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phmsociety

1ST ANNUAL CONFERENCE OF THE PHM SOCIETY

SAN DIEGO, CA, USA

Sep 27 – Oct 1, 2009
Hilton San Diego Resort & Spa

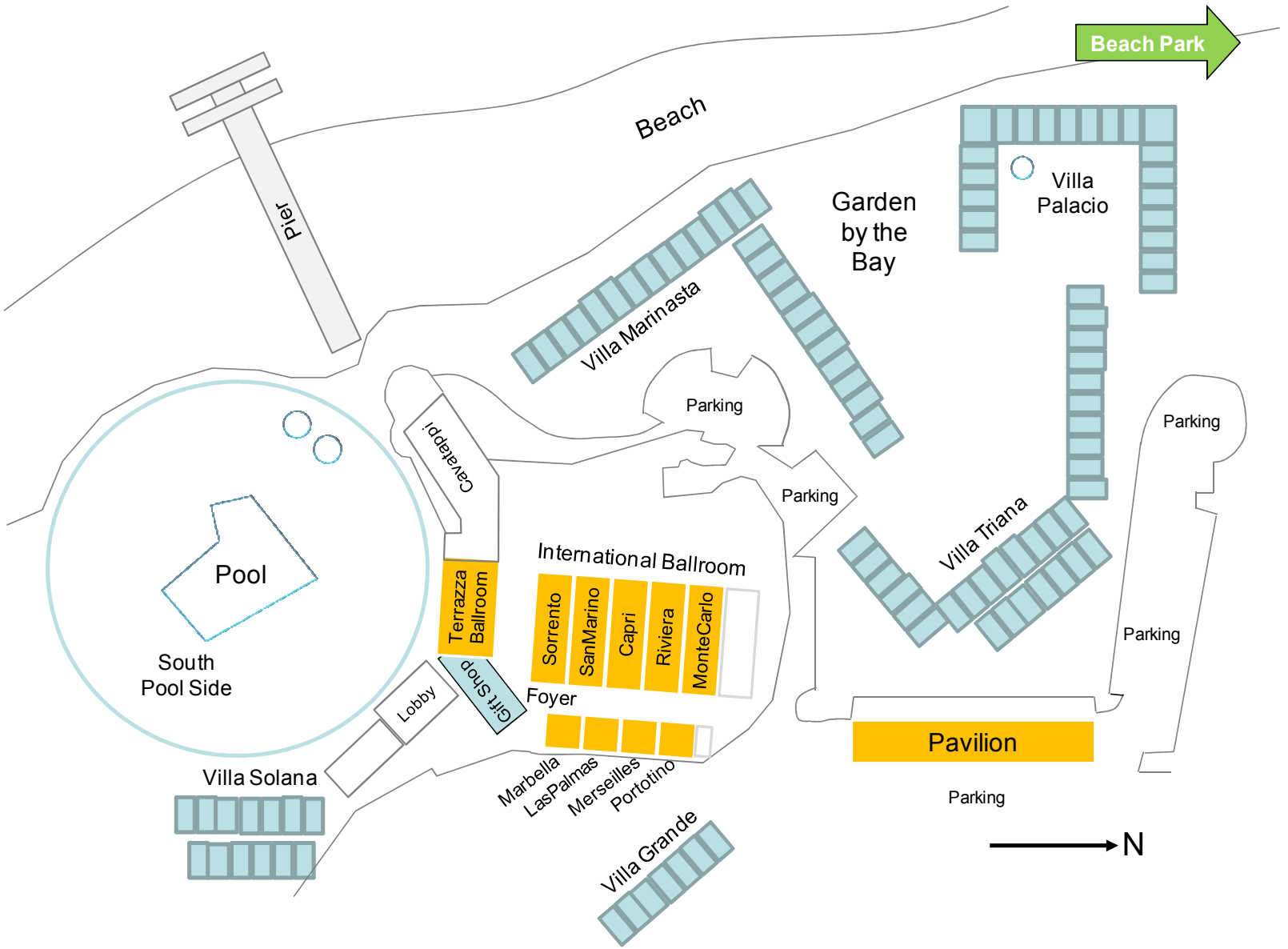



www.phmconference.org





Property Map



Note: Map not to scale

The Conference

The Prognostics and Health Management Society (PHM Society) welcomes you to its first international conference. The 2009 PHM Society Conference brings together the global community of PHM experts from industry, academia, and government in diverse application areas such as energy, aerospace, transportation, automotive, and industrial automation. The conference will feature panel discussions, hands-on demonstrations, a luminaries session, a dedicated session on fielded systems, a doctoral symposium, and a full day of tutorials free to all registrants. Results from the PHM data analysis competition will be discussed. Leading companies and research institutions will exhibit their products and demonstrate their technologies during the event. Several social events will provide opportunities for participants to connect with colleagues.

The PHM Society

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

What Sets This Conference Apart

A major differentiator for the PHM Society is its contemporary approach toward copyright: the Society will 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.

Submitted papers were reviewed by experts based on the criteria of originality, significance, quality, and clarity. The conference proceedings will be published on the web for unrestricted access by the global scholarly community (and search engines).

Doctoral Symposium

The Doctoral Symposium provides an opportunity for students to present their research interests and obtain guidance from a panel of distinguished researchers as well as comments from fellow students.

The PHM Society Doctoral Symposium will be held as a workshop on Sunday September 27, 2009. In order to allow sufficient time for discussions, the organizing committee has selected a limited number of students. Students presenting at the Doctoral Symposium will also be invited to present a poster of their research at the conference and their thesis abstract will appear in the conference proceedings. All students are invited to attend the Doctoral Symposium even if they are not interested in presenting their work.

Luminaries Session

The PHM Society is excited to announce a special Luminary Session on Prognostics as a keystone event for this year's conference. Four experts from radically different domains will challenge your perspectives on Prognosis and provide you with new insight on how to face the abundance of challenges in the PHM/CBM community. A never before seen compilation of prognosticators representing the Engineering, Meteorology, Decision Science, and Financial/Economic domains will each give a keynote speech followed by an engaging Panel Session.

Presenters:

Mr. Stephen Engel

Engineering

Steve is an Associate Technical Fellow for the Aerospace Sector of the Northrop Grumman Corporation. For nearly 20 years, Mr. Engel has focused on diagnostics and prognostics design and development for military systems. He is presently coauthor of the model-based reasoning algorithm used for Prognostics Health Management onboard the Joint Strike Fighter. He is also the technical lead responsible for the design of reasoning and prediction algorithms for DARPA's Structural Integrity Prognosis System. Mr. Engel holds a dozen patents in PHM, artificial intelligence paradigms and related technologies.

Dr. Mark E. Johnson

Meteorology / Climatology

Mark E. Johnson is Professor of Statistics at the University of Central Florida in Orlando

and has served on the Florida Commission on Hurricane Loss Projection Methodology. Professor Johnson is the author of Multivariate Statistical Simulation (Wiley) and has published in such journals as Risk Analysis, Bull. of the American Meteorological Society, Technometrics, J. of the Amer. Stat. Assoc., Biometrics, and J. of the Royal Stat. Soc.

Dr. Thomas R. Stewart
Decision Science / Policy
Thomas R. Stewart is Director of the Center for Policy Research at Rockefeller College of Public Affairs and Policy, University at Albany. He received his Ph.D. in Quantitative Psychology from the University of Illinois and has worked at the Center for Research on Judgment and Policy, Institute of Cognitive Science at the University of Colorado, and at the National Center for Atmospheric Research. Dr. Stewart's research interest is in professional judgment under conditions of complexity and uncertainty. His research includes studies of physician and weather forecaster judgment.

Dr. Jerry Nickelsburg
Financial / Economic
Jerry Nickelsburg is a senior economist at UCLA Anderson Forecast in which he plays a key role in the economic modeling and forecasting of California economies. He is a regular presenter at the Los Angeles Mayor's Economic Conference and has been cited in the Financial Times, New York Times, Los Angeles Times, Reuters, Variety, CNBC, NBC, PBS, and L.A. Business Journal. He received his Ph.D. in economics from the University of Minnesota in 1980 specializing in monetary economics and econometrics. He was formerly a professor of Economics at the University of Southern California and has held executive positions with McDonnell Douglas, Boeing as well as the Federal Reserve Board of Governors developing forecasting tools, and has advised banks, investors and financial institutions.

Fielded Systems

The Conference will feature a "Fielded Systems" session. In this session, invited speakers will discuss their experience with fielded PHM solutions. A fielded system is one that has left the prototype stage and that has been in active use over a long period of time for a sizable number of units (where "sizable" depends on the application domain). The emphasis is on sharing lessons learned, both good and bad. The lectures will provide interesting insights into what the value proposition was, which corrections had to be made, what some of the shortcomings were, and what the user reaction was (and, in addition, some anecdotal notes). These insights might provide a calibration point for transitioning PHM solutions, and they might provide ideas for future research.

The list of speakers includes:

1. **Chris Minnella**, *Impact Technologies*, LLC, and **Frank Zahiri**, *Warner Robins Air Force Base*,
   "Condition-Based Maintenance for a Vertical Machining Center-the Warner Robins Experience"
2. **Tom Dresch**, *BAE Systems*,
   "A Commercial Vehicle Fleet Health Management Solution with Machine Learning Technology"
3. **Johnny Wright**, *Goodrich Corp.*,
   "HUMS Experience"
4. **Keith Calhoun**, *Rolls-Royce*,
   "Engine PHM"
5. **Eric Hamby**, *Xerox Corporation*,
   "Lessons Learned in Deploying Diagnostic Systems"
6. **Tom Mooney**, *General Electric*,
   "Health Management for In-Service Jet Engines"
7. **Bruno Maino**, *Agusta Westland Co*.
   "AW Experience in the Analysis and Exploitation of the Transmission Vibration Monitoring Data for the Health Management of the Helicopter Gearboxes"
8. **Bart Cotton**, *Data Power Monitoring Corp.*,
   "Living History – A Tale of 9,849 Batteries"
9. **Steve O'Flarity**, *PurePower MRO Health and Data Commercial Engines and Global Services, P&W*,
   "Engine PHM"

Data Analysis Competition

The PHM Data Challenge is a competition open to all potential conference attendees. This year the challenge was focused on fault detection and magnitude estimation for a generic gearbox using accelerometer data and information about bearing geometry.

Participants were scored based on their ability to correctly identify type, location, and magnitude and damage in a gear system. Winners of the Student and the Professional categories will be recognized with a cash prize. Top scoring participants will present

their solutions at a special session of the conference.

Exhibits

The following companies will exhibit at the conference:

- Accellent Technologies
- Frontier Technologies
- General Atomics
- Global Technology Connection
- Goodrich
- Impact Technologies
- IMS Center, Univ. of Cincinnati
- Life Prediction Technologies
- Metis design
- NASA IVHM
- National Instruments
- Northrop Grumman
- PHM Technology
- Ridgetop Group
- R.K. Diagnostics
- Sörman

Please refer to the exhibits floor plan on page 14 for details on booth locations.

Hardware Demonstrations

Selected participants will show off their diagnostic and prognostic engineering approaches as PHM demonstrations at Conference. Experienced professionals will share their engineering techniques to solve health management problems with the rest of the PHM community. The concept of the PHM demonstrations is to promote a hands-on learning experience for all attendees.

The hardware and/or software PHM demonstrations will be given as hands-on tutorials to small groups. Each hands-on tutorial will last for approximately 30 minutes where attendees will be allowed to ask questions. Interested participants are asked to sign up for demonstrations onsite at the registration desk.

Sea Craft

2 paddle boats will be available free of charge to conference participants between 11:45 and 3:45 on Tuesday, Wednesday, and Thursday for use in the bay. Please see the registration desk for more details. Availability is on a first-come first-served basis.

The following demonstrations will be provided:

Tuesday, September 29, 2009		
8:30 – 9:15 am	Ultrasound Damage Detection	Intopsys
9:15 – 10:00 am	MATLAB-based Process and Equipment Monitoring (PEM) and Process and Equipment Prognostics (PEP) Toolboxes	University of Tennessee
10:00 – 10:30 am	*Break*	
10:30 – 11:15 am	Actuator/Motor Start and Extended Operation under One-Transistor Trigger Suppression and Winding Fault	Impact Technologies
11:15 am – 12:00 pm	Health Monitoring and Fault Diagnosis of Split-Torque Gearbox	University of Illinois
12:00 – 1:30 pm	*Break*	
1:30 – 2:15 pm	Prognostic Enabled EMA Test Fixture	Ridgetop Group
2:15 – 3:00 pm	Generator Prognostic and Diagnostic Algorithms	Global Technology Connection
3:00 - 3:30 pm	Break	
3:30 – 4:15 pm	Battery Prognostics Testbed	Ames Research Center
4:15 –5:00 pm	Multi-sensor Array Algorithm	Kennedy Space Center
Wednesday, September 30, 2009		
1:30 – 2:15 pm	Ultrasound Damage Detection	Intopsys
2:15 – 3:00 pm	Health Monitoring and Fault Diagnosis of Split-Torque Gearbox	University of Illinois
3:00 - 3:30 pm	*Break*	
3:30 – 4:15 pm	Actuator/Motor Start and Extended Operation under One-Transistor Trigger Suppression and Winding Fault	Impact Technologies
4:15 – 5:00 pm	Multi-sensor Array Algorithm	Kennedy Space Center
Thursday, October 1, 2009		
8:00 – 8:45 am	Battery Prognostics Testbed	Ames Research Center
8:45 – 9:30 am	Prognostic Enabled EMA Test Fixture	Ridgetop Group
9:30 – 10:15 am	*Break*	
10:15 – 11:00 am	Generator Prognostic and Diagnostic Algorithms	Global Technology Connection
11:00 – 11:45 am	MATLAB-based Process and Equipment Monitoring (PEM) and Process and Equipment Prognostics (PEP) Toolboxes	University of Tennessee

Tutorials

The tutorials will give both experienced practicioners as well as newcomers insightful information into state of the art health management techniques. The tutorials run all of Monday and are free of charge. They cover basic aspects of diagnostics and prognostics, go into how PHM connects with logistics and explain cost-benefit calculations, and discuss how to use component health information to reconfigure systems on the fly. In addition, advanced subjects such as software health management and verification and validation will be illuminated. The speakers and their subjects are listed below

Neil Eklund
Industrial Artificial Intelligence Lab
GE Global Research
"Anomaly Detection and Diagnostics"
Monday, 8am-9:45am

Neil Eklund received a B.S. in 1991, two M.S. degrees in 1998, and a Ph. D. in 2002, all at the Rensselaer Polytechnic Institute. Dr. Eklund was a research scientist at the Lighting Research Center from 1993 to 1999. He was in the network planning department of PSINet from 1999 to 2002, before joining General Electric Global Research in Niskayuna, NY in 2002. He has worked on a wide variety of research projects, including early detection of cataract using intraocular photoluminescence, multiobjective bond portfolio optimization, and on-wing fault detection and accommodation in gas turbine aircraft engines. His current research interests involve applying artificial intelligence to create robust solutions to real-world problems for the finance, aviation, and oil and gas industries. Dr. Eklund is also an adjunct professor in the Engineering/CS department at Union Graduate College in Schenectady, NY, since 2005 where he teaches classes in Computational Intelligence and Machine Learning.

Wes Hines
Professor, Nuclear Engineering Department
Director, Reliability and Maintainability Engineering
College of Engineering
University of Tennessee
"Empirical Methods for Process and Equipment Prognostics"
Monday 10:15am-12noon

Wes Hines received the BS degree in Electrical Engineering from Ohio University in 1985, and was a nuclear qualified submarine officer in the Navy. He then received both an MBA and an MS in Nuclear Engineering from The Ohio State University in 1992, and a Ph.D. in Nuclear Engineering from The Ohio State University in 1994.
Dr. Hines teaches and conducts research in artificial intelligence and advanced statistical techniques applied to process diagnostics, condition based maintenance, and prognostics. Much of his research program involves the development of algorithms and methods to monitor high value equipment, detect abnormalities, and predict time to failure. He has authored over 250 papers and has several patents in the area of advanced process monitoring and prognostics techniques.

Tim Felke
Fellow
Condition Based Maintenance Center of Excellence
Honeywell
"PHM and Logistics"
Monday, 8am-9:15am

Tim Felke joined Honeywell in 1984 as a control systems analyst and was the manager for their Systems Analysis and Engineering Sciences department for several years. He was a principle author of the proposal for the Central Maintenance Computer for the Boeing 777 and then was a leader in its development. Since then he has been an Engineering Fellow for the diagnostic and knowledge management functions of the Aircraft Diagnostic and Maintenance Systems group. In this work he has published

several papers and is the principle inventor or significant contributor on nearly a dozen patents. He holds a BS in Electrical Engineering from Arizona State University.

Peter Sandborn
Professor, Department of Mechanical Engineering / CALCE
University of Maryland
"PHM Return on Investment "
Monday, 9:15am-10:30am

Peter A. Sandborn (S'84–M'86 SM'01) received the B.S. degree in engineering physics from the University of Colorado, Boulder, in 1982; and the M.S. degree in electrical science, and Ph.D. degree in electrical engineering, both from the University of Michigan, Ann Arbor, in 1983, and 1987, respectively. He is an Associate Professor in the CALCE Electronic Products and Systems Center in the Department of Mechanical Engineering at the University of Maryland, College Park, where his interests include technology tradeoff analysis for electronic packaging, system life cycle economics, electronic part obsolescence, and virtual qualification of electronic components and systems. Prior to joining the University of Maryland, he was a founder and Chief Technical Officer of Savantage, Austin, TX, and a Senior Member of Technical Staff at the Microelectronics and Computer Technology Corporation, Austin. He is the author of over 100 technical publications and books on multichip module design, and part obsolescence forecasting.

George Vachtsevanos
Professor Emeritus
Georgia Institute of Technology
Chief Scientist, Impact Technologies
"Using Prognostics Information in Reconfigurable Control"
Monday, 10:45am-12noon

George J. Vachtsevanos is a Professor Emeritus of Electrical and Computer Engineering at the Georgia Institute of Technology. He was awarded a B.E.E. degree from the City College of New York in 1962, a M.E.E. degree from New York University in 1963 and the Ph.D. degree in Electrical Engineering from the City University of New York in 1970. He directs the Intelligent Control Systems laboratory at Georgia Tech where faculty and students are conducting research in intelligent control, neurotechnology and cardiotechnology, fault diagnosis and prognosis of largescale dynamical systems and control technologies for Unmanned Aerial Vehicles. His work is funded by government agencies and industry. He has published over 240 technical papers and is a senior member of IEEE. Dr. Vachtsevanos was awarded the IEEE Control Systems Magazine Outstanding Paper Award for the years 2002-2003 (with L. Wills and B. Heck). He was also awarded the 2002-2003 Georgia Tech School of Electrical and Computer Engineering Distinguished Professor Award and the 2003-2004 Georgia Institute of Technology Outstanding Interdisciplinary Activities Award.

Gabor Karsai
Professor, Electrical Engineering and Computer Science
Vanderbilt University
"Software Health Management"
Monday, 1:30pm-3pm

Gabor Karsai received the B.Sc., M.Sc., and Dr.Techn. degrees from the Technical University of Budapest, Budapest, Hungary, in 1982, 1984, and 1988, respectively, and the Ph.D. degree from Vanderbilt University, Nashville, TN, in 1988. He is currently a Professor of electrical engineering and computer science and a Senior Research Scientist with the Institute for Software Integrated Systems, Department of Electrical Engineering Computer Science, Vanderbilt University. He has over 25 years of experience in software engineering. He conducts research on the design and implementation of embedded systems, programming tools for visual programming environments, and the theory and practice of model-integrated computing. He has published over 100 papers and is the coauthor of four patents. He has worked on several large projects in the recent past, including one on fault-

adaptive control technology that has been transitioned into aerospace applications and another on the model-based integration of embedded systems whose resulting tools are being used in embedded software development tool chains worldwide.

Francois Hemez
Team Leader, ESA-WR Validation Methods
Los Alamos National Laboratory
"Validation and Verification"
3:30pm-5pm

François Hemez has been Technical Staff Member at Los Alamos National Laboratory since 1997. He was a member of the Weapon Response group for seven years; served as Validation Methods team leader for one year; and is currently with X-Division. He manages the code verification project of the Advanced Scientific Computing program and contributes to the development and application of Verification and Validation (V&V), uncertainty quantification, and decision-making for engineering, nuclear energy, and weapon physics projects. Dr. Hemez has a proven scientific record (over 270 publications, including 21 peer-reviewed papers) in a broad spectrum of computational science areas, including theoretical, computational, and experimental dynamics, computational physics, verification and validation, uncertainty quantification, and information theory.
Dr. Hemez co-founded and chaired the Society for Experimental Mechanics (SEM) technical division on model validation and uncertainty quantification from 2005-2009; and was elected on the SEM executive board from 2007-2009. He developed and taught the first-ever V&V graduate-level course offered in a U.S. University (University of California San Diego, spring 2006). François Hemez has received several awards for his contribution to V&V in the last decade, among which the Junior Research Award of the European Association of Structural Dynamics (2005); and two U.S. Department of Energy Defense Program Awards of Excellence for applying V&V to programmatic work at Los Alamos (2006).

Agenda

Sunday, September 27, 2009			Location	Time
Registration			**Foyer**	**7:00am-5:00pm**
Doctoral Symposium Session	*J.Bird, S.Letourneau (Chairs)*	NRC (Canada)	**Sorrento/ San Marino**	**8:00am-5:00pm**

Monday, September 28, 2009			Location	Time
Registration			**Foyer**	**7:00am-5:00pm**
Bagels and Coffee			Foyer	7:00-8:00am
Tutorial Session 1A Introduction to Diagnostics and Prognostics	*Randy Bickford (Session Chair)*	*Expert Microsystems*	**Sorrento/ San Marino**	**8:00am-12noon**
Diagnostics	W.Hines	Univ. of Tennessee(USA)		
Break - Coffee			Foyer	9:30-10:00am
Prognostics	N.Eklund	GE (USA)		
Tutorial Session 1B Advanced Topics	*G.Shao (Chair)*	*Honeywell*	**Capri/ Riviera**	**8:00am-12noon**
PHM and Logistics	T.Felke	Honeywell (USA)		
Return on Investment	P.Sanborn	CALCE/ Univ. of Maryland (USA)		
Break - Coffee			Foyer	10:30-10:45am
Using Prognostics Information in Reconfigurable Control	G.Vachtsevanos	Georgia Tech. (USA)		
Break				12noon-1:30pm
Tutorial Session 2A	*G.Shao (Chair)*		**Sorrento/ San Marino**	**1:30-3:00pm**
Software Health Management	G.Karsai	Vanderbilt Univ. (USA)		
Break - Coffee			Foyer	3:00-3:30pm
Tutorial Session 2B	*G.Shao (Chair)*		**Sorrento/ San Marino**	**3:30-5:00pm**
V&V for PHM	F.Hemez	Los Alamos National Lab (USA)		
Reception and Exhibits			**Foyer and Terrazza**	**5:30-7:30pm**

Tuesday, September 29, 2009			Location	Time
Registration			**Foyer**	**7:00am-5:00pm**
Bagels and Coffee			Foyer	7:00-8:00am
Exhibits			**Terrazza**	**8:00am-5:00pm**
Opening Remarks	[1]K.Goebel, [2] S.Uckun	[1]General Chair, [2]President (PHM Society)	**Pavilion**	**8.00-8:30am**
Hardware Demos			**Monte Carlo**	**8:30am-5:00pm**
Paper Session 1A Prognostic Methods	*M. Orchard (Session Chair)*	*University of Chile*	**Sorrento/ San Marino**	**8:30-10:00am**
Exact Nonlinear Filtering and Prediction in Process Model-Based Prognostics	[1]J.A.DeCastro, [1]L.Tang, 2Loparo, [3]K.Goebel, [4]G.Vachtsevanos	[1]Impact Tech., [2]Case Western Reserve Univ., [3]NASA Ames, [4]Georgia Tech. (USA)		
Failure Prognosis Using Timed Failure Propagation Graphs	[1]S.Abdelwahed, [2]G.Karsai	[1]Mississippi State Univ., [2]Vanderbilt Univ. (USA)		
Prognosis of Gear Health using Stochastic Dynamical Models with Online Parameter Estimation	M.Gasperin, P.Boskoski, D.Juricic	Jozef Stefan Institute (Slovenia)		
Paper Session 1B Diagnostic Methods I	*R. Rajamani (Session Chair)*	*Pratt & Whitney*	**Capri/ Riviera**	**8:30-10:00am**
Hierarchical Fault Diagnosis in Satellites Formation Flight	A.Barua, K.Khorasani	Concordia Univ. (Canada)		
A Multi-Fault Modeling Approach for Fault Diagnosis and Failure Prognosis of Engineering Systems	B.Zhang, C.Sconyers, R.Patrick, G.Vachtsevanos	Georgia Tech., Impact Techn. (USA)		
Computationally Efficient Tiered Inference for Multiple Fault Diagnosis	J.Liu, L.Kuhn, J.de Kleer	PARC (USA)		
Paper Session 1C Data Processing	*JB Schroeder (Session Chair)*	*AFRL*	**Por/Mar/ Las**	**8:30-10:00am**
A Review of Time Synchronous Average Algorithms	[1]E.Bechhoefer, [2]M.Kingsley	[1]Goodrich, [2]Sikorsky (USA)		
Application of Blind Source Separation Techniques for Generation of PHM Useful Information	[1]B.P.Leão, [2]J.P.P.Gomes, [2]R.K.H.Galvão, [2]T.Yoneyama	[1]Embraer,[2]Instituto Tecnológico de Aeronáutica (Brazil)		
Bearing Envelope Analysis Window Selection	E.Bechhoefer, P.Menon	Goodrich (USA)		
Break – Coffee			Terrazza	10:00-10:30am
Paper Session 2A Damage Estimation	*K. Hicks (Session Chair)*	*JPL*	**Sorrento/ San Marino**	**10:30am-12noon**
Estimation of Life Consumption for Advanced Drilling Tools	D.Garvey, M.John, J.Baumann	Baker Hughes (Germany)		
New Processing to Detect and Track Damage in an Aerospace Wing Attachment Fitting	D.L.Parker, W.G.Frazier	Miltec (USA)		

Tuesday, September 29, 2009			Location	Time
Physics-based Remaining Useful Life Prediction for Aircraft Engine Bearing Prognosis	[1]N.Bolander, [2]H.Qiu, [2]N.Eklund, [3]E.Hindle, [3]T.Rosenfeld	[1]Sentient, [2]GE Global, [3]GE Aviation(USA)		
Paper Session 2B Sensing and Sensor Architectures	*A. Saxena (Session Chair)*	*SGT*	**Capri/ Riviera**	**10:30-11.30am**
Carbon Nanotube Coated Piezoelectric Ceramic for Self-Health-Monitoring	L.Zhang, G.Lanzara, F.K.Chang	Stanford Univ. (USA)		
Power Management for A Distributed Wireless Health Management Architecture	[1]S.Saha, [1]B.Saha, [2]K.Goebel	[1]MCT, [2]NASA Ames (USA)		
Paper Session 2C Anomaly Detection	*M. Roemer (Session Chair)*	*Impact*	**Por/Mar/ Las**	**10:30am-12noon**
A novel Bayesian Least Squares Support Vector Machine based Anomaly Detector for Fault Diagnosis	T.Khawaja, G.Vachtsevanos	Georgia Tech. (USA)		
A Systematic PHM Approach for Anomaly Resolution: A Hybrid Neural Fuzzy System for Model Construction	P.P.Bonissone, X.Hu, R.Subbu	GE (USA)		
Signal Stream Clustering for Tool-Rotation-Level Tool Condition Monitoring in Milling Process	[1]S.J.Phua, [1]X.Li, [2]W.K.Ng, [1]B.S.Lim, [1]W.Zhong, [1]J.Zhou	[1]SIMTech, [2]Nanyang Technology Univ. (Singapore)		
Box Lunch at the Beach Park				12noon-1:30pm
Paper Session 3A Uncertainty Management	*R. Mackey (Session Chair)*	*JPL*	**Sorrento/ San Marino**	**1:30-3:00pm**
A Novel RSPF Approach to Prediction of High-Risk, Low-Probability Failure Events	[1]M.Orchard, [2]L.Tang, [3]K.Goebel, [4]G.Vachtsevanos	[1]Univ. of Chile (Chile), [2]Impact Tech., [3]NASA Ames [4]Georgia Tech (USA)		
Entropy-based probabilistic fatigue damage prognosis and algorithmic performance comparison	[1]X.Guan, [1]Y.Liu, [2]A.Saxena, [2]J.R.Celaya, [3]K.Goebel	[1]Clarkson Univ., [2]SGT, [3]NASA Ames (USA)		
Uncertainty Quantification in Fatigue Damage Prognosis	S.Sankararaman, Y.Ling, C.Shantz, S.Mahadevan	Vanderbilt Univ. (USA)		
Paper Session 3B PHM System Design and Benchmarking	*W. Hines (Session Chair)*	*University of Tennessee*	**Capri/ Riviera**	**1:30-3:00pm**
Benchmarking Diagnostic Algorithms on an Electrical Power System Testbed	[1]T.Kurtoglu, [2]S.Narasimhan, [3]S.Poll, [4]D.Garcia, [5]S.L.Wright	[1]MCT, [2]UARC, [3]NASA Ames, [4]SGT, [5]Vanderbilt Univ. (USA)		
Integrated Design of On-line Health and Prognostics Management	M.Walker, R.Kapadia	General Atomics (USA)		

Tuesday, September 29, 2009			Location	Time
Towards StateCharts Based Failure Propagation Analysis for Designing Embedded PHM Systems	S.Kramer, I.Tumer	Oregon State Univ. (USA)		
Paper Session 3C Data-Driven Diagnostics	*P. Bonissone (Session Chair)*	*GE Global Research*	**Por/Mar/ Las**	**1:30-3:00pm**
Data-Driven Roller Bearing Diagnosis Using Degree of Randomness and Laplace Test	[1]B.Ling, [2]M.Khonsari, [3]R.Hathaway	[1]Migma Systems, [2]Louisiana State Univ., [3]NASA Dryden (USA)		
Investigation on Fault Detection for Split Torque Gearbox Using Acoustic Emission and Vibration Signals	[1]R.Li, [1]D.He, [2]E.Bechhoefer	[1]Univ. of Chicago, [2]Goodrich (USA)		
Model Based Bearing Fault Detection Using Support Vector Machines	K.Kappaganthu, C.Nataraj, B.Samanta	Villanova Univ. (USA)		
Break – Coffee			Terrazza	3:00-3:30pm
Workshop Session Education in PHM	*K.Reichard (Chair)*	Penn State Univ. (USA)	**Sorrento/ San Marino**	**3:30-5:00pm**
Townhall Meeting Future Trends in CBM & PHM	*[1]A.Hess and [2]G.Shao (Chairs)*	[1]Hess Group, [2]Honeywell (USA)	**Capri/ Riviera**	**3:30-5:00pm**
Posters			**Pavilion**	**5:30-7:30pm**
Reception			**Pavilion**	**5:30- 7:30pm**

Workshop on Education in PHM

3:30 – 5:00pm, Tuesday
Sorrento/San Marino

The goals of the PHM Society include promotion of PHM Education in Industry and Academia as well as providing a conduit for the presentation and dissemination of PHM Research and Information. This Session is meant to provide a forum for discussion how the PHM Society can best meet these goals. Discussion topics include:

- How can the PHM Society promote and provide educational opportunities
- What kinds of educational services are attractive to members
- How can the PHM Journal best serve both the academic and industrial communities

Townhall Meeting on Future Trends in CBM and PHM

3:30 – 5:00pm, Tuesday
Capri/Riviera

During this event, we will discuss future trends in CBM and PHM. The meeting is moderated by a panel of recognized leaders in the field. Using the "Townhall Meeting" style, participants are invited to actively engage with the panel in discussing roadmaps, challenges and enablers, amongst others. This event promises to provide an interesting experience for all participants.

Wednesday, September 30, 2009			Location	Time
Registration			**Foyer**	**7:00am-5:00pm**
Bagels and Coffee			Foyer	7:00am-8:00am
Luminaries Session	*G.Kacprzynski (Chair)*	Impact Tech. (USA)	**Pavilion**	**8:00-9:30am**
Engineering	S.Engel	Northrop Grumman (USA)		
Meteorology / Climatology	M.Johnson	Univ. of Central Florida (USA)		
Percolation Break: Coffee & Refreshments			Pavilion	9:25-9:40am
Luminaries Session	*G.Kacprzynski (Chair)*	Impact Tech. (USA)	**Pavilion**	**9:40-10:45am**
Decision Science / Medical	T.Stewart	SUNY Albany (USA)		
Financial / Economic	J.Nickelsburg	UCLA Anderson Forecast(USA)		
Percolation Break: Coffee & Refreshments			Pavilion	10:45-11:00am
Plenary Session (all luminaries)	*G.Kacprzynski (Chair)*	Impact Tech. (USA)	**Pavilion**	**11:00-11:45am**
Best Paper Award Data Challenge Awards	[1]*K. Reichard,* [2]*N.Eklund (Chairs)*	[1]Penn State Univ., [2]GE (USA)	**Pavilion**	**11:45am-12noon**
Exhibits			**Terrazza**	**12noon-5:00pm**
Break				12noon-1:30pm
Hardware Demos			**MonteCarlo**	**1:30pm-5:00pm**
Paper Session 4A Data Challenge 2009 I	[1]*N. Eklund,* [2]*B.Saha,* [3]*E.Bechhoefer (Chairs)*	[1]GE, [2]MCT, [3]Goodrich (USA)	**Sorrento/ San Marino**	**1:30–3:00pm**
Information Reconstruction Method for Clustering and Diagnosis of Generic Gearbox Signals	[1,2]F.Wu, [1]Y.Shen, [2]Z.Lee	[1]Xi'an Jiaotong Univ. (China), [2]Univ. of Cincinnati (USA)		
A Systematic Methodology for Gearbox Health Assessment and Fault Diagnosis	A.Al-Atat, D.Siegel, Z.Lee	Univ. of Cincinnati (USA)		
Paper Session 4B System-Level Health Reasoning	*S. Uckun (Session Chair)*	*PARC*	**Capri/ Riviera**	**1:30–3:00pm**
A Prognostics and Health Management System for an Unmanned Combat Aircraft System – A Defense Acquisition University Case Study	R.Di Lorenzo, H.Bayer	Defense Acquisition Univ.- Mid-West (USA)		
Integrating Model-based Diagnosis and Prognosis in Autonomous Production	[1]P.Maier, [2]M.Sachenbacher, [2]T.Ruhr, [2]L.Kuhn	[1]Technical Universität München (Germany), [2]PARC (USA)		
The Interaction of PSS and PHM - a Mutual Benefit Case	T.Grubic, I.Jennions, T.Baines	Cranfield Univ. (U.K)		
Paper Session 4C Validation, Verification & Metrics	*I. Tumer (Session Chair)*	*Oregon State University*	**Por/Mas/ Las**	**1:30–3:00pm**

Wednesday, September 30, 2009			Location	Time
APU FMEA Validation Using Operation and Maintenance Data	C.Yang, S.Letourneau, E.Scarlett, M.Zaluski	NRC (Canada)		
On Applying the Prognostics Performance Metrics	[1]A.Saxena, [1]J.R.Celaya, [2]B.Saha, [2]S.Saha, [3]K.Goebel	[1]SGT, [2]MCT, [3]NASA Ames (USA)		
Towards Verification of Operational Procedures using Auto-Generated Diagnostic Trees	[1]T.Kurtoglu, [2]R.Lutz, [3]A.Patterson-Hine	[1]MCT, [2]JPL/Caltech [3]NASA Ames (USA)		
Break – Coffee			Foyer	3:00-3:30pm
Paper Session 5A Data Challenge 2009 II	*1N.Eklund, [2]B.Saha, [3]E.Bechhoefer (Chairs)*	[1]GE, [2]MCT, [4]Goodrich (USA)	**Sorrento/ San Marino**	**3:30-5:00pm**
Model Based Approach for Identification of Gears and Bearings Failure Modes	R.Klein, E.Rudyk, E.Masad, M.Issacharoff	R K Diagnostics (Israel)		
Bearing fault detection with PHM Data Challenge Application	[1]P.Boskoski, [2]A.Urevc	[1]Institute Jožef Stefan, [2]Univ. of Ljubljana (Slovenia)		
Paper Session 5B Model-Based Diagnostics	*JB Schroeder (Sessino Chair)*	*AFRL*	**Capri/ Riviera**	**3:30-5:00pm**
Computing Multiple Minimal Diagnoses	[1]A.Feldman, [2]G.Provan, [1]A.van Gemund	[1]Delft Univ. of Technology (Netherlands), [2]Univ. College Cork (Ireland)		
Experimental Data Collection and Modeling for Nominal and Fault Conditions on Electro-Mechanical Actuators	[1]E.Balaban, [2]A.Saxena, [1]K.Goebel, [3]C.Byington, [3]M.Watson, [3]S.Bharadwaj, [3]M.Smith	[1]NASA Ames, [2]SGT, [3]Impact Technologies (USA)		
Online Model-based Diagnosis for Multiple, Intermittent and Interaction Faults	L.Kuhn, J.de Kleer, J.Liu	PARC (USA)		
Paper Session 5C: Adaptive Control and Decision-Making	*L. Hernandez (Sessino Chair)*	*Global Strategic Solutions*	**Por/Mar/ Las**	**3:30-5:00pm**
Situational Awareness and Decision-Making for Distressed Aircraft	I.Lopez, N.Sarigul-Klijn	UC Davis (USA)		
Diagnosis and Fault-Adaptive Control for Mechatronic Systems using Hybrid Constraint Automata	P.Maier, M.Sachenbacher	Technical Universität München (Germany)		
Prognostics Enhanced Reconfigurable Control of Electro-Mechanical Actuators	[1]D.W.Brown, [1]G.Georgoulas, [1]B.Bole, [2]H.-L.Pei, [3]M.Orchard, [4]L.Tang, [5]B.Saha, [6]A.Saxena, [7]K.Goebel, [1]G.Vachtsevanos	[1]Georgia Tech, [2]S.China Univ. of Tech. (China), [3]Univ. of Chile (Chile), [4]Impact Tech. [5]MCT, [6]SGT, [7]NASA Ames (USA)		
Banquet Dinner			**Prado**	**5:30-9:00pm**

Thursday, October 1, 2009			Location	Time
Registration			**Foyer**	**7:00am-5:00pm**
Bagels and Coffee			Foyer	7:00-8:00am
Hardware Demos			**MonteCarlo**	**8:00-11:45am**
Paper Session 6A Structural Health Management	*T. Kurtoglu*	*MCT*	**San Marino**	**8.00-9:00am**
A Cable-Free Digital Sensor-Bus for Structural Health Monitoring of Large Area Composite Structures	[1]S.S.Kessler, [1]C.T.Dunn, [1]M.Borgen, [1]A.Raghavan, [2]J.Duce, [2]D.L.Banks	[1]Metis, [2]Boeing (USA)		
An Integrated Health Management and Prognostic Technology for Composite Airframe Structures	F.-K.Chang, I.Mueller, S.Roy, A.Mittal, K.Lonkar, C.Larrosa	Stanford Univ. (USA)		
Paper Session 6B Diagnostic Methods II	*K. Reichard (Chair)*	*Penn State University*	**Capri/ Riviera**	**8.00-9:30am**
Combination of Simulation and State Observers for Consistency-based Diagnosis	A.Bregon, B.Pulido, C.Alonso-Gonzalez	Univ. of Valladolid (Spain)		
Efficient on-line parameter estimation in TRANSCEND for nonlinear systems	[1]A.Bregon, [1]B.Pulido, [2]G.Biswas	[1]Univ. of Valladolid (Spain), [2]Vanderbilt Univ. (USA)		
Fault diagnostic system based on approximate reasoning	P.Boškoski, B.Musizza, J.Petrovcic, D.Juricic	Institute Jožef Stefan (Slovenia)		
Paper Session 6C Return-on-Investment Analysis	*J. Bird (Chair)*	*NRC*	**Por/Mar/ Las**	**8.00-9:30am**
Cost-Benefit Analysis Trade-Space Tool as a Design-Aid for the U.S. Army Vehicle Health Management System (VHMS) Program	[1]J.Hines, [1]L.Bennett, [1]C.Ligetti, [1]J.Banks, [2]S.Nestler	[1]ARL-Penn State, [2]US Military Academy - West Point (USA)		
Metrics, Models, and Scenarios for Evaluating PHM Effects on Logistics Support	J.J.Luna	Frontier Technologies (USA)		
Using Condition Based Maintenance to Improve the Profitability of Performance Based Logistic Contracts	J.Reimann, G.Kacprzynski	Impact Tech. (USA)		
Break – Coffee			Foyer	9:30-9:45am
Paper Session 7A Health Management for Electrical & Electronic Systems	*S. Vohnout (Chair)*	*Ridgetop Group*	**San Marino**	**9:45-11:15am**
Analysis of Built-In Self-Tests for Electronic Control Units	[1]K.W.Przytula, [1]D.Allen, [1]T.-C.Lu, [2]N.Anderson, [2]J.Wanner	[1]HRL Labs, [2]Phoenix Intl. (USA)		

Thursday, October 1, 2009			Location	Time
Effects of Lightning Injection on Power-MOSFETs	[1]J.R.Celaya, [2]S.Saha, [3]P.Wysocki, [4]K.Goebel	[1]SGT, [2]MCT, [3]ASRC, [4]NASA Ames (USA)		
Robust Differential Protection with Intermittent Cable Faults for Aircraft AC Generators	A.Tantawy, X.Koutsoukos, G.Biswas	Vanderbilt Univ. (USA)		
Paper Session 7B Probabilistic Methods	*N. Frankle (Session Chair)*	*Frontier Technologies*	**Capri/ Riviera**	**9:45-11:15am**
Health Monitoring Assessment and Prognostic (HealthMAP) for Advanced Arresting Gear (AAG) System	R.Kapadia, R.Gross, M.Walker, M.Venkatesh	General Atomics(USA)		
Methods for Probabilistic Fault Diagnosis: An Electrical Power System Case Study	[1]B.Ricks, [2]O.Mengshoel	[1]Univ of Texas, [2]CMU-Silicon Valley (USA)		
Probabilistic Structural Health Monitoring Using Acoustic Emission	M.Rabiei, M.Modarres, P.Hoffman	Univ. of Maryland (USA)		
Paper Session 7C Physics-of-Failure Modeling	*P. Dussault*	*US Army*	**Por/Mar/ Las**	**9:45-11:15am**
Model-Based Diagnostics and Prognostics for Solid Rocket Motors	[1]D.G.Luchinsky, [1]V.V.Osipov, [2]V.N.Smelyanskiy, [2]A.Patterson-Hine, [3]B.Hayashida, [3]M.Watson, [4]J.McMillin, [5]D.Shook, [6]M.Johnson, [7]S.Hyde	[1]MCT, [2]NASA Ames, [3]NASA Marshall, [4]ATK Thiokol (USA)		
Model-based Prognostics with Fixed-lag Particle Filters	[1]M.Daigle, [2]K.Goebel	[1]UC Santa Cruz, [2]NASA Ames (USA)		
Modeling Li-ion Battery Capacity Depletion in a Particle Filtering Framework	[1]B.Saha, [2]K.Goebel	[1]MCT, [2]NASA Ames (USA)		
Break			Capri/ Riviera	11:15am-12:30pm
Fielded Systems Invited Session	*[1]A.Hess, [2]G.Vachtsevanos (Chairs)*	[1]Hess Group, [2]Georgia Tech	Capri/ Riviera	**12:30-3:50pm**
Condition-Based Maintenance for a Vertical Machining Center	C.Minnella	Warner Robins Air Logistics Center, Impact Tech. (USA)		
The Hybrid Bus PHM Experience	T. Dresch	BAE Systems (USA)		
HUMS Experience	J.Wright,	Goodrich (USA)		
Engine PHM	Keith Calhoun	Rolls-Royce (UK)		
Lessons Learned in Deploying Diagnostic Systems	E.Hamby	Xerox Corp. (USA)		
Health Management for In-Service Jet Engines	T.Mooney	GE (USA)		
Health Management of Helicopter Gearboxes	B.Maino	Agusta Westland (Italy)		
Thursday, October 1, 2009			Location	Time

Monitoring Backup Battery Systems: Lessons Learned	B.Cotton	Data Power Monitoring Corp. (USA)		
Engine Monitoring	S.O'Flarity	Pratt & Whitney (USA)		
Break – Coffee			Foyer	3:50-4:00pm
Fielded Systems / Plenary (All Fielded Systems Presenters)	[1]*A.Hess,* [2]*G.Vachtsevanos (Chairs)*	[1]Hess Group, [2]Georgia Tech (USA)	Capri/ Riviera	**4:00-4:50pm**
Final Remarks	K.Goebel	General Chair	Capri/ Riviera	**4:50-5:00pm**
Event Ends				**5:00pm**

Poster Details

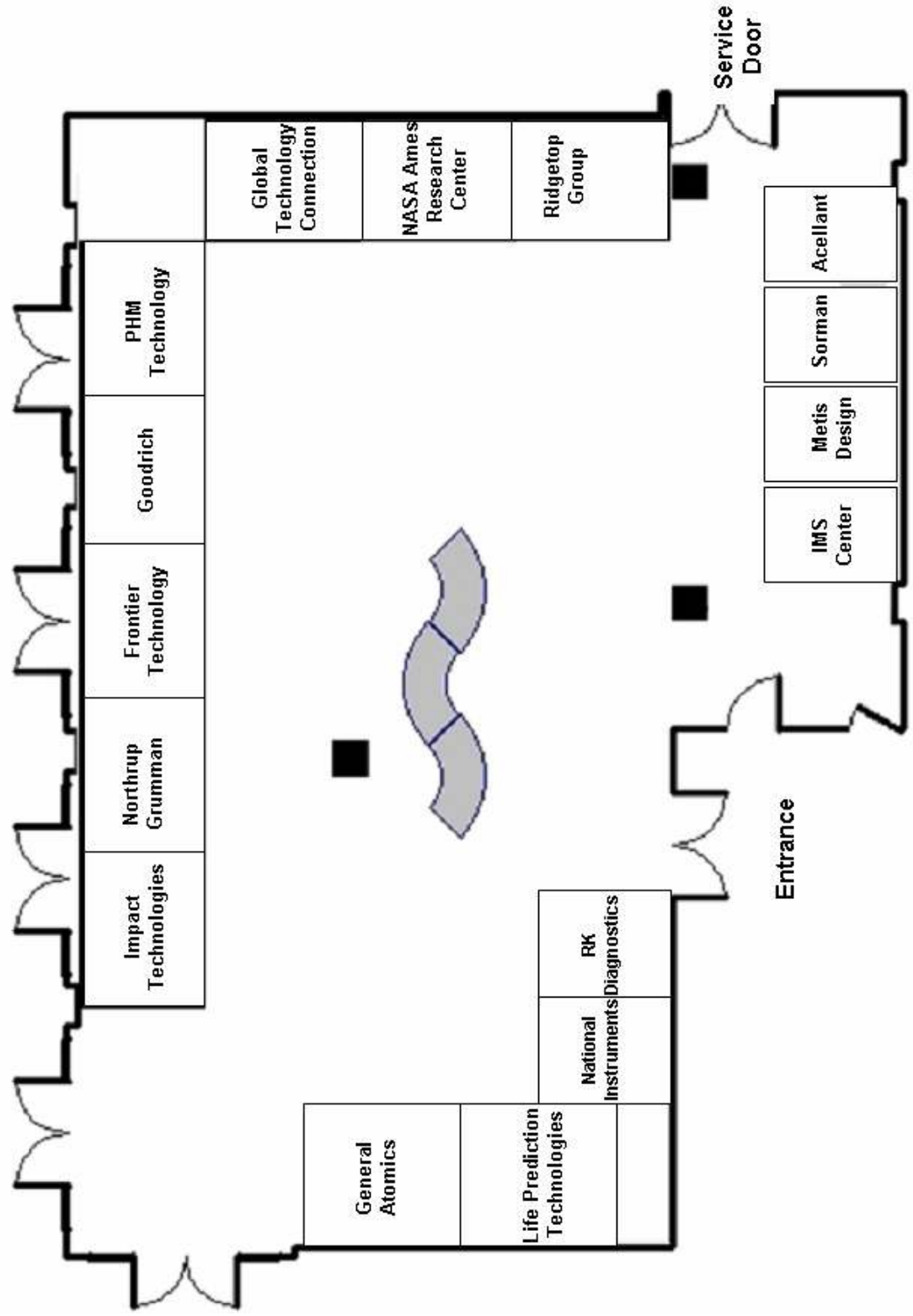
Poster Title	Authors	Affiliations
A Maturation Environment to Develop and Manage Health Monitoring Algorithms	J.Lacaille	Snecma (France)
A prognosis case study for electrolytic capacitor degradation in DC-DC converters	C.Kulkarni, G.Biswas, X.Koutsoukos	Vanderbilt Univ. (USA)
A Prognostic Model for Electrohydraulic Servovalves	L.Borello et al.	Politecnico of Turin (Italy)
A state-space model for multi-scale fatigue damage prognosis	J.He, Z.Lu, Y.Liu	Clarkson Univ. (USA)
A System-Level Approach to Fault Progression Analysis in Complex Engineering Systems	M.Abbas, G.Vachtsevanos	Georgia Tech. (USA)
An Innovative Approach to Electromechanical Actuator Emulation and Damage Propagation Analysis	N.Kunst, C.Lynn	Ridgetop (USA)
An Intelligent Architecture for on-line Failure Prognosis using Probabilistic Least Squares Support Vector Regression Machines	T.Khawaja, G.Vachtsevanos	Georgia Tech. (USA)
An Overview of Prognosis Health Management Research at GRC for Gas Turbine Engine Structures with Special Emphasis on Deformation and Damage Modeling	S.Arnold et al.	NASA Glenn (USA)
ARINC 573/717, 767 and 647A: The Logical Choice for Maintenance Recording and IVHM Interface Control or Frame Updates	M.D.Sudolsky	Boeing (USA)
Classification of wear phenomena by specific ultrasonic emission detection for prognostic purposes	K.U.Dettman, D.Soeffker	Univ. of Duisburg (Germany)
Complex System Prognostics : a New Systemic Approach	F.Peysson, M.Ouladsine,R.Outbib	University Paul Cezanne, Marseille (France)

Poster Title	Authors	Affiliations
Design of an Electrical Power System using a Functional Failure and Flow State Logic Reasoning Methodology	D.C.Jensen, I.Tumer, T.Kurtoglu	Oregon State Univ., MCT (USA)
Effect of Electrostatic Discharge on Electrical Characteristics of Discrete Electronic Components (Technical Brief)	P.Wysocki et al.	ASRC (USA)
Fuzzy Neural Network Modelling for Tool Wear Estimation in Dry Milling Operation	X.Li et al.	Singapore Institute of Manufacturing Tech (Singapore)
Generating a diagnostic system from an automated FMEA	N.Snooke	Aberystwyth Univ. (U.K)
Health Indices Based on Morphology and Complexity Measures of Vibration Signals for Machine Condition Monitoring and Prognostics	B.Samanta, C.Nataraj	Villanova Univ. (USA)
Health prognosis based on an new approach for damage accumulation calculation	K.U.Dettmann, D.Soeffker	Univ. of Duisburg-Essen (Germany)
Identifying Optimal Prognostic Parameters from Data: A Genetic Algorithms Approach	J.B.Coble, J.W.Hines	Univ. of Tennessee (USA)
Incorporating Active Healing and Feedback in Structural Systems	D.Huston, D.Hurley, A.Gervais, K.Gollins	Univ. of Vermont (USA)
Integrated Approach to Capability Enhancement and Maintenance: A Proposed Framework	E.Kelly, S.Ratchev	Univ. of Nottingham (U.K)
Optimal Feature Set for Detection of Inner Race Defect in Rolling Element Bearings	K.Kappaganthu, C.Nataraj, B.Samanta	Villanova Univ. (USA)
Overview of PHMBIT	B.Woollard	Raytheon (USA)
Prognostics Framework for Remaining Life Prediction of Cutty Sark Iron Structures	Y.Z.Rosunally et al.	Univ. of Greenwich (UK)
Reducing Uncertainty in Damage Growth Properties by Structural Health Monitoring	A.Coppe et al.	Univ. of Florida (USA)
The Effects on Fatigue Life of Aluminum Based on Surface Conditions	O.Scott-Emuakpor, T.George, C.Cross	AFRL (USA)
Towards Accelerated Aging Methodologies and Health Management of Power MOSFETs	J.Celaya et al.	SGT

Doctoral Symposium Posters

Poster Title	Author	Affiliation
Multi-Sensor Based Framework for Machine Condition Monitoring	A.Rezaei	Queen's University (Canada)
Identification of Structure-Specific Damage Properties and its Impact on Improved Prognosis	A.Coppe	University of Florida (USA)
Heterogeneous and Dated Data for Optimizing Operations and Maintenance on Aircraft Fleets	A.B.Zakour	LaBRI (France)
Nonlinear Filtering for PHM	B.Leão	Instituto Tecnológico de Aeronáutica (Brazil)
Function-Based Failure and Flow State Reasoning for Robust PHM Development	D.Jensen	Oregon State Univ. (USA)
Prognostics Enhanced Reconfigurable Control of Electro-Mechanical Actuators and Related Systems	D.W.Brown	Georgia Tech. (USA)
Engine Gearbox Prognostics Based on Vibration Analysis and In-line Oil Debris Monitoring: Technical and Economical Merits	S.Alneri et al.	Alta Scuola Politecnica, Politecnico di Torino (Italy)
Structural Health Diagnostics of Dynamic Vehicles Under Uncertainty	I.Lopez	Univ. of California, Davis (USA)
An Automated Approach for Fusing Data Sources to Identify Optimal Prognostic Parameters	J.Coble	Univ. of Tennessee, Knoxville
IVHM- An Enabler to the "Servitization" of Companies within the Manufacturing Sector - A Model Approach	L.Redding	Cranfield Univ. (UK)
Pervasive Reasoning: Integration of Planning and Health Information Gathering	L.Kuhn	Technical University of Munich (Germany)
Self-Diagnosis and Self-Planning with Constraint-based Hybrid Models	P.Maier	Technische Universität München (Germany)
Condition Monitoring of High Reliability Electronics using Resistance Based Methods	R.Lowe	Auburn Univ. (USA)

Exhibits Floor Plan



Conference Banquet at the Prado
(Wednesday, September 30)

The conference banquet will take place at the historic Prado Restaurant in Balboa Park. *Tour buses will leave the hotel around 5:20 pm. Please meet outside the lobby immediately following the technical sessions.*

Travel and Sightseeing

Must-visit Places

- La Jolla
- Old Town
- Seaport Village
- Coronado
- Balboa Park
- World Famous San Diego Zoo
- Cabrillo National Monument

Tours

Tours will take place during the technical sessions and are geared towards spouses and guests that may not be as interested in the technical sessions. Tours will be conducted by a bus. *There are a limited number of seats on the bus, so please be sure to confirm attendance to ensure that you can participate in this event.*

Tour of General Atomics
(Monday, September 28)

Sign up for this event is now closed.

The tour will include demonstrations of the following facilities at **General Atomics**:

- Magnetic Levitation (MagLev)
- BioFuels pond and lab
- Fusion area

General Atomics (GA) was conceived in 1955 at San Diego, California for the purpose of harnessing the power of nuclear technologies for the benefit of mankind. General Atomics' basic research into fission and fusion has matured into competence in many technologies, making GA and its affiliated companies one of the world's leading resources for high-technology systems development ranging from the nuclear fuel cycle to remotely operated surveillance aircraft, airborne sensors, and advanced electric, electronic, wireless and laser technologies.

The tour bus will leave at 8:30am on Monday morning and will return around noon. Please board the bus by 8.15am.

San Diego City Tour
(Tuesday, September 29)

Enjoy a San Diego journey through the vibrant downtown areas of Gaslamp Quarters with its old world buildings. Travel along The Embarcadero with its wonderful harbor views, home of one of the oldest merchant sailing ships in the world. Drive through Balboa Park with its unique Exposition Museums. A drive across the Bay to Coronado with its charming streets, beautiful beaches and National Historic Landmark Hotel del Coronado is also included. Visit to La Jolla, known as the Jewel of the Pacific, a charming seaside village with many upscale shops and eateries with panoramic ocean views. Visit colorful Old Town, California's birthplace.

The tour bus will leave the hotel at 9 am and return around 4 pm.

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