



# The Drawbacks of Modern Machineries

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**Dr. Abdu Shaalan**

Industrial Automation Programme Leader



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- For the Engineering Institute of Technology (EIT) visit: <https://www.eit.edu.au/>
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# Introduction – Presenter



## Dr. Abdu Shaalan

- Abdu is a PhD holder in the fields of Industrial Automation and Advanced Maintenance practices from the University of Sunderland.
- He is a research enthusiast and has held multiple research projects over the years, including a research fellowship with the nursing school, several KTP projects with local manufacturers, and was recently awarded a Teaching Fellowship in AI in Education.
- Abdu's research focus is on Industrial Automation and Advanced Maintenance practices in the advances of Industry 4.0 technologies.
- Teaching-wise, Abdu held multiple programme lead positions ranging from Undergraduate and Postgraduate levels.
- Currently a programme leader for Undergraduate and Postgraduate Industrial Automation programmes at ECT.



# Agenda

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- |    |   |
|----|---|
| 1. | The Promise vs Reality of Modern Automation |
| 2. | Challenges of Maintaining Modern Machinery  |
| 3. | Building Reliable Automation Systems        |
| 4. | Modern Maintenance Strategies               |
| 5. | Common Causes of Asset Failure              |
| 6. | A Modern Maintenance Framework              |
| 7. | The Human Factor in Automation              |
| 8. | Key Takeaways & Recommendations             |



# Automation promised more than it often delivers



## The promise

Industrial automation was introduced to improve manufacturing processes and raise product quality.



## The reality

In many cases automation becomes a burden and added complexity, frequent breakdowns, and no measurable improvement.

# Complexity outpaced the maintenance



## Complex, one-of-a-kind assets

Large bespoke machines integrate many systems under modern control.



## Failures harder to read

With hundreds of sensors and connections, faults are difficult to interpret and rectify.



## Obsolete strategies

Traditional maintenance approaches no longer fit modern, automated assets.



## Maintenance becomes the bottleneck

More technology means more to maintain and more ways to halt production.

# Requirements to build a reliable automation system

## Three elements and two quality indicators



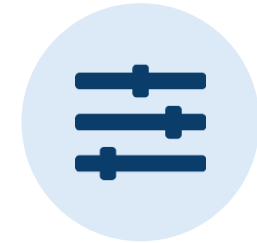
### Power

The energy that drives the system



### Program of instruction

The software logic controlling the process



### Control system

Sensors and actuators executing the cycle

## TWO INDICATORS OF AUTOMATION QUALITY



### Product features

Designed-in capability focused on what the product can do, set at design stage.



### Freedom of deficiencies

Final-product quality with accurate execution of the system's input parameters.

# A clear program of instruction



## Write it clear from day one

A clear, systematic program lets any programmer step in for fault-finding and diagnostics, saving large amounts of time in a complex system.

### BUILD IN MODES OF OPERATION



**Automated**

Standard production mode: The system runs the cycle



**Manual**

Operator present to activate specific functions



**Putting**

Test individual sensors and actuators in isolation



**Inching**

Reduced speed for accurate diagnostics of parts

# Structure the program in layers



## Plant module

The whole production plant



## Facility module

A machine or plant part e.g. a press or storage system



## Application module

Functional units e.g. material feed or filling unit



## Basic module

Individual drives & sensors down to bolts, nuts, belts

# Documentation: The reference set every asset needs



Schematic diagrams



Wiring diagrams



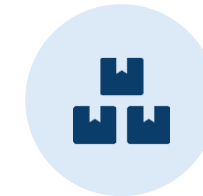
Control program



Operating guidance



Suggested maintenance



Components list

## Maintaining a highly performing asset

Structured strategies, continuous monitoring and timely upgrades



# Three generations of maintenance

1

1940s–50s

1ST GENERATION

## Run-to-fail

Corrective maintenance: Repair only after breakdown.

2

1960s–70s

2ND GENERATION

## Planned schedules

Preventive maintenance, work planning and control, early computers.

3

1980s–now

3RD GENERATION

## Condition & reliability

CBM, FMEA, RCM & TPM: High skills, teamwork, monitoring.

# Corrective vs preventive maintenance



## Corrective (CM)

*Act AFTER breakdown*

- ✓ Repair or replace once a failure occurs
- ✓ Usually stops the whole system
- ✓ Failure can spread to other parts
- ✓ High, unpredictable financial impact



## Preventive (PM)

*Act BEFORE breakdown*

- ✓ Maintain to a pre-set plan
- ✓ Parts serviced before they fail
- ✓ Prevents unscheduled stoppages
- ✓ Protects assets & avoids sudden loss

# TPM: The people-first strategy



*Japan, 1950s*

Improves machine reliability and employee morale, uniquely focused on the human aspect, engaging operators in simple maintenance.

## THE EIGHT PILLARS

1 5S

2 Autonomous maintenance

3 Focused maintenance

4 Planned maintenance

5 Quality maintenance

6 Education & training

7 Safety, health & environment

8 Office TPM & development

Measured by OEE = Availability × Performance × Quality

# RCM: Born in aviation



Reduce downtime & cost, improve safety

Developed in aviation, now used across military, mining, rail and industry.

## GUIDING STANDARDS

IEC 60300-3-11

SAE-JA1011

SAE-JA1012

*Selection data: MTTF · MTBR · Availability · Maintenance cost*

## THE RCM PROCESS

- 1 Define the system & its boundaries
- 2 Identify the most essential items (MSI)
- 3 Identify failure causes & predict effects
- 4 Develop FMEA for each MSI
- 5 Run reliability simulations for intervals
- 6 Apply RCM decision logic → PM policy
- 7 Build the maintenance plan & schedule

# CBM: Maintain on real data



# FMEA: Failure Mode & Effects Analysis



## What it is

A semi-qualitative method to identify every potential failure mode and quantify its effect on the system.

Decomposes the machine to component level, then analyses each component's failure mode.

Run by a cross-disciplinary team; tackles the highest-priority failures first.



## Targets the right parts

Focus effort where failures originate



## Supports safe design

Informs fault-tolerant, testable design



## Prioritises by risk

Reduce the worst failures first

# No single strategy is enough



## TPM

Organisational & human focus, engagement, skills, culture



## RCM

Machine focus, deep failure analysis & reliability



## CBM

Machine focus, real-time condition & early warning



Each was built for different goals, using one alone leaves gaps. The opportunity: select the right pillars from each, reinforced by digital technology.

# What UK manufacturers actually do

## THE STUDY

# 5 manufacturers

*across different sectors & sizes*

Oil & gas

Food & beverages

Automotive

Aerospace

OEM



Semi-structured interviews

Managers, engineers & operators



Maintenance records

Collected & analysed for quality



Real-time observation

Maintenance applications watched on site



Finding: most relied on reactive & planned maintenance, TPM, RCM & CBM were never fully implemented.

# Problem 1: Failure records were broken



## No classification

Most failures unclassified or wrongly classified



## Too few categories

Classifications didn't cover all failure types



## Mixed actions

Failures, installs & routine work logged together



## Poor descriptions

Little or no detail on faults or actions taken



## Unjustified spend

Unexplained costs on parts and labour hours



## Unreliable KPIs

Inaccurate OEE, MTBF and MTTR calculations

# Problem 2: Why machines kept failing



## OEM build quality

Unreliable machines from poor build quality



## Obsolescence

Old age + weak maintenance shortening lifetime



## Overload

Pushed beyond capability to hit capacity targets



## Operator misuse

Disregard for operating conditions & criteria



## Poor asset knowledge

Weak understanding of machines & operating modes

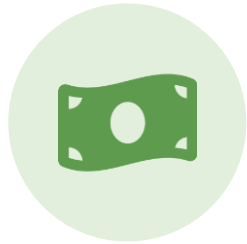


## Neglected upkeep

Essential repairs and checks skipped

# What blocks effective maintenance

1



## Financial

Unreliable assets bought cheap;  
no budget for training & skills

2



## Limited knowledge

Gaps across mechanical, electrical,  
control and strategy

3



## Limited time

Few staff, high workload,  
unpredictable failure peaks

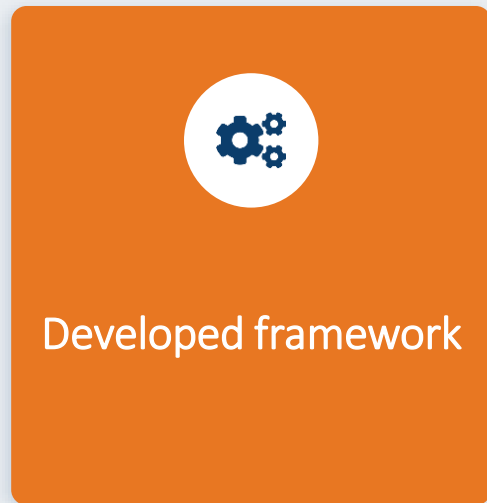
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## Low reliability

Special-purpose machines with  
built-in design flaws

# A modern maintenance framework



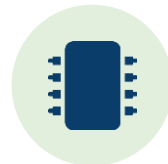
## Management

- Workforce: skills, training, engagement, culture
- Organisational: OEE, MTTR, MTBF, cost, ROI



## Technical

- Existing strategies evaluation
- Site & assets evaluation
- Documentation: evaluate & generate



## Digital technologies

- Condition monitoring & sensing nodes
- Automation & control-system modernisation

# Evaluate the asset, then the documents



## Existing strategies

Assess what's in place, run-to-fail, preventive or proactive



## Site & assets evaluation

Physical structure, control system, product quality, visual checks, operating conditions



## Documentation evaluation

Examine OEM schematics, wiring, control program, components & maintenance guidance



## Documentation generation

Failure categorisation (M,E,H,P,C), RCM task selection, operator guidance, 5S for control parts

# Condition monitoring & automation



## Condition monitoring

Identify critical components & the sensing nodes that reveal early failure signs:

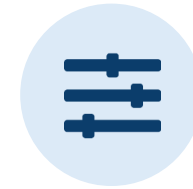
Temperature

Vibration

Ultrasound

Current & voltage

Object detection



## Automation systems

- ✓ Evaluate the existing control system
- ✓ Assess modernisation of the control system
- ✓ Integrate sensing nodes with the control system
- ✓ Address communication with supervisory systems
- ✓ Evaluate communication network, cloud & IoT

# Metrics that prove performance over time



**OEE**

Overall Equipment Effectiveness, availability × performance × quality



**MTTR**

Mean Time To Repair, how fast you recover from failure



**MTBF**

Mean Time Between Failures, how reliable the asset is



**Maintenance cost**

Total spend to keep the asset running



**Return on investment**

Value delivered against maintenance spend

# Match the strategy to criticality

## Run-to-fail



### Least-critical parts

Low/no dependency on other parts; no impact on quality if they fail. Saves resources for what matters.

## Autonomous maintenance



### Mid-importance parts

Lubricating, cleaning, alignment checks, done by operators in idle gaps, no high skill needed.

## Planned maintenance



### Critical parts

Scheduled professional checks & replacements at set times to prevent sudden breakdowns.

# The human aspect of automation

## People are part of the asset



### Workforce related

The maintenance team and operators directly shape an asset's lifetime and deterioration, misuse or skipped upkeep shortens its life.

*TPM puts the human aspect first, engaging operators improves both machines and morale.*



#### Evaluate skill levels

Know what skills exist vs. what the assets demand



#### Identify & train

Targeted training programs to close the gaps



#### Engagement

Involve operators; connect management & shop floor



#### Culture improvement

Build a culture that supports change & ownership

# The barriers are human as much as technical



## Resistance to change

Existing organisational culture pushes back on new strategies



## Management disengagement

Without leadership buy-in, frameworks stall



## Skills mismatch

Expertise lags behind advanced technology on the floor



## Complexity overload

Too many technologies to maintain without the right people

The biggest barriers to maintenance strategies are rarely the machines, they are people, knowledge and culture.

# Three takeaways to leave with



01



**Build it right**

Clear requirements, maintainable software, layered architecture and complete documentation — quality starts at the build stage.

02



**Maintain it smart**

No single strategy fits — combine TPM, RCM and CBM pillars, reinforced with condition monitoring and clean data.

03



**Lead the people**

Skills, training, engagement and culture decide the outcome — knowledge transfer is what makes the framework deliver.



Thank You!

# Upcoming Courses



Please note: courses listed below are subject to their own regulatory requirements—refer to the relevant website for further information.

Engineering Institute of Technology (EIT) <i>Australian Accredited Qualifications &amp; Short Courses</i>	Start Date
52886WA Advanced Diploma of Industrial Automation Engineering	4 August 2026
52892WA Advanced Diploma of Electrical and Instrumentation (E&I) Engineering in Mining	1 September 2026
52911WA Graduate Certificate in Internet of Things (IoT) for Engineering (Foundations)	7 July 2026
Bachelor of Science (Industrial Automation Engineering)	8 February 2027
Graduate Certificate in Industrial Automation and Machine Learning	4 January 2027
Graduate Certificate in Industrial Automation Engineering	4 January 2027
Master of Engineering – Applied Research (Industrial Automation)	4 January 2027
Master of Engineering (Industrial Automation)	4 January 2027
Professional Certificate of Competency in Allen Bradley Controllogix / Logix5000 PLC Platforms	8 September 2026
Professional Certificate of Competency in Control Valve Sizing, Selection and Maintenance	13 October 2026

# Upcoming Courses



Please note: courses listed below are offered by separate institutions in the UK and South Africa, each subject to their own regulatory requirements - refer to the relevant website for location-specific details.

Engineering College of Technology (ECT) <i>UK qualifications</i>	Start Date
Bachelor of Engineering (Honours) in Industrial Automation	21 September 2026
Bachelor of Engineering (Honours) in Electrical Engineering	21 September 2026
Master of Science (Power System Analysis and Renewable Integration)	5 October 2026
Master of Science (Industrial Automation and Instrumentation Control)	5 October 2026

Engineering College of Science and Technology (ECST) <i>South African accredited qualification &amp; ECSA-endorsed</i>	Start Date
Bachelor of Engineering Technology in Electrical Engineering	3 August 2026

Q&A



## Contact Us:



### Website

[www.eit.edu.au](http://www.eit.edu.au)



### Head Office

6 & 8 Thelma Street, West Perth,  
Perth, WA 6005



### Phone

Inside Australia: 1300 138 522  
Outside Australia: +61 8 9321 1702



### Email

[webinars@eit.edu.au](mailto:webinars@eit.edu.au)



### Courses

<https://www.eit.edu.au/schedule/>



### Website

[www.ect.ac.uk](http://www.ect.ac.uk)



### Head Office

Whittle Way, Stevenage SG1 2FS,  
United Kingdom



### Phone

Inside UK: 0208 335 4014  
Outside UK: +44 208 335 4014



### Programmes

<https://www.ect.ac.uk/programmes/>



### Website

[www.ecst.ac.za](http://www.ecst.ac.za)



### Head Office

Unit 3, Elevation Gardens,  
Elevation Close, Waterfall  
Office Park, Midrand, 1686



### Phone

Within South Africa: 010 823 4497  
Outside South Africa: +27 11 823 4497



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