Robot Cell Development and Sanding Application in RoboPinta

Ajay Sharma, RDI Expert

ROBOPINTA

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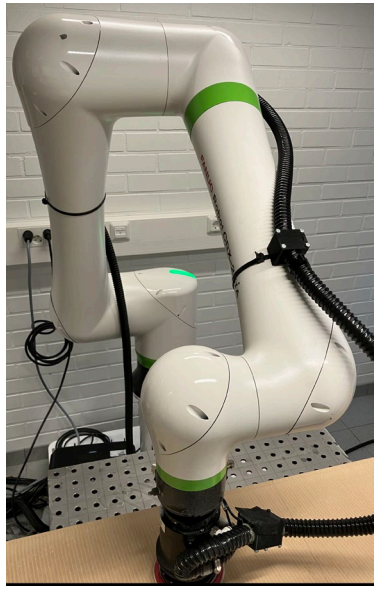
Content

Robot printing in Plast Lab Img. By: Ajay Sharma

Robot milling in Plast Lab Img. By: Ajay Sharma



Robot sanding in Centria Img. By: Ajay Sharma

1. Installation of automatic tool changer.
2. Integration of ATC in robotic cell.
3. Benefits of ATC implementation.
4. Integration of milling spindle to ABB IRC5.
5. Setup for robotic sanding process.
6. Sanding trials output.
7. Benefits of robotic sanding.
8. Lab infrastructure and technical report.

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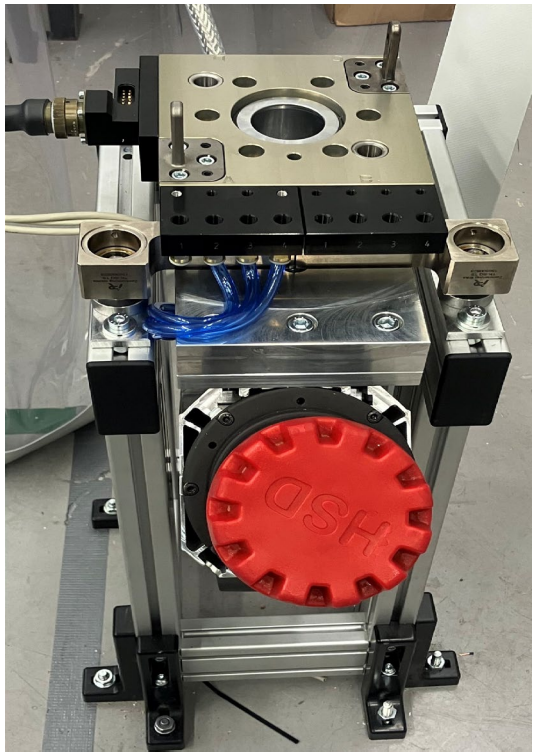
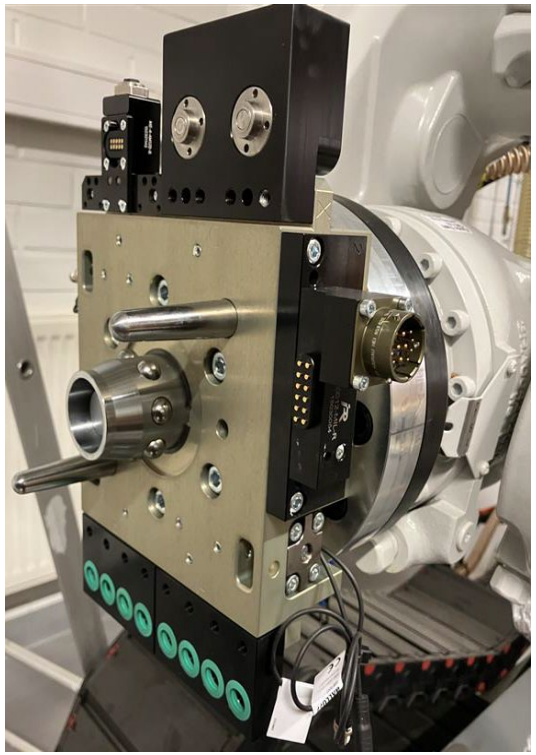
Installation of Automatic Tool Changer

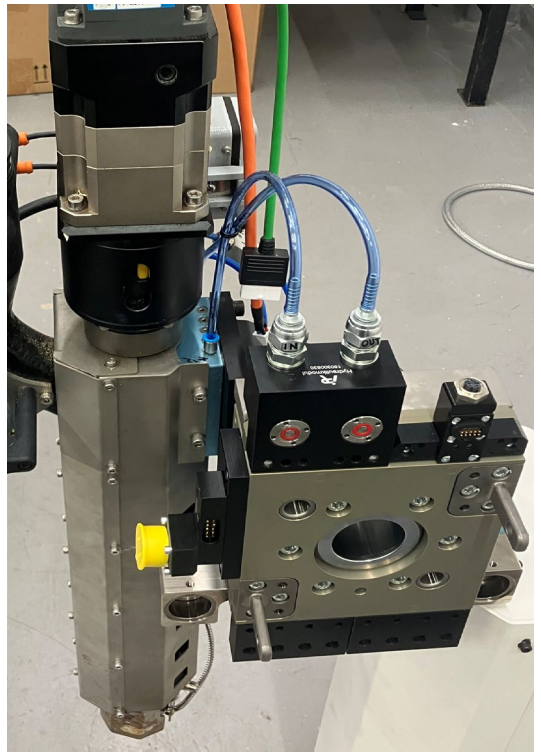
IPR ATC is installed and integrated in current ABB IRC5 robot cell for smooth and rapid tool change and to make cell more flexible according to work between 3D printing and milling operations.



ATC Tool Side – Milling Spindle, Img. By: Ajay Sharma



ATC Robot Side – Main Wrist, Img. By: Ajay Sharma



ATC Tool Side – Printing Extruder, Img. By: Ajay Sharma

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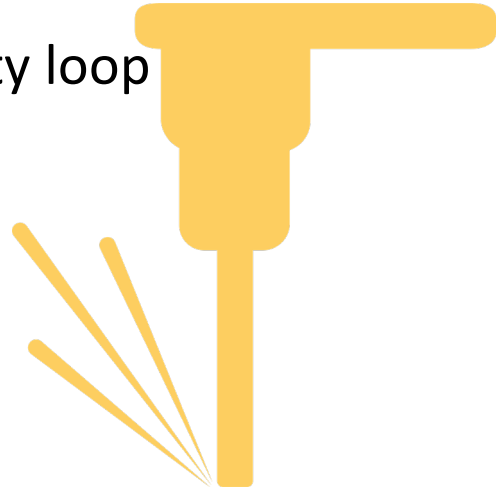
Integration of ATC in robotic cell

Robot with 3D printing extruder, Img. By: Ajay Sharma

Robot with milling spindle, Img. By: Ajay Sharma

Automatic Tool Changer integration with ABB IRC5 controller for safe interlocking and safe operation consists of the below major steps: -

- Electronics wiring and pneumatics channel installation.
- Mapping of ATC wired I/Os with robot controller I/Os.
- Sensor feedback and safety loop development and testing.



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Benefits of ATC implementation

Robot while doing head changing process at Plast Lab, Img. By: Ajay Sharma

- Increased production flexibility
- Reduced cycle time and downtime
- Higher return on investment (ROI)
- Improved process consistency
- Flexible and scalable

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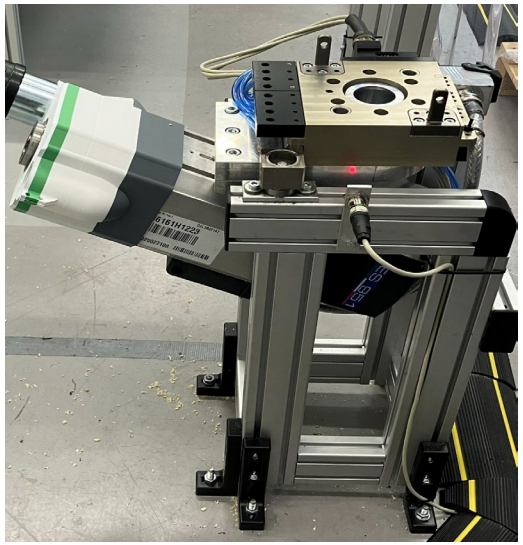
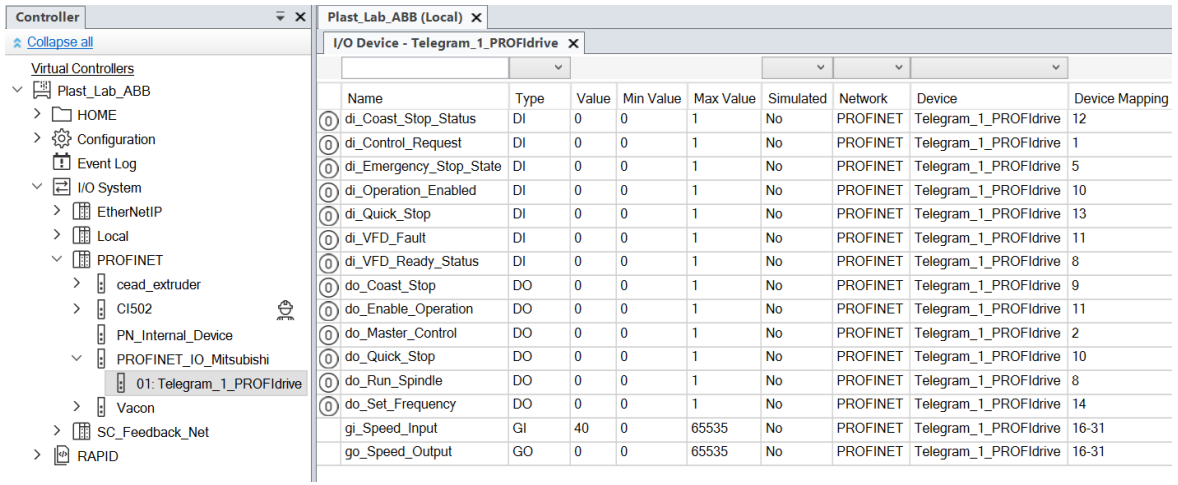
Integration of milling spindle to ABB IRC5





Name	Type	Value	Min Value	Max Value	Simulated	Network	Device	Device Mapping
di_Coast_Stop_Status	DI	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	12
di_Control_Request	DI	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	1
di_Emergency_Stop_State	DI	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	5
di_Operation_Enabled	DI	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	10
di_Quick_Stop	DI	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	13
di_VFD_Fault	DI	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	11
di_VFD_Ready_Status	DI	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	8
do_Coast_Stop	DO	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	9
do_Enable_Operation	DO	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	11
do_Master_Control	DO	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	2
do_Quick_Stop	DO	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	10
do_Run_Spindle	DO	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	8
do_Set_Frequency	DO	0	0	1	No	PROFINET	Telegram_1_PROFIdrive	14
gi_Speed_Input	GI	40	0	65535	No	PROFINET	Telegram_1_PROFIdrive	16-31
go_Speed_Output	GO	0	0	65535	No	PROFINET	Telegram_1_PROFIdrive	16-31

HSD milling spindle on docking stand, Mitsubishi VFD and a snapshot of signals mapping in IRC5 at Plast Lab, Img. By: Ajay Sharma

For robotic machining operation in at Plast Lab, a milling spindle is integrated in the robotic system. Integration consists of following steps:

- Electronics wiring of spindle sensors
- Variable frequency drive installation and connection for spindle
- Communication of VFD and robot controller
- Profinet setup and I/O mapping
- Signals testing and telegram setup
- Testing and trials.

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Lab infrastructure and technical report

Below is a glimpse of facilities available:-

1. ABB IRB6700-175/3.05 Robot with Payload of 175 KGs and stroke limit of 3.05 meters.
2. IRC5 Robot Controller
3. CEAD Extruder for 3D Printing
4. HSD milling spindle for machining operation
5. Mitsubishi VFD for spindle control
6. IPR ATC for rapid tool changing
7. Milling tool magazine

This development is to be continued with upcoming installations of chips removal and dust collection system and a master PLC station for future integrations. Integration technical report is available at https://www.theseus.fi/items/88c26638-0253-4d00-acbe-9fd7fe7727c6

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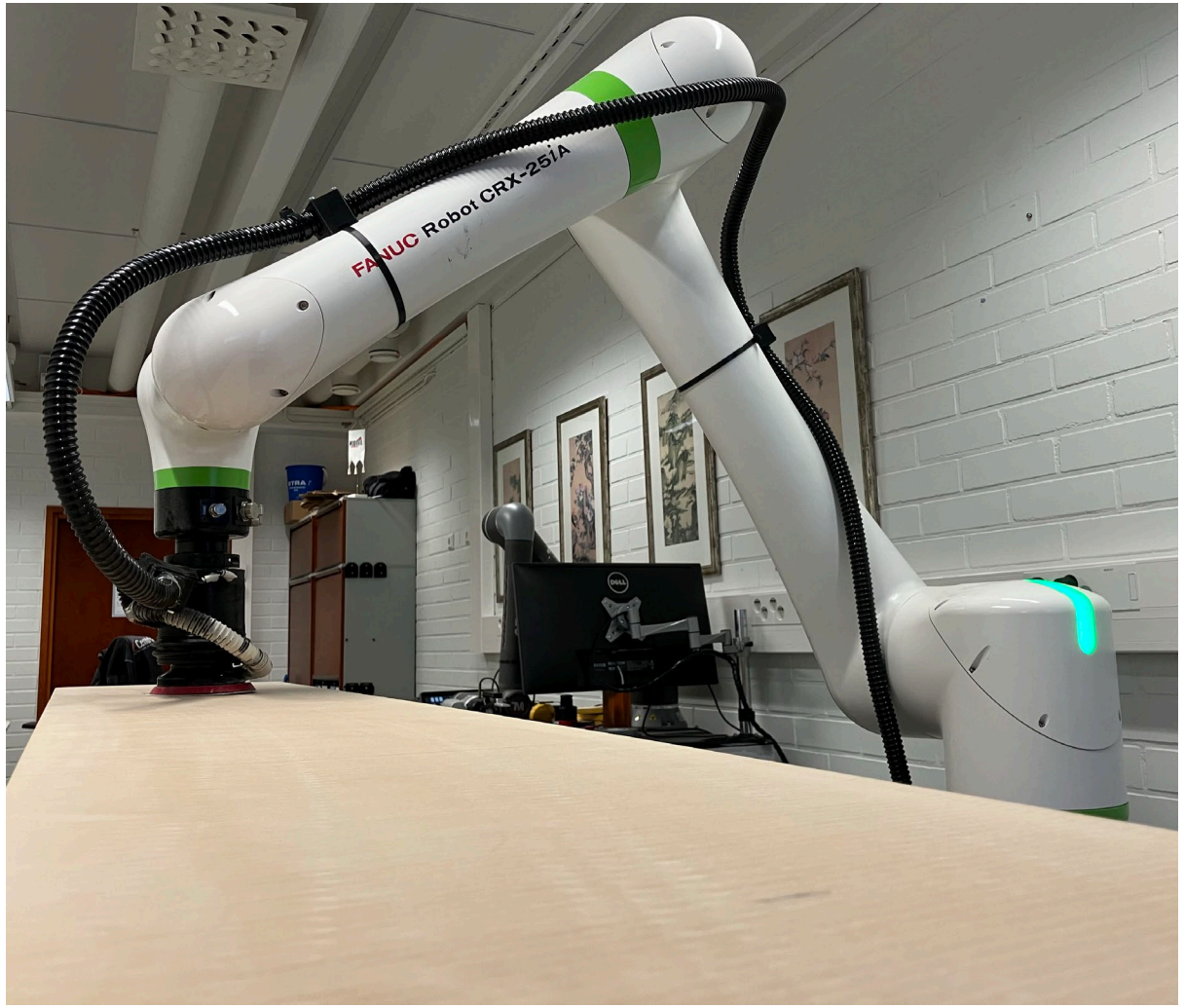
Setup for robotic sanding process

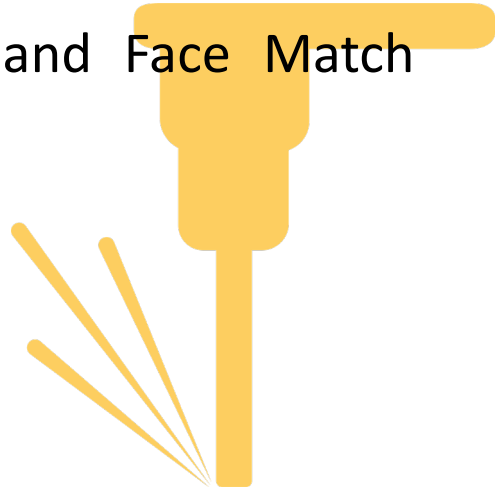


FANUC CRX-25iA cobot performing sanding operation at Centria University of Applied Sciences, Img. By: Ajay Sharma

Robotic sanding was executed with a collaborative system with integrated force control function.

We used:-

- FANUC CRX-25iA, R30iB Mate Plus (ABB System can also be used for sanding)
- Schunk 125 mm orbital sander
- Abranet 120 Grade Sandpaper
- Integrated Force Control and Face Match function.



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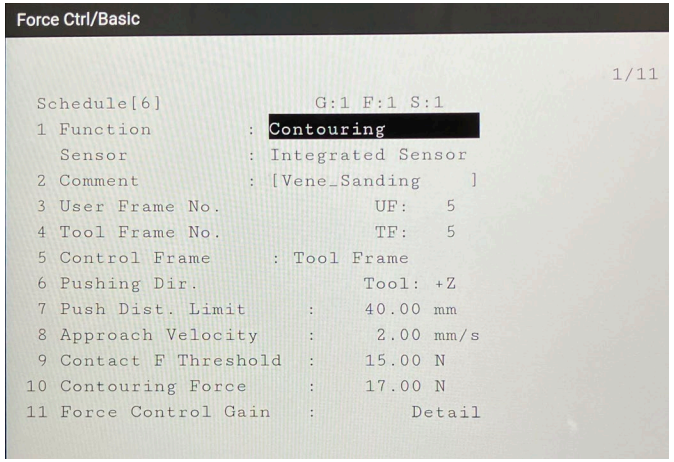
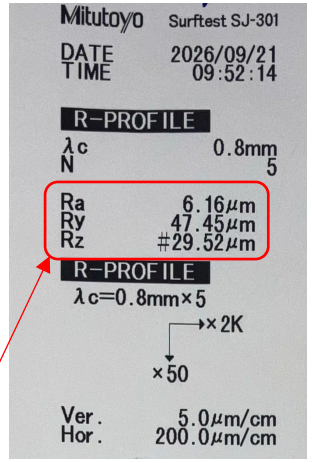
Sanding trials output

- Material sanded - PP-wood fiber composite
- Sanding disc - P120 Abranet abrasive
- Achieved surface roughness - Ra (average roughness) = 1.93 µm and Rz (average maximum height) = 8.18 µm after four sanding passes.

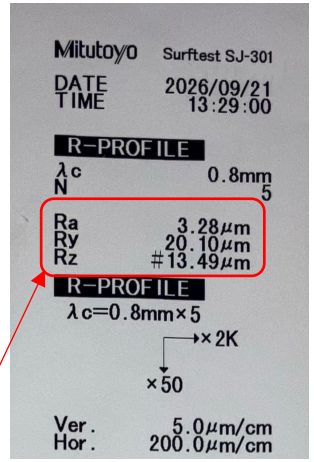
Results representing approximately 70% improvement over the initial surface condition. Testing is done by Mitutoyo SurfTest SJ-301



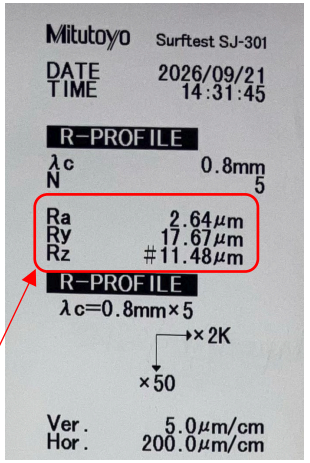
Force Control snippet showing parameters used to perform sanding, Img. By: Ajay Sharma



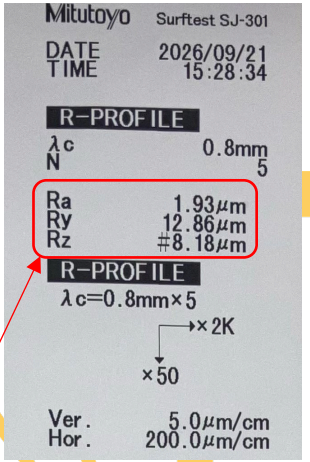
Surface reading before sanding



Surface reading after 1st pass with P120 and 14 N force



Surface reading after 2nd pass with P120 and 16 N force



Surface reading after 4th pass with P120 and 17 N force

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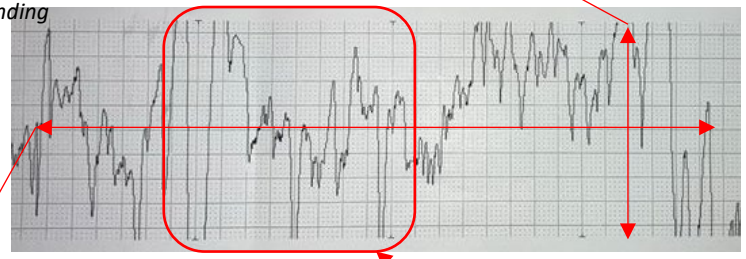
Sanding trials analysis

The measured surface roughness is within a suitable range for mechanical keying, which enhances adhesion between the substrate and the applied coating. To further improve surface quality and achieve a smoother, high-gloss finish, progressive sanding with P600 to P1200 grit abrasives can be employed.

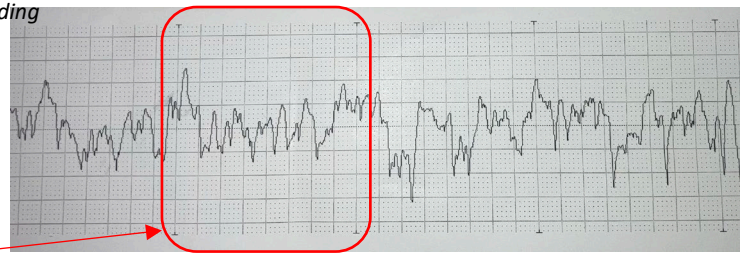
Application	Typical Ra Range (µm)	Surface Description	Suitable for Ra = 1.93 µm ?
High-gloss mould (automotive/Class-A composite finish)	0.05 - 0.20	Mirror-like	Much too rough
Glossy tooling gelcoat after polishing	0.05 - 0.30	Highly polished	Too rough
Painted cosmetic surface (before topcoat)	0.2 - 1.0	Smooth sanded surface	Slightly rough
Primer adhesion surface	0.8 - 3.0	Controlled scratch pattern	Good
Tooling gelcoat adhesion to substrate	1.0 - 5.0	Mechanical keying surface	Very suitable

Rz line representing the average of up and down values of the peaks and valleys in a reading segment of the surface

Before sanding



After sanding



Ra line representing the average of up and down values of the peaks and valleys relative to center line in a reading segment of the surface

*Graphical representation of **Ra** and **Rz** values before and after sanding with P120 grade paper, Img. By: Ajay Sharma*

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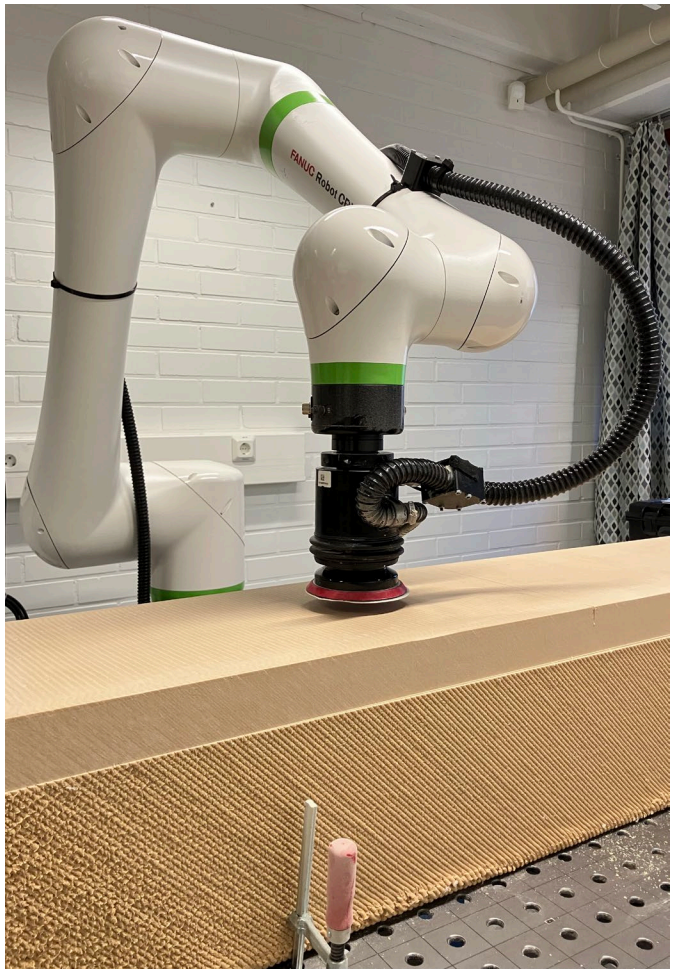
Benefits of robotic sanding



FANUC CRX-25iA cobot performing sanding operation at Centria University of Applied Sciences, Img. By: Ajay Sharma

- Consistent surface quality
- Improved coating readiness
- Reduced manual labor
- Higher productivity
- Access to complex geometries
- Precise force control
- Easy process optimization
- Improved worker safety
- Scalable automation
- Digital process monitoring

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Thank You!

Presented By Ajay Sharma (RDI Expert)

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