APQP 4 Wind®

AI in Quality: From Reactive to Predictive



Host:

Jingchen Xi (Christina) – Global Development Lead, APQP4Wind

Malene Frits Bou Zeid – Communication & Marketing Coordinator, APQP4Wind

Speaker:

Kemal Dorak – Global Quality Leader and AI practitioner, Vestas

The APQP4Wind concept is becoming the common frame of reference for quality assurance in the wind industry. The APQP4Wind organization is a non-profit, non-political organization endorsed by world-leading utilities, wind turbine manufacturers, and suppliers.

History of APQP4Wind Organization

2014-2017

- **The idea of APQP4Wind was born**
- **Kick-Off Event hosted by Vestas,** presenting the APQP4Wind framework to the wind industry for the first time
- **Manual 1.1 and Workbook were published**
- Bureau Veritas Certification and DNV held the first courses

2018-2020

- **APQP4Wind became an independent organization with a Board of Directors**
- **The Analysis Tool was released**
- GE Renewable Energy, ZF and Goldwind joined the Board of Directors
- The Company Membership was launched
- First Country Ambassadors were announced
- TÜV Rheinland became a Training Provider

2021-2026

- **APQP4Wind Assessment Tool was introduced**
- Refresher Training was offered for the first time
- GRI Renewable Industries joined the Board of Directors
- APQP4Wind became the hosting platform for Industry Standards and Technical Information Management (TIM Wind)
- **Vattenfall and Ørsted joined the APQP4Wind Board of Directors as the first utility companies**
- The APQP4Wind Community reached 170+ Company Members

The revolution is gaining pace



11000+
Manuals sold worldwide

9000+
course participants

1600+
companies with certified employees

Training in **+50** countries

4
Global Training Providers

+170
Company Members

APQP 4 Wind®

Strengthens the cooperation between Customers and Suppliers

As a member of APQP4Wind, you become part of a strong and wide networking platform with a growing number of members – both global Utility Companies and Developers, Original Equipment Manufacturers, and Suppliers



See the full list on our website: https://apqp4wind.org/company-membership/our-members

Meet the speaker:

Kemal Dorak

- Head of Global Manufacturing Quality at **Vestas**
- 20+ years of experience in manufacturing quality, operations, project management, and global value chains
- Expert in quality strategy, APQP, manufacturing readiness, risk management, and continuous improvement
- Driving the adoption of AI and advanced analytics in quality management
- Applying AI to quality deliverables, problem-solving, risk intelligence, data readiness, and governance
- Advocate of human-governed AI to strengthen quality performance and risk prevention across the wind industry



WEBINAR 1 OF 3

AI in Quality & APQP4Wind

Understand & Imagine

Kemal Dorak
Head of Quality · AI practitioner

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Why AI now?

A strong partner..



More data

grows faster than we can read it



More complexity

more variants, tiers and changing requirements.



Cost pressure

efficiency and cost-out targets every year



AI

Closes the gaps

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THE SERIES

Three webinars , one AI Journey

WEBINAR 1

AI in Quality & APQP4Wind

Understand & Imagine

- AI in quality
- AI basics
- Responsible AI
- AI Applications Demo

WEBINAR 2

Deeper capabilities of Generative AI

Design & Plan

- AI models
- Data architecture
- Gen AI Elements
- Tools & Integrations
- Implementation roadmap
- AI Applications Demo

WEBINAR 3

Building AI-Powered Quality Solutions

Build & Deploy & Validate

- Architecture
- Development
- Testing
- Deployment
- Validate

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WEBINAR 1

How the next 90 minutes run

PART 1	**AI in APQP4Wind & Quality** What AI can do for quality	15 min
PART 2	**AI basics** What AI, ML and Generative AI really mean	25 min
PART 3	**Responsible AI** AI failure modes and governance	5 min
PART 4	**Live demo: four working AI applications** Prevention, assurance, prediction, problem solving	35 min
Q&A	**Your questions**	10 min

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PART 1 · 15 MINUTES

AI in APQP4Wind & Quality



From reactive quality to predictive and preventive quality

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Quality is data-rich — *but insight is hidden*

Your data has a story to tell

WHAT WE HAVE

Documents
FMEA, drawings, specs

Records
NC, Audits, PPAP

Signals
Process & Product logs

People
Engineers, auditors, Process owners

BUT THE EVIDENCE IS…

Fragmented
Spread across many tools

Inconsistent
Names & types differ

Underused
Lessons not reused

WHAT AI ENABLES

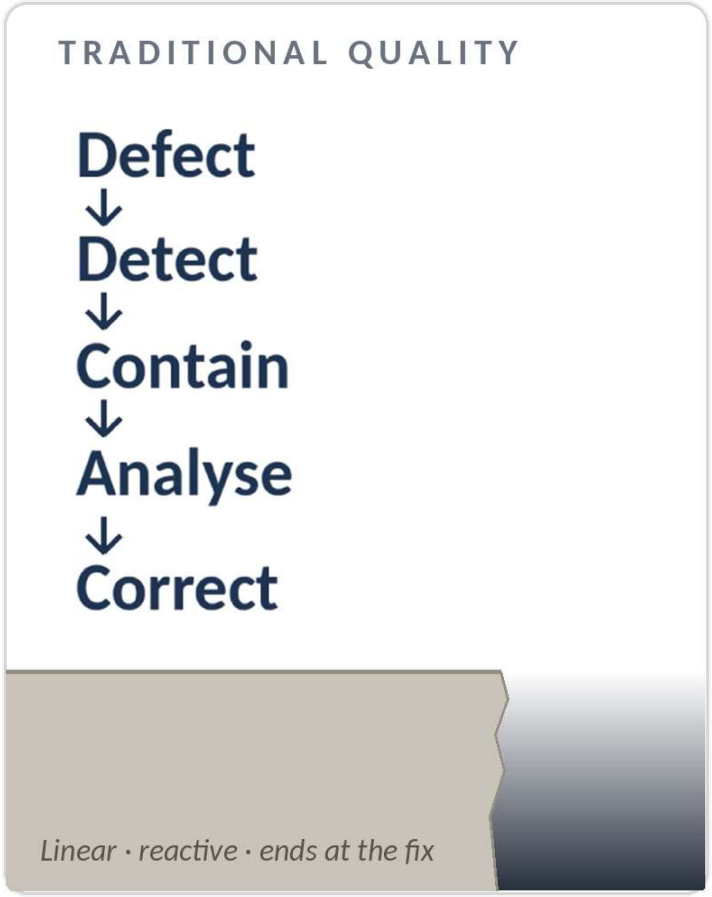
AI connects the evidence

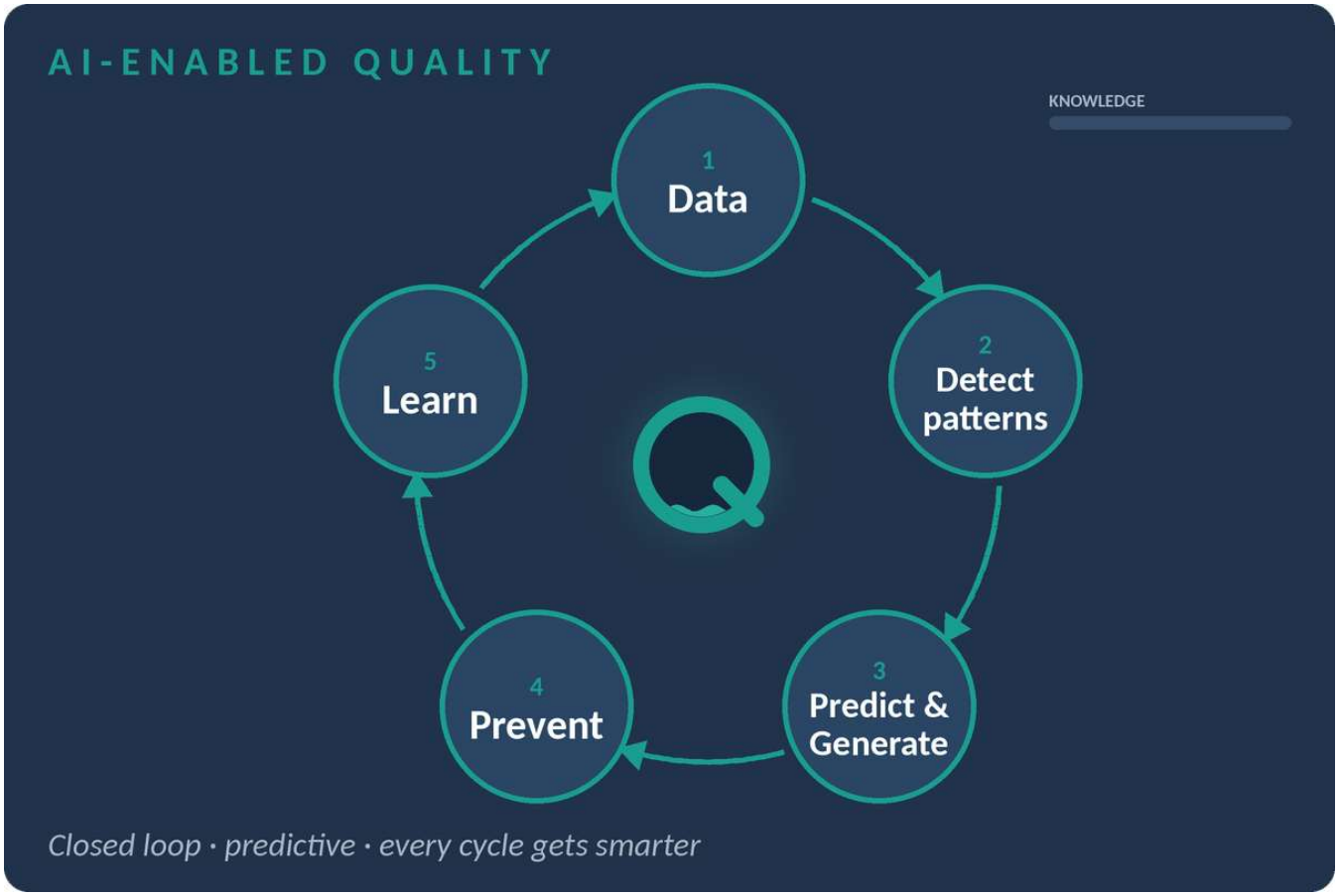
Better & faster quality decisions

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What is changing in quality and APQP4Wind with AI ?

Data is the new fuel …





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PART 1

Eight things AI does in Quality & APQP4Wind

Prevent

Stop problems before they happen

EXAMPLE

Before a new turbine cable is released, AI reviews past failures and customer requirements and flags missing risks in the PFMEA

Predict

Warn where a problem is likely

EXAMPLE

Blade bonding temperature, humidity and process data to warn which bonds have a higher defect risk

Detect

See defects automatically

EXAMPLE

Camera detects porosity, cracks, or surface defects on cast components.

Analyse

Structure root cause from messy evidence

EXAMPLE

50 bolt-related NCRs from several suppliers and shows the common failure patterns for the engineering team to investigate.

Generate

Draft FMEAs, control plans, reports, A3s

EXAMPLE

Control plan drafted from from the process flow, PFMEA, drawing and customer requirements.

Verify

Check evidence against requirements

EXAMPLE

Heat number on the material certificate does not match the dimensional report.

Recommend

Suggest what to do next

EXAMPLE

Paint thickness starts drifting, AI proposes likely checks and corrective actions for the quality engineer to review.

Learn

Reuse what the company already knows

EXAMPLE

A solved gearbox bearing problem becomes searchable knowledge when a similar issue appears on the next turbine project.

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PART 1

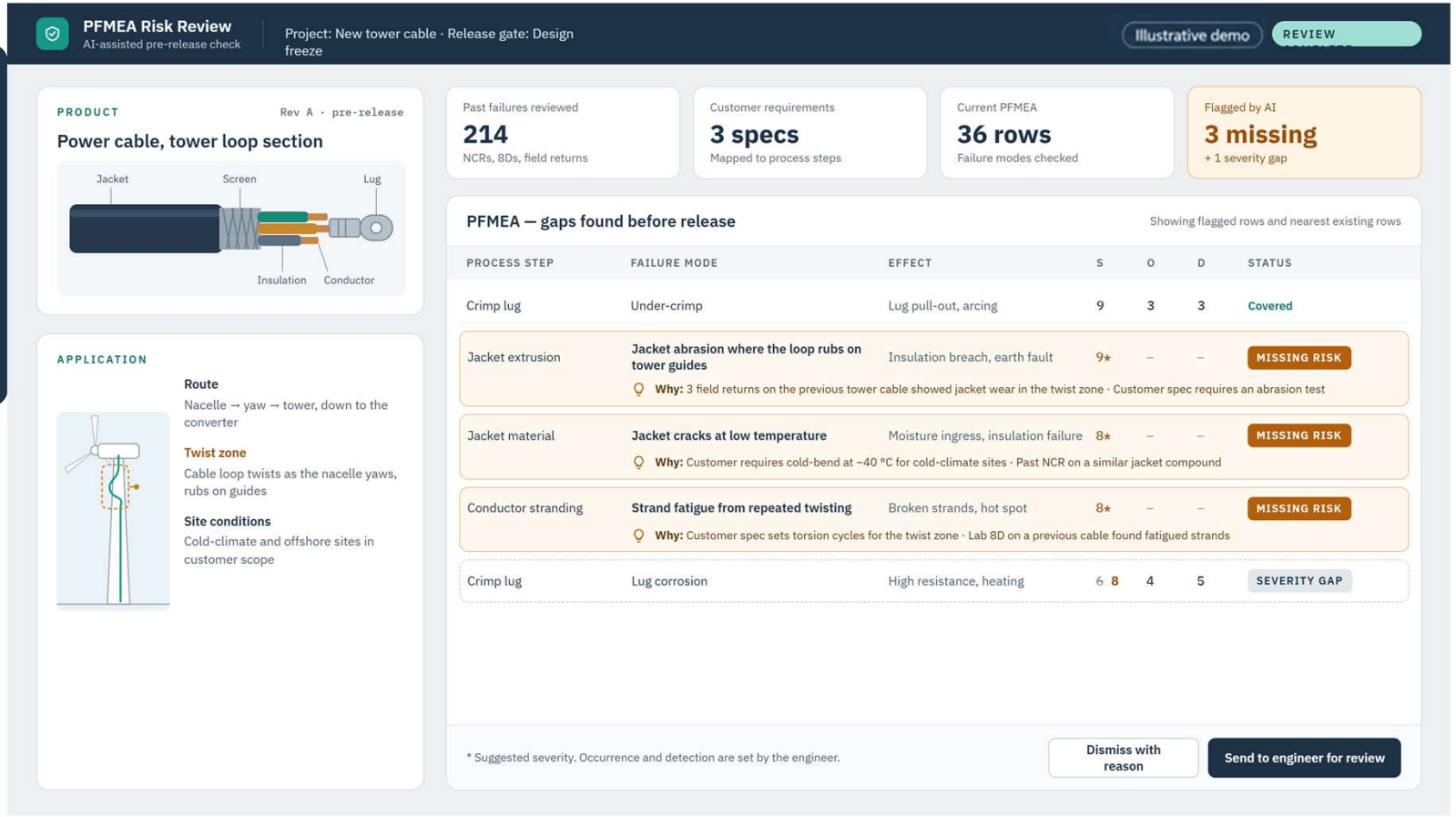
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Stop problems before they happen

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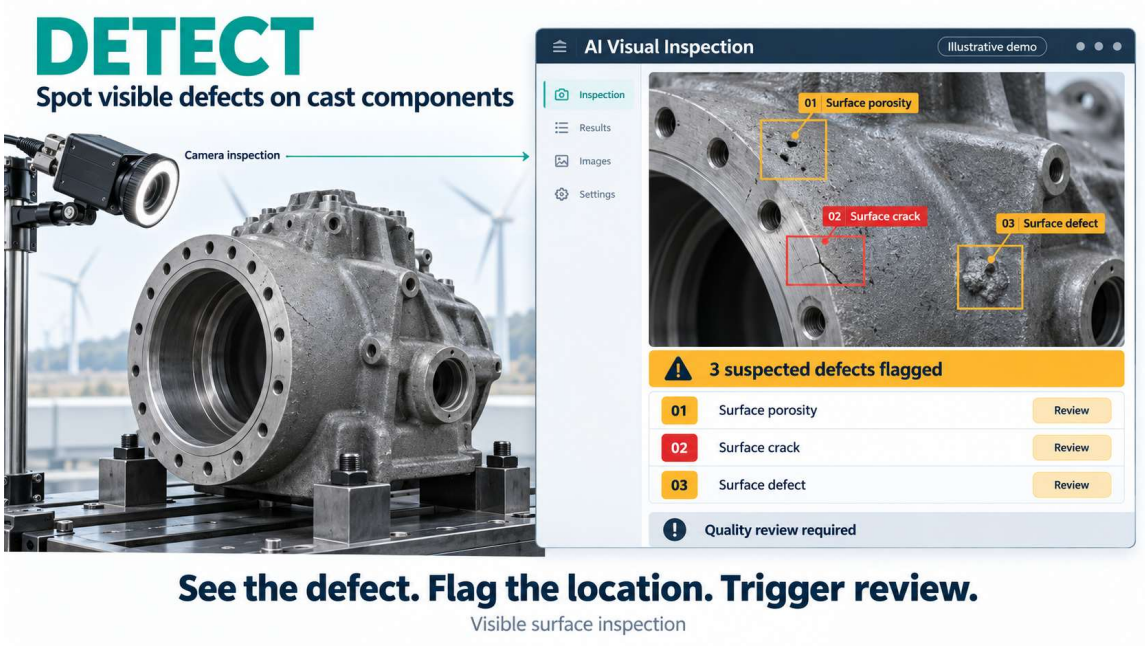
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PART 1

Eight things AI does in Quality & APQP4Wind



Detect

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EXAMPLE

Camera detects porosity, cracks, or surface defects on cast components.

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PART 1

Eight things AI does in Quality & APQP4Wind



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PART 1

AI use cases for A4W and Quality

Documents

Too many documents

→ **Document verification**

Procedures hard to find

→ **Smart QMS portal**

Risk & problem solving

Disconnected FMEA & NCs & Specs

→ **Risk intelligence**

FMEA takes weeks

→ **AI-assisted FMEA**

Repeat NC investigations

→ **AI-assisted 8D / A3**

Data

Data collected, never used

→ **Defect prediction**

Messy factory data

→ **AI data engineering**

Projects & training

APQP actions scattered

→ **AI project management**

Unclear digital solution

→ **Solution & business case**

Few training examples

→ **Scenario generator**

*Every problem here is something a competent person already does — **just slowly.***

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PART 1

AI use cases for A4W and Quality

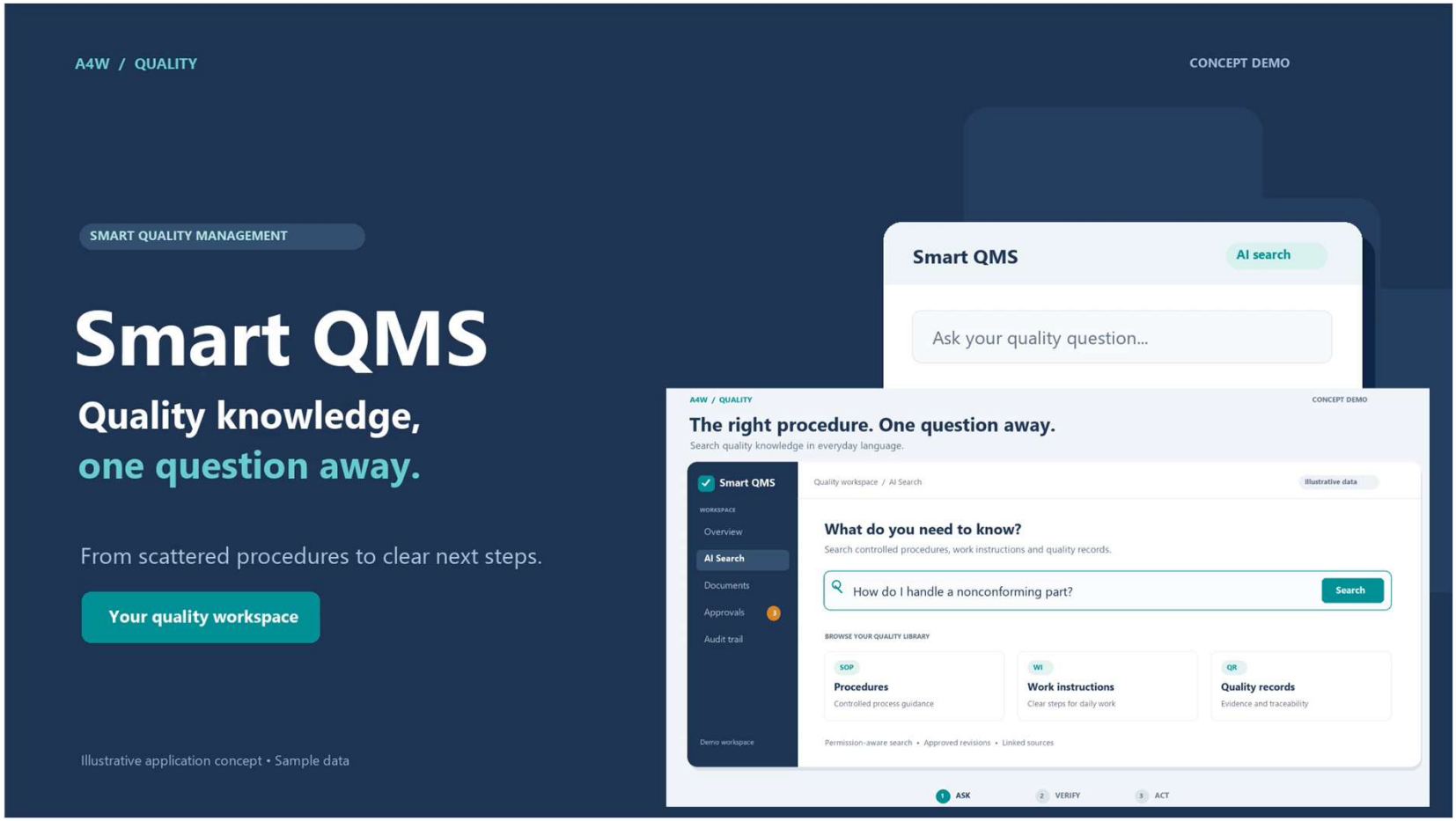
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PART 1

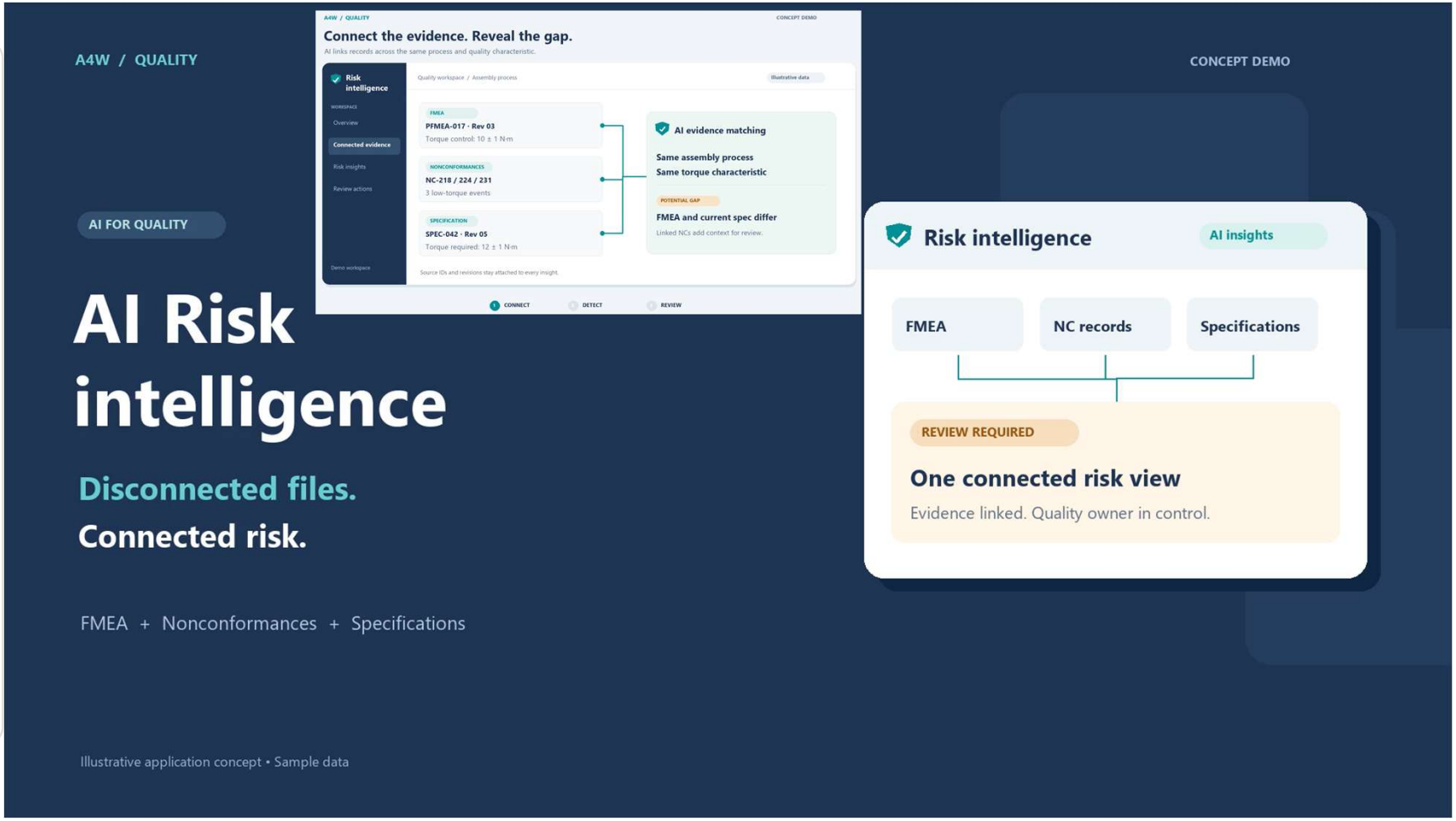
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→ **AI-assisted 8D / A3**



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PART 2 · 25 MINUTES

AI Basics

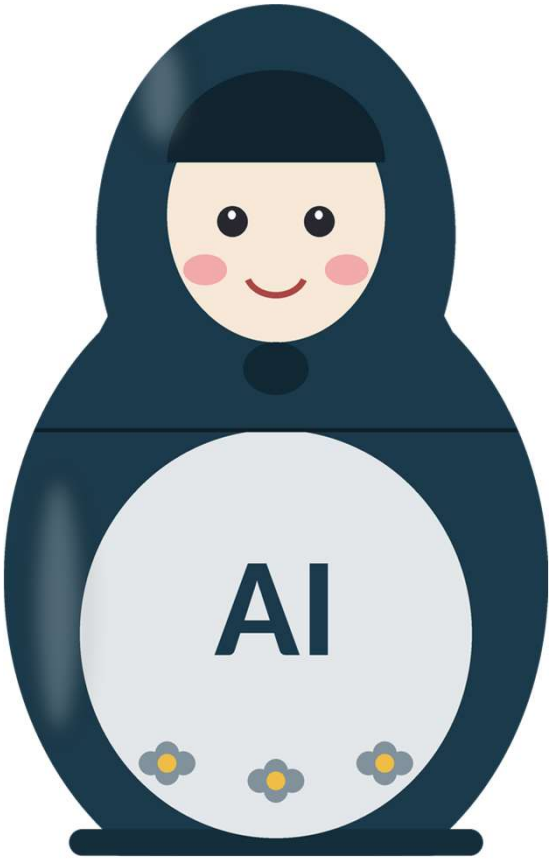


What AI, ML and Generative AI really mean

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AI, Machine Learning, Deep Learning & Generative AI

PART 2



AI Artificial Intelligence

Computers doing tasks that normally need a human brain.

Example: deciding, planning, answering questions.

ML Machine Learning

Computers learn from past data.

Example: Netflix suggesting what to watch, or warning that a machine is likely to fail.

DL Deep Learning

Computers can handle images, sound and speech.

Example: Face ID unlocking your phone, or a camera spotting scratches on a part.

Gen AI Generative AI

Computers generate text, images, video, code and voice.

Example: ChatGPT, or drafting an FMEA for an engineer to review.

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Kitchen analogy for AI

AI, Machine Learning, Deep Learning & Generative AI

PART 2



AI

The whole restaurant

The complete system, including its people, tools and decisions.

ML

The learning chef

Learns from feedback to improve recipes.

DL

Layers working together

Stations learn together

Gen AI

The creative chef

Creates a new dish

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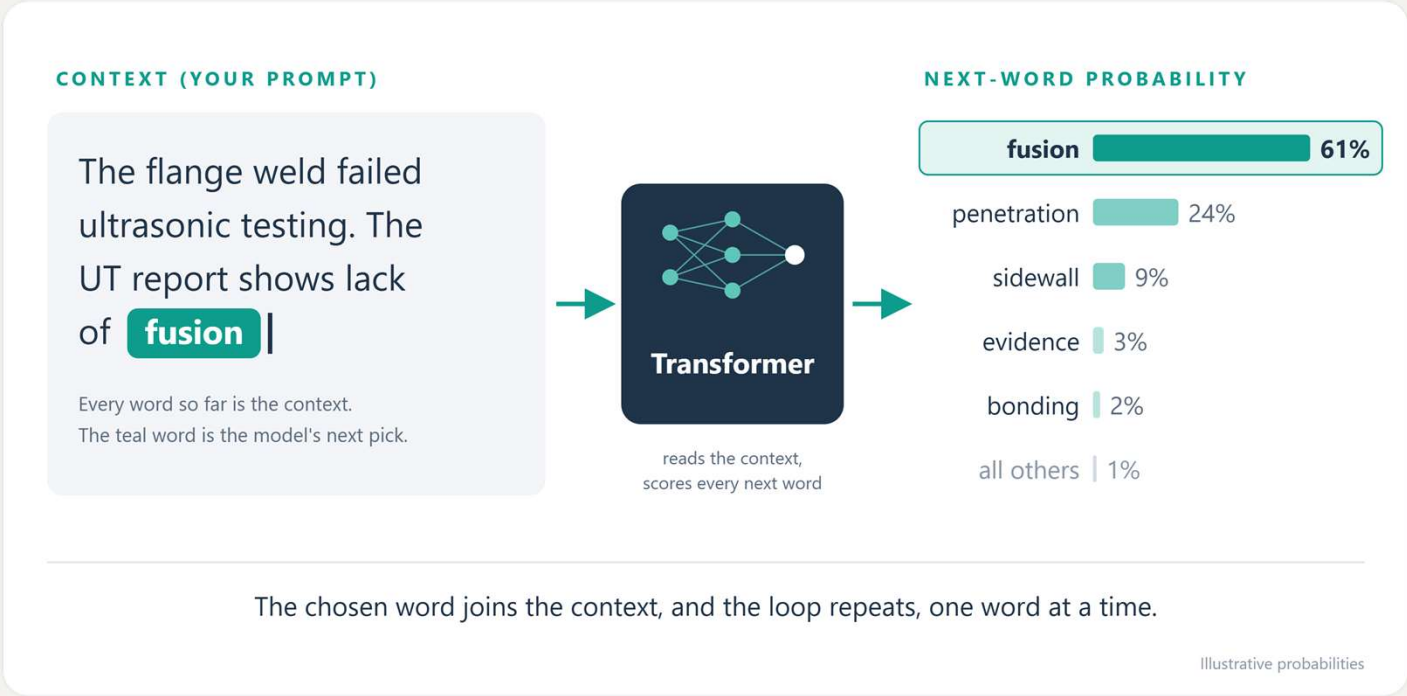
Generative AI, GPT and LLM (Large Language Model)

PART 2

G Generative
Creates new content.

P Pre-trained
Trained on large amounts of data

T Transformer
Uses context to predict next word



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Generative AI Platforms

PART 2

Commercial Models

ChatGPT
OpenAI

Claude
Anthropic

Gemini
Google

Grok
xAI

Pros

- Strong capability
- Easy to use

Cons

- Pay per use
- Data handling depend on provider/contract.

Open-Source Models

Mistral AI

LLaMA

Qwen

Gemma

deepseek

Hugging Face

Pros

- Free $ to run
- Data can stay in-house & safer

Cons

- Needs own hardware
- Less parameters

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Generative AI Elements

Choose the right element for every quality challenge.



Prompting Techniques

Guide clearly

EXAMPLE

"Review this 8D and list missing evidence."



RAG

Retrieval-augmented generation

Give your documents

EXAMPLE

Find the approved torque spec in our procedures.

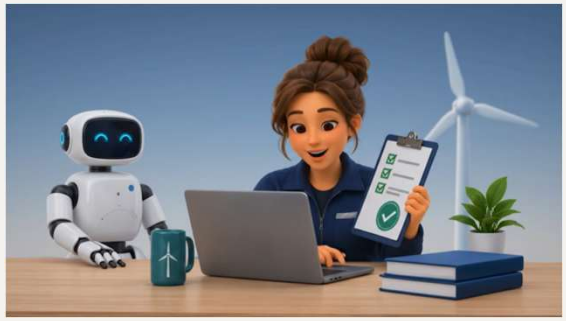


Fine-tuning

Train it on your data

EXAMPLE

FMEA model trained on our past FMEAs.



AI agents

Autonomous & Simultaneous execution

EXAMPLE

8D agent gathers evidence, then asks for approval.

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Machine Learning Demo : Chicken deliciousness prediction

PART 2

5 INPUTS

- Frying temperature
- Cooking time
- Sauce amount
- Spice level
- Crispiness

MODEL

learns patterns from 1,000 rows

OUTPUT

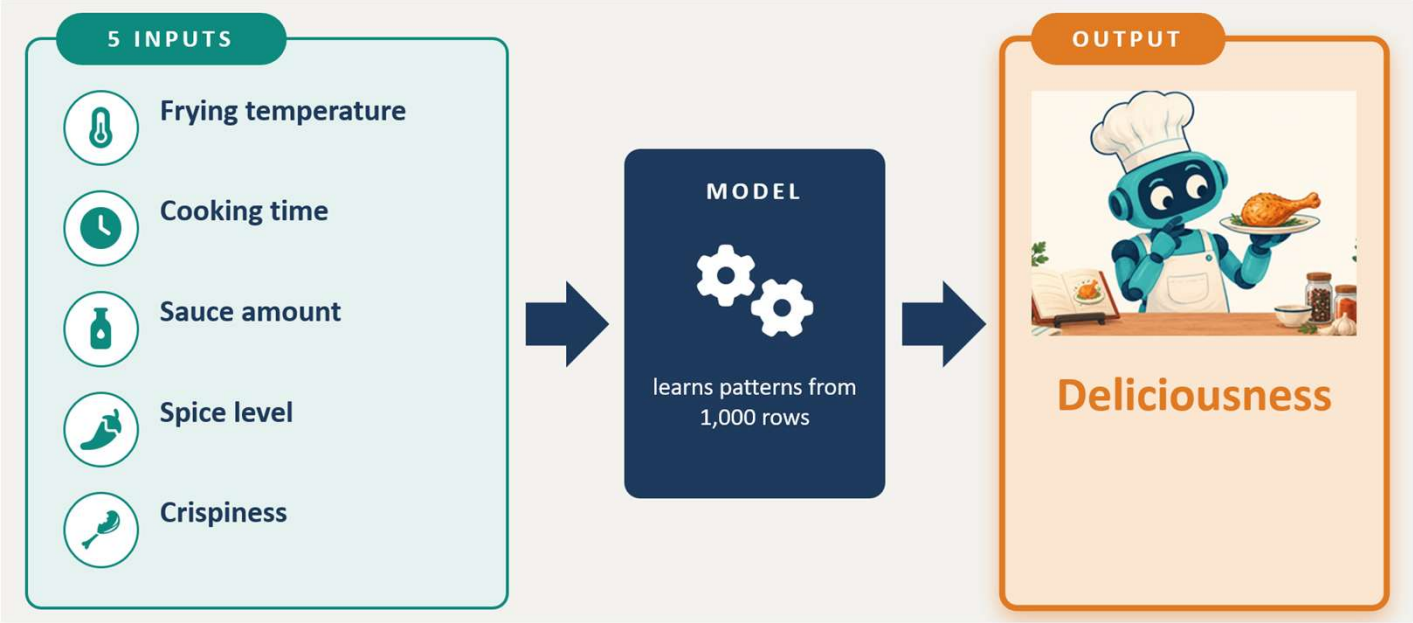


Deliciousness

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Machine Learning Demo : Chicken deliciousness prediction

PART 2



The machine-learning Steps

1. Collect data
2. Process data
3. Select inputs and outputs
4. Training
5. Verify results
6. Analyze and use results

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Step 1 · Collect data: 1,000 chicken tastings

PART 2 · THE TRAINING DATA

#	Frying temp (°C)	Cooking time (min)	Sauce (ml)	Spice (0-10)	Crispiness (1-10)	Deliciousness (1-10)
1	178.0	8.79	20.6	5.6	6.9	**9.4**
2	179.9	8.74	29.1	6.3	7.5	**8.6**
3	176.2	8.23	23.0	6.0	3.6	**8.5**
4	172.2	10.35	14.3	2.5	7.5	**4.7**
5	175.0	8.92	34.5	7.2	4.5	**6.7**
6	171.6	10.18	18.5	3.3	3.3	**4.8**
7	178.4	9.25	19.0	2.5	5.2	**7.6**
8	186.7	7.62	8.4	3.7	3.3	**4.0**
			⋮ *990 more rows* ⋮			
999	181.0	7.37	12.3	3.5	7.5	**7.7**
1000	172.6	8.02	4.8	5.4	4.7	**5.9**

1,000
rows of synthetic customer feedback

5 → 1
input features → 1 output

Inputs (what we control or measure)

Output (what the model predicts)

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Fried Chicken Deliciousness Prediction Analysis

Best recipe

Frying temperature

177 °C

Spice level (mild)

~5

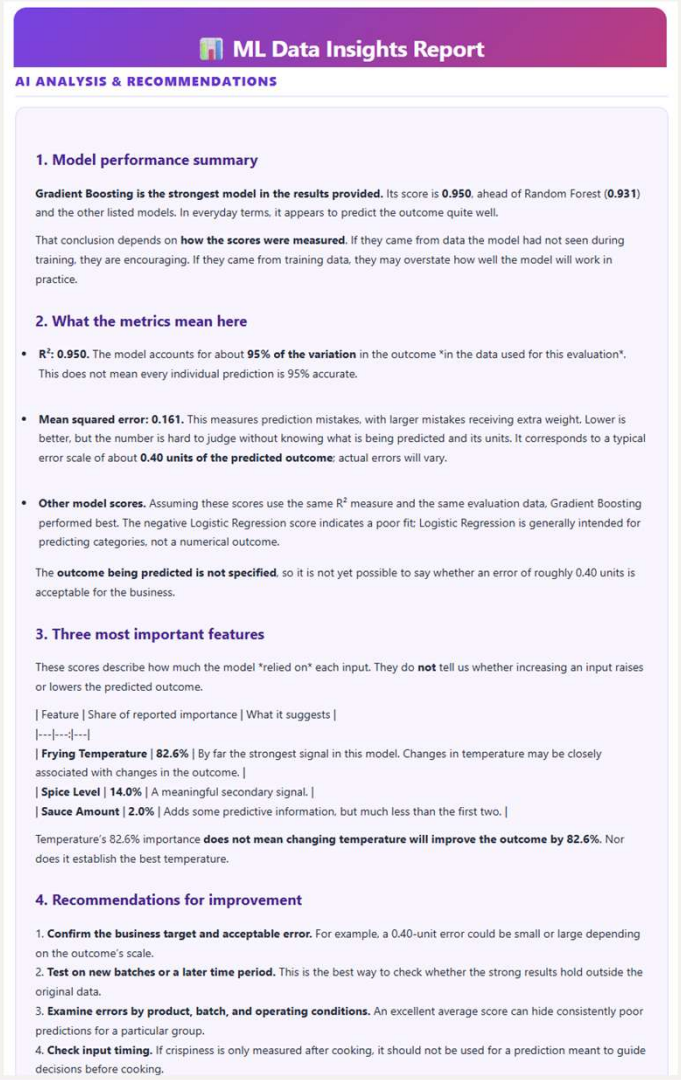
RANK	FRYING TEMPERATURE (°C)	COOKING TIME (MIN)	SAUCE AMOUNT (ML)	SPICE LEVEL (0-10)	CRISPINESS (1-10)	PREDICTED
1	177.50	8.39	23.60	4.50	10.00	**9.0496**
2	177.20	9.88	20.70	4.80	8.40	**9.0495**
3	177.80	8.36	15.40	5.30	9.90	**9.046**

RANK	FRYING TEMPERATURE (°C)	COOKING TIME (MIN)	SAUCE AMOUNT (ML)	SPICE LEVEL (0-10)	CRISPINESS (1-10)	PREDICTED
1	166.20	10.18	4.70	1.20	1.30	**0.9997**
2	165.70	7.31	4.90	9.90	1.70	**0.9995**
3	192.70	9.07	7.20	0.70	1.50	**1.0013**

chicken ML_Insights_Report_2026-09-20.html

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ML App Insights Function



ML Data Insights Report

AI ANALYSIS & RECOMMENDATIONS

1. Model performance summary

Gradient Boosting is the strongest model in the results provided. Its score is **0.950**, ahead of Random Forest (**0.931**) and the other listed models. In everyday terms, it appears to predict the outcome quite well.

That conclusion depends on **how the scores were measured**. If they came from data the model had not seen during training, they are encouraging. If they came from training data, they may overstate how well the model will work in practice.

2. What the metrics mean here

- **R^2: 0.950.** The model accounts for about **95% of the variation** in the outcome *in the data used for this evaluation*. This does not mean every individual prediction is 95% accurate.
- **Mean squared error: 0.161.** This measures prediction mistakes, with larger mistakes receiving extra weight. Lower is better, but the number is hard to judge without knowing what is being predicted and its units. It corresponds to a typical error scale of about **0.40 units of the predicted outcome**; actual errors will vary.
- **Other model scores.** Assuming these scores use the same R^2 measure and the same evaluation data, Gradient Boosting performed best. The negative Logistic Regression score indicates a poor fit; Logistic Regression is generally intended for predicting categories, not a numerical outcome.

The **outcome being predicted is not specified**, so it is not yet possible to say whether an error of roughly 0.40 units is acceptable for the business.

3. Three most important features

These scores describe how much the model *relied on* each input. They do **not** tell us whether increasing an input raises or lowers the predicted outcome.

Feature	Share of reported importance	What it suggests
Frying Temperature	**82.6%**	By far the strongest signal in this model. Changes in temperature may be closely associated with changes in the outcome.
Spice Level	**14.0%**	A meaningful secondary signal.
Sauce Amount	**2.0%**	Adds some predictive information, but much less than the first two.

Temperature's 82.6% importance **does not mean changing temperature will improve the outcome by 82.6%.** Nor does it establish the best temperature.

4. Recommendations for improvement

1. **Confirm the business target and acceptable error.** For example, a 0.40-unit error could be small or large depending on the outcome's scale.
2. **Test on new batches or a later time period.** This is the best way to check whether the strong results hold outside the original data.
3. **Examine errors by product, batch, and operating conditions.** An excellent average score can hide consistently poor predictions for a particular group.
4. **Check input timing.** If crispiness is only measured after cooking, it should not be used for a prediction meant to guide decisions before cooking.

Input tokens	Output tokens	Total tokens	Approx. cost
429	1.024	1.453	$0.011098

openai · gpt-6-sol · Approximate list-price estimate; verify with your provider/API account.

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PART 3 · 5 MINUTES

Responsible AI



what can go wrong, who stays accountable, and what is now expected.

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PART 3

AI can make mistakes !

Wrong output

Hallucination
→ Verify against the source

False alarms / misses
→ Test good and bad parts

Drift
→ Re-test after updates

Wrong input

Missing context
→ Give the full picture

Bad data
→ Clean inputs first

Bias
→ Check varied cases

Human & security

Overreliance
→ A human makes the decision

Traceability
→ Keep input and output

Confidentiality
→ Approved tools only

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PART 3

Human + AI

AI DOES THE HEAVY LIFTING		PEOPLE STAY ACCOUNTABLE
Finds 12 similar NCs	→	Engineer confirms the root cause
Drafts the 8D report	→	Engineer challenges the assumptions
Predicts supplier risk	→	Manager approves the action

An AI recommendation is not a quality approval.

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PART 3

Responsible AI is not a nice to have!

- Governance
- AI literacy
- Cybersecurity
- Data protection
- Traceability
- Transparency
- Human oversight
- Validation
- Lifecycle monitoring

01 · EU LAW

EU regulatory framework

- Regulation (EU) 2024/1689 — AI Act
- Regulation (EU) 2026/1744 — Digital Omnibus on AI
- Regulation (EU) 2023/1230 — Machinery Regulation
- Directive (EU) 2022/2555 — NIS2
- Regulation (EU) 2024/2847 — Cyber Resilience Act
- GDPR Art. 22 and Art. 35

02 · MANAGEMENT SYSTEMS

Management, governance & risk frameworks

- ISO/IEC 42001 — AI management system
- ISO/IEC 23894 — AI risk management
- ISO/IEC 42005 — AI system impact assessment
- ISO/IEC 38507 — AI governance for governing bodies
- ISO/IEC 27001 — information security
- ISO 31000 — risk management
- NIST AI RMF 1.0 + GenAI Profile (AI 600-1)

03 · TECHNICAL & SECTOR

Evidence

- ISO/IEC 22989 — AI terminology
- ISO/IEC TR 24028 — trustworthiness
- ISO/IEC 24029 — robustness of neural networks
- ISO/IEC 5259 — data quality for ML
- ISO/IEC 25059 — quality model for AI systems
- DNV-RP-0671 — assurance of AI-enabled systems
- CEN-CENELEC JTC 21 — European/harmonized standards

AI governance should be designed into the quality process — not added after deployment.

PART 3

Responsible AI

WHAT QUALITY ALREADY DOES	THE AI EQUIVALENT	REFERENCE
QMS ISO 9001 · IATF 16949	AI management system	ISO/IEC 42001
FMEA Risk before you build	AI risk & impact assessment	ISO/IEC 23894 · 42005
Validation & MSA Is the measurement right?	Model validation & robustness	ISO/IEC 24029
Traceability Lot genealogy	Data lineage & model versions	ISO/IEC 5259
PPAP / product approval Evidence first	Technical file & conformity	EU AI Act
Control plan & SPC Watch the process	Lifecycle monitoring & drift	AI Act Art. 72

AI governance should be designed into the quality process — not added after deployment.

"Conceptual analogy — not a one-to-one legal equivalence. Requirements depend on AI Act classification and role."

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PART 4 · 35 MINUTES

AI applications Demo



Prevention · Assurance · Prediction · Problem solving

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PART 4

AI-powered quality apps — live demo

1

A3 / 8D

Problem solving

DEMOS

- Tower welding
- Hub casting porosity

2

FMEA Builder

Prevention

DEMOS

- Offshore cable FMEA
- Blade FMEA review

3

VeriDoc

Document verification

DEMOS

- Pitch cylinder PPAP
- Generator as-built docs

4

ML for All

Prediction

DEMOS

- Blade bondline quality
- Fried chicken 🍗

COMING IN NEXT WEBINARS

Data engineer · Bridge agents · Project management · Reporting

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A3 / 8D App demo problems

DEMO 1

Tower welding issue

1.8% → 8% weld repair rate (target 2%)

Problem	UT rejects on flange-to-shell SAW welds
Impact	6–14 h per repair · 2 towers 6–9 days late
Customer	OEM wants containment in 48 h, A3 in 10 days
Suspects	New flux batch · humid weather · new welder

DEMO 2 with Local AI model

Hub casting porosity

14.7% hubs rejected (usually 3–4%)

Problem	Porosity in blade flanges (mostly flange C)
Impact	38 hubs on hold · assembly slots blocked
Customer	8D rejected; wants treatment-batch link
Suspects	New FeSiMg lot · low pour temp · pattern fix

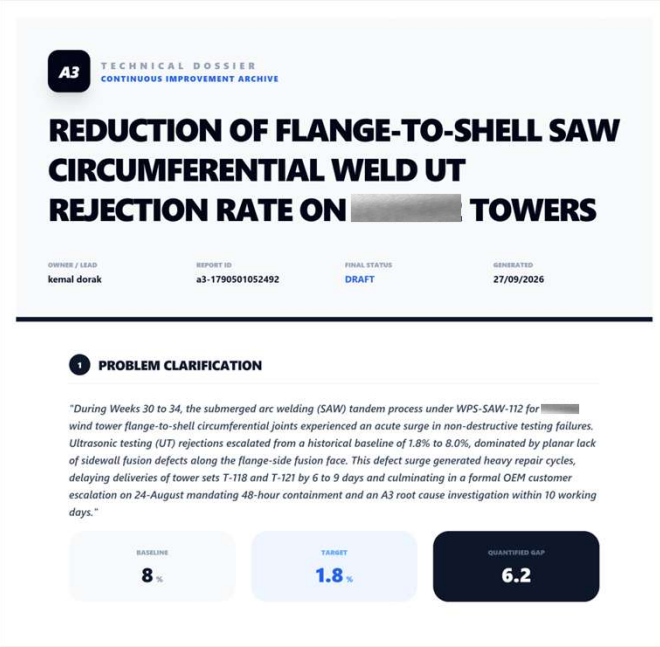
***SYNTHETIC DEMO DATA — NO REAL COMPANY, CUSTOMER OR PRODUCT DATA**

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A3/8D App Demo Reports

DEMO 1

Tower Welding 8D Report


TECHNICAL DOSSIER
CONTINUOUS IMPROVEMENT ARCHIVE

REDUCTION OF FLANGE-TO-SHELL SAW CIRCUMFERENTIAL WELD UT REJECTION RATE ON [redacted] TOWERS

OWNER / LEAD: kemal dorak
REPORT ID: a3-1790501052492
FINAL STATUS: DRAFT
GENERATED: 27/09/2026

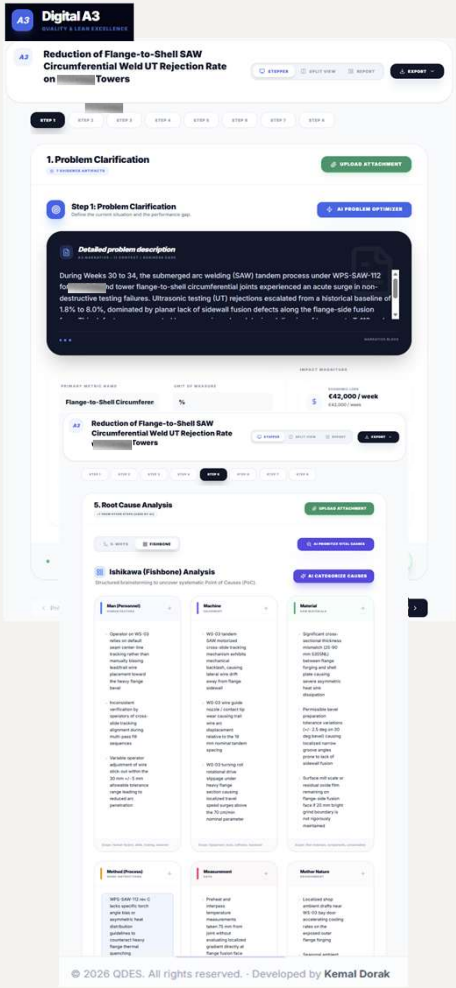
1 PROBLEM CLARIFICATION

"During Weeks 30 to 34, the submerged arc welding (SAW) tandem process under WPS-SAW-112 for [redacted] wind tower flange-to-shell circumferential joints experienced an acute surge in non-destructive testing failures. Ultrasonic testing (UT) rejections escalated from a historical baseline of 1.8% to 8.0%, dominated by planar lack of sidewall fusion defects along the flange-side fusion face. This defect surge generated heavy repair cycles, delaying deliveries of tower sets T-118 and T-121 by 6 to 9 days and culminating in a formal OEM customer escalation on 24-August mandating 48-hour containment and an A3 root cause investigation within 10 working days."

BASELINE 8 % | TARGET 1.8 % | QUANTIFIED GAP 6.2

Reduction of Flange-to-Shell SAW Circumferential Weld UT Rejection Rate on

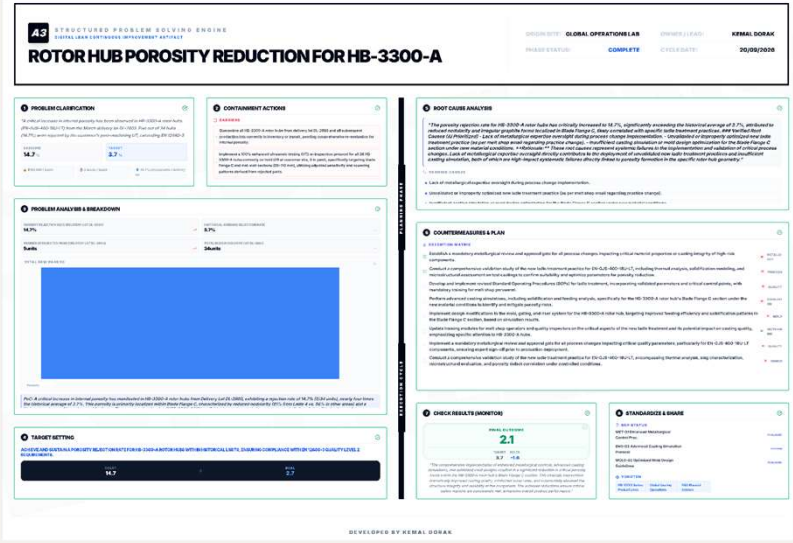
App view



DEMO 2

Hub Casting Porosity A3 Report

(Local AI model used)


STRUCTURED PROBLEM SOLVING ENGINE

ROTOR HUB POROSITY REDUCTION FOR HB-3300-A

ORIGIN SITE: GLOBAL OPERATIONS LAB | OWNER / LEAD: KEMAL DORAK
PHASE STATUS: COMPLETE | CYCLE DATE: 20/09/2026

PROBLEM CLARIFICATION
CONTAINMENT ACTIONS
ROOT CAUSE ANALYSIS
PROBLEM ANALYSIS & BREAKDOWN
COUNTERMEASURES & PLAN
CHECK RESULTS (MONITOR)
STANDARDIZE & SHARE
TARGET SETTING

DEVELOPED BY KEMAL DORAK

Rotor Hub Porosity Reduction for HB-3300-A-A3.pdf

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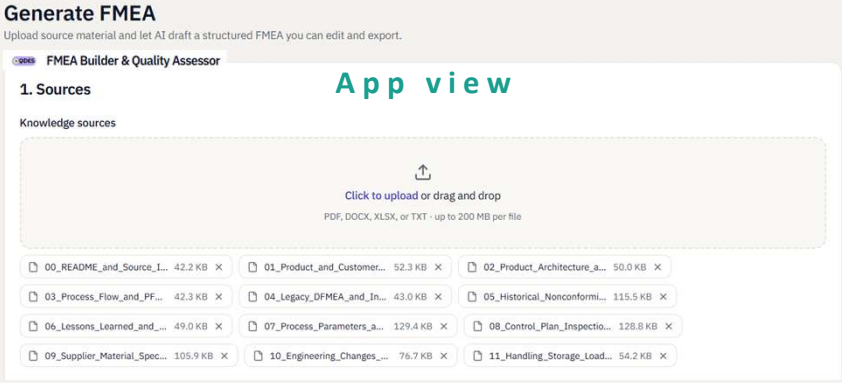
FMEA App Demo 1 Results

Demo 1
Offshore Cable FMEA

Input Documents

- 00_README_and_Source_Index.docx
- 01_Product_and_Customer_Requirements.docx
- 02_Product_Architecture_and_Design_Basis.docx
- 03_Process_Flow_and_PFD.xlsx
- 04_Legacy_DFMEA_and_Interface_Risk_Register.xlsx
- 05_Historical_Nonconformities_CAPA_Warranty.xlsx
- 06_Lessons_Learned_and_8D_Summaries.docx
- 07_Process_Parameters_and_Control_Limits.xlsx
- 08_Control_Plan_Inspection_Test_and_MSA.xlsx
- 09_Supplier_Material_Specifications_and_Incoming_Quality.xlsx
- 10_Engineering_Changes_Deviations_and_Concessions.xlsx
- 11_Handling_Storage_Loadout_Installation_Interface.docx

Generation & Output



FMEA PFMEA

PFMEA · 96 rows

Process Step	Work Element	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Potential Cause(s)	Occurrence	Current Controls	Detection	RPN	Action Priority	Recommended Action
P001 Incoming materials and release	Receive conductor wire	Semicon screen discontinuity	Electrical stress concentration and unstable partial-discharge performance	8	Wrong, damaged, or nonconforming conductor wire received; inadequate incoming inspection	4	Operator check; material-lot segregation and receipt record	6	192	Medium	Add supplier certificate verification, visual inspection, and continuity screening before release
P002 Incoming materials and release	Receive XLPE compound	Water-blocking discontinuity	Longitudinal water migration after sheath damage	9	Incorrect XLPE compound, moisture exposure, or uncontrolled material storage	4	Laboratory release per material lot; approved recipe	5	180	High	Verify compound identity, shelf life, moisture condition, and lot traceability before release
P003 Incoming materials and release	Receive semiconductive compound	Armour wire crossover	Point loading, sheath indentation, and fatigue initiation	8	Incorrect compound receipt or material mix-up; inadequate identification	3	Automated interlock; lot identification	5	120	Medium	Use barcode identity verification and quarantine unidentified or damaged containers
P004 Incoming materials and release	Receive copper screen wires	Outer sheath pinhole	Seawater ingress, corrosion, and oversheath test failure	9	Damaged, corroded, or incorrect screen wire received	3	Record review per drum	6	162	High	Inspect drum condition, wire surface, dimensions, and certificate-to-lot correlation
P005 Incoming materials and release	Receive bedding tapes	Contamination at joint interface	Electrical tracking or partial discharge at accessory interface	8	Contaminated, wet, or improperly packaged bedding tape	4	Laboratory release per drum	5	160	Medium	Inspect packaging and cleanliness; perform defined laboratory acceptance testing
P006 Incoming materials and release	Receive armour wires	End seal leakage	Moisture ingress during storage or	8	Damaged packaging, open ends, or	4	Operator check per joint	6	192	Medium	Inspect seals and packaging on receipt and record acceptance

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FMEA PFMEA cable.pdf

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FMEA App Demo 2 Results

Demo 2
Blade FMEA Assessment

FMEA to be Assessed



Assessment & Results

FMEA Builder & Quality Assessor

App view

Assessment Results

Excel | PDF | Save to Cloud

OVERALL QUALITY SCORE

50/100

Assessed 46 failure mode(s); overall quality score 50/100.

50	50	50	50
Completeness	Clarity	Severity Justification	Recommended Actions

Row	Completeness	Clarity	Severity Justification	Recommended Actions	Findings
0	50	50	50	50	B-001: Incorrect glass fabric style or areal weight accepted
1	50	50	50	50	B-002: Moisture-affected reinforcement used
2	50	50	50	50	B-003: Expired hardener issued to production
3	50	50	50	50	B-004: Wrong core density accepted
4	50	50	50	50	B-005: Corroded receptor component accepted
5	50	50	50	50	B-006: Obsolete material revision picked
6	50	50	50	50	B-007: Contamination left on mould surface
7	50	50	50	50	B-008: Insufficient release agent coverage
8	50	50	50	50	B-009: Gelcoat applied below minimum thickness
9	50	50	50	50	B-010: Lay-up started before gelcoat reaches tack-free condition
10	50	50	50	50	B-011: Root insert batch not traceable
11	50	50	50	50	B-012: Root inserts positioned off bolt circle
12	50	50	50	50	B-013: Incorrect ply orientation installed
13	50	50	50	50	B-014: Ply missing in spar-cap transition

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Blade FMEA Quality Assessment.pdf

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Document Verification App Demo 1 - PPAP Review

Input Documents

PRODUCTION PART APPROVAL PROCESS (PPAP)

Supplier Submission Package - 18 Elements
Hydraulic Pitch Cylinder Assembly

0. Package Index

No	PPAP element	Section	Status	Evidence reference
1	Design Records	1	Submitted	Drawing register, section 1.1
2	Authorized Engineering Change Documents	2	Submitted	ECN register, section 2.1
3	Customer Engineering Approval	3	Submitted	Deviation register, section 3.1
4	Design FMEA	4	Submitted	DFMEA extract, section 4.1
5	Process Flow Diagram	5	Submitted	Flow table, section 5.1
6	Process FMEA	6	Submitted	PFMEA extract, section 6.1
7	Control Plan	7	Submitted	Control plan, section 7.1
8	Measurement System Analysis Studies	8	Submitted	MSA summary, section 8.1
9	Dimensional Results	9	Submitted	Dimensional report, section 9.1
10	Material and Performance Test Results	10	Submitted	Test summary, sections 10.1-10.2
11	Initial Process Studies	11	Submitted	Capability summary, section 11.1
12	Qualified Laboratory Documentation	12	Submitted	Laboratory register, section 12.1
13	Appearance Approval Report	13	Not applicable	Justification, section 13
14	Sample Production Parts	14	Submitted	Sample register, section 14.1
15	Master Sample	15	Submitted	Master sample record, section 15.1
16	Checking Aids	16	Submitted	Checking aid register, section 16.1
17	Customer-Specific Requirements	17	Submitted	CSR checklist, section 17.1
18	Part Submission Warrant	18	Submitted	PSW, section 18.1

Criteria & References

QDES VeriDoc — Supplier Document Verification & Compliance

PPAP 18 Elements - Hydraulic Component v1 v1 published — 58 criteria

PPAP-01-01	Element 1 - Design records are included	structural	major
PPAP-01-02	Element 1 - Drawing register identifies document number, title and revision	structural	major
PPAP-01-03	Element 1 - Submitted drawing revision matches the customer released revision	comparative	critical
PPAP-01-04	Element 1 - Special characteristics are identified and classified	structural	major
PPAP-02-01	Element 2 - Authorized engineering change documents are listed	structural	major
PPAP-02-02	Element 2 - Every engineering change carries a customer approval date	structural	major
PPAP-02-03	Element 2 - Released changes are incorporated in the submitted revision	semantic	major
PPAP-03-01	Element 3 - Customer engineering approval evidence is present	structural	major
PPAP-03-02	Element 3 - Open deviations carry a customer disposition	extractive	critical
PPAP-04-01	Element 4 - DFMEA is included with severity, occurrence, detection and RPN	structural	major
PPAP-04-02	Element 4 - High risk failure modes have a recommended action	structural	major
PPAP-04-03	Element 4 - DFMEA is revision controlled and team based	structural	minor
PPAP-05-01	Element 5 - Process flow diagram covers the full manufacturing sequence	structural	major
PPAP-05-02	Element 5 - Inspection and verification operations appear in the flow	structural	minor
PPAP-06-01	Element 6 - PFMEA is included and revision controlled	structural	major
PPAP-06-02	Element 6 - PFMEA operations are traceable to the process flow	semantic	minor
PPAP-06-03	Element 6 - Severity 9 failure modes are controlled in the control plan	semantic	major
PPAP-07-01	Element 7 - Control plan contains the required columns	structural	major
PPAP-07-02	Element 7 - Every controlled characteristic has a reaction plan	structural	major
PPAP-07-03	Element 7 - All special characteristics appear in the control plan	semantic	critical
PPAP-07-04	Element 7 - Control methods are appropriate for critical characteristics	comparative	major
PPAP-08-01	Element 8 - Measurement system analysis studies are included	structural	major
PPAP-08-02	Element 8 - Gauge R&R for the bore diameter gauge is within the customer limit	extractive	major
PPAP-08-03	Element 8 - Gauge R&R for the rod diameter gauge is within the customer limit	extractive	major
PPAP-08-04	Element 8 - MSA covers every special characteristic	semantic	major
PPAP-08-05	Element 8 - Reported MSA assessments match the customer acceptance limits	comparative	major
PPAP-09-01	Element 9 - Dimensional results are reported per feature	structural	major
PPAP-09-02	Element 9 - All measured features are within the drawing limits	comparative	critical
PPAP-09-03	Element 9 - No measurement results are left blank	structural	major
PPAP-09-04	Element 9 - Reported results are consistent with the measured values	semantic	major



Compliance report

QDES VeriDoc — Supplier Document Verification & Compliance

Compliance Report

Per-criterion verdicts with confidence and click-through evidence (page/bbox or sheet/cell).

Compliance score

76 / 100

8	45	1	4	FAIL	REJECT	8/57
fail	pass	skipped	needs_review	critical auto-fail	final decision	detection coverage

Decision: REJECT - Reject because reject-level criteria failed: PPAP-07-03, PPAP-17-02, PPAP-18-04
Main reject reasons: PPAP-07-03, PPAP-17-02, PPAP-18-04

Reproducibility & document

Criteria set: PPAP 18 Elements - Hydraulic Component v1 v1
Model config: [redacted]
Canonical hash: [redacted]
Source: pdf - 9 pages - ?
Verification layers: rules on | OCR not used | retrieval hybrid_bm25_vector | vector DB pgvector | embeddings openai | LLM openai/gpt-5.6-terra
PII/privacy flags: 0
[redacted]

Criteria results (58)

pass	Element 1 - Design records are included structural	major	conf 1.00
pass	Element 1 - Drawing register identifies document number, title and revision structural	major	conf 1.00
needs_review	Element 1 - Submitted drawing revision matches the customer released revision comparative	critical	conf 0.98
pass	Element 1 - Special characteristics are identified and classified structural	major	conf 1.00
pass	Element 2 - Authorized engineering change documents are listed structural	major	conf 1.00
pass	Element 2 - Every engineering change carries a customer approval date structural	major	conf 1.00
pass	Element 2 - Released changes are incorporated in the submitted revision semantic	major	conf 0.99
pass	Element 3 - Customer engineering approval evidence is present structural	major	conf 1.00
pass	Element 3 - Open deviations carry a customer disposition extractive	critical	conf 1.00
pass	Element 4 - DFMEA is included with severity, occurrence, detection and RPN structural	major	conf 1.00

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Document Verification App Demo 2 - As-built Document Verification

Input Documents

AS-BUILT DOCUMENTATION DOSSIER

Final Quality Record Package

0. Dossier Index

No	Document	Section	Document reference
1	Certificate of Conformity	1	EDS-COC-0417
2	Bill of Materials and Traceability	2	EDS-BOM-0417
3	Material Certificates	3	Supplier certificates, see register
4	Non-Destructive Testing Report	4	EDS-NDT-0417
5	Dimensional Inspection Report	5	EDS-DIM-0417
6	Routine Test Report	6	EDS-FAT-0417
7	Surface Protection Report	7	EDS-SPR-0417
8	Non-Conformance Register	8	EDS-NCR-LOG
9	Packing List	9	EDS-PL-0417
10	Delivery Note and Transport Record	10	EDS-DN-0417
11	Final Release	11	EDS-REL-0417

AsBuilt_Dossier_Generator_GEN·

Criteria & References

QDES VeriDoc Supplier Document Verification & Compliance

As-Built Dossier - Wind Turbine Generator v1 v1 published — 24 criteria

AB-01	Dossier index lists all required documents	structural	major
AB-02	Certificate of Conformity is present and signed	structural	critical
AB-03	CoC issued after all tests completed	semantic	critical
AB-04	Serial number is consistent across all documents	semantic	critical
AB-05	Purchase order referenced on the CoC	extractive	minor
AB-06	Every BOM item traceable to a heat or lot number	structural	major
AB-07	Material certificates are EN 10204 type 3.1	semantic	major
AB-08	Rotor shaft yield strength meets requirement	extractive	major
AB-09	NDT inspectors are qualified to ISO 9712	structural	major
AB-10	Dimensional results within tolerance	semantic	major
AB-11	Polarization index meets minimum	extractive	critical
AB-12	High-voltage test performed at the required voltage	semantic	critical
AB-13	Vibration within IEC 60034-14 grade A	extractive	major
AB-14	Test verdicts are consistent with results	semantic	major
AB-15	Efficiency meets guaranteed value	extractive	minor
AB-16	Test report is signed	structural	major
AB-17	Coating dry film thickness meets minimum	semantic	minor
AB-18	No open NCRs at release	semantic	critical
AB-19	Release statement consistent with NCR register	semantic	major
AB-20	Packing list gross weights add up	semantic	major
AB-21	Delivery note matches packing list	semantic	major
AB-22	Transport shock excursions have a recorded action	semantic	critical
AB-23	Preservation recorded for transport	structural	minor
AB-24	Final release is signed	structural	critical

Compliance report

QDES VeriDoc Supplier Document Verification & Compliance

Compliance Report

Per-criterion verdicts with confidence and click-through evidence (page/bbox or sheet/cell).

Compliance score

35 / 100

11	11	2	FAIL	REJECT	11/24
fail	pass	needs_review	critical auto-fail	final decision	detection coverage

Decision: REJECT - Reject because reject-level criteria failed: AB-02, AB-04, AB-11, AB-12, AB-18

Main reject reasons: AB-02, AB-04, AB-11, AB-12, AB-18

Reproducibility & document

Criteria set: As-Built Dossier - Wind Turbine Generator v1 v1

Model config

Canonical hash

Source: pdf · 5 pages · ?

Verification layers: rules on | OCR not used | retrieval hybrid_bm25_vector | vector DB pgvector | embeddings openai | LLM openai/gpt-6-luna

PII/privacy flags: 0

Run

Criteria results (24)

pass	Dossier index lists all required documents structural	major	conf 1.00
fail	Certificate of Conformity is present and signed structural	critical	conf 0.99
needs_review	CoC issued after all tests completed semantic	critical	conf 0.99
fail	Serial number is consistent across all documents semantic	critical	conf 0.99
pass	Purchase order referenced on the CoC extractive	minor	conf 1.00
pass	Every BOM item traceable to a heat or lot number structural	major	conf 1.00
fail	Material certificates are EN 10204 type 3.1 semantic	major	conf 1.00
pass	Rotor shaft yield strength meets requirement extractive	major	conf 1.00
fail	NDT inspectors are qualified to ISO 9712 structural	major	conf 1.00
pass	Dimensional results within tolerance semantic	major	conf 1.00

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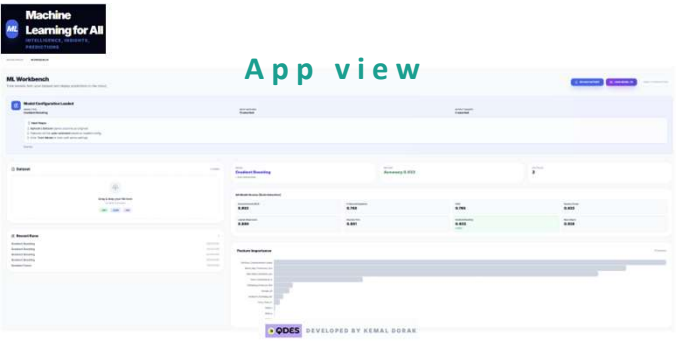
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Blade Bondline Quality Demo 2 ML App Prediction Analysis

“Synthetic model example — factors associated with predicted bondline quality”

App view



What makes bondline Quality better ?

Contamination	Thickness	Mix ratio
< 2	< 3	> +4

RANK	SAMPLE_ID	CURE_TEMPERATURE_C	CURE_TIME_HR	BOND_GAP_THICKNESS_MM	MIX_RATIO_DEVIATION_PCT	SURFACE_CONTAMINATION_INDEX	AMBIENT_HUMIDITY_PCT	CLAMPING_PRESSURE_KPA	SHIFT_A	SHIFT_C	SHIFT_B	PROBABILITY
1	bld-00001	84.00	10.00	2.40	4.00	1.90	59.00	360.00	1.00	1.00	0.00	97.06%
2	bld-00001	70.00	9.50	2.60	4.00	1.50	75.00	295.00	1.00	1.00	1.00	96.81%
3	bld-00001	72.00	7.50	1.90	4.00	1.80	53.00	285.00	0.00	1.00	1.00	96.81%

RANK	SAMPLE_ID	CURE_TEMPERATURE_C	CURE_TIME_HR	BOND_GAP_THICKNESS_MM	MIX_RATIO_DEVIATION_PCT	SURFACE_CONTAMINATION_INDEX	AMBIENT_HUMIDITY_PCT	CLAMPING_PRESSURE_KPA	SHIFT_A	SHIFT_C	SHIFT_B	PROBABILITY
1	bld-00001	45.00	2.00	9.10	-2.00	5.30	26.00	125.00	0.00	0.00	1.00	100%
2	bld-00001	48.00	3.00	9.70	-5.50	3.70	21.00	235.00	1.00	0.00	0.00	100%
3	bld-00001	50.00	3.00	11.80	-3.00	3.30	86.00	125.00	1.00	1.00	1.00	100%

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Illustrative synthetic values only — not process specifications or engineering limits.

bondline ML_Insights_Report_2026-09-20.html

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Closure and Wrap up · 5 MINUTES

What we learned

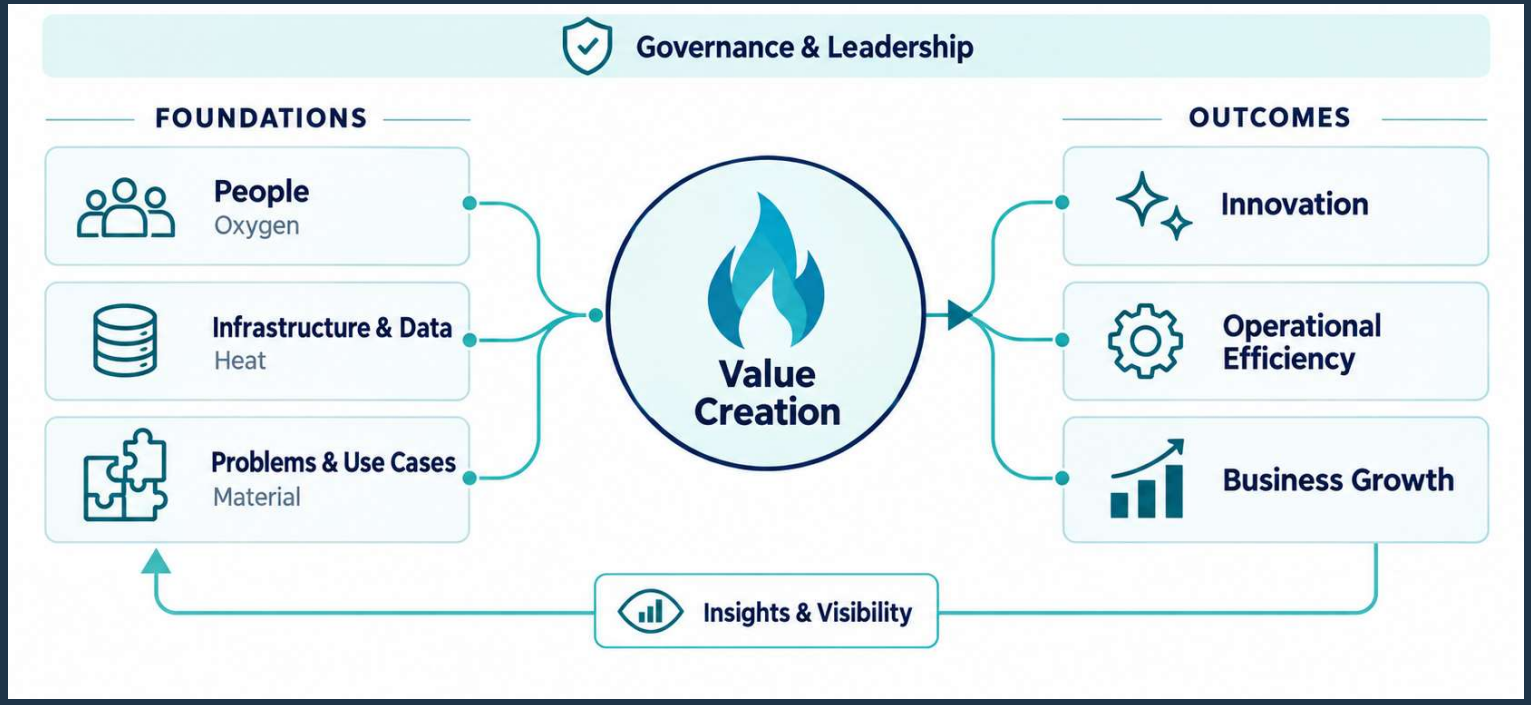


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What all four Demo applications had in common

People + Data + Problem + AI

= Supports Better & Faster quality decisions



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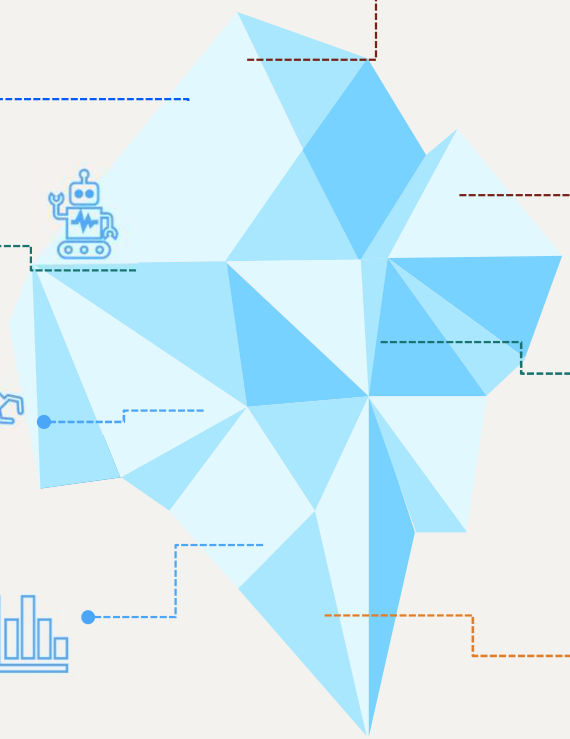
One tool does not fit All –
Selecting right tool for the problem

GEN AI - Fine-Tuning
Best for : Company specific AI models
Example Use case : FMEA generation in company format

Automation Tools
Best for: Connecting apps & automating repetitive tasks
Example Use case: Sending reminders for APQP deliverables/actions

Machine Learning
Best for : Predictive maintenance
Example Use case : Predicting crane downtime

Data Analytics (*BI*)
Best for : Pareto analyses
Example Use case : Top 5 defects



GEN AI - Agentic Flow
Best for : Guided problem solving and multi tasking
Example Use case : Formulating root-causes

GEN AI - RAG
Best for : Document discovery + Knowledge
Example Use case : Finding past 8Ds

Deep Learning (*Computer vision*)
Best for : Visual Inspection
Example Use case : End-of- line weld check

Data Engineering (*Medallion*)
Best for : Data Readiness
Example Use case : Structuring legacy databases

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The AI quality architecture



BUSINESS PROBLEM	Where every one of these starts
QUALITY DATA	Documents · measurements · Deliverables · NCs · process · records · field logs
DATA & KNOWLEDGE LAYER	Structured, searchable, governed
AI INTELLIGENCE	LLM · ML · RAG · rules · agents
QUALITY APPLICATIONS	FMEA Builder · VeriDoc · Digital 8D · Predictive quality · Risk intelligence
HUMAN DECISION	The non-negotiable layer
Quality Management System/ A4W	Where the output has to land to be worth anything

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WHAT is NEXT?

Is your problem a good AI candidate?

- ☑ **Recurring**
  Does it happen again and again?
- ☑ **Expensive**
  Does it cost time or money, or create risk?
- ☑ **Evidence-rich**
  Do we have documents, images, history or measurements?
- ☑ **Human-verifiable**
  Can an expert check whether the answer is right?
- ☑ **Measurable**
  Can we measure the improvement?

Start Imagining

Picture the solution

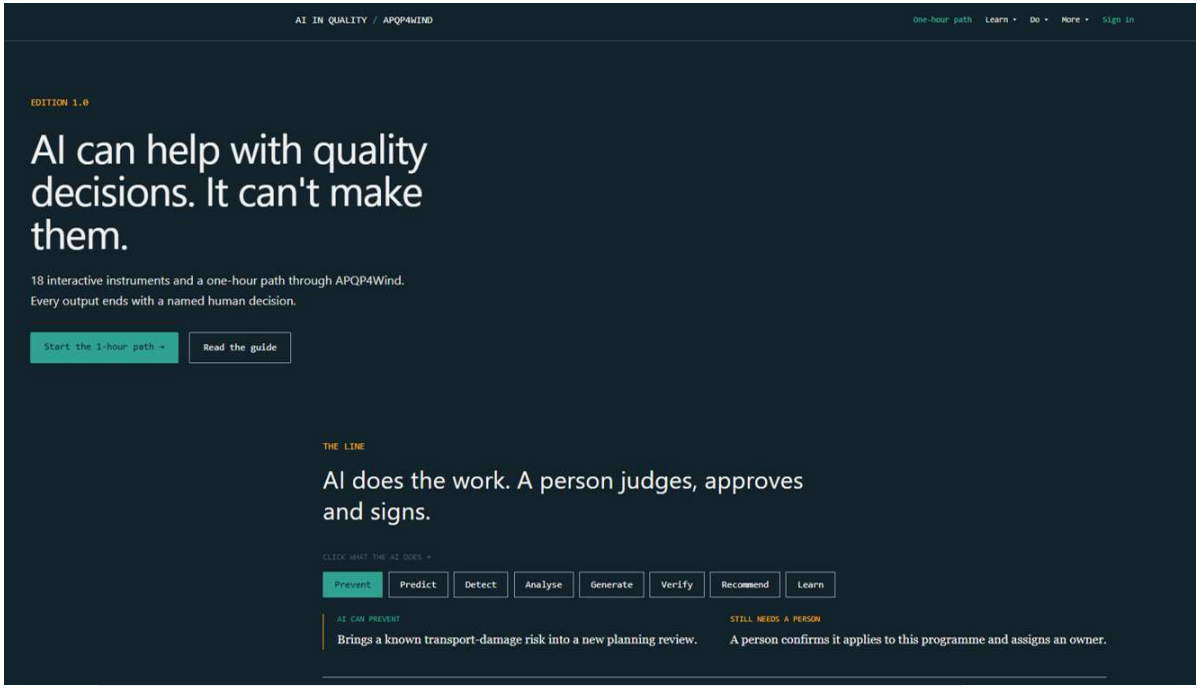
Find the right tool

Bring it to next webinar…

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Shaping the AI journey in wind, together





IN DRAFT

AI Guideline

Draft Edition 1.1 · AI guideline for the wind value chain

IN DEVELOPMENT

AI Roadmap Web App

Prototype · Interactive instruments, learning and roadmap preparation

Stay tuned…

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Questions



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