Robots in the Smart Factory

Dr. Michael Klos, YASKAWA Robotics Europe

YASKAWA

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Robots in the Smart Factory

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1. Who is Yaskawa ?
2. Smart Digital Workflows
3. Smart IoT and AI based Production Management
4. Smart Robotics Plug & Play Mindset
5. Smart Programming with the Smart Pendant
6. Conclusions

YASKAWA

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YASKAWA

PRODUCTS

Industrial robots

38,000

AC drives

1.6 Million

Servos and motors

2.6 Million (each)

Global Production Volume (2020)

Industrial robots	AC drives	Servos and motors
500,000	30 Million	22 Million

Accumulated Production (2020)

INNOVATION

Inventor of

Mechatronics

Introduction of a holistic engineering philosophy (1969).


Yaskawa Headquarters, Japan
32 Production Locations worldwide
YASKAWA
Yaskawa Europe Robot Factory, Kočevje (SLO)

Yaskawa Europe Robot Factory, Kočevje (SLO)

YASKAWA ROBOTICS EUROPE – PORTFOLIO OVERVIEW

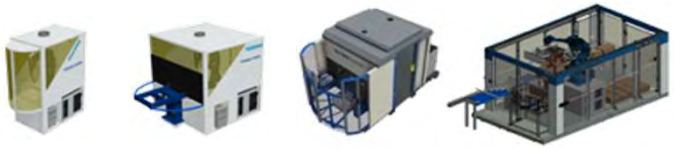
ROBOTS

MOTOMAN ROBOTS & ACCESSORIES TO SYSTEM INTEGRATORS

MOTOMAN ROBOTS TO AUTOMOTIVE / OEM

SYSTEMS

STANDARD ROBOTIC SOLUTIONS & COLLABORATIVE SYSTEMS



CUSTOMIZED ROBOTIC WELDING SOLUTIONS

TOTAL CUSTOMER SUPPORT

SPARE PARTS, TRAINING, SERVICE, REPAIR, REFURBISHMENT, APPLICATION STUDIES, ENGINEERING EXPERTISE, RISK ASSESSMENT & SAFETY CONSULTING SERVICES

THE MOTOMAN ROBOT PORTFOLIO (> 130 MODELS)

SCARA / DELTA ROBOTS

2 .. 3 .. 5 ..6 kg
High Speed Pick Place

COLLABORATIVE ROBOTS

Red Dot
Award 2021

10 .. 20 kg
Human-Robot-Collaboration

4/5 AXIS ROBOTS

80 .. 100 .. 190 .. 320 .. 500 .. 800 kg
Palletizing

4/6 AXIS ROBOTS

2 .. 5 .. 10 .. 15 .. 40 kg
Painting

6 AXIS ROBOTS

Red Dot
Award 2018

Red Dot
Award 2019

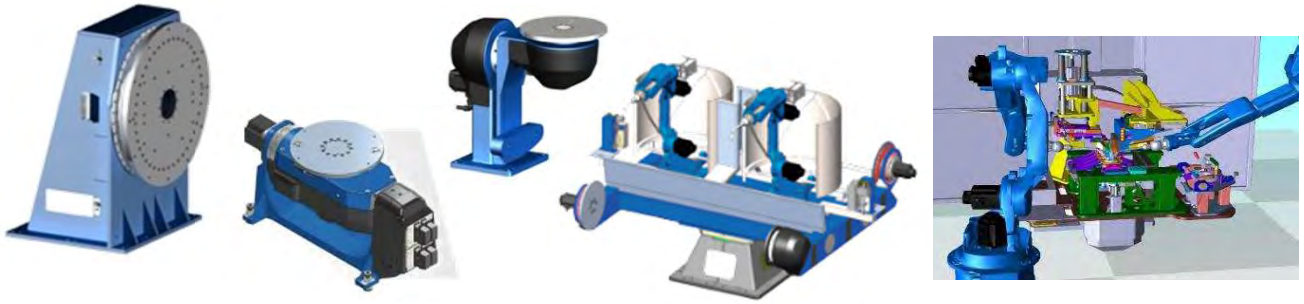
0.5 .. 4 .. 7 .. 8 .. 12 .. 20 .. 25 .. 35 .. 50 .. 88 .. 110 .. 120 .. 150 .. 165 .. 180 .. 215 .. 225 .. 250 .. 280 .. 300 .. 400 .. 600 ..... 900 kg
Handling – Assembly - Machine Tending - Arc / Spot Welding – Machining

7/15 Axis Robots

5 .. 10 .. 20 .. 50 kg
Flexible Handling – Lab Automation

PERIPHERAL PRODUCTS (HARDWARE)

WORKPIECE POSITIONERS (up to 72 Axes in coordinated Motion)



Modular System, 200 Standard Models + Customer specific Models + Jigs

Pre-configured Product & Function Packages
Compact Spot Welding Guns

GANTRIES

Single / Multi-Robots, ... 30 m Length

TRACKS

max. 24 m Length

EXTERNAL AXES

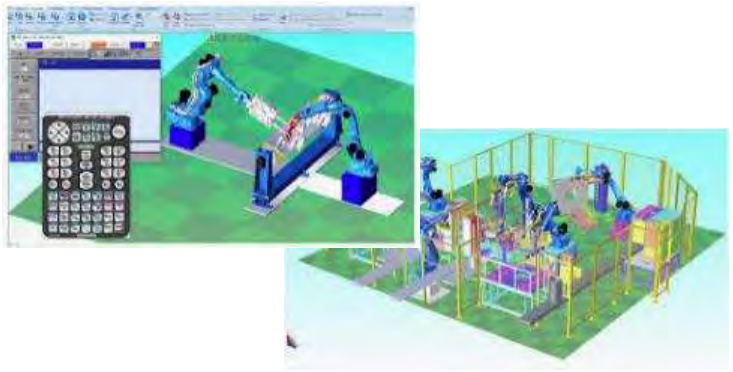
50 .. 5000 W, 72 per Controller

INTELLIGENT VISION

Conveyor / Bin Picking

SOFTWARE AND CONNECTIVITY

OFFLINE SIMULATION / OLP DIGITAL TWIN



Offline Simulation Engineering Tools
HTML HMI, FTP, Backup, Remote Programming

PROGRAMMING AND OPERATING

Software Apps & Wizards

IoT – INDUSTRIE 4.0

I3-Mechatronics, YASKAWA Cockpit,
Data Collectors, OPC-UA

COMMUNICATION

I/O, Fieldbus, Varan, Euromaps,
Functional Safety, PLC, ROS, Interfaces

FUNCTIONAL APPLICATION SOFTWARE PACKAGES

Arc Welding | Spot Welding | Handling | Painting

> 200 Application specific Software Options & Technology Packs,
Sensor / Weld Timer Integrations, Error Recovery Routines

CONTROLLER FUNCTIONS

> 100 Functions - Sensors, Vision,
Communication, Interfaces

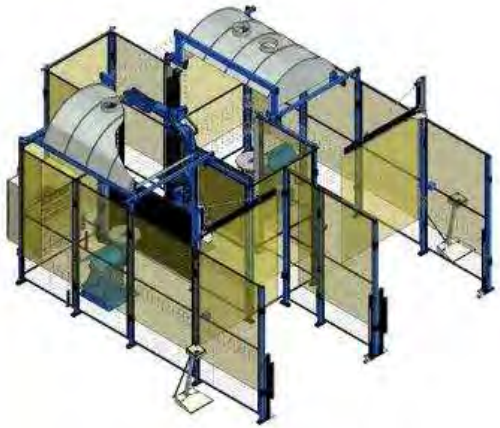
STANDARD ARC WELDING CELLS

Weld4Me Cobot Stations

ArcWorld RS/HS

ArcWorld CS

Cobot Welding Cells (CE)



Standard Arc Systems

ArcWorld SD

SUPPORTING THE WORLD OF ROBOT PROGRAMMING

Software Apps, Wizards

Teach Pendant

Smart Pendant

Hand Guiding

Motologix PLC IEC61131

Future:

Autonomous Robots

Gesture Control

Offline Simulation MotoSim

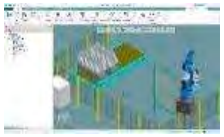
YRC1000

YRC1000micro

SIEMENS

DELMIA

DELFOI



Offline Simulation Line Planning

Digitizer Tools / Aids

SprutCAM

Robotmaster

Mastercam

alma

YASKAWA COMPASS

CAD/CAM

ROS Industrial

ROSVITA

ROS & Addons

wandelbots

drag&bot

ARTIMINDS

3rd P. Programming Tools

LabVIEW

MATLAB

PC-Software, HMI (via MotoPlus API)

YASKAWA

scansonic

KEYENCE

ZIVID

COGNEX

wenglor

SENSOPART

MECHMIND

Photoneo

FIZYR

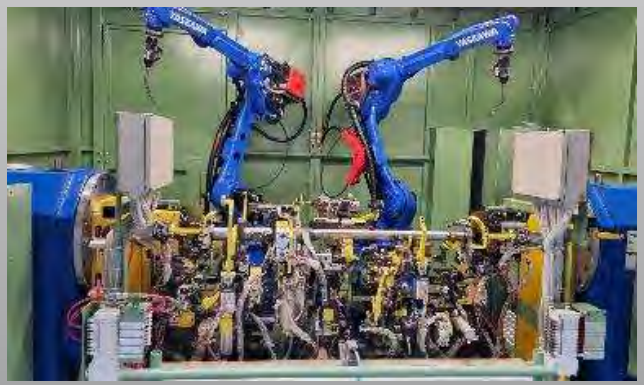
Vision & Sensors Guidance

SYSTEM BUSINESS – TURNKEY ROBOT WELDING SYSTEMS










GLOBAL YASKAWA ACADEMY

Live Trainings

E-Learning

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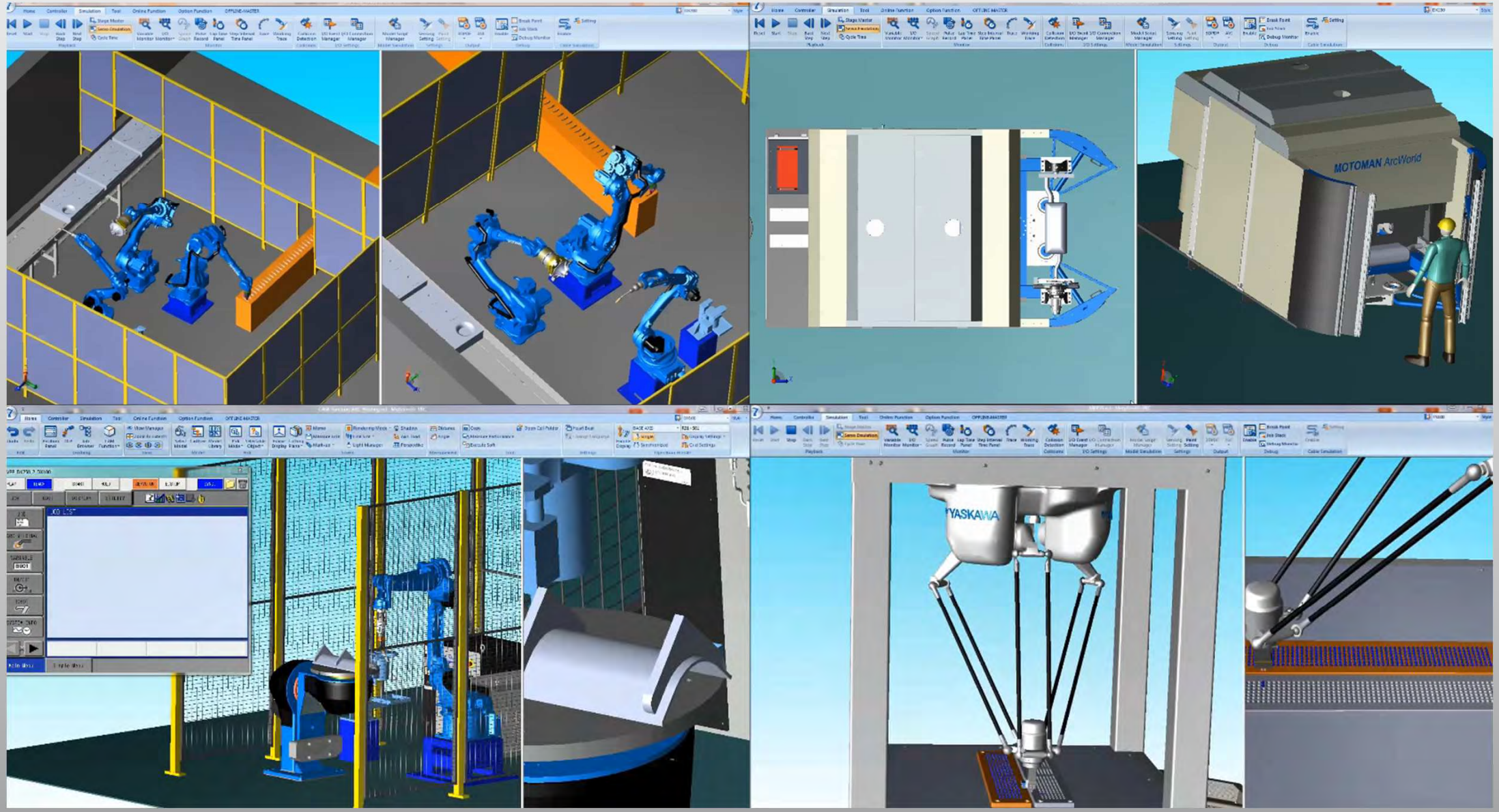
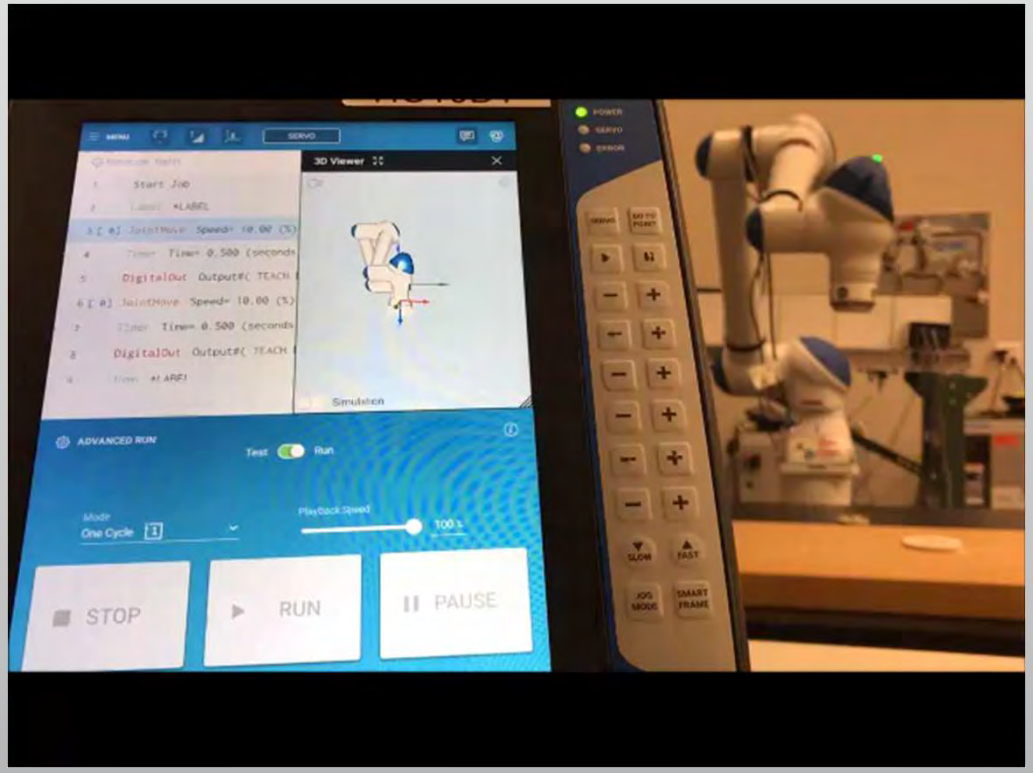
YASKAWA

OFFLINE SIMULATION - MOTOSIM

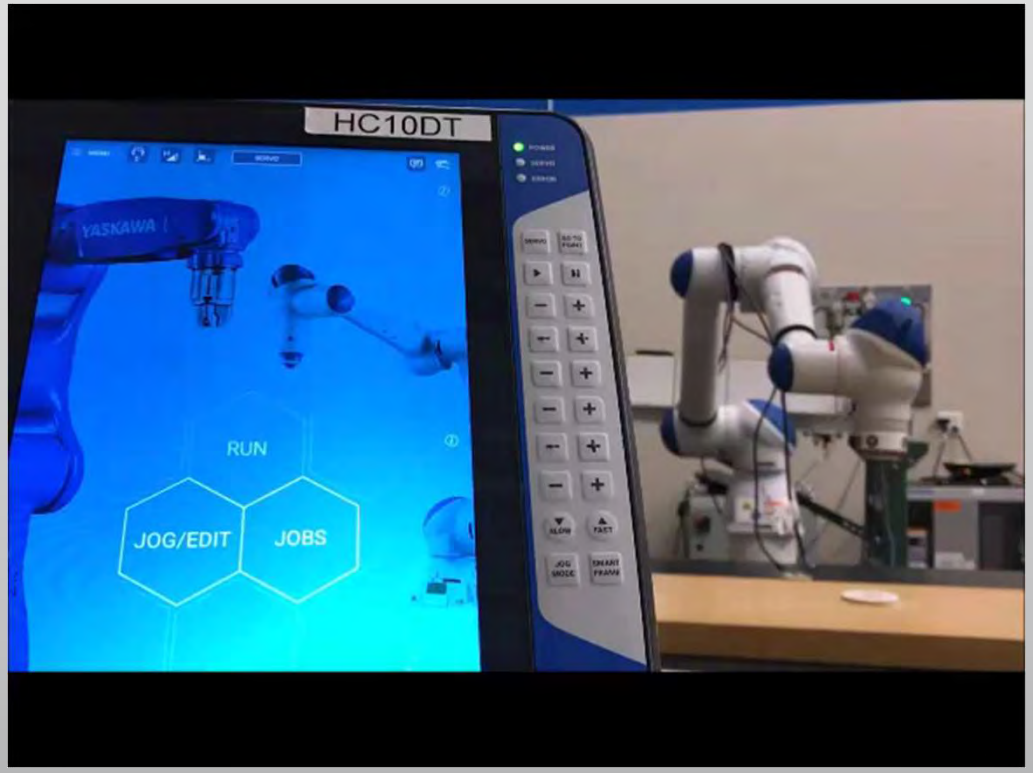


DIGITAL TWIN - ON-SCREEN 3D SIMULATION

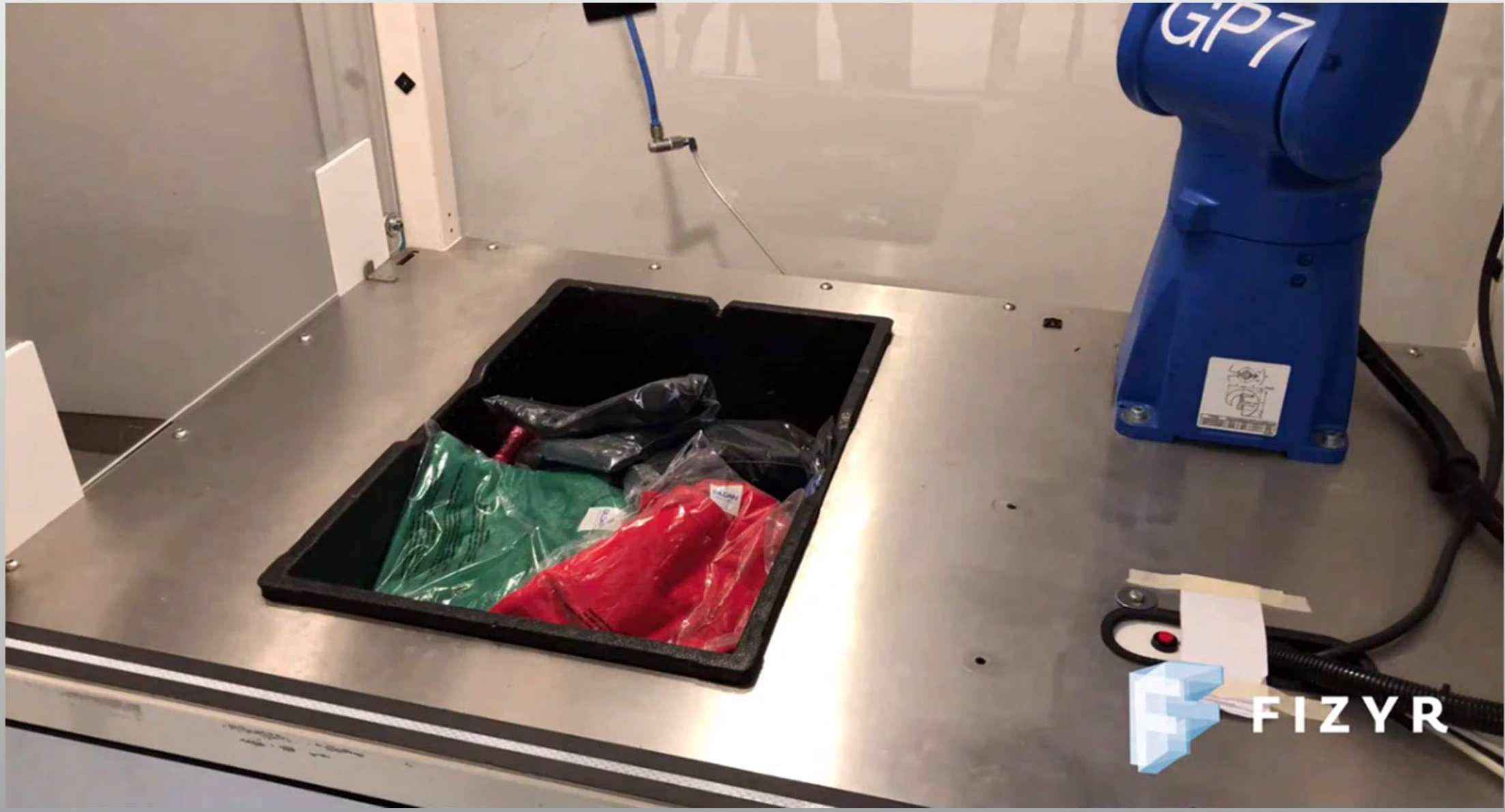
Toggle between Real Motion and 3D Simulation



Setup and Visualisation of Safety Range Limits

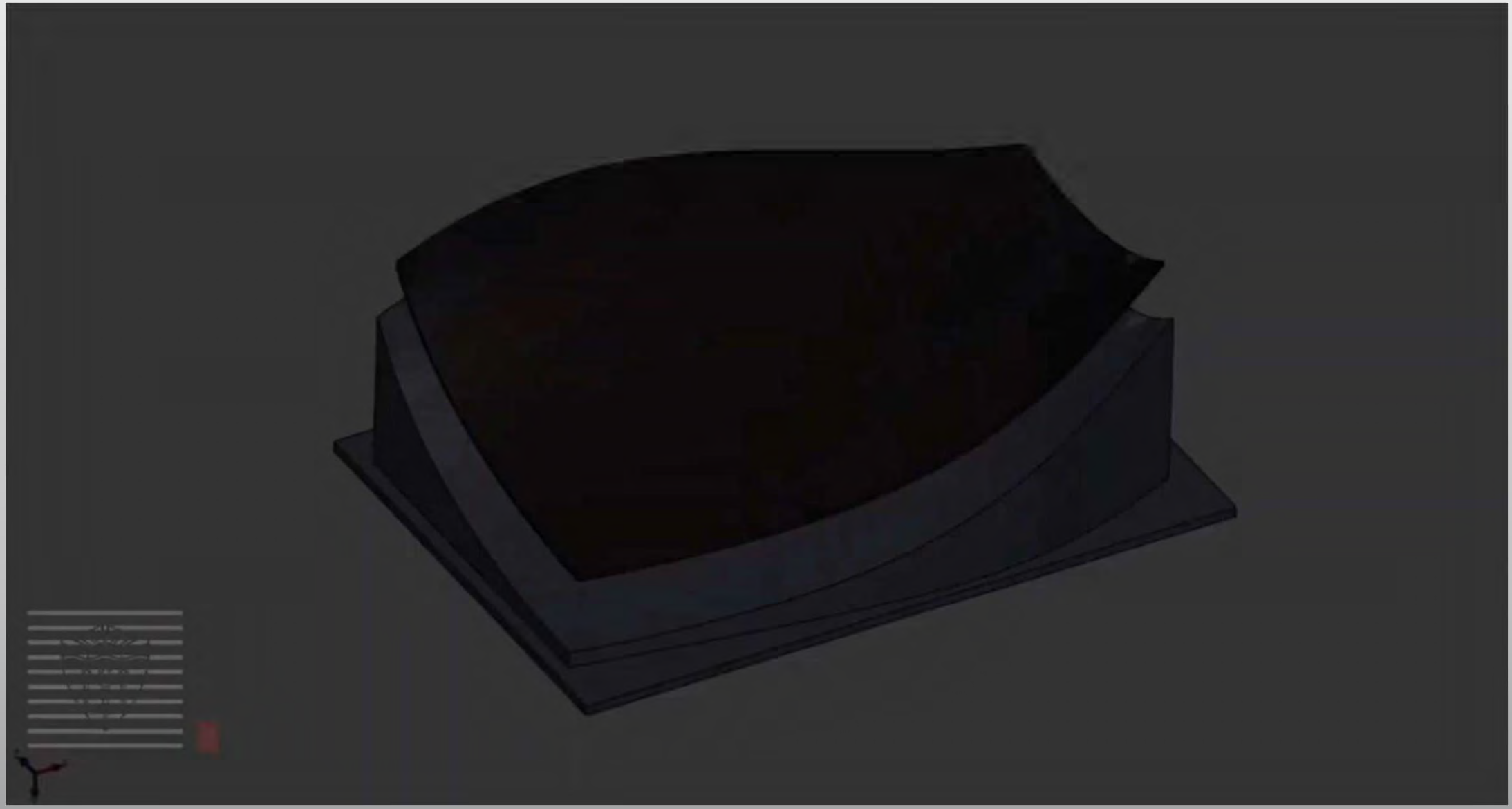


MACHINE VISION (PICK&PLACE)

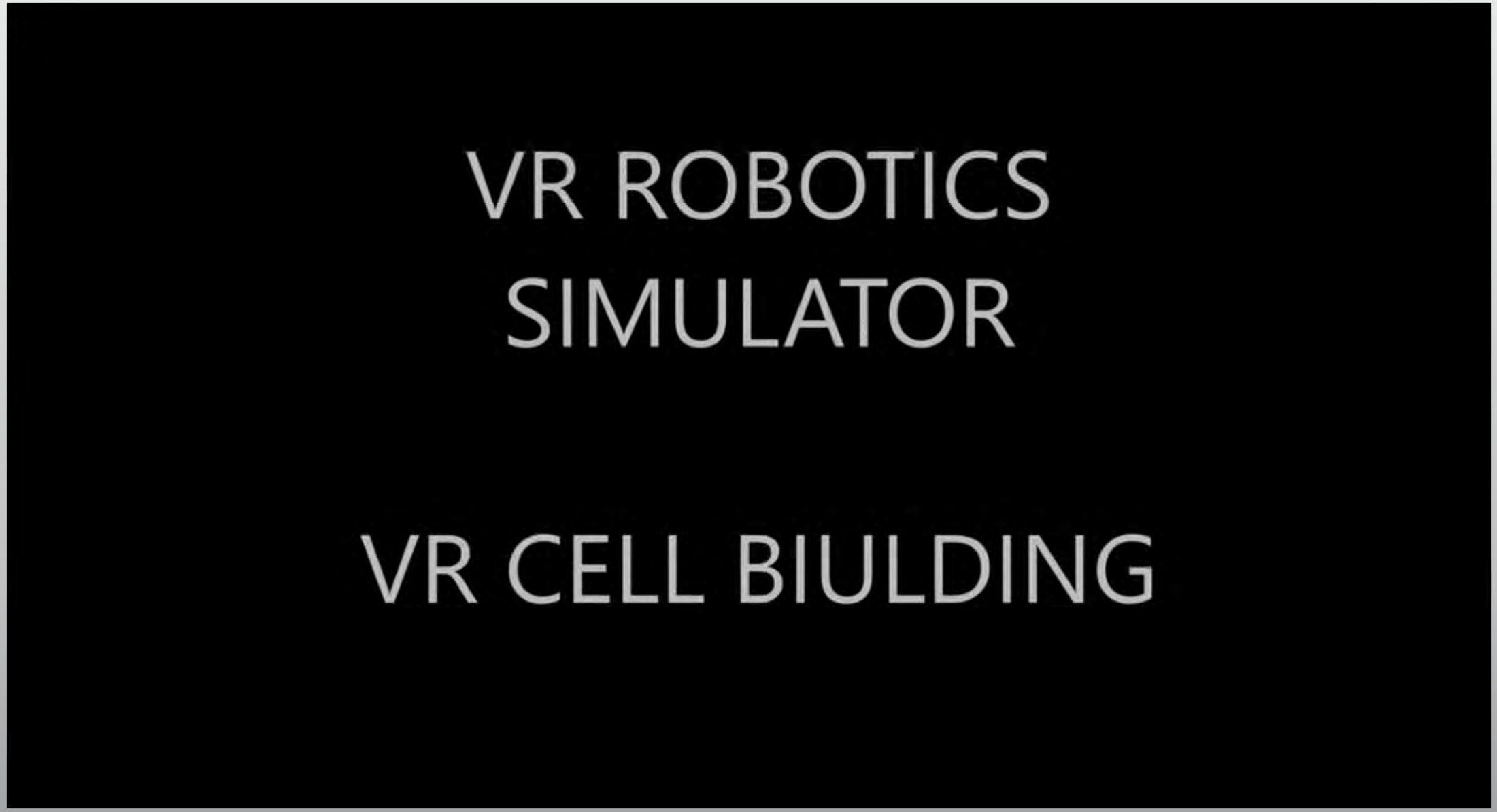


MACHINE VISION GUIDED SEAM FINDING

CAD/CAM PROGRAMMING



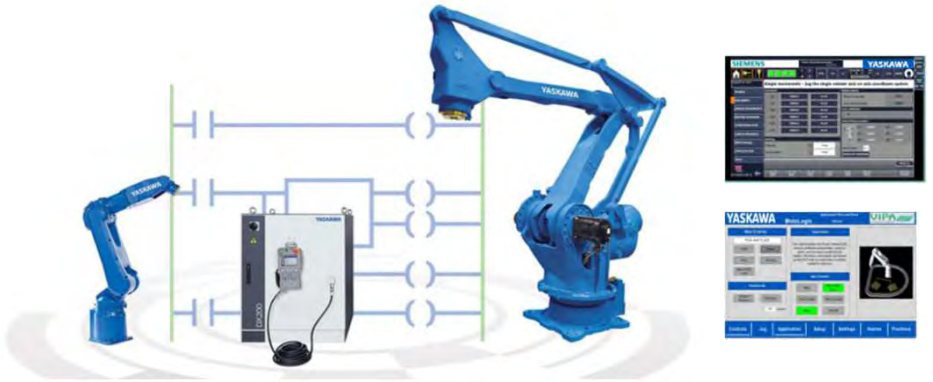
VIRTUAL REALITY OFFLINE PROGRAMMING (2017)

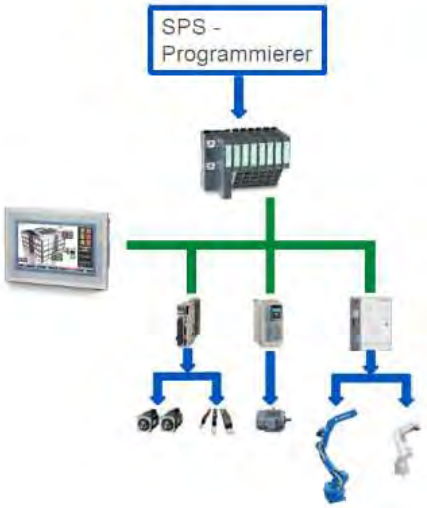


PLC (SPS) FUNCTION BLOCKS - MOTOLOGIX

Robot Programming via PLC (IEC 61131) Function Blocks

- Embedded in the PLC Programmer‘s software coding environment
- Function Block Library
- Same Performance as convential TP-Programming
- Robot Peripherals directly controlled via PLS (Gripper, Conveyor, Sensors)
- No robot specific programming skills or trainings required





SIEMENS
Ingenuity for life

BECKHOFF

Rockwell Automation

YASKAWA
STANDARD

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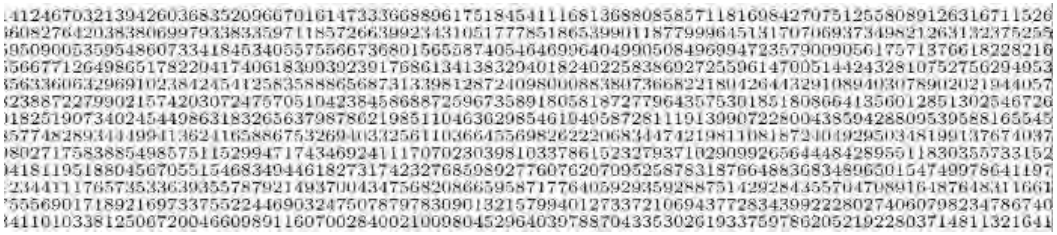
YASKAWA

INDUSTRY 4.0 – SO MANY QUESTIONS ……



Will computers take control over my production?
How can a production system optimize itself without me?
Do I need millions of sensors producing billions of data?
Collecting data is not intelligent decision making !
Will the system take decisions away from me ?
Who grants for Process Stability ?
Where to start resolving error situations ?
Is my data still my property ?
Who is leading the Data Revolution? IT-Gang? Can I trust them?
And who is taking the risk ?
Oh God, I have to replace my production staff with IT nerds ?
What is the real benefit for my company and customers ?
Will my customer ever pay for all those efforts ?
Is this all really „lean“ ?
.....

INDUSTRY 4.0 – SO MANY QUESTIONS ……

But I just want this:

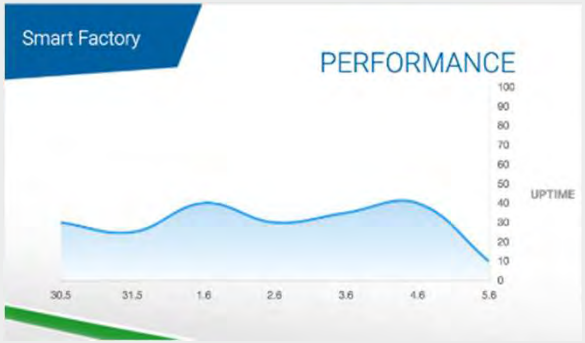
ERROR FREE PRODUCTION

QUICK RECOVERY FROM PRODUCTION STOPS

UNDERSTANDING THE DIGITAL REVOLUTION
FROM „DATA“ TO „INFORMATION“

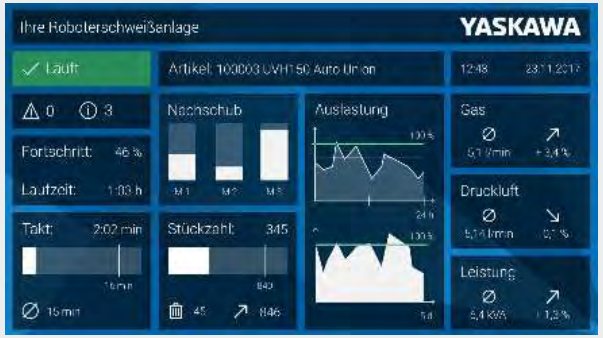
PRODUCTION

THE PAST | LIVE | THE FUTURE



Aggregate & Display Data
⇒ strong KPIs
⇒ statistical interpretation
⇒ manual interventions

„Big Data“



Display Data
⇒ Interfacing
⇒ Some KPI
⇒ manual interpretation
⇒ manual interventions

„Small Data“

Drive Process using Data
⇒ Powerful KPIs
⇒ automatic, intelligent evaluation and predictions
⇒ automatic interventions supported by AI

„Big Data & AI“

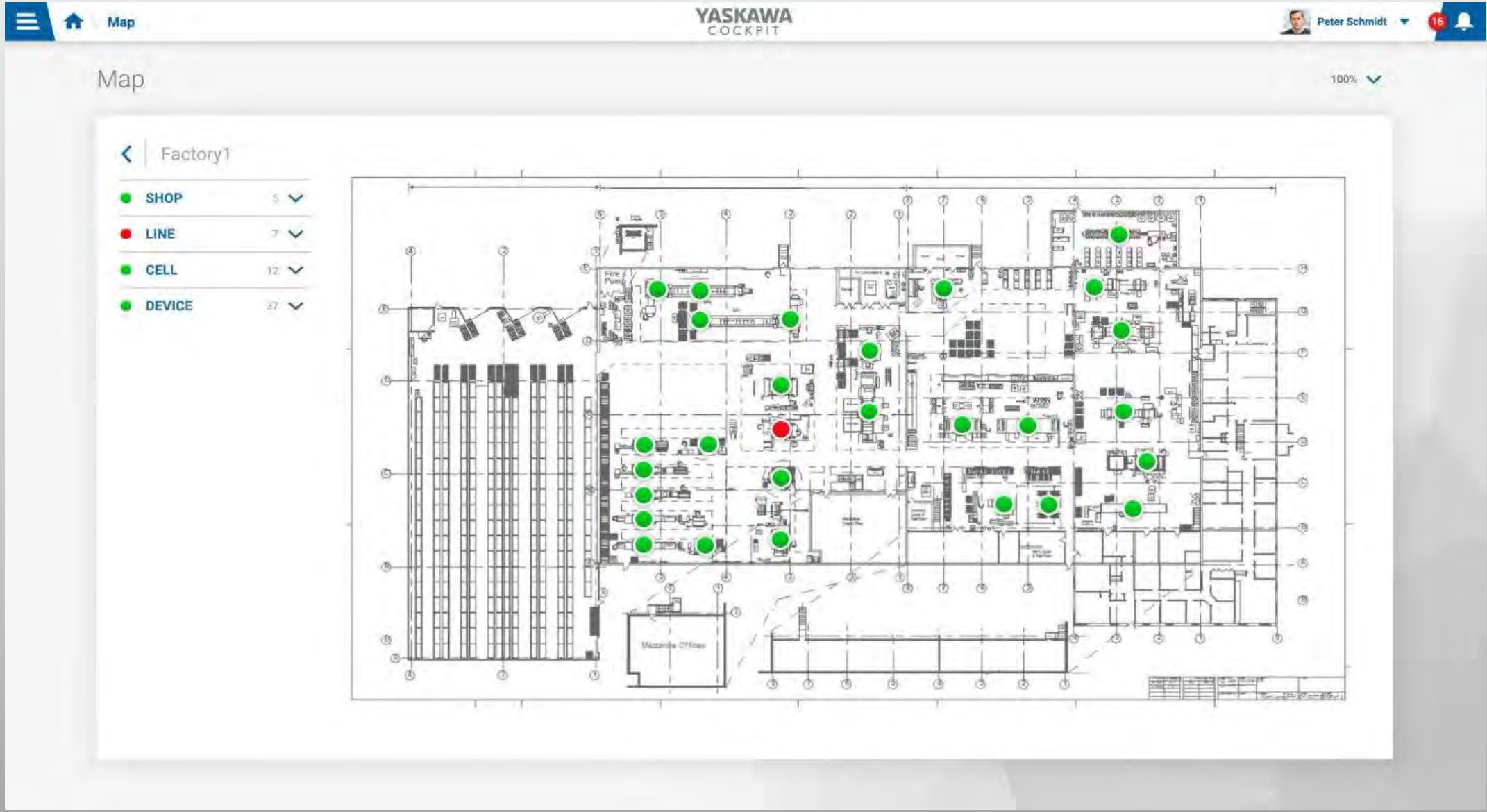
HOW IS MY FACTORY RUNNING ?

DO ALL PRODUCTION CELLS WORK PROPERLY ?

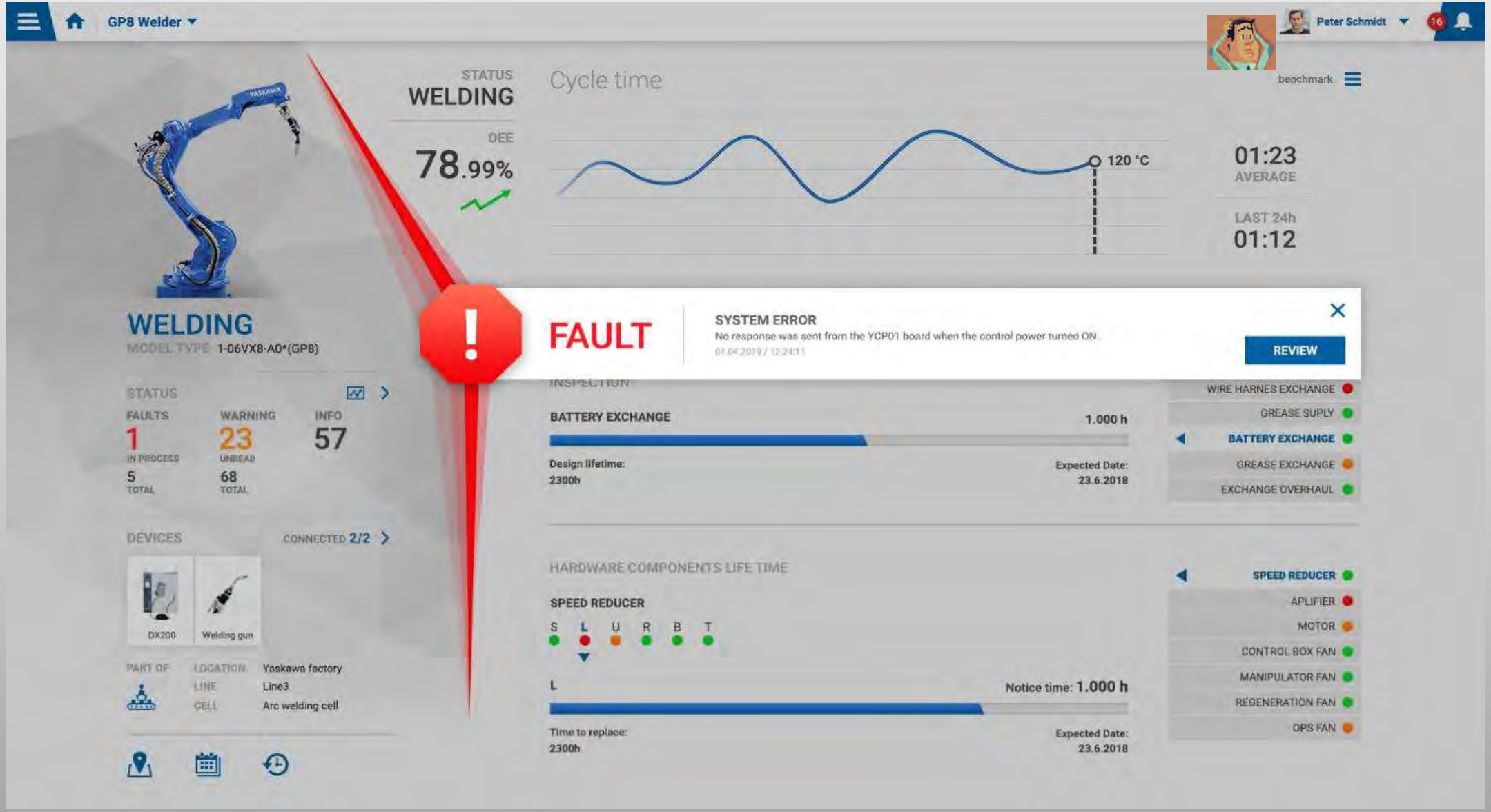
ARE ALL COMPONENTS IN GOOD CONDITION?

NOTIFY ME IMMEDIATELY IN CASE OF PROBLEMS !

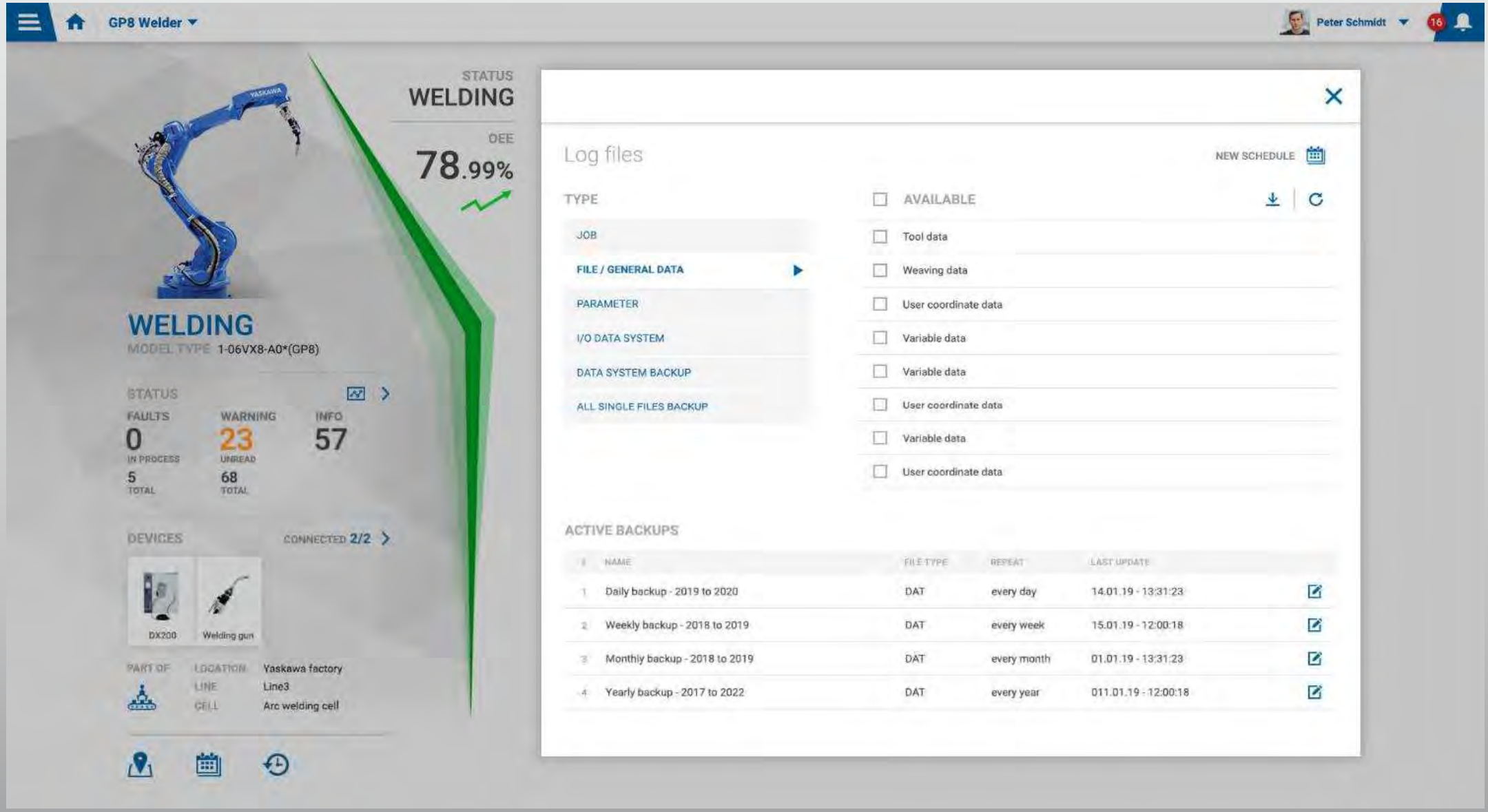
WHERE IS THE PROBLEM ?



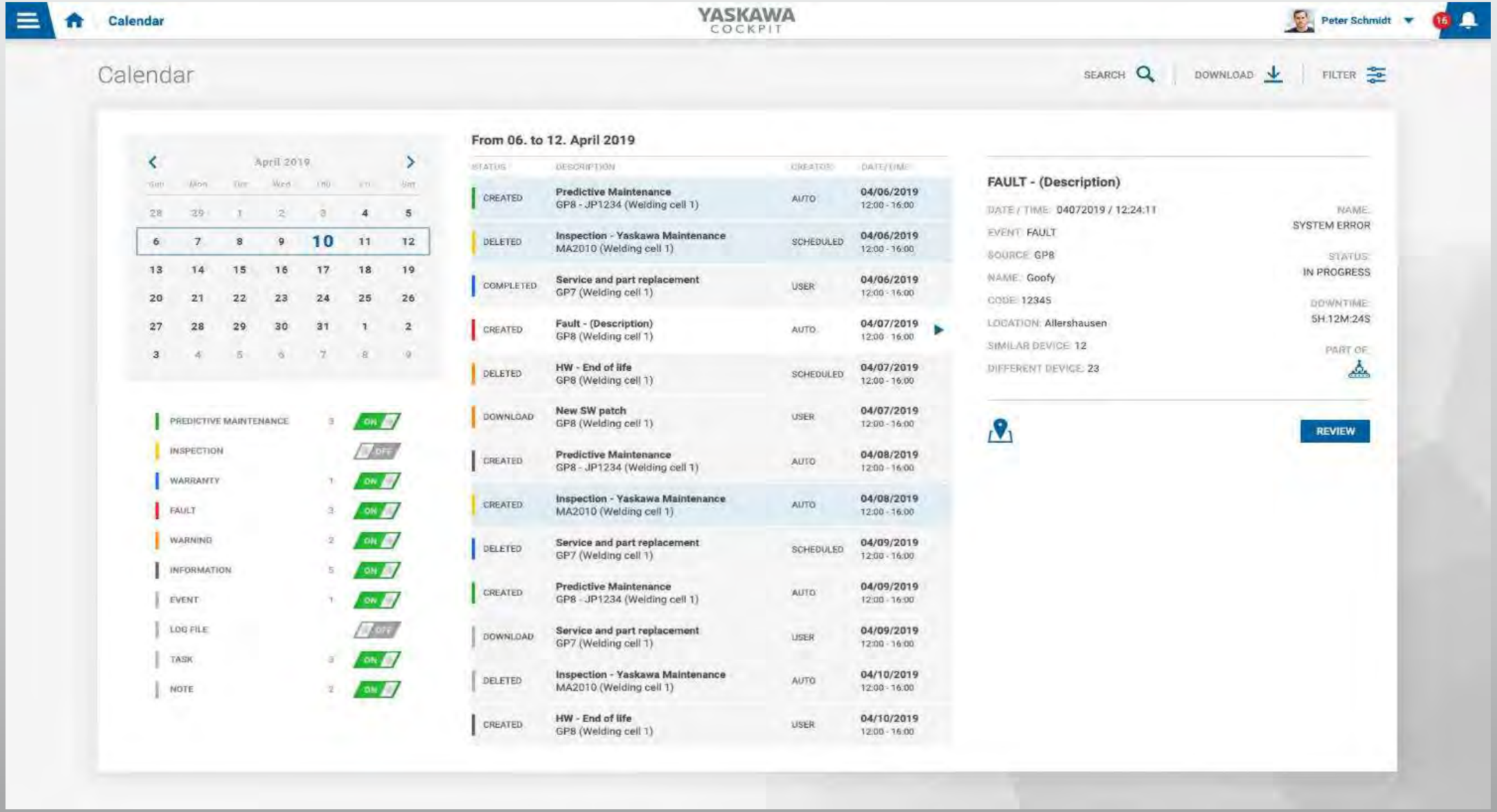
WHICH COMPONENT CAUSES THE PROBLEM ?



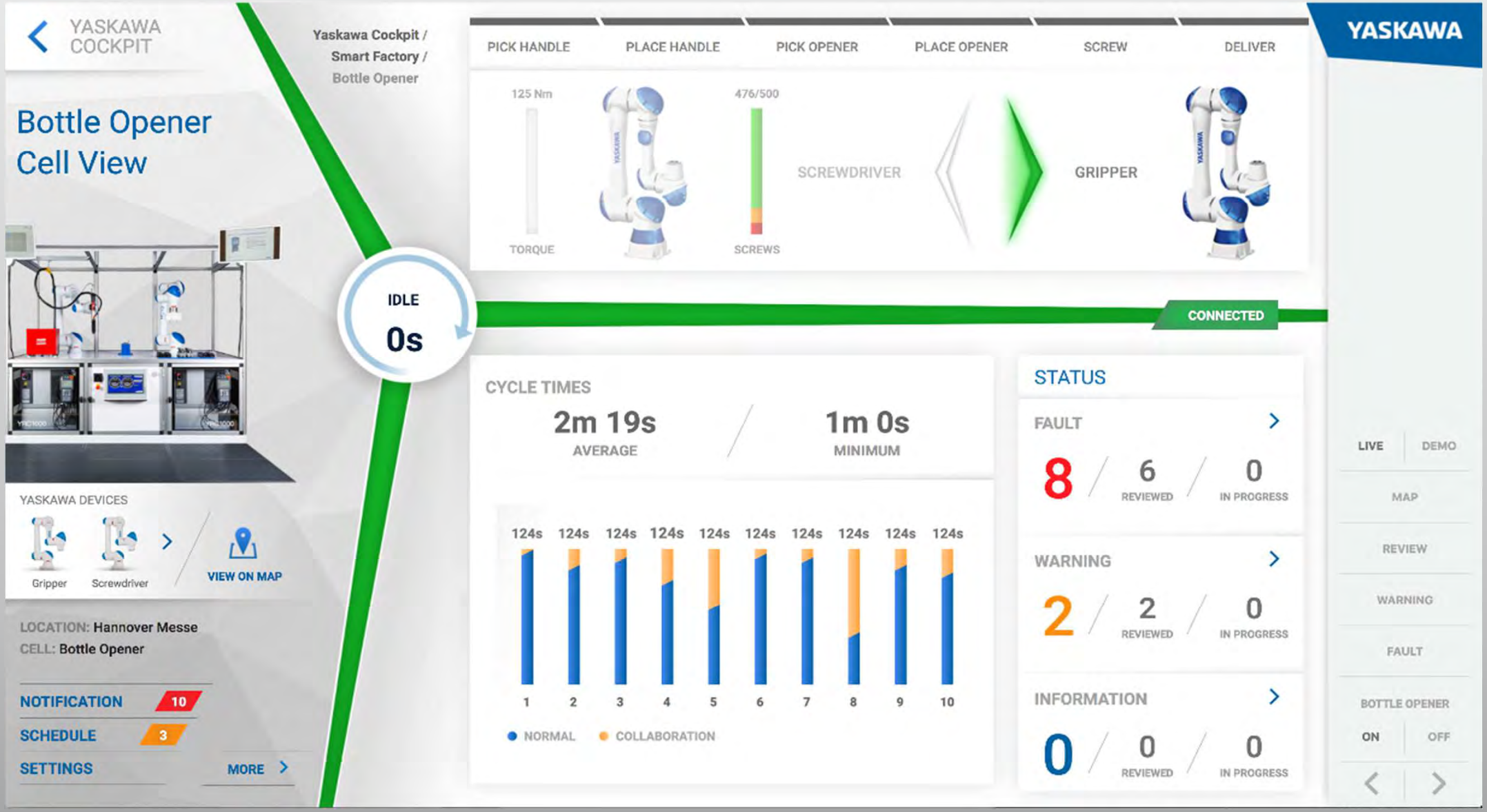
GIVE ME MATERIAL TO FIX THE PROBLEM !



EFFICIENT SCHEDULING OF MY MAINTENANCE STAFF



PRODUCTION RATE CONTROL



INDUSTRY 4.0 – SO MANY QUESTIONS ……

Sounds good, but …

WHAT IS THE REAL PAYBACK OF THIS SOFTWARE ?

ROI CALCULATION – USE CASE (1)

Prevent production downtime with predictive maintenance

Production running in 3 shifts
Currently they have 3 maintenance staff in each shift for interventions in case of production stoppages. Total maintenance staff = 9

With predictive maintenance they could have 3 maintenance staff in morning shift + 2 staff in afternoon and night shift. Total maintenance staff = 7

*Saving: 2 staff * 45.000 Eur annual salary = 90.000 Eur due to better planning*

IoT Software functionality required: device view, calendar diary view, predictive maintenance, scheduling

ROI CALCULATION – USE CASE (2)

Improved efficiency at production interventions

Use case: Production stop due to failure on production machine
Currently Yaskawa service staff visits customer to identify the failure (2 day). After identification orders a spare part (1 day). Second visit to replace broken spare part (1 day). Total number of visits = 2. Days to fix the problem = 4.

With IoT Software: Yaskawa reads out data history of machine to identify the failure (1 hour). Spare part is ordered in the same day (1 day delivery). Visit to replace broken part (1 day).Total number of visits = 1. Days to fix the problem = 2.

*Saving: 2 days of production stop: 6 shift * 60sec cycle time*5 Eur/part = 14.400 Eur. 1 visit of Yaskawa technician = 1000 Eur. Total saving =* ***15.400 Eur.***

IoT Software functions enabling doing that: backups, exporting data, device management, notifications, calendar view, knowledge base, user management.

ROI CALCULATION – USE CASE (3)

Better control and traceability over production quality
Automotive Customers specifying IATF16949

Currently the company does not measure all the parameters on all production machines in order to see if one of the parameters changes, which could affect the quality of a product. Defected products can be produced for 4 or even more hours before identifying defect.

Most companies address this by increasing the number of employees in QA department, due to high QA requirements of their customers, especially in automotive industry (assurance, traceability, claim procedures, etc.)

With YCF customer can control all crucial parameters on production machines in order to see changes in real time and prevent defected parts being produced. Immediate detection of defected products. On top of that full traceability for each product.

Decrease cost/staff in Quality Management, comply with Automotive requirements, big savings in managing claim procedures.

ROI CALCULATION – USE CASE (4)

Reducing Scrap Rate from 7% to 5% and Part sorting costs in case of defect claims

With IoT SW, customer gets notifications immediately and can initiate immediate reaction based on exact production figures.

*Current scrap rate on production line **7%**:*
cycle time = 60 sec/part, 480 parts/shift, 8.640 parts/week (18 shifts); 414.720 parts/year (48 CW)
Part production price = 4 Eur
on one production line only!

	No.	EUR
Part production per year	414.720	
Current scrap - 7 %	29.030	116.122
Reduced scrap - 5%	20.736	82.944
Scrap saving	**8.294**	**33.178**

*In case of defect: manual sorting to identify exact number of defected parts: 3 days stock in production + 3 days stock at customer + 2 days on the way = 24 hours*60 part/hour = 1.440 parts/day*
sorting only for 1 occurence of claim

	No.	EUR
Potentially infected parts - 8 days production	11.520	
Sorting cost per part		0,5
Sorting cost		**5.760**

Total saving: 33.178 Eur + 5.760 Eur = 38.938 Eur
Not even considering reputation and the penalty of customer for claim!

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YASKAWA

SMART ROBOTICS – THE CHALLENGE

THE CLASSICAL ROBOT CELL PLANNING MINDSET

Workcell Layout
by experienced SI

Tooling & Fixtures
customized

Robot Selection
by experienced SI

Simulation
by experienced SI

Programming
by experienced SI

Operation
24/7

TARGET USE CASES:

- System Integrators
- High volume, flexible industrial production
- Tailored, optimized automation solutions
- Usage period >3 years, litte changes after installation
- Robots embedded in workflows and communication networks
- Upfront ROI, Availability, TCO, cycle time targets
- Functionality, Connectivity
- Experienced Programmers

SMART ROBOTICS – THE CHALLENGE

THE SMART ROBOTICS MINDSET


Robot Selection
Web Page


Robot Programming by non-experienced user
Easy-to-program


Tooling & Components Selection
Plug&Play Ecosystem


Workcell Element Selection
Plug&Play Ecosystem


Safety & Collision Force measurement
Consulting => SW Tool


Cell Layout and Cycle Time Optimization
Consulting => SW Tool

Operation

Flexibility

THE CLASSICAL ROBOT CELL PLANNING MINDSET


Workcell Layout
by experienced SI


Tooling & Fixtures
customized


Robot Selection
by experienced SI


Simulation
by experienced SI


Programming
by experienced SI

Operation
24/7

TARGET USE CASES:

- Entry level users starting to automate
- Small volume, high mix
- Configurable plug&play toolkits to realize multiple standard automation solutions
- Usage period not defined, high likelyhood for repurposing and changes after installation
- Standalone use cases
- Limited technical complexity - Clarity, simplicity, intuitiveness
- No clear ROI picture
- Novice Programmers

TARGET USE CASES:

- System Integrators
- High volume, flexible industrial production
- Tailored, optimized automation solutions
- Usage period >3 years, litte changes after installation
- Robots embedded in workflows and communication networks
- Upfront ROI, Availability, TCO, cycle time targets
- Functionality, Connectivity
- Experienced Programmers

SMART ROBOTICS – ACTIONS ADDRESSING CUSTOMER NEEDS

THE SMART ROBOTICS MINDSET

Robot Selection
Web Page

Robot Programming by non-experienced user
Easy-to-program

Tooling & Components Selection
Plug&Play Ecosystem

Workcell Element Selection
Plug&Play Ecosystem

Safety & Collision Force measurement
Consulting => SW Tool

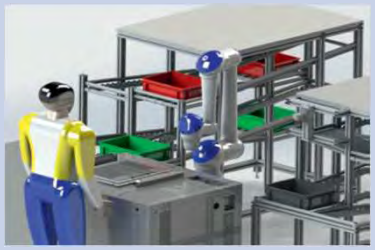
Cell Layout and Cycle Time Optimization
Consulting => SW Tool

CE

Operation

Flexibility

CONSULTING & SUPPORT & SERVICES



Engineering Support
Planning / Simulation
Tools & Support
SI Network

CE & Safety Certification Support
Collision Force measurement

PRODUCTS

Cobots & Robots !

PROGRAMMING OPTIONS

Hand Guiding
Smart Teach Pendant
Apps & Wizards

EDUCATION & DOCUMENTATION

E-Learning
How-To-Videos
Online-Documentation

PLUG & PLAY ECOSYSTEM

SMART SERIES

STANDARD WORKCELLS

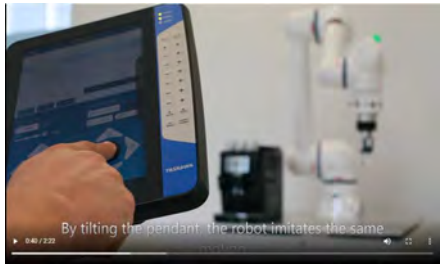
Turnkey Workstations

SMART ROBOTICS – THE SMART SERIES PROGRAM

Web Configurator and Engineering Tools

E-Learning & Trainings

Apps & Application Wizards – SW Engineering SDKs



How-To Videos

White Papers & Background Publications

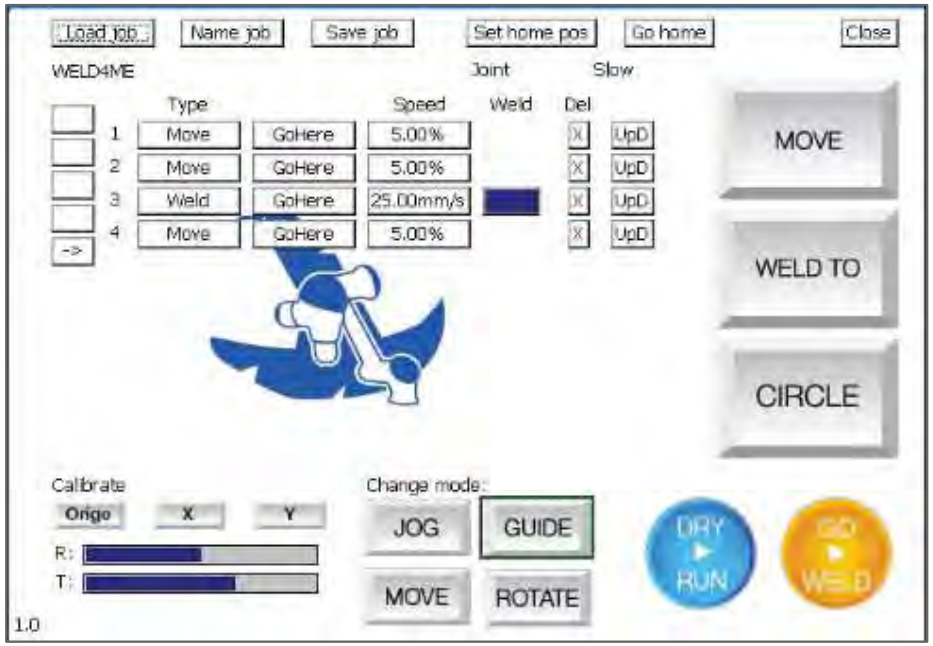
ZIMMER robot SCHUNK
PILZ WEISS ROBOTICS
ROBOTIQ SCHMALZ SICK

Plug&Play Partner Program

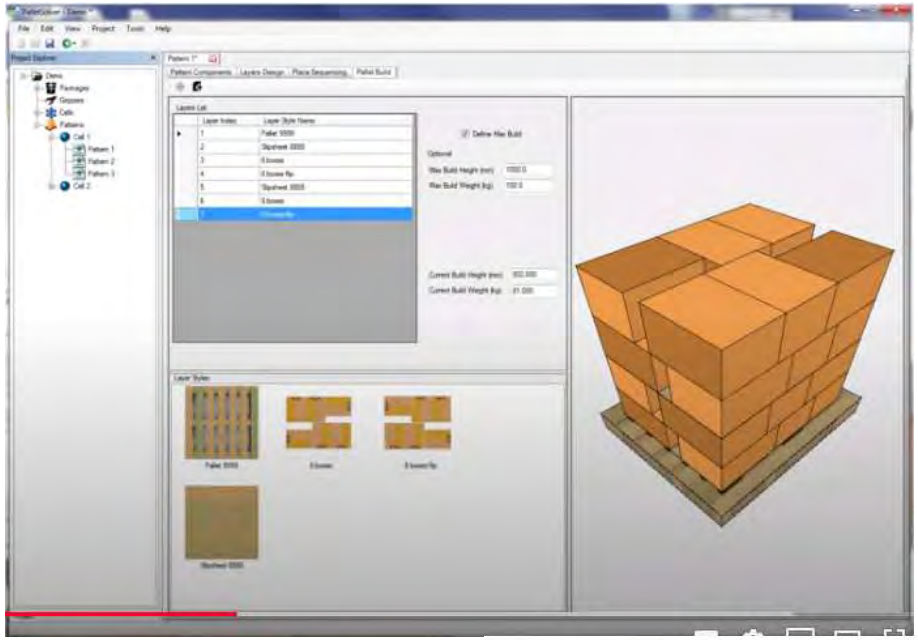
SMART SERIES

https://www.yaskawa.eu.com/products/robots/smart-series

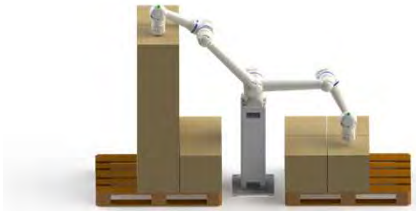
APPLICATION SPECIFIC SOFTWARE APPS



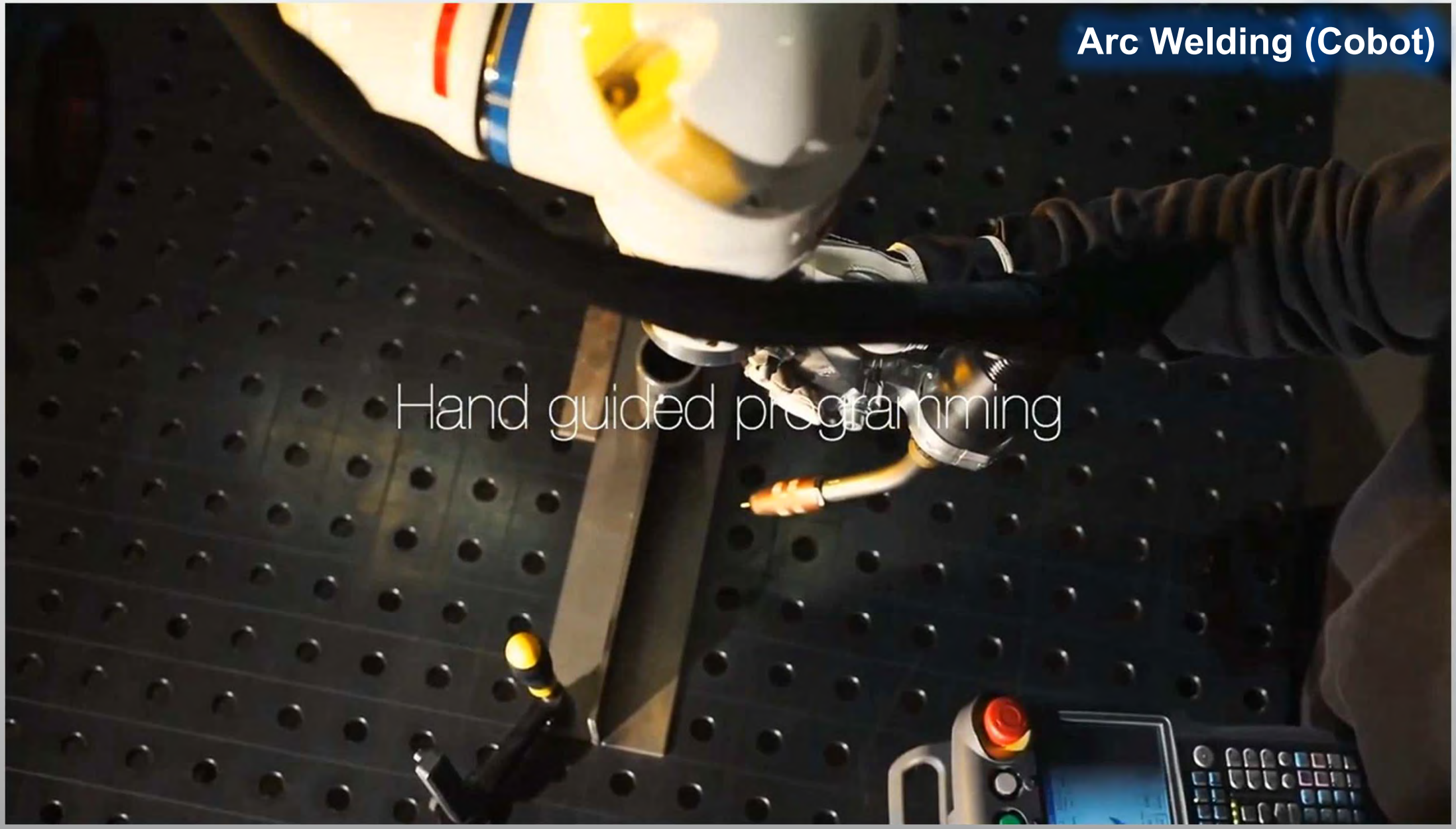
Arc Welding
Yaskawa
Welding Wizard



Palletizing
Yaskawa
Pallet Solver



Arc Welding (Cobot)



YASKAWA Cobot Model HC10DT-IP67 (Collaborative Robot) https://www.youtube.com/watch?v=P-OqTfwPqUU

SMART ROBOTICS - TURNKEY PACKAGES (EXAMPLES)

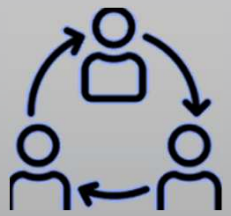
ARC WELDING

by Yaskawa

MICRO BREWERY PACKAGING

by Yaskawa & System Integrators

Customer



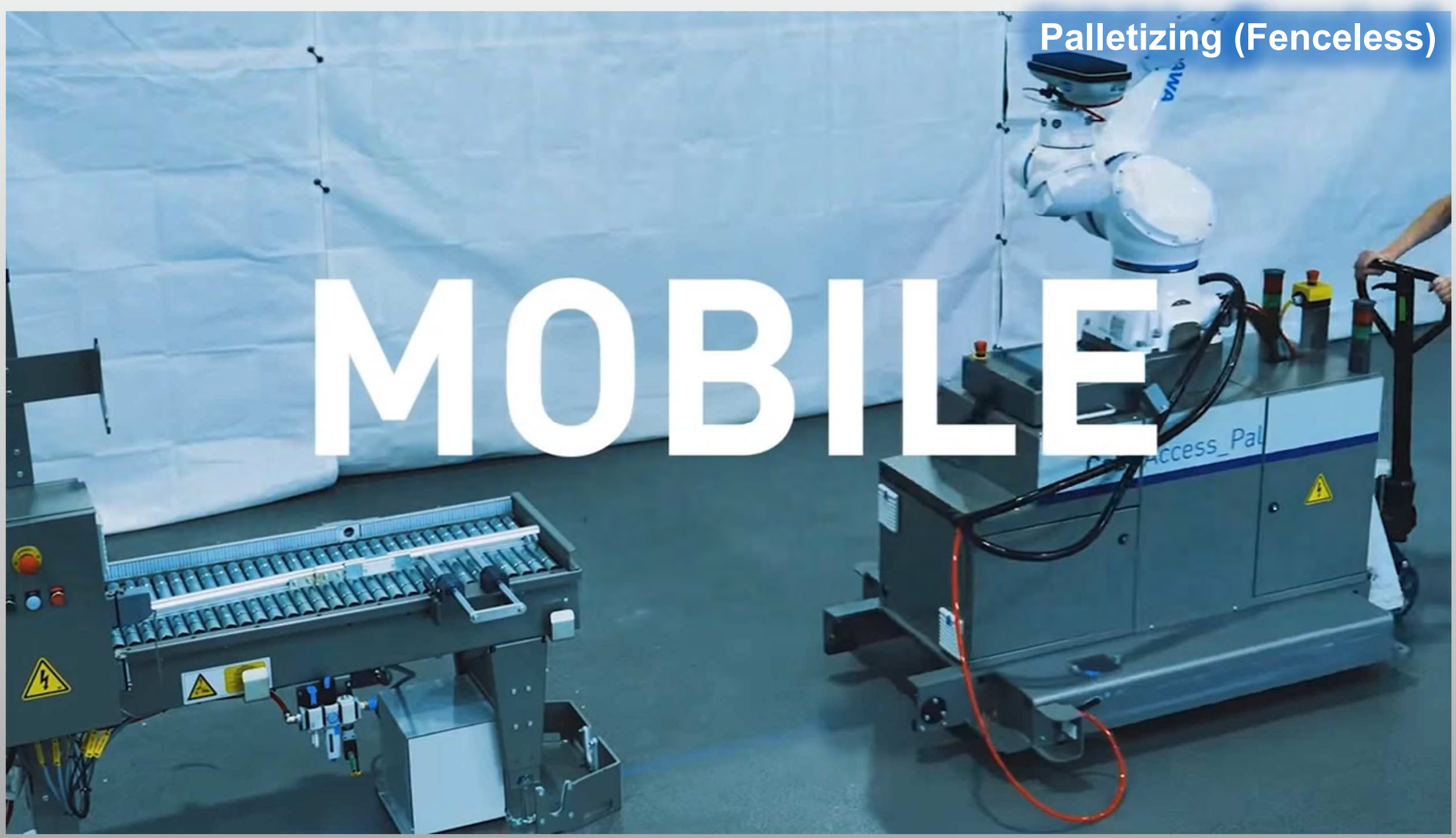
Yaskawa System Integrator

PALLETIZING

GIZELIS ROBOTICS

by System Integrators

Palletizing (Fenceless)



SI: SIDEL Robot Model: MOTOMAN HC20 (Collaborative) https://www.youtube.com/watch?v=YXS9zqmub8Q

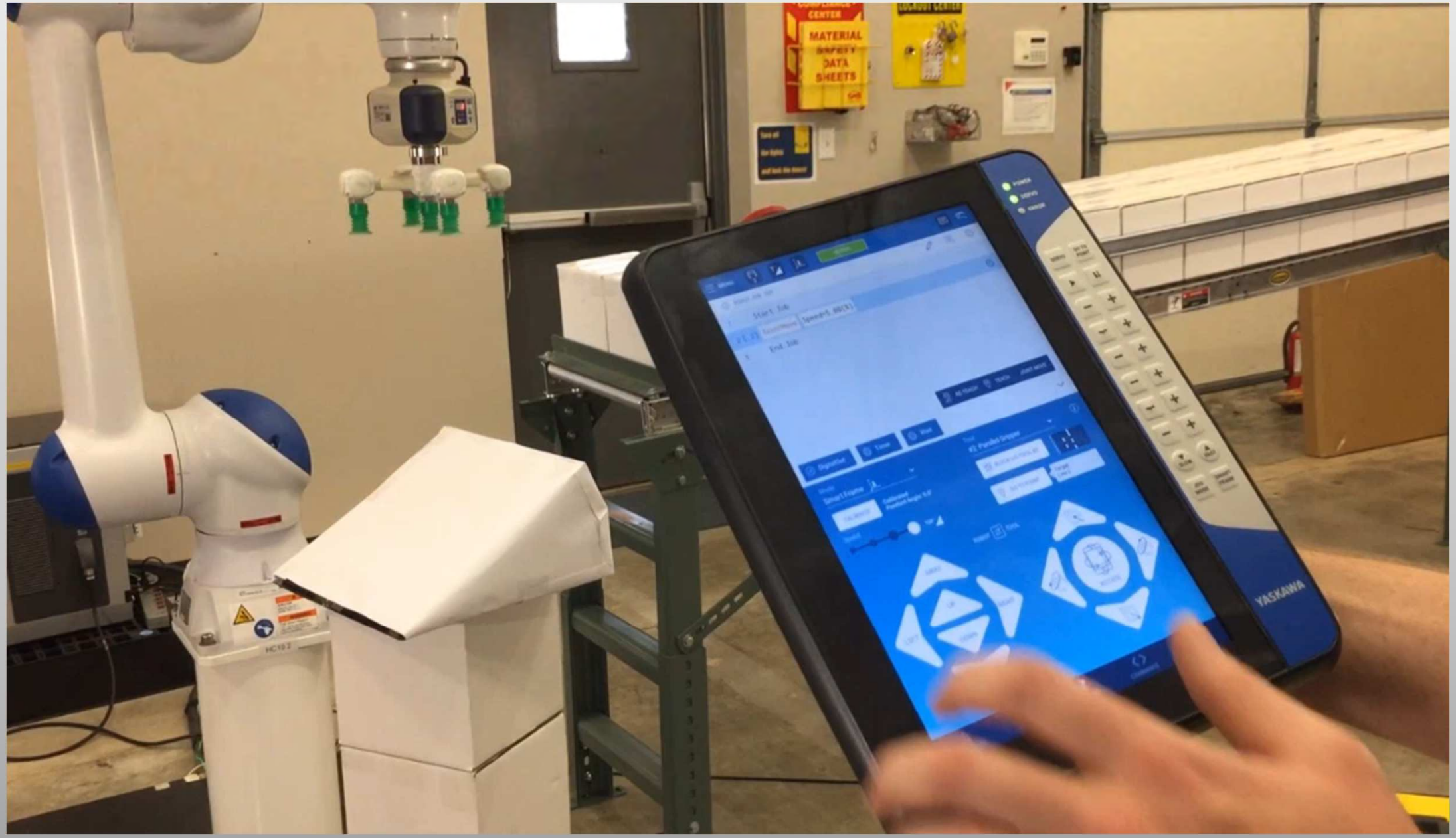
Robots in the Smart Factory

Dr. Michael Klos, YASKAWA Robotics Europe

1. Who is Yaskawa ?
2. Smart Digital Workflows
3. Smart IoT and AI based Production Management
4. Smart Robotics Plug & Play Mindset
5. **Smart Programming with the Smart Pendant**
6. Conclusions

YASKAWA

SMART ROBOTICS – THE SMART FRAME TECHNOLOGY ©



SIMPLE TOOL CONFIGURATION (TCP SETUP)

Smart Pendant

Tool #3: GRIPPER & PART

PRESETS

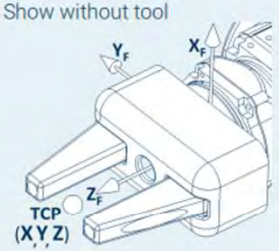
General | Interference

Name: GRIPPER & PART

Block I/O: Sample

Tool Center Point (TCP) — Orientation — ESTIMATE — Show without tool

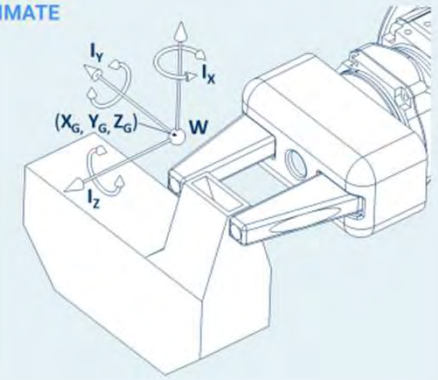
X_F	0.000 mm	R_X	0.0000 deg
Y_F	0.000 mm	R_Y	0.0000 deg
Z_F	50.000 mm	R_Z	0.0000 deg



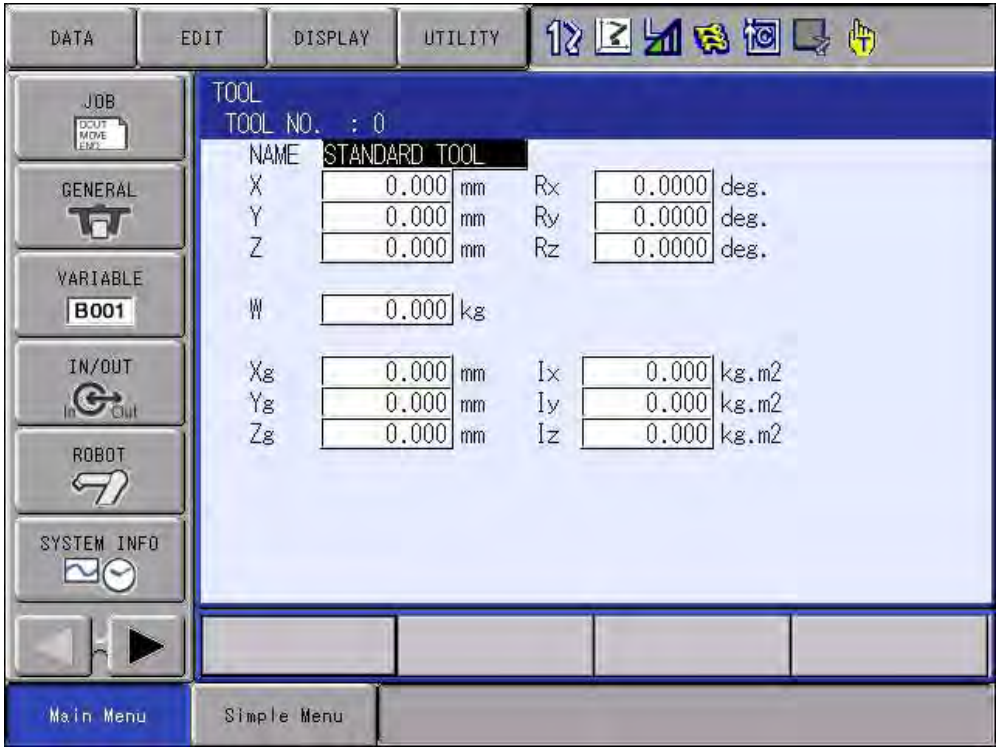
Weight — ESTIMATE

W: 5.000 kg

Center of Gravity		Moment of Inertia	
X_G	0.000 mm	I_X	0.000 kg-m^2
Y_G	0.000 mm	I_Y	0.000 kg-m^2
Z_G	75.000 mm	I_Z	0.000 kg-m^2

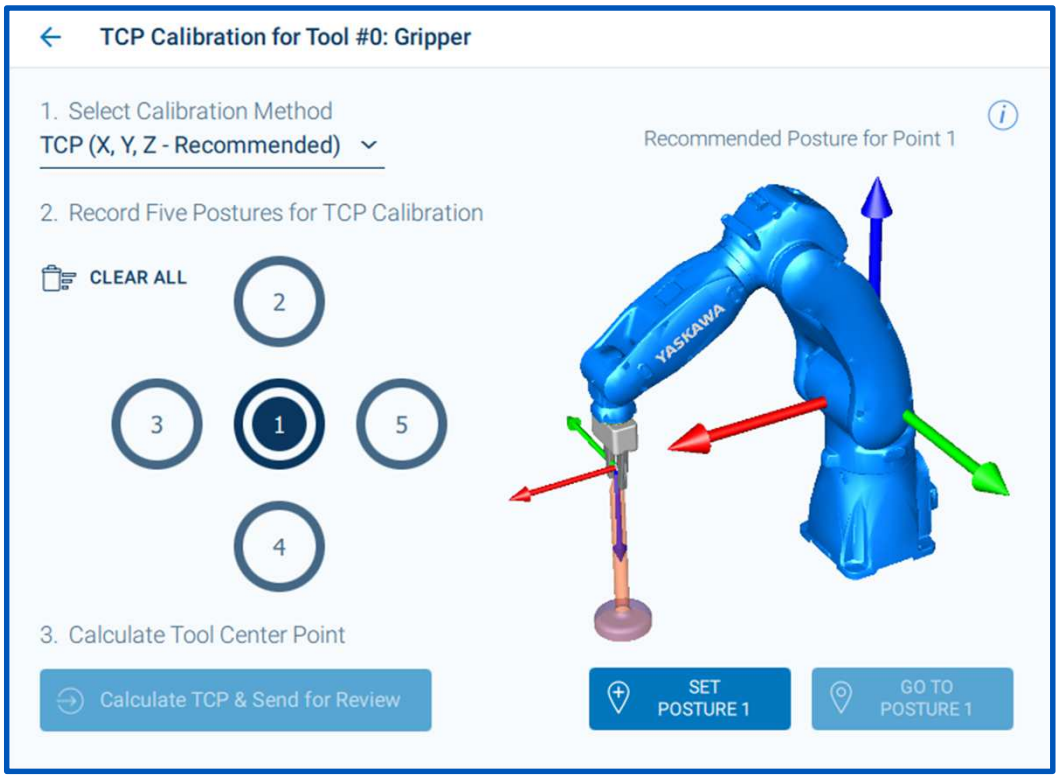


Teach Pendant

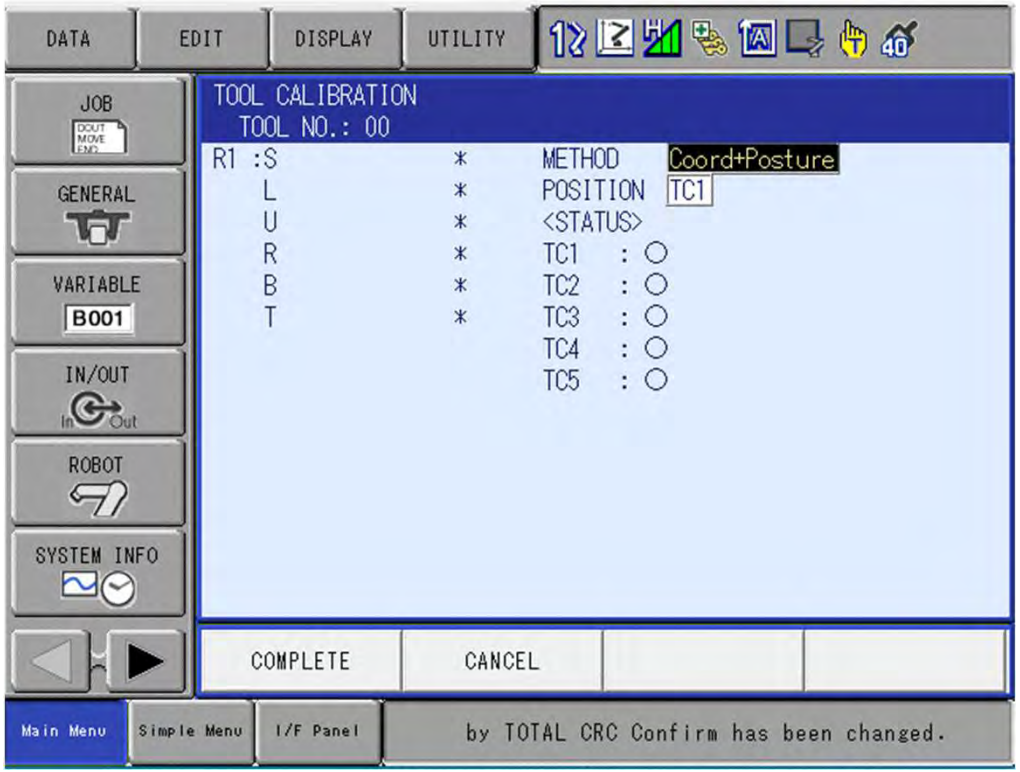


TCP CALIBRATION

Smart Pendant

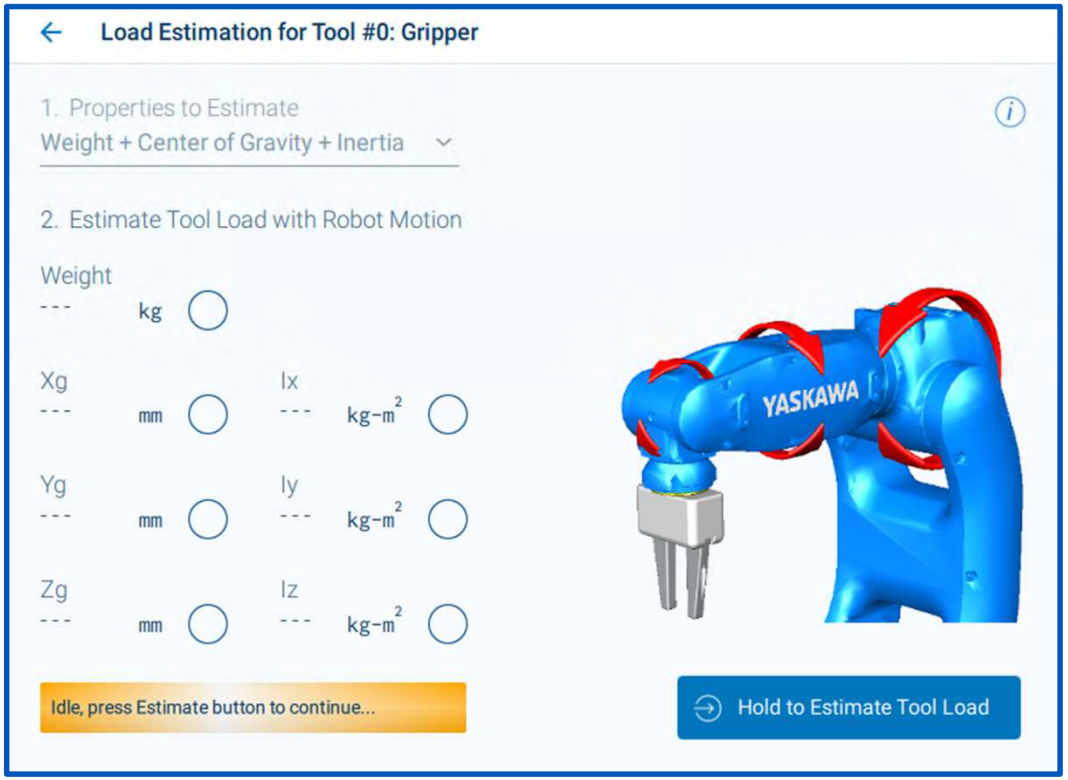


Teach Pendant

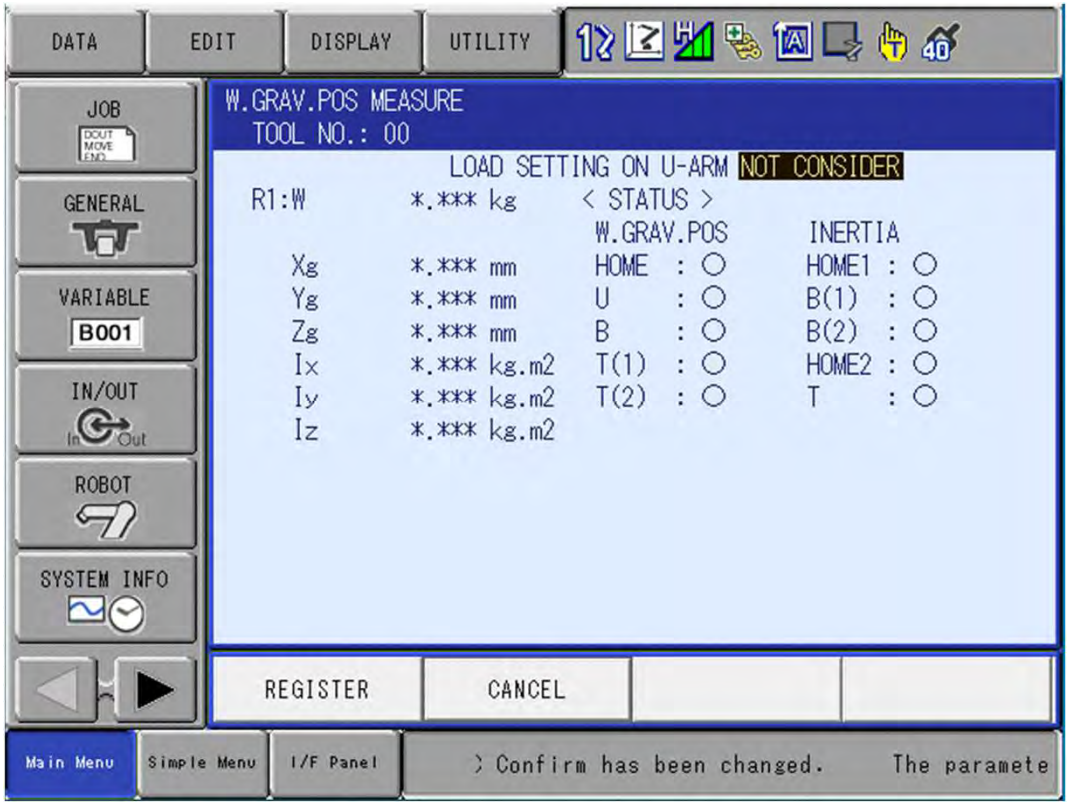


TOOL LOAD ESTIMATION

Smart Pendant

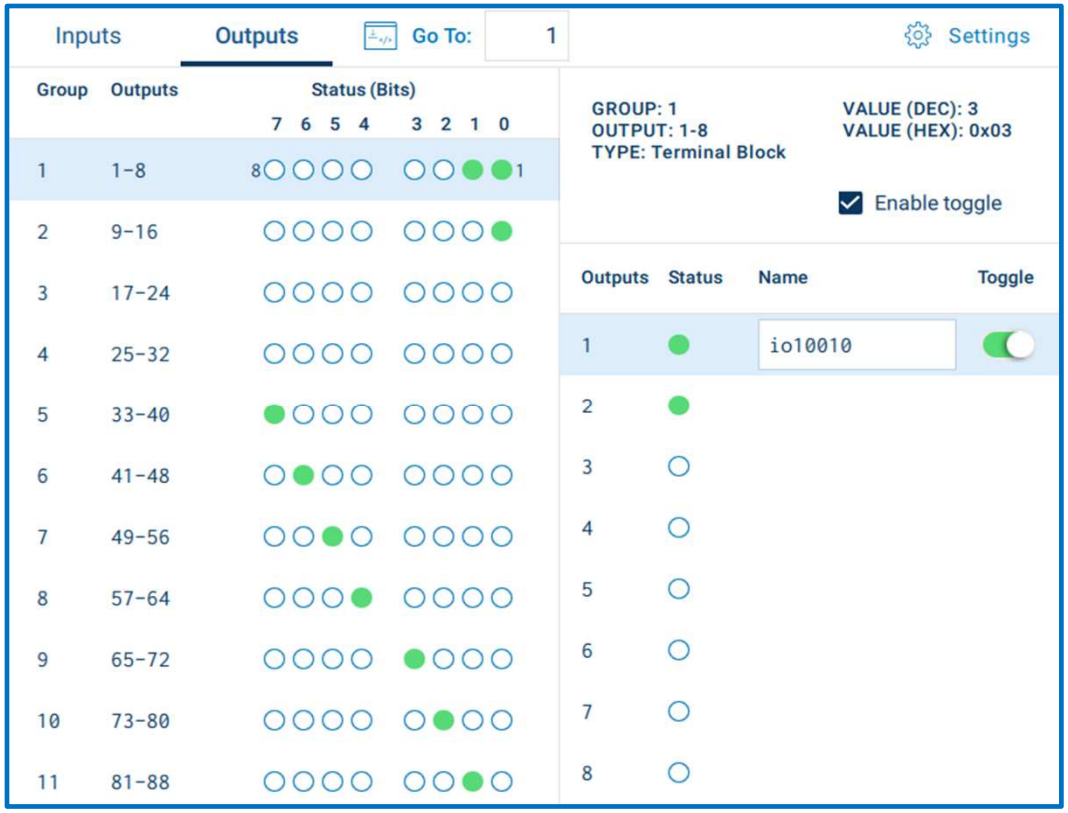


Teach Pendant



INPUTS/ OUTPUTS (I/O'S)

Smart Pendant



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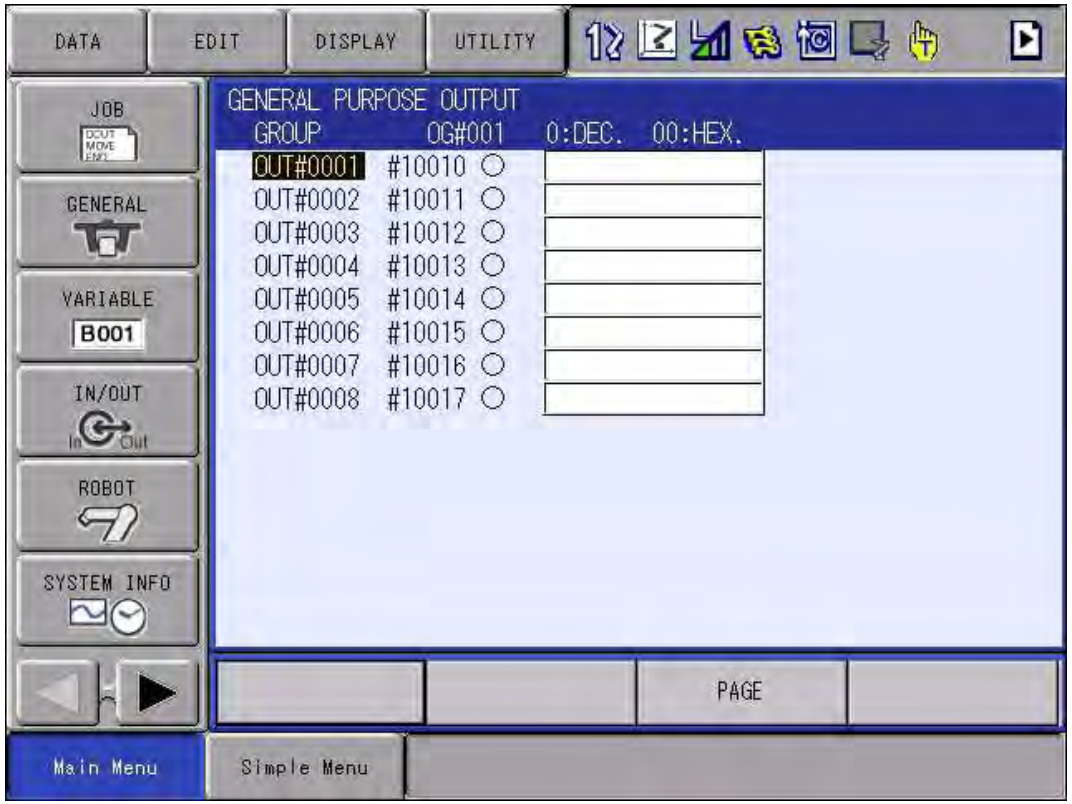
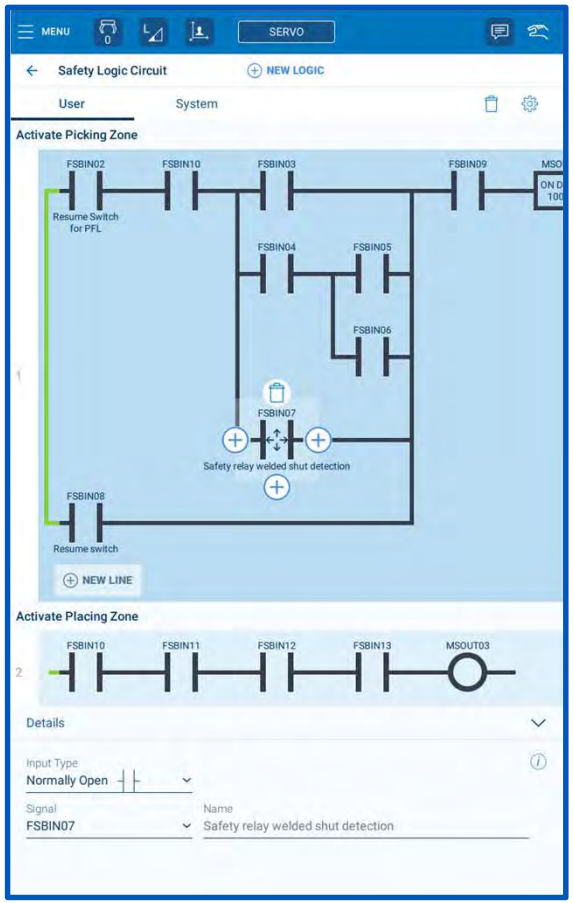


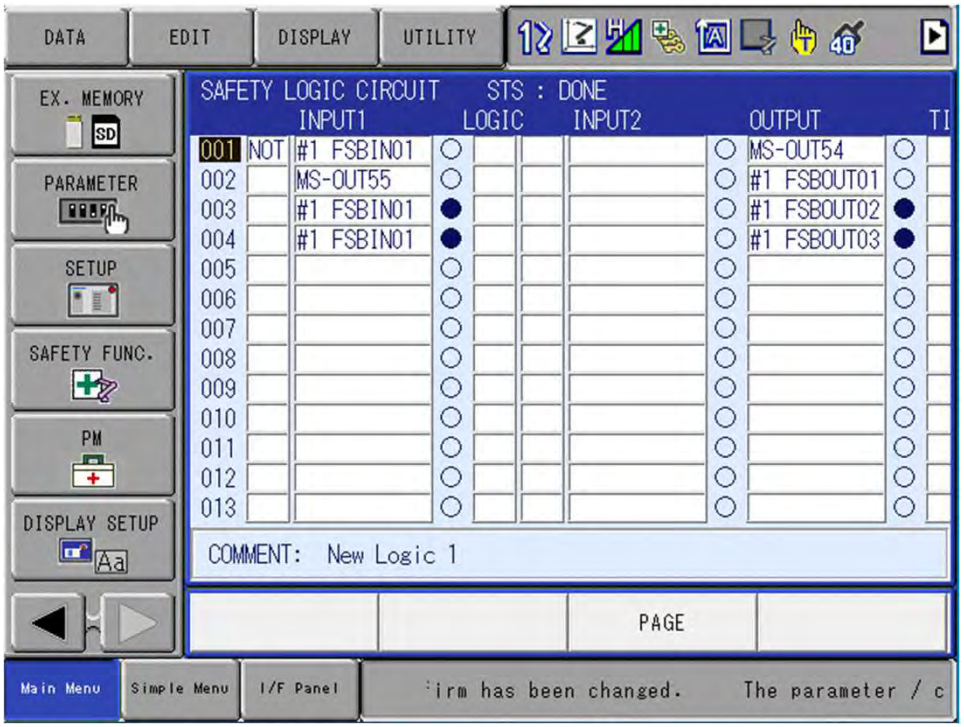
SAFETY LOGIC CIRCUIT

Smart Pendant

Diagram, Drag & Drop with muti-level logic



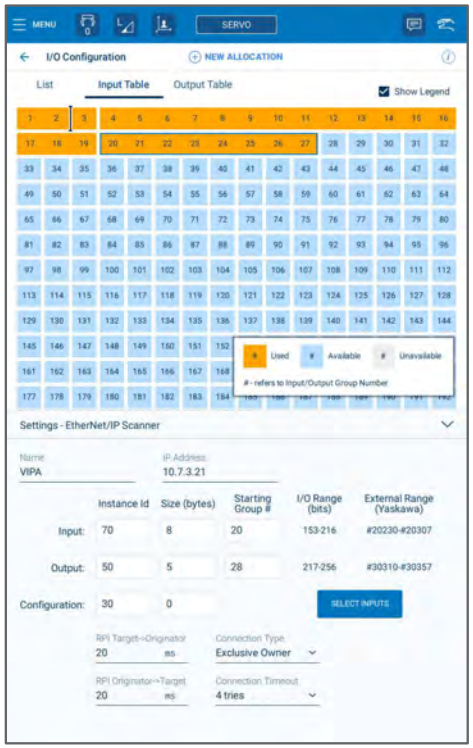
Teach Pendant



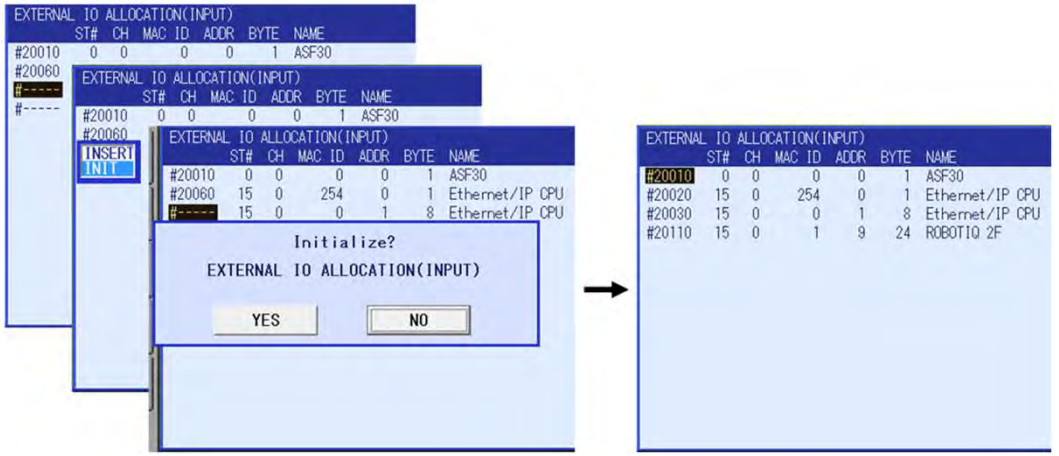
ETHERNET/IP AND I/O ALLOCATION

Smart Pendant

Graphical setup and NO MAINTENANCE MODE required



Teach Pendant



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YASKAWA

THE SMART ROBOTICS MINDSET

Robot Selection
Web Page

Robot Programming by non-experienced user
Easy-to-program

Tooling & Components Selection
Plug&Play Ecosystem

Workcell Element Selection
Plug&Play Ecosystem

Safety & Collision Force measurement
Consulting => SW Tool

Cell Layout and Cycle Time Optimization
Consulting => SW Tool

CE

Operation

Flexibility

THE CLASSICAL ROBOT CELL PLANNING MINDSET

Workcell Layout
by experienced SI

Tooling & Fixtures
customized

Robot Selection
by experienced SI

Simulation
by experienced SI

Programming
by experienced SI

CE

Operation
24/7

YASKAWA

THE FULL PICTURE

ONE STOP SUPPLIER FOR ALL ROBOTIC AUTOMATION PRODUCTS.

So many more challenges out there,
crying for automation …. let‘s talk !

YASKAWA

YASKAWA

Let‘s talk !

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Business Development
Robotics Division

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