Welcome to Scottsdale!

Welcome to historic Scottsdale for the 2019 Annual Conference of the Prognostics and Health Management (PHM) Society. This marks the 11th year of the conference, and will attract greater participation and offer richer programs than ever before to continue our success story. Scottsdale is a popular winter vacation mecca for entire North-America in the area of Arizona known as the “Valley of the Sun,” and with a slogan of “The West’s Most Western Town.” A tiny farming community of 2,000 people covering only 1.17 square miles in Phoenix, Scottsdale has become a vibrant city of more than 200,000 residents encompassing nearly 200 square miles. Its many golf courses and resorts attract visitors from around the world. Art galleries abound amid the towering palm trees, purple shadowed mountains, and pastel landscapes. The city boasts more than 300 sunny days per year. The lively restaurants, nightclubs, and cultural and sporting events add a metropolitan touch, yet cowboy ranches and Indian reservations are a brief ride away. In addition to its booming tourism industry, Scottsdale has become a diverse high tech industry. John is becoming recognized as a leader in health care and medical research. It offers a vast array of recreational activities, including biking, hiking, white water rafting, horseback riding, and ballooning. The arts are flourishing in the city, which has its own symphony orchestra and more art showcases per capita than almost any other city in the world. The conference week also overlaps with the 11th year of the conference, and will attract greater participation and offer richer programs than ever before to continue our success story.

What Sets This Conference Apart from Other Events

The Prognostics and Health Management Society (PHM Society) welcomes you to its 11th annual international conference. As the Society’s annual premier event, the 2019 PHM Conference brings together the global community of PHM experts from industry, academia, and government in diverse application areas, such as, but not limited to, unmanned systems, wind energy, oil and gas, aerospace, transportation, automotive, precision agriculture, commercial space, human health & performance, smart manufacturing, and industry 4.0. In addition to technical paper sessions, the conference features a workshop on Measurement and Evaluation for PHM in Manufacturing, invited expert panels on a plurality of critical issues and applications, a doctoral symposium, a dedicated poster session, Luminary and Keynote speakers, and tutorials free to all registrants. Leading companies and research institutions will exhibit their products and demonstrate their technologies during the event. A PHM Data Challenge will be carried out in parallel and the results will be presented during the conference. The PHM Society features also two, two-day intensive short courses (PHM Fundamentals and Analytics for PHM) before the start of the main conference. Several social events will round up the program by providing ample opportunities for participants to connect with colleagues, including a career fair, diversity & inclusion breakfast, and, for the first time, a Golf tournament “PHM goes PGA” at the end of the conference.

The PHM 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 communities.

Lastly, the conference has taken pride in building up its industry-focused panel sessions over the last several years. Most conferences do an outstanding job highlighting cutting-edge research, yet fail to offer a healthy amount of contributions from industry leaders who cannot necessarily share their work through technical publications. Our conference does both! Our panel sessions have featured, and will continue to feature, PHM practitioners with real-world experience who share candid insight as to how PHM has impacted their organizations.

The PHM Society is free and entitles you to full access to papers, tutorials and proceedings—join or update your profile today! Sincere appreciation to the sponsors of this brochure!
**Optional PHM Fundamentals Short Course Details and Agenda**

**September 21 – 22; Location: Arizona II**
Separate Registration Required

Course Leaders: Dr. George Vachtsevanos (Georgia Tech) and Dr. Karl Reckard (Pennsylvania State University)

This introductory course will be taught by recognized international 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. Through a lecture (with Q&A), networking and workshop format with specialist experts, you will:

1. Establish a baseline for defining the extent and capabilities of PHM, specifically needs and organization
2. Identify specific details of PHM Applications (metrics, sensors, cost benefits, reliability) and PHM Methods (diagnostics, prognostics, data driven methods and uncertainty)
3. Identify issues and needs and a way forward including Continuing Professional Development (CPD)
4. Examine case studies of PHM applications across diverse domains to identify solutions and impacts
5. Plan a PHM application in two mini workshops with expert group leaders

**Topics Include:**
- Introduction to PHM (Taxonomy, scope, basics, standards-for all talks)
- Denning Requirements for PHM (Basics and illustrative examples)
- PHM Performance Metrics (Basics and illustrative examples)
- Diagnostics Methods (Basics and illustrative examples)
- Case Study for requirement metanomics (Description of an application)
- Prognostics (Basics and illustrative examples including uncertainty)
- Data Analytics Methods (Basics and illustrative examples)
- Prognostics Case Studies (2 case studies for prognosis and data analytics information)
- Sensors & Data Processing (Available/Required data and organization)
- Analysis mini workshop (Small group data design activity with worksheet)
- CBM+ and PHM Technologies (Basics and illustrative examples)
- PHM Management Cost Benefit Analysis (Basics with cost Benefits examples)
- Plenary - Issues and Needs (Review to compile collected issues from all participants)
- Reliability and Life Cycle Management (Linking reliability and PHM approaches)
- Case Study Workshop Introduction (Small group activity builds on data design mini)
- Fielded Systems Case Studies-1 (2 case studies for CBM and Reliability)
- Fielded Systems Case Studies-2 (3rd case study for CBA)
- Case Study Mini Workshop (Small group activity and reporting)
- Way Forward (Paths, Resources, Continuing Professional Development)

**Saturday, September 21, 2019**

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**Optional PHM Data Analytics Short Course Details and Agenda**

**September 21 – 22; Location: Arizona III**
Separate Registration Required

Course Leader: Dr. Not Eklund (Alatysik)
Course Administrator: Jeff Bird (TELcos)

This course is designed for engineers, scientists, and managers who are interested in data driven methods for asset management. You will learn how to identify potential data driven projects, visualize data, screen data, construct and select appropriate features, build models of assets from data, evaluate and select models, and deploy asset monitoring systems. By the end of the course, you will have learned the essential skills of processing, manipulating and analyzing data of various types, creating advanced visualizations, detecting abnormal behavior, diagnosing faults, and estimating remaining useful life. Note that this course is an advanced course with only a brief, high-level overview of PHM presented - students are expected to know the basics of PHM already. New practitioners are encouraged to take the fundamentals course or contact the course leader to examine their background and skills.

The course is about two thirds lecture, and an optional one third hands-on lab. Students who elect to take the lab will be expected to bring a laptop with Python 3.5.2 installed. The course is about two thirds lecture, and an optional one third hands-on lab. Students who elect to take the lab will be expected to bring their own laptops with Python 3.5.2 installed.

**Topics Include:**
- Overview of Data-driven PHM
- Review of Basic Statistics
- Data Transformation and Feature Extraction
- Case Studies Workshop Introduction (Small group activity builds on data design mini)
- Fielded Systems Case Studies – 1
- Fielded Systems Case Studies – 2
- Fielded Systems Case Studies-1 (2 case studies for CBM and Reliability)
- Fielded Systems Case Studies-2 (3rd case study for CBA)
- Case Study Mini Workshop (Small group activity and reporting)
- Way Forward (Paths, Resources, Continuing Professional Development)
- Wrap up with Evaluation Forms

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**Hands-on Lab**

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PHM Applications of Deep Learning Workshop

Monday, 12:30 – 4:30, Location: Arizona II & III Workshop Leaders: Dr. Jon Eskin (Akamai)
Opening Keynote: Quo Vadis, Deep Learning in PHM? The Magic, the Cowritten for, and the Darkest Dean of the New Age of Artificial Intelligence with Prof. Dr. Olga Fink (Chair of Intelligent Maintenance Systems, ETH Zürich)
Closing Keynote: TrajectNets: Novel Deep Learning Architectures for Prognostics, and Speech Recognition; e.g., AlphaGo and AlphaZero have achieved different domains, including computer vision, language processing, genomics, and speech recognition; e.g., AlphaGo and AlphaZero have achieved super-human performance on complex games without human input. Despite these encouraging results, these techniques have seen little adoption by industry for PHM applications. There are several obstacles that need to be surmounted to enable the broad adoption of deep learning for PHM: Limited number of representative training samples, particularly for different types of faulty conditions and representative time-to-failure trajectories

BENEFITS OF PARTICIPATION:
• Hear from other industry professionals (including personnel from large and small manufacturers) about their challenges, needs, and best practices to measure the performance of monitoring, diagnostic, and prognostic technologies
• Understand what technologies are actually being developed and integrated to enhance your ability measure monitoring, diagnostic, and prognostic solutions
• Learn the latest measurement techniques that can be applied within your own manufacturing environments
• Builds upon the success of the 2018 Industry Forum: Monitoring, Diagnostics, and Prognostics for Manufacturing Operations that was documented in a publicly-available report.

Monday, September 23, 2019
7:00 – 8:00 Breakfast (provided)
8:15 – 9:40 Large Machine – Challenges, Needs, and Best Practices for Verifying and Validating PHM Technologies – Sarah Lukens (General Electric), Greg Cohn (Honeywell), Changhui Yang (Faulconer), Nicholas Larrabee, Brian Weiss (South Carolina), and Maq Soils (US Army Engineering Laboratory)
9:45 – 9:55 Break
9:55 – 11:15 Small Machine – Challenges, Needs, and Best Practices for Verifying and Validating PHM Technologies – Radu Pavel (TechSolve), Sara Fuller (Mississippi State), Brad Smith (Cleveland); and Luis Gonzalez – Mendez (TechSolve)

Lunch on your own
11:15 – 12:30
12:30 – 2:00
Technology Development & Integration – Emergent PHM and the Capabilities that must be Assessed – David Siegel (Preditronics); Mark Walker (ON Semiconductor); Ed Ippolito (Machine-Instrumentation); Frank Zainu (US Air Force Sustainment Center); and Frank A. Weiss (Vanderbilt University)

Break
2:00 – 2:15
2:15 – 3:40
Measurement and Evaluation Research Developing Independent V&V of PHM – Brian Weiss (NST), Michael Brundage (NST), and Kristin Michael Sharp (NST), and Doug Thomis (NST)
Assessment of Different Industrial V&V Techniques for PHM – Xiondong ‘Alex’ Jia (Honeywell); Brian Weiss (South Carolina); Frank A. Weiss (Vanderbilt University); and Felip Parajó (Universitat Politècnica de Catalunya)

4:30 – 4:10 Wrap-up
4:10 – 4:30

Measurement and Evaluation for PHM in Manufacturing (ME4PHM) Workshop

Monday, 7:00 – 4:30, Location: Arizona I Workshop Leaders: Brian Weiss (Vanderbilt) and Michael Brundage (NST)
This half-day workshop on the afternoon of 23 September will provide a forum for PHM researchers and practitioners to discuss the potential, applicability, benefits, challenges, and current obstacles of deep learning for PHM applications. The focus will be on theory and application of deep learning to anomaly detection, condition monitoring, diagnostics, and prognostics.

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8:15 – 9:40 Large Machine – Challenges, Needs, and Best Practices for Verifying and Validating PHM Technologies – Sarah Lukens (General Electric), Greg Cohn (Honeywell), Changhui Yang (Faulconer), Nicholas Larrabee, Brian Weiss (South Carolina), and Maq Soils (US Army Engineering Laboratory)
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4:30 – 4:10 Wrap-up
4:10 – 4:30

PhD Symposium

Monday, 8:30 – 5:00, Location: Pueblo I & II Symposium Chair: James Cole (University of Tennessee, Knoxville) and Felipe Viana (University of Central Florida)
The PhD 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 collegial setting. The PhD Society Doctoral Symposium will be held in a workshop on the first day of the conference. The panels for the DS are:

• Maria Corbetta (NASA Ames Research Center)
• Felipe Parajo (Universitat Politècnica de Catalunya)
• Shawn Sheng (National Renewable Energy Laboratory)
• Felipe Viana (University of Central Florida)

Saturday, September 21, 2019
10:00 – 10:30 Presentation R2 (10 min)
Vibration-based Condition Monitoring of Industrial Drives Operations under Non-stationary Conditions – Madhurina Dev Choudhury (University of Auckland)
Panelist Feedback & Audience Q&A
10:30 – 11:00 Presentation R3 (10 min)
Adapting Approximate Entropy as a Health Indicator for Robust Fault Detection for UAV Safety and Traffic Management – Jaewoo Hu (Arizona State University)
Panelist Feedback & Audience Q&A
12:00 – 12:30 Presentation R5 (10 min)
Probabilistic Data Analysis and Mitigation for UAV Safety and Traffic Management – Daniel Walker (University of Tennessee)
Panelist Feedback & Audience Q&A
12:30 – 1:00 Presentation R6 (10 min)
Modular Data Management for Fault Detection – Michael Luebke (University of Kentucky)
Panelist Feedback & Audience Q&A
1:30 – 2:00 Presentation R7 (10 min)
Novel Wear Monitoring, Algorithms, for Cable Health Monitoring – Xiang Wang (University of South Carolina)
Panelist Feedback & Audience Q&A
2:30 – 3:00 Presentation R8 (10 min)
Deep Learning in Prognostics and Diagnostics of Machine Health Condition – Wuo Jie (Purdue University) Break
3:00 – 3:30 Presentation R9 (10 min)
Adaptive Prognostics and Health Management Using Streaming Data in Big Data Environment – Jinghe Fang (University of Cincinnati)
Panelist Feedback & Audience Q&A
3:30 – 4:00 Presentation R10 (10 min)
A Framework to Interpret Deep Learning-Based Health Monitoring for Emerging Technologies – Nambiyappan Namkar Lee (University of Maryland)
Panelist Feedback & Audience Q&A
4:30 – 4:45 Feedback from Students & Audience
4:45 – 5:00 Break

Social Program

Student Social Pool Event
Tuesday, 8:00 – 10:00, Location: McCormick Hotel pool-side
Network with the PHM community students in a relaxing atmosphere by the pool. A perfect evening to socialize and enjoy food and refreshments from the hotel’s pool bar & grill. Pool facilities will stay open, so don’t forget your swimsuits!

PHM Conference 11th Anniversary Banquet
Wednesday, 6:00 – 10:00, Location: Botanical Gardens (for guest tickets, please see Registration Desk)
Diversity Outreach Breakfast
Thursday, 7:00 – 8:00, Location: Coronado I – III
Did you know that PHMS has recently committed to a Diversity Statement? Join a distinguished panel of PHM experts for a discussion on Inclusion and Diversity in PHM. This event will be documented in a resultant report that can be shared in a cost-effective manner.

Women in PHM池: An Inclusive Community of Females in PHM
Thursday, 9:00 – 10:30, Location: Coronado I – III
Did you know that PHMS has recently committed to a Diversity Statement? Join a distinguished panel of PHM experts for a discussion on Inclusion and Diversity in PHM. This event will be documented in a resultant report that can be shared in a cost-effective manner.

Mobile App

The PHM Conference will be offering 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 PHM2019 event and, if prompted, use passcode phms2019.
Tuesday, September 24, 2019

Session Chair: Sergio Martin-del-Campo
– Manuel Arias Chao

7:00 – 8:00 Session Chair: Xiaodong Jia

Keynote Speaker: Stan Martin (Kid Ridge National Laboratory)
"How Bio Fuels and Other Renewable Energy Sources May Impact Global Climate Change and Alter the Course of History"

Tuesday, 1:30 – 3:00, Location: Arizona III

Panel Session 3A: Blockchain in Control & Aerospace
Invited Paper Session 3A: Blockchain in Control & Aerospace

Tuesday, 10:45 – 11:15, Room: Arizona III
Session Chair: Jose Celaya (RonaldBerg)
Thursday, September 26, 2019
10th Annual Conference of the Prognostics and Health Management Society 2019

**Session: Paper Session 9A: Gearbox Diagnostics**

**Chair:** Melina Hodkiewicz (GAIA)

- **Comprehensive Analysis of the Performance of Gear Fault Detection Algorithms** – Eric Beecheferl, Brent Butterworth (GPMCM; Gamar International)

**An Evaluation of Empirical Approach for Gearbox Diagnosis in the Construction Equipment – Koen Kimi** (D’Osioon, Itrra, UMP)

**Tooth Count Slew Safety Assessment in the Early Stage of Crack Propagation Using Gearbox Dynamic Model** – Xiangyang Wang, Ming J. Zuo, Zhigang (Will) Tian

**Closing Remarks**

**Location:** Arizona I

**Time:** 3:45 - 5:00

**Session: Paper Session 9B: Diagnostics III**

**Chair:** Gregory Huerta (PARC)

- **A Simulative Framework for Fault Diagnosis of Hybrid Powertrain** – Boubakeur Roubah, Alexander Feldman (U. at Buffalo - SUNY)

**An Evaluation of Prognostics and Health Management on the Cloud – An Introduction to Jose Celaya and Indranil Bose (Schlumberger)

**Session Chair:** Yutian Pang

**Session Title:** System Level Health Management

**Location:** Arizona I

**Time:** 9:00 – 10:30

**Session: Paper Session 9C: Prognostics III**

**Panel Session 9: Theoretical Aspects of Prognostics**

- **Chetan Kulkarni (University Of Tennessee, Knoxville)**
  - **A Predictive Maintenance Approach for Complex Equipment Based on Faults Identification and Isolation in Dynamic Systems Using Multiple Classifiers**

- **Mark Harris, Ian Jennions (Schlumberger)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

- **Hicham Janati, Michael E. Sharp (NIST)**
  - **Inter-Turn Short-Circuit Failure of PMSM Indicator Based on Kalman Filter**

**Panel Session 10: PHM for Air Traffic Management**

- **Jiaojia Shi (PARC)**
  - **A Deep Learning-Based Method for Cutting Parameter Optimization for CNC Machine Tool**

- **Brock Middaugh (Idlettechs)**
  - **A Simulation Engine for the Characterization of Capacity Degradation of Lithium-ion Batteries Undergoing Heterogeneous Operating Conditions**

**Panel Session 11: PHM for Manufacturing**

- **Melinda Hodkiewicz (GAIA)**
  - **A Prognostics Framework for Power Semiconductor IGBT Modules through Monitoring of the On-State Voltage**

**Panel Session 12: PHM for Manufacturing**

- **Sarah Lukens (Hess PHM Group)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

**Session Chair:** Richard Melin (Honeywell)

**Session Title:** PHM Education and Professional Development Workshop

**Location:** Arizona I

**Time:** 9:30 – 11:00

**Session: Paper Session 13: Prediction Methods**

**Panel Session 13: Prediction Methods**

- **Brian Weiss (Idlettechs)**
  - **An Integrated Model for Probabilistic Failure Rate Estimation of Lithium-ion Batteries Through Bayesian Inference**

- **Kalyani Zope (PARC)**
  - **Data-driven Approach to Equipment Taxonomy Classification**

**Closing Remarks**

**Location:** Arizona I

**Time:** 4:45 - 5:00

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**Paper Session 9A: Gearbox Diagnostics**

Thursday, 9:00 – 10:30, Room: Arizona II

**Chair:** Melina Hodkiewicz (GAIA)

- **A Comprehensive Analysis of the Performance of Gear Fault Detection Algorithms** – Eric Beecheferl, Brent Butterworth (GPMCM; Gamar International)

**An Evaluation of Empirical Approach for Gearbox Diagnosis in the Construction Equipment – Koen Kimi** (D’Osioon, Itrra, UMP)

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**Closing Remarks**

**Location:** Arizona I

**Time:** 3:45 - 5:00

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**Paper Session 9B: Diagnostics III**

Thursday, 9:00 – 10:30, Room: Arizona II

**Chair:** Gregory Huerta (PARC)

- **A Simulative Framework for Fault Diagnosis of Hybrid Powertrain** – Boubakeur Roubah, Alexander Feldman (U. at Buffalo - SUNY)

**An Evaluation of Prognostics and Health Management on the Cloud – An Introduction to Jose Celaya and Indranil Bose (Schlumberger)

**Session Chair:** Yutian Pang

**Session Title:** System Level Health Management

**Location:** Arizona I

**Time:** 9:00 – 10:30

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**Paper Session 9C: Prognostics III**

**Panel Session 9: Theoretical Aspects of Prognostics**

- **Chetan Kulkarni (University Of Tennessee, Knoxville)**
  - **A Predictive Maintenance Approach for Complex Equipment Based on Faults Identification and Isolation in Dynamic Systems Using Multiple Classifiers**

- **Mark Harris, Ian Jennions (Schlumberger)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

- **Hicham Janati, Michael E. Sharp (NIST)**
  - **Inter-Turn Short-Circuit Failure of PMSM Indicator Based on Kalman Filter**

**Panel Session 10: PHM for Air Traffic Management**

- **Jiaojia Shi (PARC)**
  - **A Deep Learning-Based Method for Cutting Parameter Optimization for CNC Machine Tool**

- **Brock Middaugh (Idlettechs)**
  - **A Simulation Engine for the Characterization of Capacity Degradation of Lithium-ion Batteries Undergoing Heterogeneous Operating Conditions**

**Panel Session 11: PHM for Manufacturing**

- **Melinda Hodkiewicz (GAIA)**
  - **A Prognostics Framework for Power Semiconductor IGBT Modules through Monitoring of the On-State Voltage**

**Panel Session 12: PHM for Manufacturing**

- **Sarah Lukens (Hess PHM Group)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

**Closing Remarks**

**Location:** Arizona I

**Time:** 4:45 - 5:00

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**Session: Paper Session 13: Prediction Methods**

**Panel Session 13: Prediction Methods**

- **Brian Weiss (Idlettechs)**
  - **An Integrated Model for Probabilistic Failure Rate Estimation of Lithium-ion Batteries Through Bayesian Inference**

- **Kalyani Zope (PARC)**
  - **Data-driven Approach to Equipment Taxonomy Classification**

**Closing Remarks**

**Location:** Arizona I

**Time:** 4:45 - 5:00

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**Session: Paper Session 14: Predictions**

**Panel Session 14: Predictions**

- **Joseph Carson (PARC)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

- **Brock Middaugh (Idlettechs)**
  - **A Simulation Engine for the Characterization of Capacity Degradation of Lithium-ion Batteries Undergoing Heterogeneous Operating Conditions**

**Closing Remarks**

**Location:** Arizona I

**Time:** 4:45 - 5:00

---

**Session: Paper Session 15: PHM for Manufacturing**

**Panel Session 15: PHM for Manufacturing**

- **Karen Buchholz (Garmin)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

- **Hicham Janati, Michael E. Sharp (NIST)**
  - **Inter-Turn Short-Circuit Failure of PMSM Indicator Based on Kalman Filter**

**Closing Remarks**

**Location:** Arizona I

**Time:** 4:45 - 5:00

---

**Session: Paper Session 16: PHM for Manufacturing**

**Panel Session 16: PHM for Manufacturing**

- **Joseph Carson (PARC)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

- **Brock Middaugh (Idlettechs)**
  - **A Simulation Engine for the Characterization of Capacity Degradation of Lithium-ion Batteries Undergoing Heterogeneous Operating Conditions**

**Closing Remarks**

**Location:** Arizona I

**Time:** 4:45 - 5:00

---

**Session: Paper Session 17: PHM for Manufacturing**

**Panel Session 17: PHM for Manufacturing**

- **Karen Buchholz (Garmin)**
  - **A Data Life Cycle Model Proposition for Integrated Vehicle Health Management and Simulations**

- **Hicham Janati, Michael E. Sharp (NIST)**
  - **Inter-Turn Short-Circuit Failure of PMSM Indicator Based on Kalman Filter**

**Closing Remarks**

**Location:** Arizona I

**Time:** 4:45 - 5:00
Tuesday and Wednesday, 9:00 – 5:00
Tuesday, September 24, 2019
Tuesday, 9:00 – 10:30, Location: Apache I
Matteo Corbetta (SGT, NASA Ames Research Center)

Abstract: This tutorial will focus on the fundamentals and basic concepts of prognostics and health management, giving emphasis to condition-based approaches. The audience will be introduced to the key elements that compose a prognostic framework, their interaction, uncertainty and effect on the prediction accuracy.

Tuesday, 10:45 – 12:15, Location: Apache I
Shankar Sankararaman (PwC)

Presenter Bio: Shankar Sankararaman received a B.S. in civil engineering from the Indian Institute of Technology, Madras, in 2007, and later received a M.S. degree in mechanical engineering from Politecnico di Milano in 2016, 2012 and 2009.

Tutorials
Tuesday, September 25, 2019

Tutorials
Tuesday, 9:00 – 10:30, Location: Apache I
Matteo Corbetta (SGT, NASA Ames Research Center)

Abstract: This tutorial will focus on the fundamentals and basic concepts of prognostics and health management, giving emphasis to condition-based approaches. The audience will be introduced to the key elements that compose a prognostic framework, their interaction, uncertainty and effect on the prediction accuracy.

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and older adults 65 years of age and older will double by the year 2030, challenges associated with these applications; and how PHM capabili
achieve these same and additional space related goals. These associat
and orbit to surface vehicles; and all kinds of support subsystems and
these far reaching goals will include: crewed space and surface based
increasing on a very accelerating rate. After the legacy NASA developed
platforms, as well as quick to launch and reusable space vehicles, is
Session Chairs:
Tuesday, 3:15 – 4:45, Location: Arizona I
motive market and how PHM technologies can help mitigate warranty
challenges and opportunities posed by the increasingly electrified auto
quirements and growing societal pressures, the auto industry is turning
electric or electronic components. With increasingly tight emission re
billion USD in 2016 for warranty claims – with 50% or more related to
Panelists:
Regan Dixon (General Motors)
Steve Holland (General Motors; retired)
Ravindra Patala (KPA Limited)
Michael Pecht (CALCE, University of Maryland)
Daniel Riegel (Robert Bosch GmbH)
Panel Session 4: PHM for Space Applications
Tuesday, 3:15 – 4:45, Location: Arizona I
Session Chairs: Derek DeVries (NSC) and Andy Hess (The Hess PHM Group)
Description: The planned use of manned and long term crewed space platforms, as well as long lived and reusable space vehicles, is increasing on a very accelerating rate. After the legacy NASA-developed Space Shuttle and LEO ISS; among many things, there are near term NASA plans and long term criteria and plans to extend human life to a permanent lunar base, a present asteroid, and Mars bases. Vehicles and platforms to accomplish these far reaching distancetransportations are critical. The evolution of space stations and habitats; various types of launch, long range transportation, and orbit to surface vehicles; and all kinds of support subsystems and technologies for these are all part of the PHM and CBM+ discussion. Commercial based entities are aggressively developing systems to achieve these and many other far reaching goals for humanity. Associated commercial focused applications include space tourist to LEO, space based solar power, deep space exploration, etc. This panel will focus on issues and challenges associated with these applications; and how PHM capabiliti
can be applied to reduce risks, increase efficiencies, and ensure re
tsistent operation of these vehicles, platforms, habitats, and systems.
Panelists:
Derek R. DeVries (NSC)
Terry George Vachssenovics (Georgia Tech)
James A. Larkin (Aerion Rocketdyne)
Panel Session 5: PHM for Human Health and Performance
Wednesday, 10:45 – 12:15, Location: Arizona I
Session Chairs: Thumon Lockhart (Arizona State University) and Erica Forsythe (ORNL)
Description: The age distribution and the mean age are undergoing rapid and significant changes worldwide. Based on current projections made by the United States Census Bureau, the present population of older adults 65 years of age and older will double by the year 2030, and constitute a significant portion of the total population. Consider
ing the increase in life expectancy by 55 and 65 and contributing to their chronic conditions, with nearly 50% of them reporting two or more con
ditions, PHM technologies for monitoring, diagnosis and interventions for these chronic conditions becomes critically important. Many chronic diseases that severely
limit quality of life are difficult to manage in their later stages, but can be managed much more effectively and efficiently by PHM. For example, underpinnings of Predictive Health Management (PHM) – “predict and render preventive measures prior to failure” is well suited to respond to the health needs of the older adults. Implementation of new and innova
tive approaches to healthcare delivery that focuses on an integrated, yet affordable approach of “taking the gap” between the traditionally separate fields of health monitoring and prevention is necessary. As such, this panel will discuss contributions in the fields of wearable smart sensors, sensor-oriented data analytics and data mining, predic
tion and diagnosis, and electronic health records and databases - all in the context of PHM for achieving good health for the older adults. Moreover, this panel builds on the discussions of the experience and processes encountered/created by the panelists, and highlights specific topics and issues pertaining to the development and implementation of standards and guidelines concern
ing the PHM of older adults. These include: crewed space and surface based
Panel Session 6: Precision Agriculture
Wednesday, 10:45 – 12:15, Location: Arizona I
Session Chair: Alice Robinson (Kearney Research)
Description: The Precision Agriculture Revolution has been the worldwide successful of the precision agriculture revolution and specifically the emerging revolution in Data
Driven agriculture. Precision Agriculture has been defined by Wikipedia as the key component of the third wave of modern agriculture revolu
tion. However, despite the many significant advances that have been made in GPS-based data logging, many of the applications of the use of the sen
sors and drones for soil and crop monitoring, data-driven, daily farm management still remains a “Holy Grail” to be fully realized. This panel will examine the use of Big Data and AI techniques, and analysis for rapidly delivering actionable information on a daily basis for support
ing farm management decisions.
Panelists:
David Brown (Pivot Bio)
Eric Johnson (ORNL)
Stan Martin (ORNL)
Panel Session 7: PHM Enablers for Autonomous Systems
Wednesday, 3:15 – 4:45, Location: Arizona I
Session Chairs: Karl Reichard (Pennsylvania State University) and George Vachssenovics (Georgia Tech)
Description: PHM and other technologies in the design and operation of unmanned autonomous systems (aerial, ground, sea surface and undersea vehicles). Autonomous systems are attracting the attention of researchers and users in a variety of appli
cation domains from Intelligence, Surveillance and Reconnaissance to rescue operations, autonomous ground, air, and ocean vehicles, driverless taxis, underwater exploration, among others. It is documented that autonomous systems (UAVs, for example) are failing at alarming rates and PHM related techniques and methods for their re
silient design and safe operation. The panel is inviting the participation of scientists, researchers, and industry professionals to learn about the latest research and current and future technologies for improved system perform
ance. Actual case studies and examples will be used to illustrate the technology and its innovations.
Panelists:
Yao Cui (Rokita)
Yuan-Kang Lin (University of Arizona)
Kai Goebel (PARC)
Session Chairs: Karl Reichard (Pennsylvania State University) and Ash Thakker (Global Technology Connections, Inc.)
Panel Session 8: Fielded Systems: Lessons Learned
Wednesday, 3:15 – 4:45, Location: Arizona I
Session Chairs: Karl Reichard (Pennsylvania State University) and Ash Thakker (Global Technology Connections, Inc.,)
Description: Several long-term career practitioners in the fields of PHM and CBM+ will share their experiences, observations, and les
sons learned as part of this distinguished panel of experts. Much can be learned from the requirements generation, development, Verification and Validation, implementation, maturation, field use, sustained support, and enterprise-wide use of real world PHM systems. Just the develop
ment and implementation of an enterprise-wide and fully integrated PHM system; provides many lessons learned - both good and bad. This important focused area will also be explored around the question: “just who owns the data that these systems produce?” These issues need to be discussed, documented, and viewed across the many industry sectors that are fielding PHM sys
tems. Short presentations will be given by all panel participants that de
scribe their particular topic area and experiences within the PHM/CBM+
Panelists:
James “(Hoffy)” Hoffmeister (Ridgrop Group)
Mark Hollins (NAVUR)
Dong Keun Kang (Northrop/Lockheed Martin RMS)
Pyush Modh (MIDVA)
Michael Penn (University of Maryland)
Panel Session 9: Theoretical Aspects of Prognostics
Thursday, 9:00 – 10:30, Location: Apache I
Session Chair: Chetan Kulkarni (S3T, NASA Ames Research Center)
Description: The opportunity to learn and share the latest advancements of theore
tical Aspects in Prognostics. In many of the Prognostic and Health Management applications particle filtering-based algorithms are being implemented. These non-Gaussian and non-linear system approaches and frameworks have demonstrated their drawbacks when trying to estimate the reliability of failure in non-linear systems. The non-Gaussian systems perform poorly in uncertain operating profiles. To overcome this issue, it is first necessary to establish adequate performance metrics for the framework which has been developed. The panel is presented in recent years. It has been observed that much work has been done on standardizing prognostics defini
tions but there is much work to be done. The session plans to bring together academics and industry experts in the area to discuss about the lack of standards due to varied end-user requirements and applications in different systems, domains, including aero
space, automotive, nuclear power, electrical, etc.;
Panelists:
Marcos Orlich (Universidad de Chile)
Marcus Quiñones (Vanderbilt University)
Bing Zhang (University of South Carolina)
Panel Session 10: PHM19 Education and Professional Development Workshops
Thursday, 9:00 – 10:30, Location: Arizona I
Session Chairs: Karl Reichard (Pennsylvania State University) and Jeff Bird (TECnoS)
Description: The PHM Society mission emphasizes free and unre
stricted access to PHM knowledge and promotes international collaboration in PHM and leading the advancement of PHM as an engineering discipline. ‘Products’ for PHM education and profes
sional development accessible to the whole community contribute to all of these aims. The PHM Taxonomy under development offers a common basis for un
derstanding PHM domains, and skills and levels advancement. The PHM Continuing Professional Development Guidelines offer personal and or
ganizational career planning and enhancement for the PHM community as a whole
This workshop format will validate and advance the scope, content, and applications of these two products to serve the widest domains of PHM and the PHM knowledge and products will be made available in advance through updates to the existing PHM Society forums.
Panelists:
Jeff Bird (PHM Society EPD Committee Chair)
Jamie Cobb (University of Tennessee) Manny Nwadiogbu (Analatom)
Manny Nwadiogbu (Analatom)
Session 11: Small Business
Thursday, 10:45 – 12:15, Location: Arizona I
Session Chair: Michael Pecht (CALCE, University of Maryland)
Description: There are a variety of different small business organizations involved in prognostics and health management technology and solu
tions, and their applications include use cases in both the commercial and government/defense sector. Challenges and successes from small business organizations in this field will be highlighted, including how they engage and collaborate with larger organizations on PHM related projects, whether they focus on a service product or type of business model, most current approaches for engaging and partnering their business. Aspects related to which funding approaches they consider, such as SBIR/government grants, venture capital / investment, among other considerations. Ways forwards on how the PHM Society can engage and involve more small business organizations. Include more topics at the conference will also be considered.
Panelists:
Eric Boecherer (GPMS Inc.)
Sudipto Ghosh (Qualtech Systems Inc.)
Logen Johnson (Analatom)
Manny Nwadiogbu (Small Asset Monitoring & Management Systems)
Panel Session 12: Standards for the Digital Stage
Thursday, 3:15 – 4:45, Location: Arizona I
Session Chair: Jeff Bird (TECnoS) and Brian Weiss (NIST)
Description: Every industry associated with the discipline of PHM is un
dergoing a digital transformation. This is especially so with the auto
mobile sector, but other, more traditional disciplines are not far behind. Most standard-setting organization have taken cognizance of this shift and provided PHM documents outlining their approach to digital and all the new technology. In the mobility sector, the SAE Interna
tional is forming a number of technical committees to deal with digi
tal transformation and to develop standards to related different aspects of the phenomenon. Digital communications and interoperability, Block
chain, Model-based design and testing, Artificial Intelligence in safety critical systems, etc., are some of the topics being considered. Other organizations involved with standards setting in this area are also develop
ing standards in this area. This panel will bring together industry experts to discuss the latest progress in these fields.
Panelists:
Steve Holland (General Motors (retired))
Loren Johnson (SAE International)
Logen Johnson (Analatom)
Brian Weiss (NIST)
Kevin Sullivan brings more than 23 years’ experience in the Arizona Commerce Authority. He has spent his career leading and growing high-performance sales teams primarily within the high-technology industry. His experiences with both startup (DirectTV, Accrue Software) and large, established global companies in Silicon Valley (SGI, Aspect Communications & Adobe) has provided a wealth of knowledge, which he utilizes to lead the ACA’s business attraction efforts.

Mr. Sullivan is a results-driven executive with solid operations management and sales experience in both startup and large, established global companies. He has extensive experience in the areas of data analytics, data management, and machine learning technologies in high-technology industry. His experience with both startup (DirecTV, Accrue Software) and large, established global companies in Silicon Valley (SGI, Aspect Communications & Adobe) has provided a wealth of knowledge, which he utilizes to lead the ACA’s business attraction efforts.

Mr. Sullivan holds a Bachelor of Science degree in Business Administration from Saint Mary’s College and a Juris Doctor from Washburn University.

Luminary Speaker: PHM in Sports: Finding Balance Between Curiosity & Practicality

Location: Grand Coronado I – III

Speaker: Sergio Santamaria

Sergio Santamaria enjoys music and travel and resides in Phoenix, Arizona.

Abstract: Prognostics & Health Management, as a field of study, holds an extremely direct and relevant application to the world of sports and, specifically, sports analytics. In professional sports—especially the NBA—the phrase ‘load management’ has become nearly synonymous to being able to manage the daily and weekly, and eventually the annual, training load effectively in order to achieve the goals of the entire team. The definition of load management varies significantly from one team to the other and is a process that a team must implement, if possible, in order to achieve their overarching goals. The focus must be on the preventive management of injuries and maximizing athlete performance, as well as being able to achieve both. In an effort to create a productive and healthy environment for athletes, the NBA has been experimenting and using PHM research, while exploring the balance between curiosity and practicality in various research domains.

Speaker: Keynote Speaker: Josh Melin

Keynote Speaker: Advancements in Asset Health Monitoring Using AI

Wednesday, 12:15 – 1:30

Location: Grand Coronado I – III

Speaker: Josh Melin

Josh Melin has been with Honeywell for over 20 years in positions of increasing responsibility in Engineering, Project Management, Lean, Site Operations Leadership, and Product Line Leadership. Josh holds a Bachelor’s of Science Degree in Mechanical Engineering from the Pennsylvania State University and a Master’s of Business Administration from Arizona State University.

Abstract: How Bio Fuels and Other Renewable Energy

Keynote Speaker: How Bio Fuels and Other Renewable Energy

Location: Grand Coronado I – III

Speaker: Sergio Santamaria

Sergio Santamaria enjoys music and travel and resides in Phoenix, Arizona.

Abstract: Renewable energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports. If used wisely, renewable energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports. If used wisely, renewable energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports.

Abstract: In this new epoch will be largely determined by the choices we as nations, corporations, and individuals make. How we use energy is one determinant of this trajectory. To the extent that we use energy wisely and efficiently, our energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports.

Abstract: How Bio Fuels and Other Renewable Energy

Location: Grand Coronado I – III

Speaker: Sergio Santamaria

Sergio Santamaria enjoys music and travel and resides in Phoenix, Arizona.

Abstract: Renewable energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports. If used wisely, renewable energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports. If used wisely, renewable energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports. If used wisely, renewable energy resources have the potential to mitigate the worst effects of climate change, eliminate dependence on imported oil, and reduce the costs of fuel imports.
The PHM Society introduces an exciting new type of opportunity for 2019. It is called the Product Showcase, where presenters may take advantage of a unique platform to advertise company products and services in a focused environment. The intent is to generate audience interest for follow-up.

The Product showcases will be comprised of a series of 10-min marketing presentations. The communication will be one-way, where all the attendees/listeners are reserved for online viewing. Attendees will enjoy this approach as companies strive to make significant first impressions during a condensed window of time.

Product Showcase
Wednesday, 9:00 – 10:30
Location: Grand Concourse I – III

9:00 – 9:05 Introduction and Ground Rules

9:05 – 9:15 PTC Thingworx – The Industrial IoT Platform for PHM – Ian Bolton (PTC)

9:15 – 9:25 The Digital Shift in Bogie Service – Justinian Rosca (Siemens)

9:25 – 9:35 Comprehensive Fault Management – the TEAMS way – Sudpto Ghoshal (QSI)

9:35 – 9:45 A Rigorous Approach for Robust System Design and a Digital Data Marketplace for Data They Produce – Ben Towne (SAE Industry Technologies Consortia)

9:45 – 9:55 Oil Debris Monitoring – Advanced Techniques for Equipment Health Management – Stefania Danavirt (Istaspos)


Closing Remarks
10:25 – 10:30

Conference Chairs: Jim Laskin, Hafiz deselect, Laura P способ, (spatial Microsystems) and Derek Davies (NGC)

Sincere Thanks to All Review Managers and Reviewers
Andrew Hess – President (The Hess PHM Group)
Konica Waithall – Vice-president (Collins Aerospace)
Karl Reichard – Treasurer (Pennsylvania State University)
Peter Sardamn – Secretary (University of Maryland)
Jeff Bird (TECOS, CA)
Scott Clements (Lockheed Martin Corp.)
Derek DeVaney (Northrop Grumman)
Neil Eklund (Avialent)
David Engel (Aviation Control Solutions)
Wolfgang Fink (University of Arizona)
Kai Goebl (PHRC)
David He (University of Illinois – Chicago)
J. Wesley Hines (University of Tennessee – Knoxville)
Steve Holland (General Motors (retired))
Ian Janninsen (Cranfield University, UK)
Greg Kacprzynski (Lockheed Martin Corp.)

Dave Larsen (Collins Aerospace)
Jay Lee (University of Cincinnati)
John Madisen (Northrop Grumman)
Sankaran Mahadevan (Vanderbilt University)
Raj Rajamani (IBM Consulting)
Albinus Saxena (General Electric)
Ginger Shao (Honeywell)
Joseph Thoro (ARAMCO)
Santali Toke (Telair)
George Vachtsevanos (Georgia Tech)

Honeywell is a Fortune 100 technology company that delivers industry-specific solutions that include aerospace products and services; control technologies for buildings and industry; and performance management global solutions. Our technologies help everything from aircraft, hospital systems, commanding plants, supply chains, and workers become more connected to make our world smarter, safer, and more sustainable.

In 1999 sparked the growth of the PC gaming market, redefined modern computer graphics, and revolutionized parallel computing. More recently, GPU deep learning ignited modern AI—the next era of computing.—GPU-accelerated computing speed results in human assistance, cybersecurity, platform sustainment, autonomous systems, robotics, healthcare and more.

PHM Society Board of Directors

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Lockheed Martin solves the world's toughest technology challenges. More than 70 nations rely on Lockheed Martin employees, products and technologies to help them protect and connect their citizens and advance scientific discovery. In a time of growing unpredictability and ever-changing threats, innovation and performance are at the center of everything we do.

Northrop Grumman is a proud corporate sponsor of the PHM Society. Northrop Grumman is a leading global security company providing innovative systems, products and solutions in aerospace, electronics, information systems, and technical services to government and commercial customers worldwide. Please visit www.northropgrumman.com for more information.

PHM Society Bronze Corporate Contributor

SAE Industry Technologies Consortia (SAE ITC) is a trade association affiliate of SAE International ideally suited to help the Mobility Community implement the solutions and best practices captured in its comprehensive standards and technical documents. Together, SAE International and SAE ITC are helping unlock the potential of Integrated Vehicle Health Management (IVHM) and the economic advantages it offers through groundbreaking standards, databases and training resources.

PHM2019 Conference Sponsors

Collins Aerospace, a unit of United Technologies Corporation, is a leader in technologically advanced and intelligent solutions for the global aerospace and defense industry. Created in 2018 by bringing together UTC Aerospace Systems and Rockwell Collins, Collins Aerospace has the capabilities, comprehensive portfolio and expertise to solve customers’ toughest challenges and to meet the demands of a rapidly evolving global market.

GE Aviation is a world-leading provider of commercial, military and general aviation jet and turboprop engines and components as well as avionics, electrical power and mechanical systems for aircraft. As a key technology company, GE Aviation continues to design, manufacture and maintain engines, components and integrated systems for military, commercial and general aviation aircraft as well as aero-derivative gas turbines for marine applications. GE Aviation is becoming a digital industrial business with its ability to harness large streams of data that are providing incredible insight into engine operation, real-time data collection and machine learning. GE Aviation is a world leader in integrated engine maintenance resource—holding a portfolio of PHM solutions including Predictive Maintenance, Asset Performance Management, Flight Risk Management through big data, AI, and analytics.

For 155 years, the Siemens name has been synonymous with cutting-edge technologies and continuous growth in profitability. With our wide array of products, systems and services, we are world leaders in information and communications, automation and control, power, medical solutions, transportation and lighting. Sustainable success is our number one priority. Our activities focus on meeting the needs of our customers and creating value for our shareholders and employees. Our innovation, invested in our own laboratories and in collaboration with customers, business partners and universities—are our greatest strength. Siemens’ global network of innovation is developing new products and services for a world that—while limited in resources—is boundless in possibilities.

PHM Conference 2019 Platinum Sponsors (continued)

MathWorks is the leading developer of mathematical computing software. Engineers and scientists worldwide rely on its products to accelerate the pace of discovery, innovation, and development. MATLAB and Simulink are used throughout the automotive, aerospace, communications, electronics, and industrial automation industries as fundamental tools for research and development. For more information visit www.mathworks.com.

In 1999 sparked the growth of the PC gaming market, redefined modern computer graphics, and revolutionized parallel computing. More recently, GPU deep learning ignited modern AI—the next era of computing.—GPU-accelerated computing speed results in human assistance, cybersecurity, platform sustainment, autonomous systems, robotics, healthcare and more.

PHM Conference 2019 Gold Sponsors

THINK is a solution provider dedicated to designing, implementing, testing, validating, and maintaining applications that employ model-based reasoning and machine intelligence technologies for the purposes of delivering improved situational awareness, predictive control, and knowledge-based decision support. More specifically, the THINK Engineering team has over 30 years of domain experience applying these technologies to Autonomous Operations, Cybersecurity, and Integrated Vehicle Health Management (IVHM) solutions using state of the art expert systems and model-based reasoning platforms. THINK is actively working on autonomous operations projects on behalf of DoD and NASA.

Gastop is a leading manufacturer of advanced equipment for the global aerospace market. To ensure that you have real-time awareness of the condition of your equipment. With 40 years of experience, we have developed fleet maintenance and monitoring programs which transform maintenance from the traditional scheduled or reactive maintenance, to a proactive condition-based approach.

Global Technology Correlations, Inc. has developed next-generation diagnostic/prognostic predictive tools for the maintenance of critical components on aircraft and machinery. These innovative CBM+ solutions can substantially reduce the maintenance cost, increase up-time and improve safety in a variety of high-value assets such as Batteries, Generators, Motors, Pumps, Jet-engines and Turbo-machinery, etc.

GPMS offers a next-generation Health and Usage Monitoring System for rotorcraft. Their flagship FaultSense™ product combines advanced hardware and cloud-based software to provide remote monitoring and predictive maintenance capability. GPMS gives operators the power to know about it before it breaks, fix it before it matters.

QSI provides technology for equipment health diagnosis, prognosis and fault management design. QSI's TeamAIP™ solution identifies failing or failed components, enables dispatchers to avoid critical situations, and delivers optimal, context-aware troubleshooting instructions. QSI clients have achieved a threefold reduction in unscheduled downtime and diagnostics part usage.

Since 1916, SAE has worked hand-in-hand with the aerospace community to find solutions and advance technology and certification such as the globally adopted AS, AMS, ARP and ARJ technical documents - becoming the world's largest, most respected aerospace standards development organization. SAE makes groundbreaking contributions to efforts in PHM and Integrated Vehicle Health Management standardization and has developed a collection of resources to further the technology development and adoption of these landmark concepts.

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