Image courtesy of Adobe Stock

Before We Start...

- SLIDO is being used for written questions & polls Scan the QR Code below
- Everyone is muted
- ZOOM for verbal questions (use raise hand)
- CHAT for ongoing discussion & networking
- In between each panelist presentation, the moderator will select a question to be posed to the panelist. Questions will be fielded for no more than 2-3 minutes between presentations.
- Panelist presentations are expected to be approximately 5 minutes (or less)
- General audience Q&A will be open after the last panel presentation





Rank the challenges, (1) being most critical to address to (7) being least critical to address, to advance maintenance strategies on the factory floor.

(1/3)

1. Cultural challenges (e.g., workforce is hesitant to adopt new technology)

4.88

2. Lack of bandwidth to push advancements forward – the team knows what should be done, but simply doesn't have the bandwidth to push it forward due to other priorities or day-to-day fire fighting

slido

4.63

3. Lack of technological awareness – unsure of what technologies are out there that could advance existing maintenance activities

4.38

Rank the challenges, (1) being most critical to address to (7) being least critical to address, to advance maintenance strategies on the factory floor.

(2/3)

4. Lack of management support – management does not see the need to advance maintenance efforts

3.50

4. Unknown financial impact - unable to make the business case to invest in new maintenance technologies

3.50

6. Lack of confidence in emergent/advanced technologies – new technologies have the potential to advance existing maintenance capabilities yet they are still unproven, relatively untested, or immature

2.75

slido

Rank the challenges, (1) being most critical to address to (7) being least critical to address, to advance maintenance strategies on the factory floor.

(3/3)

7. Known negative financial impact – investing in desired maintenance capabilities is cost prohibitive

1.75

slido

PHM for Manufacturing Assessing Operations to Advance PHM Capabilities

- Chair Brian A. Weiss (NIST)
- Moderator Greg Vogl (NIST)
- Panelists
- Adam Simpson (Atlas Roofing)
- Doug Thomas (NIST)
- Matt Malloy (EWI)
- Graham Immerman (MachineMetrics)



Panel Agenda

- Introduction of PHM for Manufacturing
- Some house rules
- Panelist perspectives
- Audience discussion and Q&A



In a few words or less, what are you hoping to get out of today's PHM for Manufacturing panel



Assement needs Success stories Shared challenges use cases

Common challenges

case studies What Industry 4.0 really is

PHM for Manufacturing

- Respond in real time to meet changing demands and conditions
- Deal with uncertainty and anomalies to enable continues improvement



• Minimize unplanned downtime

• Optimize planned downtime

• Spend less money





Advancing Maintenance - Considerations

- How to prioritize maintenance trouble spots?
- How to determine what level of improvement is needed?



- How do I choose appropriate hardware and software solutions?
- How to quantify the financial impact?

Physical Physics Ph

Where <u>YOU</u> Fit into Today's Panel...

- MANUFACTURERS What are your challenges to advancing your maintenance practices?
- TECHNOLOGY DEVELOPERS What capabilities do you see as vital or are emerging to advance maintenance?
- TECHNOLOGY INTEGRATORS What are the custom solutions that deliver value to the manufacturer?
- OTHER PERSPECTIVES What solutions have performed well in other domains that could prove valuable to manufacturing?





Who You Will Hear From...

- Adam Simpson (Atlas Roofing)
- Doug Thomas (NIST)
- Matt Malloy (EWI)
- Graham Immerman (MachineMetrics)
- ...and YOU!





More Details on Questions...

We have three options to participate:

- <u>Text Questions in Sli.do</u>
 - Please include "@Panelist" if your question is directed at a specific panelist.
- <u>Verbal Questions in Zoom</u>
 - Use the "Raise Hand" feature and we will call on you at the appropriate time. We likely will not be able to get to all of your questions in the limited time we have.
- Networking and Chatting in Rocket Chat
 - If you wish to engage the other attendees in discussion now and beyond the panel. There is no guarantee discussions from the chat will be reviewed by the panelists.

Please ensure your contributions are professional, thoughtful, and within the scope of the panel.

If you are a manufacturer, how would you classify your organization's current maintenance practices' improvement journey?



My organization has no plans to improve our maintenance practices nor have any improvements been made in the last 1-2 years.

17 %

My organization is actively taking steps (either in planning or execution) to improve its maintenance practices.

50 %

My organization has made improvements to its maintenance practices in the last 1-2 years.

33 %



Strategy on Advanced Technologies in Maintenance

A Manufacturer's Perspective



Introduction

- Adam Simpson Senior Director of Operations with Atlas Roofing Corporation
- Atlas Roofing manufactures high performance roofing and construction materials.



- I have worked in manufacturing for nearly 20 years, having spent most of that time in the building materials industry.
- I have held roles in Engineering, Production, Operations, and Plant Management.
- I have a BS in Engineering from Miami University and an MBA from Johns Hopkins.



Background

- My perspective today comes from that of a mid-size to large manufacturer working to change the culture around how we maintain assets.
- I have participated in two CMMS implementations, spanning nearly 10 years from the first to the most recent.
 - Traditional software applications
 - Cloud based service applications
- It is my belief that to change your maintenance philosophy, you must be willing to embark on a cultural change within your organization.



Maintenance Philosophies

- Breakdown Maintenance Run to failure
- **Preventative Maintenance** Maintain your assets on a strict schedule, lessening the likelihood for failure.
 - Oil changes at 5,000 miles
- **Predictive Maintenance** Condition based; maintenance is preformed based on the condition of the machine.
 - Real time asset monitoring to determine when maintenance is needed

How would you best describe your maintenance 01 philosophy today?

Breakdown Maintenance

15 %

Preventative Maintenance

69 %

Predictive Maintenance

15 %



Painting the Picture

- Historically, maintenance has been viewed as a cost center, chipping away at a company's bottom line. Focus during the annual budget process to reduce cost without jeopardizing service.
- Firefighters who come when needed to put out a fire that has already started.
- Squeaky wheel repair men whoever speaks the loudest gets the attention while other areas/departments are overlooked.







Stages of Asset Management Implementation

Where does advanced technology fit in this model?



Strategic Asset Management Inc. We Deliver Change



Building Blocks

- Good foundation
 - Upper management support (corporate and plant management).
 - A good functioning CMMS to organize your efforts. Data-Data-Data.
 - What is measured can be monitored and improved.
 - A maintenance culture focused on keeping the equipment running and not fixing what has already failed.
 - Supporting infrastructure.
 - Manpower committed to supporting the maintenance process.
 - Maintenance storeroom to support the work.
 - Operations that understands the need for maintenance down time.
 - A partnership between Ops and Maintenance teams striving for uninterrupted processes.



Advanced Technologies

Are you considering implementing new technologies?

- Vibration, thermal, ultrasonic testing, oil sampling, etc.
- What supporting systems do you have in place?
- Will the organization accept the data and find it useful?
- Does it make sense for your organization to implement. Cost vs ROI.
- It's not a one size fits all proposition.
 - High cost to repair, without redundancy, potential for significant down stream disruption.
 - Low cost to repair, built in redundancy, low risk of process disruption.



Advanced Technologies

- Cannot be viewed as a quick add-on or a silver bullet. Instead, it must be an integral part of maintenance philosophy.
- The technology may require a greater skill set that you may have with your current technicians. How do you close that gap?



Final Thoughts

- Advanced technology when integrated into a disciplined and structured maintenance culture can work to enhance the effectiveness of the maintenance program.
- However, when Advanced Technology is incorporated into a culture that doesn't exhibit the foundational requirements to support it the value of that technology will fall short of everyone's expectations.



Question for Adam



Manufacturing Machinery Maintenance

Douglas Thomas, Economist National Institute of Standards and Technology





National Institute of Standards and Technology

- US Government Agency
- Promotes US innovation and industrial competitiveness
 - Standards and guidelines
 - Reference datasets + software tools
 - Test methods + performance metrics
 - Use cases + test scenarios
 - Roadmaps and case studies



Applying Economics

Estimating national costs/benefits associated with adopting advanced maintenance

- Make the business case
- Maintenance expenditures
- Potential money saved by advancing maintenance strategies
- Waste reduction
- Downtime reduction
- Survey data
- IAC data





Survey Findings: Costs/Losses

ohmsociety

- Discrete Manufacturing (NAICS 321-339, Excluding 324, 325)
- Maintenance costs: \$74.5 billion
 - Maintenance Expenditures \$57.3 billion
 - Faults and failures \$16.3 billion
 - Inventory \$0.9 billion
- Preventable losses: \$119.1
 - Downtime: \$18.1 billion
 - Defects: \$0.8 billion
 - Lost sales: \$100.2 billion
 - 16.03 injuries and 0.05 deaths per million employees



Survey Findings: Reactive Maintenance

- Reactive maintenance (top 25% using reactive vs bottom 25%)
- 3.3 times more downtime
- 16.0 times more defects
- 2.8 more lost sales due to defects from maintenance
- 2.4 times more lost sales due to delays from maintenance
- 4.9 times more inventory increases due to maintenance issues





Survey Findings: Predictive Maintenance

- Predictive maintenance vs preventive maintenance (top 50% compared to bottom 50%)
- 15 % less downtime
- 87 % lower defect rate
- 66 % less inventory increases due to unplanned maintenance





5

Industrial Assessment Centers:

Estimated Average Returns for 10 Years

- DOE Industrial Assessment Centers
- Trained professors and students assess man. Facilities
- 424 Standardized recommendation categories
- IAC assess those facilities with high ROI (cherry picked)
- Avg employment: 167

Š	atus pro	obe Description	Ry D	1 ^{RR}	Investment	#of Recommendatio
_	2.4157	ESTABLISH A PREDICTIVE MAINTENANCE PROGRAM	73 649	672.4%	1 661	182
ntec	4.126	INSTALL SENSORS TO DETECT DEFECTS	1 315 091	5875.0%	31 771	17
lemer	4.611	BEGIN A PRACTICE OF PREDICTIVE / PREVENTATIVE MAINTENANCE	326 637	1656.6%	4 462	241
d m	4.661	USE IIOT SENSORS AS ALARMS	142 491	671.9%	26 843	3
	4.662	USE IIOT SENSORS FOR DUTY CYCLE DETERMINATION	90 089			3
Total	2.4157	ESTABLISH A PREDICTIVE MAINTENANCE PROGRAM	73 433	643.7%	2 141	219
	4.126	INSTALL SENSORS TO DETECT DEFECTS	2 010 111	2250.4%	209 639	51
	4.611	BEGIN A PRACTICE OF PREDICTIVE / PREVENTATIVE MAINTENANCE	426 220	2239.4%	6 141	451
	4.661	USE IIOT SENSORS AS ALARMS	110 265	510.0%	23 101	4
	4.662	USE IIOT SENSORS FOR DUTY CYCLE DETERMINATION	47 763			8

For the IAC to conduct an assessment, a facility must generally have the following: gross annual sales of \$100 million or less, consume energy at a cost greater than \$100,000 and less than \$2.5 million per year, employ no more than 500 people, and have no technical staff whose primary duty is energy analysis



Question for Doug





Matt Malloy

EWI

An advanced engineering service provider dedicated to helping conquer complex design and production challenges

Expertise across a range of technologies

- Joining
- Forming
- Additive Manufacturing
- Advanced Automation

- Materials Engineering
- Structural Integrity
- Nondestructive Technology
- Data Science

\$40+ Million

Working together **150+ Staff** to find solutions

In state-of-art capital equipment











My Background

- ~18 years of manufacturing and R&D expertise across various advanced manufacturing industries
 - Automation
 - Advanced manufacturing technology advisory
 - Consumer electronics manufacturing
 - Semiconductor/nanotech
- Aspects of PHM in nearly all roles
- Strong interests in robotics and 3D printing technologies (the fun stuff!)





Perspective on PHM

- Viewing from an external perspective based on last three years of automation and technology advisory work
- Companies that used to ignore this topic now see the value
 - But...knowing it needs to be done is different then doing it
- All-or-nothing vs. targeted approach
- Benefits of a targeted approach
 - Usually more practical
 - May be possible with low-cost and readily available technologies
 - Faster ROI
 - Build momentum and support with early wins



Question for Matt





MANUFACTURING'S INDUSTRIAL DATA PLATFORM FOR MACHINES

Filter Default						SAVE MANAGE COLUMNS LOAD
Name 个	Status	Make	Model	Last 24 Hours	Last 30 Days	Last 52 Weeks
DOOSAN	UNAVAILABLE	Doosan	PUMA GT2100MB	0.0%	0.3%	11.4% M.M.
FEELER 1	ACTIVE	Feeler	HV800	18.8%	23.9%	38.2% MMMM
FEELER 2	READY	Feeler	HV800	0.9%	21.6%	34.4% MMM
HV1100V	ACTIVE	Feeler	HV1100V	0.0%	15.7%	12.0% MIMM
NAK TW20	UNAVAILABLE	Nakamura-Tome	TW-20	0.0%	0.0%	5.0% Lan
NAK WY-100II	UNAVAILABLE	Nakamura-Tome	WY-100II	0.0%	12.9%	6.0%
ROBO 1	FEED_HOLD	Fanuc	RoboDrill T21IF	3.1%	37.1%	45.2% MMMM
ROBO 2	READY	Fanuc	RoboDrill T21IF	2.4%	a.1%lilato mototo	15.8% Amman
ROBO 3	READY	Fanuc	RoboDrill T21IFIA	2.4%	10.1%	14.9% M. M.M.
STAR 1	ACTIVE	Star	SB20 TYPE E	14.5%	59.4%	60.7% WW
STAR 2	ACTIVE	Star	SB20R TYPE E	15.3%	55.0%	64.2% W
ľ						
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TOP PAIN POINTS FOR MANUFACTURING

WHY MANUFACTURERS STRUGGLE



UNPLANNED DOWNTIME

Machines fail often, leading to expensive maintenance and unplanned downtime..



LACK OF DATA

Systems of today heavily dependent on manual data input. Bad data leads to massive inefficiencies that affect every component of a manufacturer's operations



IOT SOLUTIONS FAIL 80% OF THE TIME

"Do-it-all" systems cost a lot of money, are difficult to deploy due to custom nature, and create an over-reliance their legacy tech

OT DO Older g

OT DOESN'T HAVE IT SKILLS

Older generation of manufacturers are retiring,, tribal knowledge leaving with them. New generation of people don't have the skills and experience.



FAILURE RATE OF IIOT IMPLEMENTATIONS

-McKinsey, 2020

THE AVERAGE RATE OF MACHINE UTILIZATION

-MachineMetrics Industry Benchmarking Report, 2020

phmsociety

INDUSTRIAL DATA PLATFORM FOR MACHINES









EDGE PLATFORM

Connect machines in minutes
with universal machine
connectivity and automatic data
mapping

High frequency data access for advanced analytics

Remote device management to keep software up to date and manage custom containers

DATA PLATFORM

- Queryable time-series warehouse that scales to 1000's of machines
 - REST API's for building apps
 - No-code workflows that trigger workers or other systems to take action

Layer operational data on top of machine data

APPLICATIONS

- Drive value Immediately after connecting machines with outof-the-box applications
- Visualize data across the factory floor to empower workers to meet production goals

INTEGRATIONS

- Connect to 3rd party applications for customized BI, analytics, and workflows
- Webhook triggers that enable workflows using nocode and low-code tools

CUSTOMERS & PARTNERS WORLDWIDE

HUNDREDS OF CUSTOMERS AND THOUSANDS OF MACHINES CONNECTED



php

WHY MACHINE DATA?



PEOPLE/SYSTEM-DRIVEN STRATEGY



MACHINE-DRIVEN STRATEGY



HOW DOES THIS APPLY TO MAINTEN NCE?

PEOPLE/SYSTEM-DRIVEN STRATEGY



MACHINE-DRIVEN STRATEGY



TOP MAINTENANCE PAIN POINT

Calendar-based preventative maintenance is not only inefficient but often lead to over-maintenance, which is expensive, or under-maintenance, which results in machine breakages and downtime.



THE SOLUTION:

Empower maintenance systems with real-time data from manufacturing equipment.

AUTONOMOUS MAINTENANCE





THE MAINTENANCE AUTOMATION JOURNEY







Calendar-Based Preventative Maintenance



Usage-Based Preventative Maintenance Condition-based Predictive Maintenance



Al-based Predictive Maintenance



USAGE BASED MAINTENANCE

DRIVE MAINTENANCE ACTIVITIES BASED ON ACTUAL MACHINE RUN TIME

> > >







CONDETION MONETORING

MONITOR MACHINE CONTROL AND SENSOR DATA IN REAL-TIME









PREDICEN/E MAENTENANCE

DETECT AND PREVENT FAILURES FOR AUTONOMOUS MANUFACTURING





Plot out tool wear to identify problems before they cause defects or unplanned downtimes





MAINTENANCE TRIGGERS IN MACHINEMETRICS



- Production Run Hours
- Cycle Counts

Meter values in CMMS updated automatically on a scheduled basis

CONDITION BASED

- Categorized Downtime Event
- Machine Alarm Condition
- Analog Sensor Value Exceeded



• Anomaly Detected

MachineMetrics workflow adds event

• Failure Predicted

in CMMS automatically

MachineMetrics workflow adds event in CMMS automatically

Status 🕕 Name ① \sim Machine 🕕 Trigger 🕕 Actions (1) Upkeep Alarm **All Machines** Alarm Temp-High Upkeep Manual Workflow All Machines Manual Manual Vebhook Upkeep Metering **All Machines** Every day @ 11:30 AM Scheduled Upkeep Unplanned Maintenance Downtime Unplanned Maintenance All Machines



Question for Graham







For our Panelists or the Audience

- As a manufacturer, what is your biggest challenge to introducing new maintenance practices into your facility?
- What is the most important piece of financial data a manufacturer can analyze to gauge the performance of their maintenance practices?
- What existing maintenance technologies do you find is most beneficial to manufacturers in the robotics or 3D printing domains?
- From your perspective, what is the biggest challenge that small manufacturers face when implementing an automated work order system?





Thank you!

Thank you to all of you who attended today's panel on PHM for Manufacturing. And thanks to our panelists for their time and perspective.

> If you would like to continue these discussions and network with the other conference attendees, please use the chat feature in the hub

Enjoy the rest of the conference!

How would you rate the overall quality of this 0 1 0 session?

