

The background of the slide is a collage of industrial images. In the center, a man wearing a white hard hat, safety glasses, and an orange high-visibility vest is looking down at a laptop. The background behind him is a dark, blurred industrial setting. To the left, there are several large blue industrial motors. To the right, there are large, complex metal machinery components. The entire image is overlaid with a white geometric pattern of triangles.

FLUKE[®]

Reliability

**Building your
PdM Roadmap –**
Steps to Start or take
your program to the
next level!

Michael Watson CMRP, CRL
Fluke Corporation

Meet the Speaker



FLUKE®

Michael Watson, CMRP, CRL

- Product Application Specialist at Fluke Corp. (5 years)
- Previously work at Caterpillar for 30+ years
- Focusing on company's reliability and condition monitoring solutions (Accelix)
- Has 25+ years' experience in asset management, engineering, PM and reliability



**Certified Maintenance & Reliability
Professional (CMRP)**



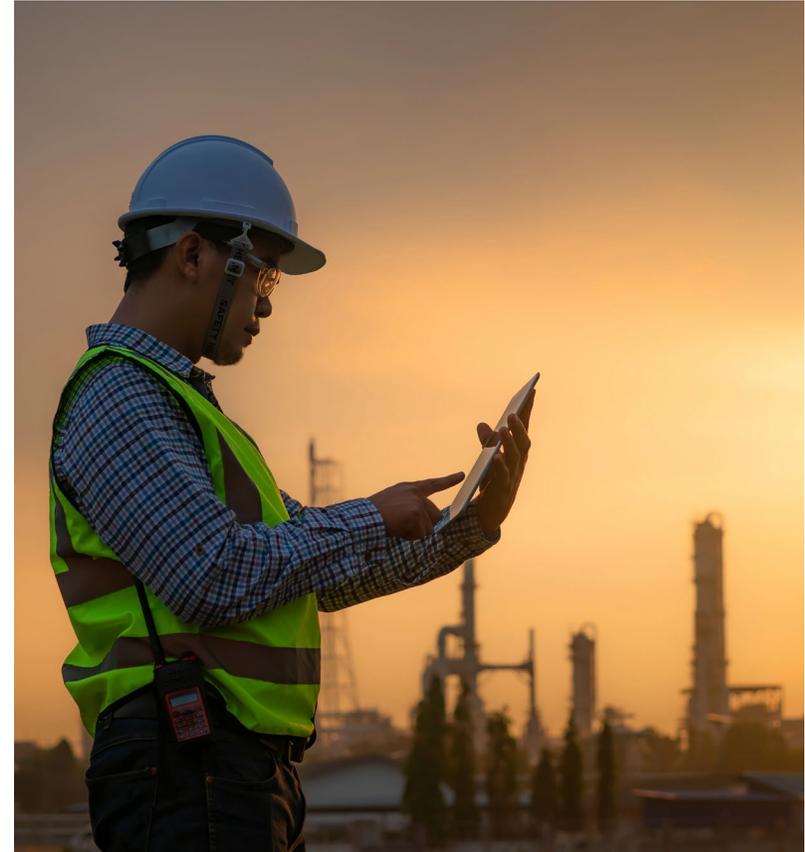
**Certified Maintenance & Reliability
Professional (CRL)**



**Thermal/Infrared Thermography
Level II certified**

Building your PdM Roadmap – Steps to Start or take your program to the next level!

- Safety Brief
- Setting a Vision
- Understanding your Assets
- Technology Selection
- Managing Change
- Sustainability



Every organization is somewhere on this journey ...



3 challenges confronting today's maintenance leaders



1

How do we grow a reliability program
... when we are 100% busy?

We have no time to collect/analyze data and generate reports.

2

How do we make the best decisions
... when we have incomplete information?

We don't have time to conduct all the necessary routes, nor can we have access to all machines

3

How do we monitor all critical assets
... with limited resources?

We must allocate/balance resources needed for planned/calendar-based maintenance, repairs, and emergencies, etc.

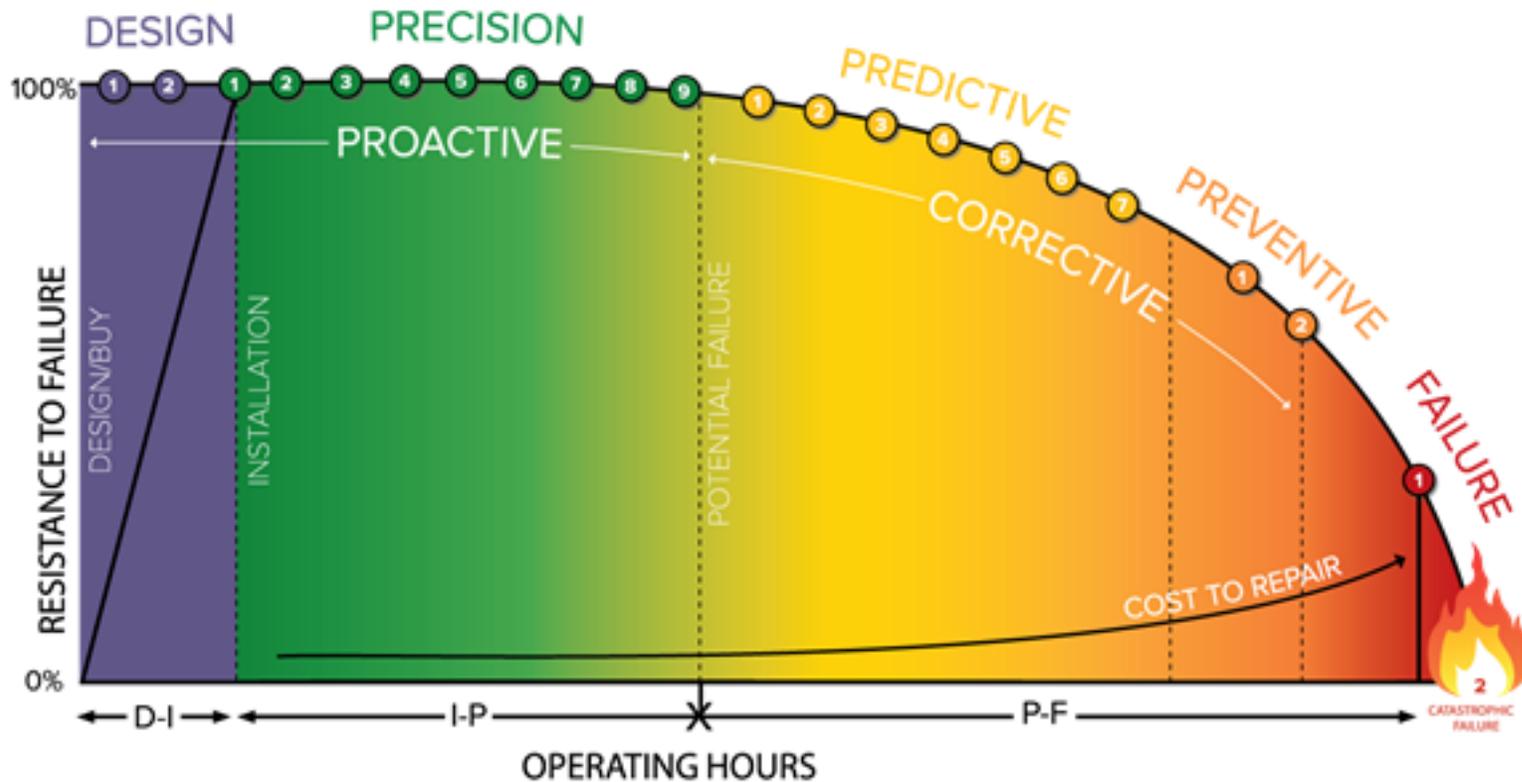
Predictive equipment vendors have been developing and improving tools / software

Resources remains the challenge and to solve we need to understand People – Process – Technology – Culture

P-F Curve

D-I-P-F CURVE

(DESIGN - INSTALLATION - POTENTIAL FAILURE - FAILURE)



Attribution/Inspiration: The D-I-P-F curve was originally developed by Doug Plucknette, Certified Reliability Leader, Author, RCM Blitz (ISBN: 978-0-9838741-6-4) and further modified/evolved by Brian Heinsius, Certified Reliability Leader

DESIGN/BUY

- 1 Design for Reliability (DFR)
- 2 Purchase for Purpose

PRECISION

- 1 Precision Commissioning
- 2 Precision Installation
- 3 Defect Elimination
- 4 Precision Alignment and Balancing
- 5 Work Processes and Procedures
- 6 Asset Condition Management
- 7 Lubrication Reliability
- 8 Clean to Inspect (SS)
- 9 Operate for Reliability

PREDICTIVE

- 1 Condition Directed Tasks
- 2 Ultrasound Testing (UT)
- 3 Fluid Analysis (FA)
- 4 Vibration Analysis (VIB)
- 5 Motor Testing (MT)
- 6 Infrared Imaging (IR)
- 7 Non Destructive Testing (NDT)

PREVENTIVE

- 1 Time-Directed Tasks
- 2 Human Senses (audible noise, hot to touch, smell)

FAILURE

- 1 Functional Failure
- 2 Catastrophic Failure

Your goals make you unique, not your challenges

- Choose your Adventure
- Build a business case
- Start Small
- Implementation for Success
- Sustain and Grow



Why Asset Criticality?

- Identify high-level risk mitigation strategies for key equipment.
- Replacement and maintenance budget prioritization.
- A criticality score as part of a Repair Work order priority ranking
- Optimum number of spare parts for each piece of equipment.
- Focus team efforts and energy on the most critical assets.



Risk Matrix (example....basic....one of many)

		Likelihood				
		1 Rare	2 Unlikely	3 Possible	4 Likely	5 Almost Certain
Consequences	5 Catastrophic	5 Moderate	10 High	15 Extreme	20 Extreme	25 Extreme
	4 Major	4 Moderate	8 High	12 High	16 Extreme	20 Extreme
	3 Moderate	3 Low	6 Moderate	9 High	12 High	15 Extreme
	2 Minor	2 Low	2 Moderate	6 Moderate	8 High	10 High
	1 Negligible	1 Low	2 Low	3 Low	4 Moderate	5 Moderate

Asset Criticality Tool (one of many...)

Equip. Score	Priority Score	Total Score	Cat
AxBxCxD	ExFxG	ESxPS	A,B or C

Criticality Assessment Criteria

Equipment Score (ES)

The Equipment Score is obtained by multiplying the results for the four factors:
 $ES = \text{Factor A} \times \text{Factor B} \times \text{Factor C} \times \text{Factor D}$

FACTOR A

Effect on production Output (Factor A)	Factor Score
No significant impact/standby equipment is available	1
Minor impact on production. Unlikely to affect other areas of the plant	2
Failure would have significant impact on output and may affect other sections	3
Major impact on the plant's operations , failure would cause over 40% of plant production to stop	4

FACTOR B

Utilization (Factor B)	Factor Score
Equipment is used on an occasional basis	1
Equipment is required to function independently for up to 50% of available time	2
Equipment is part of a continuous process, required to function for a major proportion of the planned production time	3
Equipment is required to function for all of the planned time	4

FACTOR C

Quality (Factor C)	Factor Score
No effect on product quality	1
Minor effect on product quality	2
Critical effect on product quality and can result in major losses	3

FACTOR D

Effect on Safety or Environment (Factor D)	Factor Score
Little or no risk to the safety of people, equipment or the environment	1
Minor risk to people, equipment or the environment	2
Minor to people, equipment or the environment, which requires notification to relevant authorities	3
Major impact on the plant's operations , failure would cause over 40% of plant production to stop	4

Note: These descriptions and times demonstrate the principle. Individual companies may be required to amend/modify descriptions and times to meet their own situation.

Priority Score (PS)

Priority Score is obtained by multiplying the results for the three factors:
 $ES = \text{Factor E} \times \text{Factor F} \times \text{Factor G}$

FACTOR E

Frequency of Failure (Factor E)	Factor Score
Failures are rare, less than once per year	1
Occasional failure between 3 and 12 months	2
Failure likely between 1 and 3 months	3
Frequent failures at least once per month	4
Frequent failures at least once per week	5

FACTOR F

Downtime/Repair Time (Factor F)	Downtime	Factor Score
Minor	0 - 30 min	1
Significant	30 - 120 min	2
Major	2 - 8 hrs	3
Severe	> 8 hrs	4

FACTOR G

Waste (Factor G)	Quantity	Factor Score
No waste is generated under normal operating conditions	0%	1
Small amounts of waste are produced by failure	2%	2
Waste is produced during production that is significant	5%	3
Quantities of waste are significant and warrant immediate attention	10%	4

The total criticality score is obtained by multiplying the Equipment Score Score:

$$\text{Criticality Score} = ES \times PS$$

Technology for Predictive Maintenance

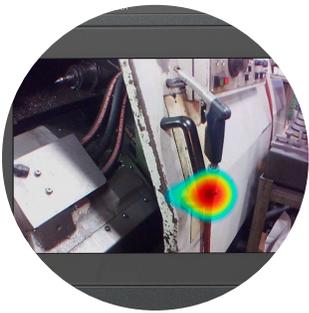


Vibration

- Bearing failures
- Misalignment
- Looseness
- High Resistance
- Fouling
- Overheating
- Insulation breakdown
- Incorrect flow
- Leaks



Infrared Thermography



Acoustic/Ultrasound

Vibration technology in Predictive Maintenance

1. Hardware + 2. Software + 3. Services

Analyze



VIBEXPERT 2



VIBGUARD IIoT

Diagnose



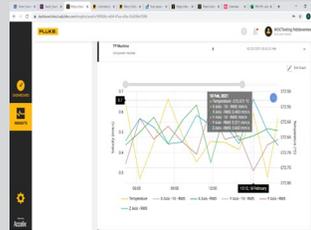
Fluke 810



VIBSCANNER 2



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Live-Asset Spectra

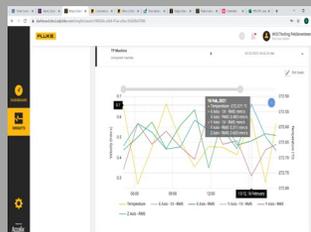
Screen



Fluke 805



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Live-Asset Portal

Handheld

Remote



Onsite Services

- Precision Balancing
- Simple to Complex Alignment
- Onsite Vibration Diagnostics



Remote Services

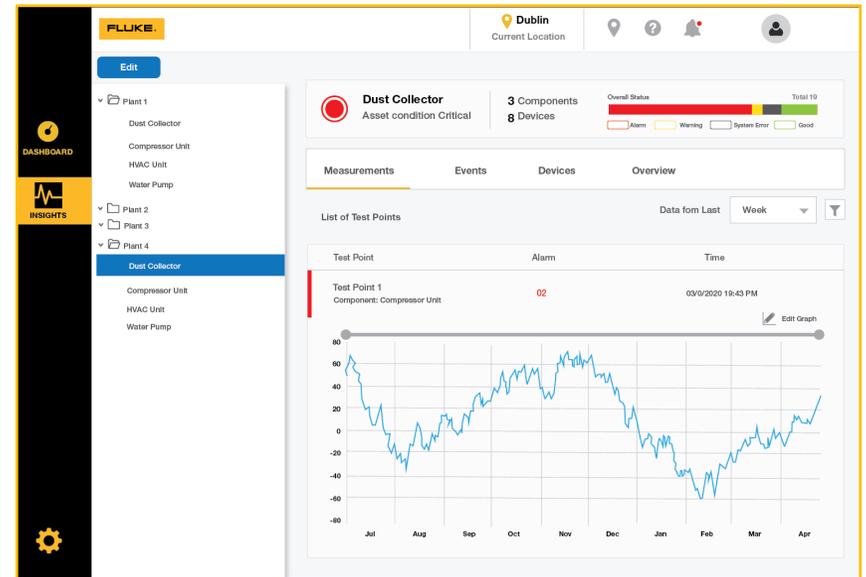
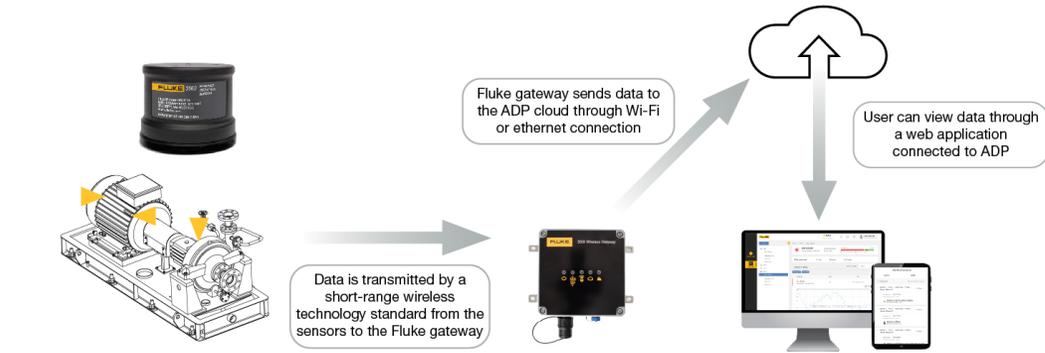
- Periodic Monitoring & Diagnosis
- Event-based Diagnosis
- On-Demand Expertise



Program Setup

- Consulting / ISO CAT Training
- Installation/Configuration
- Start Monitoring

Wireless Vibration Sensor Solutions – remote monitoring



Vibration monitoring: Challenges for the modern maintenance teams

Asset Challenges: **Hard to access**



Hydraulic (Oil) Pump

- Used in difficult areas
- Pumping hydraulic for critical machines Pumps hazardous materials



Centrifugal Pump

- Used in difficult areas
- Pumps can be pumping hazardous materials



Axial Flow Fan

- Small fans in the duct work and overhead areas that are hard to reach
- In places like clean rooms, fan failure can take the whole system down



Blower - Fan Type

- Generally, blowers are up high where they are difficult to reach
- High temps at blower make area unsafe for techs



Fans Belt Driven

- Fans may have access problems, with bearings under guards
- The whole fan may be in a room that you can't access without shutting down the fan

Team Capacity Challenges

Too Many Assets to Service

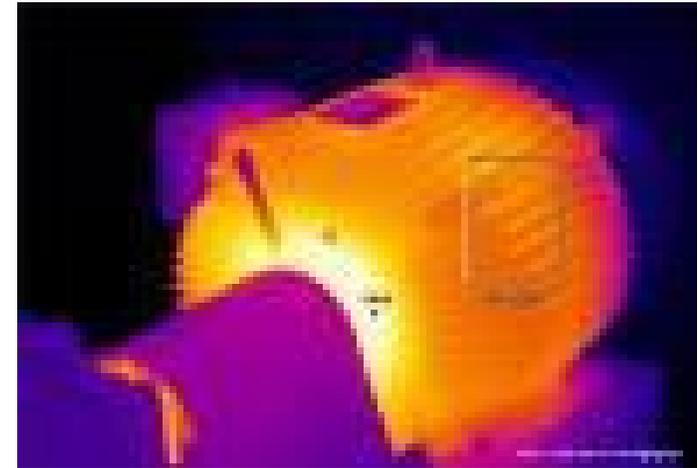
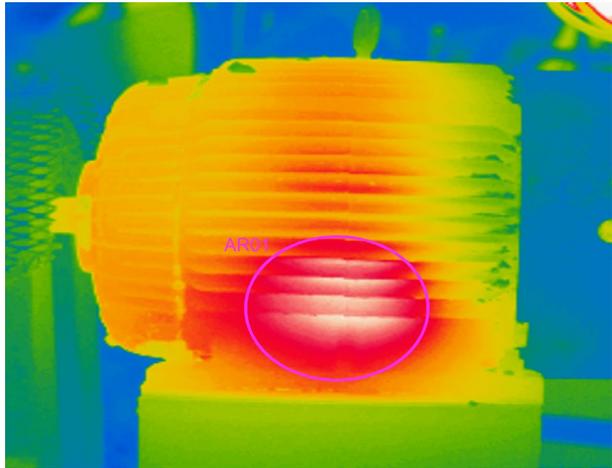
Shortage of Expertise

Shortage of Time

Need Implementation Help

Need On-Demand Expert Access

Infrared Thermography in Predictive Maintenance



People and Process of Fluke Connected Thermography



People

- Level II trained Reliability Engineer
- Trained Maintenance Technicians

Route Based Asset Screening

- Detailed Work Order
- Standard Work description and Procedures
- Markings on Assets / QR code

Comparative Review or Exception Reporting

- Baseline and compare to nameplate rating
- Alert with 10C increase, and Alarm with 20C increase

Build a program and scale

Leverage the cloud to Store your Data



1

Infrared Thermography Asset Screening or Troubleshooting in electrical panel with Fluke Camera

Fluke Connect mobile app

2

Software: Fluke FC Assets tag assign Asset ID



3

Connect to Cloud: Upload the Fluke Connect mobile app data to the Fluke Connect Cloud

5

eMaint Integration: Sync data from the Fluke Connect Cloud with the eMaint

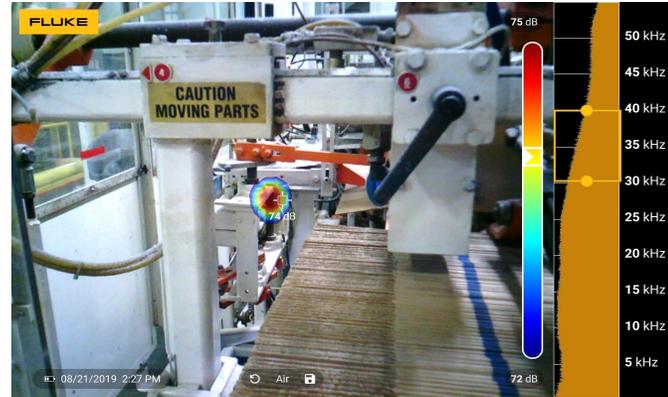
4

View Remotely: Sync data from the Fluke Connect Cloud with the Mobile, Web or Desktop App (Internet required)

Acoustic/Ultrasound in Leak Detection for Gas Systems

Recommended Leak detection

- Compressor systems
 - Process Equipment
 - Air Tools
 - Overhead Air
- CO2, Nitrogen, Exhaust, Natural Gas
- High Pressure, Low Pressure, Vacuum



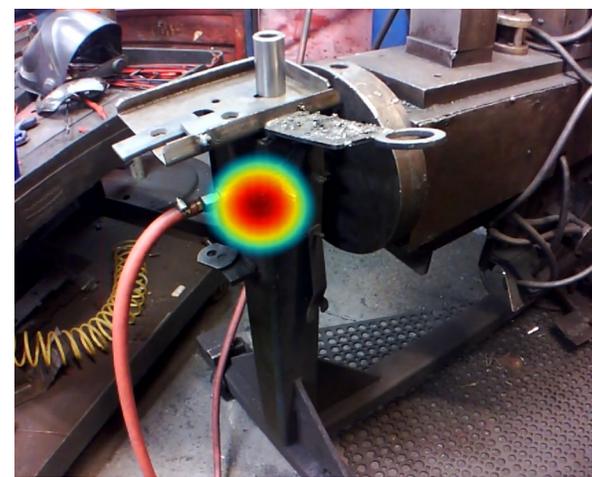
Detects while equipment is running



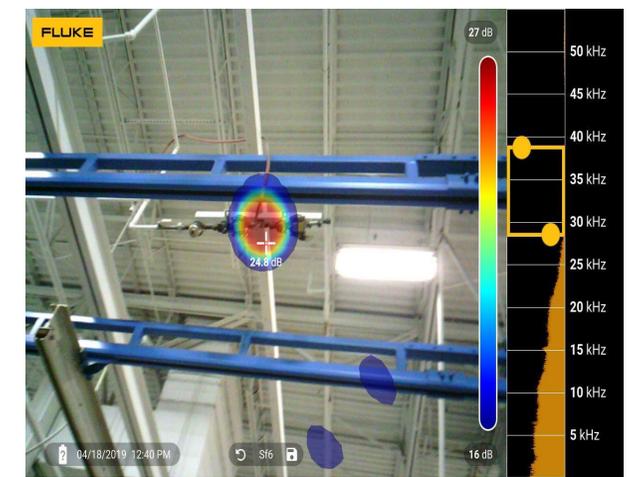
Detects through screens



Process equipment

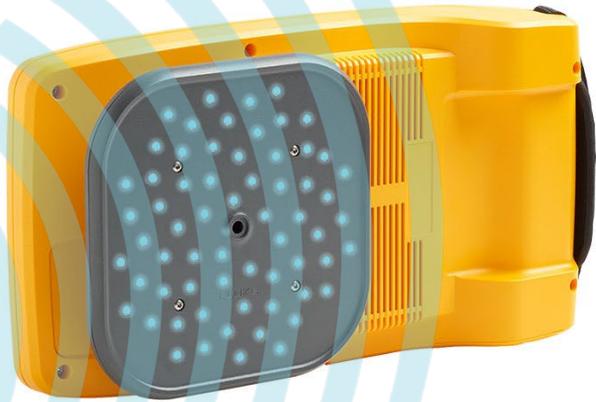


Air tools



Overhead air

How is the SoundMap™ created in the Fluke ii900/ii910



How does imager know where to put sound on the image?



FLUKE ii900 2 leaks every < 5 minutes

- Scan large areas at-a-glance
- Take a picture that pinpoints the leak location
- See multiple leaks on a single image
- Record and share pictures/videos
- Integrate pictures/videos in EAM WO



Plan and Review PM Route

Using the ii900, Planner/Technician Reliability Prof. run routes, inspect all equipment, compressed air equipment, Inert Gas lines and fittings



Download Acoustic Images to PC

Download acoustic images to PC. Upload AS2 files to Fluke Connect Desktop application, and create Potential Cost Savings Report.



Create Work Order

Create Work Order request, add air/gas leaks photos and notes to WO



Assign Work Order

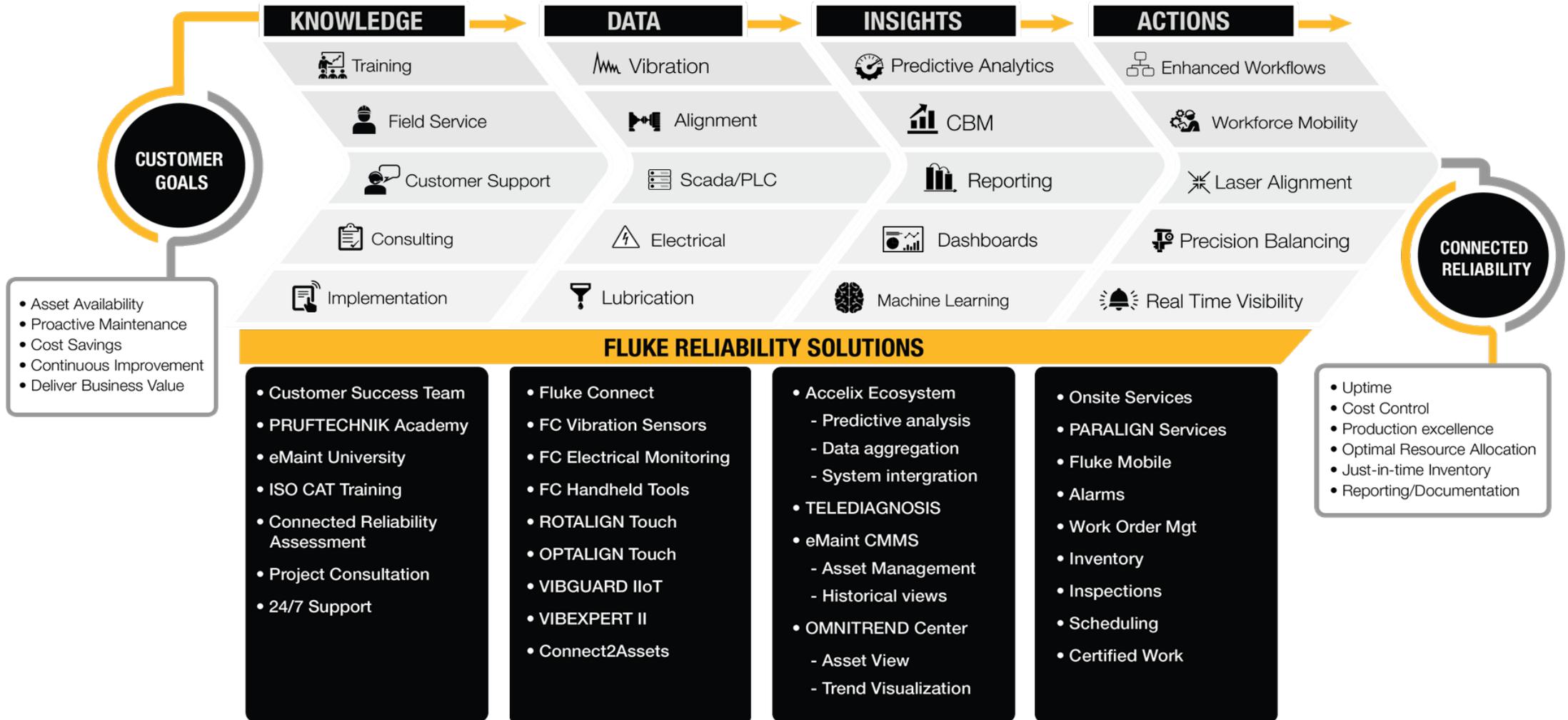
Assign air leak repair Work Orders to Technicians for repair, track all labor hours and repair parts cost in EAM system.



Track WO Progress & Recheck

Track all repairs progress. Recheck past air leaks to confirm all repairs are complete and resolved.

Connected Reliability



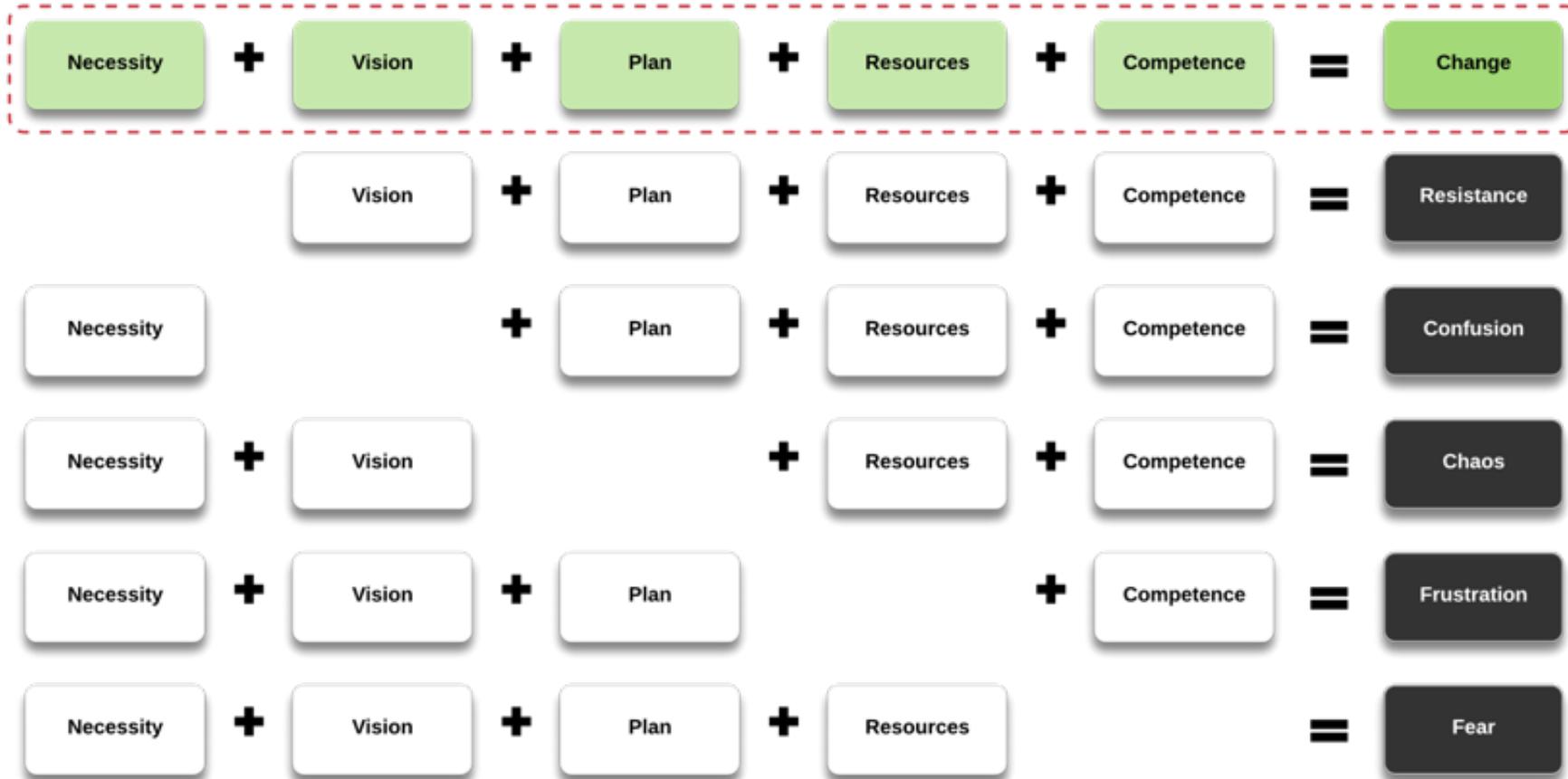
Technology Implementations



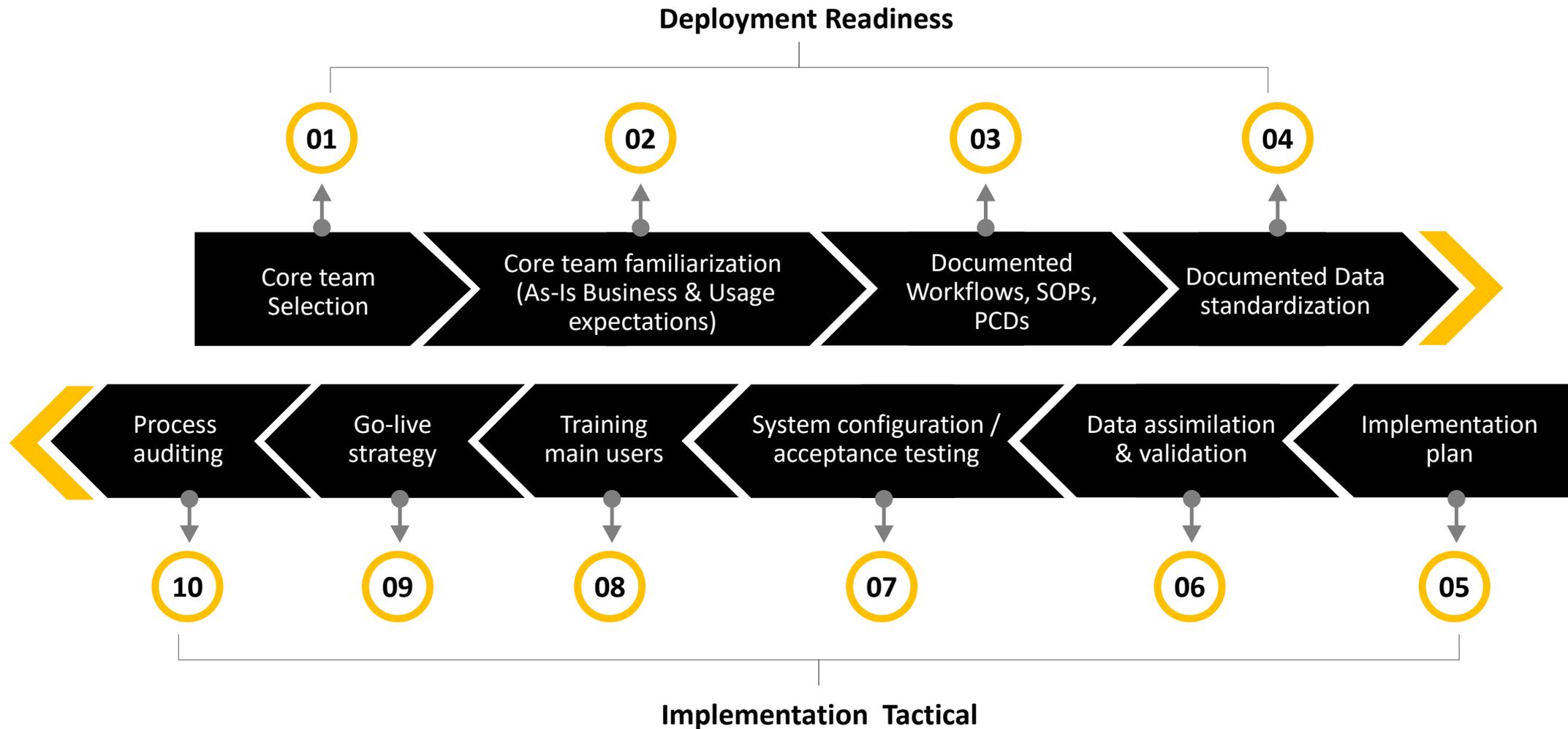
"Culture Eats Strategy"

BEFORE YOU START...

CULTURE AND INCREMENTAL CHANGE



FRS 10 Key Steps - A Proven Fundamental Method of Change (MOC) Strategy



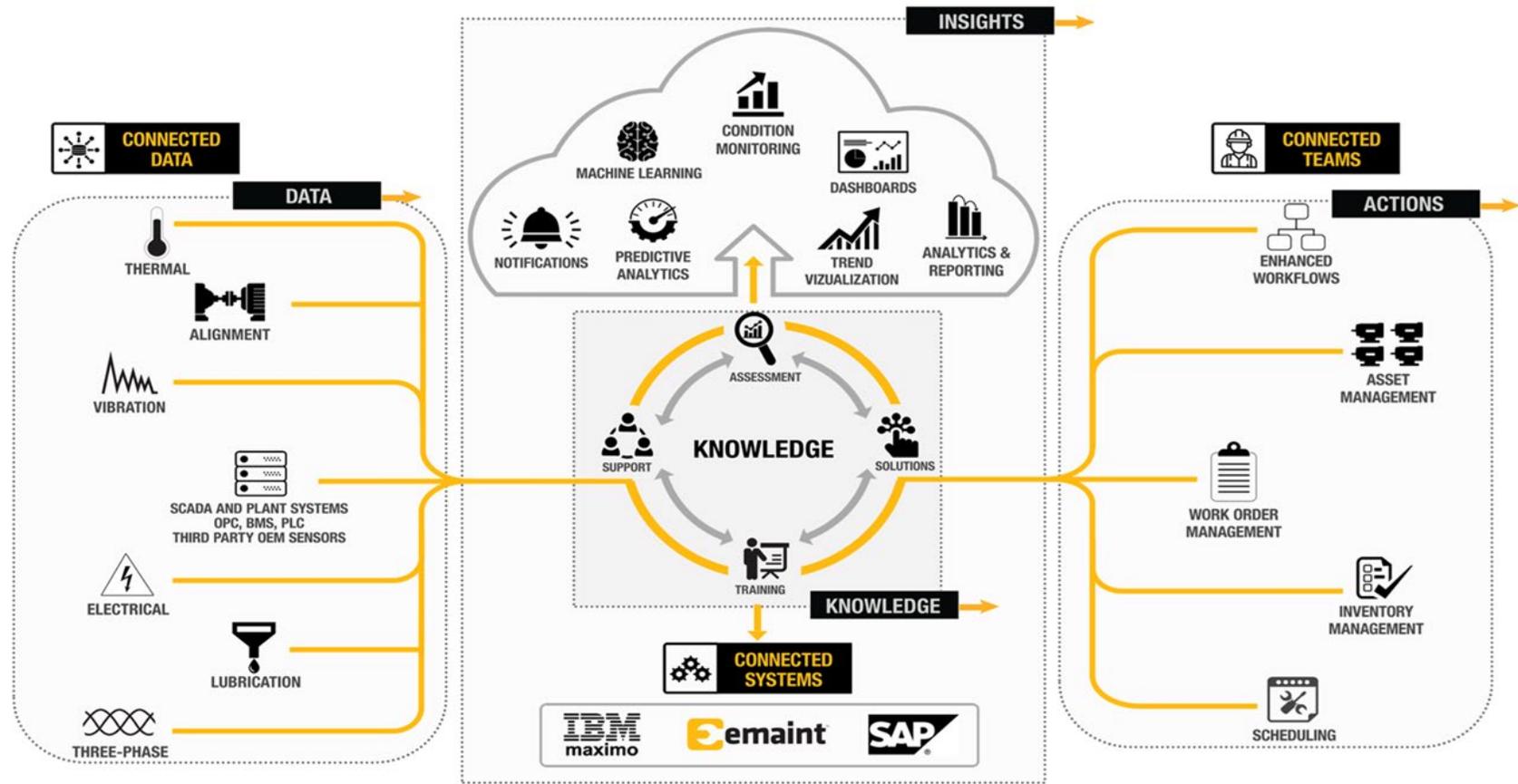
Resiliency and Sustainment

*Vision – What you
want to Accomplish*



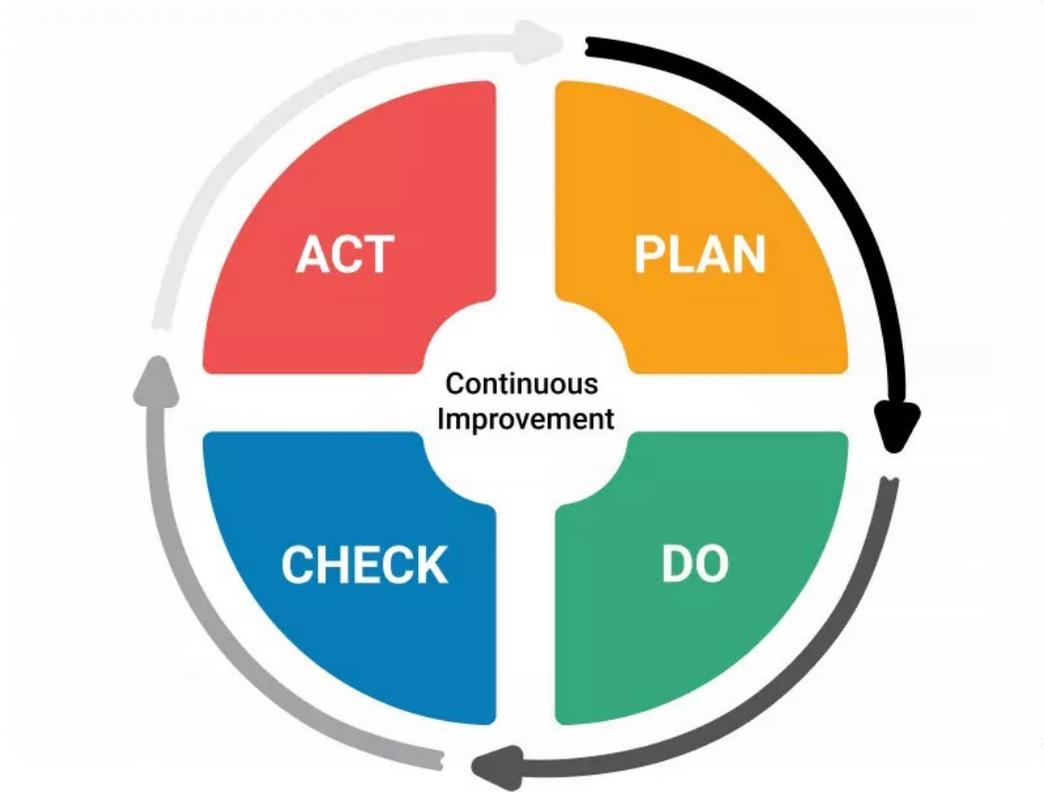
Knowledge Management

- What Data Where?
- 5 R's of Data
- Data Silos
- Process capability
- Leverage SOP's



Sustainability and Resiliency

- Develop your People
 - Ongoing Training
 - Knowledge Transfer
- Communication Plan
 - Inform vs Reporting
 - Management vs Team
- Visual Management
 - KPI's
 - PdM Adherence
- Continuous Improvement
 - Annual Program review
 - Plan – Do – Check - Act



Building your PdM Roadmap

– Steps to Start or take your program to the next level!

1. Set your Vision
2. Asset Criticality and Risk
3. Technology Selection
4. Implementation Method of Change
5. Sustain and Continuous Improvement



To learn more about **Fluke Reliability**



FEEDBACK

Questions or feedback on the Questions tab or contact your Customer Success Manager



eMaint University

Visit additional webinars on maintenance and reliability topics:
<https://emaintuniversity.litmos.com/home/library>



DEMO

Visit [Accelix.com](https://www.accelix.com) for a demo of our Connected Reliability Framework.



FLUKE®

Reliability

THANK YOU!
