phmsociety

PHM Education and Professional Development Panel REPORT

Let's workshop PHM Offerings and Needs. Nov. 1 , 2022

Welcome and intro: Jeff Bird (PHM Society and TECnos)

Resource Examples and Provocative Questions by panelists

Prof. Jamie Coble- Univ. Tennessee Knoxville

Prof. Sankaran Mahadevan- Vanderbilt

Dave Larsen- Collins Aerospace

Open discussion and Prioritization of Opportunities

Moderator: Dr. Karl Reichard, Penn State

How the PHM Society is trying to help- taxonomy, Professional Development Guidelines, portal, short courses, conference education, …

1. **What are some existing PHM education and professional development resources?**
2. **What do you need, and how do we justify it?**
3. **How could the PHM Society help?**

Desired Outcomes

> Summary of access methods: PHM Society website & standards page; dedicated sites

> Priorities on gaps in knowledge & processes

PHM Society Education and Professional Development Committee

Jeff Bird, Jamie Coble, Nancy Madge, Karl Reichard and George Vachtsevanos

PHM Society Role?

Society Objectives

1. Free access to PHM knowledge,
2. Interdisciplinary and international collaboration
3. Advance the engineering discipline

Observations

1. Diverse body of PHM knowledge out there: Standards, lessons learned, information, few case studies
2. Multi-disciplinary awareness and engagement is lacking: Many entrants come from single specialities
3. Wide continuing standards participation is difficult: Small companies, long time frame for development
4. To mature knowledge from theory to practice is challenging: Knowing about relevant standards across disciplines, Developing Body Of Knowledge to complement academic training
5. Data and information sharing protocols are essential but problematic: Proprietary and sector specific information

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PHM Taxonomy- what is the scope of PHM?

"A set of capabilities, information and decision-making tools for diagnosis, prognosis and health management of complex systems – Integrating technologies from systems engineering, reliability, analytics"

1. System physical modeling
2. Data Modeling
3. Analytics
4. Test and Experimental (Design and conduct)
5. Software Systems
6. Hardware Systems

7. Life Cycle Analysis
8. Verification and Validation
9. Human Factors
10. System Engineering
11. Cost Benefit Analysis
12. Certification
13. Standards
14. Digital Transformation (new)

PHM Society EPD Activities

Traditional

1. Panels and tutorials at conferences
2. Pre-conference short courses-

New initiatives

1. PHM EPD Portal: One stop for docs, resources, forum, taxonomy
2. *EPD Users Group and EPD Guidelines*

PHM Fundamentals and Case Studies Short Course

Introduction to PHM
Deriving Requirements for PHM
PHM Performance Metrics
Methods- Diagnostics, Prognostics, Analytics
Case Studies - Methods
Sensors and Processing
Small Group Workshop 1
CBM+ Technologies
PHM Cost Benefit Analysis
Small Group Workshop 2
Fielded Systems Case Studies CBM, CBA
Way forward (you and us)

Analytics for PHM Short Course with examples

Overview of data-driven PHM
Review- Fundamental statistics, Data Visualization
Machine learning - introduction and concepts
Data transformation & Feature Extraction
Methods- Classification and Regression
Introduction to Neural Networks
Hands-on Lab
Feature Selection and Characterizing Performance
Model Selection and Anomaly Detection
Deep Learning I, II and Applications
Practical matters
Hands-on Lab

Sampling of PHM EPD Resources

1. Internal technical programs- Collins Aerospace technical University- Systems College, Communities of Practice, mentoring
2. Open online courses (audit and credit)
    - Coursera: course (weeks-months), specialization (3-5), certificate with project, degree
        - Machinery failure analysis (21): machine design, survival analysis, materials
        - Data science (3179): data analysis, machine learning, probability and statistics
        - Signal processing (45): filtering, images/audio/biodata, GPU programming
        - Systems engineering (1331): model-based, requirements, dynamics, fluids, architecture
        - Technical supervisor (29): communications, products, entrepreneur
        - Certification engineering (398?): risk, quality, design, manufacturing
    - AWS: courses (hours), learning plans by roles or solutions (e.g., 15 courses for 12-26 hours), skill builder

Workshop Panelists

Prof. Jamie Coble- Univ. Tennessee Knoxville

Prof. Sankaran Mahadevan- Vanderbilt

Dave Larsen- Collins Aerospace

Questions to be addressed:

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Discussions Among 40+ attendees

- Need to identify the core competencies needed by industry and academia for PHM professionals: can we crowd source ideas in the particular fields to identify common themes to drive new courses, webinars, resources compilations, …
- Universities are working to provide bridges to industry needs for new workers- engineering informed statistics, internships, capstone projects, 1 year M. Eng. and full collaborative projects
- Industry pull is encouraged, e.g., 'soldier-sponsored'; Disconnects exist between what universities teach and what professionals need. PHM Society could promote more interactions.
- NIST has some best practice resources https://www.nist.gov/programs-projects/prognostics-and-health-management-reliable-operations-smart-manufacturing-phm4sm; SAE on cost benefit analysis
- "YouTube" model for learning- short, specific sources of information but need for integration and experience
- Need to distinguish/highlight PHM augmentations to conventional systems engineering- PHM is seen as an activity (not always necessary) but not a discipline
- Collins uses an internal Community of Practice to share and mentor in addition to their Technical University's System Engineering School
- Need product orientations and best practice guides for new workers to complement their technical knowledge and enable nimbleness and adaptability
- Challenges are the development time and skills for focused short courses fitting people's busy lives, and PHM integrated into system requirements by informed clients
- Create a short presentation (45 minutes) for executives about PHM and ROI: introduce into leadership and MBA programs, build discussion and acceptance of PHM contributions
- Use opportunity to bring hands-on experience by recruiting veterans into project teams

Discussions- Priorities

Some key issues from the presentations and discussion ***ranked by audience votes***

22 Better ways to integrate multi-disciplines in PHM
19 Access to PHM case studies ands success stories
12 Orientations to the PHM as a discipline like Body of Knowledge and taxonomy
8 **Access to a resource inventory like the PHM Society portal**
2 Just in time/short presentations on key topics like ROI and management brief
0 Participation in an EPD User Group with diversity features

Way Forward- Get Involved!

- IJPHM papers and communications
  Indexed in the Emerging Sources Citation Index
  - Submit an abstract for a paper or a communications
  - Propose a Special Issue
- Updates on EPD in progress
  - *PHM EPD Portal* - PHM Education and Professional Development Portal - PHM Society as part of the Society community
  - EPD Users Group - join
  - Forum discussions – participate in the EPD forum: PHM Education - PHM Society
- What else would be useful?

Please visit and participate in the PHM22 discussion group on WHOVA

Thank you
Hope to see you in Tokyo in 2023 for PHMAP23 and Salt Lake City for PHM23