Survival Skills for R&M
Superheroes of the Next Decade

Dr. Klaus Blache
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Introducing your keynote

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Director, RMC & Research Professor

Dr. Blache has over 35 years of experience in various areas of manufacturing and continuous improvement. His experience includes a focus on lean manufacturing, reliability & maintenance, competitive analysis, continuous improvement tools & techniques, new facility planning and implementation, industrial engineering, ergonomics, and change management. He has written and lectured globally in numerous technical and management areas.
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How we collectively implement all of the new technologies will eventually impact all of us.

- So much stuff. I don't know what to do first?
- AI and machine learning? I can barely make production goals.
- What's edge computing?
- 3D Printing - pixel or voxel?
- So much data, but daily decisions aren't easier or more effective.
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Dr. Strange = Dr. How

- Cloud
- Wireless
- Big Data
- Blockchain
- IoT
- SmartWearables
- Interconnectivity
- Virtual Assistants
- Machine Intelligence
- Digital Twin
- Augmented Reality
- 3D Printing
- Real-time Data


Artificial Intelligence
The IoT Platform Opportunity

The Internet of Things (IoT) has a potential economic impact of 2.7-6.2 trillion USD until 2025

<table>
<thead>
<tr>
<th>Industry</th>
<th>Potential Economic Impact (Trillion USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Internet</td>
<td>Low: 5.2, High: 0.7, X-Y: 3.7-10.8</td>
</tr>
<tr>
<td>Automation of Knowledge Work</td>
<td>Low: 5.2, High: 0.7, X-Y: 3.7-10.8</td>
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<tr>
<td>Internet of Things</td>
<td>Low: 2.7-6.2</td>
</tr>
<tr>
<td>Cloud Technology</td>
<td>Low: 1.7-6.2</td>
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<tr>
<td>Advanced Robotics</td>
<td>Low: 1.7-6.2</td>
</tr>
<tr>
<td>Autonomous and Near-Autonomous Vehicles</td>
<td>Low: 0.2-1.9, High: 0.7-1.6</td>
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<tr>
<td>Next-Generation Genomics</td>
<td>Low: 0.7-1.6</td>
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<tr>
<td>Energy Storage</td>
<td>Low: 0.1-0.6</td>
</tr>
<tr>
<td>3D Printing</td>
<td>Low: 0.2-0.6</td>
</tr>
<tr>
<td>Advanced Materials</td>
<td>Low: 0.2-0.5</td>
</tr>
<tr>
<td>Advanced Oil and Gas Exploration and Recovery</td>
<td>Low: 0.1-0.5</td>
</tr>
<tr>
<td>Renewable Energy</td>
<td>Low: 0.2-0.3</td>
</tr>
</tbody>
</table>

Who will capture this opportunity?

SOURCE: McKinsey Global Institute analysis
All of these incoming technologies have the capability of transforming every one of our operations…. But,

1. How believable and achievable are the promises?
2. How long before it’s actually useable (affordable and practical)?
Digital Transformation

**CONNECTIVITY**
- Sensors
- Smartphones
- Tablets
- SCADA

**MOBILITY**
- Maintenance
- Supply Chain
- Field service

**USABILITY**
- Ergonomics
- Culture
- Adds value / ease of use

No group was more than 20% likely to say their Enterprise software did “very well” in preparing them to consume data from the IoT

Only 31% regularly access Enterprise software from mobile device

In situations where Enterprise software usability is poor, 88% would use spreadsheets (mainly Microsoft Excel)
“Until now, much of the business value from digital technologies has either been limited because the business processes did not change to fully leverage them or they were lost due to departmental disconnects.”

‘Despite all the improvements in data management and information sharing, it appears that spare parts inventories have not reduced at all. In fact, they have gotten bigger. It appears that supply chain collaboration is yet to have any real impact in the spare parts storeroom. Perhaps even more concerning is that the companies are not small, unsophisticated, or geographically isolated. They operate with sophisticated (and expensive) ERP software. They are fully connected. Yet their spare parts inventories continue to increase.’

1.Source: Industry Week, The Road To Digital Transformation: A Progress Report for Manufacturing, by Oracle
2.P. Slater and K. Blache, Efficient Plant, Spare-Parts Management: From Isolation to Collaboration, 9-18-18
Average Reported Stock Turns for Client Companies, by Year

Source: P. Slater and K. Blache, Efficient Plant, Spare-Parts Management: From Isolation to Collaboration, 9-18-18
“Machine learning is clearly in earlier stages than IIoT or cloud. Less than a third have it in use, and most have found it has not met expectations.”

Lack of training or understanding, skills shortage, technology immature/not working were all noted by 24% to 34% of the companies.

1.Source: Industry Week, The Road To Digital Transformation: A Progress Report for Manufacturing, by Oracle
Evolution of Asset Management - Maintenance / Reliability

Impacted by changing complexity, expectations, business needs, new understanding of R&M

First Generation
- Fix it when it’s broke
- Some computer usage

Second Generation
- Systems to plan & control work
- Large scale maintenance projects

Third Generation
- Design for R&M
- Sophisticated CMMS & Expert Systems
- FMEA, PMO, RCA, Hazard/Integrity Windows
- Multiskilling, Teams
- Condition Monitoring, PdM
- RCM

Fourth Generation
- Systems Thinking
- Real-time data
- Learning systems
- Wireless
- Mobility
- Integration
- Cloud

Disruptive or Competitive?


NCMS & SAE M.110

N&H Study

RCM2

RCM2 SAE JA-1011

Adapted from J. Moubrey, RCM2
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Benchmarking Studies – Ongoing

Major Studies

1991
2008
2017
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Average Maintenance Type Percent
(sorted by Reactive, 2017 UT-RMC Study)

- PdM
- Reactive
- Preventive

Top 25% | Middle 50% | Bottom 25%
Albert Einstein: The definition of **insanity** is doing the same thing over and over and expecting different results.

Klaus Blache: The definition of **Maintenance insanity** is doing the same maintenance over and over and expecting different results.
90 percent of the world’s data was generated in the past 2 years

More than anything we envisioned, Software and Data will drastically change how we do business within the next decade
TITAN …theoretically capable of 20 petaflops – or more than 20,000 trillion calculations every second.

In 2018, ORNL delivered SUMMIT, the next leap in leadership-class computing systems for open science

(Fastest supercomputer in the world, capable of 200 petaflops = 6.3 billion people making calculations at same time every second, for one year)

https://vimeo.com/273729306
3D Printing – What can be printed today?

Vote YES / NO

- Airplane and car parts
- Cloth
- Pizza
- Chocolate
- Guitar, Flute, Violin
- Body parts (kidney, skin, bones)
- 3D printer
- Maintenance parts

https://readwrite.com/2014/02/14/3d-printing-printers-projects-applications-prints/
Pattern Recognition – Machine Learning – Artificial Intelligence

- **Focused / Narrow** - computer vision, language processing, image recognition, self-driving car, business decisions, etc.

- **General** - Reasoning in human environment (perception/memory/decision)

Source: https://bdtechtalks.com/2017/05/12/what-is-narrow-general-and-super-artificial-intelligence/
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AI

Maintenance Supervisor

I’ll be back

I am back

Artificial Intelligence

Algorithms

Source: IBM, Wikipedia & philosophersforchange.com
“We are the Reliability Borg. Your biological and technological distinctiveness will be added to our own. Resistance is futile.”

ROSS, WATSON, TESLA, etc.
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Wearables – work and health
• Better overall information - digitize maintenance tasks
• Assistance from experts
• Replace lost skills
• Aging workforce
• Safety
• Health
• Voice based headphones
• Assist robots
• Grip strength gloves
• Etc,
75% of facilities still aren’t doing enough Predictive Maintenance to protect their assets

Most facilities still struggle with full implementation of TPM, especially autonomous maintenance

Most suggestion programs can’t even average “one suggestion per employee”
Organizational culture and reliability process maturity

Source: Book: *The Relativity of Continuous Improvement*, Dr. Klaus Blache, Dec., 2015
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Send HELP For PdM/CBM
Green Lantern: “No matter how bad things get, something good is out there, just over the horizon.”

What the Green Lantern meant was:

“As more predictive technologies are performed on more assets, Maintenance Cost /RAV will decline.”
Batman: “It’s not who I am underneath, but what I do that defines me.”

What Batman meant was:

“Proactive reliability and maintainability needs to be led and demonstrated.”
Spiderman: “With great power comes great responsibility.”

What Spiderman meant was:

“Things like artificial intelligence, big data, interconnectivity and the web will have the power for great changes – some competitive, some disruptive. Where there is great power there is great responsibility. Decide wisely.”
Prof. Charles Xavier: “Just because someone struggles and loses their path, doesn’t mean they can’t be saved.”

What Prof. Charles Xavier meant was:

“With 75% of North America not doing enough predictive technologies, there is great opportunity to make it a competitive advantage.”
Dr. Octopus: “Intelligence is a privilege, and it needs to be used for the greater good of people.”

What Dr. Octopus meant was:

“With the increased intelligence of using multiple technologies simultaneously, data historians, and optimizing algorithms, the contributions, by and for the people, can be greatly enhanced.”
Wonder Woman: “What one does with the truth is more difficult than you think”

What Wonder Woman meant was:

“Don’t be afraid to make the tough decisions. Make decisions based on data.”
Iron Man: “Heroes are made by the path they choose, not the powers they are graced with.”

What Iron Man meant was:

“Reliability and Maintainability needs to be integrated into your Corporate/plant strategy. Making a difference starts with you.”
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“most interesting man in the world”

From Dos Equis XX Commercials

“Mosquitoes refuse to bite him purely out of respect”

“Superman has pajamas with his logo”

“other guy”

“Machines are afraid to break down when he enters the factory”

“If he gets a question wrong on a Certification Exam, they change the question”
We are talking machine learning and AI, while most facilities are just trying to survive day-to-day. Can IoT slow down enough to bring along the current plant floor needs?
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I'M GONNA PUMP

YOU UP

memecrunch.com

Source: https://www.pinterest.com/pin/219372865833929414/
I will “turn up the heat” to ensure each PM task is mitigating a potential failure.

I’ll “stretch out” the time between PM tasks where required.

It’s clobbering time for those unnecessary PM tasks.

20-50% removed from my experiences.

If I get invisible, will that help me find the “hidden failures”?

Fantastic 4
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Millennials 1982 - 2004

According to the US Census Bureau, the number was over 83 million in 2015. A recent IBM study stated that by 2020 Millennials will be 50 percent of the US workforce and by 2030 that number will increase to 75 percent.

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Few Final Comments:

1. Become a master of “how to implement”

2. Get your data ready (enough that you are willing to make decisions using it)

3. Get your PdM/CBM performed on your assets
Paradigm Shifts

Disruptive Innovations

Source: PhilosophersforChange.org
You are the **Green Lantern**

- Green Lantern: 80%
- The Flash: 65%
- Iron Man: 65%
- Superman: 60%
- Hulk: 55%

**Strong will power and a good imagination.**
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You won’t like it if I get angry

Clean Up Your Data