

TAJMAC-ZPS

MANUFACTURING CELL 4.0

PROJECT HISTORY

2017 - 2019

At the INTEMAC laboratories in Kuřim, Manufacturing Cell 4.0 was developed to demonstrate the basic principles and verify partial solutions based on digital technologies and the Industry 4.0 concept.

Project partners: TAJMAC-ZPS, B+R Automation, Renishaw, Comau, Sewio, SMC and Unicorn.

Testbed project objectives:

- Adaptive manufacturing
- Unified communication and control
- Easy connectivity of cell components and external systems
- System diagnostics and predictive maintenance
- Post-process inspection of workpieces
- Augmented reality

2019

Application of the tested technologies in an automated workstation designed for repeat single-part and small-batch production: Manufacturing Cell 4.0 for TAJMAC-ZPS.

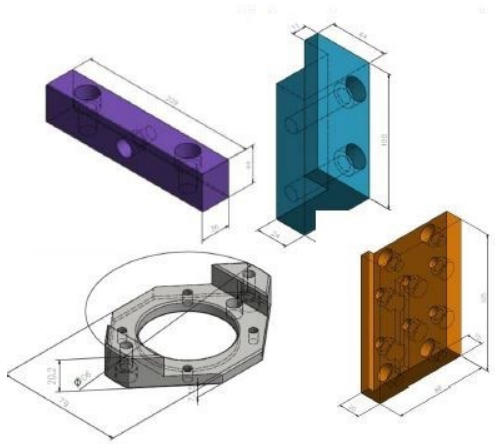
Additional technology and business partners: B&R Automation, ABB, Eltep, Schunk and OptiSolutions.

STAGE 1 - Production analysis, suitable parts, repeatability and batch production

Classification into handling groups

- For each of n = 220 parts, the number of rotations and gripping dimension were defined

Parent	Quantity (2017)	Length (mm)	Weight	No. of rotations	1st rotation	2nd rotation	3rd rotation	4th rotation
RN03720311002	589	103	3,0	2	60	58		
R105L1018D1	569	41	0,1	2	20	12		
R73.2.215.12	289	215	3,1	3	30	30	30	



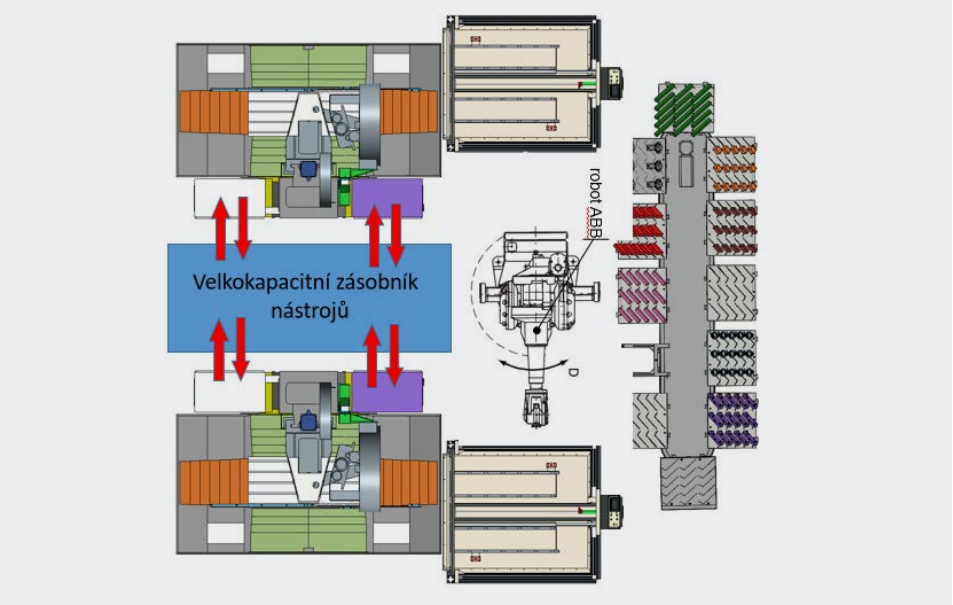
- Groups created by size and weight
- The criterion is the total Quantity (2017)

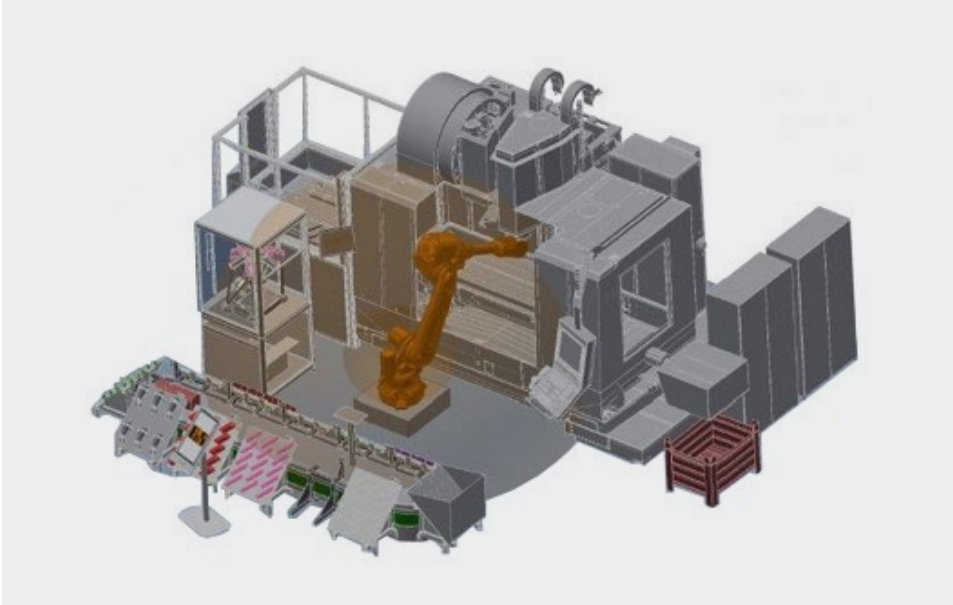
Sum of Quantity (2017) Row labels	Column labels													Grand total
10			144	22										166
20			1 890	238	200	57	60	30		24				2 499
30			1 703	392	190	311	71	44			20	80	20	2 831
40		22	1 402	522	195	225	45	80	20					2 511
50			617	335	242	40	40				31			1 305
60				161	730	40	20						21	972
70			24	108		52								184
80			145	90		115	106							456
90					21									21
100			20	40								25		85
110						40								40
Grand total														

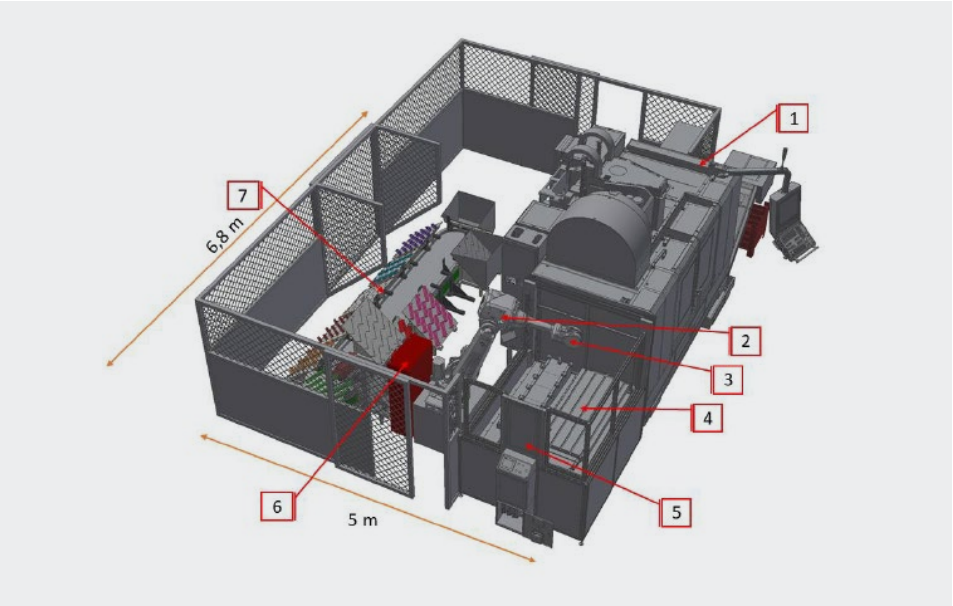
Total annual production for n = 220 in 2017: 11,070 parts

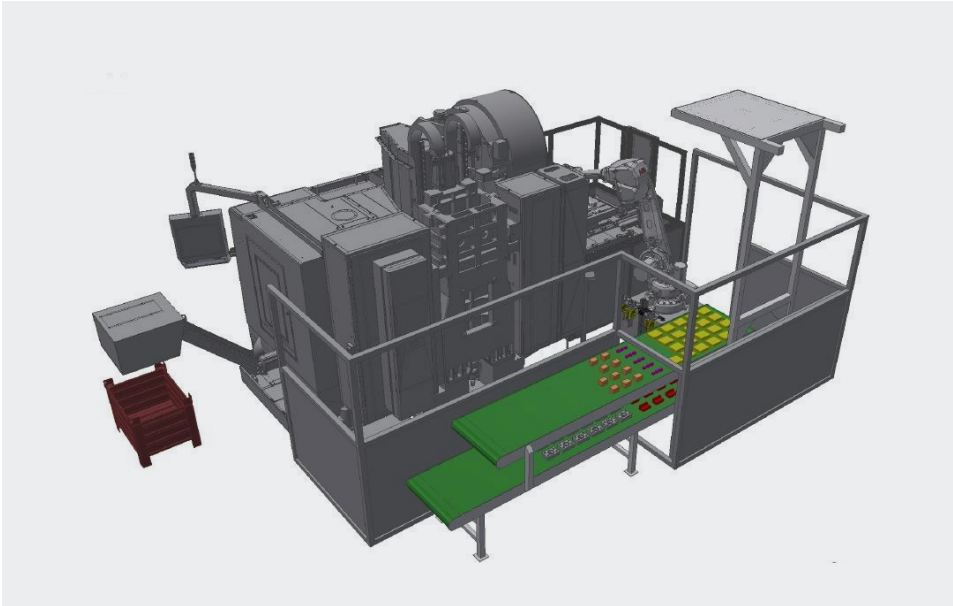
220 part types met the selection criteria, with batches of 5 to 20 parts and repeatability 3 to 6 times per year. Average machining time per item was approximately 20 minutes; setup time was 60 minutes per item.

STAGE 2 - Solution concepts and feasibility study





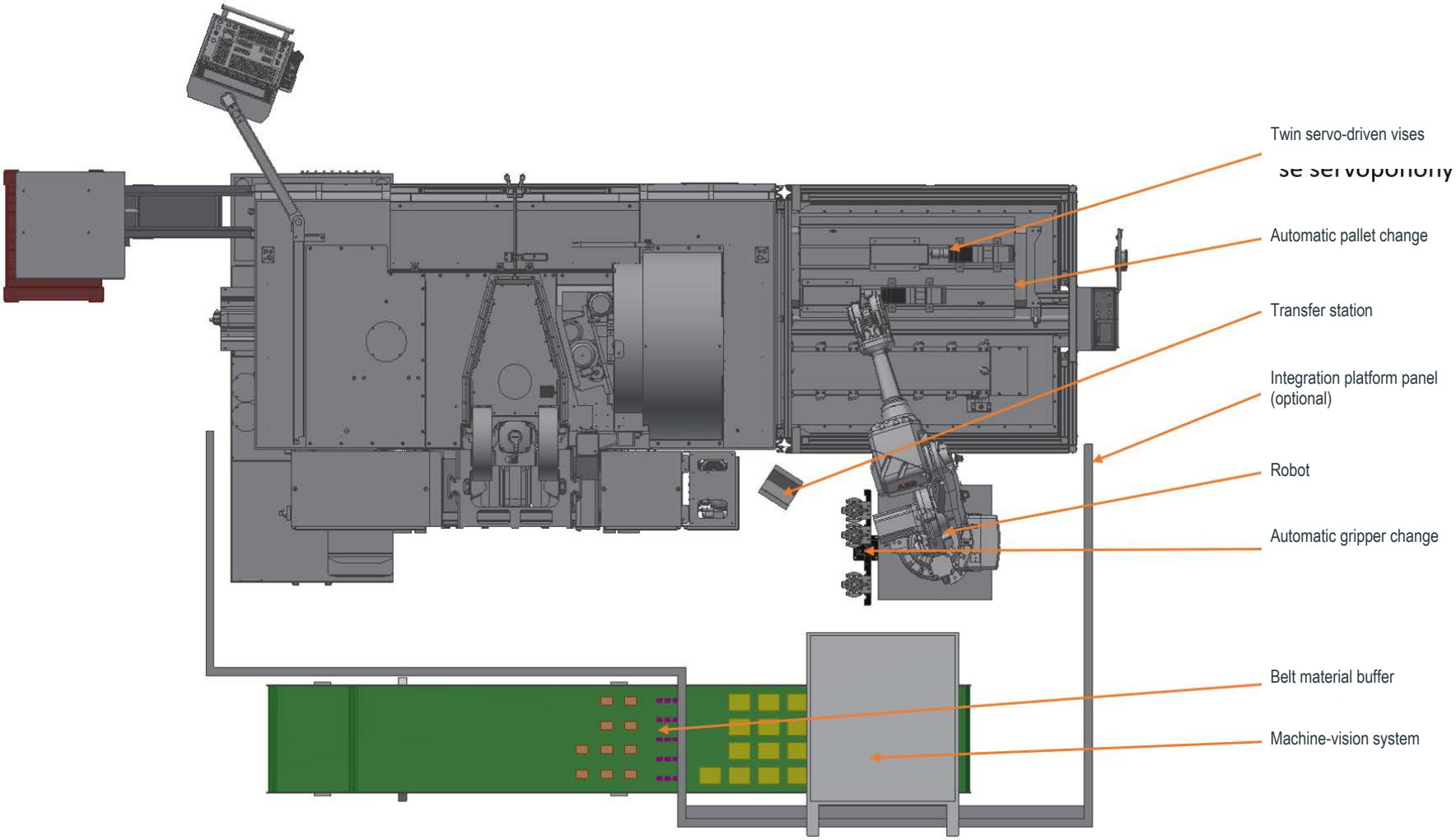




STAGE 3 - Selection of the preferred solution, workstation layout, component specification and itemized budget

STAGE 4 - Supplier assignment, implementation master plan, work schedule and execution

STAGE 5 - Trial operation

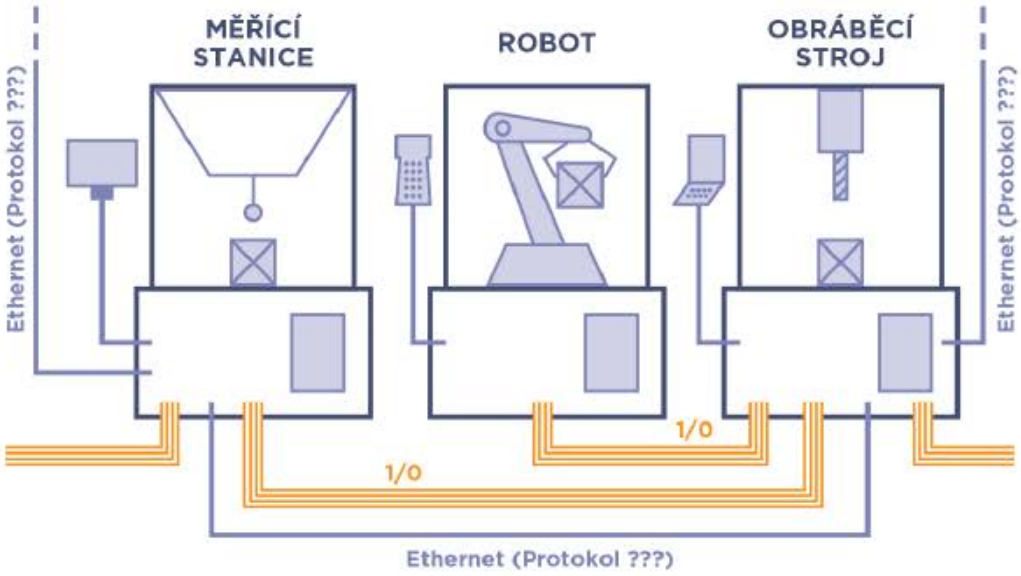


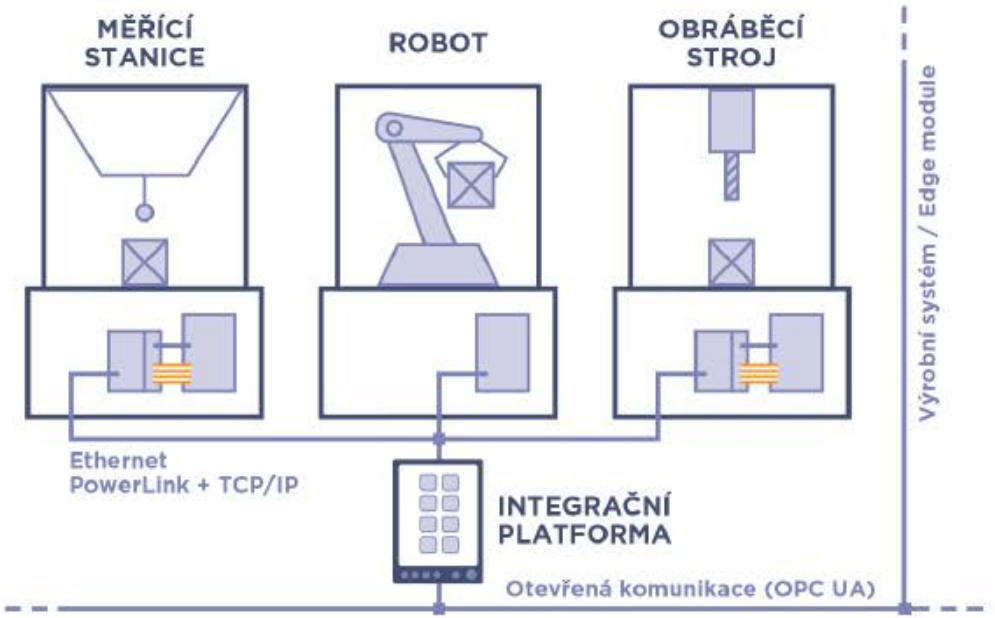
KEY FEATURES OF THE MANUFACTURING CELL

- For repeat single-part and small-batch production
- Workpiece size range W x H x L: (16 to 105) x (12 to 110) x (20 to 230 mm)
- 24-hour machine availability with one operator on the morning shift
- Unattended operating time is determined by the input buffer capacity
- Just-in-time product delivery
- Open solution with easy expandability
- Fast return on investment
- All components controlled from one place
- Simple operation and teaching of new components without robot programming



INTEGRATION PLATFORM





- B&R Automation platform
- All components controlled from one place
- Cell operations run by calling parameterized procedures
- Easy connection of additional components
- TCP/IP communication between components
- OPC UA standard cell communication interface
- Remote management of the manufacturing cell

MACHINE



Upgraded MCV1260i vertical machining centre in the following configuration:

- Siemens Sinumerik 840SL control
- ISO 40 spindle, planetary gearbox, 10,000 rpm
- 2 x 30 tool magazine
- Upper wash, tray wash and wash gun
- Working-area extraction
- APC with utilities supplied to the pallet in both the APC and machining area
- Additional high-capacity chip container
- Renishaw tool and workpiece probes
- Chipblaster high-pressure through-spindle coolant
- ECO Friendly
- Industry 4.0 option
- Remote diagnostics

ABB IRB4600 ROBOT



Configuration using ROBOTemplate

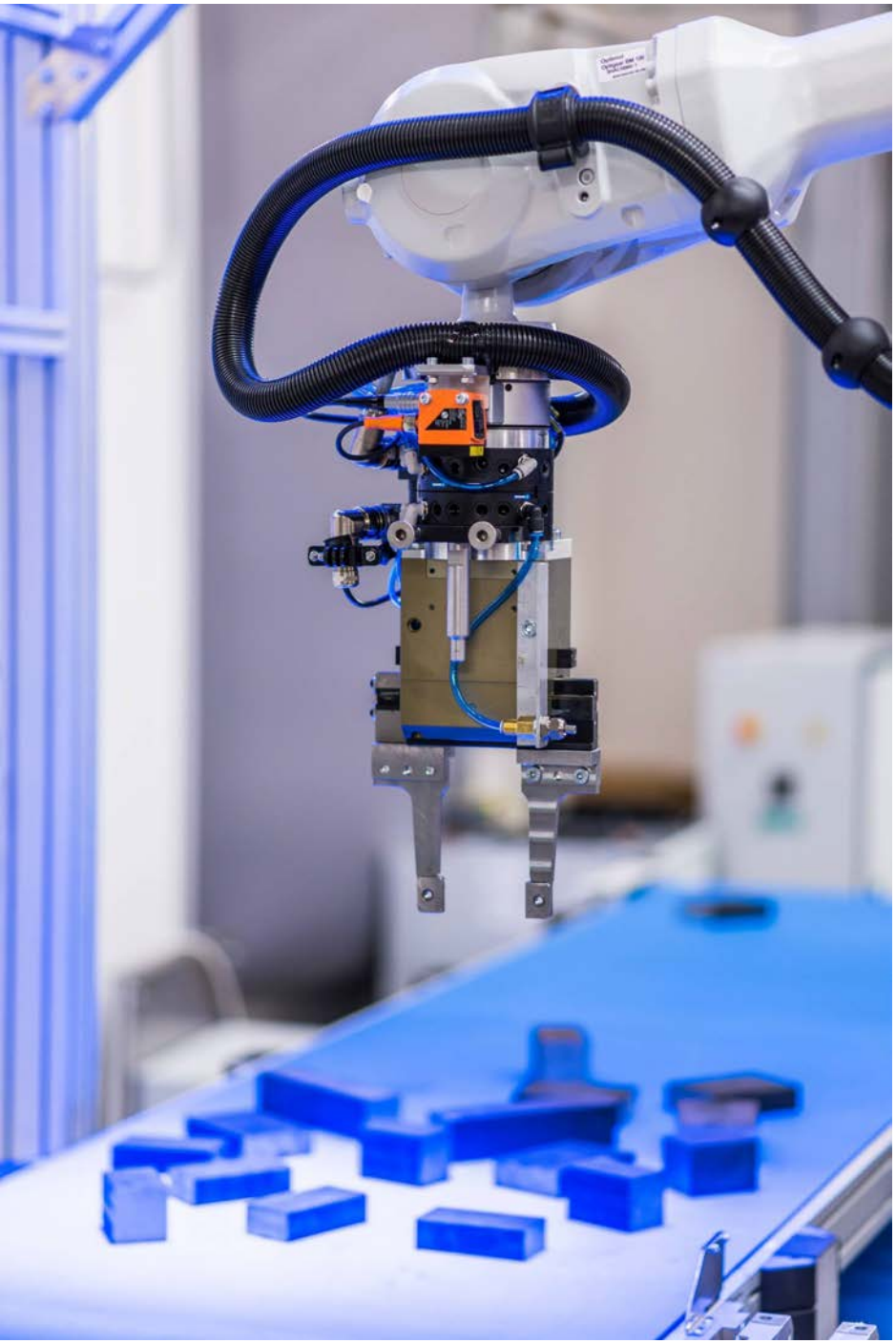
ROBOTemplate





- Force control - collision protection and controlled robot clamping force
- Interchangeable Schunk grippers; automatic selection by size (8-61 mm and 54-110 mm)
- Gripped-dimension check, accuracy +/- 2 mm
- Workpiece air blow-off
- ROBOTemplate - developed by ABB Czech Republic

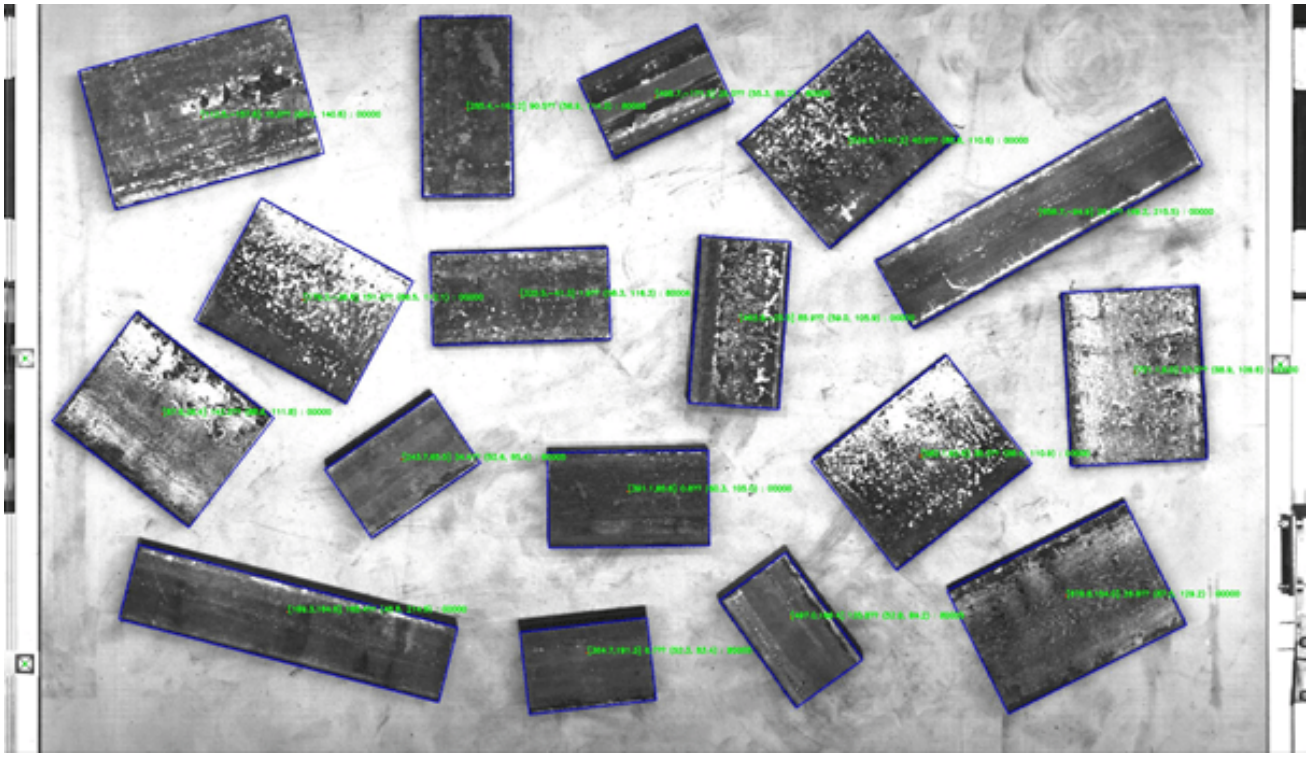
VISION SYSTEM



Recognition of blank shapes, dimensions and positions on the conveyor using artificial intelligence algorithms

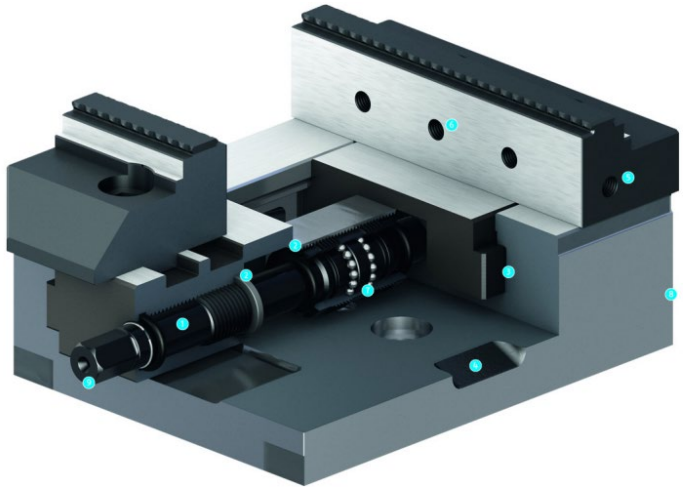
Baumer 2D camera

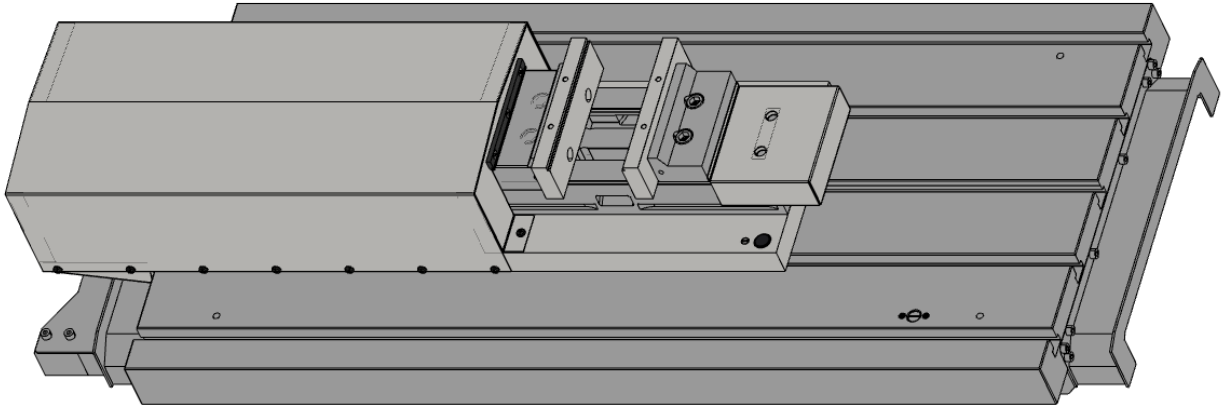
The vision system runs on the LOTYLDA software platform from OptiSolutions.



WORKPIECE CLAMPING

- Schunk self-centring precision vise
- Jaw drive by B&R servo motors
- Control from the B&R integration platform
- Selectable jaw opening
- Controlled clamping force in the jaws
- Verification of the clamped workpiece dimension





TOOLS AND TOOL MANAGEMENT

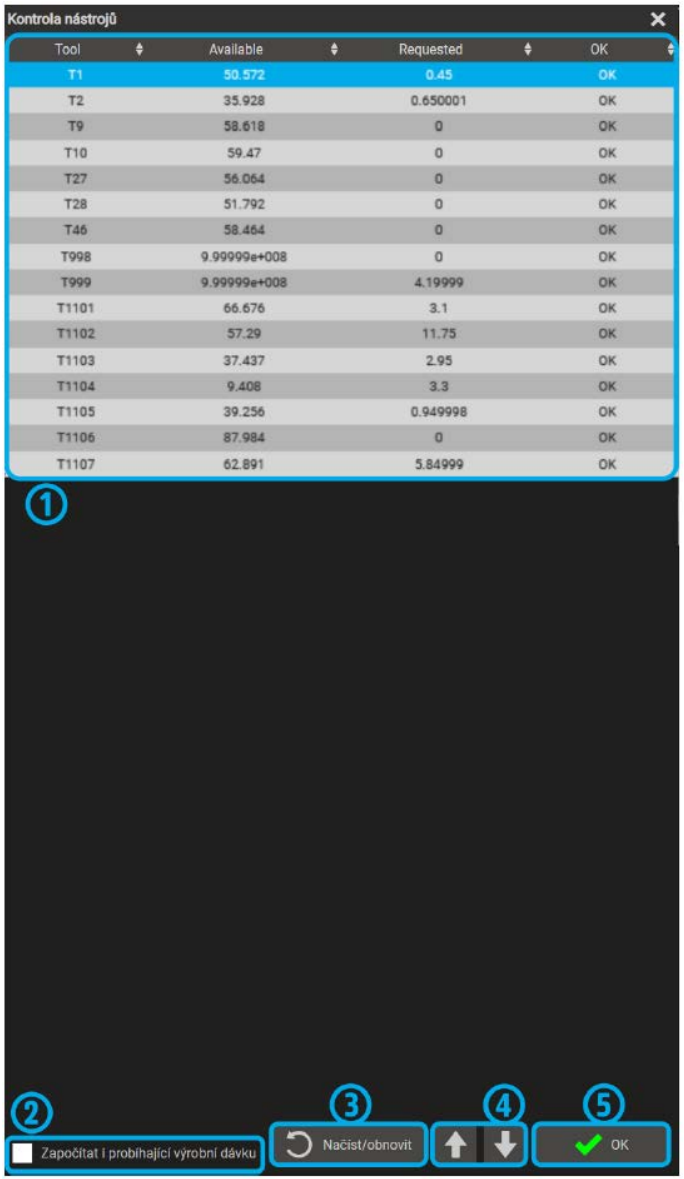
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Renishaw NC4+Blue tool probe



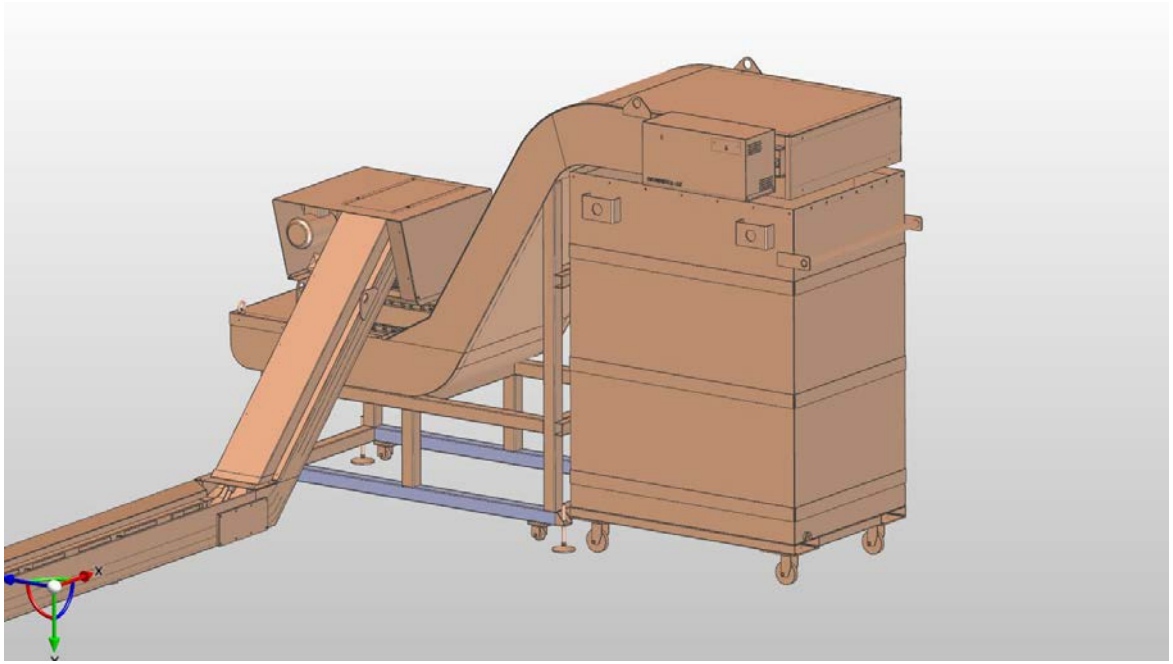
Renishaw OMP40 workpiece probe



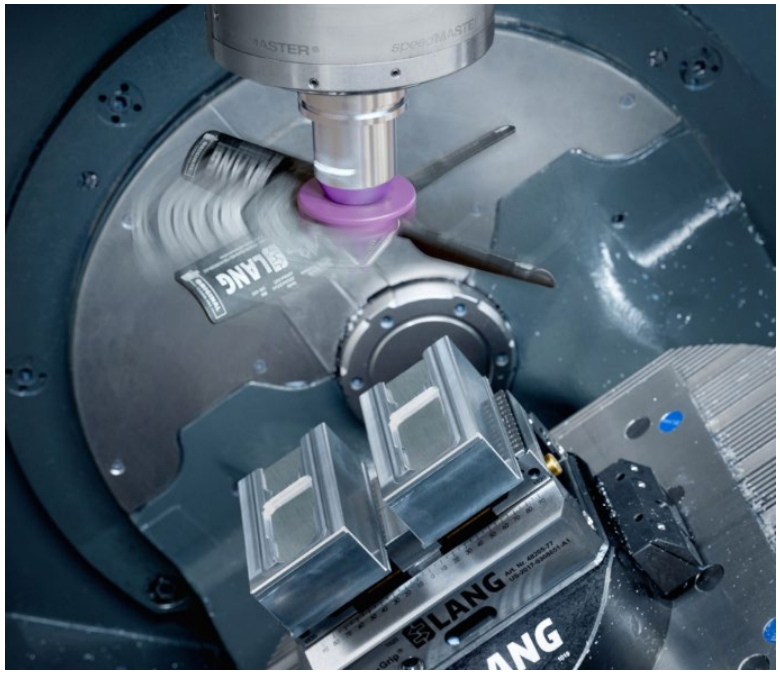
Tool management from the integration platform

CHIP MANAGEMENT

Additional high-capacity chip container



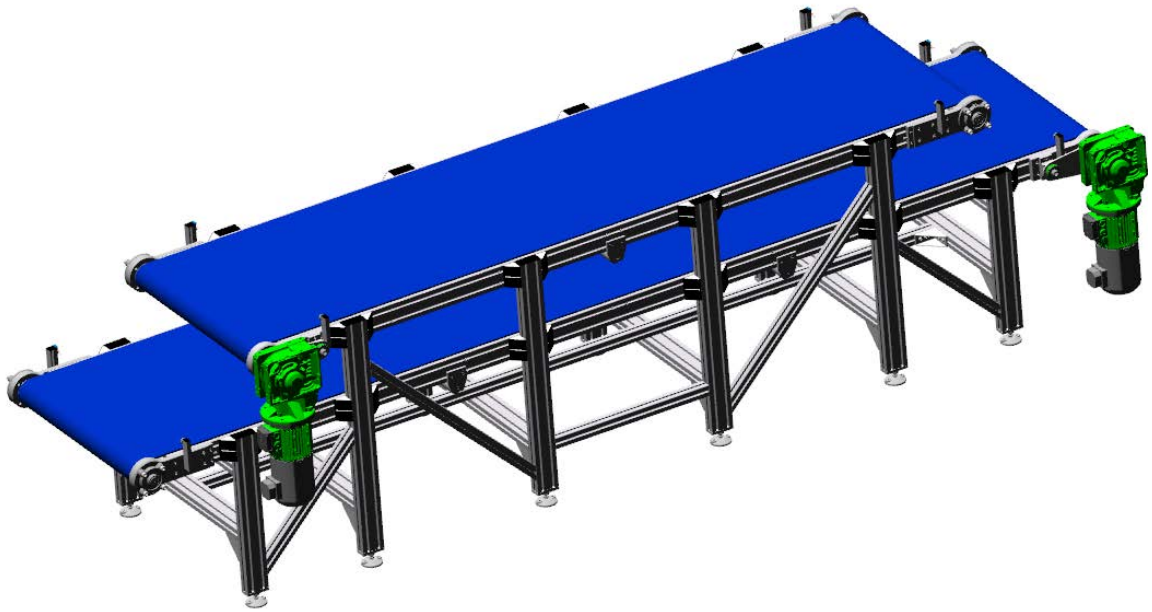
Workpiece washing and air blow-off
Lang Clean.Tec Chip Fan

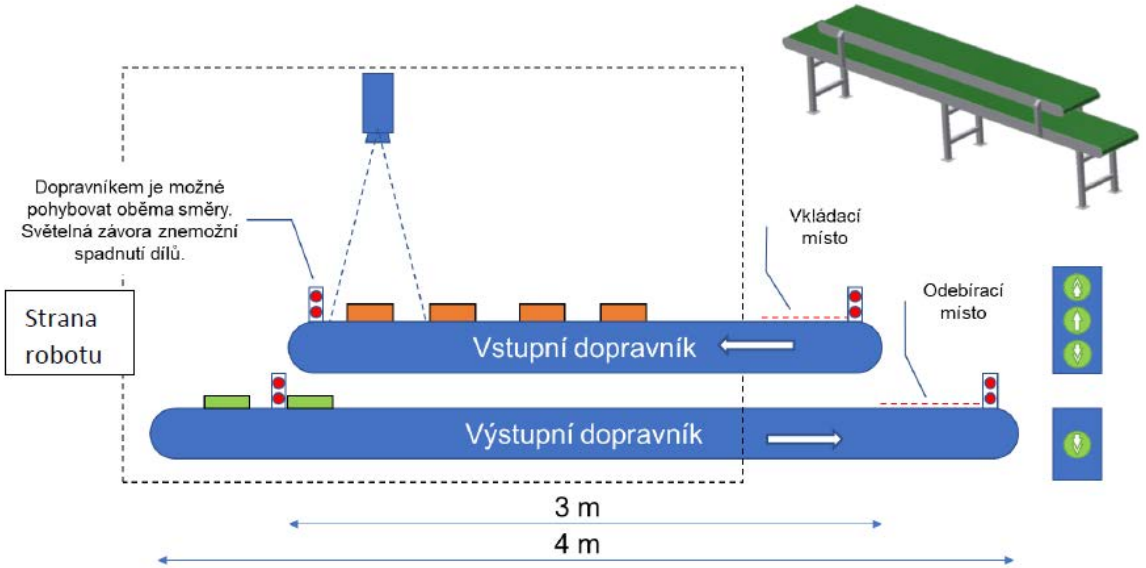


- [x] Additional lower wash for telescopic covers

BELT CONVEYOR

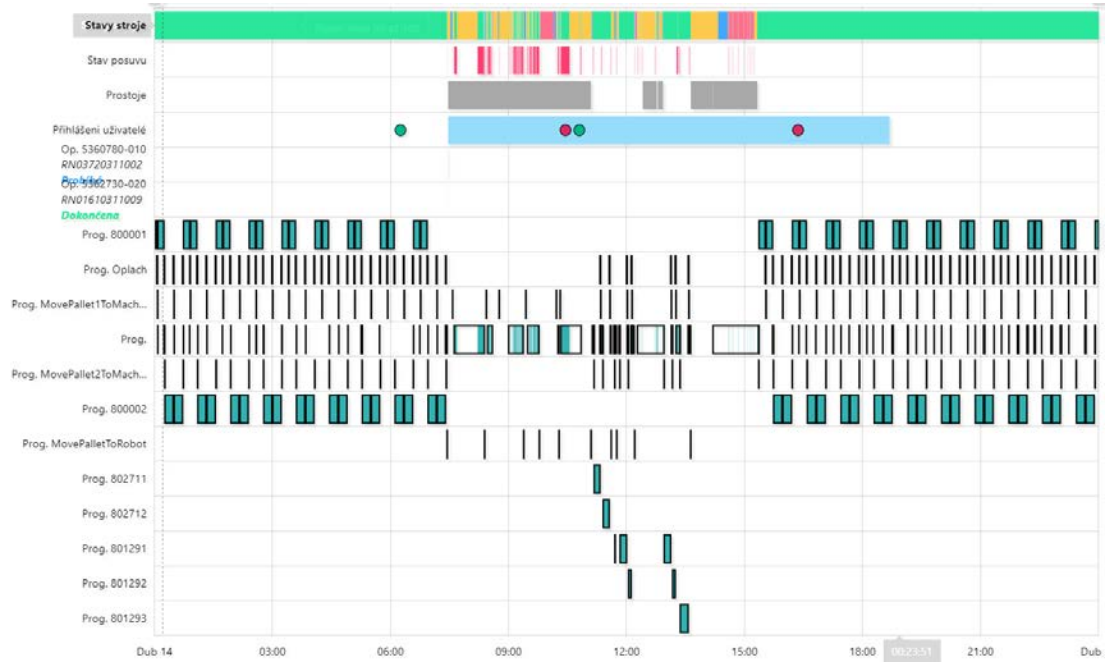
- Input buffer capacity for up to 60 hours of operation
- Blanks do not need to be arranged in a defined pattern on the input buffer
- Unrecognized or surplus blanks are automatically placed on the output belt by the robot
- Laser barriers for very small workpieces
- Variable matrix placement according to finished workpiece size

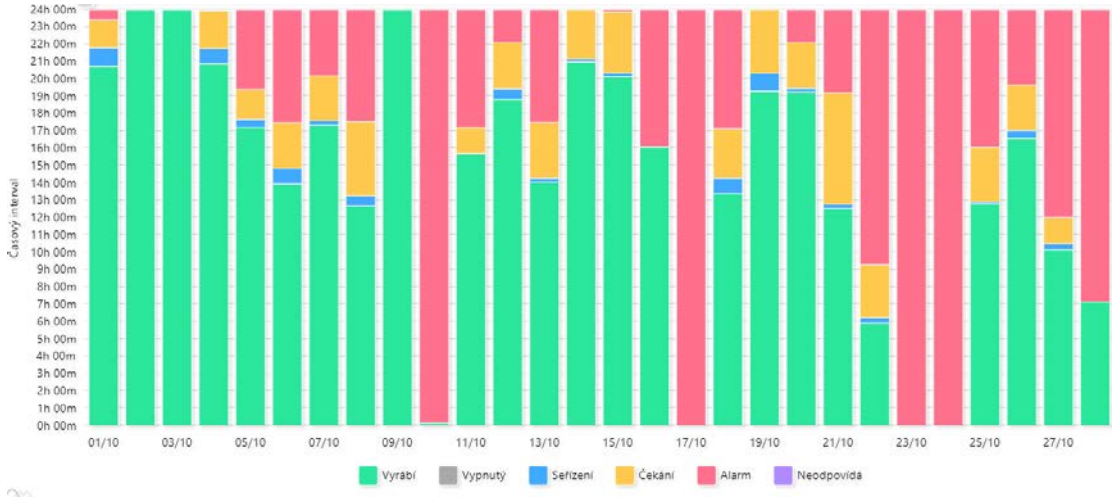




ERP INTEGRATION AND PRODUCTION MONITORING

- Production batch assignment from the work queue
- Expected production time of the batch
- Automatic reporting after each part is produced
- Remote monitoring of the manufacturing cell





CELL OPERATING MODE

MON-THU

1st shift - preparation of new setups, commissioning of new NC programs and routine operating maintenance

2nd and 3rd shifts - unattended operation

FRI-SUN

1st shift - preparation of new setups, commissioning of new NC programs and scheduled maintenance of key components

Weekend operation until the input buffer capacity is exhausted

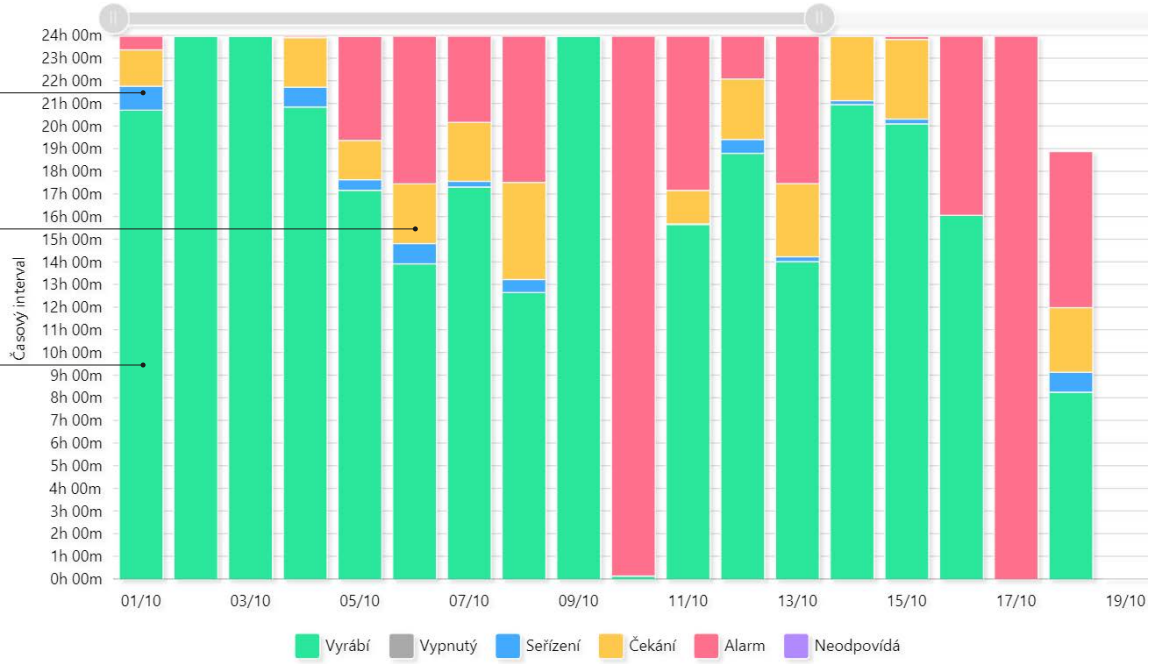
UTILIZATION COMPARISON OF IDENTICAL MACHINES

Robotic cell setup

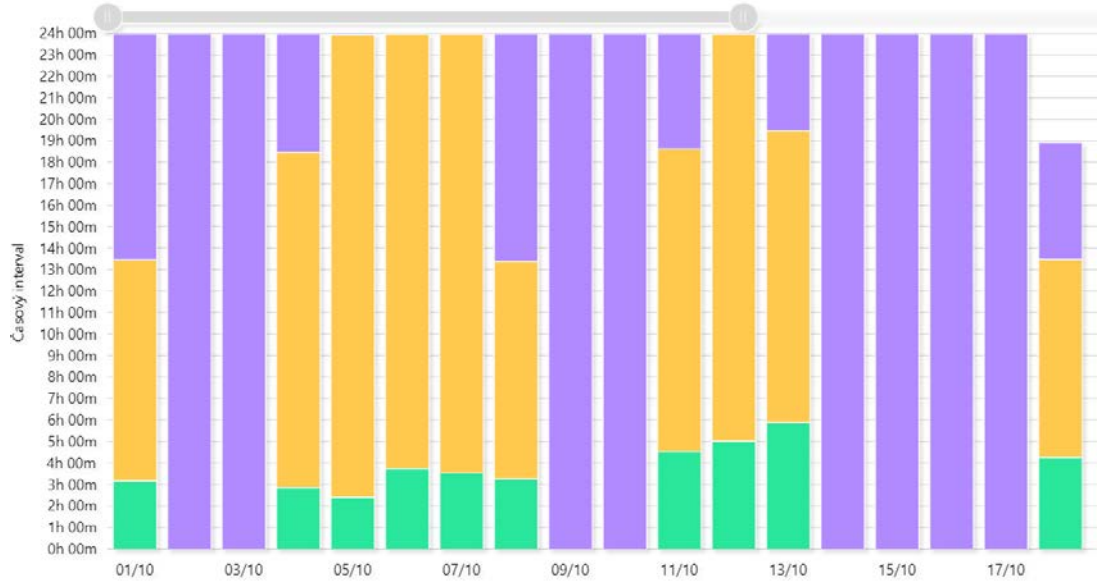
New NC program commissioning

Automatic operation

FAMC 1260i



ZPS MCV1260i AVP



OPERATING EXPERIENCE

- 24-hour machine availability with one operator on the morning shift
- Machine utilization OEE: 85-87%
- Average operating time per week: 106 hours
- The cell currently contains approximately 250 production items

Compared with an identical CNC machine operated on one shift, the following savings are achieved:

- 3x higher available production capacity
- 35% better machine utilization (a conventional machine reaches OEE 55-65%, depending on the work type, with 8-hour availability)
- 35-50% reduction in auxiliary time related to clamping and machine setup
- 60% reduction in unit production costs at an average batch size of 20 parts
- The delivery date is not affected by human factors
- 100% repeatability of production and quality