



Delivering
Excellence
Together



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15th October 2025*

Agenda



1

Introduction

*What is off-site construction?
What are the objectives of the project?*

2

Use case

*Manufacturing Operations
Overview of Steel Frame
System area*

3

Digital system

*Data driven solution to
improve Steel Frame
System area Monitoring,
Planning &
Scheduling*

4

Conclusions

*Remarks on the proposed
system & Further Activities*

Introduction



What is off-site manufacturing and why is gaining traction?



Innovative approach involving the design and production of structural components in a **factory** before being installed on **site**



Opportunity to **improve** project **planning** control, **productivity** and **delivery** time



Wide **variability**: geographical conditions, budget, building functions and client personalization

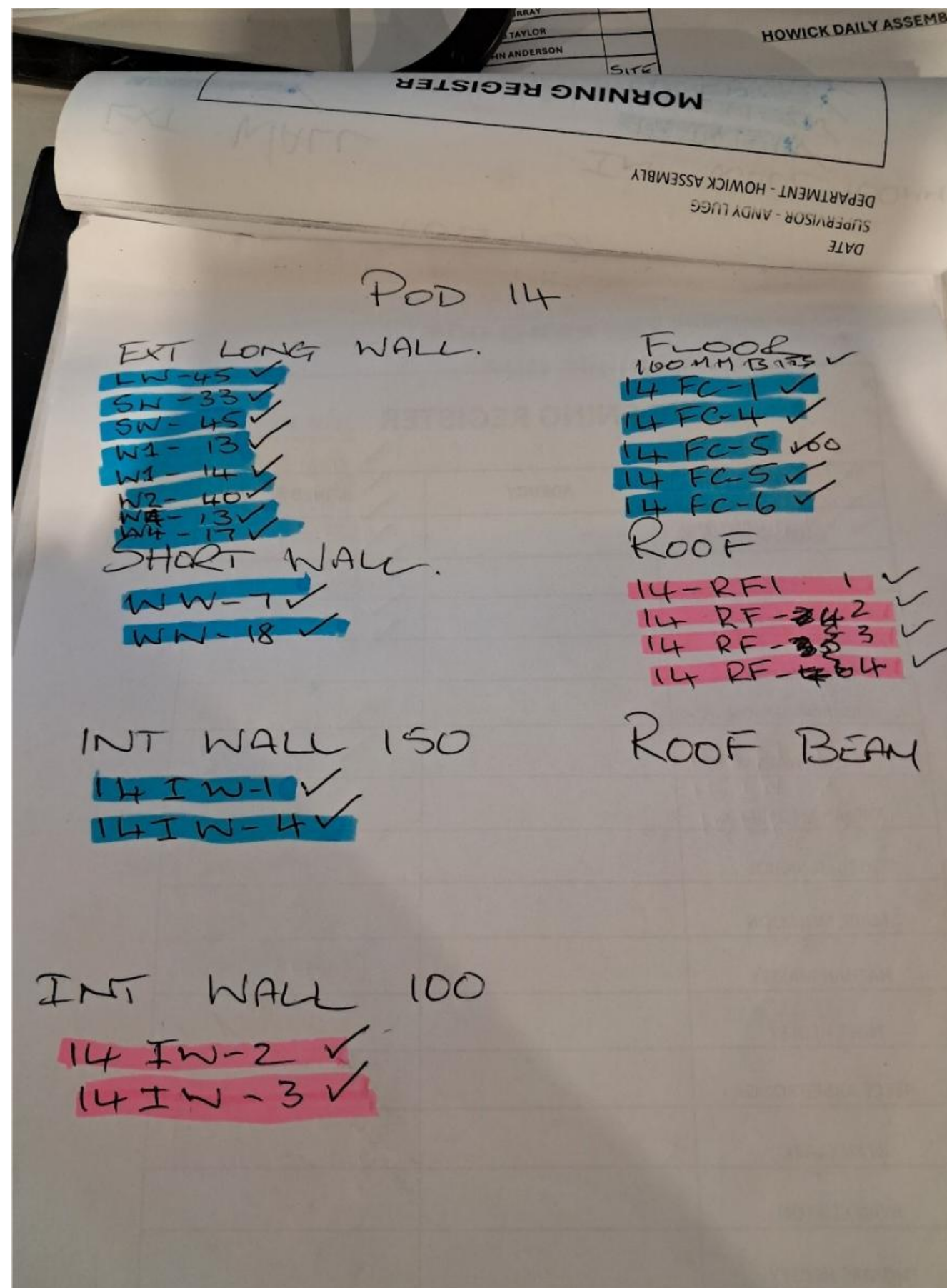


Due to **low standardization** construction has **very low** average **profit margins** compared to other sectors such as manufacturing (McKinsey and Company)

Introduction



How off-site construction companies track production?



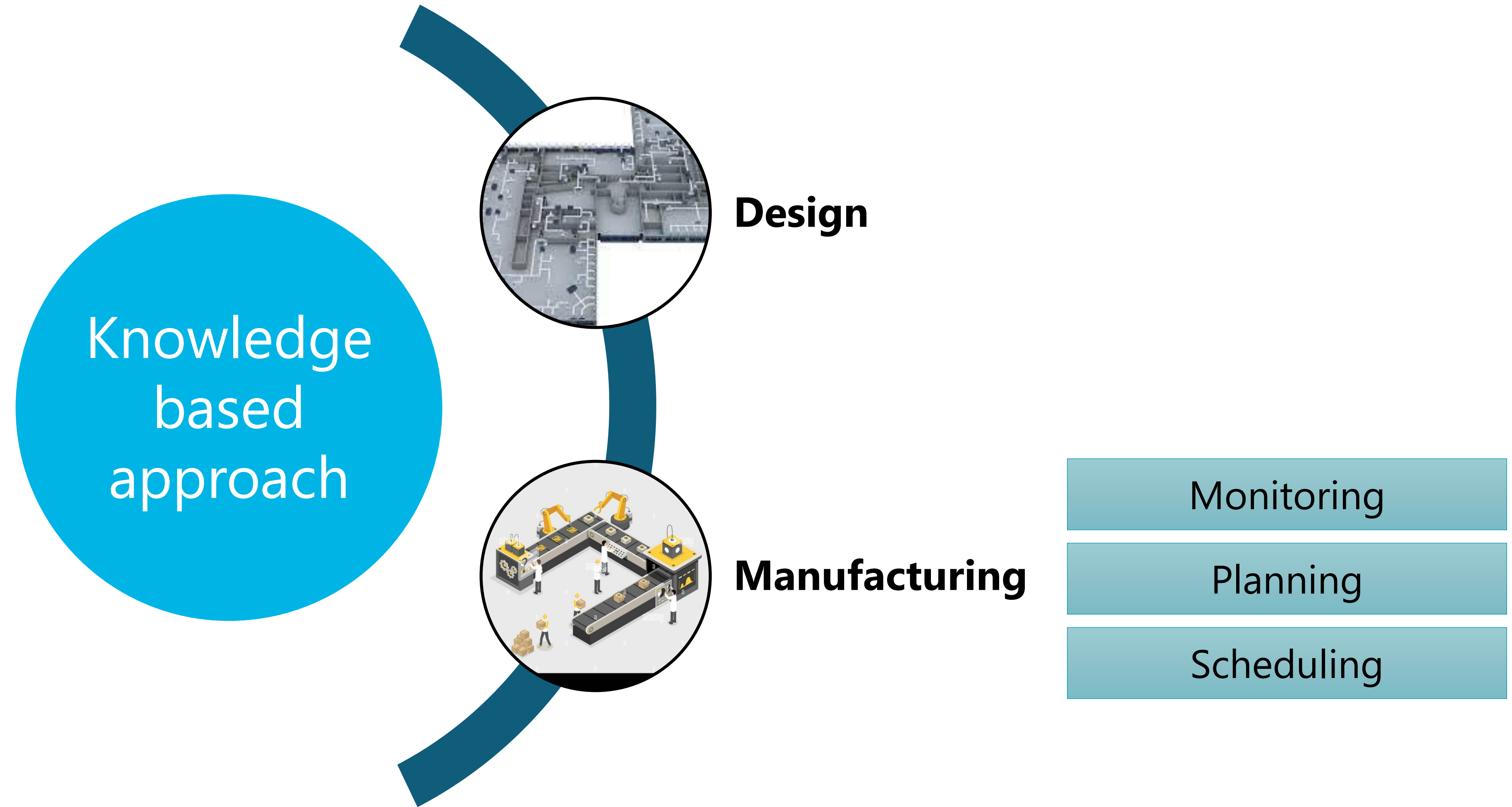
»»» **Low adoption** of established **manufacturing standards** and **principles**

»»» **Limited digital footprint** to monitor factory operations

»»» **Ripple effects** on:

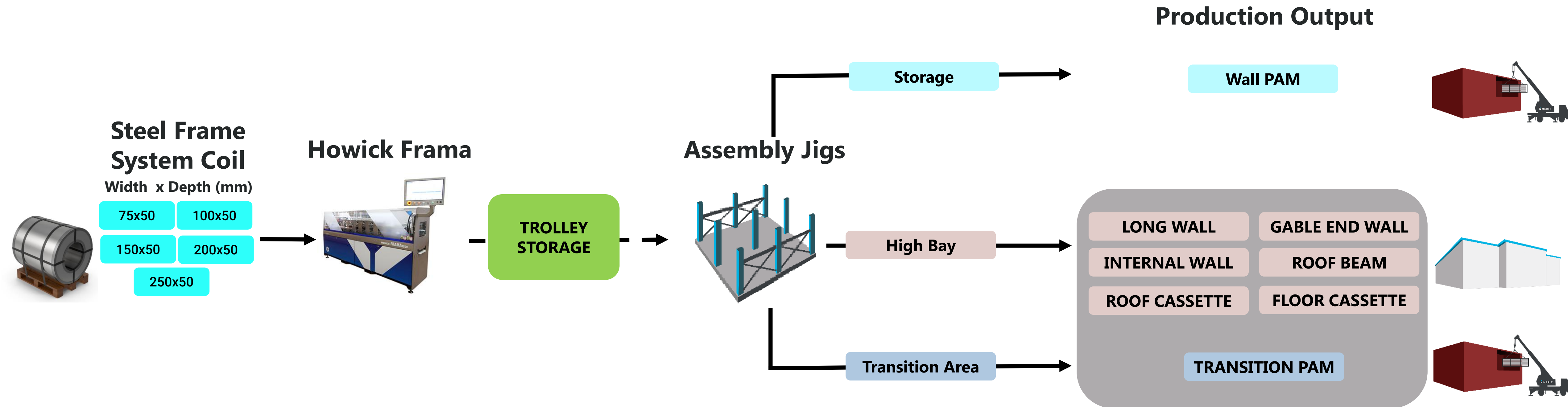
- Cost evaluations
- Resources dimensioning and efficiency
- Project deadlines

Introduction



»»» **Which manufacturing job shop is considered?**

Use Case



Use Case

Howick Machine



- 1 dedicated operator:
 - Run manufacturing sequence
 - Machine set ups for coil changes
 - Admin and Quality jobs
- Material Handling into trolleys

Trolleys



- Structured into 2 sides and 4 levels for storing up to 8 frames
- Each frame has a traveller pack containing Audit Sheet, Assy Drawing and Green Tag
- Material Handling is manual

Assembly jigs



- Up to 4 assembly workers for 2D assembly
- **BathPod** and **UltraPod** to the High bay
 - **WallPams** into Stillages
- **Transition PAM** frames to transition manufacturing cell

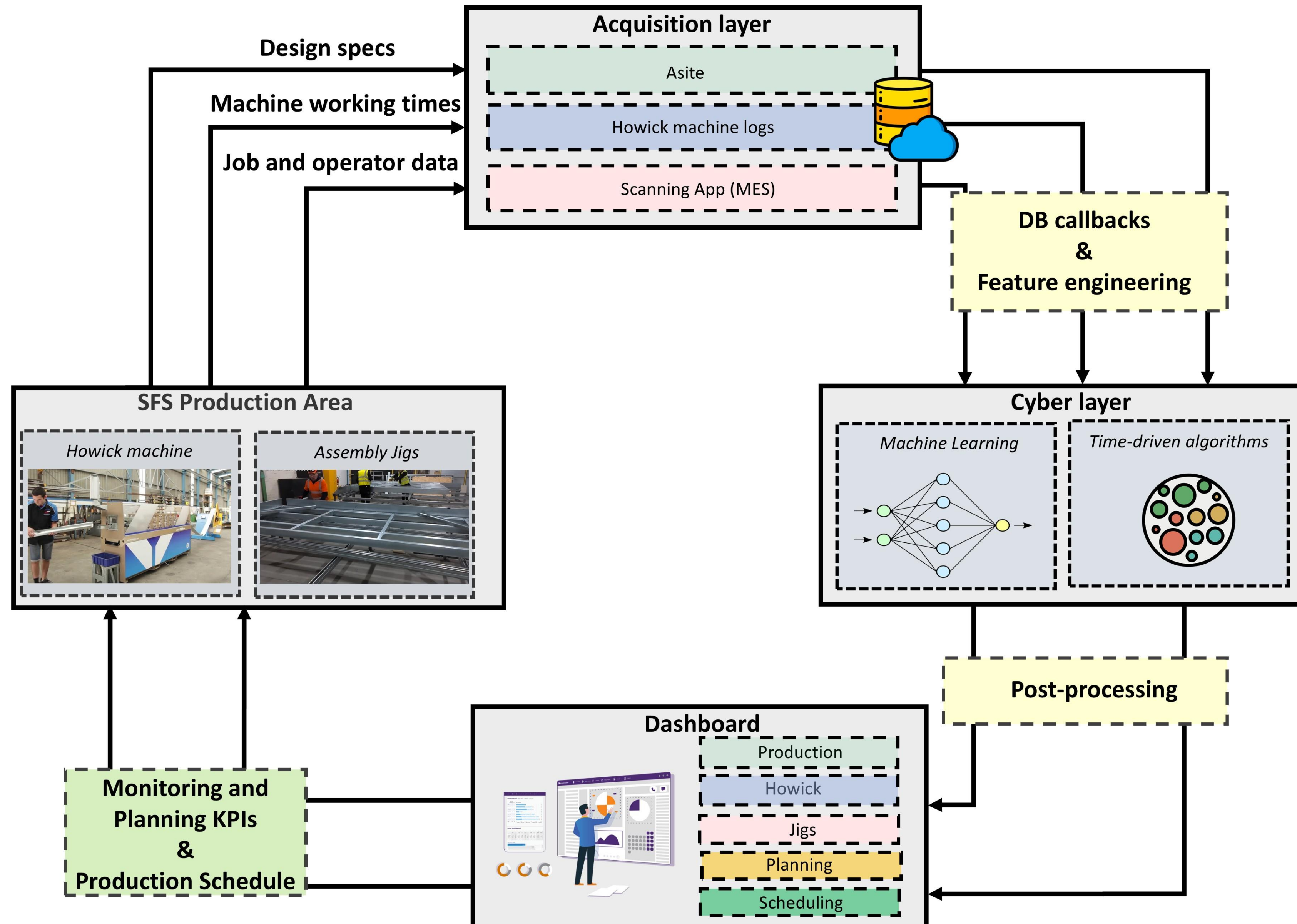


Stillages

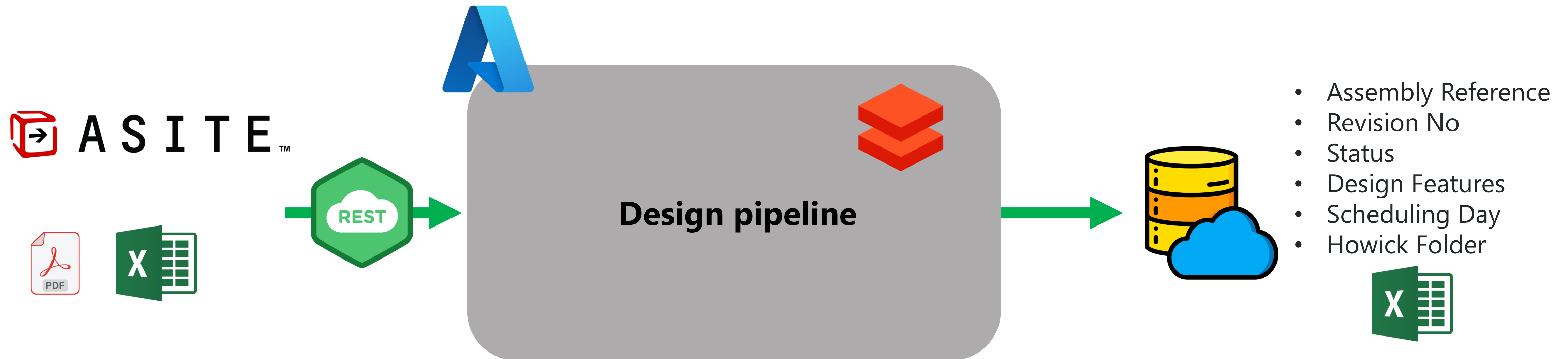


- Store variable number of WallPams
- Used for on-site delivery

Digital System - Overview



Digital System – Acquisition Layer



How to schedule data to production and send CSV files to the Howick Machine?

Digital System – Dashboard: Scheduling



ProjectID	AssemblyRef	ProductionRef	RevisionNo	Status	ScrewCount	Coil	DirectLink	SchedulingDay	Len
10734	10734-MRT-ZZ-02-DR-S-09-1006	02-09-1006	C01	Approved IFC	42	150.0	https://adoddleak.asite.com/lnk/oLKR867TdpA6xupAndM	—	25490.2
10734	10734-MRT-ZZ-02-DR-S-09-1007	02-09-1007	C01	Approved IFC	42	150.0	https://adoddleak.asite.com/lnk/oLKR86sodpA6aspAndM	—	26768.6
10300	10300-MRT-Z3-01-DR-S-3039-02	Z3-01-3039-02	C01	Approved IFC	122	100.0	https://adoddleak.asite.com/lnk/XM49LBJH6LkxdsLXXn	—	44183.8
10752	10752-MRT-ZZ-01-DR-S-6518-18GW1	18GW-1	C03	Approved IFC	124	150.0	https://adoddleak.asite.com/lnk/67Lr4LAtKapaRKCEgbLk	—	48808.6
10752	10752-MRT-ZZ-01-DR-S-6518-18IW1	18IW1	C04	Approved IFC	136	100.0	https://adoddleak.asite.com/lnk/M9oxeRqudBeAkpUnBMea	—	49850.2
10752	10752-MRT-ZZ-01-DR-S-6518-18IW2	18IW2	C04	Approved IFC	180	100.0	https://adoddleak.asite.com/lnk/R79goELCEe6rb9uk6rdG	—	52119.3
10752	10752-MRT-ZZ-01-DR-S-6518-18IW3	18IW3	C04	Approved IFC	117	100.0	https://adoddleak.asite.com/lnk/zaKgqxGlxrdopyu7kpab	—	43291.3
10752	10752-MRT-ZZ-01-DR-S-6519-19FC1	19FC-1	C02	Approved IFC	80	250.0	https://adoddleak.asite.com/lnk/9AypKo7lp58eddspx7k	2025-09-12 14:15:00	41442.4
10752	10752-MRT-ZZ-01-DR-S-6519-19FC2	19FC-2	C02	Approved IFC	160	250.0	https://adoddleak.asite.com/lnk/XM569rMS6opg5RhlZydyj	2025-09-12 14:15:00	49505.4
10752	10752-MRT-ZZ-01-DR-S-6519-19FC3	19FC-3	C02	Approved IFC	144	250.0	https://adoddleak.asite.com/lnk/RAyE9rgUEq8njohk6rdG	—	44235.2
10752	10752-MRT-ZZ-01-DR-S-6519-19FC4	19FC-4	C02	Approved IFC	144	250.0	https://adoddleak.asite.com/lnk/aMydKdCd8gqGFBz5Ar	—	45123.4
10752	10752-MRT-ZZ-01-DR-S-6519-19FC5	19FC-5	C01	Approved IFC	308	100.0	https://adoddleak.asite.com/lnk/Bn8x88olnGkrqKFEk54L	—	72628
10300	10300-MRT-Z3-00-DR-S-3066-03	Z3-00-3066-03	C01	Approved IFC	44	100.0	https://adoddleak.asite.com/lnk/oRngz5xuocj8yypAAEX	—	21565
10300	10300-MRT-Z3-00-DR-S-3067-01	Z3-00-3067-01	C02	Approved IFC	80	100.0	https://adoddleak.asite.com/lnk/aMz67XSddLegAlBkkj	—	23442.6
10300	10300-MRT-ZZ-00-DR-S-2158-02	Z2-00-2158-02	C01	Approved IFC	60	100.0	https://adoddleak.asite.com/lnk/aM86g97HdR9xrBkkj	—	24312.1
10300	10300-MRT-ZZ-00-DR-S-2159-01	Z2-00-2159-01	C01	Approved IFC	58	100.0	https://adoddleak.asite.com/lnk/XMqz5Eouk4ogkEhLXXn	—	23104.5
10300	10300-MRT-ZZ-00-DR-S-2160-01	Z2-00-2160-01	C01	Approved IFC	64	100.0	https://adoddleak.asite.com/lnk/eMqzyEKSkXogLRHBrKL	—	28785.5

Mirror all Asite Activity. Jobs can be send to the Howick if the following are true:

» Status = 'Approved IFC'

» SchedulingDay=NULL

ProjectID	AssemblyRef	ProductionRef	RevisionNo	Status	ScrewCount	Coil	DirectLink	SchedulingDay	Len
10734	10734-MRT-ZZ-02-DR-S-09-1006	02-09-1006	C01	Approved IFC	42	150.0	https://adoddleak.asite.com/lnk/oLKR867TdpA6xupAndM	—	25490.2
10734	10734-MRT-ZZ-02-DR-S-09-1007	02-09-1007	C01	Approved IFC	42	150.0	https://adoddleak.asite.com/lnk/oLKR86sodpA6aspAndM	—	26768.6
10300	10300-MRT-Z3-01-DR-S-3039-02	Z3-01-3039-02	C01	Approved IFC	122	100.0	https://adoddleak.asite.com/lnk/XM49LBJH6LkxdsLXXn	—	44183.8
10752	10752-MRT-ZZ-01-DR-S-6518-18GW1	18GW-1	C03	Approved IFC	124	150.0	https://adoddleak.asite.com/lnk/67Lr4LAtKapaRKCEgbLk	—	48808.6
10752	10752-MRT-ZZ-01-DR-S-6518-18IW1	18IW1	C04	Approved IFC	136	100.0	https://adoddleak.asite.com/lnk/M9oxeRqudBeAkpUnBMea	—	49850.2
10752	10752-MRT-ZZ-01-DR-S-6518-18IW2	18IW2	C04	Approved IFC	180	100.0	https://adoddleak.asite.com/lnk/R79goELCEe6rb9uk6rdG	—	52119.3
10752	10752-MRT-ZZ-01-DR-S-6518-18IW3	18IW3	C04	Approved IFC	117	100.0	https://adoddleak.asite.com/lnk/zaKgqxGlxrdopyu7kpab	—	43291.3
10752	10752-MRT-ZZ-01-DR-S-6519-19FC1	19FC-1	C02	Approved IFC	80	250.0	https://adoddleak.asite.com/lnk/9AypKo7lp58eddspx7k	2025-09-12 14:15:00	41442.4
10752	10752-MRT-ZZ-01-DR-S-6519-19FC2	19FC-2	C02	Approved IFC	160	250.0	https://adoddleak.asite.com/lnk/XM569rMS6opg5RhlZydyj	2025-09-12 14:15:00	49505.4
10752	10752-MRT-ZZ-01-DR-S-6519-19FC3	19FC-3	C02	Approved IFC	144	250.0	https://adoddleak.asite.com/lnk/RAyE9rgUEq8njohk6rdG	—	44235.2
10752	10752-MRT-ZZ-01-DR-S-6519-19FC4	19FC-4	C02	Approved IFC	144	250.0	https://adoddleak.asite.com/lnk/aMydKdCd8gqGFBz5Ar	—	45123.4
10752	10752-MRT-ZZ-01-DR-S-6519-19FC5	19FC-5	C01	Approved IFC	308	100.0	https://adoddleak.asite.com/lnk/Bn8x88olnGkrqKFEk54L	—	72628
10300	10300-MRT-Z3-00-DR-S-3066-03	Z3-00-3066-03	C01	Approved IFC	44	100.0	https://adoddleak.asite.com/lnk/oRngz5xuocj8yypAAEX	—	21565
10300	10300-MRT-Z3-00-DR-S-3067-01	Z3-00-3067-01	C02	Approved IFC	80	100.0	https://adoddleak.asite.com/lnk/aMz67XSddLegAlBkkj	—	23442.6
10300	10300-MRT-ZZ-00-DR-S-2158-02	Z2-00-2158-02	C01	Approved IFC	60	100.0	https://adoddleak.asite.com/lnk/aM86g97HdR9xrBkkj	—	24312.1
10300	10300-MRT-ZZ-00-DR-S-2159-01	Z2-00-2159-01	C01	Approved IFC	58	100.0	https://adoddleak.asite.com/lnk/XMqz5Eouk4ogkEhLXXn	—	23104.5
10300	10300-MRT-ZZ-00-DR-S-2160-01	Z2-00-2160-01	C01	Approved IFC	64	100.0	https://adoddleak.asite.com/lnk/eMqzyEKSkXogLRHBrKL	—	28785.5

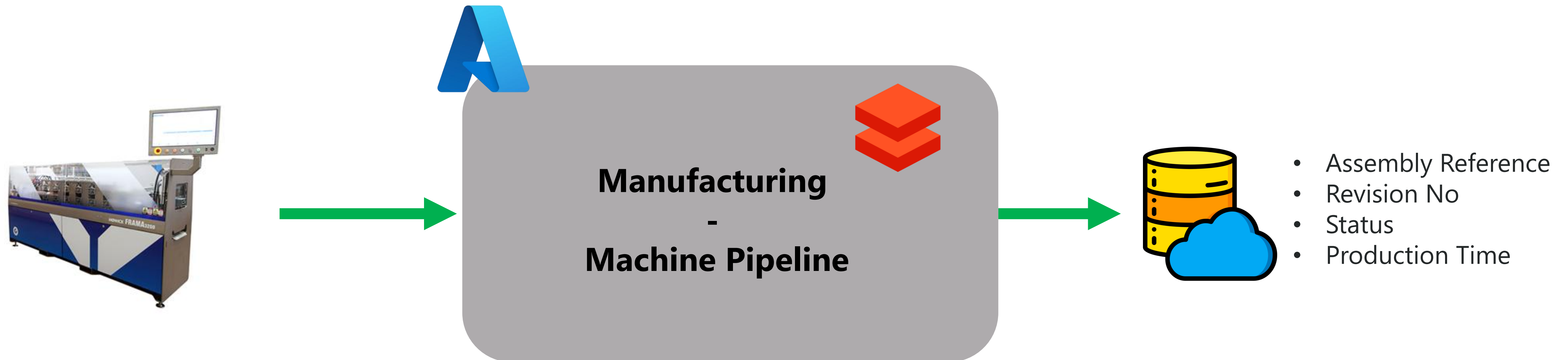
Upon Assembly Reference selection the system asks:

» Select Scheduling Day = Date and Time (optional)

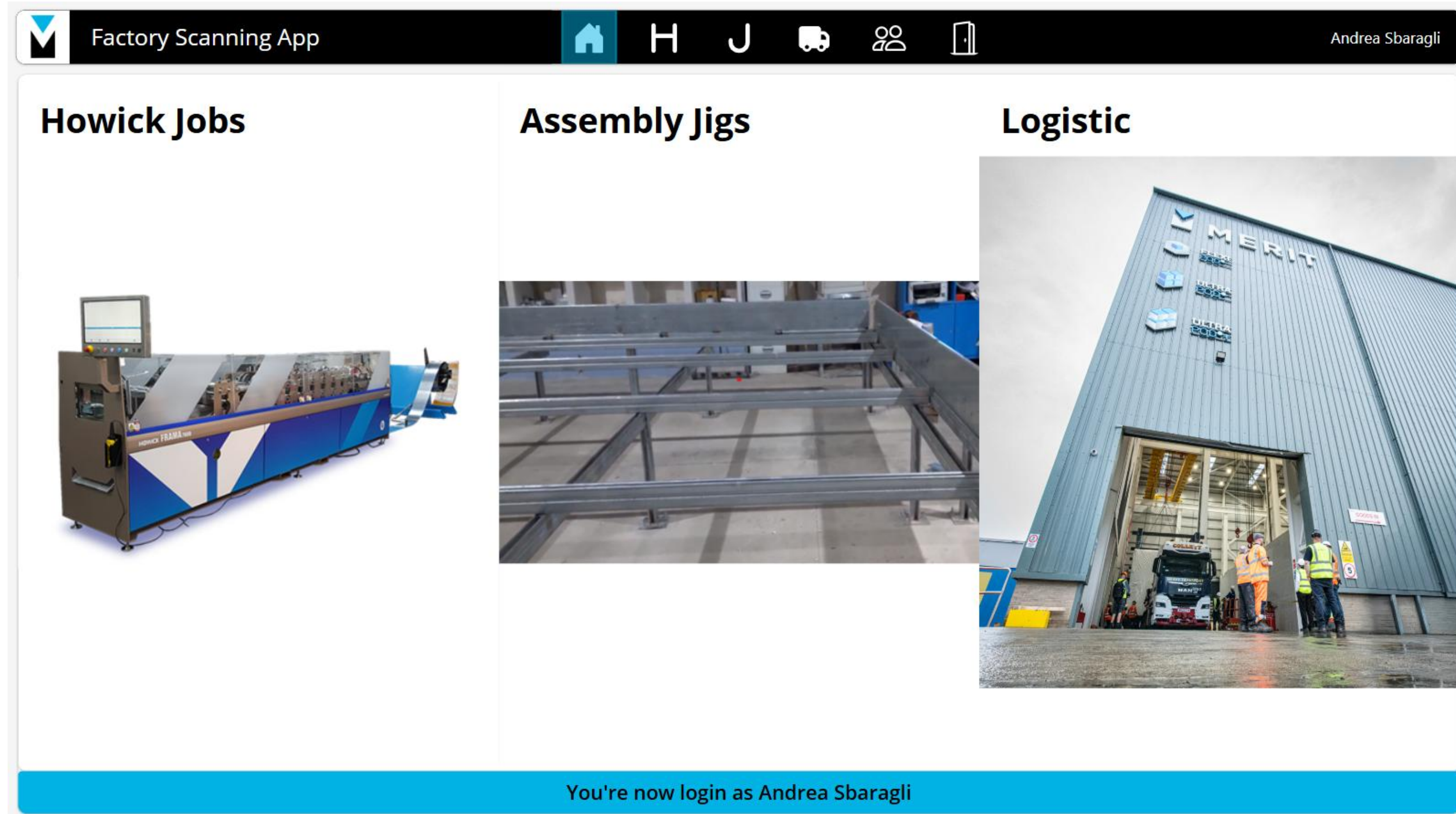
» Select Name of the Howick folder

How to capture production data to evaluate process efficiency?

Digital System – Acquisition Layer



Digital System – Acquisition Layer: MES



Digital System – Acquisition Layer: MES



Factory Scanning App (TEST) Andrea Sbaragli

Howick Jobs overview Admin function

PROJECT --ALL-- MACHINE STATUS Howick Machine 1 Completed: 0 10581-MRT-ZZ-01-DR-S-6806-LW3

ASSEMBLY REF	REV	COIL	LEN	SCHEDULED DAY	HOWICK FOLDER	HIGH PRIORITY	START TIME	END TIME	OPERATORS	STATUS	
10581-MRT-ZZ-01-DR-S-6500-DP11	C01	100.0	13.9	07/10/2025	7th-Oct		03/10/2025 08:04		Mark Lui,Cashin Martin	INCOMPLETE Trolley: 2	Audit OPEN
10581-MRT-ZZ-01-DR-S-6500-DP12	C01	100.0	14.9	07/10/2025	7th-Oct		03/10/2025 09:15		Andy Ryan	INCOMPLETE Trolley: 8	Audit OPEN
10581-MRT-ZZ-01-DR-S-6500-RF04	C01	100.0	28.8	07/10/2025	7th-Oct		03/10/2025 15:37	06/10/2025 11:34	Andrea Sbaragli	COMPLETE Trolley: 10	Audit OPEN
10581-MRT-ZZ-01-DR-S-6500-RF10	C01	100.0	28.7	07/10/2025	7th-Oct		06/10/2025 12:12	06/10/2025 15:33	Andrea Sbaragli,Mark Lui	COMPLETE Trolley: 7 E	Audit OPEN
10581-MRT-ZZ-01-DR-S-6806-LW3	C01	100.0	34.2	07/10/2025	7th-Oct		08/10/2025 14:00		Andrea Sbaragli	PROGRESS Machine 1	Audit OPEN
10581-MRT-ZZ-01-DR-S-6806-LW4	C01	100.0	33	07/10/2025	7th-Oct					NEW	Audit OPEN
10752-MRT-ZZ-GF-DR-S-6508-8FC4	C01	200.0	27.9	07/10/2025	1st-Oct					NEW	Audit OPEN
10752-MRT-ZZ-GF-DR-S-6513-13GW1	C01	150.0	31	07/10/2025	1st-Oct					NEW	Audit OPEN
10300-MRT-Z1-00-DR-S-1150-02	C02			10/10/2025						NEW	Audit OPEN
10300-MRT-Z1-00-DR-S-1001-55	C02						03/07/2025 14:00	03/07/2025 15:00	Andrea Sbaragli	SCRAP	Audit OPEN

Assembly Ref 21 jobs

Scheduled Jobs flows into the Howick Area of the Manufacturing Execution System (MES)



Jobs have different status and informations



Workers can log in the job by pressing OPEN

Jobs control panel enables to capture several process driven activities



Uptime and downtime events



Record quality checks



Print QR codes and enter Trolley information

Factory Scanning App (TEST) Andrea Sbaragli

Assembly Ref
10581-MRT-ZZ-01-DR-S-6806-LW3

Revision No
C01

Status
IN PROGRESS

Start Time
08/10/2025 14:00

End Time

Machine
Howick Machine 1

Operators
Andrea Sbaragli

Start Timer

Andrea Sbaragli

WorkStart 08/Oct 14:00:06 -

☒ Printed Trolley No. & Lv:

Digital System – Acquisition Layer: MES



Factory Scanning App

Assembly Jig overview

PROJECT: --ALL-- JIG STATUS: Jig 1 Completed: 0 Available, Jig 3 Completed: 0 Available, Jig 2 Completed: 0 Available, Jig 4 Completed: 0 10752-MRT-ZZ-GF-DR-S-6514-14RC3

ASSEMBLY REF	REV	High Priority	STORAGE TIME	START TIME	END TIME	Screw Num	OPERATORS	STATUS
10752-MRT-ZZ-01-DR-S-6518-18IW2	C02		1422 hrs	12/08/2025 07:59	12/08/2025 09:52		Paul Mitchell,Brett Thackray,Billy Sweet	ABORT
10752-MRT-ZZ-01-DR-S-6519-19FC6	C01		1159 hrs	20/08/2025 12:25	22/08/2025 09:21	280	Carl Chapman,Terry Goodwin,Paul Mitchell,Jonathan Howe	ABORT
10752-MRT-ZZ-GF-DR-S-6506-6GW1	C03		893 hrs	02/09/2025 08:28	02/09/2025 11:39	100	Terry Goodwin,Paul Mitchell	ABORT
10752-MRT-ZZ-GF-DR-S-6514-14RC3	C01		364 hrs	26/09/2025 12:01		196	Mark Scott,Brett Thackray,Billy Sweet,Kevin Scott	ON HOLD
10752-MRT-ZZ-GF-DR-S-6514-14RC4	C01		362 hrs			196		AVAILABLE
10752-MRT-ZZ-GF-DR-S-6508-8FC1	C02		77 hrs			60		AVAILABLE
10752-MRT-ZZ-GF-DR-S-6508-8FC2	C01		76 hrs			140		AVAILABLE
10752-MRT-ZZ-GF-DR-S-6508-8FC3	C01		76 hrs			100		AVAILABLE
10752-MRT-ZZ-GF-DR-S-6508-8FC4	C01		75 hrs			60		AVAILABLE
10752-MRT-ZZ-GF-DR-S-6508-8RC1	C01		75 hrs			36		AVAILABLE

Assembly Ref SCAN Verify Assembly Ref

Completed Howick Jobs flows as available into the Jigs area



Jobs have different status and informations



Workers can log in the job by scanning frames QR code

Factory Scanning App

Assembly Ref: 10752-MRT-ZZ-GF-DR-S-6514-14RC3

Revision No: C01

Status: ON HOLD

Start Time: 26/09/2025 12:01

End Time:

Jig: Jig 4

Operators: Mark Scott, Brett Thackray, Billy Sweet, Kevin Scott

Add Operator

Start Timer	Team Stop	Job Abort
Mark Scott	Brett Thackray	
WorkStart 26/Sep 12:01:43 - 26/Sep 13:23:45	WorkStart 26/Sep 12:17:13 - 26/Sep 13:23:36	
End of Shift 26/Sep 13:23:45 -	End of Shift 26/Sep 13:23:36 -	
Billy Sweet	Kevin Scott	
WorkStart 26/Sep 12:17:27 - 26/Sep 13:23:50	WorkStart 26/Sep 12:17:39 - 26/Sep 13:23:55	
End of Shift 26/Sep 13:23:50 -	End of Shift 26/Sep 13:23:55 -	

Audit Sheet Fit QR codes to Frame Location Stillage loc. missing

Jobs control panel enables to capture several process driven activities



Uptime and downtime events



Record quality checks



Enter Storage Location

Digital System – Acquisition Layer: MES



Factory Scanning App (TEST) Andrea Sbaragli

Logistic overview

SharePoint: Stillage Delivery Note

STILLAGE NAME	LOCATION	STATUS	FRAME COUNT	FACTORY TIME	SHIPPING TIME	
Wall Pam Stillage 1	Factory	AVAILABLE	2	06/10/2025 12:27		OPEN
Wall Pam Stillage 2	Factory	AVAILABLE	0	06/10/2025 08:59		OPEN
Wall Pam Stillage 3	Factory	AVAILABLE	0	06/10/2025 11:32		OPEN
Wall Pam Stillage 4	Shipped to Site	FULL	1	01/10/2025 11:34	06/10/2025 10:08	OPEN
Wall Pam Stillage 5	Factory	AVAILABLE	0	06/10/2025 13:47		OPEN
Wall Pam Stillage 6	Factory	AVAILABLE	0	06/10/2025 15:54		OPEN
Wall Pam Stillage 7	Factory	FULL	1	03/10/2025 10:40	03/10/2025 10:34	OPEN
Wall Pam Stillage 8	Factory	FULL	0	07/10/2025 09:31		OPEN

8 stillages

The Logistic Area digitize Stillages delivery to site

- » Stillages have several features
- » Admin staff logs into Stillages by pressin OPEN

Factory Scanning App (TEST) Andrea Sbaragli

Stillage Name: Wall Pam Stillage 4

Status: FULL

Location: Shipped to Site

Frame Count: 1

Shipping Time: 06/10/2025 10:08

Factory Time: 01/10/2025 11:34

Admin functions

Cannot change stillage status when it is not in factory

Global ARef Filter

Frames in Wall Pam Stillage 4 (shipped)

1 frames

Project: 10300

10300-test8 [C01]

Frames NOT in Wall Pam Stillage 4

7 frames

10300-test12 [C01]

10300-test15 [C22]

10300-test7 [C12]

10711-MRT-ZZ-GF-DR-S-6501-1IW1 [C06]

Stillage is FULL or Shipped to Site
Cannot transfer frame to it

10300-test20 [C03]

10752-MRT-ZZ-01-DR-S-6518-19GW3 [C02]

10300-test22 [C01]

Wall Pam Stillage 1

Wall Pam Stillage 1

Wall Pam Stillage 7

Return to Factory

Confirm Stillage Return

Stillages control panel list stored frames and has several features

- » Possibility to modify Status, Location and Stored Frames
- » Automatic generation of Delivery Notes

How to leverage these data for a data-driven decision making?

Digital System – Dashboard



Production

»»» To track overall project status

Howick

»»» Machine and workforce efficiency

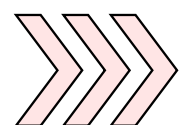
Jigs

»»» Jigs and workforce efficiency

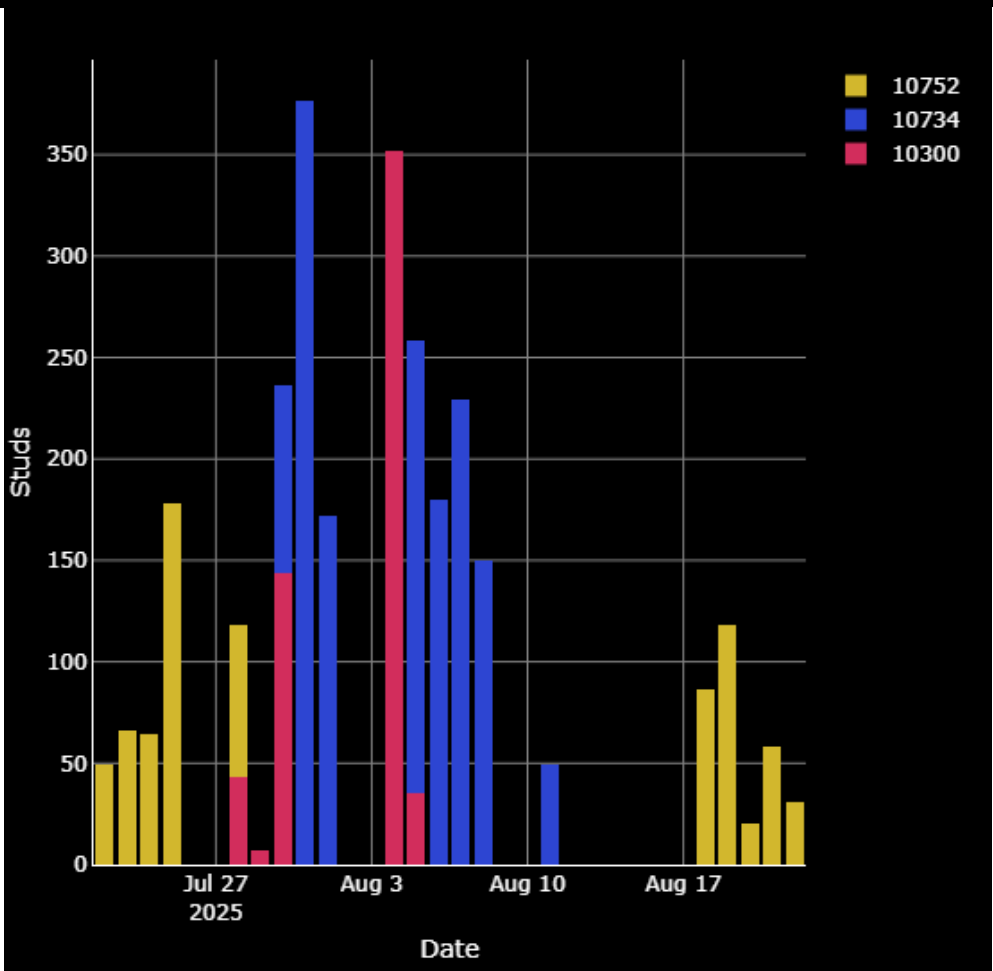
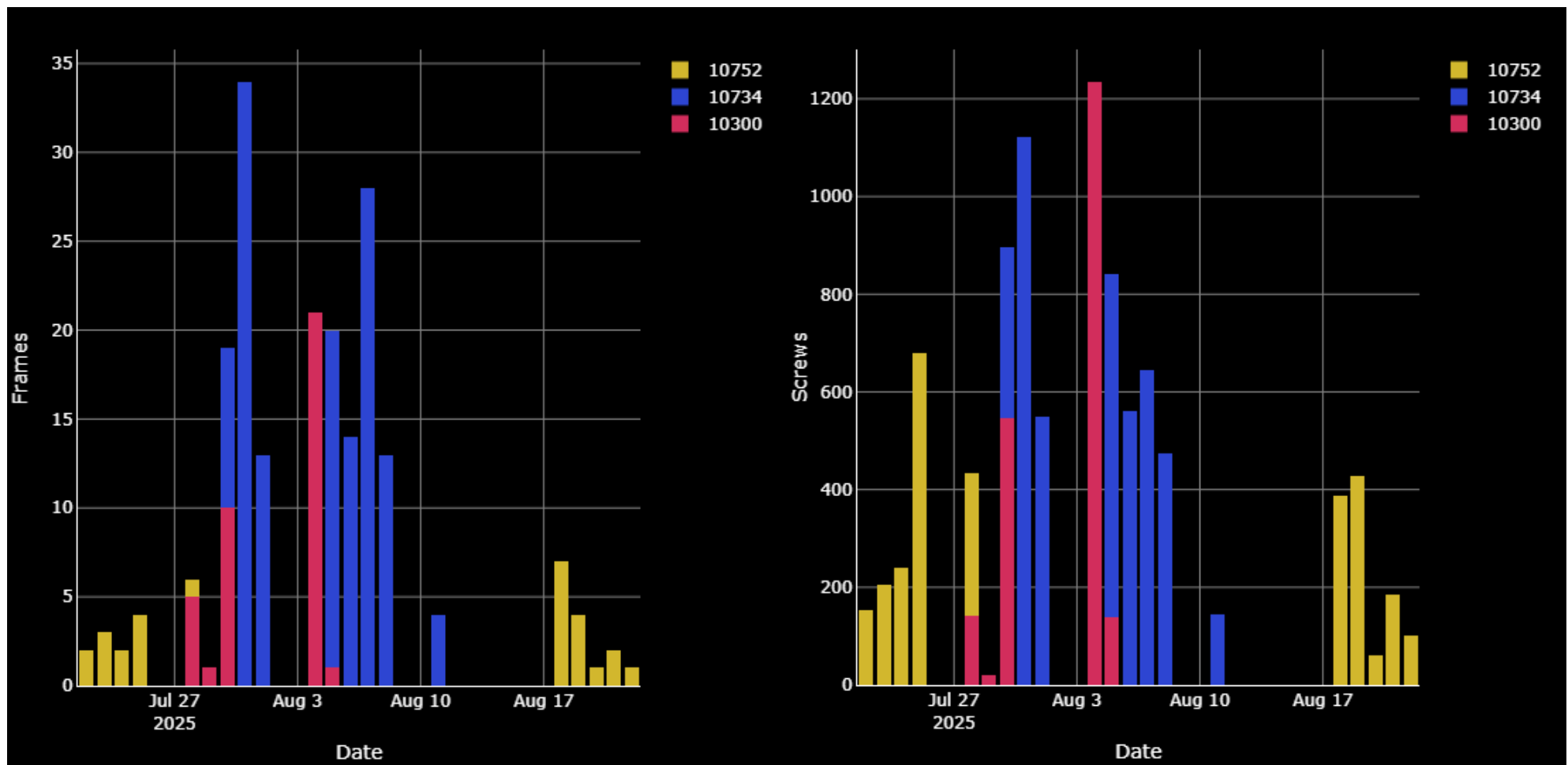
Planning

»»» Forecast cycle times before scheduling

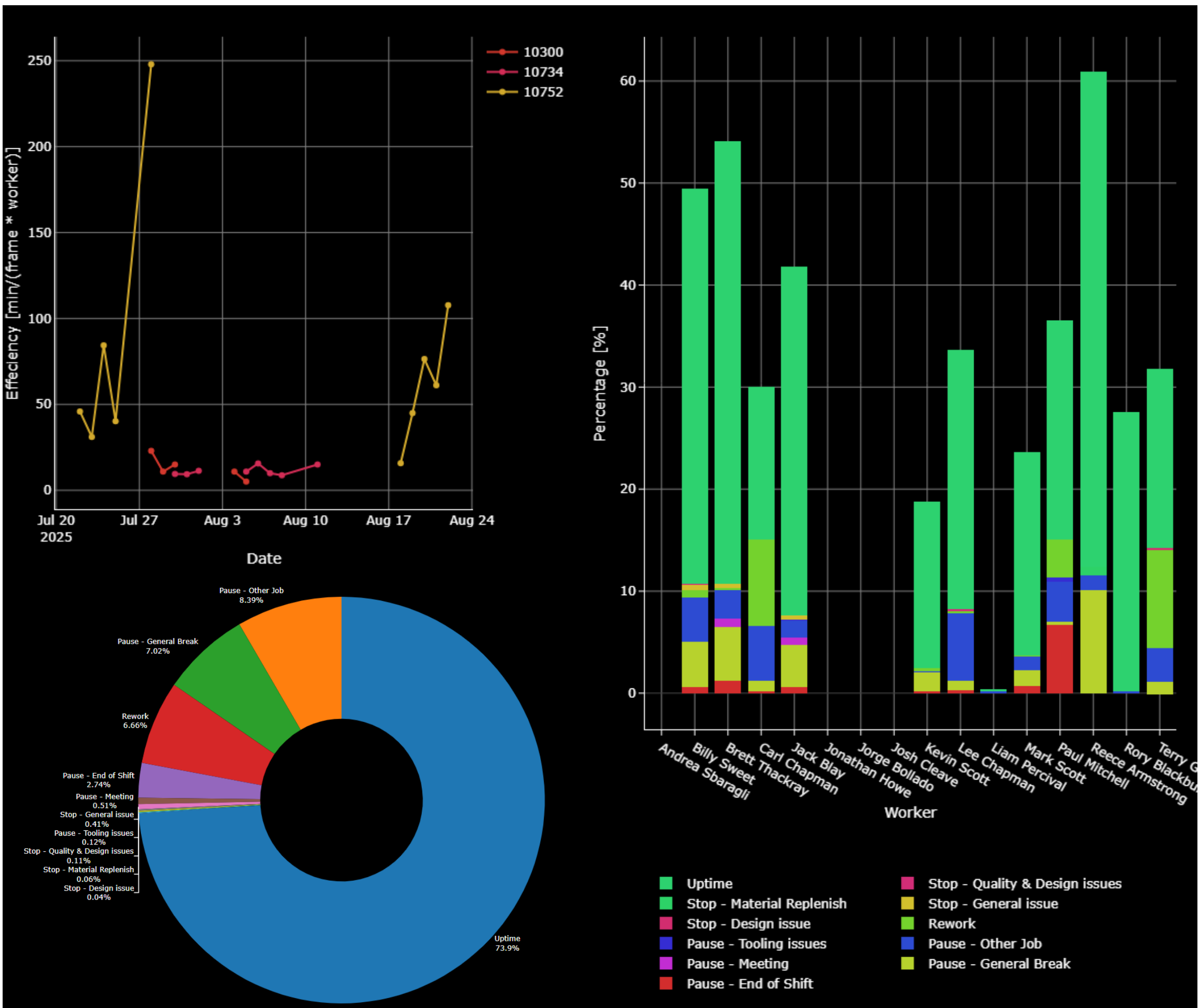
Digital System – Dashboard: Jigs



Jigs area efficiency



Workforce efficiency



Digital System – Dashboard: Planning



Manufacturing engineers interacts with this table to forecast the Assembly Reference (ARef) Work Time (WT) for production cycles

ProjectID	ARef	Coil	Len	WT [min]
P1	AR-01	C1	50.2	7.4
P1	AR-02	C1	32.7	5.5
P2	AR-03	C3	15.0	3.7
...	...	...	...	...
P4	AR-50	C3	77.5	13.1



Enhanced visibility for **coil consumption** and **cost allocation**



Detailed **shipping due dates** to site

What is the methodology to forecast working times?

Digital System – Dashboard: Planning



This approach has been validated with 8 months of productions involving 2099 frames having working times between 0.2 to 26.4 minutes



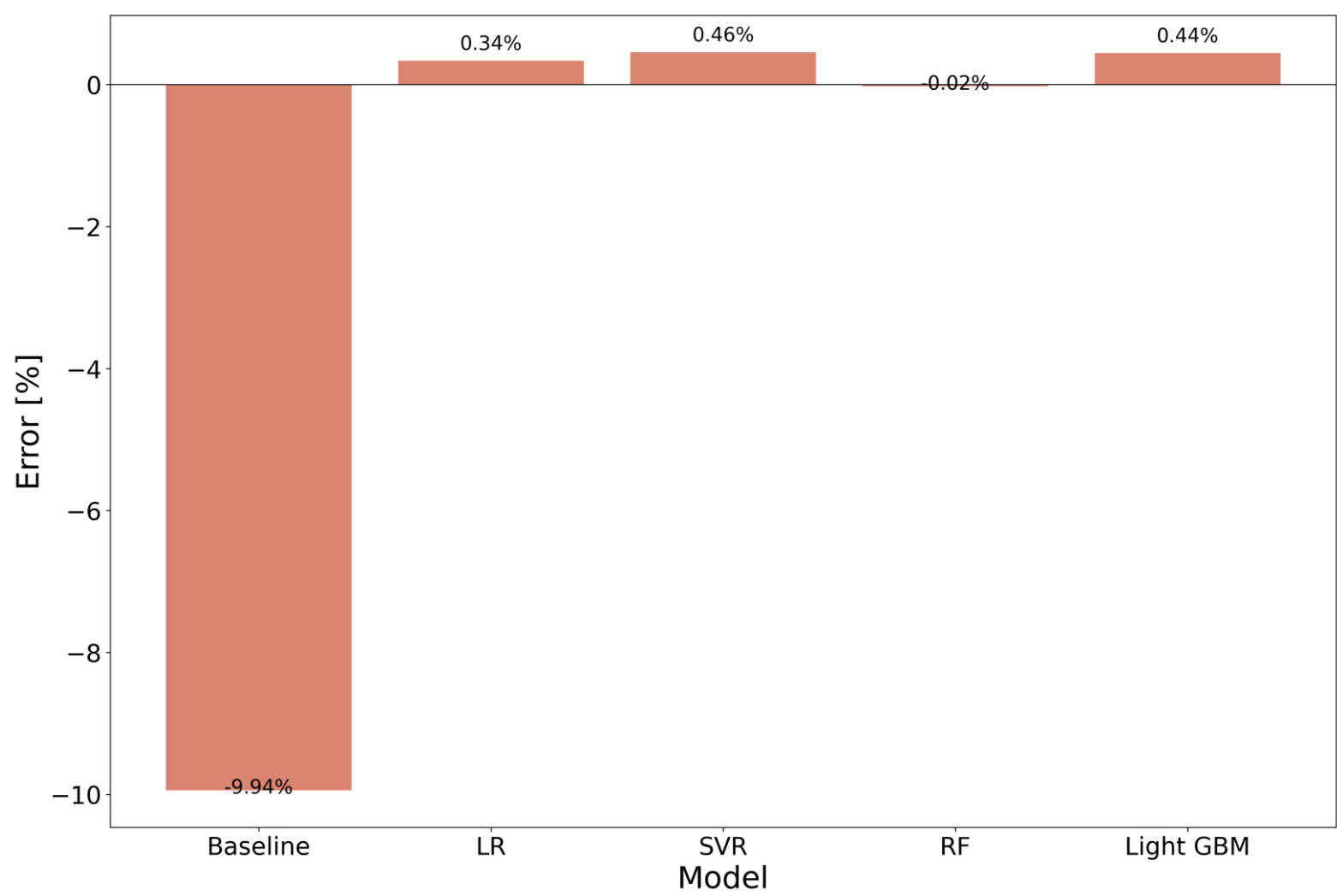
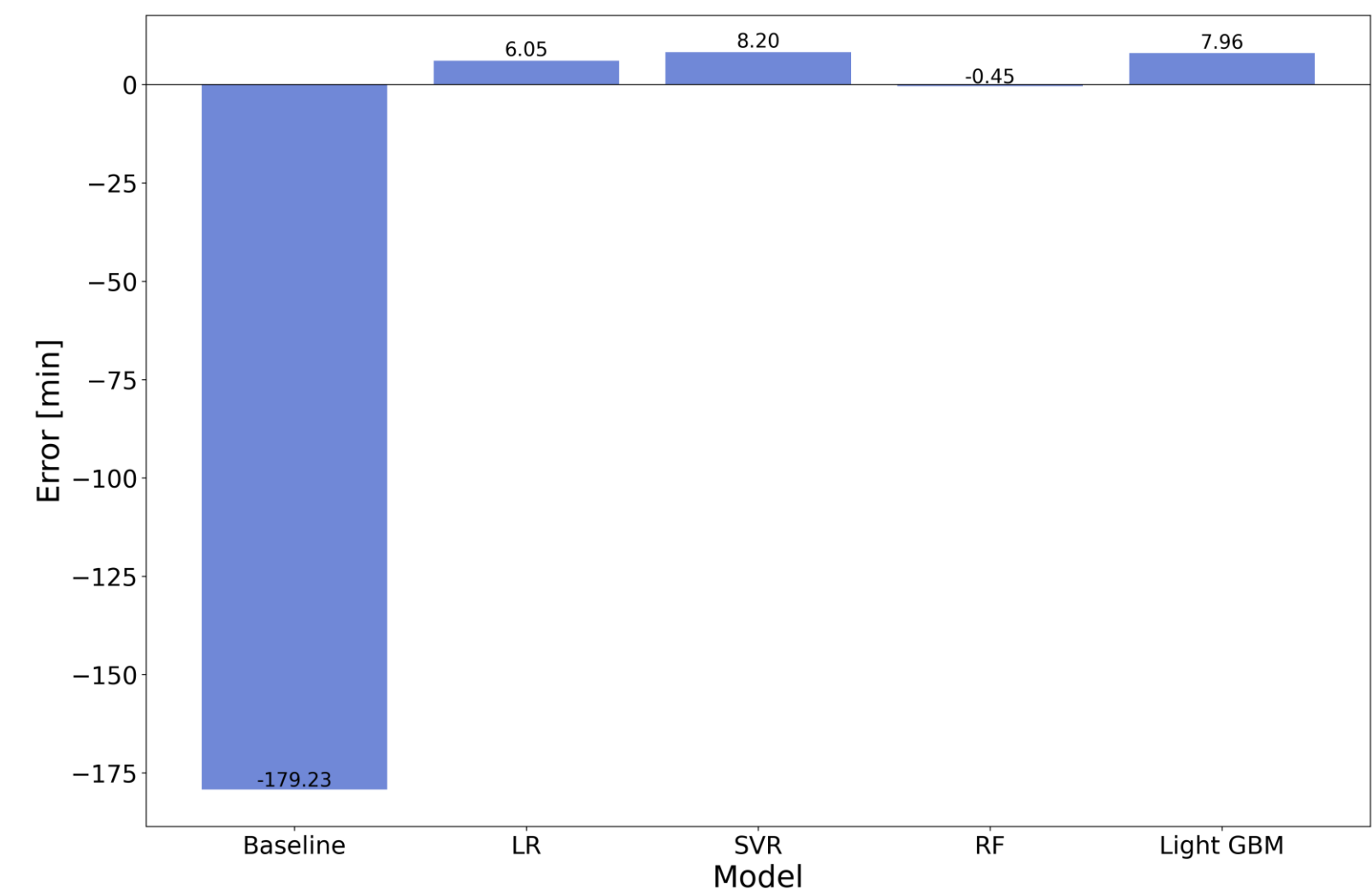
Feature extraction of design features



Machine learning models to forecast work times

Regressor	TrTime [sec]	RMSE	MAE	MAPE	MdAE	MdAPE	R^2
Baseline	NA	1.19	0.78	19.09%	0.50	17.81%	0.84
LR	NA	0.72	0.51	14.51%	0.37	11.36%	0.94
SVR	8.2	0.88	0.55	17.26%	0.39	12.39%	0.92
RF	44.0	0.85	0.52	13.79%	0.33	10.84%	0.92
Light GBM	14.8	0.85	0.55	16.02%	0.37	11.92%	0.92

Error Propagation on the test set (420 frames)



Conclusions



Use Case

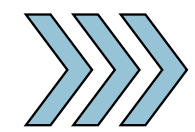
- How manufacturing operations are structured?
- Which digital solution is required to improve the operations?

Digital Solution

- Acquisition Layer: which data has to be captured for a data-driven decision making?
- Cyber Layer: What are algorithms to be leveraged to derive KPIs?
- Dashboard: How to structured the data analytics?

Conclusions

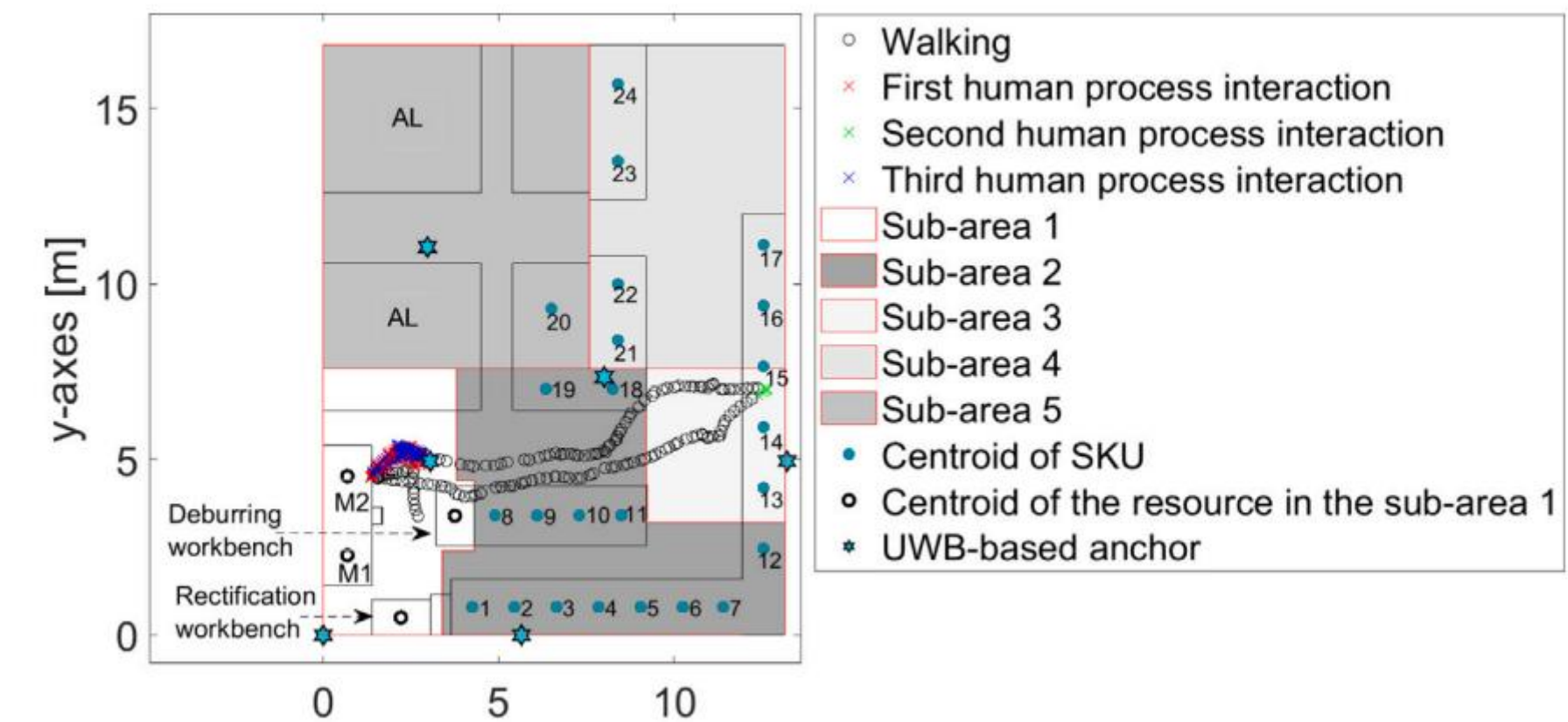
What is coming next?



Finalise the data analytics dashboard



Use of Internet of Things sensors to improve assets visibility



Delivery Team



Automation Team



Namra Mahak
Automation Developer



Mark Lui
Power Platform
Engineer



Shambhavee Pandey
Dev Project Lead



Cashin Martin
Data Engineer

Production Team



Robert Wade
Director of Production



Gary Armstrong
Manufacturing Engineer



Daniel Stanbury
Programme and Performance
Reporting Specialist



*Thank you very much
for your attention*

*Andrea Sbaragli, PhD
15th October 2025*