Panelist Feedback & Audience Q/A                                     |
| 5:00 – 5:10 | Presentation #7: Toward Battery Health Management for  
Small-size Battery-powered Rotary-wing Aircraft  
Gina Sierra, University of Chile                |
| 5:10 – 5:30 | Panelist Feedback & Audience Q/A                                     |
| 5:30 – 6:30 | Doctoral Symposium Dinner for participants and panelists              |
| 6:30 – 6:40 | Presentation #8: Deep Learning Based Diagnosis  
of Journal Bearing Rotor Systems  
Joon Ha Jung, Seoul National University         |
| 6:40 – 7:00 | Panelist Feedback & Audience Q/A                                     |
| 7:00 – 7:10 | Presentation #9: Probabilistic Pipe Strength and Toughness  
Estimation through Information Fusion with Bayesian Updating  
Sonam Dahire, Arizona State University          |
| 7:10 – 7:30 | Panelist Feedback & Audience Q/A                                     |
| 7:30 – 7:40 | Presentation #10: Meta Learning for Fault Tolerant  
PHM Systems Considering Correlated Failures  
Saikath Bhattacharya, University of Massachusetts Dartmouth |
| 7:40 – 8:00 | Panelist Feedback & Audience Q/A                                     |
| 8:00 – 8:15 | Panelists Final Thoughts                                              |
| 8:15 – 8:20 | Feedback from Students & Audience                                    |
| 8:20 – 8:30 | Conclusions and Feedback                                             |
### The Conference

The Prognostics and Health Management Society (PHM Society) welcomes you to its annual international conference. As the Society’s annual flagship event, the 2016 PHM Conference brings together the global community of PHM experts from industry, academia, and government in diverse application areas such as smart manufacturing, wind energy, oil and gas, aerospace, transportation, automotive, and industrial automation. The conference features keynote and luminary presentations, invited panel sessions, technology demonstrations, a data challenge, a special session for Human Assets, a doctoral symposium, tutorials, and a dedicated poster session during planned social hours, a Job Fair, and a two-day intensive short course on PHM fundamentals in conjunction with the conference. Several social events will provide opportunities for participants to connect with colleagues.

### The PHM Society

For years, the field of PHM was represented under a variety of banners, including aerospace, reliability, failure analysis and prevention, mechanical engineering, and others. PHM is broader than any single field of study. The PHM Society was established to unite the diverse PHM community and to establish PHM as a legitimate scientific and engineering discipline that draws from electrical, mechanical, civil, and chemical engineering, computer and materials science, reliability, test and measurement, artificial intelligence, physics, and economics. We invite you to establish PHM as a meta-discipline that synergizes these fields.

PHM society membership is free and entitles you to full access to papers, tutorials and proceedings.

### What Sets This Conference Apart

A major differentiator for the PHM Society is its contemporary approach toward copyright: the Society does not take ownership of your work! Instead, authors retain copyright through a Creative Commons License while allowing the PHM Society to distribute their work broadly through modern media. As a result, your original articles will reach the entire world for free and without access restrictions.

The conference includes high-quality tutorials, and original contributions submitted as full-length papers and posters. All submissions are reviewed by up to four experts in the field based on the criteria of originality, significance, quality, and clarity. The conference proceedings are published on the web for unrestricted access by the global scholarly and applications community.

### Mobile App

The PHM Conference will be using the Whova mobile app this year. Easily access the most up-to-date agenda information, read full PDF versions of all papers, connect with other attendees, and much more using the free app on your phone or tablet. Get “Whova” from the App Store or Google Play and sign in with your e-mail account. Search for the PHM2016 event and passcode phpmsociety, if prompted.
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<th>Track D: Technology Demos</th>
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<td>Reserved for PHM Conference</td>
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<td>9:45 – 10:15</td>
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<tr>
<td>10:15 – 12:00</td>
<td>Lunch on your own</td>
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<td>1:00 – 1:45</td>
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<tr>
<td>1:45 – 3:15</td>
<td>Tutorial Session 1A: Cripple Creek A</td>
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<td>Tutorial Session 2A: Cripple Creek B</td>
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<td>3:15 – 3:30</td>
<td>Opening Welcome Reception</td>
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<td>3:30 – 4:00</td>
<td>Opening Remarks</td>
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<tr>
<td>4:00 – 5:00</td>
<td>Paper Session 1A: Aviation I</td>
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<tr>
<td>5:00 – 5:30</td>
<td>Paper Session 1B: Diagnostics I</td>
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<td>Reserved for PHM Technology Demonstration Setup</td>
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<tr>
<td>5:30 – 6:00</td>
<td>Paper Session 2A: Systems I</td>
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**Monday, October 3, 2016**

### Paper Session 1A: Aviation I
**Monday, 1:45 – 3:30, Room: Cripple Creek A**

**Session Chair:** Rhonda Whalthan — UTAS

1. **Improved Time-Based Maintenance in Aeronautics with Linear Support Vector Machines** — Marcia Baptista¹, Ivo P. de Medeiros², Joao P. Malere³, Helmut Prendinger⁴, Cairo L. Nascimento Jr.⁵, Elsa Henriques²⁶(¹Universidade de Lisboa, Portugal; ²²Embraer SA, Brazil; ³³National Institute of Informatics, Japan)

   Flight Anomaly Tracking for Improved Situational Awareness: Case Study of Germanwings Flight 9525 — Murat Yasar⁷(¹United Technologies Research Center)


### Paper Session 1B: Diagnostics I
**Monday, 1:45 – 3:30, Room: Cripple Creek B**

**Session Chair:** Abhinav Saxena — NASA

1. **Solenoid Valve Fault Diagnosis for Urban Railway Braking Systems with Physical Model and Embedded Sensor Signals** — Boseong Seo¹, Sooho Jo², Hyunseok Oh³, Byeng D. Youn⁴(¹²,²³Seoul National University, Republic of Korea)

   Spur Gear Electrical Pitting Wear Diagnostic from Tribological Responses — Surapol Raadnuï(¹‘King Mongkut’s University of Technology North Bangkok, Thailand)

   Integration of failure assessments into the diagnostic process — Roxane Koitz¹, Franz Wotawa¹²(¹²Institute for Software Engineering, Austria)

2. **Autonomous Operations System: Development and Application** — Jaime A. Toro Medina¹, Kim N. Wilkins², Mark Walker³, Gerald M. Stahl¹²(¹NASA Kennedy Space Center; ²General Atomics; ³D2K Technologies)

### Paper Session 2B: Features I
**Monday, 3:45 – 5:30, Room: Cripple Creek B**

**Session Chair:** Ravi Rajamani — drR² Consulting

1. **Distributed Real Time Compressor Blade Health Monitoring System** — LiJie Yu¹, Sachin Srivastava² (¹GE Power Services Engineering, USA; ²GE Power Services Engineering, India)


### Paper Session 2A: Systems I
**Monday, 3:45 – 5:30, Room: Cripple Creek A**

**Session Chair:** Kirtland McKenna — Colorado School of Mines

1. **Autonomous Operations System: Development and Application** — Jaime A. Toro Medina¹, Kim N. Wilkins², Mark Walker³, Gerald M. Stahl¹²(¹NASA Kennedy Space Center; ²General Atomics; ³D2K Technologies)
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<th>Track B: Technical Paper Sessions</th>
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<td>7AM – 5PM</td>
<td>Registration</td>
<td></td>
<td>Location: 3rd Floor Foyer</td>
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<tr>
<td>7:45 – 8:00</td>
<td>Continental Breakfast</td>
<td>Opening Remarks</td>
<td>Location: 3rd Floor Foyer</td>
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<tr>
<td>8:00 – 8:45</td>
<td>Luminary Presentation: Dr. David Hilmers, former Astronaut, Baylor College of Medicine “Dealing with Disaster in Space and on Earth”</td>
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<td>Location: Crystal Ballroom</td>
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<tr>
<td>8:45 – 10:15</td>
<td>Paper Session 3A: Prognostics I</td>
<td>Paper Session 3B: Turbines</td>
<td>Location: 3rd Floor Foyer</td>
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<tr>
<td>10:15 – 10:30</td>
<td>Break</td>
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<tr>
<td>10:30 – 12:00</td>
<td>Paper Session 4A: Data Challenge Winners</td>
<td>Paper Session 4B: Diagnostics II</td>
<td>Location: 3rd Floor Foyer</td>
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<tr>
<td>12:00 – 1:15</td>
<td>Conference Lunch</td>
<td>Keynote Speaker: Rhonda Whalthall, United Technologies Aerospace Systems “The Role of PHM at Commercial Airlines”</td>
<td>Location: Crystal Ballroom</td>
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<tr>
<td>1:15 – 3:00</td>
<td>Paper Session 5A: Industrial &amp; Manufacturing Applications I</td>
<td>Paper Session 5B: Features II</td>
<td>Location: 3rd Floor Foyer</td>
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<tr>
<td>3:30 – 5:15</td>
<td>Paper Session 6A: Aviation II</td>
<td>Paper Session 6B: Batteries I</td>
<td>Location: Crystal Ballroom</td>
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<tr>
<td>5:15 – 7:30</td>
<td>Poster Reception</td>
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**Paper Session 3A: Prognostics I**

**Tuesday, 8:45 – 10:15, Room: Cripple Creek A**

**Session Chair: Kai Goebel — NASA Ames**

1†An Inference-based Prognostic Framework for Health Management of Automotive Systems — Chaitanya Sankavaram1, Anuradha Kodali2, Krishna Pattipati3, Satnam Singh4, Yilu Zhang5,6 (*University of California Santa Cruz, NASA Ames Research Center; 6CA Technologies, GM India Science Lab, India*)

PHM Decision Support Under Uncertainty — Murat Yasar1, Teens Lovett2 (*United Technologies Research Center*)

A New Prognostics Approach for Bearing Based on Entropy Decrease and Comparison with existing Methods — Seokgoo Kim1, Sungho Park2, Ju-Won Kim3, Jungwha Han4, Daeun An5, Nam Ho Kim6, Joo-Ho Choi7 (*Korea Aerospace University, Korea; 34Korea Railroad Corporation, Korea; 56University of Florida*)

**Paper Session 3B: Turbines**

**Tuesday, 8:45 – 10:15, Room: Cripple Creek B**

**Session Chair: Ian Jeniowski — Cranfield University**

Enhancing Turbine Performance Degradation Prediction with Atmospheric Factors — Xiaomo Jiang1, TsungPo Lin1, Eduardo Mendoza1,2 (*General Electric Company*)

Gas Turbine Engine Health Data Analysis for Parameter Reduction and Condition Assessment — Amar Kuma1, Alka Srivastava1, Nita Goel1, Marzia Zaman1,2,3 (*Tecsis Corporation*)

Method and System for Predicting Hydraulic Valve Degradation on a Gas Turbine — James D’Amato1, John Patanian1,2 (*GE Power*)

**Paper Session 4A: Data Challenge Winners**

**Tuesday, 10:30 – 12:00, Room: Cripple Creek A**

**Session Chair: Nicholas Proops — Seagate**

Invited paper published in IJPHM (www.ijphm.org)

**Paper Session 4B: Diagnostics II**

**Tuesday, 10:30 – 12:00, Room: Cripple Creek B**

**Session Chair: Scott Clements — Lockheed Martin Aeronautics**

A Computationally-Efficient Inverse Approach to Strain-Based Damage Diagnosis — James E. Warner1, Jacob D. Hochhalter2, William P. Leser3, Patrick E. Leser1, John A. Newman1,2,4 (*NASA Langley Research Center*)

Reducing Tachometer Jitter to Improve Gear Fault Detection — Eric Bechhoefer1, Dave He2 (*GPMS Inc.; 1University of Illinois at Chicago*)

Distributed Adaptive Fault-Tolerant Formation Control of Second-Order Multi-Agent Systems with Actuator Faults — Moshen Khalili1, Xiaodong Zhang2, Yongcan Cao3 (*Wright State University; 1University of Texas, San Antonio*)

**Paper Session 5A: Industrial & Manufacturing Applications I**

**Tuesday, 1:15 – 3:00, Room: Cripple Creek A**

**Session Chair: Douglas L. Van Bossuyt — Colorado School of Mines**

Inertial Measurement Unit for On-Machine Diagnostics of Machine Tool Linear Axes — Gregory W. Vogl1, M. Alkan Donmez2, Andreas Archenti3, Brian A. Weiss4 (*National Institute of Standards and Technology; 2KTH Royal Institute of Technology, Sweden*)

Condition Based Monitoring for A Hydraulic Actuator — Stephen Adams1, Peter A. Beling2, Kevin Farinholt3, Nathan Brown4, Sherwood Potter5, Qing Dong6 (*University of Virginia; 3Luna Innovations Inc.; 56Naval Surface Warfare Center*)

†Present Status and Future Growth of Advanced Maintenance Technology and Strategy in US Manufacturing — Xiaoming Jin1, Brian A. Weiss2, David Siegel3, Jay Lee4 (*Northeastern University; 2National Institute of Standards and Technology; 3University of Cincinnati*)

**Paper Session 5B: Features II**

**Tuesday, 1:15 – 3:00, Room: Cripple Creek B**

**Session Chair: Junda Zhu — United Technologies Aerospace Systems**

Automotive PHM & Advanced Analytics – James E. Warner1, Jacob D. Hochhalter2, William P. Leser3, Patrick E. Leser1, John A. Newman1,2,4 (*NASA Langley Research Center*)

Modeling and Testing of Gas Turbine Engine Systems Under Low Cycle Fatigue — Kevin Farinholt1, Andrew Nelson2 (*Tecsis*)

**Panel Session 4: Technology Demonstration**

**Tuesday, 8:45 – 10:15, Room: Cripple Creek B**

**Panel: Machine Learning for Monitoring**

- Via ChipCHECK [GasTOPS]
- System Health [MathWorks]
- Second-Order Multi-Agent Systems with Actuator Faults — Andreas Archenti3, William P. Leser1, Patrick E. Leser1, John A. Newman1,2,4 (*NASA Langley Research Center*)

**Panel Session 3: Data Challenge**

**Tuesday, 8:45 – 10:15, Room: Cripple Creek B**

**Panel: Sensor Fusion for PHM**

- Sensor Fusion for PHM [UTRC]
- Smartphone Based Multi-Modal [Tecsis]
- Distributed Adaptive Fault-Tolerant Formation Control of Second-Order Multi-Agent Systems with Actuator Faults — Moshen Khalili1, Xiaodong Zhang2, Yongcan Cao3 (*Wright State University; 1University of Texas, San Antonio*)

**Panel Session 2: Condition Based Monitoring**

**Tuesday, 8:45 – 10:15, Room: Cripple Creek B**

**Panel: Oil and Gas, Automation and PHM**

- Reducing Tachometer Jitter to Improve Gear Fault Detection — Eric Bechhoefer1, Dave He2 (*GPMS Inc.; 1University of Illinois at Chicago*)
- Distributed Adaptive Fault-Tolerant Formation Control of Second-Order Multi-Agent Systems with Actuator Faults — Moshen Khalili1, Xiaodong Zhang2, Yongcan Cao3 (*Wright State University; 1University of Texas, San Antonio*)
### Tuesday, October 4, 2016

#### Track C: Panel Sessions

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<th>Topic</th>
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<tr>
<td>8:45 – 9:15</td>
<td>2nd Floor</td>
<td>Giovanni Jacazio</td>
<td>Polyteneic University of Turin</td>
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<tr>
<td><strong>Session Chair:</strong> Giovanni Jacazio</td>
<td><strong>Polytechnic University of Turin</strong></td>
<td>An Application of Data Driven Anomaly Identification to Spacecraft Telemetry Data — Gautam Biswas¹, Hamed Khorasangi², Gerald Stanton³, Abhishek Dubey⁴, Somnath Deb⁵, Sudipto Ghoshal⁶ (¹Vanderbilt University; ²University of Valladolid, Spain; ³SGT, Inc.)</td>
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<tr>
<td><strong>System-Level Prognostics for The National Airspace</strong> — Matthew Daigle¹, Shankar Sankararaman², Indranil Roychoudhury³ (¹NASA Ames Research Center; ²University of Valladolid, Spain; ³SGT, Inc.)</td>
<td><strong>Prognostic Reasoner Based Adaptive Power Management System for A More Electric Aircraft</strong> — Robin Kuttikkadan Sebastian¹, Suresh Perinpinayagam², Alirza Alghassi³ (¹Hindustan Aeronautics Limited, India; ²Cranfield University, UK)</td>
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#### Track D: Technology Demos

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<td>Smartphone Based Multi-Modal Sensor Fusion for PHM [UTRC]</td>
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<td>10:30 – 12:00</td>
<td>2nd Floor</td>
<td>Machine Learning for Monitoring System Health [MathWorks]</td>
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<td>1:15 – 3:00</td>
<td>2nd Floor</td>
<td>Rapid Oil Debris Identification via ChipCHECK [GasTOPS]</td>
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<tr>
<td>3:30 – 5:15</td>
<td>2nd Floor</td>
<td>Smartphone Based Multi-Modal Sensor Fusion for PHM [UTRC]</td>
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<tr>
<td>5:15 – 7:30</td>
<td>2nd Floor</td>
<td>Rapid Oil Debris Identification via ChipCHECK [GasTOPS]</td>
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**Session Chair:** Jeff Bird — TECnos

**Time Domain Reflectometry (TDR) Sensor Measurement in Contaminated Oils** — Jonathan Geisheimer¹, Shilpa Jagannath², Farhana Zaman³ (¹²Meggit Sensing Systems) Evaluation of Features with Changing Effectiveness for Prognostics — Vepa Atamuradov¹, Fatih Camci² (¹Mevlana University, Turkey; ²Antalya International University, Turkey) A Qualitative Fault Isolation Approach for Parametric and Discrete Faults Using Structural Model Decomposition — Matthew Daigle¹, Anibal Bregón², Indranil Roychoudhury³ (¹NASA Ames Research Center; ²University of Valladolid, Spain; ³SGT, Inc.)

**Paper Session 6A: Aviation II**

Tuesday, 3:30 – 5:15, Room: Cripple Creek A

**Session Chair:** Giovanni Jacazio — Polytechnic University of Turin

**An Application of Data Driven Anomaly Identification to Spacecraft Telemetry Data** — Gautam Biswas¹, Hamed Khorasangi², Gerald Stanton³, Abhishek Dubey⁴, Somnath Deb⁵, Sudipto Ghoshal⁶ (¹Vanderbilt University; ²University of Valladolid, Spain; ³SGT, Inc.)

**System-Level Prognostics for The National Airspace** — Matthew Daigle¹, Shankar Sankararaman², Indranil Roychoudhury³ (¹NASA Ames Research Center; ²SGT, Inc.)

**Prognostic Reasoner Based Adaptive Power Management System for A More Electric Aircraft** — Robin Kuttikkadan Sebastian¹, Suresh Perinpinayagam², Alirza Alghassi³ (¹Hindustan Aeronautics Limited, India; ²Cranfield University, UK)

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**Paper Session 6B: Batteries I**

Tuesday, 3:30 – 5:15, Room: Cripple Creek B

**Session Chair:** Amir Kashani — University of Maryland

**Remaining Useful Life Predictions in Lithium-Ion Battery Under Composite Condition** — Yejin Kim¹, Jongsoo Lee² (¹Yonsei University, Republic Of Korea)
Wednesday, October 5, 2016

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<th>Time</th>
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<td>Floor Foyer</td>
<td>Registration</td>
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<tr>
<td>7:45 – 8:00</td>
<td>Cripple Creek A</td>
<td>Continental Breakfast</td>
<td>Location: 3rd Floor Foyer</td>
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<tr>
<td>8:00 – 8:45</td>
<td>Cripple Creek B</td>
<td>Opening Remarks</td>
<td>Location: Crystal Ballroom</td>
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<tr>
<td>8:45 – 10:15</td>
<td>Cripple Creek B</td>
<td>Paper Session 7A: Deep Learning I</td>
<td>Paper Session 7B: Systems II</td>
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<td>Paper Session 8A: Data Driven Methods</td>
<td>Paper Session 8B: Prognostics II</td>
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<td>1:15 – 3:00</td>
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<td>Paper Session 9A: Missing Data</td>
<td>Panel Session 8: Railway PHM</td>
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<td>Paper Session 10A: Deep Learning II</td>
<td>Paper Session 10B: Industrial &amp; Manufacturing Applications II</td>
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<tr>
<td>6:00 – 6:30</td>
<td>Cripple Creek A</td>
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<td>For guest tickets, please see Registration Desk</td>
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<td>9:30 – 10:00</td>
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**Paper Session 7A: Deep Learning I**
Wednesday, 8:45 – 10:15, Room: Cripple Creek A

*Session Chair: Steven Adams — University of Virginia*

Deep Learning Based Diagnostics of Orbit Patterns in Rotating Machinery — Haedong Jeong¹, Sunhee Woo², Suhyun Kim³, Seungtae Park⁴, Heechang Kim⁵, Seungchul Lee⁶ (¹²University of Illinois at Chicago; ³Green Power Monitoring Systems)

Using Deep Learning Based Approaches for Bearing Fault Diagnosis with AE Sensors — Miao He¹, David He², Eric Bechhoefer² (²University of Illinois at Chicago; ³Green Power Monitoring Systems)

Combining Deep Learning and Survival Analysis for Asset Health Management — Linxia Liao¹, Hyung-il Ahn² (¹GE Digital; ²Noodle Analytics, Inc.)

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**Paper Session 7B: Systems II**
Wednesday, 8:45 – 10:15, Room: Cripple Creek B

*Session Chair: Carl Byington — Impact Technologies/Sikorsky, A Lockheed Martin Company*

Case Study in Improving the Health of a Remote Monitoring & Diagnostics Center — Sanjeev Heda (¹GE Power)

Critical Components Selection for A Prognostics and Health Management System Design: An Application to an Overhead Contact Line System — M. Brahim¹, K. Medjaher², M. Louauhti³, N. Zerhouni⁴ (⁴FEMTO-ST Institute, France; ³ALSTOM, France; ²INP-ENIT, France)

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**Paper Session 8A: Data Driven Methods**
Wednesday, 10:30 – 12:00, Room: Cripple Creek A

*Session Chair: Jon Bednar — Boeing*

A Data-Driven Health Management Application for Failure Detection and Diagnosis in Electrical Submersible Pumps — Supriya Gupta¹, Michael Nikolau², Luigi Saputelli³ (³University of Houston; ²Frontender Corporation)

Reciprocating Compressor Valve Condition Monitoring Using Image-Based Pattern Recognition — John N. Trout¹, Jason R. Kolodziej² (²Rochester Institute of Technology; ³Instituto Tecnologico de Aeronautica, Brazil)

Comparison of Model-Based Vs. Data-Driven Methods for Fault Detection and Isolation in Engine Idle Speed Control System — Ruochen Yang¹, Giorgio Rizzoni² (²Center for Automotive Research; ³Ohio State University)

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**Paper Session 8B: Prognostics II**
Wednesday, 10:30 – 12:00, Room: Cripple Creek B

*Session Chair: Ash Thacker — Global Technology Connection*

Deriving Prognostic Continuous Time Bayesian Networks from Fault Trees — Logan Perreault¹, Monica Thornton², John W. Sheppard³ (³Montana State University)

Probabilistic Prognosis of Non-Planar Fatigue Crack Growth — Patrick E. Leser¹, John A. Newman⁴, James E. Warner⁵,
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<td>PHM Standards Experience for Manufacturing</td>
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<tr>
<td>7:45 – 8:00</td>
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<td>Continental Breakfast</td>
<td>PHM for Static Components [Metis/UTAS]</td>
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<td>8:45 – 10:15</td>
<td>Cripple Creek A</td>
<td>“Diagnositics with a Noisy Sensor: From Aircraft to Player Performance”</td>
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<td>10:15 – 10:30</td>
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<td>Technology Demonstration:</td>
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<td>PHM Standards Experience for Manufacturing</td>
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<td>Jeff Bird (Rogers), Ravi Rajamani (drR Consulting)</td>
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<td>Panel Session 7:</td>
<td>Technology Demonstration:</td>
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<td>Smart Manufacturing PHM</td>
<td>Machine Learning for Monitoring System Health [MathWorks]</td>
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<td>Brian A. Weiss (NIST)</td>
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<td>12:00 – 1:15</td>
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<td>1:15 – 3:00</td>
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<td>Technology Demonstration:</td>
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<td>Department of Defense (DoD) Condition Based Maintenance Plus (CBM+) Service Panel Review</td>
<td>Rapid Oil Debris Identification via ChipCHECK [GasTOPS]</td>
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<td>Kevin Bostick (U.S. Army)</td>
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<td>Panel Session 10:</td>
<td>Technology Demonstration:</td>
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<td>Select Military Maintenance Projects Funded through the Commercial Technologies for Maintenance Activities (CTMA) Program</td>
<td>PHM for Static Components [Metis/UTAS]</td>
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<td>Debbie Lila (NCMS)</td>
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**Paper Session 9A: Missing Data**
Wednesday, 1:15 – 3:00, Room: Cripple Creek A

**Session Chair: Peter Beling — University of Virginia**

Application of Multiple-Imputation-Particle-Filter For Parameter Estimation of Visual Binary Stars with Incomplete Observations — Rubén M. Claveria¹, David Acuña², René A. Mendez¹, Jorge F. Silva¹, Marcos E. Orchard² (¹University of Western Australia, Australia; ²University of Maryland)

Failure Prognostics with Missing Data Using Extended Kalman Filter — Wlami Olivesres Loesch Vianna¹, Takashi Yoneyama¹ (EMBRAER S.A., Brazil; ¹Instituto Tecnológico de Aeronautica, Brazil)

On the Practical Performance of Minimal Hitting Set Algorithms from a Diagnostic Perspective — Ingo Pili¹, Thomas Quartsch², Franz Wotawa³ (¹Graz University of Technology, Austria; ²HTL Pinkafeld)

**Paper Session 10A: Deep Learning II**
Wednesday, 3:30 – 5:15, Room: Cripple Creek A

**Session Chair: Scott Clements — Lockheed Martin Aeronautics**

Deep Health Indicator Extraction: A Method Based On Auto-Encoders and Extreme Learning Machines — Yang Hu¹, Thomas Palmé², Olga Fink³ (¹Zurich University of Applied Sciences, Switzerland; ²General Electric, Switzerland)

Using Deep Learning Based Approaches for Bearing Remaining Useful Life Predication — Jason Deutsch¹, David He² (²University of Illinois at Chicago)

Deep Learning for Structural Health Monitoring: A Damage Characterization Application — Soumalya Sarkar¹, Kishore K. Reddy², Michael Giering³, Mark R. Gurvich⁴ (⁴United Technologies Research Center)

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**Paper Session 10B: Industrial & Manufacturing Applications II**
Wednesday, 3:30 – 5:15, Room: Cripple Creek B

**Session Chair: Brian A. Weiss — National Institute of Standards**

Case Study of a Faulted Planet Bearing — Eric Bechhoefer¹, Dave He² (¹GPMS Inc.; ²University of Illinois at Chicago)

Towards Detection of Water Management Faults for PEM Fuel Cells Under Variable Load — Pavle Boškoski¹, Andrej Debenjak², Dani Juric?ic³, Biljana Mileva Boshkoska⁴ (¹Jožef Stefan Institute, Slovenia; ³Faculty of Information Studies in Novo mesto, Slovenia)

Hidden Markov Model Based Detection and Classification of Foreign Objects in Heat-Exchange Tubes — Portia Banerjee¹, Lalita Udpa², Satish Udpa³ (³Michigan State University)
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<td>8:00 – 8:45</td>
<td>Joint PHM/DX Keynote Presentation: Dr. Rui Abreu, PARC</td>
<td>“Testing and Debugging Software-Intensive Systems”</td>
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<td>8:45 – 10:15</td>
<td>Paper Session 11A: Structural Health Management</td>
<td>Paper Session 11B: Batteries II</td>
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<td>10:30 – 12:00</td>
<td>Paper Session 12A: PHM for Electrical Systems</td>
<td>Paper Session 12B: Deep Learning III</td>
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<td>Lunch on your own</td>
<td>Reserved for PHM Conference</td>
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<td>Closing Remarks Location: Crestone A</td>
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### Paper Session 11A: Structural Health Management

**Session Chair:** Abbas Chokor — Arizona State University  
Detection of Fatigue Cracks in Shafts Via Analysis of Vibrations and Orbital Paths — R. Perez1, L. Rogel2, J. Bortman3, R. Klein4 (1,2,3Ben-Gurion University of the Negev, Israel; 4R.K. Diagnostics, Israel)  
“Big Data Analytics in Online Structural Health Monitoring — Guowei Cai1, Sankaran Mahadevan1 (1Vanderbilt University)  
Quadrotor Actuator Fault Diagnosis with Real-Time Experimental Results — Remus Avram1, Xiaodong Zhang2, Mohsen Khalili3 (1Wright State University)

### Paper Session 12A: PHM for Electrical Systems

**Session Chair:** José Celaya — Schlumberger  
A Review of Photovoltaic Systems Prognostics and Health Management: Challenges and Opportunities — Abbas Chokor1, Mounir El Asmar2, Sumanth V. Lokanath3 (1Arizona State University; 2First Solar Inc.)  
Failure Precursor Identification and Degradation Modeling for Insulated Gate Bipolar Transistors Subjected to Electrical Stress — Junmin Lee1, Hyunseok Oh2, Chan Hee Park3, Byeng D. Youn4, Deog Hyeon Kim5, Byung Hwa Kim6, Yong Un Cho7 (1,2,4Seoul National University, Republic of Korea; 5,6,7Hyundai Motor Group, Republic of Korea; 1,2,5General Motors Global R&D)  
Impedance-Based Health Monitoring of Electromagnetic Coil Insulation Subjected to Corrosive Deterioration — N. Jordan Jameson1, Michael H. Azarian2, Michael Pecht3 (1,2,5CALCE, University of Maryland)

### Paper Session 11B: Batteries II

**Session Chair:** Peter Beling — University of Virginia  
Parameters Optimization of Lebesgue Sampling-Based Fault Diagnosis and Prognosis with Application to Li-Ion Batteries — Wuzhao Yan1, Bin Zhang2, Marcos Orchard3 (1University of South Carolina; 2Universidad de Chile, Chile)  
A Fusion Method Based On Unscented Particle Filter and a Naïve Bayes Model for Lithium-Ion Battery Remaining Useful Life Prediction — Jiayu Chen1, Dong Zhou2, Chuan Lu3 (1Beihang University, China)  
Data-Driven Prognostics of Lithium-Ion Rechargeable Battery Using Bilinear Regression — Charlie Hubbard1, John Bavlsik2, Chinmay Hegde3, Chao Hu4 (1,2,3Iowa State University)

### Paper Session 12B: Deep Learning III

**Session Chair:** David Siegel — Predictronics  
Wearable EEG-based Activity Recognition in PHM-related Service Environment via Deep Learning — Soumalya Sarkar1, Kishore Reddy2, Alex Dorgan3, Cali Fidopiastis4, Michael Giering5 (1,2,3,4United Technologies Research Center)  
Smart Diagnosis of Journal Bearing Rotor Systems: Unsupervised Feature Extraction Scheme by Deep Learning — Hyunseok Oh1, Byung Chul Jeon2, Joon Ha Jung3, Byeng D. Youn4 (1,2,4Seoul National University, Republic of Korea)  
Prognostics of Combustion Instabilities from Hi-speed Flame Video using a Deep Convolutional Selective Autoencoder — Adedotun Akintayo1, Ken Gwn Lore2, Soumalya Sarkar3, Soumik Sarkar4 (1,2,3Iowa State University; 4United Technologies Research Center)

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1Invited paper published in IJPHM (www.ijphm.org)
### 27th International Workshop on Principles of Diagnosis: DX-2016
(Held concurrently with PHM2016)

#### Session I
**Wednesday, 10:30 – 12:00, Room: Crestone B**

- *Using Partial Diagnoses for Sequential Model-Based Fault Localization* — Kostyantyn Shchekotykhin, Thomas Schmitz, Dietmar Jannach
- *Diagnosability of Discrete-Event Systems with Uncertain Observations* — Xingyu Su, Marina Zanella, Alban Grastien
- *Applying Simulated Annealing to Problems in Model-based Diagnosis* — Alexander Diedrich, Alexander Feldman, Alejandro Perdomo-Ortiz, Rui Abreu, Johan de Kleer, Oliver Niggemann

#### Session II
**Wednesday, 1:15 – 3:00, Room: Crestone B**

- *Diagnosing PARC’s Refrigerator Benchmark with Data-Driven Methods* — Alexander Feldman, Rui Abreu, Bhaskar Saha, Anurag Ganguli, Johan de Kleer
- *A Novel Anomaly Detection Algorithm for Hybrid Production Systems based on Deep Learning and Timed Automata* — Nemanja Hranisavjevic, Oliver Niggemann, Alexander Maier

#### Session III
**Wednesday, 3:30 – 5:15, Room: Crestone B**

- *Minimal Hiting Set Computation via Hypothesis Exploration* — Marina Zanella, Ingo Pill
- *Model-Based Diagnosis using Variable-Fidelity Modeling* — Gregory Provan
- *Exploiting Structural Metrics in FMEA-Based Abductive Diagnosis* — Roxane Koitz, Franz Wotawa

#### Session IV
**Thursday, 10:30 – 12:00, Room: Crestone B**

- *A π-Calculus Formalization of Contract Violation Diagnosis* — Gianluca Torta, Roberto Micalizio
- *Solving Sequential Diagnosis by Compilation to Boolean Satisfiability* — Ester Lazebnik, Roni Stern, Meir Kalech
- *Solving Diagnosability of Hybrid Systems via Abstraction and Discrete-Event Techniques* — Alban Grastien, Louise Travé-Massuyès, Vicenç Puig

#### Session V
**Friday, 8:30 – 10:00, Room: Crestone B**

- *Diagnosability Planning for Controllable Discrete Event Systems* — Hassan Ibrahim, Philippe Dague, Alban Grastien, Lina Ye, Laurent Simon
- *A General Characterization of Model-Based Diagnosis* — Gregory Provan

#### Session VI
**Friday, 10:30 – 12:00, Room: Crestone B**

- *Fault-Driven Minimal Structurally Overdetermined Set in a Distributed Context* — Gustavo Pérez, Elodie Chantery, Louise Travé-Massuyès, Javier Sotomayor
- *Diagnosis of Intermittent Faults with Conditional Preferences* — Cédric Pralet, Xavier Pucel, Stéphanie Roussel

#### Job Fair
The PHM Society is holding a Job Fair within the PHM16 conference in Denver, CO. The PHM Job Fair is an exposition for PHM employers to meet with prospective job seekers. The Job Fair is FREE and OPEN to all registered PHM16 conference participants. Candidates of all ages, all levels of experience, and all industries are encouraged to attend. For further details or questions, please contact us on (need email address here). Check at Registration Desk for locations/times.
A Short Course on PHM
Fundamentals and Cases Studies

Sunday, October 1 – 2, Room: Crystal Ballroom AB
Separate Registration Required

The PHM Society offers this updated two-day intensive short course titled PHM Fundamentals and Case Studies—from Monitoring/Sensing to Fault Diagnosis/Failure Prognosis and Case Studies, on PHM tools, methods, applications and case studies on October 1 and 2 in Denver USA right before the PHM16 conference. This follows from the first offering at the PHM14 conference in Fort Worth, TX with 48 attendees and ratings of 4/5. It was also run in 2015 in San Diego and 2016 in Bilbao, Spain.

This fourth offering of the course is presented by recognized experts in the PHM field and will cover the current state of the art in PHM technologies, sensors and sensing strategies, data mining tools, CBM+ technologies, novel diagnostic and prognostic algorithms as well as a diverse array of application examples/case studies. It is addressed to engineers, scientists, operations managers, educators, small business principals and system designers interested to learn how these emerging technologies can impact their work environment.

- Comprehensive introduction and two workshop sessions for detailed analysis
- Needs, Requirements and Metrics, Diagnostics, Prognostics and Data Analytics
- Condition Based Maintenance, Data Requirements, Cost Benefit Analysis and Reliability
- Seven real world case studies: aerospace bearings, batteries, data fusion, land vehicles, UAVs

Presenters from drR², GE, Georgia Tech, NASA, Penn State, Schlumberger and TECnos

Doctoral Symposium

Sunday, 1:00 – 9:00, Room: Aspen AB
Session Chairs: Jamie Coble – Univ. of Tennessee, Knoxville

The Doctoral Symposium provides an opportunity for graduate students to present their research interests and plans at a formative stage in their research. The students will receive structured guidance from a panel of distinguished researchers as well as comments from conference participants and fellow students in a collegiate setting. The PHM Society Doctoral Symposium will be held as a workshop on the first two days of the conference. The panelists for the DS are:

- Ravi Rajamani, drR² Consulting
- Jose Celaya, Schlumberger
- Nicholas Propes, Seagate
- Gautam Biswas, Vanderbilt University

Doctoral Symposium Session 1
Sunday, 1:15 – 3:00, Room: Aspen AB
- Circuit Breaker Health and Reliability Monitoring: The Key to Realizing a Smarter Electricity Grid – Payman Dehghanian, Texas A&M University
- Algorithms for Hybrid Diagnostics of Nonlinear Systems – Turki Haj Mohammad, Villanova University
- Fault-Tolerant Supervisory Control Mechanism for Chiller Plants – Khushboo Mittal, University of Connecticut

Doctoral Symposium Session 2
Sunday, 3:30 – 5:30, Room: Aspen AB
- Bayesian Cramér-Rao Bounds for Time-of-Failure Probability

Tutorials

As educational events, tutorials provide a comprehensive introduction to the state-of-the-art. Tutorials address the interests of a varied audience: beginners, developers, designers, researchers, practitioners, and decision makers who wish to learn a given aspect of prognostic health management. The tutorials will be Monday morning and are free of charge to all registrants. Tutorials will focus both on theoretical aspects as well as industrial applications of prognostics. These tutorials reach a good balance between the topic coverage and its relevance to the community.

Tutorial Session 1A: Diagnostics
Monday, 8:00 – 9:45, Room: Cripple Creek A
- Matthew Daigle
  NASA Ames Research Center
- Indranil Roychoudhury
  SGT Inc., NASA Ames Research Center

Abstract: The area of diagnostics is focused on the detection, isolation, and identification of system faults. Diagnostics is critical in guaranteeing correct, efficient, and safe operation of complex systems. In model-based diagnostics, faults are diagnosed by reasoning over a model of the system that captures both nominal and faulty behavior. While model-based diagnosis of static systems is well-established, diagnosis of dynamic systems presents a number of additional challenges, and many different approaches have been developed to handle them using different kinds of models and reasoning algorithms. This tutorial will present the general approach of model-based diagnostics, survey different fault diagnosis approaches available in literature, and present a framework for model-based diagnosis of dynamic systems. Advanced concepts of structural model decomposition and distributed diagnosis will also be presented. Case studies will be used to explain the concepts and demonstrate their application to real-world systems.

Presenter Bios: Matthew Daigle received the B.S. degree in Computer Science and Computer and Systems Engineering from Rensselaer Polytechnic Institute, Troy, NY, in 2004, and the M.S. and Ph.D. degrees in Computer Science from Vanderbilt University, Nashville, TN, in 2006 and 2008, respectively. From September 2004 to May 2008, he was a Graduate Research Assistant with the Institute for Software Integrated Systems and Department of Electrical Engineering and Computer Science, Vanderbilt University, Nashville, TN. During the summers of 2006 and 2007, he was
an intern with Mission Critical Technologies, Inc., at NASA Ames Research Center. From June 2008 to December 2011, he was an Associate Scientist with the University of California, Santa Cruz, at NASA Ames Research Center. Since January 2012, he has been with NASA Ames Research Center as a Research Computer Scientist. His current research interests include physics-based modeling, model-based diagnosis and prognosis, simulation, and hybrid systems. Dr. Daigle is a member of the Prognostics and Health Management Society and the IEEG.

Indranil Roychoudhury received the B.E. (Hons.) degree in Electrical and Electronics Engineering from Birla Institute of Technology and Science, Pilani, Rajasthan, India in 2004, and the M.S. and Ph.D. degrees in Computer Science from Vanderbilt University, Nashville, Tennessee, USA, in 2006 and 2009, respectively. Since August 2009, he has been with SGT, Inc., at NASA Ames Research Center as a Computer Scientist. His research interests include hybrid systems modeling, model-based diagnostics and prognostics, distributed diagnostics and prognostics, and Bayesian diagnostics of complex physical systems. Dr. Roychoudhury is a Senior Member of the IEEE and a member of the Prognostics and Health Management Society and the AIAA.

**Tutorial Session 1B: An Introduction to Data-Driven Prognostics of Engineered Systems**

**Monday, 8:00 – 9:45, Room: Cripple Creek B**

**Jamie Baalis Coble**  
**University of Tennessee, Knoxville**

**Abstract:** Approaches to prognosis of components and systems are typically divided into model-based and data-driven algorithms. Model-based algorithms rely on first principles based physics of failure models of the evolution of degradation. Data-driven methods use historic run-to-failure and accelerated degradation test data to discover the underlying relationships between measured data and equipment lifetime. Algorithms for data-driven prognostics can be categorized into three types according to the type of information used for prognosis, generally in order of greater specificity and accuracy. Type I (reliability-based) prognostics uses traditional reliability analysis to estimate the lifetime of an average component operating under average conditions. Type II (stressor-based) prognostics incorporate information about how a component or system will be operated (e.g., load, temperature, speed, pressure, demand) to evaluate the lifetime of an average component operating in some specific environment. Type III (degradation-based) prognostics track the condition of a specific component under its specific operation. This condition (or some measure indicative thereof) can be trended to failure. This tutorial will introduce the general concept of prognostics and place it into context in a full health management system. Empirical prognostic algorithms in each of the three types will be presented.

**Presenter Bio:** Dr. Jamie Baalis Coble is an Assistant Professor in the Nuclear Engineering department at the University of Tennessee, Knoxville. Dr. Coble’s expertise is primarily in statistical data analysis, empirical modeling, and advanced pattern recognition for equipment condition assessment, process and system monitoring, anomaly detection and diagnosis, and failure prognosis. Dr. Coble is currently pursuing research in prognostics and health management for active components and systems. Her research interests expand on past work in monitoring and prognostics to incorporate remaining useful life estimates into risk assessment, operations and maintenance planning, and optimal control algorithms. Prior to joining the faculty at UTK, she worked in the Applied Physics group at Pacific Northwest National Laboratory. Her work there focused primarily on data analysis and feature extraction for detecting anomalies and degradation in large passive components (e.g., concrete structures, pipes, welds), advanced active components (e.g., pumps, motors, valves), and other nuclear systems.

**Tutorial Session 2A: Security Prognostics**

**Monday, 10:15 – 12:00, Room: Cripple Creek A**

**Scott C. Evans**  
**General Electric Global Research**

**Abstract:** In this Tutorial we cast a vision for Security Prognostics (SP) for critical systems, promoting the view that security related protections would be well served to integrate fully with Monitoring and Diagnostics (M&D) systems that assess the health of complex assets and systems. To detect complex Cyber threats we propose combining system parameters already in use by M&D systems for Prognostics and Health Monitoring (PHM) with security parameters. Combining system parameters used by M&D to detect non-malicious faults with the system parameters used by security schemes to detect complex Cyber threats will improve: (a) accuracy of PHM (b) security of M&D, and (c) availability and safety of critical systems. We also introduce the notion of Remaining Secure Life (RSL), assessed based on the propagation of “security damage,” to create the prospect for Security Prognostics. RSL will assist in the selection of appropriate response(s), based on breach or compromise to security component’s and potential impact on system operation. An example of M&D data is provided which is normally associated with non-malicious faults providing input to detect Malware execution through time series monitoring.

**Presenter Bio:** Dr. Scott C. Evans is Senior Research Engineer in the Machine Learning Lab at General Electric Global Research in Niskayuna, NY. He has 39 patents and over 45 publications in the areas of algorithms, wind analytics, sequence analysis, cybersecurity, and wireless network routing / Quality of Service (QoS). Scott holds a PHD in Electrical Engineering from Rensselaer Polytechnic Institute, an MS in Electrical Engineering from the University of Connecticut and a BS in Electrical Engineering from Virginia Tech. Scott is currently a key contributor and machine learning task leader on a $5.6 million IARPA program applying machine learning and causal inference to detect insider threat. Before joining General Electric Research, Scott served as a nuclear-trained Submarine Officer in the United States Navy.

**Tutorial Session 2B: Big Data Analytics**

**Monday, 10:15 – 12:00, Room: Cripple Creek B**

**John Patanian**  
**General Electric Power**

**Abstract:** Big Data is a widely used, perhaps overused term when discussing modern analytics applications. While there is a lot of hype, there are many examples of not previously feasible capabilities enabled by big data technologies, such as large scale exploratory analysis, feature engineering and predictive modeling.

In open source software, Big Data is synonymous with the Apache Hadoop tech stack. The presentation will review key analytics related components of Hadoop including HDFS, Kafka, Hive, Spark, Sqoop, Oozie, and Yarn and their function in batch, interactive, and streaming use cases. Special attention will be given to how analytics have greatly expanded in the transition to Apache Spark and the inclusion of Python and R as first class components.

The tutorial will feature an applied example where Big Data tools were used in developing an anomaly detection algorithm.

**Presenter Bio:** John Patanian is Principal Engineer, analytics for GE power and has over 20 years experience in software development, machinery diagnostics, product management, controls optimization, and thermodynamic performance. He holds a masters degree in Computer Science from the University of Washington and a Bachelor’s degree in Mechanical Engineering from Rensse-
PHM technology will be an irreplaceable tool on the fleet, system
ers and operators adopting the predictive maintenance strategy,
availability and production rate. Therefore, as more and more own
optimize the wind farm maintenance strategy and maximize turbine
variation. On top of that, prognostics capability is also crucial to
ble and accurate readings regardless of the operating condition
challenge to offer robust diagnostic solutions that can provide sta
with the dynamic adjustment from the control system, it is a global
ation of wind turbine drivetrain is continuously fluctuating. Combined
stochastic nature of wind speed and direction, the operating condi
farm operators and maintenance practices. Moreover, due to the
lab based testing along with the valuable experience from wind
erspectives on PHM for human assets. Conversations will include
PHM’s current and envisioned applications within general health-
care, theatre, and space environments along with how the needs,
data stream, and supporting PHM tools, can be better designed,
developed, implemented, verified, and validated to impact smart
healthcare.

Panelists:
David Hilmer, Baylor College of Medicine
Dorit Donoviel, NSBRI
Col. ret. Ron Poropatich, University of Pittsburgh
Mark Derriso, Wright-Patterson AFB
Dragan Djurdjanovic, University of Texas-Austin

Panel Session 2: Wind Energy
Tuesday, 8:45 – 10:15, Room: Crestone A
Session Chair: Junda Zhu – NRG

The nature of the planetary section design of wind turbine gear-
boxes calls for the most advanced prognostics and health man-
agement solutions in hardware, software, logistics and algorithm
pective. These technology advancements require field and lab based testing along with the valuable experience from wind farm operators and maintenance practices. Moreover, due to the stochastic nature of wind speed and direction, the operating condition of wind turbine drivetrain is continuously fluctuating. Combined with the dynamic adjustment from the control system, it is a global challenge to offer robust diagnostic solutions that can provide stable and accurate readings regardless of the operating condition variation. On top of that, prognostics capability is also crucial to optimize the wind farm maintenance strategy and maximize turbine availability and production rate. Therefore, as more and more owners and operators adopting the predictive maintenance strategy, PHM technology will be an irreplaceable tool on the fleet, system and component level maintenance planning.

Panelists:
Shawn Sheng, NREL
Zhiwei Zhang, Romax
Alex Byrne, DNV GL
Junda Zhu, NRG

Panel Session 3: Oil and Gas, Exploration and Production
Tuesday, 10:30 – 12:00, Room: Crestone A
Session Chair: Rune Schlanbusch – Teknova AS

As oil companies race for cost reduction, considerable work is in-
vested in automating the process of drilling and production. One
of their goals is to minimize the offshore crew and replace it with
small crews in operations centers controlling the installations from
land. Condition based maintenance is seen as an important topic
towards realizing offshore autonomy without hampering risk. For
efficient development, equipment groups have to be identified
which leads to the most necessary and cost efficient results. The
chosen monitoring technology must have strict requirements with
respect to reliability and need rigorous documentation, for fitting
the acceptable risk levels within the industry. Current challenges
include no clear standardization and IT security.

Panelists:
Joseph Thorp, ARAMCO
Rune Schlanbusch, Teknova AS
Neil Eklund, Schlumberger
Gilbert Chahine, National Oilwell Varco

Panel Session 4: Automotive PHM and Advanced Analytics
Tuesday, 1:15 – 3:00, Room: Crestone A
Session Chair: Steven W. Holland – General Motors

PHM technology has entered production use in the automotive
domain and is expected to become increasingly important for 1) Advanced Diagnostics and 2) True Prognostics. The scope of this panel includes the opportunities and barriers to the growth of PHM for commercial and, possibly, fleet applications. This panel is highly qualified to address the critical role suppliers will need to play in collaboration with the OEMs/Integrators to maximize the value to themselves but more importantly to the end customer. The power of Advanced Analytics further expands the scope and illustrates the paradigm shifting nature of the opportunity before us.

Panelists:
Yilu Zhang, General Motors
Barry Einsig, CISCO
Tim Felke, Honeywell
Mohak Shah, Bosch
Mircea Gradu, Hyundai

Panel Session 5: PHM Education & Professional Development
Tuesday, 3:30 – 5:15, Room: Crestone A
Session Chairs: Jeff Bird – TECnos, Karl Reichard – Penn State

Successfully implementing PHM technologies across diverse sec-
tors requires practitioners with multi-disciplinary knowledge and
complex applications experience. The academic sector provides
the bases in various specialties through degrees, certificates and
short courses. Are these tools good enough to convince asset
agers to develop and implement impactful PHM solutions? The
PHM Society has proposed a PHM Taxonomy to define the
skills and mastery levels. In addition, the Society has proposed a
Continuing Professional Development scheme to guide practitio-
ers, employers and educators.

Panelists:
George Vachtsevanos, Georgia Tech
Greg Kacprzynski, Impact Technologies/Sikorsky, A Lockheed
Martin Company
Ravi Rajamani, drR² Consulting
Kai Goebel, NASA
Lacklan Astfalck, University of Western Australia

Panel Session 6: PHM Standards Experience for Manufacturing
Wednesday, 8:45 – 10:15, Room: Crestone A
Session Chairs: Jeff Bird – TECnos, Ravi Rajamani – dr² Consulting

This panel sets the stage for beginning the PHM Society community’s conversation with respect to the standards needs and wants of manufacturing stakeholders. The panel’s goals are to: understand the contributions and development needs for information, guidelines and standards for PHM technologies in the aerospace sector; and how these could be the basis for other sectors, particularly the complex domain of manufacturing. First to introduce the needs and opportunities for PHM contributions to in the manufacturing sector. Then to show how information documents, recommended practices and standards have been developed systematically, for example, under SAE International HM-1 for the aerospace sector. Finally, to discuss the management of this development, and implementation process from the point of view of SAE International. Then with the audience, to identify key needs and development processes in preparation for the following Smart Manufacturing Panel.

Panelists:
Brian A. Weiss, NIST
Ravi Rajamani, dr² Consulting
Logan Johnson, SAE International

Panel Session 7: Smart Manufacturing PHM
Wednesday, 10:30 – 12:00, Room: Crestone A
Session Organizer: Brian A. Weiss – NIST

As manufacturing environments become more complex, fault and failure opportunities increase throughout the factory. Manufacturing complexity can stem from many factors including greater flexibility and reconfigurability in manufacturing processes (to leverage new technology and/or support product customization). This complexity forces manufacturers to assess and re-assess areas of risk within their manufacturing processes. Those areas of greatest risk often become ideal targets for PHM. Including PHM (i.e., condition monitoring, diagnostics, and prognostics) can increase operational efficiency and decrease downtime. This panel both builds on the discussions of the experience and processes from the Standards Experience for Manufacturing Panel and highlights some specific challenges, needs, and wants with respect to the development and implementation of standards and guidelines with respect to PHM. This diverse group of panelists present their standards and guidelines perspectives on PHM within Smart Manufacturing. Conversations will include PHM’s current and envisioned applications within factory environments along with how the needs, data stream, and supporting PHM tools, can be better designed, developed, implemented, verified, and validated to impact smart manufacturing.

Panelists:
David Siegel, Predictronic
Tom Bugnitz, Manufacturer’s Edge
Al Salour, Boeing
Joel Niedig, ITAMCO

Panel Session 8: Railway PHM
Wednesday, 1:15 – 3:00, Room: Cripple Creek B
Session Chair: David Siegel – Predictronic

The maintenance strategies for rolling stock, railway infrastructure, and signaling equipment for the railway industry are moving towards a more predictive and condition based maintenance approach. With the advances in sensors, data and network infrastructure, and advanced data analytics, the railway industry has made great strides in realizing predictive maintenance offerings and has the ability to further extend these offerings in the near future. There are numerous examples of predictive maintenance for infrastructure (track geometry/rail condition, point machines), rolling stock (brake pads, diesel engines, traction motors, wheel health, real-time monitoring/event analysis), and the panelist will discuss some of these current efforts. In addition, the panelist will discuss the current challenges (both business and technical) for developing and deploying PHM technologies in the railway industry. Lastly, some thoughts on the future direction of PHM and data analytics for the railway industry will be discussed from both the panelist and the audience members.

Panelists:
Parham Shahidi, PARC
Yan Liu, National Research Council Canada
Pierre Dersin, Alstom Transport
Zachery Gardner, VisioStack
Milan Karunaratne, GE Transportation

Panel Session 9: Department of Defense (DoD) Condition Based Maintenance Plus (CBM+) Service Panel Review
Wednesday, 1:15 – 3:00, Room: Crestone A

A panel of Service leaders from across the Department will showcase their evolving Condition Based Maintenance Plus (CBM+) capabilities. The panelists will summarize the challenges and benefits experienced while identifying, developing, implementing, and maturing the Services’ approaches to improve weapon system sustainment. This discussion will share best practices and highlight the enabling tools and technologies that are driving increased operational readiness and reduced logistics cost through more effective maintenance practices.

Opening Keynote Address:
Kevin Bostick, Army AMC Deputy G3/4 for Logistics Integration
Panel Moderator:
Greg Kilchenstein, Director, Enterprise Maintenance Technology, Office of Secretary of Defense for Maintenance

Panelists:
Dave Pack, Army G-44(M) CBM+ Program & Field Maintenance
Debora Naguy, Air Force AFLCMC Product Support Engineering
Marc Borkowski, NAVSEA 04RM Maintenance Engineering
Dwayne Cole, NAVAIR CBM+ Enterprise Team

Panel Session 10: Select Military Maintenance Projects Funded through the Commercial Technologies for Maintenance Activities (CTMA) Program
Wednesday, 3:30 – 5:15, Room: Crestone A

A panel consisting of industry maintenance providers will present the technology projects that have been funded and developed to address specific maintenance challenges across the Department of Defense (DoD). The panelists will discuss the development of their projects from the initial requirement and resourcing to prototyping and fielding. The scope of technologies being presented will include intermittent fault detection, maintenance inspection automation, task performance visualization, and big data analytics. This discussion will show how maintenance activities and industry participants can leverage the CTMA collaborative agreement between the DoD and the National Center for Manufacturing Sciences (NCMS) to develop critical maintenance capabilities not otherwise available. Additional project information is available at the CTMA booth in the exhibit hall.
Performing PHM at its basic core is collecting and analyzing data looking for and identifying trends and features that can be used to determine system health. Accomplishing PHM requires data from many different sources and thus leading data derived/driver approaches into the ‘Big Data’ paradigm. The Internet of Things (IoT) is an example that is fast becoming a vast land of ‘Big Data’ ripe for processing. A necessity is thus to efficiently process and mine the data.

The panelists in this session will describe approaches used to efficiently processes ‘Big Data’ in order to produce the attributes necessary for successful PHM. Current and state of the art analytic approaches will be discussed based upon the experiences of the panelist and audience. In addition, the application of cloud based computation will be discussed. Applications of discussed approaches will also be included and audience participation will focus on other potential applications and approaches.

Panel Session 12: Fielded Systems
Thursday, 1:15 – 3:00, Room: Crestone A
Session Chairs: Andy Hess – Hess PHM Group, Brian A. Weiss – NIST

Much can be learned from the requirements generation, development, Verification and Validation, implementation, maturation, fielded use, and fleet support of real world PHM systems. Just the development of the individual capabilities that make up a comprehensive and fully integrated PHM system; provides a large number of lessons learned - both good and bad. These need to be discussed, documented, and viewed across the many industry sectors that are fielding PHM systems.

Panelists:
- Gregory Ditzler, University of Arizona
- Seth Deland, MathiWorks
- Bill Nieman, General Electric
- Bill Roberts, SAS
- Neil Eklund, Schlumberger

Keynote #1: Trends and Recent Advances of Industrial Big Data Analytics and Cyber Physical Systems for PHM Applications
Monday, 1:00 – 1:45
Room: Crystal Ballroom
Dr. Jay Lee
University of Cincinnati

Abstract: In today’s competitive business environment, companies are facing challenges in dealing with big data issues for rapid decision making for improved productivity and business innovation. Many product and manufacturing systems are not ready to manage big data due to the lack of smart analytics tools. U.S. has been driving the Cyber Physical Systems (CPS), Industrial Internet, and Advanced Manufacturing Partnership (AMP) Program to advance future manufacturing. Germany is leading a transformation toward 4th Generation Industrial Revolution (Industry 4.0) based on Cyber-Physical Production System (CPPS). It is clear that as more predictive analytics software and embedded IoT are integrated in industrial products, predictive technologies can further intertwine smart IoT to predict product performance autonomously and further optimize the smart service systems.

The presentation will address the trends of predictive big data analytics and CPS for future industrial PHM application. First, predictive analytics and Cyber-Physical System (CPS) enabled industrial systems will be introduced. Second, advanced predictive analytics technologies for self-aware industrial systems with case studies will be presented. Finally, business innovation based on industrial big data will be introduced using case studies.

Speaker Bio: Dr. Jay Lee is Ohio Eminent Scholar, L.W. Scott Alter Chair Professor, and Distinguished Univ. Professor at the Univ. of Cincinnati and is founding director of National Science Foundation (NSF) Industry/University Cooperative Research Center (I/UCRC) on Intelligent Maintenance Systems (www.imscenter.net) which is a multi-campus NSF Industry/University Cooperative Research Center which consists of the Univ. of Cincinnati (lead institution), the Univ. of Michigan, Missouri Univ. of S&T, and the Univ. of Texas-Austin. Since its inception in 2001, the Center has been supported by over 85 global companies including P&G, GE Aviation, Eaton, National Instruments, Boeing, GM, Ford, Chrysler, Toyota USA, Siemens, Parker Hannifin, Spirit AeroSystems, Ingersoll Rand, Intel, Applied Materials, Lam Research, Bosch Rexroth (Germany), Alstom (France), Omron (Japan), Nissan (Japan), Tekniker (Spain), FMTC (Belgium), Kistler (Switzerland), Samsung (Korea), Shanghai Electric (China), SANY (China), Baosteel (China), HIWIN (Taiwan), Foxconn (Taiwan), etc. He is the pioneer on Industrial Big Data and has authored the book “Industrial Big Data” which has been a top selling book. He was selected as 30 Visionaries in Smart Manufacturing by SME in 2016.

His current research focuses on Industrial Big Data Analytics, Cyber Physical Systems, and Self-Aware Asset Management Systems. He is one of the pioneers in the field of Intelligent Maintenance Systems, Prognostics and Health Management (PHM), as well as Predictive Analytics of Asset Management. He as mentored his students and won 1st prize of PHM Data Challenges five times since 2008. He also mentored his students and developed a spin-off company Predictronics through NSF ICorps Award in 2012. Currently, he serves on the Advisory Board for a number of start-up companies including Predictronics and Falkorny, etc.

He was invited to be a member of White House Cyber Physical Systems (CPS) American Challenge Program in Dec. 2013, a member of Technical Advisory committee (TAC) of Digital Manufacturing and Design Innovation (DMDI) in Feb. 2014, as well as a member of Leadership Council of MForeseeit which is a NSF/NIST Newly established manufacturing Think Tank in Sept. 2015. He serves as a senior advisor to McKinsey & Company as well as a S&T advisor to Alstom Transport, France. In addition, he serves on the Board of Governors for Frost Sullivan Manufacturing Leadership Council, SME Smart Manufacturing Digital Transformation Executive Committee, Scientific Advisory Board of Flanders’ MECHATRONICS Technology Centre (FMTC) in Leuven, Belgium, Scientific Committee of SIMTech of Singapore, etc. He also serves...
Rhonda Walthall has led the development and implementation of the Aircraft System Health Management at UTC Aerospace Systems. Since 2010, she has authored/co-authored numerous highly influential articles and technical papers in the areas of Prognostics and Health Management, E-Manufacturing, Industry 4.0, and Cyber Physical Systems in Manufacturing, etc. He has over 20 patents and trademarks. He is a frequently invited speaker and has delivered over 300 invited speeches worldwide including over 200 keynote and plenary speeches at major international conferences. He is a Fellow of ASME, SME, as well as a founding fellow of International Society of Engineering Asset Management.

Rhonda has received a number of awards including the most recent Prognostics Innovation Award at NI Week by National Instruments in 2012 and NSF Alex Schwarzkopf Technological Innovation Prize and MFPT (Machinery Failure Prevention Technology Society) Jack Frarey Award in 2014. He is also a frequent invited speaker and has delivered over 300 invited speeches worldwide including over 200 keynote and plenary speeches at major international conferences. He is a fellow of ASME, SME, and MFPT (Machinery Failure Prevention Technology Society) Jack Frarey Award in 2014. He is also a honorary advisor to the Heifer International – a charity organization working to end hunger and poverty around the world by providing livestock and training to struggling communities.

Keynote #2: The Role of PHM at Commercial Airlines
Tuesday, 12:00 – 1:15
Room: Crystal Ballroom
Rhonda Walthall
UTC Aerospace Systems

Abstract: As profit margins at commercial airlines in the United States approach levels typically seen in other industries, the airlines are starting to invest in processes that will improve operational efficiencies, improve customer satisfaction, and reduce direct operating costs. The supply of Data Analytic companies offering the capability to provide business insight to achieve these goals is endless. With modern aircraft producing a terabyte of data on every single flight, smart sensors being installed on more and more components, and the Internet of Things ensuring more connectivity, how will the airlines use this information to achieve their operational goals? What information do they really need? Are they willing to pay for it?

In this presentation, Rhonda will discuss the current state of the commercial airlines, what their cost drivers are, and how PHMs can be used to lower their costs and improve their operations, assuming they are willing to pay for it.

Speaker Bio: Rhonda Walthall is the Manager of Prognostics and Health Management at UTC Aerospace Systems. Since 2010, she has led the development and implementation of the Aircraft System Health Management (ASHM) Program. Prior to joining UTC in 2003, she worked for Northwest Airlines and McDonnell Douglas Aircraft Company.

Rhonda is a member of SAE International and the 2016 recipient of the James M. Crawford Technical Standards Board Outstanding Achievement Award. She is the current Chair of the newly formed Reliability, Supportability, and Health Management Systems Group, the Integrated Vehicle Health Management (IVHM) Steering Group, and the 2016 Fellows Selection Committee. She is an active member of the E32 Committee for Propulsion Systems Health Management and the HM-1 Committee for Health Management.


Rhonda is an active member of the Prognostics Health Management (PHM) Society, Toastmasters International, and Women in Aviation International. Rhonda holds one patent and two invention disclosures.

Rhonda received her Bachelor of Science Degree in Aeronautical and Astronautical Engineering from Purdue University and a Master’s Degree in Business Administration from Pepperdine University.

Keynote #3: Testing and Debugging Software-Intensive Systems
Thursday, 8:00 – 8:45
Room: Crystal Ballroom
Dr. Rui Abreu
PARC

Abstract: Although considerable effort has been invested in developing methods for testing and failure detection, synthesis of programs from abstract models and verification of programs (and models), techniques for locating the root cause of observed program failures are still relatively immature. Therefore, the utility for general testing and debugging techniques remain limited to specific programs, execution environments, and problem contexts. Furthermore, no plug&play toolset exists providing state-of-the-art techniques to help developers with testing and debugging.

In this talk, we will discuss current state-of-the-art techniques for testing and debugging and how the combination of all these techniques helps to gain a better understanding of the software application. The techniques discussed in the talk are available within a plugin for the Eclipse IDE, coined GZoltar.

Speaker Bio: Dr. Rui Abreu holds a Ph.D. in Computer Science - Software Engineering from the Delft University of Technology, The Netherlands, and a M.Sc. in Computer and Systems Engineering from the University of Minho, Portugal. His research revolves around software quality, with emphasis in automating the testing and debugging phases of the software development life-cycle as well as self-adaptation. Dr. Abreu has extensive expertise in both static and dynamic analysis algorithms for improving software quality. He is the recipient of 5 Best Paper Awards, and his work has attracted considerable attention. He is currently a member of the Model-Based Reasoning group at PARC’s System and Sciences Laboratory.
Dr. Daniel Mack enters his fourth season with the Kansas City Royals after the Challenger accident.

Prior to entering medical school at the age of 42, he was a Marine Corps colonel, aviator and electrical engineer and served as a NASA astronaut on four space shuttle missions, including the first NASA manned spaceflight. The events leading up to this tragedy, the lessons learned, and my experiences as a crewmember on the return to flight mission will be discussed. After retirement from NASA and the Marine Corps, I completed medical school, residency, and became a professor at the Baylor College of Medicine in Houston, Texas. My experiences as a physician in an Ebola treatment unit in Liberia during the recent outbreak in West Africa will be described as well as current research on the prevention of and rapid response to new epidemics. The similarities of working in the remote environments of outer space and resource-poor countries will be highlighted.

Speaker Bio: Dr. Hilmers is a Professor in the Departments of Internal Medicine and Pediatrics, the Center for Space Medicine, and the Center for Global Innovation at the Baylor College of Medicine in Houston, Texas. He is board certified in both internal medicine and pediatrics. In addition to teaching, his clinical pursuits have included international HIV, pediatrics special needs, adolescent medicine, aerospace medicine, emergency medicine, tropical medicine, nutrition, and inpatient internal medicine. His research interests include aerospace medicine, refugee health, micronutrient deficiencies, food fortification programs, disease outbreaks such as Ebola, and the influence of malnutrition on infectious diseases such as HIV and malaria. He has done international volunteer service and disaster relief work in over 50 countries and recently spent two months treating patients in an Ebola Treatment Unit in Liberia. Prior to entering medical school at the age of 42, he was a Marine Corps colonel, aviator and electrical engineer and served as a NASA astronaut on four space shuttle missions, including the first after the Challenger accident.

Luminary Presentation #2: Diagnostics with a Noisy Sensor: From Aircraft to Player Performance

Dr. Daniel Mack
Kansas City Royals

Abstract: The knowledge and experience gained in Dr Mack’s projects in Diagnostics and and Anomaly Detection for Aircraft provided a unique look at player performance analytics, that goes beyond the data-driven tools used. In this talk, Dr Mack will discuss a bit about a domain transformation that is inspired from the diagnostics work, and what the future might hold for sports analytics in this mold. With that link in place, Dr Mack will then touch upon how he would bring information back across that transformation into PHM.

Speaker Bio: Dr. Daniel Mack enters his fourth season with the Royals and second with the title of Director of Baseball Analytics/Research Science, being promoted on January 5, 2015. He was originally hired by the organization in 2013 as an Analyst in Baseball Analytics. Mack works closely with the Baseball Analytics staff to assist with quantitative research and development of analytics in support of all areas of Baseball Operations. Prior to accepting the job with Kansas City, Mack obtained a doctorate in Computer Science from Vanderbilt University. At Vanderbilt, Mack’s dissertation focused on Machine Learning and Anomaly Detection. While pursuing his doctorate, Mack worked as a research assistant at the Institute for Software Integrated Systems where he and his research group won the NASA Associate Administrator Award for Technology and Innovation for work combining machine learning with fault diagnosis. He was also a teaching assistant while completing his master’s degree in computer science with a concentration in machine learning at Columbia University in New York. Mack graduated with a bachelor’s degree in computer science from the University of Notre Dame in 2006. A native of Reno, Nev., he resides in Kansas City, MO.
Annual Conference of the Prognostics and Health Management Society 2016
First Asia Pacific Conference of the Prognostics and Health Management Society
Organized with the Korean Society for Noise and Vibration Engineering
Ramada Plaza Jeju Hotel, Jeju, Korea
www.phmap.org

PHM 2017 Planning Meeting:
Thursday, October 6th
10:30 – 12:00
Crestone A

Ninth Annual Conference of the Prognostics and Health Management Society
Hilton St. Petersburg Bayfront Hotel, St. Petersburg, Florida
www.phmsociety.org

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- Dave Larsen, *UTC Aerospace Systems*

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- Michael Usrey, *Sporian Microsystems*
- Laurel Frediani, *Sporian Microsystems*

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- Justinian Rosca – Lead, *Siemens*

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- Brinda Thomas, *Tesla Motors*

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- Wolfgang Fink, *University of Arizona*
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- Rune Schlanbusch, *Teknova AS*
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- Jeff Bird, *TECnos*
- Karl Reichard, *Pennsylvania State University*
- Ravi Rajamani, *drR² Consulting*
- David Siegel, *Predictronics*
- Andy Hess, *The Hess PHM Group*
- Greg Kilchenstein, *Office of Secretary of Defense for Maintenance*
- Dave Cutter, *Logistics Management Institute*
- Debbie Lilu, *NCMS*
- Greg Bower, *QorTek*
- Jonathan Bednar, *Boeing*

#### Educational and Professional Development
- Jeff Bird, *TECnos*
- Karl Reichard, *Pennsylvania State University*

#### Student Activities Chair
- Abbas Chokor, *Arizona State University*

#### Poster Session Chairs
- George Gorospe, *NASA Ames Research Center*
- Bin Zhang – Lead, *University of South Carolina*

#### Conference Career Fair Chair
- Abbas Chokor – Lead, *Arizona State University*

#### Short Course Chairs
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**IVHM Center**—the Integrated Vehicle Health Management (IVHM) Centre at Cranfield University in the UK—was established in 2008. It is funded by a number of large companies—Boeing, BAE Systems, Rolls-Royce, Thales and Meggitt—to work on high impact topics. The increasingly important area of IVHM technology informs existing concepts of vehicle maintenance, repair and overhaul by offering a total health check for high-tech, high-value vehicles such as aircraft, ships, high-speed trains and high performance cars.

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The philosophy of **Condition Monitoring and Diagnostic Engineering Management (COMADEM)** is: Sustained Prosperity through Proactive Monitoring, Diagnosis, Prognosis and Management of all Assets. Since 1988, refereed annual international congresses and exhibitions have been successfully organized in UK, France, India, Canada, Finland, Australia, USA, Sweden, Portugal, Czech Republic, Spain, Japan, Norway. COMADEM has established and maintained its international reputation as one of the largest and most influential events of its kind. Through the publication of the International Journal of COMADEM, a number of special feature issues dealing with Quality, Reliability and Maintenance, Model-Based Diagnosis, Application of Artificial Intelligence Techniques, Intelligent Materials, Structures and Systems, Performance and Diagnosis of Rotating Machinery Systems and Components, Failure Diagnosis and Prognosis of Swedish Railway Systems, Energy and Environment, Knowledge-based Failure Diagnosis and Prognosis of Engineering Systems, Structural Health Monitoring, Failure Diagnosis and Prognosis of Mining Machinery and Systems and Estimating the Remaining Useful Life (RUL) of Industrial Assets have been published.

Established in 1948, the **Helicopter Association International** (www.rotor.org) is the professional trade association representing the international helicopter community. HAI's membership includes helicopter owners, operators, manufacturers, suppliers, service organizations, pilots, maintenance technicians and students. Its "Mission" is to provide its members with services that directly benefit their operations, and to advance the international helicopter community by providing programs that enhance safety, encourage professionalism and promote the unique contributions vertical flight offers society.

**CALCE** – The Center for Advanced Life Cycle Engineering (CALCE) at the University of Maryland is a driving force behind the development and implementation of physics-of-failure (PoF) approaches to reliability, and a world leader in accelerated testing, prognostics and health management (PHM) for electronic systems, electronic part supply-chain management, and sustainment of electronic systems. CALCE consists of over 100 faculty, staff, and students engaged in research with customers that range from military and avionics to automotive, telecom, medical, and consumer electronics. www.calce.umd.edu

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**Topics of interest**

- Prognostic Algorithms and Methods
- Diagnosis and Fault Isolation Methods
- Data-Driven & Model-Based Prognostics
- PHM Sensors and Devices
- Fault-Adaptive Control Methods
- Physics of failure Mechanisms
- Modeling and Simulations
- Uncertainty Representation & Management
- Verification and Validation
- PHM for Energy Applications
- PHM for Electronics and Components
- PHM for Power Smart Grids
- Aerospace and Defense Applications
- Industrial Applications
- Software Health Management
- PHM for Automotive Applications
- Structural Health Management
- Automated Reconfiguration
- Standards and Methodologies
- PHM System Design & Engineering
- Condition-Based Maintenance
- PHM Requirements & Specifications
- Decision Support for PHM
- Informal Logistics
- Asset Health Management
- Return-on-Investment Analysis
- Deployed PHM Applications

**Special Issue Announcements**

Apart from regular issues, special issues focus on advances in research in condition monitoring applications in specific application domains. CFPs soliciting papers are available from the journal website. A secondary goal is to document and benchmark the state-of-the-art in respective application domains.

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