Robots in the Smart Factory

Dr. Michael Klos, YASKAWA Robotics Europe





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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

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- 4. Smart Robotics Plug & Play Mindset
- 5. Smart Programming with the Smart Pendant
- 6. Conclusions

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PRODUCTS



Accumulated Production (2020)

INNOVATION

Inventor of

Mechatronics

Introduction of a holistic engineering philosophy (1969).





YASKAWA ROBOTICS EUROPE – PORTFOLIO OVERVIEW





THE MOTOMAN ROBOT PORTFOLIO (> 130 MODELS)



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



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SOFTWARE AND CONNECTIVITY



OFFLINE SIMULATION / OLP

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

PROGRAMMING AND OPERATING

<complex-block>

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

CONTROLLER FUNCTIONS



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



> 100 Functions - Sensors, Vision, Communication, Interfaces

STANDARD ARC WELDING CELLS



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SUPPORTING THE WORLD OF ROBOT PROGRAMMING



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SYSTEM BUSINESS – TURNKEY ROBOT WELDING SYSTEMS



















GLOBAL YASKAWA ACADEMY

Live Trainings







E-Learning







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OFFLINE SIMULATION - MOTOSIM



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DIGITAL TWIN - ON-SCREEN 3D SIMULATION

CT LA LE SERVO (m) (m) 30 Viewer 30 Start Job *LABE 10.00 Sciences 10.00 1 61 . Distallour Outputti TEA + Seconds 10.00 C Time & 500 (secor -+ Digitalout Outputs(TEACH -How at ARE! -ADVANCED RUN Test C R + -+ -One Cycle LOW MAST NOIS SMART II PAUSE RUN STOP

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



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VIRTUAL REALITY OFFLINE PROGRAMMING (2017)

VR ROBOTICS SIMULATOR

VR CELL BIULDING



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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

BECKHOFT

Rockwell Automation

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INDUSTRY 4.0 – SO MANY QUESTIONS



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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 LIVE

THE PAST

Smart Factory PERFORMANCE

Aggregate & Display Data

- \Rightarrow strong KPIs
- \Rightarrow statistical interpretation
- \Rightarrow manual interventions

"Big Data"



Display Data

- \Rightarrow Interfacing
- \Rightarrow Some KPI
- \Rightarrow manual interpretation
- \Rightarrow manual interventions

"Small Data"



THE FUTURE

Drive Process using Data

- \Rightarrow Powerful KPIs
- ⇒ automatic, intelligent evaluation and predictions
- ⇒ automatic interventions supported by AI

"Big Data & Al"

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HOW IS MY FACTORY RUNNING ?



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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 !

WELDI	NG					>
78.9	9% Log files				NEW SCHEDULE	*
	Түре	AVAILABL	E		<u>+</u>	C
	JOB	Tool data				
	FILE / GENERAL DATA	Weaving data				
WEI DING	PARAMETER	User coordina	ite data			
WELDING MODELTVPE 1-06VX8-A0*(GP8)	I/O DATA SYSTEM	Variable data				
	DATA SYSTEM BACKUP	Variable data				
FAULTS WARNING INFO	ALL SINGLE FILES BACKUP	User coordina	ite data			
0 23 57		Variable data				
5 68 TOTAL TOTAL		User coordina	ate data			
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A COLUMN TWO IS NOT THE OWNER.	I NAME	FRETVPE	GEPEAT	LAST UPDATE		
26	Daily backup - 2019 to 2020	DAT	every day	14.01.19 - 13:31:23		
DX200 Welding gun	2 Weekly backup - 2018 to 2019	DAT	every week	15.01.19 - 12:00:18		
PART OF LOCATION Yaskawa factory	3 Monthly backup - 2018 to 2019	DAT	every month	01.01.19 - 13:31:23		
LINE Line3 GELL Arc welding cell	4 Yearly backup - 2017 to 2022	DAT	every year	011.01.19 - 12:00:18		

EFFICIENT SCHEDULING OF MY MAINTENANCE STAFF

Cal	end	lar											SEARCH Q D	IOWINLOAD 🚣 FILTER
								From 06. to	12. April 2019					
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	3	4	-5	0	1	8		DELETED	HW - End of life GP8 (Welding cell 1)	SCHEDULED	04/07/2019 12:00 - 16:00		DIFFERENT DEVICE, 23	<u>A</u>
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								1 minutes	HW - End of life		04/10/2019			



PRODUCTION RATE CONTROL



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INDUSTRY 4.0 – SO MANY QUESTIONS



Sounds good, but ...

WHAT IS THE REAL PAYBACK OF THIS SOFTWARE ?

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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.

Q

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!

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	11/1/	0,5
Sorting cost	MAS S	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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SMART ROBOTICS – THE CHALLENGE

THE CLASSICAL ROBOT CELL PLANNING MINDSET



Workcell Layout by experienced SI



Tooling & Fixtures customized





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Programming by experienced SI by experienced SI 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 CLASSICAL ROBOT CELL PLANNING MINDSET



Workcell Layout by experienced SI



Tooling & Fixtures by experienced SI by experienced SI by experienced SI customized







24/7

Operation Programming



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:

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- 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





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SMART ROBOTICS – THE SMART SERIES PROGRAM



Web Configurator and **Engineering Tools**





E-Learning & Trainings







How-To Videos



Plug&Play Partner Program





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

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APPLICATION SPECIFIC SOFTWARE APPS

MOVE
MOVE
-
1
1
WELD TO
CIBCLE

Arc Welding Yaskawa Welding Wizard





Palletizing Yaskawa Pallet Solver





Arc Welding (Cobot) Hand guided programming

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Cobot Model HC10DT-IP67 (Collaborative Robot)

https://www.youtube.com/watch?v=P-OqTfwPqUU

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SMART ROBOTICS - TURNKEY PACKAGES (EXAMPLES)

ARC WELDING







by Yaskawa

YASKAWA

MICRO BREWERY PACKAGING



by Yaskawa & System Integrators

Customer



Yaskawa S

System Integrator

PALLETIZING









by System Integrators

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SI: SIDEL Robot Model: MOTOMAN HC20 (Collaborative)

https://www.youtube.com/watch?v=YXS9zqmub8Q

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6. Conclusions

SMART ROBOTICS – THE SMART FRAME TECHNOLOGY ©



SIMPLE TOOL CONFIGURATION (TCP SETUP)



TCP CALIBRATION

Smart Pendant



Teach Pendant





DATA	EDIT	DISPLAY	UTILITY	12 🗹 🚧 🌭 🕼 🕞 🖨 🎸
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Main Menu	Simple Me	nu I/F Panel	by TC	TAL CRC Confirm has been changed.

TOOL LOAD ESTIMATION



INPUTS/ OUTPUTS (I/O'S)

Smart Pendant



Teach Pendant



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2	9-16	0000	000					Enable	toggle
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9	65-72	0000	•000	C	6	0			
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SAFETY LOGIC CIRCUIT

Smart Pendant



Diagram, Drag & Drop with muti-level logic







DATA	EDIT	DISPLAY	UTILITY	12 🖻 🚧 🗞	🛛 🖵 🖨 🎸	Þ
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SETUP		#1 F2B1				000
SAFETY FUNC.	008					0000
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				PAGE		
Main Menu Sir	mple Menu I	/F Panel	[:] irm has	been changed.	The paramet	er /

ETHERNET/IP AND I/O ALLOCATION

Smart Pendant



Teach Pendant



Graphical setup and NO MAINTENANCE MODE required

- I/O Confi	guration	(+) NE	WALLOCATION			
List	Input Table	Output Ta	able			
lame	Туре		Input Size	Output Size	IP Address (Scanners)	
SF01(Al001 NP	N) Termina	Block	2 bytes	2 bytes	1	
therNet/IP CPU	EtherNet	/IP Status	1 bytes	1 bytes	-	
therNet/IP CPU	EtherNet	VIP Adapter	16 bytes	24 bytes	÷	
IPA	EtherNet	/IP Scanner	8 bytes	5 bytes	10.7.3.21	0
ettings - Ether	Net/IP Scanne	er.				~
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ettings - Ether ame IPA Input: Output:	Net/IP Scanne Instance Id 60 50	IP Address 10.7.3.21 Size (bytes) 8 5	Starting Group # 20 28	1/0 Range (bits) 153-216 217-256	External Range (Yaskawa) #20230-#20307 #30310-#30357	~
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So many more challenges out there, crying for automation let's talk !





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