

BEMAS

How to Build Your Virtual Maintenance Engineer for RCA

David Ariens & Willem van Lammeren
Authors & Founders - The IT/OT Insider, The IT/OT Handbook

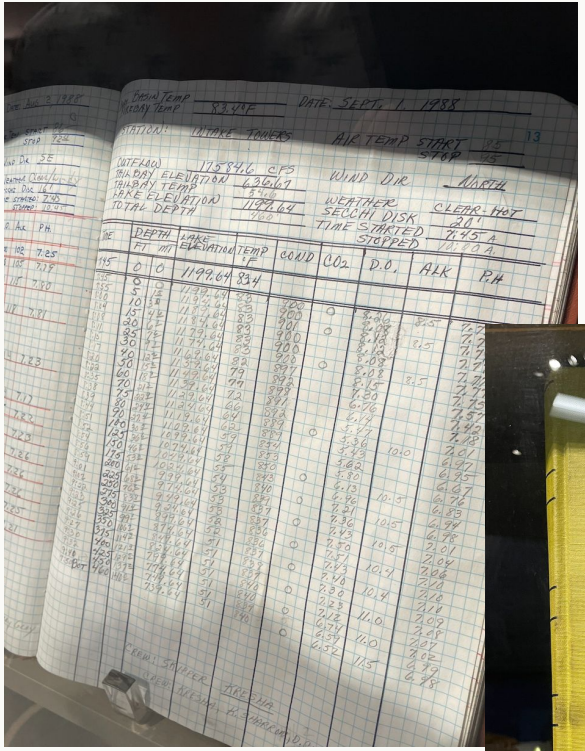
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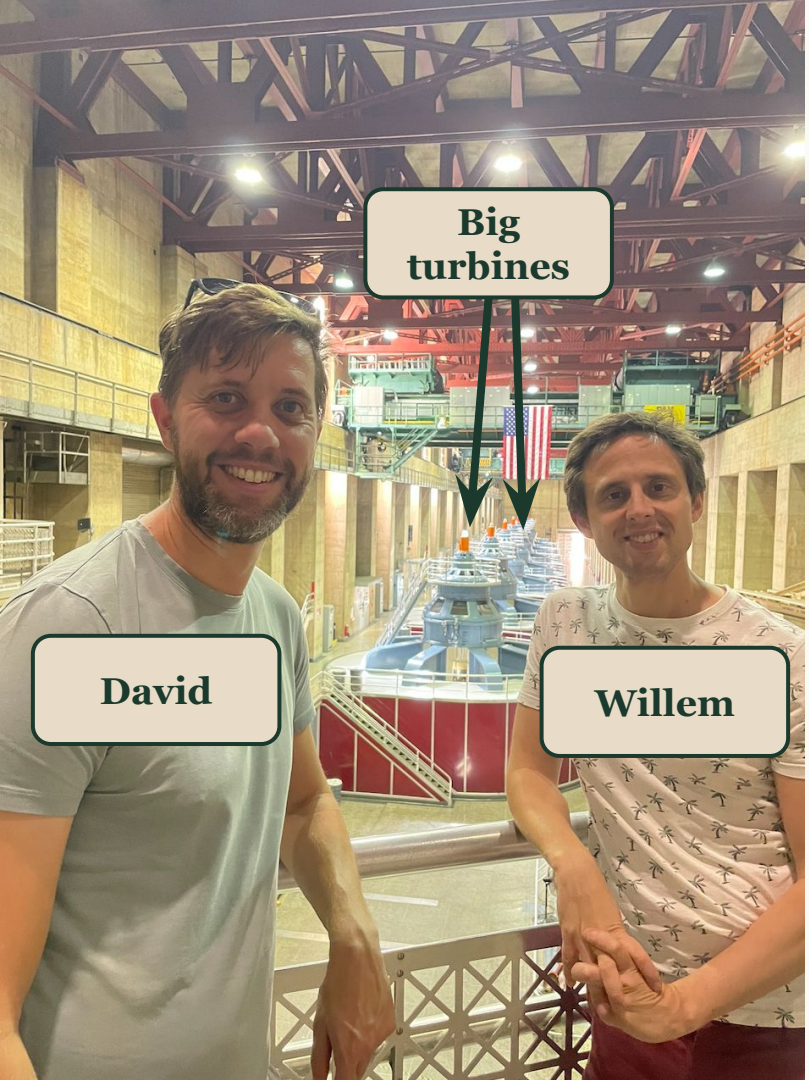


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David
Willem


DATE SEPT. 1 1988
STATION: INTAKE TOWERS
AIR TEMP START
STOP
OUTFALL 175846 CFS
TAILRACE ELEVATION 636.67
TAILRACE TEMP
LAKE ELEVATION 1199.64
TOTAL DEPTH
WIND DIR NORTH
WEATHER CLEAR: HOT
SECCHI DISK 20'
TIME STARTED 7.45 A
STOPPED 10.00 A
DEPTH
LAKE ELEVATION
TEMP °F
COND
CO2
D.O.
ALK
PH
1199.64 83.4


N7
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MECH.
MAINT.
7530-00-286-8363
FEDERAL SUPPLY SERVICE



THE CASE

You work as **reliability engineer** for the “Copper Canyon Dam”

THE CHALLENGE

Turbine 1 was stopped by the operators because of a bearing temperature alert. **You need to run the RCA process.**

Picture: David and Willem visiting the Hoover Dam, this case is inspired on a dam and uses a fully fictitious storyline and generated data!

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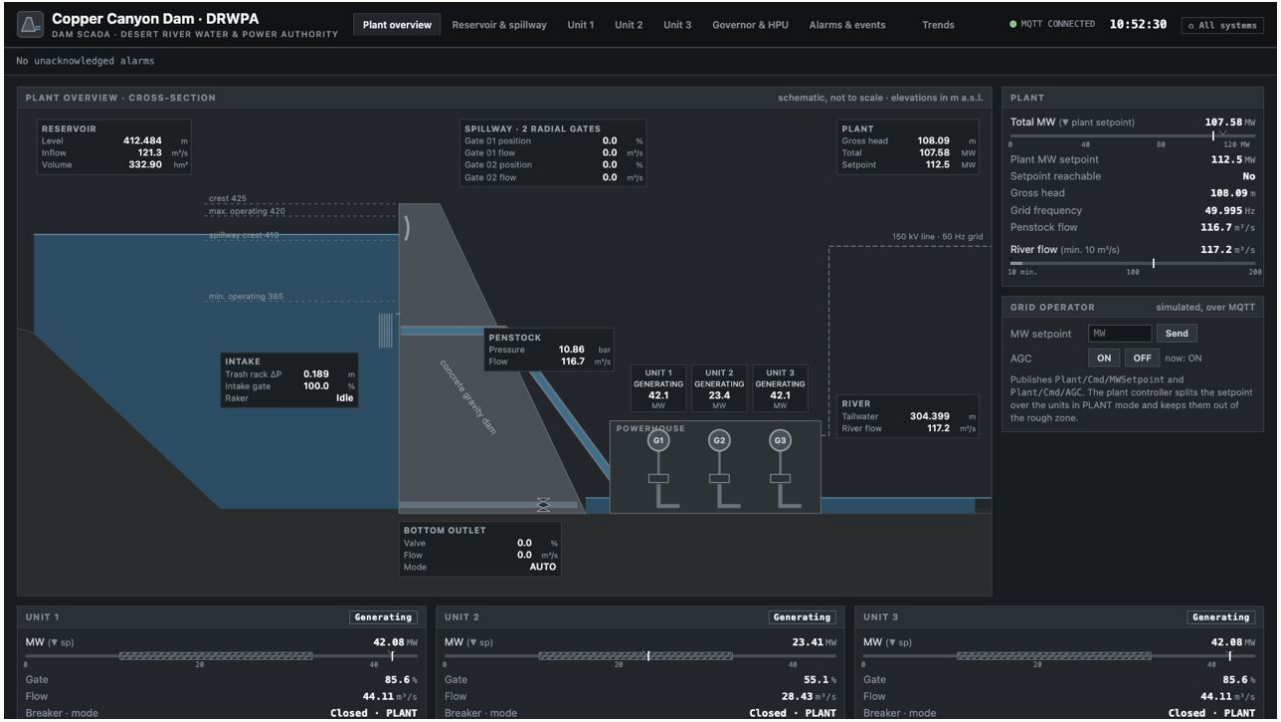
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Let’s dive in!

RCA using AI

Let’s dive in

The story - The Control Room

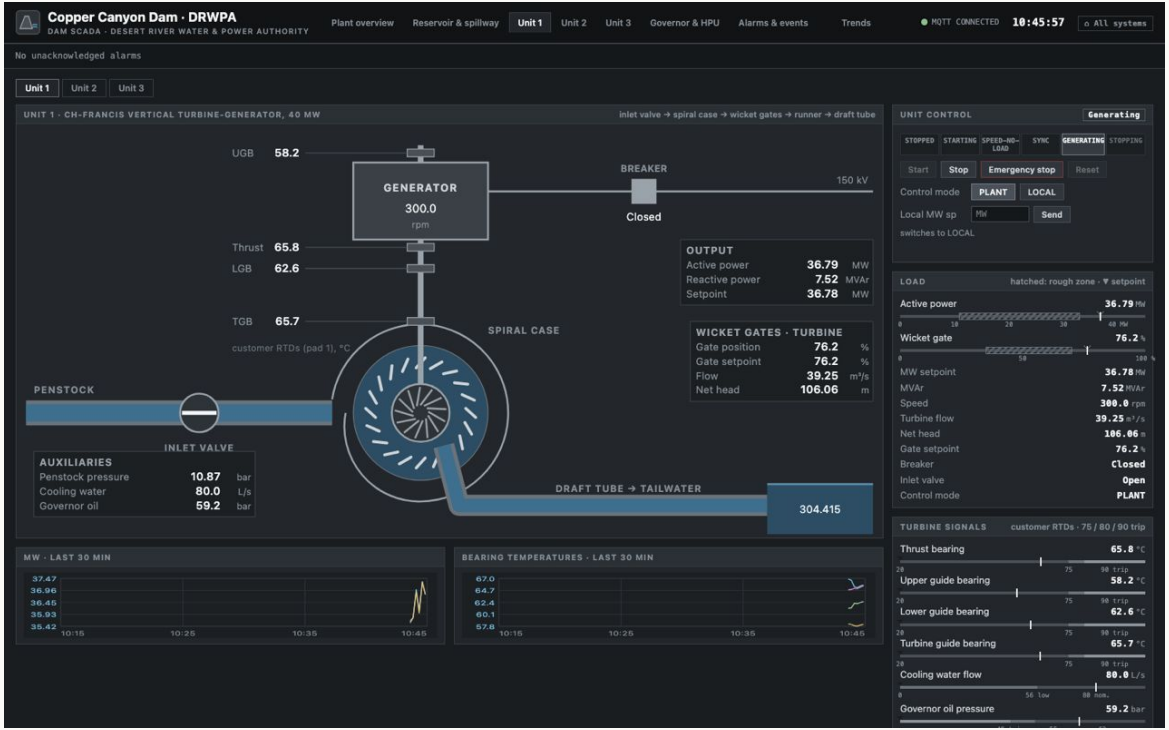


You can find the full storyline, all code, examples and more on our Github/website:
https://itotinsider.com/industrial-ai/virtual-maintenance-engineer/

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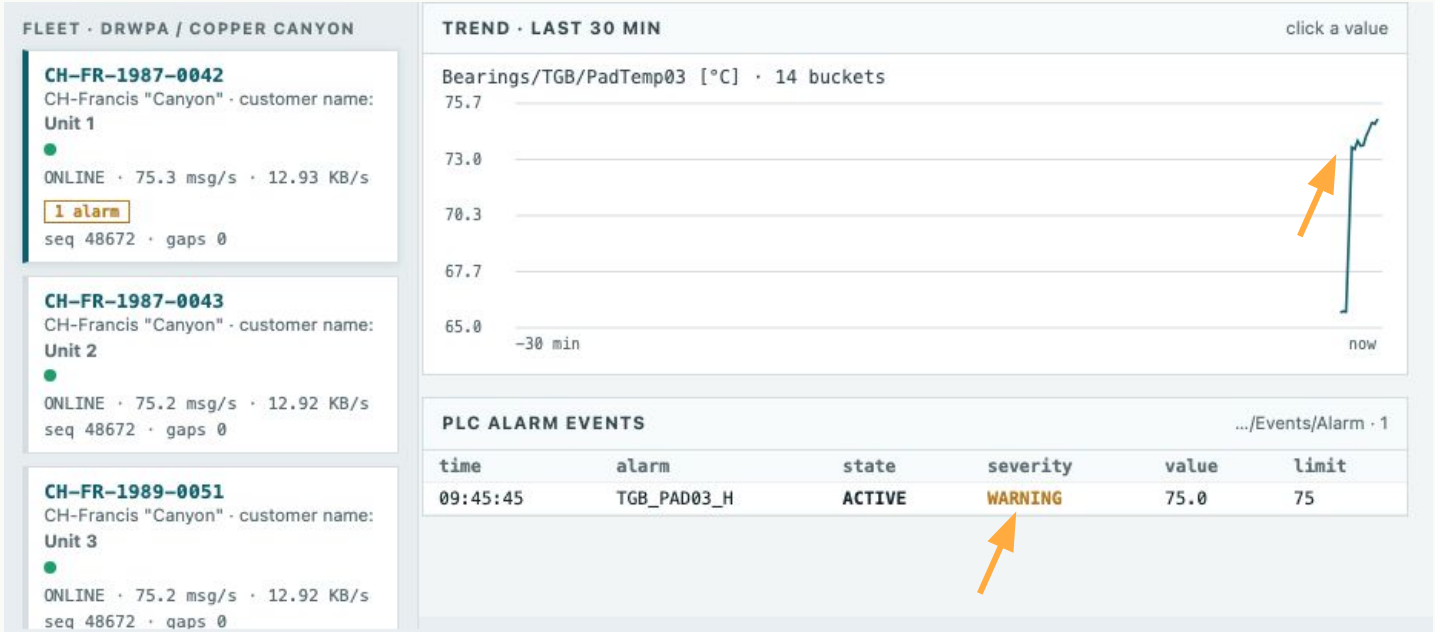
The story - The Control Room



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23:54 - A warning nobody sees



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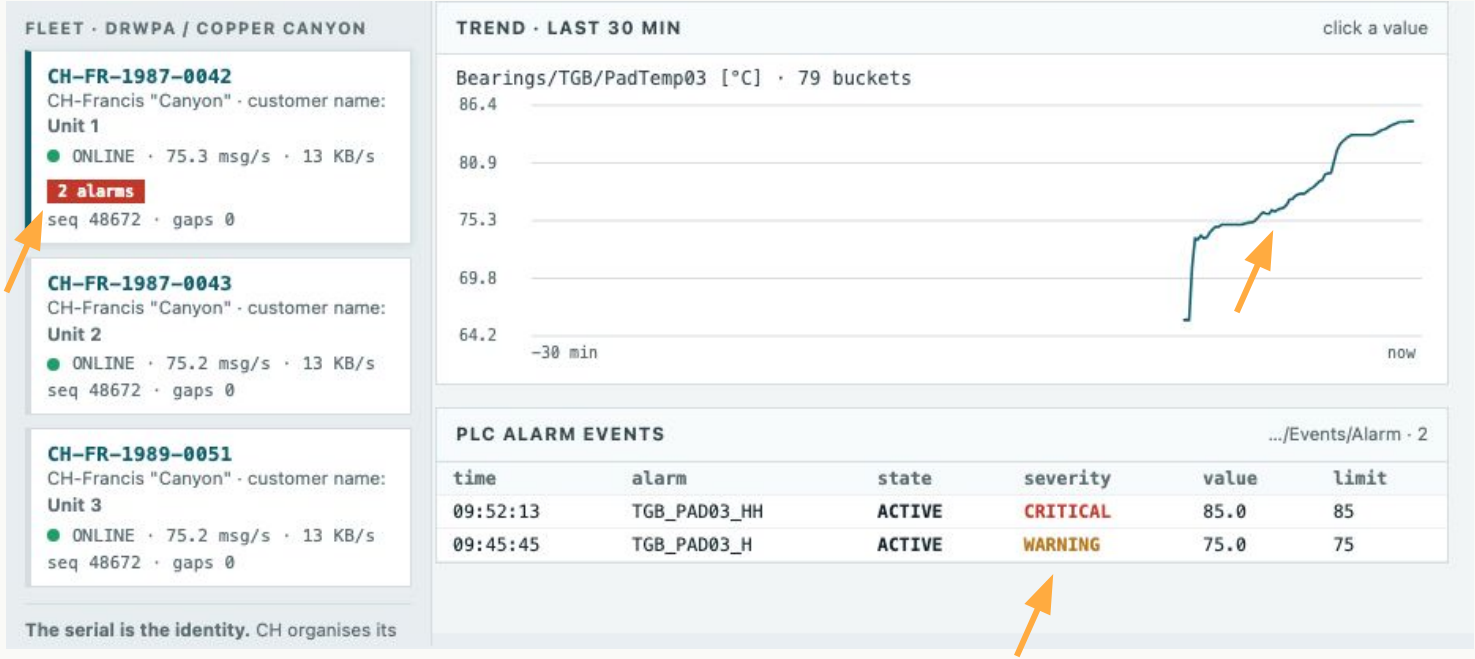
07:13 - Shift log: “all OK”

timestamp	shift	supervisor	unit	entry
2026-11-02T15:40	B	Sofia Reyes	Unit2	D. Whitaker enabled rough-zone bypass for Unit 2 per MOC-2026-019 (active from tomorrow 06:00). Reliability sign-off still pending, plant manager approved.
2026-11-03T06:05	A	Marcus Bell	Unit2	Regulation reserve trial started. U2 on part load per plant controller. U1 and U3 near 42 MW.
2026-11-03T07:13	A	Marcus Bell		Plant on AGC, setpoint 110 MW. All units generating. No alarms.



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09:03 - High-high, found by chance



Let’s dive in

09:03 - High-high, found by chance

DRWPA-OP-07 Bearing Temperature Alarm Response

Site	Copper Canyon Dam
Revision	2 (2026-10-01)
Owner	Dale Whitaker, I&C Lead; Priya Nandakumar, Reliability Engineer
Approved	Elena Marsh, Plant Manager
Change in rev 2	CH monitoring PLC pad alarms added (retrofit Sep 2026)

Fictional document, for training only. Created after RCA-2024-011 (MOC-2024-015).

1 Purpose

Respond to bearing temperature alarms quickly **without** stopping a healthy unit on a faulty measurement, and without ignoring a real bearing problem.

2 Alarm sources

Source	Measured on	Limits
Unit controller (control room)	Pad 1 of each bearing, element A	Alarm 80 °C; trip 90 °C (5 s delay, automatic)
CH monitoring PLC (CH asset viewer, CH tree)	Every pad (pad 1 element B)	H 75 °C; HH 85 °C; oil bath 65 °C

The control room sees one pad per bearing. Pads 2..n are visible only in the CH PLC data.

3 Validation before acting (unless at trip level)

Within 15 minutes of an alarm, the shift supervisor (with I&C or the reliability engineer on call) checks:

1. **Neighbouring pads** of the same bearing: do they move with it? A real pad problem raises its neighbours a little.
2. **Oil bath temperature** of that bearing: rising, even slowly?
3. **Second element** (pad 1 only): element A (control room) against element B (CH PLC). Do they agree within 2 K?
4. **Cooling water**: total flow (control room) and circuit flows (CH PLC). Do all bearings warm up together?
5. **Operating point**: load, gate position (rough zone?), recent start or load rejection.
6. **Vibration** at that bearing: any change?
7. **Recent work**: work orders, open punch items, wiring work in junction boxes.

4 Decision

Finding	Action
Single channel moves alone; neighbours, oil, element A and vibration flat	**Instrument fault suspected.** Keep the unit running. Raise an I&C work order (priority 2). Watch neighbours and oil hourly.
Neighbours and/or oil bath rising with it	**Bearing problem.** Reduce load to the lowest load **above** the rough zone (approx. 34 MW at 106 m net head; see the OP-03 table for the current head), call the reliability engineer, take an oil sample, prepare a controlled stop if the trend continues or HH (85 °C) is reached.
All bearings rising, cooling flow low	**Cooling problem.** Check and change over the strainer immediately. Reduce load.
TGB warm with high TGB vibration and draft tube pulsation	**Rough-zone operation.** Move the unit out of the zone.
Trip level reached on element A	The unit trips automatically. Do not reset before the bearing has been inspected or the measurement has been proven faulty.

5 Records

Log the alarm, the checks and the decision in the shift log. Any stop on a bearing temperature alarm triggers at least a Level 1 RCA (DRWPA-PRO-REL-01).

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09:48 - Unit Stopped - RCA requested

FLEET · DRWPA / COPPER CANYON

CH-FR-1987-0042
CH-Francis "Canyon" · customer name:
Unit 1
ONLINE · 75.2 msg/s · 12.99 KB/s
seq 62983 · gaps 0

CH-FR-1987-0043
CH-Francis "Canyon" · customer name:
Unit 2
ONLINE · 74.4 msg/s · 12.85 KB/s
seq 62975 · gaps 0

CH-FR-1989-0051
CH-Francis "Canyon" · customer name:
Unit 3
ONLINE · 75.1 msg/s · 12.97 KB/s
seq 62975 · gaps 0

TREND · LAST 30 MIN — click a value

Bearings/TGB/PadTemp03 [°C] · 145 buckets



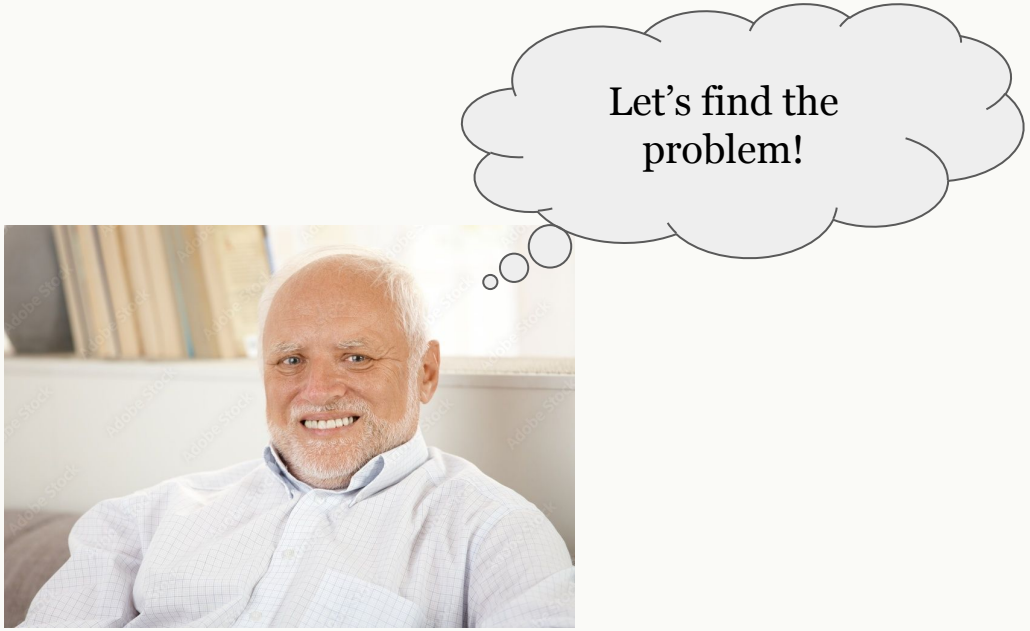
PLC ALARM EVENTS — .../Events/Alarm · 4

time	alarm	state	severity	value	limit
09:58:44	TGB_PAD03_H	CLEARED	WARNING	74.2	75
09:55:20	TGB_PAD03_HH	CLEARED	CRITICAL	84.1	85
09:52:13	TGB_PAD03_HH	**ACTIVE**	**CRITICAL**	85.0	85
09:45:45	TGB_PAD03_H	**ACTIVE**	**WARNING**	75.0	75

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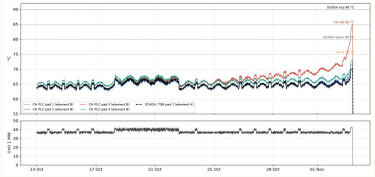
Day 2 - Reliability Engineer + RCA bot



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Day 2 - Reliability Engineer + RCA bot

Historian

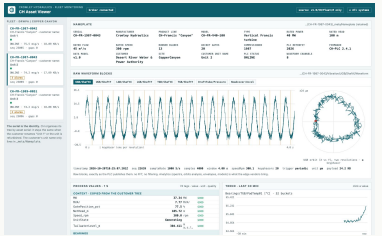


Oil Analysis

dnwpa/records/oil-analysis_2021-2026.csv

sample_id	sample_date	compartment	tan_mgKOH_g	tin_Sn_ppm	npc_dE	status	lab_comment
MLL-2023-00193	2023-02-09	TGB	0.1	0.5	7	Normal	
MLL-2023-00112	2023-05-09	TGB	0.12	1.6	9	Normal	
MLL-2023-00124	2023-08-09	TGB	0.13	1.3	5	Normal	
MLL-2023-00136	2023-11-09	TGB	0.15	2.3	10	Normal	
MLL-2024-00148	2024-02-09	TGB	0.14	1.9	11	Normal	
MLL-2024-00160	2024-05-09	TGB	0.19	3.6	14	Normal	
MLL-2024-00172	2024-08-09	TGB	0.21	4.2	15	Normal	
MLL-2024-00184	2024-11-09	TGB	0.22	4.6	16	Normal	
MLL-2025-00196	2025-02-09	TGB	0.24	5.4	18	Caution	Oxidation (TAN, MPC) and tin trending up together: early babbitt distress possible. Resample within 30 days; consider oil change and flush.
MLL-2025-00208	2025-08-09	TGB	0.3	8.1	22	Caution	Oxidation (TAN, MPC) and tin trending up together: early babbitt distress possible. Resample within 30

Reliability Data

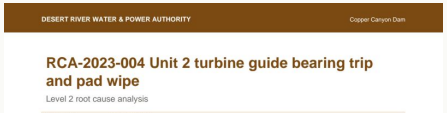


Shift logs

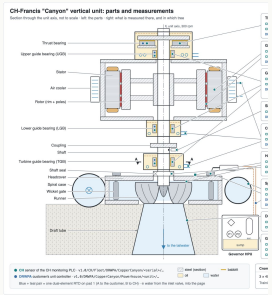
dnwpa/records/shift-log_2026-09_2026-11.csv

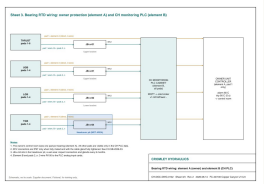
timestamp	shift	supervisor	unit	entry
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2026-11-03T07:13	A	Marcus Bell		Plant on AGC, setpoint 110 MW. All units generating. No alarms.
2026-11-03T09:03	A	Marcus Bell	Unit1	Checking U2 vibration for the trial in the CH viewer (second screen): rod HH badge on Unit1, TGB pad 3 85 C. Viewer also lists TGB pad 3 H since 23:54 yesterday. Control room U1 TGB 70 C, no SCADA alarm. Started OP-07 checks.
2026-11-03T09:14	A	Marcus Bell	Unit1	OP-07 checks with N. Farwick (I&C on call) by phone: TGB pads 2 and 4 72-73 C, warmer than pad 1 and creeping up with pad 3 over the last 30 min (viewer trend); TGB oil 58 C; pad 1 element A 70.2; element B 70.0; TB cooling flow 8.0 L/s, inlet 14.7 C; gate 84 %, out of the rough zone; TGB vibration 56 um pp, unchanged. Bearing problem per OP-07 §4. U1 to 34 MW (LOCAL). P. Nandakumar on leave until 4 Nov; oil sample requested from T. Halvorsen.
2026-11-03T09:48	A	Marcus Bell	Unit1	U1 TGB pad 3 still 81.5 C after 30 min at 34 MW. HH was reached: controlled stop per OP-07 §4, agreed with E. Marsh by phone.
2026-11-03T09:55	A	Marcus Bell	Unit1	U1 stopped 09:51. Not to be restarted before TGB inspection. Level 1 RCA required (PRO-REL-01).

Previous RCA



Supplier Docs



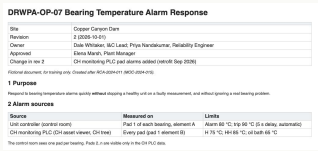


Work Orders

dnwpa/records/work-orders_2021-2026.csv

wo_number	created	status	type	short_text	long_text
WO-2023-0051	2023-01-18	CLOSED	PM	TGB oil change	TGB pot drained, flushed, refilled ISO VG 68.
WO-2025-0322	2025-01-08	CANCELLED	PM	U1 TGB oil change (24-month PM)	Postponed 2025-01-14 pending MOC-2025-004. Cancelled 2025-02-24: new interval 48 months, next due 2027-01.
WO-2025-0154	2025-02-24	CLOSED	MOD	Update PM intervals per MOC-2025-004	Bearing oil sampling 91 -> 182 days, bearing oil change 730 -> 1461 days, all units, all pots. Budget saving approx. USD 38k/year.
WO-2025-0691	2025-09-04	CLOSED	CBM	U1 TGB oil resample (lab caution Aug 2025)	Resample taken. Result similar to August (TAN 0.31, Sn 8.3). Lab: monitor at next routine sample.
WO-2026-0672	2026-08-28	DEFERRED	CBM	U1 TGB oil resample - lab CAUTION	Lab result Aug 2026 Caution (Sn 14.2, TAN 0.38, MPC 28): resample within 30 days. Deferred 2026-09-02: technicians on CH retrofit outages. New date not set.
WO-2026-0714	2026-09-12	CLOSED	CM	Punch: U1 TGB pad 4 reads 1-3 K above the other pads	Checked loop resistance and calibration: ok. Fixed pad offset, consistent with CH manual 4.3. Accepted.

Internal Docs



DRWPA-OP-07 Bearing Temperature Alarm Response

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What you have (this folder only)

Folder	What
`library/`	DRWPA's document library. Start with `library/README.md`. Supplier documents from CH (O&M manual, schematics, service bulletin), DRWPA records (asset register, FMECA, PM plan, work orders, oil analysis, MOC register, shift log), procedures and previous RCA reports
`historian/`	Historian export of both MQTT trees (DRWPA SCADA tree and the CH monitoring PLC tree per turbine): 1-minute averages for weeks, 1-second values around the event, SCADA event journal, CH PLC alarm log. Start with `historian/README.md` and `historian/tags.csv`

Use nothing outside this folder, and no general knowledge presented as site fact. If something you need is not here, say so and list it as missing evidence.

Analyse data with `python3` (standard library only: `csv`, `gzip`, `statistics`, `datetime`). Read the gzipped CSVs with `gzip.open(path, "rt")`. Keep scripts in `work/`.

How you work

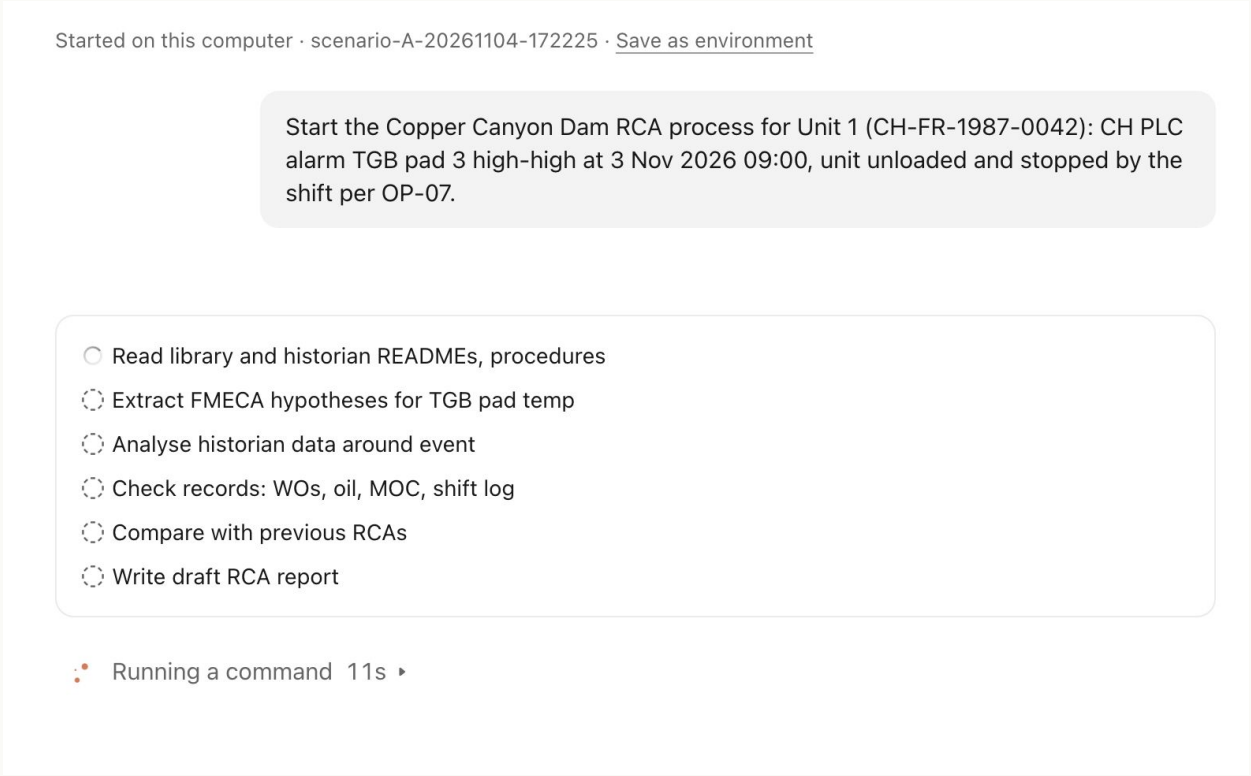
Follow **DRWPA-PRO-REL-01** (RCA procedure) and write the report in **DRWPA-FRM-REL-02** (template).

1. **Hypotheses come from the FMECA** (`library/drwpa/records/fmeca_ch-francis-unit.csv`). Every failure mode that could produce the symptoms is a hypothesis. A hypothesis not in the FMECA is allowed but flagged "not in FMECA".
2. **Every claim cites its evidence**: a file and row (work order number, lab sample, shift log time), a document and section, or a historian file, column and time window with the values. No citation, no claim.
3. **Verify or rule out each hypothesis** and show how. A hypothesis without evidence stays open; never "probably".
4. **Check the measurement before blaming the machine** (DRWPA-OP-07): neighbouring pads, oil, the second element, cooling, operating point, vibration.
5. **Separate physical, human and latent roots.** Human and latent roots only from documents and records. "Operator error" is never a root cause. Where you would need interviews, write the questions instead of the answers.
6. **Compare with previous RCAs**: repeat failure modes, earlier actions and whether they worked.

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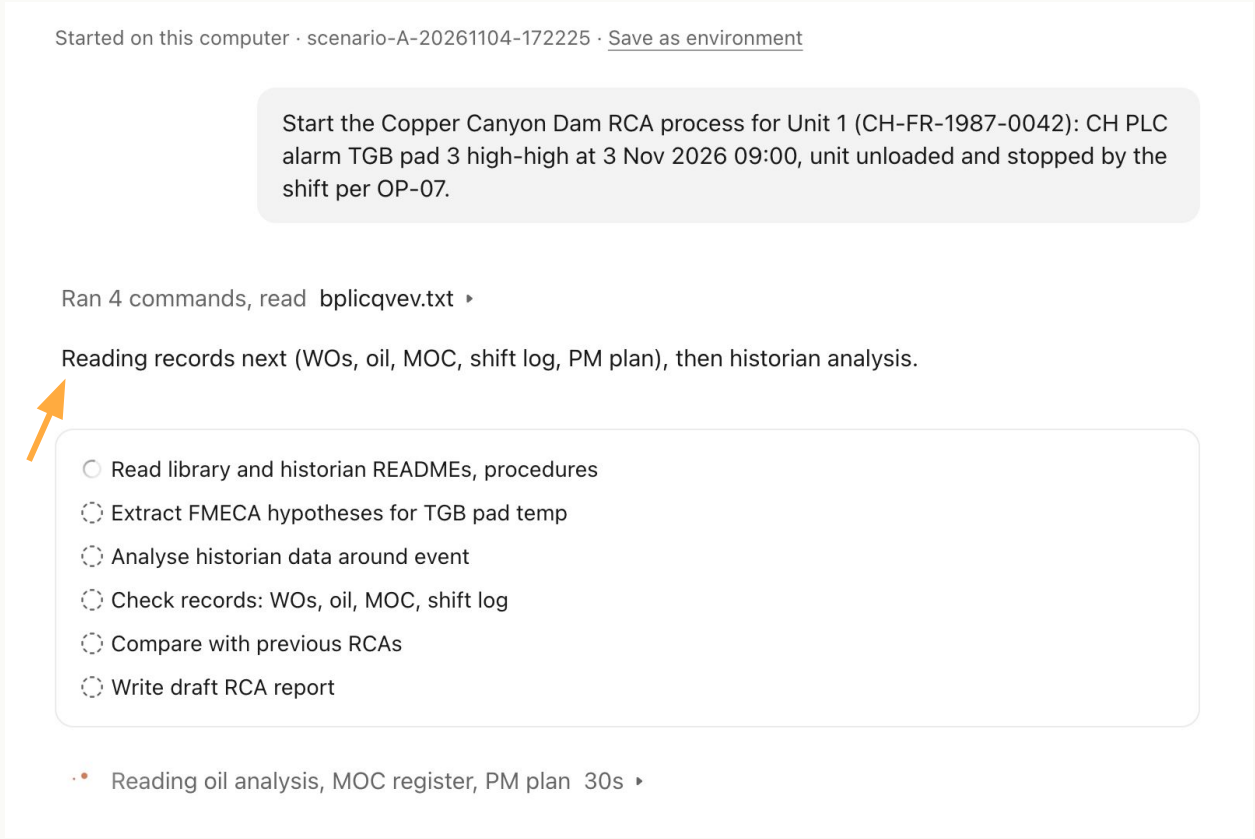
Day 2 - Reliability Engineer + RCA bot



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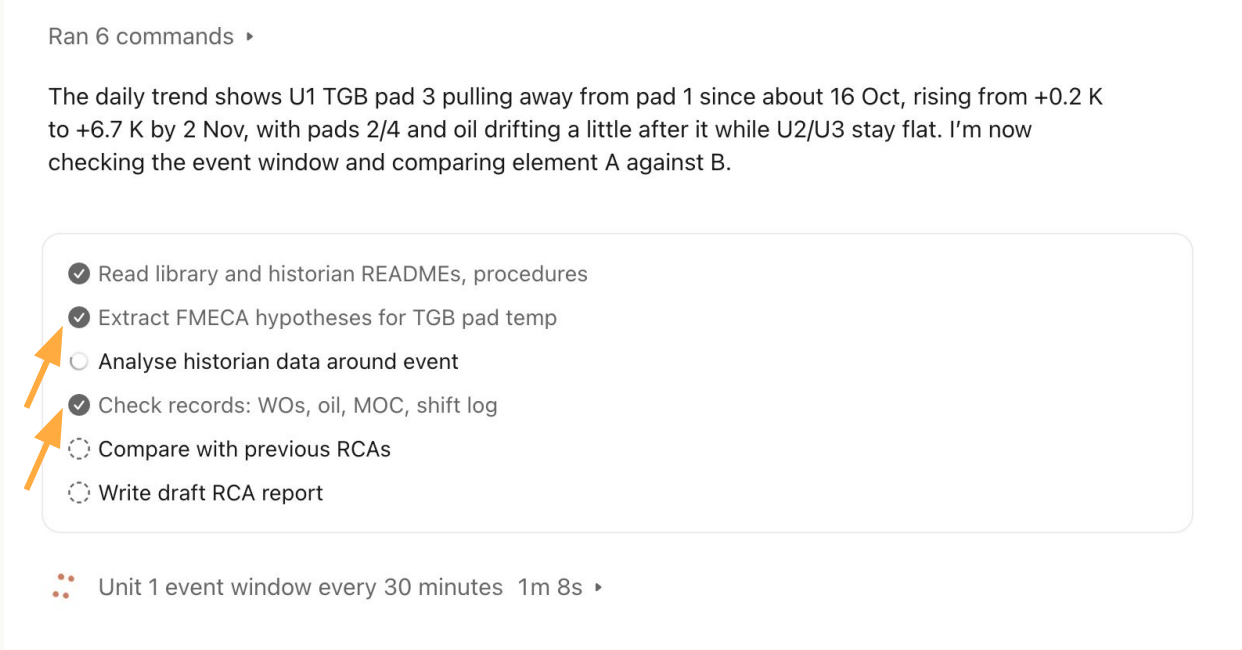
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Day 2 - Reliability Engineer + RCA bot



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The daily trend shows U1 TGB pad 3 pulling away from pad 1 since about 16 Oct, rising from +0.2 K to +6.7 K by 2 Nov, with pads 2/4 and oil drifting a little after it while U2/U3 stay flat. I’m now checking the event window and comparing element A against B.

Ran 2 commands ▸

Pad 3 looks like a real bearing temperature: its signal is clean and A/B agree within 0.3 K. I’m checking previous RCAs and CH documents next.



- ✓ Read library and historian READMEs, procedures
- ✓ Extract FMECA hypotheses for TGB pad temp
- ○ Analyse historian data around event
- ✓ Check records: WOs, oil, MOC, shift log
- ◌ Compare with previous RCAs
- ◌ Write draft RCA report

Reading 1m 35s ▸

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Day 2 - Reliability Engineer + RCA bot

Previous RCAs read. Now the CH O&M manual and service bulletin for bearing, oil and alarm limits.

Read 2 files, ran 5 commands (1 failed) ▸

Manual read (oil limits, TGB clearance, troubleshooting 8.1). Final data checks: headcover humidity sign for the connector hypothesis, U1 alarms in SCADA, schematics.

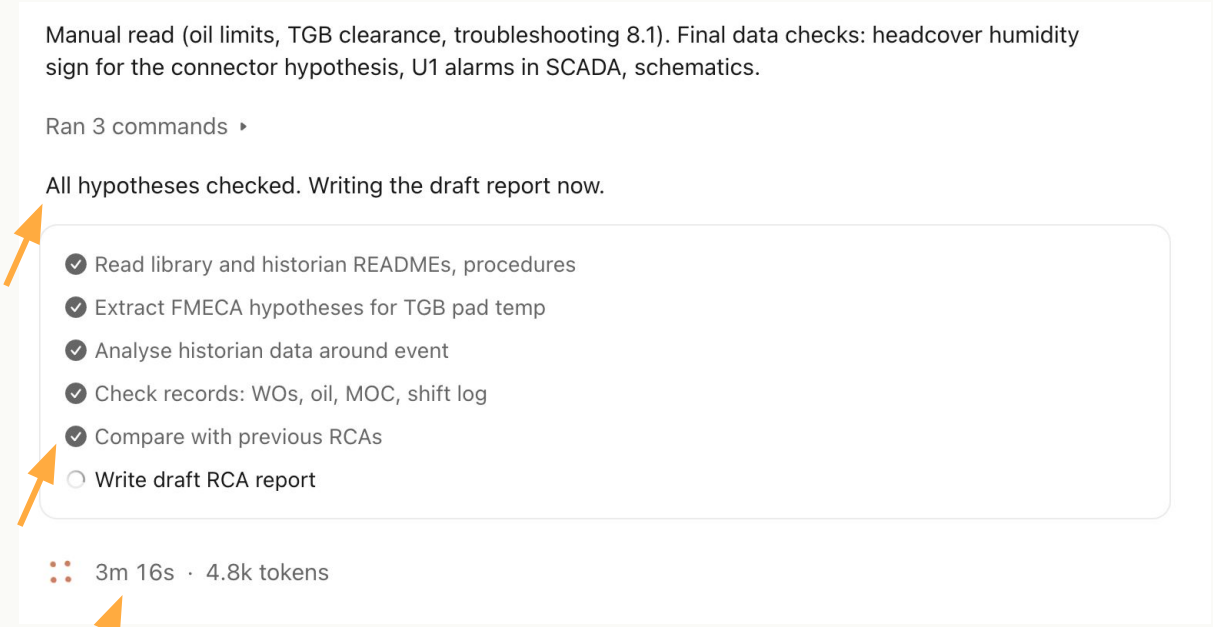
- [x] Read library and historian READMEs, procedures
- [x] Extract FMECA hypotheses for TGB pad temp
- [ ] Analyse historian data around event
- [x] Check records: WOs, oil, MOC, shift log
- [ ] Compare with previous RCAs
- [ ] Write draft RCA report

Checking sump pump starts, SCADA alarms, schematics 2m 23s ▸

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Day 2 - Reliability Engineer + RCA bot



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Day 2 - The Result (in 5 min)

1 Problem statement

On 3 November 2026 at 09:00, the CH monitoring PLC raised a high-high alarm (85 °C) on Unit 1 TGB pad 3. The shift reduced load to 34 MW and stopped the unit at 09:51.

2 Impact

- Unit 1 stopped from 09:51 and not to be restarted before a TGB inspection (shift log 09:55).
- About 76 MWh lost by 11:30, then about 42 MWh for every further hour down (`customer_1min` , `Unit1/MW`).
- The plant could not reach its setpoint: about 66 MW against 110 MW.
- Repair cost unknown until the inspection. For comparison, the 2023 Unit 2 TGB wipe cost about USD 96k (RCA-2023-004).
- No safety or environmental effect.

3 How it was detected

The first (H, 75 °C) alarm came at 23:54 on 2 Nov and went unseen for 9 hours. CH alarms do not appear in SCADA (historian/README.md), and the control room saw only pad 1 at 70 °C. The shift supervisor spotted the HH alarm by chance at 09:03 while looking at Unit 2 in the CH viewer (shift log 09:03).

4 Timeline

When	What	Source
2019	Pad 3 re-babbitted with a tight clearance (0.24 mm against 0.30 ± 0.05), accepted on concession: "trend pad 3 temperature"	asset register
Jan 2023	Last TGB oil change	WO-2023-0051
Feb 2025	MOC-2025-004 cuts oil sampling to twice a year and the oil change interval to 48 months. The reliability engineer's condition (keep the TGB quarterly, change U1 TGB oil) was not carried out	MOC register; WO-2025-0022
Feb 2025 – Aug 2026	Four lab "Caution" results, each worse than the last: tin 5.4 → 14.2 ppm, TAN 0.24 → 0.38	MLL-2025-00196 … MLL-2026-00232
Sep 2026	Resample deferred for the retrofit work, with no new date	WO-2026-0672
16 Oct – 2 Nov	Pad 3 runs further and further above pad 1 at a steady load: +0.3 K → +6.7 K	CH 1-min data
2 Nov 15:40	Unit 2 rough-zone bypass enabled. Reliability sign-off still pending	shift log
2 Nov 23:54	H alarm on pad 3, not seen	CH alarm log
3 Nov 00–05	Pad 3 rises 0.8 K per hour at a constant load	CH 1-min data
3 Nov 06:00	Unit 2 trial starts. Unit 1 goes up to about 42 MW and pad 3 rises faster	shift log; CH data
09:00	HH alarm (85 °C)	CH alarm log
09:14	OP-07 checks done: classed as a bearing problem. Load reduced to 34 MW	shift log
09:51	Unit stopped	SCADA journal

5 Evidence

- **Collected:** historian data, CH alarm log, SCADA journal, shift log, work orders, oil analysis, MOC register, PM plan, FMECA, CH manual and service bulletin, previous RCAs.
- **Still needed:**
  - the 3 Nov oil sample result
  - the TGB inspection: segment photos and clearances
  - CH PLC data from 12 Sep to 13 Oct
  - the text of concession CH-CON-2019-017
  - statements from the people on shift

6 Hypotheses

#	Hypothesis (FMECA)	Key evidence	Result
H1	Pad 3 overheating / oil film breaking down (FM-01)	Pads 2 and 4 and the oil bath rose with pad 3. Pad 3 responded to load changes the way a real pad does	**Verified** (damage still to be confirmed at inspection)
H1a	↳ Oil oxidised	TAN 0.38, varnish 28, tin 14.2 ppm and rising. Oil 46 months old, above CH's maximum of 36	Supported, open (needs the oil result)
H1b	↳ Tight pad 3 clearance	0.24 mm, below tolerance. CH: tight segments run hotter	Supported, open (measure at inspection)
H1c	↳ Higher load	Up to 42 MW from 06:00 because of the Unit 2 trial	Speeded it up; did not start it
H2	Strainer or cooling problem (FM-02, FM-03)	All cooling flows normal. Other bearings flat	Ruled out
H3	Water in the oil (FM-04)	Oil level flat. 106 ppm water	Not supported, open
H4	Faulty sensor or connector (FM-06, CH-SB-2026-03)	Neighbouring pads moved too. Pad 1's two elements agree within 0.3 K. When stopped, pad 3 cooled to match its neighbours. No signal noise	Ruled out (confirm loop resistance at inspection)
H5	Rough zone (FM-07)	Gate 73–85 %. Vibration steady at 55 µm	Ruled out
H6	Unbalance or misalignment (FM-10, FM-11)	Overall vibration normal (waveforms not archived)	Ruled out
H7	Disturbed during the retrofit or annual inspection (not in FMECA)	The rise started about 8 days after the inspection. No record of TGB work	Open

7 Root causes

Type	Root cause	Evidence
Physical (provisional)	The oil film broke down on the tightest TGB segment (pad 3) because the oil had oxidised and the babbitt was wearing	H1, H1a, H1b; oil results; asset register
Human	The reliability condition was dropped from MOC-2025-004. Lab Caution results were not followed up. The resample was deferred with no new date. The H alarm went unseen for 9 hours	MOC register; WO-2025-0022; WO-2026-0672
Latent	(1) Reliability sign-off on an MOC does not block implementation (MOC-2025-004, MOC-2025-012, MOC-2026-019). (2) Oil intervals are below CH	MOC register; PM plan; CH manual §4.5, §5.3,

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Let’s dive in

Day 2 - Reliability Engineer + RCA bot



Let’s dive in

And this is the point where the vendor demo stops…



Let’s dive in

Reality Check!
Buying a tool is not enough

Technical Barriers

Organizational Barriers

Let’s dive in

Reality Check!
Buying a tool is not enough

Technical Barriers

Organizational Barriers

POLL:

What is your most important barrier?

A: Technical - Right Data
B: Technical - Right Models/Tooling
C: Organizational - Cooperation
D: Organizational - Skills

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Reality Check!
Buying a tool is not enough

Technical Barriers

Data
Availability, Quality, Context,
Structured & Unstructured

AI/Models
Predictive, Generative, Prescriptive

Organizational Barriers

Cooperation IT-Operations

Skills

Legal/Compliance
Note: We were using a public service!

So… let’s start again :)

David Ariens
Willem van Lammeren

The IT/OT Insider is the place where we bundle all our insights on how to **advance digitalization** in manufacturing, process and critical infrastructure.

Software neutral.
Always fun!



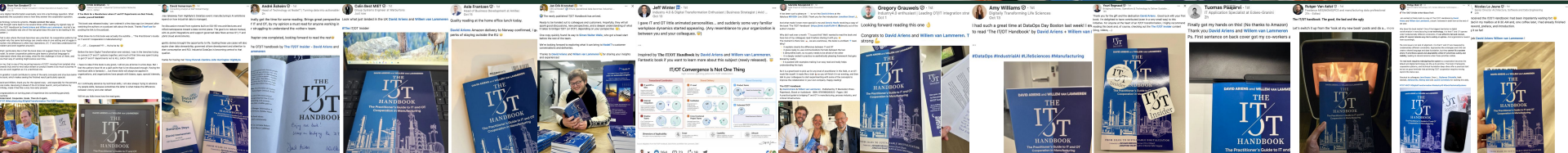
So… let’s start again :)

And…
We Wrote
The IT/OT Handbook

(Order your copy via itotbook.com)

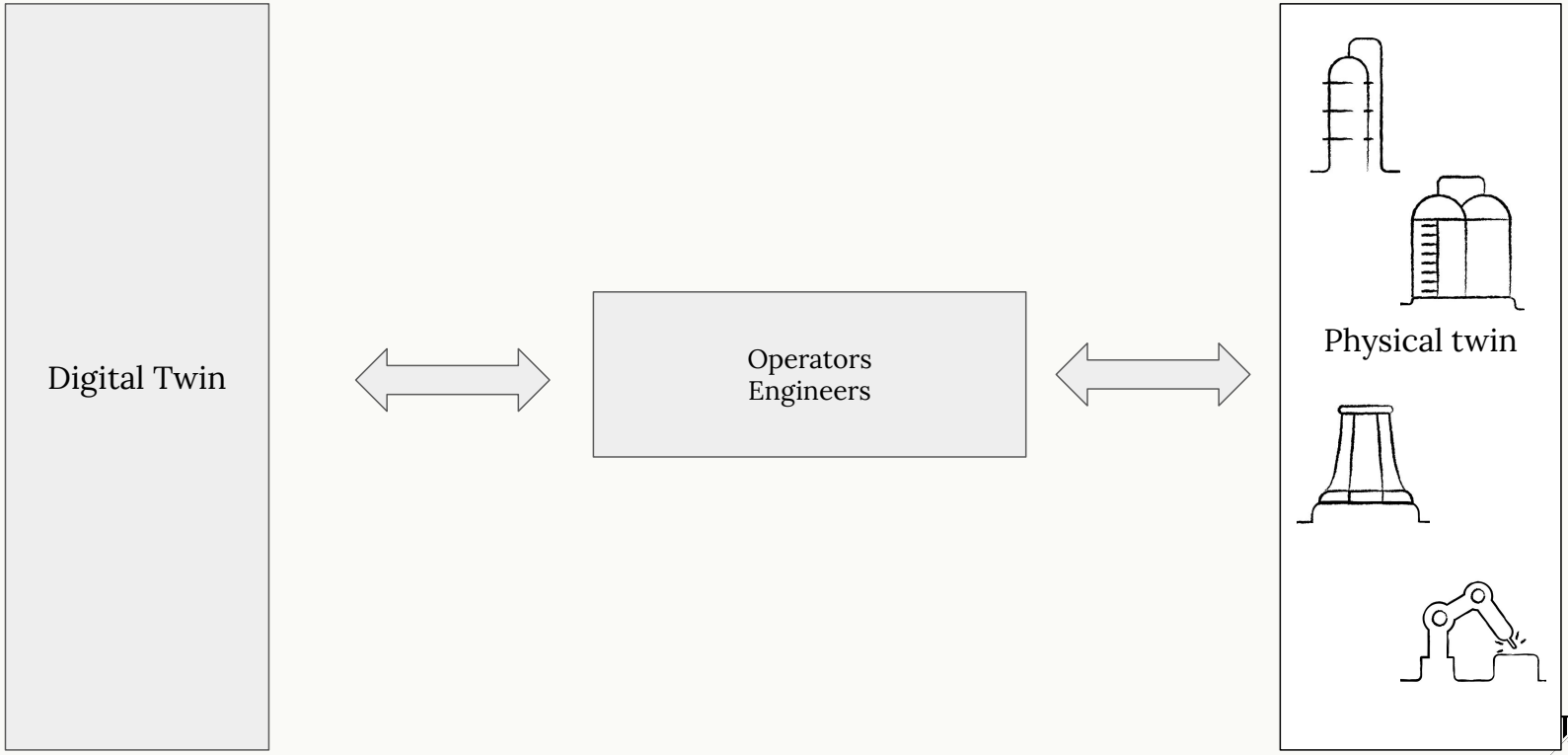


Already 2000 sold :)

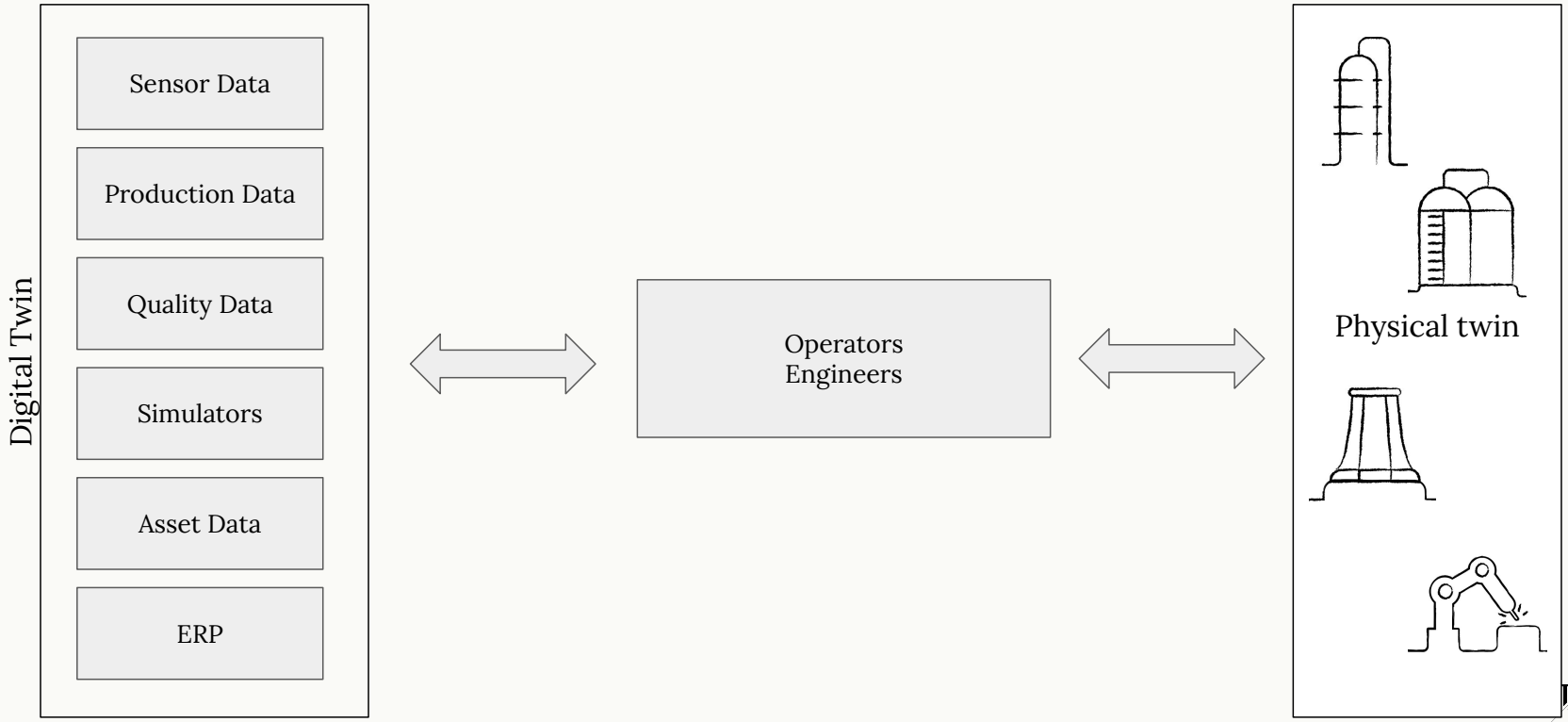


2 | How should you start?

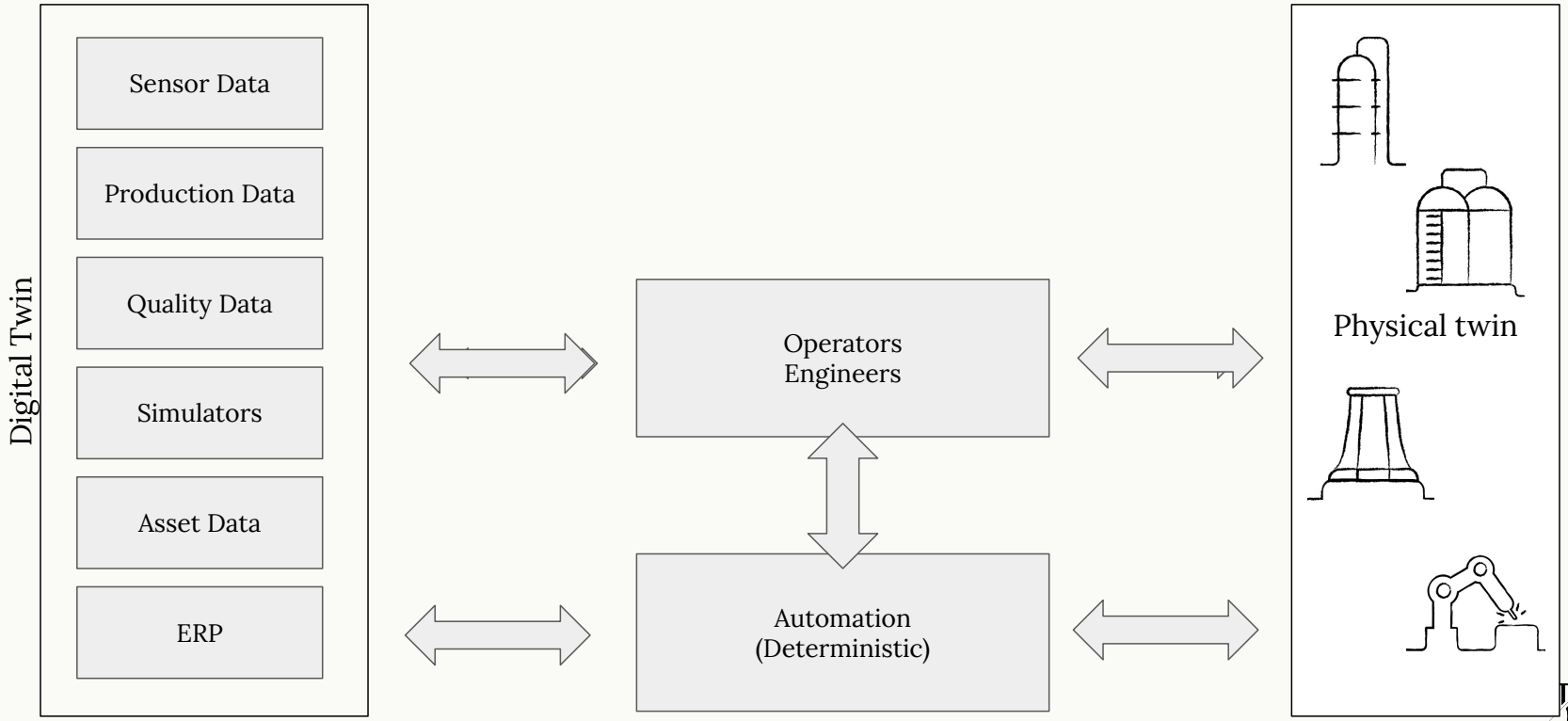
A different look at Industrial AI



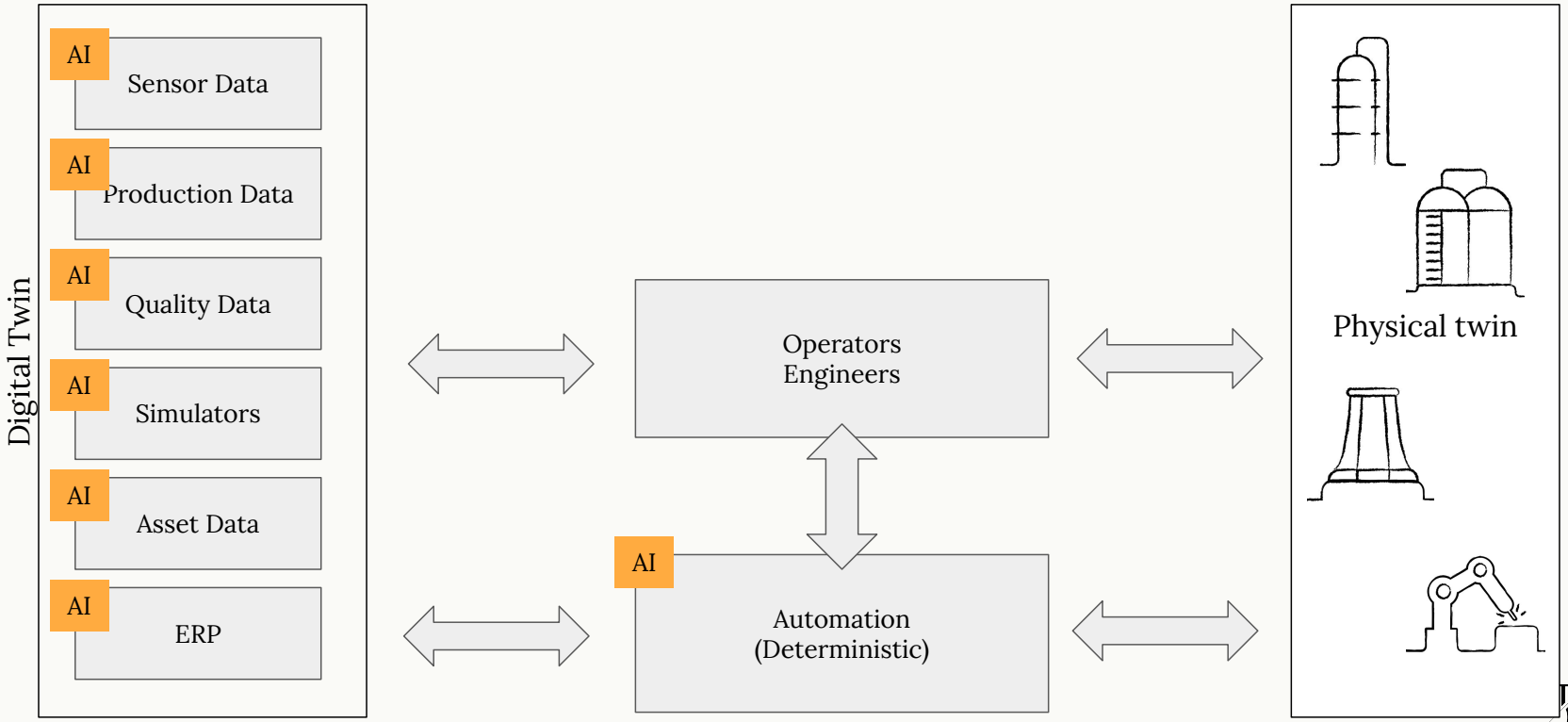
A different look at Industrial AI



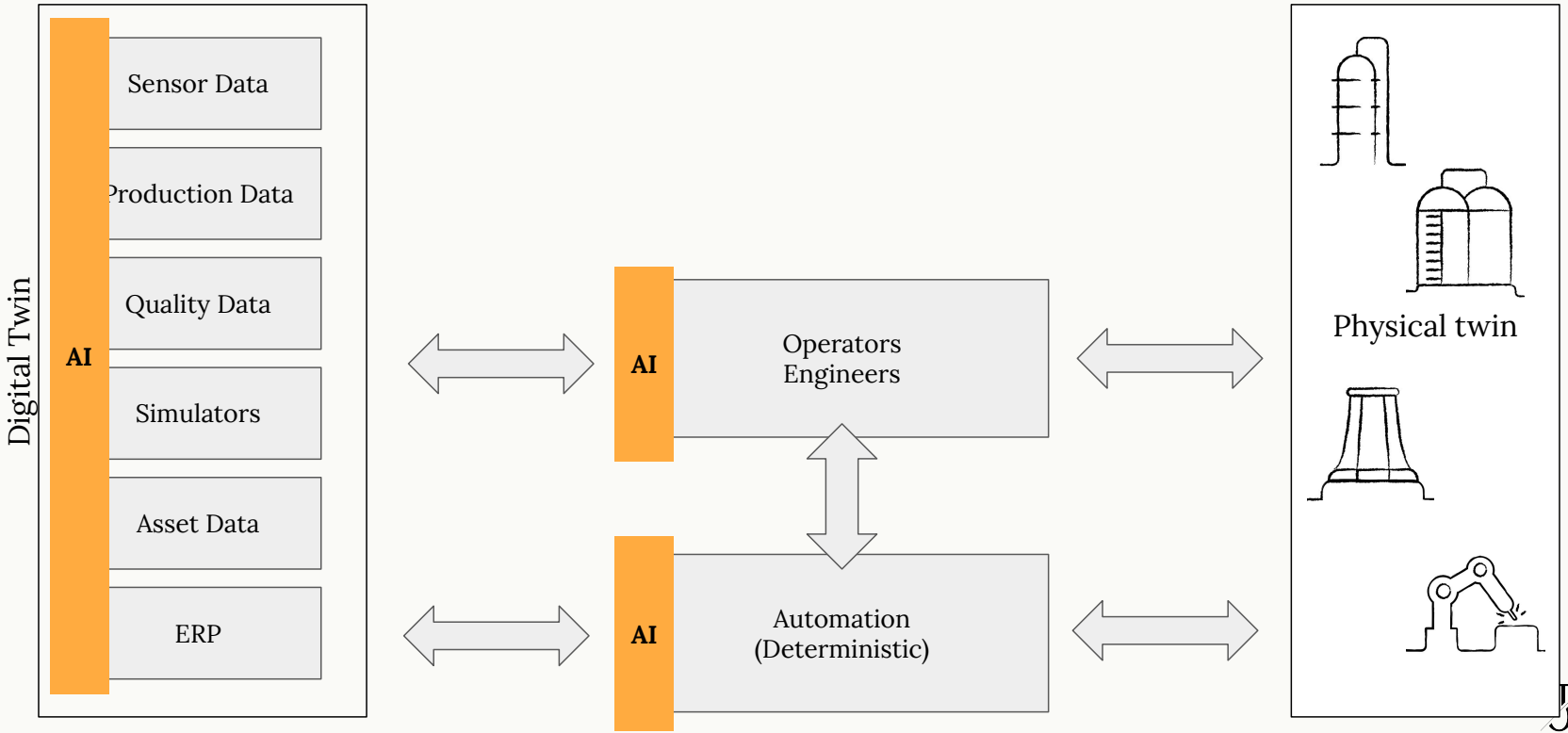
A different look at Industrial AI



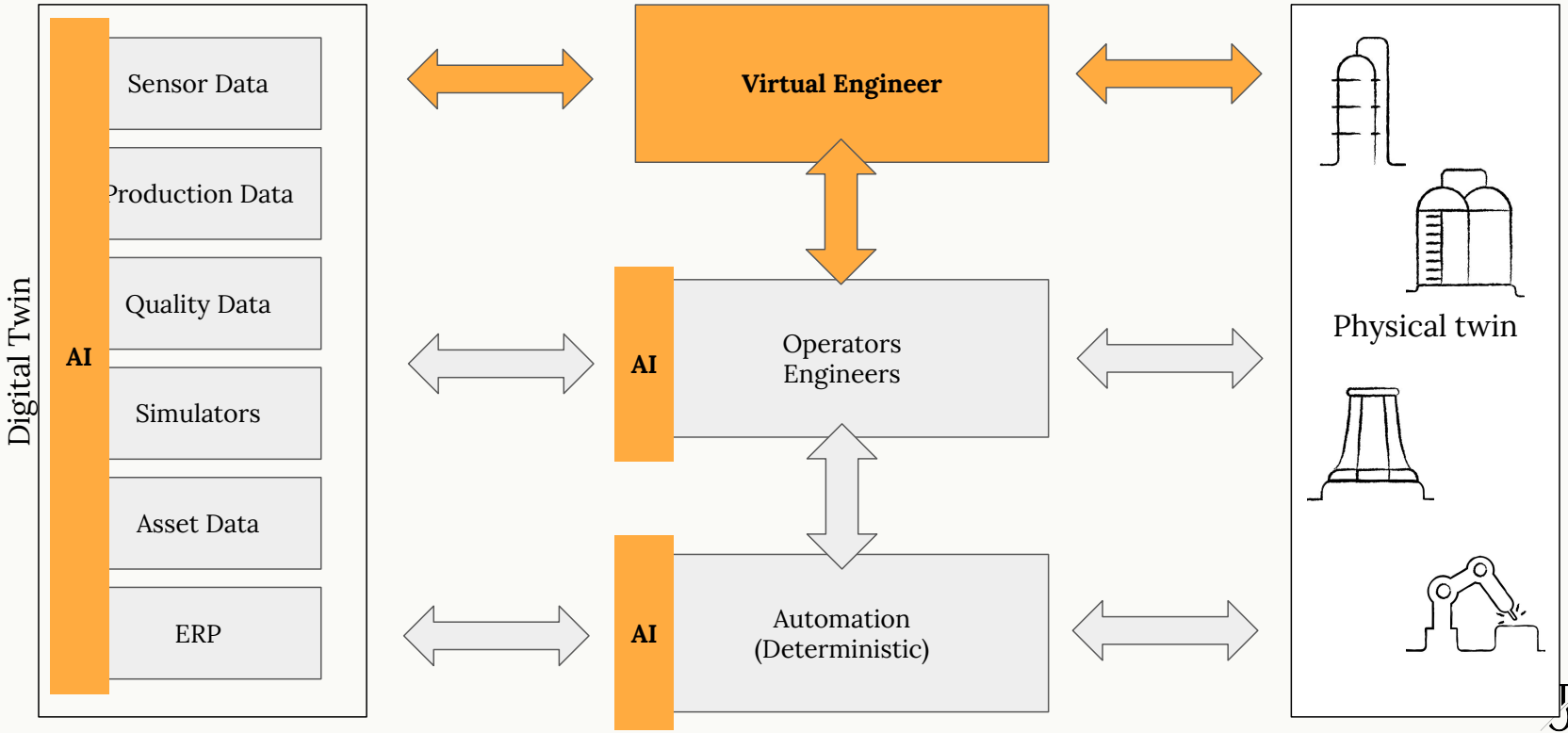
AI today: Bolted-on



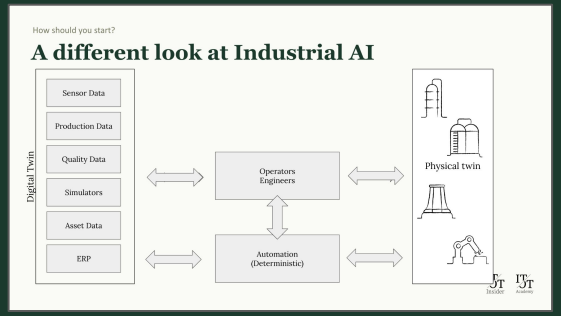
But we want more!



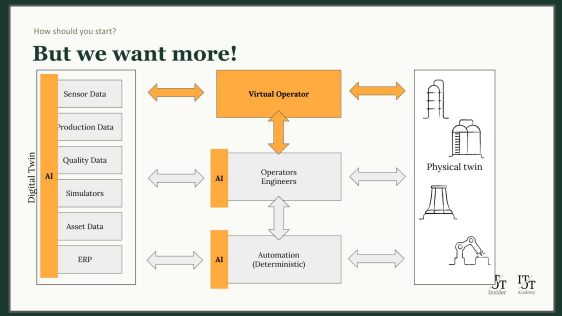
But we want more!



Going from



to



… is not a simple ‘yes or no’ decision

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How should you start?

Industrial AI Maturity Model

HUMAN CENTRIC — SYSTEM CENTRIC

L0 / Shadow AI	L1 / Chat	L2 / Reason	L3 / Virtual Engineer

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How should you start?

Industrial AI Maturity Model

HUMAN CENTRIC — SYSTEM CENTRIC

L0 / Shadow AI	L1 / Chat	L2 / Reason	L3 / Virtual Engineer

WHAT

People using their own personal AI toolset (they know from home)

RISK

Governance / legal:
Data exposure to 3th parties!

Scaling:
Does not scale

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How should you start?

Industrial AI Maturity Model



STEPPING STONE

People using the company provided AI toolset creating reports, small applications, etc using chat

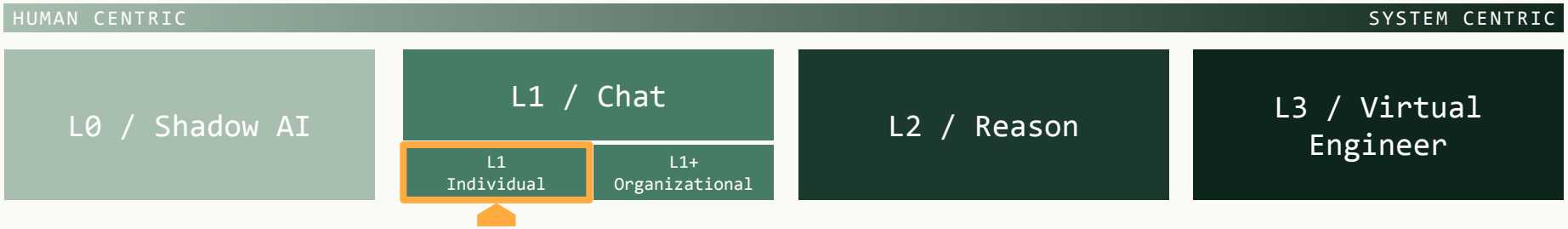
RISK

This is a very simple step to take, but we should distinguish between what an individual can achieve and what the organization can learn

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How should you start?

Industrial AI Maturity Model



WHAT

"Excel on steroids"

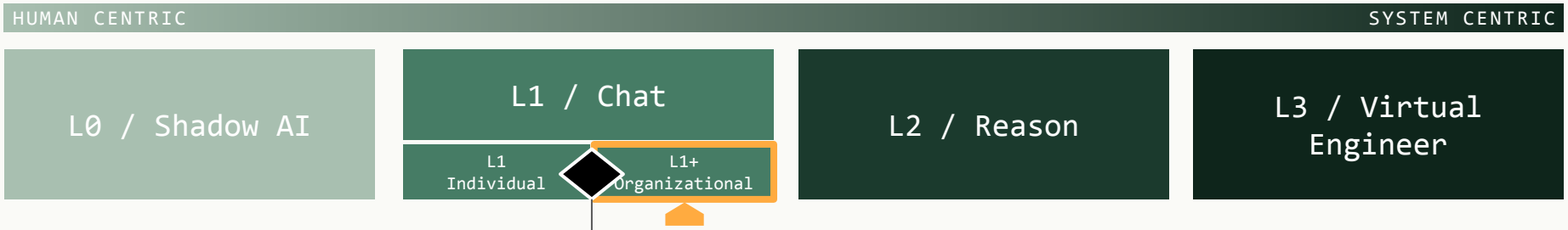
RISK

When these AI initiatives stay with the individual, this is the final station of your AI maturity

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How should you start?

Industrial AI Maturity Model



STEPPING STONE

Community / Excellence centers are established to work on standards, best practices, common language, build expertise etc

EXAMPLES L1+

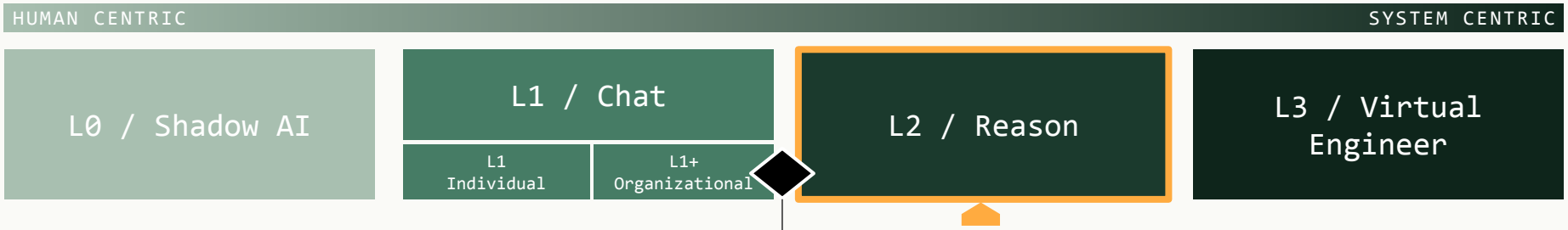
RCA Bot, 5WHY Bot, Hazop support bot, training instructor bot…

This is your ultimate prototyping and learning level!

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How should you start?

Industrial AI Maturity Model



STEPPING STONE

Central Governed Data and AI platforms
(See our Capability Maps)

Strong strategic collaboration with IT
(See our Cooperation Models)

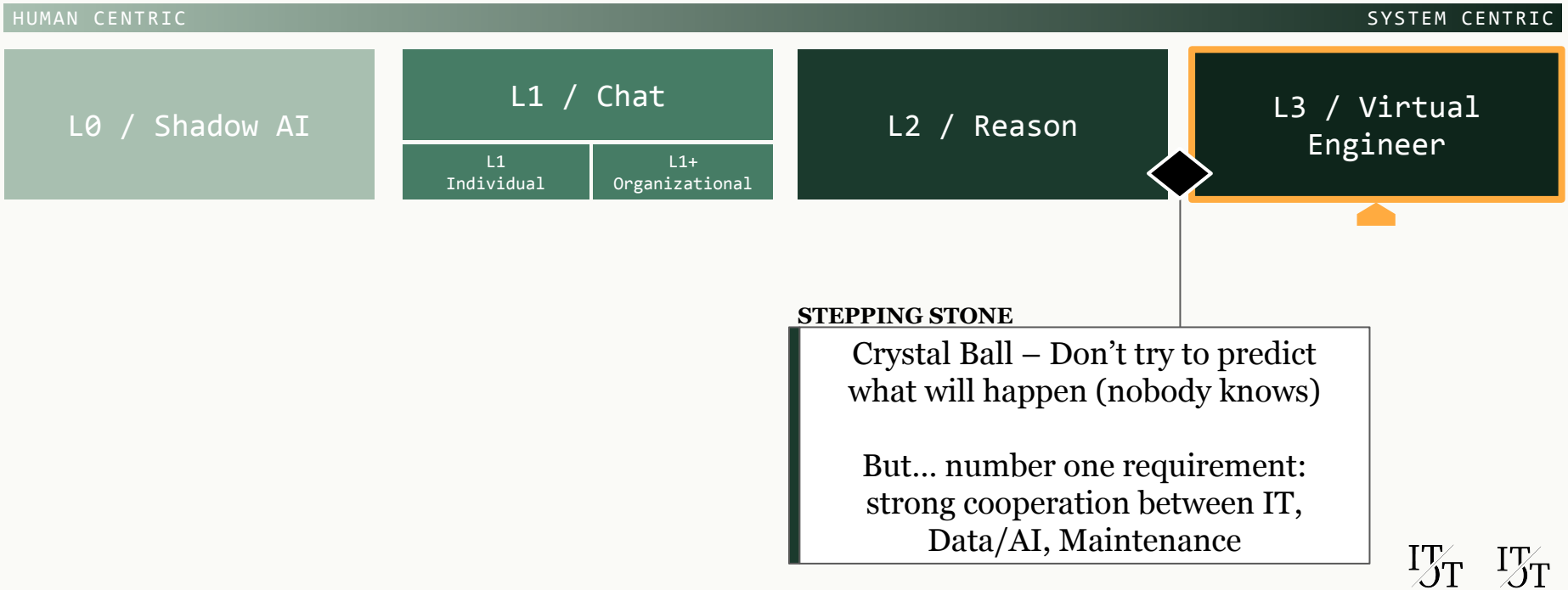
EXAMPLES L2

Anomaly automatically detected, checks all knowledge, lists potential issues, dispatches operator to get more data (you will never have enough data), creates and assigns the right work order with the right prio.

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How should you start?

Industrial AI Maturity Model



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3

What can I do?

... like tomorrow

What Can I Do?

DO NOW

Experiment

Use our examples & data as inspiration

Experiment on the company GPT with real data (if allowed)

Learn where AI tools help most and where they are weak

EXPLORE

Organize

Work & learn internally as maintenance community

Create central chat-based solutions

IT won't make your business case!

DO NEXT

Cooperate

Start a cross-functional team with IT/AI and Maintenance

Invite them to shop floor

Learn more about how cooperation works on our site

“We’ll do it ourselves!”

DO NOW	EXPLORE	DO NEXT
Experiment	**Organize**	**Cooperate**

Use our resources to get started!
https://itotinsider.com/industrial-ai/virtual-maintenance-engineer/

Download the **RCA demo set** (prompt, instructions, data, simulator)
Blog: 120+ free articles – **Youtube**: 120+ free videos
The IT/OT **Handbook**
The IT/OT **Academy** (next cohort in January)

→

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“We want focused guidance”

DO NOW

Experiment

EXPLORE

Organize

DO NEXT

Cooperate

We come to you!
AI in Maintenance Kickstart

Assessment: where you are vs. your peers
On-site Workshop to inspire your team and map your gaps
A roadmap you can take to management and IT

€9,490
travel costs excluded

Book your intake call with David:
david@itotinsider.com

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When it comes to AI...

Starting today is always the better option!

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Thank you

Get the examples here:
https://itotinsider.com/industrial-ai/virtual-maintenance-engineer/

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