PHM 2018

10th Annual Conference of the Prognostics and Health Management Society

Philadelphia, PA

September 24 – 27, 2018

www.phmconference.org

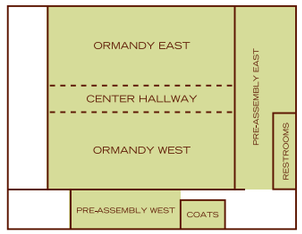
10th Anniversary

phmsociety

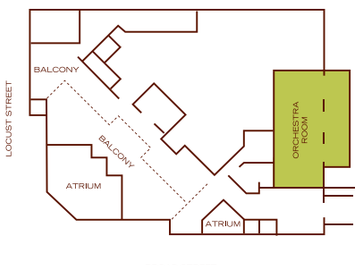
2009 – 2018

www.phmsociety.org

DoubleTree by Hilton



LOBBY LEVEL



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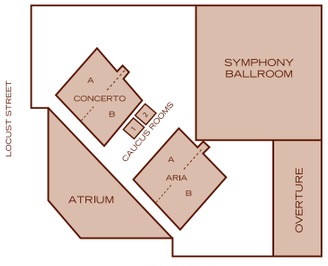
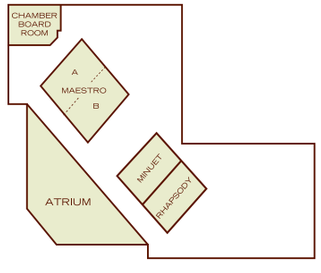
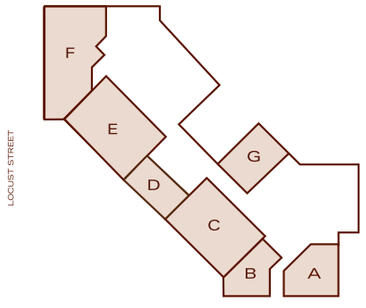


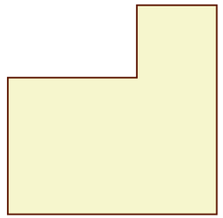
THIRD FLOOR



FOURTH FLOOR



FIFTH FLOOR
ASSEMBLY ON FIVE



FIFTH FLOOR
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Welcome to Philadelphia!

Welcome to historic Philadelphia for the 2018 Annual Conference of the Prognostics and Health Management (PHM) Society. This year features not only an exciting program, but also marks our 10-year anniversary. After holding the past two conferences under the open skies of Denver and around the beauty of St. Petersburg, we are bringing the 10th anniversary PHM Conference to the home of the recently-minted Superbowl™ Champions, Philadelphia Eagles. Although we are not in the business of predicting who will win the next Big Game, we are confident to predict this year's PHM Conference will be the society's most successful event by offering our most diverse, thought-provoking, and beneficial week of activities.

Philadelphia is known for many things. It is a passionate sports town and is well-known as the home to the Flyers (hockey), Sixers (basketball), and Phillies (baseball) in addition to the high-flying Eagles (football). Besides being the second-largest city on the East Coast, Philadelphia is also one of the most historical cities in the United States. It is home to Independence Hall (where the Declaration of Independence and the U.S. Constitution were both signed), the Liberty Bell (rang on July 8th, 1776 from the tower of Independence Hall to alert the citizens of Philadelphia of the first public reading of the Declaration of Independence), and the Betsy Ross House (where Betsy Ross lived when she made the first American flag). Our conference venue is just a short distance away from these landmarks.

The DoubleTree by Hilton Hotel Philadelphia Center City is nestled in the heart of the city a few blocks South of Philadelphia's City Hall on South Broad Street. In addition to the historical sites mentioned above, a healthy walk or a quick cab ride can get you to many other compelling city attractions. Due East of the DoubleTree will take you to Independence Mall, the Museum of the American Revolution, the National Museum of American Jewish History, Franklin Square, and the Korean War Memorial Park. Heading North will lead you to the Reading Terminal Market (where you can get signature Philadelphia Cheesesteaks), Love Park, the Masonic Temple, and the Pennsylvania Academy of Fine Arts. The West side of town features the Franklin Institute, the Academy of Natural Sciences, and the Philadelphia Museum of Art (home to the Rocky Statue and the famous steps Sylvester Stallone ran as he played Rocky Balboa). Moving South puts you at the doorstep of Pat's and Geno's (two restaurants world-renowned for their cheesesteaks), Lincoln Financial Field (home of the Eagles) and Citizens Bank Park (home of the Phillies who will be playing out of town the week of our conference). If you prefer a shorter walk, several dozen restaurants, cafes, and pubs are situated within a four-block radius from the hotel.

The program for the PHM 2018 Conference is rich with technical content and the events offer many opportunities to make and renew professional connections across the national and international PHM community. Please enjoy this program, but also be sure to step outside the conference venue and soak up the sights and sounds of Philadelphia; a city rich in history and diversity. We hope you have an enjoyable and productive week with us in Philadelphia!

Brian A. Weiss and Greg Kacprzynski

2018 Conference Co-Chairs

The Conference

The Prognostics and Health Management Society (PHM Society) welcomes you to its 10th annual international conference. As the Society's annual premier event, the 2018 PHM Conference brings together the global community of PHM experts from industry, academia, and government in diverse application areas such as smart manufacturing, unmanned systems, wind energy, oil and gas, aerospace, transportation, automotive, and industrial automation. The conference features keynote presentations, invited panel sessions, technology demonstrations, a product showcase, a data challenge, a doctoral symposium, tutorials free to all registrants, a dedicated poster session during planned social hours, a Job Fair, a half-day Industrial Artificial Intelligence for PHM workshop and two, two-day intensive short courses (PHM Fundamentals and PHM Data Analytics) in conjunction with the conference. Several social events will provide opportunities for participants to connect with colleagues.

phmconference.org

What Sets This Conference Apart from Other Events

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.

Lastly, the conference has taken pride in building up its industry-focused panel sessions these past few years. Most conferences do an outstanding job highlighting cutting-edge technical research, yet fail to offer a healthy amount of contributions from industry leaders who can't 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 organization.

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—join or update your profile today!

Saturday, September 22, 2018			
Location / Time	PHM Fundamentals Short Course Assembly F	PHM Data Analytics Short Course Assembly E	Location / Time
8AM – 5PM	Registration		8AM – 5PM
8:00 – 12:00	**PHM Fundamentals Short Course Day 1** *Separate Registration Required*	**PHM Data Analytics Short Course Day 1** *Separate Registration Required*	8:00 – 12:00
12:00 – 1:00	Lunch	Location: Maestro	12:00 – 1:00
1:00 – 5:15	**PHM Fundamentals Short Course Day 1** *Separate Registration Required*	**PHM Data Analytics Short Course Day 1** *Separate Registration Required*	1:00 – 5:15

Optional PHM Fundamentals Short Course Details and Agenda

September 22 – 23, Room: Assembly F
Separate Registration Required
Course Leaders: Dr. George Vachtsevanos (Georgia Tech) and Dr. Karl Reichard (Pennsylvania State University)
Course Administrator: Jeff Bird (TECnos)

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
4. Examine case studies of PHM applications across diverse domains to identify solutions and impacts
5. Plan a PHM application in two mini workshop settings with expert group leaders

Topics Include:

- Introduction to PHM (Taxonomy, scope, basics, standards- for all talks
- Deriving Requirements for PHM (Basics and illustrative examples)
- PHM Performance Metrics (Basics and illustrative examples)
- Diagnostics Methods (Basics and illustrative examples)
- *Case Study for requirements/metrics (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 and Data Processing (Available/Required data and organization)
- *Analysis mini workshop (Small group data design activity with worksheets)*
- CBM+ and IVHM 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 22, 2018

8:00 – 10:30	Session 1: **Welcome and Introductions** **Introduction to PHM** **Deriving Requirements for PHM** **PHM Performance Metrics**
10:30 – 10:45	Break
10:45 – 12:00	Session 2: **Diagnostics Methods** **Diagnostics Case Studies**
12:00 – 1:00	Lunch (provided)
1:00 – 3:15	Session 3: **Prognostics** **Data Analytics Methods** **Prognostics Case Studies**
3:15 – 3:30	Break
3:30 – 5:15	Session 4: **Sensors and Data Processing** **Analysis Mini–Workshop** **Summary of Workshop Results**
5:15 – 7:30	Free Time
7:30 – ?	Non-hosted dinner with all participants

Sunday, September 23, 2018

8:30 – 10:30	Session 5: **CBM+ and IVHM Technologies** **PHM Management Cost Benefit Analysis** **Plenary—Issues and Needs**
10:30 – 10:45	Break
10:45 – 12:30	Session 6: **Reliability and Life Cycle Management** **Fielded Systems Case Studies – 1**
12:30 – 1:30	Lunch (provided)
1:30 – 3:20	Session 7: **Fielded Systems Case Studies – 2** **Case Study Mini–Workshop Introduction** **Case Study Mini–Workshop**
3:20 – 3:40	Break
3:40 – 4:15	Session 8: **Way Forward** **Wrap up with Evaluation Forms**

Sunday, September 23, 2018			
Location / Time	PHM Fundamentals Short Course Assembly F	PHM Data Analytics Short Course Assembly E	Location / Time
8AM – 5PM	Registration		8AM – 5PM
8:00 – 12:00	**PHM Fundamentals Short Course Day 2** *Separate Registration Required*	**PHM Data Analytics Short Course Day 2** *Separate Registration Required*	8:00 – 12:00
12:00 – 1:00	Lunch	Location: Maestro	12:00 – 1:00
1:00 – 5:15	**PHM Fundamentals Short Course Day 2** *Separate Registration Required*	**PHM Data Analytics Short Course Day 2** *Separate Registration Required*	1:00 – 5:15

Optional PHM Data Analytics Short Course Details and Agenda

September 22 – 23, Room: Assembly E
Separate Registration Required
Course Leader: Dr. Neil Eklund (Analatom)
Course Administrator: Jeff Bird (TECnos)

This course is intended for engineers, scientists, and managers who are interested in data driven methods for asset health 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 anomalous 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 ex expected to bring a laptop with analytics software (R, Python, Matlab, or something similar) that they are familiar with pre-installed. Lab example solutions will be presented in Python.

Topics Include:

- Overview of data-driven PHM
- Review of Fundamental statistics
- Data Visualization
- Machine learning - introduction and concepts
- Data transformation & feature extraction
- Classification
- Regression
- Introduction to Neural Networks
- *Hands-on Lab*
- Feature selection
- Characterizing performance
- Model Selection
- Anomaly detection
- Deep Learning I
- Deep Learning II
- Applications
- Practical matters
- *Hands-on Lab*

Saturday, September 22, 2018

8:00 – 10:30	Session 1: **Welcome and Introductions** **Overview of Data-driven PHM** **Review of Basic Statistics** **Exploratory Data Analysis**
10:30 – 10:45	Break
10:45 – 12:00	Session 2: **Machine Learning—Introduction and Concepts** **Data Transformation and Feature Extraction** **Classification**
12:00 – 1:00	Lunch (provided)
1:00 – 3:15	Session 3: **Regression**
3:15 – 3:30	Break
3:30 – 5:15	Session 4: **Hands-on Lab**
5:15 – 7:30	Free Time
7:30 – ?	Non-hosted dinner with all participants

Sunday, September 23, 2018

8:30 – 10:30	Session 5: **Feature Selection** **Characterizing Performance**
10:30 – 10:45	Break
10:45 – 12:30	Session 6: **Model Selection** **Anomaly Detection**
12:30 – 1:30	Lunch (provided)
1:30 – 3:20	Session 7: **Applications** **Practical Matters**
3:20 – 3:40	Break
3:40 – 5:15	Session 8: **Hands-on Lab** **Wrap up with Evaluation Forms**

Monday, September 24, 2018			
Location / Time	Industrial AI for PHM Workshop	Doctoral Symposium	Location / Time
	Aria A&B	Assembly F	
7AM – 5PM	Registration		7AM – 5PM
8:00 – 1:00	*Free Time*	Doctoral Symposium Breakfast	8:00 – 9:15
		Doctoral Symposium	9:15 – 10:30
		Break	10:30 – 11:00
		Doctoral Symposium	11:00 – 12:30
		Doctoral Symposium Lunch	12:30 – 1:30
1:00 – 5:00	**Industrial AI for PHM Workshop**	**Doctoral Symposium**	1:30 – 2:30
		Break	2:30 – 3:00
		Doctoral Symposium	3:00 – 5:00
5:00 – 5:30	*Free Time*	*Free Time*	5:00 – 5:30
5:30 – 7:30	**Opening Welcome Reception with Cocktails**	**Location: The Terrace**	5:30 – 7:30

Industrial Artificial Intelligence for PHM Workshop

September 24, Room: Aria A&B

Presenters: Dr. Jay Lee (University of Cincinnati), Dr. Jaskaran Singh (University of Cincinnati), and Dr. Hossein Davari (University of Cincinnati)

Industrial AI is a systematic discipline which focuses on developing, validating and deploying various machine learning algorithms for industrial applications with sustainable performance. Combined with the state-of-the-art sensing, communication and big data analytics platforms, a systematic Industrial AI methodology will allow integration of physical systems with computational models. The concept of Industrial AI is in infancy stage and may encompass the collective use of technologies such as Internet of Things, Cyber-Physical Systems and Big Data Analytics under the Industry 4.0 initiative where embedded computing devices, smart objects and the physical environment interact with each other to reach intended goals. Advanced industries such as automotive, aerospace, health care, semiconductors, and industrial manufacturing could harness the power of Industrial AI to gain insight into the health condition and consistency of their machines and processes and use that insight to maximize their uptime, productivity and efficiency of their operations. In terms of predictive maintenance, Industrial AI can detect incipient changes in the system and determine the expected time to system failure; allowing them to optimize maintenance tasks in real time, maximizing the useful life of their equipment while still avoiding disruption to operations.

The workshop will introduce the advances in Industrial AI enabling technologies such as Big Data Analytics, Internet of Things, Cyber-Physical Systems under the Industry 4.0 architecture. The workshop will introduce system tools of Industrial AI such as Data Technology, Analytic Technology, Platform Technology and Operation technology that can facilitate the realization of a fully functional smart industry. The workshop would cover the state of the art AI computation technologies and methodologies in Industrial applications such as Deep learning, SVM, SOM etc. In addition, industrial case studies will be provided to demonstrate the implementation of such technologies. The workshop 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.

Topics:

1. Introduction to Industrial AI
2. AI Foundry within the 5C CPS Architecture
3. System tools of Industrial AI
4. Overview of the state of the art AI technologies
5. AI-based PHM Technologies demonstrated via actual industrial case studies
6. Challenges in implementation of AI in Industries
7. Conclusions

Panelists:

Matt Denesuk *(Noodle Analytics)*
Andrew Hess *(The Hess PHM Group)*
David Siegel *(Predictronics Corporation)*
Brian A. Weiss *(National Institute of Standards and Technology)*

This workshop will be led by Dr. Jay Lee, Dr. Hossein Davari, and Dr. Jaskaran Singh. Each has outstanding qualifications in the fields of Industrial AI, PHM, Big Data Analytics, Internet of Things, and Cyber-Physical Systems.

Want to be a part of next year's PHMAP2019 Conference (in Beijing, China) or PHM2019 Conference (in Scottsdale, Arizona)? See page 20 for details!

Doctoral Symposium

Monday, 8:00 – 5:00, Room: Assembly F

Symposium Chair: Jamie Coble (University 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 collegial setting. The PHM Society Doctoral Symposium will be held as a workshop on the first day of the conference. The panelists for the DS are:

Ian Jennions *(Cranfield University)*
Sarah Lukens *(GE Digital)*
Felipe Parages *(Uptake)*
Michael Sharp *(NIST)*
Douglas Van Bossuyt *(Naval Postgraduate School)*

Social Program

Sponsor Exhibits
Throughout Conference

Opening Welcome Reception
Monday, 5:30 – 7:30, Location: The Terrace

Diversity Outreach & Networking Event
Tuesday, 5:00 – 6:00, Location: Overture

Cocktail Reception with Posters
Tuesday, 6:00 – 7:30, Location: Symphony Ballroom

Student Social Dinner
Tuesday, 8:00 – 10:00, Location: Tattooed Mom

Network with the PHM community students while experiencing the classic Philly cheesesteak or other vegetarian/vegan options. Tattooed Mom offers food, drinks, and art with a local Philly flavor. It is a short walk from the hotel down the famous South Street.

PHM Conference 10th Anniversary Banquet
Wednesday, 6:00 – 10:00, Location: National Constitution Center (for guest tickets, please see Registration Desk)

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 **PHM2018** event and, if prompted, use passcode **phmsociety**.

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SEAGATE

Doctoral Symposium Agenda

Monday, September 24, 2018

8:00 – 9:15	Breakfast (provided for panelists and students)
9:15 – 9:30	Doctoral Symposium Welcome
9:30 – 10:00	Presentation #1 (10 min)
	An Integrated Reasoning Framework for Vehicle Level Diagnosis of Aircraft Subsystem Faults – Cordelia Ezhilarasu *(Cranfield University)*
	Panelist Feedback / Audience Q&A
10:00 – 10:30	Presentation #2 (10 min)
	Deep Learning Based Defects Diagnosis for Automated Fiber Placement Machine – Guangxing Niu *(University of South Carolina)*
	Panelist Feedback / Audience Q&A
10:30 – 11:00	Break
11:00 – 11:30	Presentation #3 (10 min)
	Electronic Circuit PHM with No Data – Varun Khemani *(University of Maryland)*
	Panelist Feedback / Audience Q&A
11:30 – 12:00	Presentation #4 (10 min)
	Efficient control and Fault Detection and Isolation in Building HVAC systems – Avisek Naug *(University of Maryland)*
	Panelist Feedback / Audience Q&A
12:00 – 12:30	Presentation #5 (10 min)
	Developing a Knowledge Management System for Integrated Vehicle Health Management Using a Data Life Cycle Model – Alexslis Maindze *(Cranfield University)*
	Panelist Feedback / Audience Q&A
12:30 – 1:30	Lunch (provided for panelists and students)
1:30 – 2:00	Presentation #6 (10 min)
	Health Management and Prognostics of Complex Structures and Systems – Guoyi Li *(Arizona State University)*
	Panelist Feedback / Audience Q&A
2:00 – 2:30	Presentation #7 (10 min)
	Aging Models and Lifetime Prediction of Thermally Aged Industrial Cable Insulation Polymers – Aishwarya Sriraman *(Iowa State University)*
	Panelist Feedback / Audience Q&A
2:30 – 3:00	Break
3:00 – 3:30	Presentation #8 (10 min)
	Failure and Remaining Useful Life Prediction of Wind Turbine Gearboxes – Sofia Koukoura *(University of Strathclyde)*
	Panelist Feedback / Audience Q&A
3:30 – 4:00	Presentation #9 (10 min)
	Operation-Aware Health Management for Environmental Control and Life Support System – Shijie Tang *(University of South Carolina)*
	Panelist Feedback / Audience Q&A
4:00 – 4:30	Presentation #10 (10 min)
	Robust Estimation of Connected Automated Vehicles While Performing Cooperative Tasks in Presence of Malicious Agents – Roberto Merco *(Clemson University)*
	Panelist Feedback / Audience Q&A
4:30 – 4:45	Panelists Final Thoughts
4:45 – 5:00	Feedback from Students & Audience

Tuesday, September 25, 2018					Tuesday, September 25, 2018			
Location / Time	Technical Paper Sessions	Technical Paper & Tutorial Sessions	Career Fair		Panel Sessions	Technology Demos & Product Showcases		Location / Time
	Concerto A&B	Maestro A&B	Assembly E		Aria A&B	Minuet	Rhapsody	
7:15AM – 5PM	Registration		Location: Pre-Assembly West		Registration		Location: Pre-Assembly East	7:15AM – 5PM
7:15 – 8:00	Continental Breakfast		Location: Pre-Assembly East		Continental Breakfast		Location: Pre-Assembly East	7:15 – 8:00
8:00 – 8:50	Opening Remarks **Keynote Speaker: Tom Hedberg (*NIST*)** **"Using the Digital Thread to Integrate PHM in a Model-Based Enterprise (MBE)"**		Location: Ormandy Ballroom		Opening Remarks **Keynote Speaker: Tom Hedberg (*NIST*)** **"Using the Digital Thread to Integrate PHM in a Model-Based Enterprise (MBE)"**		Location: Ormandy Ballroom	8:00 – 8:50
8:50 – 9:00	Break		Location: Pre-Assembly East		Break		Location: Pre-Assembly East	8:50 – 9:00
9:00 – 10:30	Paper Session 1A: **Diagnostics I**	Paper Session 1B: **Documentation for PHM**	Career Fair: General Session 1 **3M • FoxConn • Lockheed Martin • Seagate • NOV** (see page 12 for details)		Panel Session 1: **Automotive PHM Emerges** Steve Holland (*General Motors*)	Tech Demo: Sporian **Sensor Suites for Aircraft Electrical Systems**	*Reserved*	9:00 – 10:30
10:30 – 10:45	Break		Location: Pre-Assembly East		Break		Location: Pre-Assembly East	10:30 – 10:45
10:45 – 12:15	Paper Session 2A: **Prognostics I**	Paper Session 2B: **Reliability and Asset Management**	Career Fair Follow-up Discussions 1 **3M • FoxConn**		Panel Session 2: **Manufacturing** Radu Pavel (*TechSolve*)	*Reserved*	Tech Demo: MathWorks **RUL Estimation using MATLAB and Simulink**	10:45 – 12:15
12:15 – 1:30	Conference Lunch **Keynote Speaker: Greg Birdsall (*Lockheed Martin*)** **"Product Support at the Skunk Works®: 75 years of Sustaining Innovation"**		Location: Ormandy Ballroom		Conference Lunch **Keynote Speaker: Greg Birdsall (*Lockheed Martin*)** **"Product Support at the Skunk Works®: 75 years of Sustaining Innovation"**		Location: Ormandy Ballroom	12:15 – 1:30
1:30 – 3:00	Paper Session 3A: **Prognostics II**	Tutorial Session 1: **Anomaly Detection** Neil Eklund (*Analatom*)	Career Fair Follow-up Discussions 2 **Lockheed Martin • NOV**		Panel Session 3: **PHM Applications Deployment** Tomasz Pancewicz (*GE Aviation*)	Tech Demo: SAE ITC **Using the SAE Mobilus Platform to Find PHM Related Standards**	*Reserved*	1:30 – 3:00
3:00 – 3:30	Break		Location: Pre-Assembly East		Break		Location: Pre-Assembly East	3:00 – 3:30
3:30 – 5:00	Paper Session 4A: **Prognostics III**	Tutorial Session 2: **Systems Engineering for PHM** Ravi Rajamani (*drR² consulting*)	Career Fair Follow-up Discussions 3 **Seagate**		Panel Session 4: **PHM for Human Health and Performance** Wolfgang Fink (*University of Arizona*)	*Reserved*	Tech Demo: D2K **Leveraging Expert Systems for Creating Re-usable Online PHM Reasoning Architectures**	3:30 – 5:00
5:00 – 6:00	Diversity Outreach & Networking Event		Location: Overture		Diversity Outreach & Networking Event		Location: Overture	5:00 – 6:00
6:00 – 7:30	Cocktail Reception with Posters		Location: Symphony Ballroom		Cocktail Reception with Posters		Location: Symphony Ballroom	6:00 – 7:30
8:00 – 10:00	Student Social Dinner		Location: Meet in the Hotel Lobby		Student Social Dinner		Location: Meet in the Hotel Lobby	8:00 – 10:00

Paper Session 1A: Diagnostics I
Tuesday, 9:00 – 10:30, Room: Concerto A&B
Session Chair: Gabriel Michau (Zurich University of Applied Sciences)

Fault Isolation of an Electro-mechanical Linear Actuator – Matt Kemp[1], Eric J. Martin[2] ([1,2]*Monterey Bay Aquarium Research Institute*)

Model-based Fault Diagnostics of Servo Valves – Turki Haj Mohamad[1], Foad Nazari[2], Chandrasekhar Nataraj[3] ([1,2,3]*Villanova University*)

Development and Field Evaluation of Data-driven Whole Building Fault Detection and Diagnosis Strategy – Yimin Chen[1], Jin Wen[2] ([1,2]*Drexel University*)

Automated Hyper-parameter Tuning for Machine Learning Models in Machine Health Prognostics – Wang-Chi Cheung[1], Weiwen Zhang[2], Yong Liu[3], Feng Yang[4], Rick-Siow-Mong Goh[5] ([1,2,3,4,5]*Institute of High Performance Computing*)

Paper Session 1B: Documentation for PHM
Tuesday, 9:00 – 10:30, Room: Maestro A&B
Session Chair: Brian Weiss (NIST)

Advanced Maintenance in Manufacturing: Costs and Benefits – Douglas S Thomas[1] ([1]*NIST*)

Benchmarking for Keyword Extraction Methodologies in Maintenance Work Orders – Thurston Sexton[1], Melinda Hodkiewicz[2], Michael P. Brundage[3], Thomas Smoker[4] ([1,3]*National Institute of Standards and Technology; [2,4]The University of Western Australia*)

An Extensible System for Optical Character Recognition of Maintenance Documents – John Anthony Labarga[1], Amardeep Singh[2], Vera Zaychik Moffitt[3] ([1,2,3]*Lockheed Martin*)

A Review of PHM Data Competitions from 2008 to 2017: Methodologies and Analytics – Xiaodong Jia[1], Bin Huang[2], Jianshe Feng[3], Haoshu Cai[4], Jay Lee[5] ([1,2,3,4,5]*University of Cincinnati*)

Paper Session 2A: Prognostics I
Tuesday, 10:45 – 12:15, Room: Concerto A&B
Session Chair: Kamal Medjaher (Tarbes National School of Engineering)

A Data Driven Health Monitoring Approach to Extending Small Sats Mission – Fangzhou Sun[1], Abhishek Dubey[2], Chetan S. Kulkarni[3], Nagbhushan Mahadevan[4], Ali Guarneros Luna[5] ([1,2,4]*Vanderbilt University; [3]SGT, Inc.; [3,5]NASA Ames*)

A Theoretically Rigorous Approach to Failure Prognosis – David Acuña[1], Marcos Orchard[2] ([1,2]*University of Chile*)

Just-in-time Point Prediction Using a Computationally-efficient Lebesgue-sampling-based Prognostic Method: Application to Battery End-of-discharge Prediction – Camilo Reyes[1], Francisco Jaramillo[2], Bin Zhang[3], Chetan Kulkarni[4], Marcos Orchard[5] ([1,2,5]*University of Chile; [3]University of South Carolina; [4]NASA Ames Research Center*)

A New Adaptive Prognostics Approach Based on Hybrid Feature Selection with Application to Point Machine Monitoring – Vepa Atamuradov[1], Kamal Medjaher[2], Pierre Dersin[3], Noureddine Zerhouni[4], Fatih Camci[5] ([1,2]*INP-ENIT; [3]ALSTOM; [4]FEMTO-ST Institute; [5]Advanced Micro Devices*)

Paper Session 2B: Reliability and Asset Management
Tuesday, 10:45 – 12:15, Room: Maestro A&B
Session Chair: Jason Kolodziej (Rochester Institute of Technology)

Data-driven Application of PHM to Asset Strategies – Sarah Lukens[1], Matt Markham[2] ([1,2]*GE Digital*)

Assessment of Overhaul Effectiveness and Usage-based Inference Using Bayesian Networks – Nenad G. Nenadic[1], Christopher J. Valant[2], Sean P. McConky[3], Michael G. Thurston[4] ([1,2,3,4]*Rochester Institute of Technology*)

Condition-based Maintenance Policy Optimization Using Genetic Algorithms and Gaussian Markov Improvement Algorithm – Michael Hoffman[1], Eunhye Song[2], Michael Brundage[3], Soundar Kumara[4] ([1,2,4]*Pennsylvania State University; [3]National Institute of Standards and Technology*)

Rotating Machinery Prognostics and Application of Machine Learning Algorithms: Use of Deep Learning with Similarity Index Measure for Health Status Prediction – Asheber Wagshum Techane[1], Yu-Fu Wang[2], Bereket Haile Weldegiorgis[3] ([1,2]*Precision Machinery Research and Development Center; [3]National Taiwan University of Science and Technology*)

Paper Session 3A: Prognostics II
Tuesday, 1:30 – 3:00, Room: Concerto A&B
Session Chair: Chetan Kulkarni (SGT Inc., NASA Ames Research Center)

Fault Diagnosis and Prognosis Based on Deep Belief Network and Particle Filtering – Guangxing Niu[1], Shije Tang[2], Zhichao Liu[3], Guangquan Zhao[4], Bin Zhang[5] ([1,2,3,4,5]*University of South Carolina; [4]Harbin Institute of Technology*)

A Hybrid Battery Model for Prognostics in Small-size Electric UAVs – Gina Katherine Sierra Paez[1], Marcos Orchard[2], Chetan Kulkarni[3], Kai Goebel[4] ([1,2]*University of Chile; [3]SGT Inc.; [3,4]NASA Ames Research Center*)

System-level Prognostics Based on Inoperability Input-output Model – Ferhat Tamssaouet[1], Thi Phuong Khanh Nguyen[2], Kamal Medjaher[3] ([1,2,3]*INP-ENIT*)

Feasibility Study of a PHM System for Electro-hydraulic Servo-actuators for Primary Flight Controls – Sylvain Autin[1], Jerome Socheleau[2], Andrea Dellacasa[3], Andrea De Martin[4], Giovanni Jacazio[5], George Vachtsevanos[6] ([1,2]*United Technologies Aerospace Systems; [3,4,5]Politecnico di Torino; [6]Georgia Institute of Technology*)

Paper Session 4A: Prognostics III
Tuesday, 3:30 – 5:00, Room: Concerto A&B
Session Chair: Karl Reichard (Pennsylvania State University)

Calculating Remaining Useful Life in an Embedded System – Eric Bechhoefer[1], Rune Schlanbusch[2] ([1]*GPMS; [2]Teknova AS*)

An Integrated Health Management System Approach: Application to Shipboard Rotating Machinery – Edward W. Mayfield[1], Guangxing Niu[2], Bin Zhang[3], Paul Ziehl[4], Michael Golda[5] ([1,2,3,4]*University of South Carolina; [5]Naval Surface Warfare Center*)

Sequential Monte Carlo: Enabling Real-time and High-fidelity Prognostics – Patrick E. Leser[1], Jacob D. Hochhalter[2], James E Warner[3], Geoffrey F. Bomarito[4], William P. Leser[5], Fuh-Gwo Yuan[6] ([1,2,3,4,5]*NASA Langley; [6]North Carolina State University*)

Rapid Uncertainty Propagation for High-Fidelity Prognostics Using SROMPy and Python – James E. Warner1, Patrick E. Leser2, Jacob D. Hochhalter3 ([1,2,3]*NASA Langley*)

Wednesday, September 26, 2018						Wednesday, September 26, 2018			
Location / Time	Technical Paper Sessions	Technical Paper Sessions	Special Invited Sessions	Career Fair		Panel Sessions	Technology Demos & Product Showcases		Location / Time
	Concerto A&B	Maestro A&B	Ormandy Ballroom	Assembly E		Aria A&B	Minuet	Rhapsody	
7:15AM – 5PM	Registration			Location: Pre-Assembly West		Registration		Location: Pre-Assembly West	7:15AM – 5PM
7:15 – 8:00	Continental Breakfast			Location: Pre-Assembly East		Continental Breakfast		Location: Pre-Assembly East	7:15 – 8:00
8:00 – 8:50	Opening Remarks **Keynote Speaker: Ed Cuoco (*ThingWorx*)** **"Teaching PHM to Speak Business"**			Location: Ormandy Ballroom		Opening Remarks **Keynote Speaker: Ed Cuoco (*ThingWorx*)** **"Teaching PHM to Speak Business"**		Location: Ormandy Ballroom	8:00 – 8:50
8:50 – 9:50	Invited Panel Session **Digital Transformation and the Digital Ecosystem Across the Enterprise—from Requirements to Retirement** Andy Hess (*The Hess PHM Group*) and John Madsen (*Northrop Grumman*)			Location: Ormandy Ballroom		Invited Panel Session **Digital Transformation and the Digital Ecosystem Across the Enterprise—from Requirements to Retirement** Andy Hess (*The Hess PHM Group*) and John Madsen (*Northrop Grumman*)		Location: Ormandy Ballroom	8:50 – 9:50
9:50 – 10:05	Break			Location: Pre-Assembly East		Break		Location: Pre-Assembly East	9:50 – 10:05
10:05 – 11:35	Paper Session 5A: **Physics-based Automotive PHM Applications**	Paper Session 5B: **PHM for Air Traffic Management I**	Invited Panel Session (cont'd): **Digital Transformation**	Career Fair: General Session 2 **FoxConn • Lockheed Martin • MachineMetrics • NOV** (see page 12 for details)		Panel Session 5: **Oil and Gas** Joseph Thorp (*Aramco*)	Tech Demo: Siemens **MindSphere: An Open Cloud-based IoT Operating System for Industry**	*Reserved*	10:05 – 11:35
11:35 – 1:45	Lunch on own – *Enjoy Philadelphia!*					Lunch on own – *Enjoy Philadelphia!*			11:35 – 1:45
1:45 – 3:15	Paper Session 6A: **Structural Health Monitoring**	Paper Session 6B: **PHM for Air Traffic Management II**	Invited Session: **Data Challenge Winners**	Career Fair Follow-up Discussions 4 **Machine Metrics**		Panel Session 6: **New Instrumentation Technologies for PHM** Ed Spence (*Machine Instrumentation*)	*Reserved*	Tech Demo: GM **GM Fuel Delivery System Diagnostics & Prognostics** **GM Vehicle Electrical System Diagnostics & Prognostics**	1:45 – 3:15
3:15 – 3:30	Break			Location: Pre-Assembly East		Break		Location: Pre-Assembly East	3:15 – 3:30
3:30 – 5:00	Paper Session 7A: **PHM Applications I**	Paper Session 7B: **Degradation Assessment**	Product Showcase (see page 18 for details)	Career Fair Follow-up Discussions 5 **3M • NOV**		Panel Session 7: **Unmanned Systems** Karl Reichard (*Pennsylvania State University*) and George Vachtsevanos (*Georgia Tech*)	*Reserved*	*Reserved*	3:30 – 5:00
5:00 – 6:00	Free Time					Free Time			5:00 – 6:00
6:00 – 10:00	10th Anniversary Banquet Buses begin loading at 5:30PM			Location: National Constitution Center		10th Anniversary Banquet Buses begin loading at 5:30PM		Location: National Constitution Center	6:00 – 10:00

Paper Session 5A: Physics-based Automotive PHM Applications
Wednesday, 10:05 – 11:35, Room: Concerto A&B
Session Chairs: Chaitanya Sankavaram (University of Connecticut) and Kamal Medjaher (Tarbes National School of Engineering)

A Nonlinear Analytical Redundancy Method for Sensor Fault Diagnosis in an Automotive Application – Huanyi Shui[1], Shiming Duan[2], Chaitanya Sankavaram[3], Jun Ni[4] ([1,4]*University of Michigan;* [2,3]*General Motors*)

Development of Robust Fault Signatures for Battery and Starter Failure Prognosis – Xinyu Du[1], Yilu Zhang[2] ([1,2]*General Motors Research & Development*)

Leak Detection, Localization, and Prognosis of High Pressure Fuel Delivery System – Azeem Sarwar[1], Xiangxing Lu[2] ([1,2]*General Motors*)

Model-based Advanced Diagnosis for a Type of Electric-motor-assisted Brake System – Xiaoyu Huang[1] ([1]*General Motors*)

Paper Session 5B: PHM for Air Traffic Management I
Wednesday, 10:05 – 11:35, Room: Maestro A&B
Session Chair: Kai Goebel (NASA Ames)

Information Fusion for National Airspace System Prognostics: a NASA ULI Project – Yongming Liu[1], Kai Goebel[2] ([1]*Arizona State University;* [2]*NASA Ames Research Center*)

A Computational Platform for Analyzing the Safety of the National Airspace System – P. K. Menon[1], Bong-Jun Yang[2], Parikshit Dutta[3], Sang Gyun Park[4], Oliver Chen[5], Victor H. L. Cheng[6] ([1,2,3,4,5,6]*Optimal Synthesis Inc.*)

Impact of Early Life Failures in Services of Engineering Asset Fleets – Arinan Dourado[1], Felipe A. C. Viana[2] ([1,2]*University of Central Florida*)

Data-driven Modeling for Aviation Safety Diagnosis and Prognosis – Xiaoge Zhang[1], Yingxiao Kong[2], Abhinav Subramanian[3], Sankaran Mahadevan[4] ([1,2,3,4]*Vanderbilt University*)

Paper Session 6A: Structural Health Monitoring
Wednesday, 1:45 – 3:15, Room: Concerto A&B
Session Chair: Giovanni Jacazio (Politecnico di Torino)

Force Reconstruction for Nonlinear Structures in Time Domain – Jie Liu[1], Bing Li[2], Meng Li[3], Huihui Miao[4] ([1,2,3,4]*Xi'an Jiaotong University*)

Constrained Blind Source Separation by Morphological Characteristics and Its Application in Modal Analysis – Teng Gong[1], Zhousuo Zhang[2], Huan Wang[3] ([1,2,3]*Xi'an Jiaotong University*)

Extreme Prognostics for Remaining Useful Life Analysis of Composite Structures – Nick Eleftheroglou[1], Dimitrios Zarouchas[2], Rinze Benedictus[3] ([1,2,3]*Delft University of Technology*)

Machine Learning Based Prognostics of Fatigue Crack Growth in Notch Pre-cracked Aluminum 7075-T6 Rivet Hole – Robert Haynes[1], Ghanashyam Joshi[2], Natasha Bradley[3] ([1,3]*US Army Research Laboratory;* [2]*Southern University and A&M College*)

Paper Session 6B: PHM for Air Traffic Management II
Wednesday, 1:45 – 3:15, Room: Maestro A&B
Session Chair: Kai Goebel (NASA Ames)

A Bayesian-entropy Network for Information Fusion and Reliability Assessment of National Airspace Systems – Yuhao Wang[1], Yongming Liu[2], Zhe Sun[3], Pingbo Tang[4] ([1,2,3,4]*Arizona State University*)

Modeling the Effects of Uncertainty on the National Airspace System – Erin C. DeCarlo[1], Barron J. Bichon[2] ([1,2]*Southwest Research Institute*)

Dynamic Data Communications for Real-time Information Fusion – Weichang Wang[1], Lei Ying[2] ([1,2]*Arizona State University*)

Operational Anomaly Detection in Flight Data Using a Multivariate Gaussian Mixture Model – Guoyi Li[1], Ashwin Rai[2], Hyunseong Lee[3], Aditi Chattopadhyay[4] ([1,2,3,4]*Arizona State University*)

Invited Paper Session: Data Challenge Winners
Wednesday, 1:45 – 3:15, Room: Ormandy Ballroom
Session Chair: Nicholas Propes (Seagate)

Concurrent Remaining Useful Life Estimation for Multiple Faults in an Ion Etch Mill: A Data Driven Approach – Kuldeep Singh[1], Balaji Selvanathan[2], Kalyani Zope[3], Sri Harsha Nistala[4], Venkat Runkana[5] ([1,2,3,4,5]*Tata Consultancy Services)*

Remaining Useful Life Estimation for Systems with Abrupt Failures – Wei Huang[1], Hamed Khorasgani[2], Chetan Gupta[3], Ahmed Farahat[4], Shuai Zheng[5] ([1,2,3,4,5]*Hitachi America Ltd.)*

Recurrent Neural Networks for Online Remaining Useful Life Estimation of Ion Mill Etching System – Vishnu TV[1], Priyanka Gupta[2], Pankaj Malhotra[3], Lovekesh Vig[4], Gautam Shroff[5] ([1,2,3,4,5]*TCS Research*)

Paper Session 7A: PHM Applications I
Wednesday, 3:30 – 5:00, Room: Concerto A&B
Session Chair: Jamie Coble (University of Tennessee, Knoxville)

Fault Detection and Isolation with Fluid Mechanics Constraints For Cryogenic Combustion Bench Cooling Circuit – Camille Sarotte[1], Julien Marzat[2], Helene Piet Lahanier[3], Marco Galeotta[4], Gerard Ordonneau[5] ([1,2,3,5]*ONERA;* [4]*CNES*)

Automated Contingency Management for Water Recycling System – Shijie Tang[1], Guangxing Niu[2], Bin Zhang[3], Ash Thakker[4], Santiago Vivanco[5], Rodney Martin[6], Craig Moore[7] ([1,2,3]*University of South Carolina;* [4,5]*Global Technology Connection;* [6,7]*NASA Marshall Space Flight Center*)

Developing Health Management Strategies Using Power Constrained Hardware – Kevin M. Farinholt[1], Ali Chaudhry[2], Mark Kim[3], Ethan Thompson[4], Nathan Hipwell[5], Ryan Meekins[6], Stephen Adams[7], Peter Beling[8], Sherwood Polter[9] ([1,2,3,4,5,6]*Luna Innovations, Inc.;* [7,8]*University of Virginia;* [9]*Naval Surface Warfare Center*)

On Practical Aspects of Using RNNs for Fault Detection in Sparsely-labeled Multi-sensor Time Series – Narendhar Gugulothu[1], Vishnu TV[2], Priyanka Gupta[3], Pankaj Malhotra[4], Lovekesh Vig[5], Puneet Agarwal[6], Gautam Shroff[7] ([1,2,3,4,5,6,7]*TCS Research*)

Paper Session 7B: Degradation Assessment
Wednesday, 3:30 – 5:00, Room: Maestro A&B
Session Chair: Ravi Rajamani (drR² consulting)

Acoustic Assessment of an End Mill for Analysis of Tool Wear – Abdullah M. Alzahrani[1], Rui Liu[2], Jason R. Kolodziej[3] ([1,2,3]*Rochester Institute of Technology*)

Use of Passive Age Sensors for Projecting Remaining Thermal Life of Materials – Kenneth Watkins[1] ([1]*Polymer Aging Concepts, Inc.*)

Estimating the Uncertainty of Brake Pad Prognostics for High-speed Rail with a Neural Network Feature Ensemble – Alexandre Trilla[1], Pierre Dersin[2], Xavier Cabré[3] ([1,2,3]*ALSTOM*)

Determining the Equivalent Conicity for Railway Wheelset Maintenance with Deep Ensembles – Alexandre Trilla[1], Xavier Cabré[2] ([1,2]*ALSTOM*)

Thursday, September 27, 2018					Thursday, September 27, 2018		
Location / Time	Technical Paper Sessions	Technical Paper & Tutorial Sessions	Technical Paper Sessions		Panel Sessions	Planning Meetings	Location / Time
	Concerto A&B	Maestro A&B	Ormandy Ballroom		Aria A&B	Assembly F	
7:15AM – 5PM	Registration		Location: Pre-Assembly West		Registration	Location: Pre-Assembly West	7:15AM – 5PM
7:15 – 8:00	Continental Breakfast		Location: Pre-Assembly East		Continental Breakfast	Location: Pre-Assembly East	7:15 – 8:00
8:00 – 8:50	Opening Remarks **Keynote Speaker: Sunil Dixit (*Northrop Grumman Aerospace Systems*)** **"Quantum Computing (QC) Tailored for PHM Objectives"**		Location: Ormandy Ballroom		Opening Remarks **Keynote Speaker: Sunil Dixit (*Northrop Grumman Aerospace Systems*)** **"Quantum Computing (QC) Tailored for PHM Objectives"**	Location: Ormandy Ballroom	8:00 – 8:50
8:50 – 9:00	Break		Location: Pre-Assembly East		Break	Location: Pre-Assembly East	8:50 – 9:00
9:00 – 10:30	Paper Session 8A: **Features and Information Fusion**	Tutorial Session 3: **Prognostics** Marcos Orchard (*University of Chile*)	Paper Session 8B: **PHM for Air Traffic Management III**		Panel Session 8: **Fielded Systems** Andy Hess (*The Hess PHM Group*) and Ash Thakker (*Global Technology Connections, Inc.*)	PHMAP19 (Beijing, China) Planning Meeting	9:00 – 10:30
10:30 – 10:45	Break		Location: Pre-Assembly East		Break	Location: Pre-Assembly East	10:30 – 10:45
10:45 – 12:15	Paper Session 9A: **PHM for Gas and Wind Turbines**	Tutorial Session 4: **Deep Learning for PHM** Gabriel Michau (*Zurich University of Applied Sciences*)	*Reserved*		Panel Session 9: **Standards** Ravi Rajamani and Jeff Bird (*PHM Society Standards Committee*)	PHM19 (Scottsdale, AZ) Planning Meeting	10:45 – 12:15
12:15 – 1:30	Lunch on own – *Enjoy Philadelphia!*				Lunch on own – *Enjoy Philadelphia!*		12:15 – 1:30
1:30 – 3:00	Paper Session 10A: **Data-driven PHM**	Paper Session 10B: **PHM Applications II**	Invited Paper Session: **IJPHM Papers**		Panel Session 10: **Education and Professional Development** Jeff Bird, Karl Reichard, and Nancy Madge (*PHM Society Education and Professional Development Committee*)	*Reserved*	1:30 – 3:00
3:00 – 3:15	Break		Location: Pre-Assembly East		Break	Location: Pre-Assembly East	3:00 – 3:15
3:15 – 4:45	Paper Session 11A: **Sensor Networks**	Paper Session 11B: **PHM Applications III**	*Reserved*		Panel Session 11: **Theoretical Aspects of Prognostics** Chetan Kulkarni (*SGT Inc., NASA Ames Research Center*)	*Reserved*	3:15 – 4:45
4:45 – 5:15	Closing Remarks		Location: Aria A&B		Closing Remarks	Location: Aria A&B	4:45 – 5:15

Paper Session 8A: Features and Information Fusion
Thursday, 9:00 – 10:30, Room: Concerto A&B
Session Chair: Gabriel Michau (Zurich University of Applied Sciences)

Interpretable Unsupervised Feature Extraction and Learning of Abnormal System State Transitions in Aircraft Sensor Data – Rashmi Sundareswara[1], Franz David Betz[2], Tsai-Ching Lu[3] ([1,3]*HRL Laboratories, LLC;* [2]*Boeing*)

Calculating a Tachometer Signal from onboard a Smart Vibration Sensor – Eric Bechhoefer[1], David He[2] ([1]*GPMS;* [2]*University of Illinois at Chicago*)

Calculation of Blade Track Height Using an Optical Tracker – Eric Bechhoefer[1], Brian Tucker[2] ([1]*GPMS;* [2]*Bell Flight*)

Rolling Bearing Diagnosis Based on CNN-LSTM and Various Condition Dataset – Osamu Yoshimatsu[1], Yoshihiro Satou[2], Kenichi Shibasaki[3] ([1,2,3]*NSK Ltd.*)

Paper Session 8B: PHM for Air Traffic Management III
Thursday, 9:00 – 10:30, Room: Ormandy Ballroom
Session Chair: Brian Weiss (National Institute of Standards and Technology)

Physics-based Learning for Aircraft Dynamics Simulation – Yang Yu[1], Houpu Yao[2], Yongming Liu[3] ([1,2,3]*Arizona State University*)

Safety Monitoring and Prognostics for Automatic Aircraft Take-off – Johann Schumann[1], Alexander W. Zollitsch[2], Nils Mumm[3], Florian Holzapfel[4] ([1,2,3,4]*Technical University of Munich*)

Paper Session 9A: PHM for Gas and Wind Turbines
Thursday, 10:45 – 12:15, Room: Concerto A&B
Session Chair: Kevin McCormick (Lockheed Martin)

Data Analytics for Performance Monitoring of Gas Turbine Engine – Yuan Liu[1], Avisekh Banerjee[2], Thambirajah Ravichandran[3], Amar Kumar[4], Glenn Heppler[5] ([1,4]*Tecsis Corporation;* [2]*Life Prediction Technology Inc.;* [3,5]*University of Waterloo*)

Ensemble Learning Based Surrogate Modeling for Gas Turbine Blisk Temperature Predictions – Thambirajah Ravichandran[1], Glenn Heppler[2], Avisekh Banerjee[3] ([1,2]*University of Waterloo;* [3]*Life Prediction Technologies Inc.*)

Remaining Useful Life Estimation of Wind Turbine Blades under Variable Wind Speed Conditions Using Particle Filters – Bhavana Valeti[1], Shamim N. Pakzad[2] ([1,2]*Lehigh University*)

Development of a Data-driven Model for Marine Gas Turbine (MGT) Engine Health Monitoring – Daniel Maraini[1], Mark Simpson[2], Ronald Brown[3], Michael Porporad[4] ([1,2]*McKean Defense Group;* [3,4]*Naval Surface Warfare Center*)

Paper Session 10A: Data-driven PHM
Thursday, 1:30 – 3:00, Room: Concerto A&B
Session Chair: Neil Eklund (Analatom)

A Data-driven Approach to Material Removal Rate Prediction in Chemical Mechanical Polishing – Zhixiong Li[1], Dazhong Wu[2] ([1,2]*University of Central Florida*)

Feature Selecting Hierarchical Neural Network for Industrial System Health Monitoring: Catching Informative Features with LASSO – Gabriel Michau[1], Manuel Arias Chao[2], Olga Fink[3] ([1,2,3]*Zurich University of Applied Sciences*)

A Deep Learning-based Approach for Fault Diagnosis of Rolling Element Bearings – Mohammadkazem Sadoughi[1], Austin Downey[2], Garrett Bunge[3], Aditya Ranawat[4], Chao Hu[5], Simon Laflamme[6] ([1,2,3,4,5,6]*Iowa State University*)

Validating Machine-learned Diagnostic Classifiers in Safety Critical Applications with Imbalanced Populations – Daniel Wade[1], Andrew Wilson[2], Abraham Reddy[3], Raj Bharadwaj[4] ([1,2]*United States Army AMRDEC;* [3,4]*Honeywell Aerospace*)

Paper Session 10B: PHM Applications II
Thursday, 1:30 – 3:00, Room: Maestro A&B
Session Chair: Jamie Coble (University of Tennessee, Knoxville)

An Acoustic Time-frequency Approach to Condition Monitoring of Ventricular Assistive Devices – Ian R. Prechtl[1], Steven W. Day[2], Jason R. Kolodziej[3] ([1,2,3]*Rochester Institute of Technology*)

Identification of Diagnostic-related Features Applicable to EEG Signal Analysis – Nejra Beganovic[1], Jasmin Kevric[2], Dejan Jokic[3] ([1,2,3]*International Burch University*)

Cyberattack Detection for Power Plant Cyber-physical System Security – Weizhong Yan[1], Lalit Mestha[2], Justin John[3], Daniel Holzhauer[4], Masoud Abbaszadeh[5], Marc McKinley[6] ([1,2,3,4,5]*GE Global Research Center;* [6]*GE Power*)

Wireless Non-invasive Asset Life-cycle Monitoring System – Mark Younghoon Kim[1], Kevin Farinholt[2], Jeff Demo[3], James Eno[4], Hunter Long[5], Ethan Thompson[6] ([1,2,3,4,5,6]*Luna Innovations Inc.*)

Invited Paper Session: IJPHM Papers
Invited papers concurrently published in IJPHM (www.ijphm.org)
Thursday, 1:30 – 3:00, Room: Ormandy Ballroom
Session Chair: Chetan Kulkarni (SGT Inc., NASA Ames)

A Method for Automated Cavitation Detection with Adaptive Thresholds – Seth W. Gregg[1], John P. H. Steele[2], Douglas L. Van Bossuyt[3] ([1]*Logical Systems, LLC;* [2]*Colorado School of Mines;* [3]*Naval Postgraduate School*)

Integrated Prognostics Observer for Condition Monitoring of an Automated Manual Transmission Dry Clutch System – Sivakumar Ramalingam[1], Hanumath V. V. Prasad[2], Srinivasa Prakash Regalla[3] ([1,2]*Ashok Leyland Ltd;* [3]*BITS Pilani*)

Prognostic systems representation in a function-based Bayesian model during engineering design – Guillaume L'Her[1], Douglas L. Van Bossuyt[2], Bryan M. O'Halloran[3] ([1]*Colorado School of Mines;* [2]*KTM Research;* [3]*Naval Postgraduate School*)

Wind Turbine Bearing Fault Detection Using Adaptive Resampling and Order Tracking – Cody Walker[1], Jamie Coble[2] ([1,2]*University of Tennessee, Knoxville*)

Paper Session 11A: Sensor Networks
Thursday, 3:15 – 4:45, Room: Concerto A&B
Session Chair: Kamal Medjaher (Tarbes National School of Engineering)

Examining Workcell Kinematic Chains to Identify Sources of Positioning Degradation – Alexander Klinger[1], Brian A. Weiss[2] ([1,2]*National Institute of Standards and Technology*)

Procedure for Selecting a Transmission Mode Dependent on the State-of-charge and State-of-health of a Lithium-ion Battery in Wireless Sensor Networks with Energy Harvesting Devices – Vanessa Quintero[1], Aramis Perez[2], Francisco Jaramillo[3], Claudio Estevez[4], Marcos Orchard[5] ([1,2,3,4,5]*University of Chile*)

Towards Automated Condition Monitoring of Blowout Preventer Wellbore Packers – Se Un Park[1], Rajesh Kumar Bade[2], Daniel Barker[3], Daniel Edgardo Viassolo[4] ([1,2,3,4]*Schlumberger*)

Wireless and Autonomous Sensor for Integrated Engine Health Management – Yoann Hebrard[1], Guillaume Bastard[2], Tony Lhommeau[3] ([1]*SKF Aerospace;* [2,3]*Safran Aircraft Engines*)

Paper Session 11B: PHM Applications III
Thursday, 3:15 – 4:45, Room: Maestro A&B
Session Chair: Karl Reichard (Pennsylvania State University)

A Framework for Unifying Model-based and Data-driven Fault Diagnosis – Hamed Khorasgani[1], Ahmed Farahat[2], Kosta Ristovski[3], Chetan Gupta[4], Gautam Biswas[5] ([1,2,3,4]*Hitachi America Ltd.;* [5]*Vanderbilt University*)

Classification-based Diagnosis Using Synthetic Data from Uncertain Models – Ion Matei[1], Maksym Zhenirovskyy[2], Johan de Kleer[3], Alexander Feldman[4] ([1,2,3,4]*Palo Alto Research Center*)

A Machine Learning Approach to Diesel Engine Health Prognostics using Engine Controller Data – Steve Nixon[1], Ryan Weichel[2], Karl Reichard[3], James Kozlowski[4] ([1,2,3,4]*Pennsylvania State University*)

High Impedance Fault Detection and Location in Distribution Systems – Roghieh A. Biroon[1], Zoleikha Abdollahi[2], Ramtin Hadidi[3] ([1,2,3]*Clemson University*)

Career Fair

Career Fair
Tuesday, 9:00 – 5:00 and Wednesday, 10:00 – 5:00
Location: Assembly E

Are you still looking for a career opportunity in PHM? The PHM Society can help you to meet your next employer at the Career Fair sessions on September 25–26, 2018!

The PHM Career Fair is an exposition for PHM employers to meet with prospective job seekers. This year the PHM Society is holding a Career Fair within the 10th Annual Conference at Philadladelphia, Pennsylvania to enable recruiters and job seekers the opportunity to meet and conduct interviews. Come meet and talk with growing companies hiring in PHM!

Benefits for Recruiters

- Recruiters will have access to a large pool of candidates and early-access to their resumes to narrow down the qualified candidates.
- Recruiters will be onsite to interview and have a face-to-face interaction with the candidates for full-time, part-time and internship positions.
- The career fair is an advertised event and offers employers high visibility and recognition during the conference.
- Recruiters will be able to share a description of their vacancies prior to the conference.

Benefits for Job Seekers

- The career Fair is FREE and OPEN to all registered PHM18 conference participants and recruiters.
- Candidates of all ages, all levels of experience, and all industries are encouraged to attend.
- Candidates can access a description of the available openings and e-mail their resumes prior to the career fair to careerfair@phmconference.org.
- Recruiters will be onsite to conduct on-the-spot interviews for full-time, part-time and internship positions.

Participating Companies

3M • FoxConn • Lockheed Martin • MachineMetrics • NOV • Seagate

Tuesday, September 25, 2018

9:00 – 10:30	General Session 1: **3M • FoxConn • Lockheed Martin • NOV • Seagate**
10:45 – 12:15	Follow-up Discussions 1:
10:45 – 11:30	**3M**
11:30 – 12:15	**FoxConn**
1:30 – 3:00	Follow-up Discussions 2:
1:30 – 2:15	**NOV**
2:15 – 3:00	**Lockheed Martin**
3:30 – 4:15	Follow-up Discussions 3:
3:30 – 4:15	**Seagate**
4:15 – 5:00	**Seagate**

Wednesday, September 26, 2018

10:00 – 11:30	General Session 2: **FoxConn • Lockheed Martin • MachineMetrics • NOV**
1:45 – 3:15	Follow-up Discussions 4:
1:45 – 2:30	**MachineMetrics**
2:30 – 3:15	**MachineMetrics**
3:30 – 5:00	Follow-up Discussions 5:
3:30 – 4:15	**3M**
4:15 – 5:00	**NOV**

For further details or questions, please contact Abbas Chokor at careerfair@phmconference.org or enquire at the Registration Desk.

Tutorials

One of the unique features of the PHM conferences is **free technical tutorials** on various topics in health management taught by industry experts. As educational events tutorials provide a comprehensive introduction to the state-of-the-art in the tutorial's topic. Proposed 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. 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 1: Anomaly Detection
Tuesday, 1:30 – 3:00, Room: Maestro A&B
Neil Eklund
Analatom

Abstract: Anomaly detection (AD) is the process of identifying elements in a data set which differ from the norm. AD is difficult, because it is typically performed in an unlabeled context, taking only the internal structure of the dataset into account. Anomalous data might be the most interesting data in a particular data set, or it might represent garbage; and can arise from a plurality of sources – noise, stuck sensors, a different underlying system, an unusual mode of operation, and so on. This Tutorial will focus on the concepts and algorithms of AD for PHM data, with real-world examples and advice on algorithm selection for practical tasks.

Presenter Bio: Dr. Eklund is an experienced technologist in the space of data science, industrial analytics, and machine learning, with over 20 years of experience in developing fielded solutions to practical industrial problems. He is one of the founders of the PHM Society, and continues to serve on its board of directors. Neil is the former Chief Data Scientist for Schlumberger, where he established the first successful deployed IoT application in the oil industry, which generated $20MM+ in the first three months of operation. Prior to that, Neil was a research scientist in the Machine Learning laboratory of GE Research, working in aerospace, energy, healthcare, oil & gas, financial, and rail applications.

Tutorial Session 2: Systems Engineering for PHM
Tuesday, 3:30 – 5:00, Room: Maestro A&B
Ravi Rajamani
drR² consulting

Abstract: With the goal of delivering predictive maintenance and continuous remaining useful life estimates, PHM systems can reduce aftermarket costs by 25% or more and increase operational availability by 15% or more. This has been proven over many years of experience in the aerospace sector. However, developing PHM systems is not easy because they cut across many different disciplines and subsystems. An SE approach has been shown to be a very good way of designing and implementing PHM systems. This tutorial will give an overview of how SE can be used to develop PHM systems in a systematic manner.

Presenter Bio: Dr. Ravi Rajamani is an independent consultant who has accumulated years of experience in the area of aerospace propulsion and energy, specifically in data analytics and model-based methods for controls, diagnostics, and prognostics. He has many publications to his name including three books (chief being *Electric Flight Technology: The Unfolding of a New Future*), book chapters, journal and conference papers, and patents. In the past Ravi has worked at Meggitt, UTC, and the GE. He is active within various SAE technical committees dealing with PHM. He is also active in the PHM Society, serving on its board of directors. He is the editor-in-chief of the SAE International Aerospace Journal and has been elected a Fellow of SAE and IMechE.

Tutorial Session 3: Prognostics
Thursday, 9:00 – 10:30, Room: Maestro A&B
Marcos Orchard
University of Chile

Abstract: Uncertainty and risk management holds the key for a successful penetration of health management strategies in industrial applications. While methods to estimate and handle uncertainty have received a reasonable amount of attention in the diagnostics domain, uncertainty management for prognostics is an area which awaits major advances. This tutorial explores some of the most important theoretical and practical aspects associated to the problem of failure prognosis and risk evaluation, with special emphasis on Bayesian prognostic algorithms, outer feedback correction loops, and uncertainty characterization in long-term prediction.

Presenter Bio: Dr. Marcos Orchard is Associate Professor with the Department of Electrical Engineering at Universidad de Chile and was part of the Intelligent Control Systems Laboratory at The Georgia Institute of Technology. His current research interest is the design, implementation and testing of real-time frameworks for fault diagnosis and failure prognostics, with applications to battery management systems, mining industry, and finance. His fields of expertise include statistical process monitoring, parametric/non-parametric modeling, and system identification. His research work at the Georgia Institute of Technology was the foundation of novel real-time fault diagnosis and failure prognostic approaches based on particle filtering algorithms. He received his Ph.D. and M.S. degrees from The Georgia Institute of Technology, Atlanta, GA, in 2005 and 2007, respectively. He received his B.S. degree (1999) and a Civil Industrial Engineering degree with Electrical Major (2001) from Catholic University of Chile. Dr. Orchard has published more than 50 papers in his areas of expertise.

Tutorial Session 4: Deep Learning for PHM
Thursday, 10:45 – 12:15, Room: Maestro A&B
Gabriel Michau
Zurich University of Applied Sciences (ZHAW)

Abstract: Developments in Neural Networks have brought over the past decade a variety of solutions to problems in many fields. Neural Networks are now able to classify, recognize or segment thousands of objects in images, play games, generate new engineered products, translate languages, recognize and translate voices or gestures. Yet, in PHM, the use of neural networks is still quite limited. In this tutorial, we will first explore the fundamentals of deep learning and of its most successful applications. Understanding the strength and the limitations of Neural Networks will help us to understand why their application to PHM is not straightforward. Toy examples will be used to help familiarize with these concepts.

Presenter Bio: Dr. Gabriel Michau is a Research Associate in Predictive Maintenance at the Zurich University of Applied Sciences (ZHAW). He holds the joint PhD degree from the Queensland University of Technology (QUT), Brisbane, in Civil Engineering, and from the Ecole Normale Supéerieure de Lyon (ENSL), in Physics, Signal Processing. His research focus is now on machine learning, signal processing and data-driven approaches, applied to the Prognostic and Health Management field.

Special Invited Sessions

Invited Panel Session: Digital Transformation and the Digital Ecosystem Across the Enterprise—from Requirements to Retirement
Wednesday, 8:50 – 11:35, Room: Ormandy Ballroom
Session Chairs: Andy Hess (The Hess PHM Group) and John Madsen (Northrop Grumman)

Description: The evolving digital ecosystem and resulting digital transformation across large enterprises are both happening very fast and in many cases are here. The digital ecosystem concept can be thought as a means to regularize seamless information sharing among multi-physics models and data bases, involving multi-discipline simulations across multiple phases of the vehicle life cycle. But the digital ecosystem is more than just the means to connect information that enables concurrent engineering and better decisions at all stages of a platform's life cycle and for all levels of an enterprise. Benefits and some of the real power lies in the future capability to simulate and effectuate the entire life cycle so that all aspects of the platform's life cycle are optimized, not just the design or sustainment. Among many things, the digital ecosystem is a philosophy whereby common interconnected data models empower concurrent engineering to perform concurrent uncertainty management across all aspects of life cycle. We must rethink how we approach the current engineering and sustainment processes in the context of this digital transformation. This session will focus on identifying what the future of digital transformation should look like, the state of these evolving digital ecosystems, and how it all can be used to optimize the many stages of a platform's life cycle. Digital thread and digital twin technologies, as well as PHM capabilities and benefits; will also be explored with respect to their place and contributions to this digital transformation across enterprise-wide applications.

Panelists:
Marilyn Gaska *(Lockheed Martin)*
Abhi Seth *(Honeywell)*
Tom Hedberg *(NIST)*
Peyman Davoudabadi *(ANSYS)*

Invited Paper Session: Data Challenge Winners
Wednesday, 1:45 – 3:15, Room: Ormandy Ballroom
Session Chair: Nicholas Propes (Seagate)

- Concurrent Remaining Useful Life Estimation for Multiple Faults in an Ion Etch Mill : A Data Driven Approach – Kuldeep Singh, Balaji Selvanathan, Kalyani Zope, Sri Harsha Nistala, Venkat Runkana *(Tata Consultancy Services)*
- Remaining Useful Life Estimation for Systems with Abrupt Failures – Wei Huang, Hamed Khorasgani, Chetan Gupta, Ahmed Farahat, Shuai Zheng *(, Hitachi America Ltd.)*
- Recurrent Neural Networks for Online Remaining Useful Life Estimation of Ion Mill Etching System – Vishnu TV, Priyanka Gupta, Pankaj Malhotra, Lovekesh Vig, Gautam Shroff *(TCS Research)*

Invited Paper Session: IJPHM Papers
Thursday, 1:30 – 3:00, Room: Maestro Ormandy Ballroom
Session Chair: Chetan Kulkarni (SGT Inc., NASA Ames)

- A Method for Automated Cavitation Detection with Adaptive Thresholds – Seth W. Gregg[1], John P. H. Steele[2], Douglas L. Van Bossuyt[3] (*[1]Logical Systems, LLC; [2]Colorado School of Mines; [3]Naval Postgraduate School*)
- Integrated Prognostics Observer for Condition Monitoring of an Automated Manual Transmission Dry Clutch System – Sivakumar Ramalingam[1], Hanumath V. V. Prasad[2], Srinivasa Prakash Regalla[3] (*[1,2]Ashok Leyland Ltd; [3]BITS Pilani*)

Prognostic systems representation in a function-based Bayesian model during engineering design – Guillaume L'Her[1], Douglas L. Van Bossuyt[2], Bryan M. O'Halloran[3] (*[1]Colorado School of Mines; [2]KTM Research; [3]Naval Postgraduate School*)

Wind Turbine Bearing Fault Detection Using Adaptive Resampling and Order Tracking – Cody Walker[1], Jamie Coble[2] (*[1,2]University of Tennessee, Knoxville*)

Panel Sessions

Panel Session 1: Automotive PHM Emerges
Tuesday, 9:00 – 10:30, Room: Aria A&B
Session Chair: Steve Holland (General Motors)

Description: PHM technology has begun to enjoy limited success in the automotive domain for retail customers, fleet customers and shipping providers. The business impact achieved, while significant, is projected to rapidly increase as the industry transitions from a private-ownership-centric model to variants of ride sharing with increasing degrees of autonomy. In the newer business models, PHM simply becomes essential. This panel will explore the barriers to accelerating the impact of PHM: (1) awareness of PHM technology and its benefits by business leadership and customers alike, (2) integration of PHM into the engineering design fabric of the key players, and (3) effective industry standards & consortia to bring down the costs of implementation. Suppliers have always played a critical role in the industry and will be equally critical to the success of PHM. PHM demands a strategic approach not only aligned with company goals and product requirements but also linked into its field service support.

Panelists:
- Marc Brummer *(BMW)*
- Tim Felke *(Honeywell)*
- Azeem Sarwar *(General Motors)*
- Troy Schilling *(Bosch)*

Panel Session 2: Manufacturing
Tuesday, 10:45 – 12:15, Room: Aria A&B
Session Chair: Radu Pavel (TechSolve)

Description: A new industrial revolution is being driven by the digitization of manufacturing, automation, and the Internet. Digitization and connectivity will unlock unprecedented opportunities for factory optimization and cost savings. Products and machines will be able to communicate with each other, learn from each other, and work directly with each other without human intervention. The prognostic and health management (PHM) systems will become vital elements of the future manufacturing environment. Advanced PHM systems will offer the potential to optimize maintenance tasks in real time, maximizing the useful life of the equipment while still avoiding disruption to operations. This panel will bring together a diverse group of speakers from industry, academia, and national institutes to discuss their ongoing PHM development efforts from the perspective of the fourth industrial revolution. Potential applications will be highlighted, such as industrial robot health monitoring, incorporating machine health with factory-level decision making systems, advanced models for prognostics and health management, and designing preventive strategies for manufacturing operations. The panelists will share their thoughts on the future direction of PHM for smart manufacturing and will seek to engage the audience in sharing their own perspectives.

Panelists:
- Xiaoning Jin *(Northeastern University)*
- Justinian Rosca *(Siemens)*
- Michael Sharp *(NIST)*
- Tyler Vizek *(DMDII)*
- Lou Zhang *(Machine Metrics)*

Panel Session 3: PHM Applications Deployment
Tuesday, 1:30 – 3:00, Room: Aria A&B
Session Chair: Tomasz Pancewicz (GE Aviation)

Description: The purpose of this panel is to discuss the various issues related to the deployment, management and maintenance of successful PHM applications. We will consider how to better build systems and processes for bringing prototype PHM models into large-scale, flexible, tunable production environments. We hope to think through both patterns and anti-patterns for creating production-level PHM applications, especially at issues of scalability and design for better maintenance decision making. Questions we hope to address include:
- How to create better environments for Remote Monitoring and Diagnostic (RM&D) operators, to help them make the best maintenance decisions?
- What kinds of feedback-loops should be built into our applications?
- In which situations should we keep humans-in-the-loop in the alerting and recommendations issuing at RM&D centers, vs. when to circumvent human-level decisions?
- Should the professional software engineers be rewriting prototype models created by analytics engineers / data scientists, vs. should the code created by data scientists be allowed on production servers?
- How to implement, monitor and manage fleets of models at the production-level, so that they're easy to update, fix and replace in the future?
- How to shorten the time required from the moment the prototype-level code is ready, until the production-level code is ready, tested and deployed?

Panelists:
- Xinyu Du *(General Motors)*
- Kathryn Elliot *(Rolls Royce)*
- Jayant Sen Gupta *(Airbus)*
- Glenn Shaffer *(GE Transportation)*
- Sven Poerschmann *(LHT)*
- Adam Mcelhinney *(Uptake)*

Panel Session 4: PHM for Human Health and Performance
Tuesday, 3:30 – 5:00, Room: Aria A&B
Session Chair: Wolfgang Fink (University of Arizona)

Description: Predictive Health Management (PHM), originally applied in the Aerospace Industry, tries to predict when what part would fail for what reason(s) in order to make (preventive) maintenance more efficient and cost-effective. Over the past several years, PHM has been increasingly infused into the human healthcare, precision medicine, and human performance sectors. This panel discusses contributions in the fields of wearable smart sensors, sensor-data-fusion, machine learning and data mining, prediction and diagnosis, and electronic health records and databases - all in the context of prognostics and health management for human health and performance on Earth and in Space. Moreover, this panel builds on the discussions of the experience and processes encountered/created by the panelists, and highlights specific challenges, needs, and wants with respect to the development and implementation of standards and guidelines pertaining to PHM in the area of human health and performance. This diverse group of panelists will present their perspectives on PHM as it pertains to human assets. Conversations will include PHM's current and future envisioned applications within general healthcare, high stress work environments, sports/athletes, theatre, and space environments, along with how the needs, data stream, and supporting PHM tools, can be better designed, developed, implemented, integrated, verified, and validated to impact the new paradigm of smart healthcare.

Panelists:
- Dan Buckland *(Duke University)*
- Derek De Vries *(Orbital ATK)*
- Mark Derriso *(US Airforce)*
- Michelle Johnson *(University of Pennsylvania)*

Panel Session 5: Oil and Gas
Wednesday, 10:05 – 11:30, Room: Aria A&B
Session Chair: Joseph Thorp (Aramco)

Description: Oil & Gas companies have accelerated the deployment of PHM technologies to improve operational availability, safety and environmental performance. The panel explores advanced predictive systems, prognostic model classifications, application guidelines and remaining useful life of critical equipment to provide better targeting of technology solutions. The mapping of success and failure across the industry has allowed leading experts to develop models to quantify cost and benefit by equipment class, process and business segment. Case studies are provided that highlight best in class strategies of the most successful companies.

Panelists:
- Stephanie Germaine *(GHG Sat)*
- Sastry Malladi *(Foghorn Systems)*
- Skip Morrison *(Prognost)*
- Steve Silwa *(Seeq Corporation)*
- Mike Strobel *(Aspentech)*

Panel Session 6: New Instrumentation Technologies for PHM
Wednesday, 1:45 – 3:15, Room: Aria A&B
Session Chair: Ed Spence (Machine Instrumentation)

Description: The digital revolution coming to industrial applications under the heading IoT is enabled by emerging technology trends. Wireless sensor networks with connectivity to cloud based dashboards are proliferating in the industrial applications, offering continuous on-line CBM services. Some of these systems are developed by new entrants with IoT or AI rather than traditional CBM/PdM backgrounds, offering data driven approaches promising monitoring automation or improved accuracy diagnostics. Industrial OEMS are also implementing their own CBM programs, embedding customized sensor solutions in the hardware and shipping pre-instrumented equipment, in some cases retrofitting their installed base. Another enabling technology is the emergence of MEMS accelerometers capable of providing quality vibration-based measurement, at performance levels suitable for these applications and opening up new opportunities for integration of compact, embedded sensing solutions.

The goal is to assemble a panel discussion for PHM2018 to discuss the impact and convergence of these relatively new technologies to industries of interest to the PHM Society. Comparisons with incumbent technologies and trends can be discussed, the impact on various industries can be assessed, and the potential contributions to IIoT, new business models, new product categories and market expansion can be explored.

Panelists:
- Anthony Bastiaansen *(BossPac)*
- Eric Bechhoefer *(GPMS)*
- Joe Bergeron *(Analog Devices)*
- Dave Change *(Dytran)*
- Shannon Jelken *(Emerson–Fisher Valves)*

Panel Session 7: Unmanned Systems
Wednesday, 3:30 – 5:00, Room: Aria A&B
Session Chairs: Karl Reichard (Pennsylvania State University) and George Vachtsevanos (Georgia Tech)

Description: The panel will address 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 application domains from Intelligence, Surveillance and Reconnaissance to rescue operations, border patrol, driverless vehicles, driverless air taxis, undersea exploration, among others. It is documented that autonomous systems (UAVs, for example) are failing at alarming rates. PHM and related technologies aim to introduce new tools/methods for their resilient design and safe operation. The panel is inviting the participation of scientists/engineers, students and academics, company personnel, government personnel involved in autonomy and autonomous systems, and conference participants interested to learn about the emerging autonomous systems technologies. Panel members and panel participants will discuss current and future technologies for improved system performance. Actual case studies and examples will be used to illustrate the technological innovations.

Panelists:
- Jim Cycon *(Lockheed Martin RMS / Sikorsky)*
- Matthew Daigle *(NASA)*
- Frank Ferrese *(NSWC)*
- Kai Goebel *(NASA Ames)*
- Mathieu Kemp *(Monterey Bay Aquarium Research Institute)*
- Alberto Lacaze *(Robotics Research)*

Panel Session 8: Fielded Systems
Thursday, 9:00 – 10:30, Room: Aria A&B
Session Chairs: Andy Hess (The Hess PHM Group) 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 lessons learned as part of this distinguished panel of experts. Much can be learned from the requirements generation, development, Verification and Validation, implementation, maturation, fielded use, fleet support, and enterprise-wide use of real world PHM systems. Just the development of the individual capabilities that make up a comprehensive and fully integrated PHM system; provides many lessons learned - both good and bad. A recently evolving important focused area will also be explored around the question: "just who really 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 systems. Short presentations will be given by all panel participants that describe their particular topic area and experiences within the PHM/CBM+ domains. An open panel discussion will follow to explore some of these identified specific issues and concerns.

Panelists:
- Jeff Banks *(ARL Penn State)*
- James Buffington *(Lockheed Martin Aeronautics)*
- Derek DeVries *(Northrop Grumman)*
- Amy Grace *(UTC)*
- Frank Zahiri *(USAF Warner Robins)*

Panel Session 9: Standards: How can we track the evolving standards world?
Thursday, 10:45 – 12:15, Room: Aria A&B
Session Chairs: Ravi Rajamani and Jeff Bird (PHM Society Standards Committee)

Background: One of the PHM Society's objectives is the advancement of PHM as an engineering discipline which includes standards and education. Panels on standards in development and what is needed have been conducted and documented in past an-

nual conferences and a Society forum exists for exchanges: http://www.phmsociety.org/forum/592. SAE International as a Technical Partner has greatly contributed to these activities. The PHM Society is also a member of the US Technical Advisory Group of the ISO TC108 that covers diagnostics and prognostics. In 2010 there was a panel of a number of standards organizations.

Objectives: Update the community on the diverse PHM standards development activities. Identify gaps and development needs, particularly in the era of the Internet of Things and Digital Threads, e.g. accessing, staying current and contributing to the development of PHM standards. Introduce a PHM Standards Portal and a means to engage in ISO activities. Prioritize actions for the PHM Society through its Standards Committee.

Format: 90 minute session: Introduction and PHM Standards Portal, 3 x 15 minute presentations with gaps/issues conclusions referenced to full documents pre-loaded on the PHM forum site, 20 minute open discussion and 10 minute prioritization and way forward discussion

Panelists:
- Donnie Alonzo *(ASME)*
- Logen Johnson *(SAE HM1)*
- Ian Verhappen *(ISA)*

Panel Session 10: Education and Professional Development: How can we leverage existing training?
Thursday, 1:30 – 3:00, Room: Aria A&B
Session Chairs: Jeff Bird, Karl Reichard, and Nancy Madge (PHM Society Education and Professional Development Committee)

Background: Education and professional development are core enablers of the PHM Society to support its principles to: Provide free and unrestricted access to PHM knowledge; Promote interdisciplinary and international collaboration in PHM and Lead the advancement of PHM as an engineering discipline. Previous activities (http://www.phmsociety.org/forum/577) including panels have examined: A compilation of recommended types of PHM professional development in skills and mastery levels defined by the PHM Society Capability Taxonomy (Bird, Madge & Reichard, 2014 http://www.phmsociety.org/references/ijphm-archives), guidelines on quantitative goals for professional development over practical time periods and guidelines for preparing, evaluating and reporting plans and achievements. Last year's panel identified a number of sources for existing courses including the Defence Acquisitions University.

Objectives: Examine the kinds of education and training available to the PHM community. Identify gaps and opportunities to access content to advance personal and organizational development aims. Prioritize actions for the PHM Society through its Education and Professional Development Committee.

Format: 90 minute session: Introduction covering existing PHM Society courses and E&PD activities, 3 x 15 minute presentations with gaps/issues conclusions referenced to full documents pre-loaded on the PHM forum site, 20 minute open discussion and 10 minute prioritization and way forward discussion.

Panelists:
- Jamie Coble *(University of Tennessee, Knoxville)*
- Kathryn Elliot *(Rolls Royce)*
- Nat Nataraj *(Vilanova University)*

Panel Session 11: Theoretical Aspects of Prognostics
Thursday, 3:30 – 5:00, Room: Aria A&B
Session Chair: Chetan Kulkarni (SGT Inc., NASA Ames)

Description: This session is focused on the development of Theoretical Aspects in Prognostics. In majority of the Prognostic and Health Management applications particle filtering-based algorithms are being implemented as the state-of-the-art. However, PF-based prognosis frameworks have demonstrated their drawbacks when trying to estimate the probability of failure in nonlinear, non-Gaussian systems performing uncertain operating profiles. To overcome this issue, it is first necessary to establish adequate performance metrics for the framework which has been discussed and presented in recent years. It has been observed that not much work has been done on standardizing prognostics definitions as they suffer from ambiguous and inconsistent interpretations.

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 as well as varying application domains, including aerospace, automotive, nuclear power, electrical etc.

Panelists:
- Gautam Biswas *(Vanderbilt University)*
- Matteo Corbetta *(NASA)*
- Marcos Orchard *(University of Chile)*
- Bing Zhang *(University of South Carolina)*

Keynote Speakers

Keynote: Using the Digital Thread to Integrate PHM in a Model-Based Enterprise (MBE)
Tuesday, 8:00 – 8:50
Room: Ormandy Ballroom
Thomas Hedberg
National Institute of Standards and Technology (NIST)

Abstract: Manufacturing is more distributed and lean-oriented than in years past. Unexpected process deficiencies and part-quality escapes send ripples through globalized supply chains – costing millions of dollars in lost productivity and efficiency. Industry desires ways to move beyond reactive diagnostic and preventive methods toward enabling more predictive monitoring capabilities. Whereas, industry makes decisions currently to perform maintenance before it may be needed (i.e., sacrificing manufacturing capacity today) in hopes that the manufacturing system will be operating effectively in the future (i.e., assuming some level of manufacturing capacity is available tomorrow). This type of decision making is ineffective for ensuring a robust and reliable manufacturing system. Simply tracking machine maintenance is no longer sufficient for ensuring a manufacturing system is running optimally and effectively. Industry needs ways to combine part quality, manufacturing execution, and machine performance data to enable a health monitoring observatory for manufacturing systems. The concept of Model-Based Enterprise (MBE) promises to usher in new capabilities for spinning the digital thread of connected enterprises. This presentation will discuss the opportunities and challenges in MBE to address integrated part and process health monitoring.

Speaker Bio: Thomas Hedberg, Jr. is a Mechanical Engineer in the Systems Integration Division of the Engineering Laboratory at the National Institute of Standards and Technology (NIST). He is the Project Leader of the Digital Thread for Smart Manufacturing project in the NIST Smart Manufacturing Operations Planning and Control program and the Co-Leader of the NIST Smart Manufacturing Systems Test Bed. His current research focus is in the areas of digital-product design, smart manufacturing, and lifecycle engineering. Mr. Hedberg is a Voting Member of the American Society of Mechanical Engineers (ASME) Y14.37, Y14.41, and Y14.41.1 subcommittees from the ASME Y14 suite of standards and Co-Chair and Americas Lead for the Visualization Working Group for LOTAR International.

Prior to joining NIST, Mr. Hedberg was a Senior Mechanical Engineer and Technical Lead of the Model Based Enterprise (MBE) group at Honeywell Aerospace. In this role, he developed a strategy and implementation of MBE in Honeywell's engineering operations. He earned a M.Eng. in Engineering Management with a concentration on Systems Engineering from the Pennsylvania State University and a B.S. in Aeronautical and Astronautical Engineering from Purdue University. He is currently a Ph.D. Candidate in Industrial and Systems Engineering at the Virginia Polytechnic Institute and State University. Mr. Hedberg is a licensed Professional Engineer (PE) in the States of Arizona and Maryland.

Keynote: Product Support at the Skunk Works®: 75 years of Sustaining Innovation
Tuesday, 12:15 – 1:30
Room: Ormandy Ballroom
Greg Birdsall
Lockheed Martin

Abstract: For 75 years, Lockheed Martin's Advanced Development Programs, AKA the Skunk Works®, has been solving our nation's most difficult defense challenges by fielding and supporting revolutionary aircraft such as the U-2 Dragon Lady, SR-71 Blackbird, and F-117 Night Hawk. The basic operating principles of the Skunk Works, known simply as "Kelly's Rules," are a key component of our success. These 14 rules, as relevant today as they were in the beginnings of the Skunk Works, are recognized world-wide as governing principles for innovation. The application of these rules to aircraft sustainment will be presented through a historical look at Skunk Works programs.

Speaker Bio: Greg Birdsall is the Director of Sustainment Operations for Lockheed Martin Aeronautics Advanced Development Programs (ADP). He is responsible for execution and delivery of sustainment products and services across the entire ADP portfolio. Greg joined Lockheed Martin Aeronautics and the Skunk Works in 1983 as a design engineer on the U-2 Program. He spent the majority of his career in various Engineering or Program Management roles on the U-2, including serving as the U-2 Deputy Chief Engineer and U-2 Sustainment Manager before being selected to lead the ADP Sustainment Operations Directorate. Greg earned a Bachelor of Science Degree in Mechanical Engineering with a Minor in Material Science from California State Polytechnic University, Pomona, and a Masters Degree in Technical Management from Embry Riddle Aeronautical University.

Keynote: Teaching PHM to Speak Business
Wednesday, 8:00 – 8:50
Room: Ormandy Ballroom
Ed Cuoco
PTC (ThingWorx)

Abstract: Like it or not, if you're doing PHM for decision support someone is probably calling it "Analytics" and effective PHM Engineers must also identify as data engineers (the designers, builders and managers of information). This discipline sees the value and feels deep passion for the power of data as well as the powerful & subtle techniques that can be applied to that data to yield amazing insights. However, it can be hard to reconcile this work with the needs and frameworks of the businesses within which we all operate. In this keynote, Ed Cuoco will discuss the various human and business aspects that influence "Analytics" as a business and analytics as an offering or feature set and provide some tips for better adapting the work you do and how you communicate to key stakeholders in your organization as well as your customer base.

Speaker Bio: Ed Cuoco has spent more than two decades helping organizations develop advanced analytics strategies and data science product organizations. He has led product, analytics & strategy functions for companies in the United States and Europe, with particular focus on Energy, Oil & Gas, Transport and Logistics. He is passionate about the value that can be unlocked by combining data, logic, people and processes. In his current role as VP, Analytics at PTC, Ed is responsible for the strategy of the ThingWorx Analytics product.

Keynote: Quantum Computing (QC) Tailored for PHM Objectives
Thursday, 8:00 – 8:50
Room: Ormandy Ballroom
Sunil Dixit
Northrop Grumman Aerospace System

Abstract: The transition of QC technologies from laboratories to practical state-of-the-art systems is becoming a reality across a diverse range of applications. Disciplines poised to exploit QC processing include image processing, weather forecasting, data mining, and others. The time is ripe for PHM societies to become major players in QC to obtain the exponential gains in computational power required to meet real time health management mission objectives. This presentation introduces QC technology from the foundational "qubit" building block of QC to the pertinent founding physics underlying the Uncertainty Principle, Quantum Superposition and Entanglement, Quantum Error Corrections, Quantum Cryptography, and Quantum Algorithms. We investigate QC languages and compilers, QC algorithmic approaches that may be tailored for PHM, and running QC algorithms on publicly available platforms. Finally, if time permits, we include a discussion on Quantum Teleportation and Quantum Paradoxes.

Speaker Bio:
- Systems Engineering Manager 5 years
- Software Engineering Manager & Technical Fellow 15 years
- Logistics, Support & Operations 4 years
- Program Manager & Principle Investigator (PI) on several DoD, DARPA, and NASA programs
- Ph.D. Physics (Particle and Nuclear Physics), University of Notre Dame
- M.S. Physics (Particle and Nuclear Physics), Massachusetts Institute of Technology

Over 20 years of IVHM industry collaboration
- NDIA, PHM Society, IEEE, OBD (automotive), SAE (IHM1 Standards Committee), NASA & JPL, USAF (Industry Consortium 2004-2005 IVHM Future Planning), Numerous Universities, others
- Various Internal and National Publications & Presentations on the Subject
- Various Publications in Particle and Nuclear Physics
- Various Patents

Research and program interests have been primarily in the areas of IVHM, Image Processing, Embedded Computing, Distributed Computing, Avionics, and others on NASA, Air Force, Army, Navy, and DARPA programs; Model Driven Architectures; Distributed Software Architectures; Probabilistic Methods; Modeling and Simulation; Data Analytics; Information Exploitation; Quantum Computing; Particle Physics; Nuclear Physics; and String Theory.

Technology Demonstrations

Session Chairs: Jim Larkin (Aerojet Rocketdyne) and Laurel Frediani (Sporian Microsystems)

The PHM Society invites our conference sponsors to show off their diagnostic and prognostic engineering approaches through PHM Technology Demonstrations. The concept of the demonstrations is to offer a true "hands-on" learning experience for attendees. Multiple demonstrations will be given as brief tutorials to small groups. Each demo will last 30 to 60 minutes, where attendees will be encouraged to actively participate.

Technology Demonstrations
Tuesday, 9:00 – 5:00, Rooms: Minuet & Rhapsody
Wednesday, 10:05 – 3:15, Rooms: Minuet & Rhapsody

Tuesday, September 25, 2018

9:00 – 10:30 Sensor Suites for Aircraft Electrical Systems – Sporian
10:45 – 12:15 Remaining Useful Life Estimation using MATLAB and Simulink – MathWorks
1:30 – 3:00 Using the SAE Mobilus Platform to Find PHM Related Standards – SAE Industry Technologies Consortia
3:30 – 5:00 Leveraging Expert Systems for Creating Re-usable Online PHM Reasoning Architectures – D2K

Wednesday, September 26, 2018

10:05 – 11:35 MindSphere: An Open Cloud-based IoT Operating System for Industry – Siemens
1:45 – 2:30 GM Fuel Delivery System Diagnostics & Prognostics – GM
2:30 – 3:15 GM Vehicle Electrical System Diagnostics & Prognostics – GM

Product Showcases

Session Chairs: Jim Larkin (Aerojet Rocketdyne) and Laurel Frediani (Sporian Microsystems)

The PHM Society introduces an exciting new type of opportunity for 2018. 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 exchange.

The Product Showcase sessions will be comprised of a series of 10-minute marketing presentations. The communication will be one-way, where all questions/answers are reserved for off-line. Audiences will enjoy this approach as companies strive to make significant first impressions during a condensed window of time.

Product Showcases
Wednesday, 3:30 – 5:00, Room: Ormandy Ballroom

Wednesday, September 26, 2018

3:30 – 3:35 *Introduction and Ground Rules*
3:35 – 3:45 SAE Industry Technologies Consortia
3:45 – 3:55 Siemens
3:55 – 4:05 D2K
4:05 – 4:15 Seagate
4:15 – 4:25 Seeq
4:25 – 4:35 GM
4:35 – 5:00 *Closing Remarks*

SAE ITC An SAE International Affiliate
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GM
SIEMENS
SEAGATE
MathWorks
SPORIAN MICROSYSTEMS, INC
D2K Technologies

Poster Presentations: Tuesday 6:00 – 7:30
Maestro A&B (During Cocktail Reception)

Technical Program Posters

A Blind Blur Detection Method for Electro-optic (EO) Images – Gregory Bower (*QorTek, Inc.)*
Predictive Maintenance of the Aircraft Engine Bleed Air System Component – Savitha Ramasamy[1], Yang Xue[2], Royston Phoon[3], Richard Han[4], Nelson Low[5], Chee Siang Lim[6] ([1,2,6]*Agency for Science, Technology and Research;* [3,4,5]*Singapore Airlines Limited)*
Rail Suspension System Fault Detection using Deep Semi-Supervised Feature Extraction with One-class data – Xiaomeng Peng[1], Xiaoning Jin[2] ([1,2]*Northeastern University)*

Doctoral Symposium Posters

An Integrated Reasoning Framework for Vehicle Level Diagnosis of Aircraft Subsystem Faults – Cordelia Ezhilarasu (*Cranfield University)*
Deep Learning Based Defects Diagnosis for Automated Fiber Placement Machine – Guangxing Niu (*University of South Carolina)*
Electronic Circuit PHM with No Data – Varun Khemani (*University of Maryland)*
Efficient Control and Fault Detection and Isolation in Building HVAC systems – Avisek Naug (*Vanderbilt University)*
Developing a Knowledge Management System for Integrated Vehicle Health Management Using a Data Life Cycle Model – Alexslis Maindze (*Cranfield University)*
Health Management and Prognostics of Complex Structures and Systems – Guoyi Li (*Arizona State University)*
Aging Models and Lifetime Prediction of Thermally Aged Industrial Cable Insulation Polymers – Aishwarya Sriraman (*Iowa State University)*
Failure and Remaining Useful Life Prediction of Wind Turbine Gearboxes – Sofia Koukoura (*University of Strathclyde)*
Operation-Aware Health Management for Environmental Control and Life Support System – Shijie Tang (*University of South Carolina)*
Robust Estimation of Connected Automated Vehicles While Performing Cooperative Tasks in Presence of Malicious Agents – Roberto Merco (*Clemson University)*

Sincere Thanks to All Review Managers and Reviewers

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PHMAP 2019 Asia-Pacific
Beijing, China, July 25 – 28, 2019

Second Asia-Pacific Conference of the Prognostics and Health Management Society
Beijing, China

Planning Meetings:
Thursday, October 5th
9:00 – 10:30 (PHMAP2019)
10:45 – 12:15 (PHM2019)
Assembly F

Volunteers Needed!

Save the Dates!!

PHM 2019
Scottsdale, AZ, September 23 – 26, 2019

Eleventh Annual Conference of the Prognostics and Health Management Society
Scottsdale Resort at McCormick Ranch, Scottsdale, AZ
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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 International standards and technical documents. Together, SAE International and SAE ITC are helping unlock the potential of Integrated Vehicle Health Management (IVHM) technology and the economic advantages it offers through groundbreaking standards, databases and training resources.

PHM Conference 2018 Silver Sponsors

D2K Technologies (D2K) is a software solution provider dedicated to designing, implementing, testing, validating, and maintaining applications that employ model-based reasoning and machine intelligence technologies. The D2K Engineering team has over 30 years of domain experience applying these technologies to Autonomous Operations (AO) and Prognostics and Health Management (PHM) solutions.

Seagate is the global leader in data storage solutions. As demand for storage technology grows, the need for greater efficiency and more advanced capabilities continues to evolve. Today data storage is more than just archiving; it's about providing ways to analyze information, understand patterns and behavior, to re-live experiences and memories. It's about harnessing stored information for growth and innovation. Seagate is building on its heritage of storage leadership to solve the challenge of getting more out of the living information that's produced everyday.

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PHM Design, LLC is a consulting firm founded by Carl Byington, a Professional Engineer and prior Owner and Technical Director at Impact Technologies, which specialized in designing innovative Prognostics and Health Management (PHM) and Condition-based Maintenance (CBM) solutions. Through acquisitions, Carl continued with Sikorsky Aircraft and Lockheed Martin to support customers to develop and deploy predictive analytics for improved asset health management. Carl possesses over 25 years of design, analysis, and testing experience with fluid power, thermal, mechanical, and electronic systems, and performed as the Principal Investigator (PI) on over 60 programs for the US military, NASA, and other customers. He continues to provide consultative, teaching, and strategic leadership services in this area.

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calce	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
COMADEM™	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.
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diag21	Diag21 is an association that was created in 2009, at the initiative of a group of industrials Aeronautics and Defence. Its internationally oriented, is dedicated to the optimization of testability, diagnosis and prognosis (PHM) of complex systems in the areas of aerospace, land, car, rail and marine. Close to industry needs, diag21 offers exchange and service platforms.
Helicopter Association International	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.
IMS CENTER FOR INTELLIGENT MAINTENANCE SYSTEMS	The IMS Center is a leading NSF Industry/University Cooperative Research Center (I/UCRC) in the area of Prognostics and Health Management (PHM). The Center has over fifteen years of experience in developing and delivering PHM solutions for a wide-range of applications. IMS Center's mission is to enable products and systems to achieve and sustain near-zero breakdown performance, and transform maintenance data to useful information for improved productivity and asset life-cycle utilization. Since its inception, the Center has conducted over 100 successful industry and NSF supported projects, and has attracted over 80 members from all across the globe. The IMS Center was recently identified as the most economically impactful I/UCRC in NSF's recent study titled Measuring the Economic Impacts of the NSF Industry/University Cooperative Research Centers Program: A Feasibility Study. According to this study, the Center delivered its members a $846.7 Million in combined benefits over the last ten years.
Cranfield IVHM Centre / BOEING	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.
MFPT	MFPT is a non-profit professional society with a 45-year legacy of promoting failure prevention technology. An interdisciplinary technical organization, MFPT is strongly oriented towards the practical application of health management across every engineering sphere. The MFPT community includes professional scientists, engineers, failure analysts, maintenance specialists and others who represent a wide variety of disciplines from government agencies, universities, research institutes and industry.
SAE INTERNATIONAL	Since 1916, SAE has worked hand-in-hand with the aerospace community to find solutions to its most common problems through such globally adopted AS, AMS, AIR, and ARP technical documents - becoming the world's largest, most respected aerospace standards development organization. SAE makes groundbreaking contributions to efforts in Integrated Vehicle Health Management standardization and has developed a collection of resources to further this technology and the economic advantages it offers.

IJPHM

International Journal of Prognostics and Health Management

(ISSN: 2153-2648)

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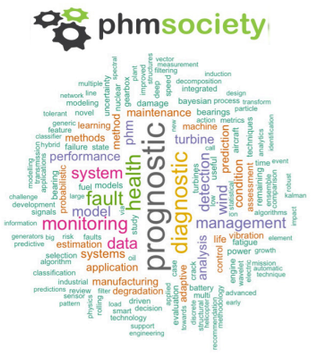

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Topics of interest

- 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
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- Structural Health Management
- Automated Reconfiguration
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- PHM System Design & Engineering
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- PHM Requirements & Specifications
- Decision Support for PHM
- Informed Logistics
- Asset Health Management
- Return-on-Investment Analysis
- Deployed PHM Applications

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Special Issue Announcements

Apart from regular issues, special issues focus on advances in research in condition monitoring applications in specific application domains. Open 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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