



Milling machine manufacturer

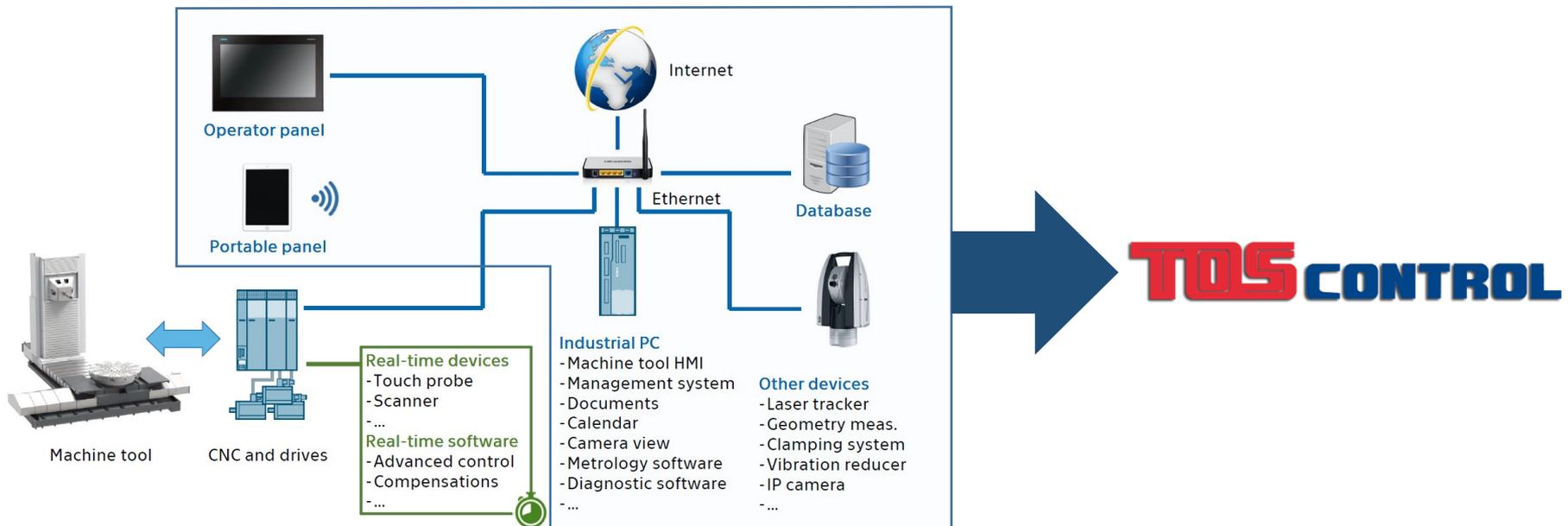
TOS VARNSDORF a.s.



TOS Control

- **Unified machine tool interface** – for operators and also for the external systems
- **Specialized apps** for extended functionality with uniform design
- Shown **directly on control system panel**
- Gate for **communication with other systems** (OPC-UA, database SQL)

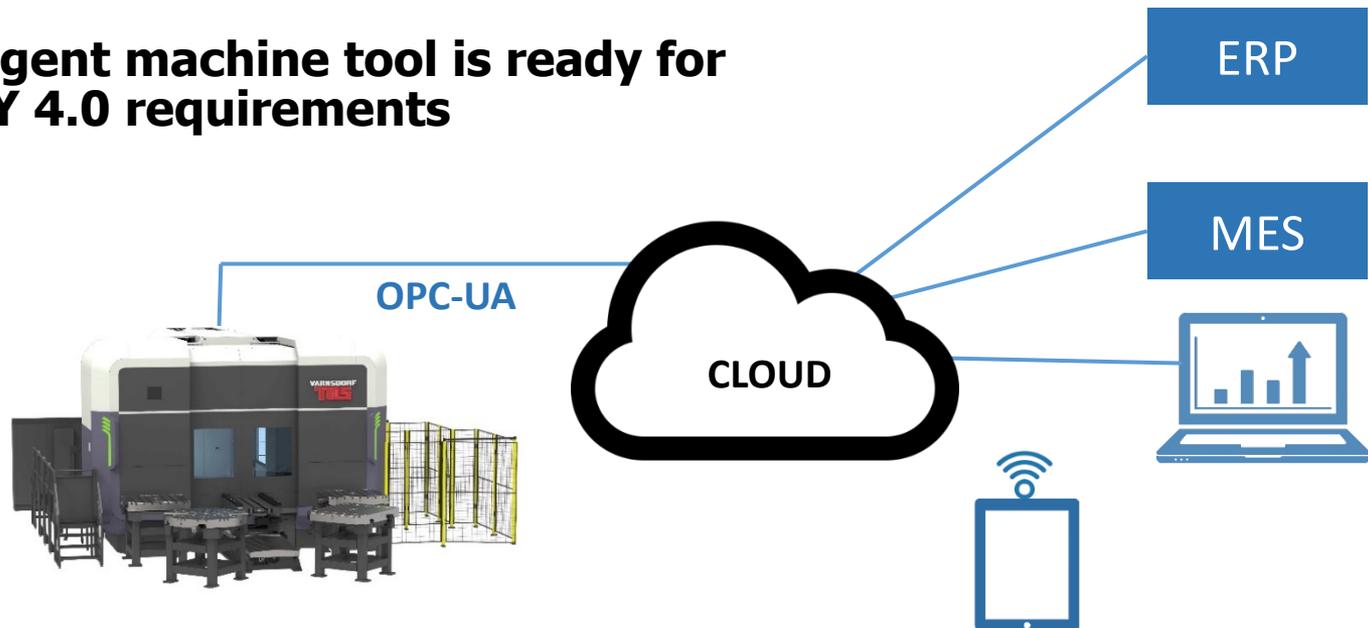
Extension over the basic control system interface that **other manufacturers do not use**



Added Value of TOS Control

- Machine **integration** to plant information system – online data exchange
- Planning with respect to **real machine state** – **online monitoring and prediction**
- Improvement of machine tool **functionality** – machining, inspection, compensation ...
- **Digital twin** for **technology check**, **machining results check** and **machining process improved monitoring**
- **Unified interface and connectivity**
- User friendly **interaction** with operator, foreman and planner

The intelligent machine tool is ready for INDUSTRY 4.0 requirements



New control panels

Sinumerik 840D SL



- Newly for all machines sold since 01/2020
- Brand new design
- The panel body is always the same, changeable connection arm as needed
- 22“ touch screen

New control panels

Heidenhain TNC 640



- Newly for all machines sold since 01/2020
- Expedition 05/2020
- Brand new design
- The panel body is always the same, changeable connection arm as needed
- 24" touch screen

New control panels



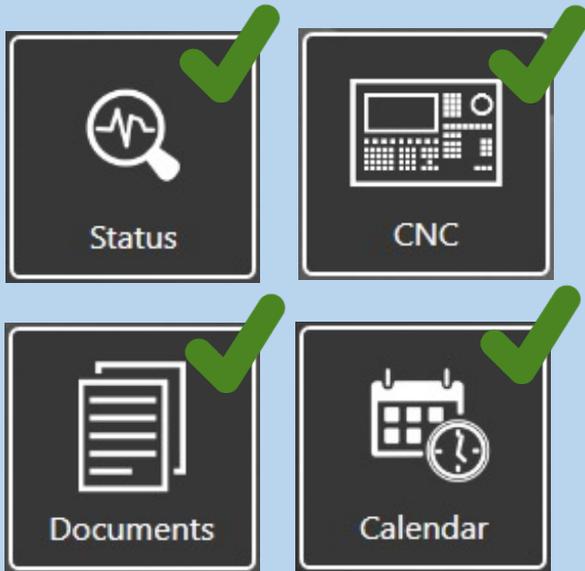
Both control panels can be optionally equipped with an RFID chip unit, which allows:

- Identification of machine operator and access level
- Quick login and logout of machine operator
- Possibility of quick “locking” of the machine

TOS Control – apps overview

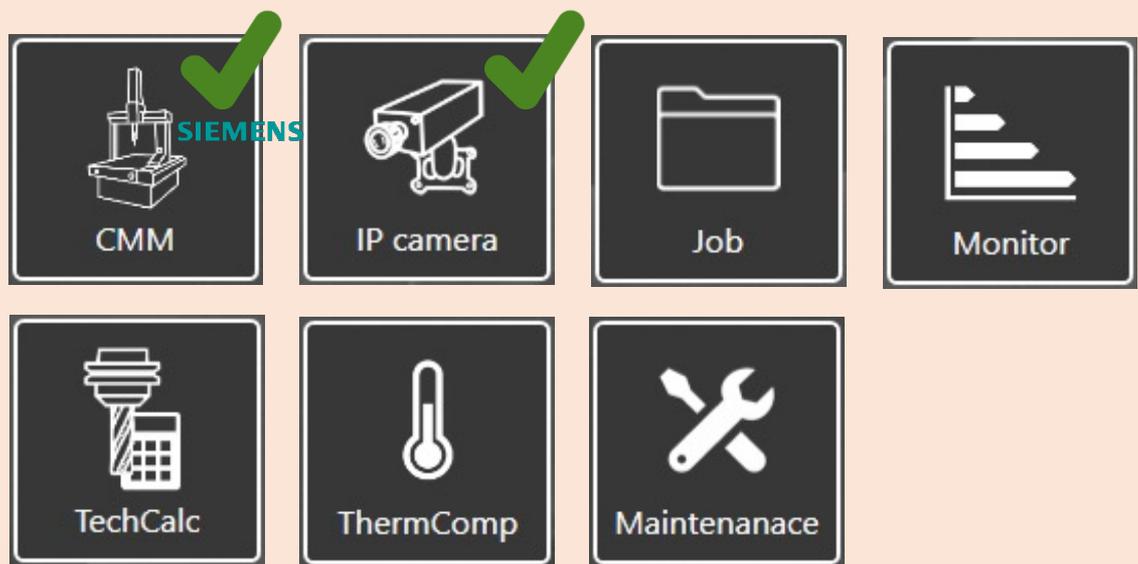
BASIC APPLICATIONS

- Standard equipment
- Included in the basic equipment of the machine



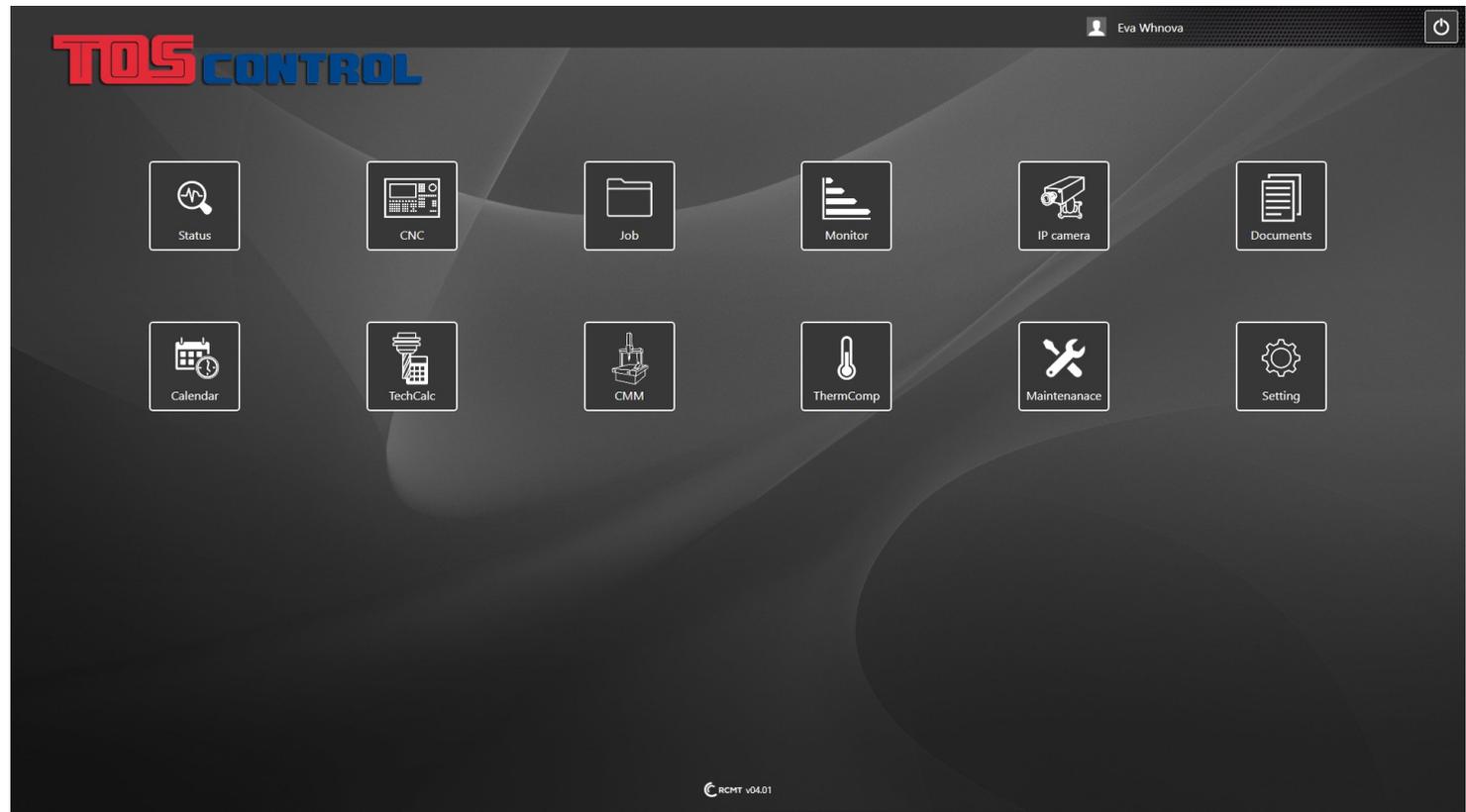
EXTRA APPLICATION

- Additional machine equipment (surcharge)
- Enables full utilization of TOScontrol's potential



TOS Control – Main menu

- **Main screen** after control system loading
- **Overview** of individual application – like on smartphone
- **Logged user ID**
- Power off button



TOS Control – User account

- User Information
- Overview of its rights, folders and access to the machine
- Option to log out or lock screen
- Possibility to change the password

The screenshot displays the user account management interface for Eva Whnová. The interface is divided into several sections:

- User Information:**
 - Whnová Eva**
 - Username: evicka
 - Email: evhn@tosvarnsdorf.cz
 - Phone: +420 739 531 463
- Password settings:**
 - Old password:
 - New password:
 - Confirm password:
 - Set password** button
- User rights:**

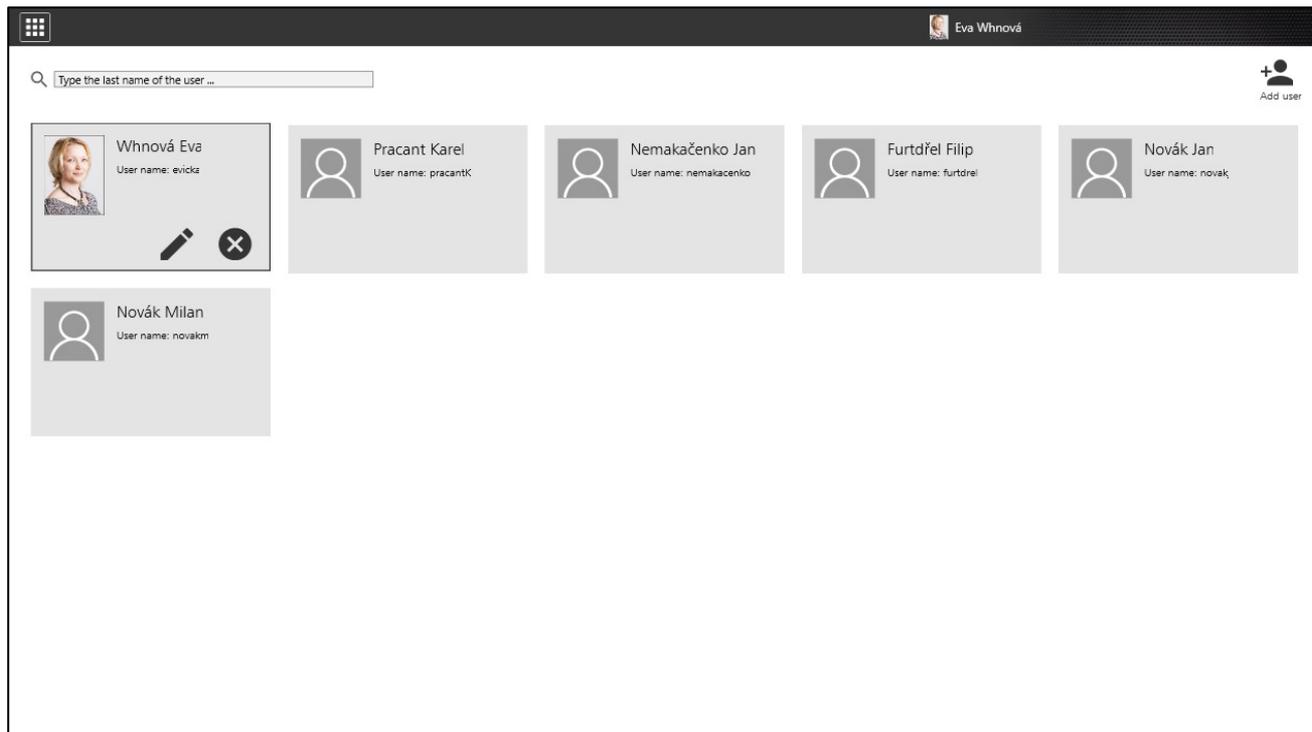
Category	Can Edit
Admin	YES
Manager	YES
Worker	YES
Guest	YES
Master	YES
- User machines:**

Machine Number	Machine Name
448281	Stroj 1
452450	Stroj 2
482420	Stroj 3

At the bottom of the interface, there are two buttons: **Lock** (with a lock icon) and **Logout** (with a right arrow icon). A 3D model of a machine is visible in the bottom right corner of the interface.

TOS Control – Administration of user accounts

- Access only with Administrator rights
- Overview of all users
- Ability to add a new user
- Editing and deleting users
- Allocation of user rights





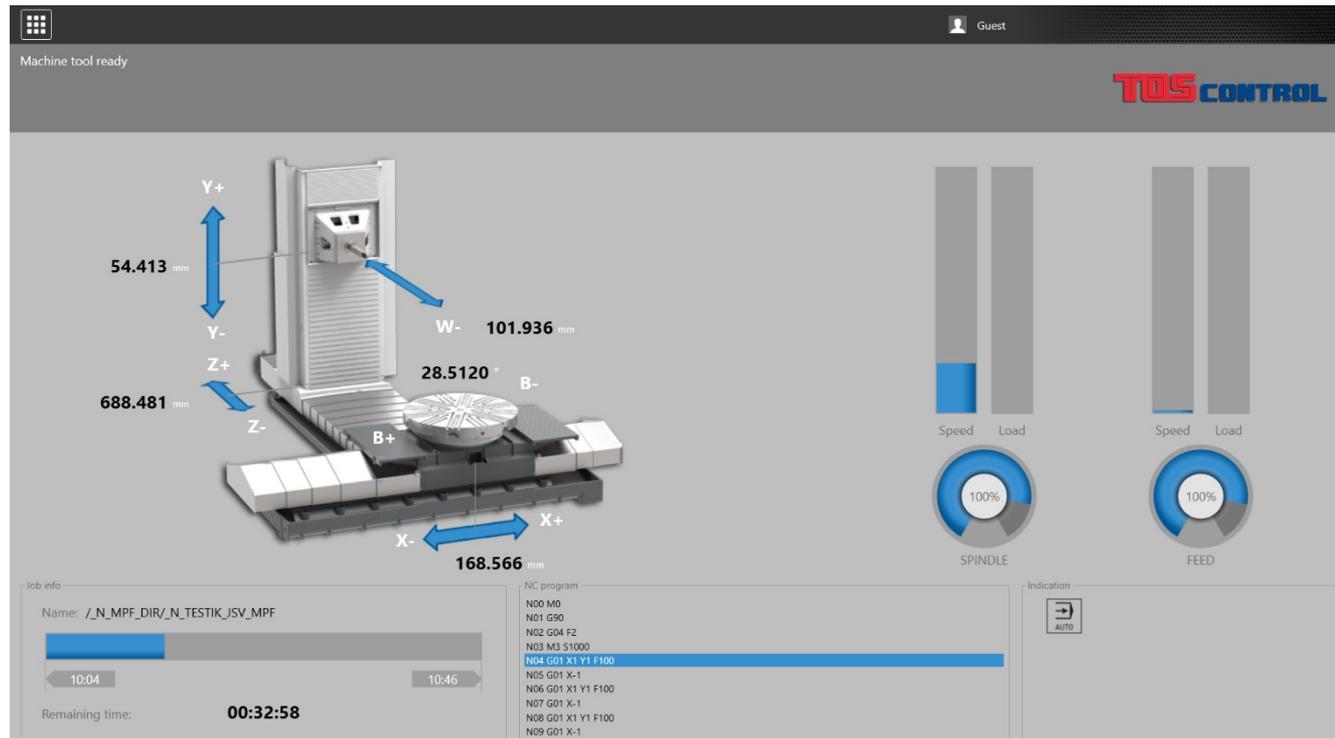
Status

TOS Control – Status

Category: BASIC APP

State: **READY**

- Overview of **machine tool state** – virtual cockpit
 - Actual program, process flow
 - Actual position of machine axes
 - Override, speed, machine load
 - Operation mode
 - Alarms





TOS Control – CNC

Category: BASIC APP

State: **Ready**

- View of standard control system HMI
 - Sinumerik Operate
 - Heidenhain HEROS
- Ready for Siemens Sinumerik 840D sl, finalization for Heidenhain TNC640
- Uniform design of side bar – e.g. IP cam, 3D model, Calendar ...

The screenshot displays the TOS CNC control HMI interface, divided into several functional areas:

- Manual operation:** Shows position display with MODE: NOML. Values for X (+0.000), Y (+0.000), Z (+100.000), A (+0.000), C (+0.000), and S1 (+0.000).
- Job overview:** Includes a calendar and a 3D model of the workpiece.
- Machine status:** Displays active machine data for NC/MPF/TESTIK_JSU, including position [mm] and dist-to-go for X, Y, and Z axes.
- Program data:** Lists program blocks (N03 to N11) with parameters like M3, S1000, G01, X1, Y1, F100, and G04.
- Control panel:** Features buttons for M, S, F, TOUCH PROBE, PRESET MANAGEMENT, 3D-ROT, and TOOL TABLE.

Machine	Position [mm]	Dist-to-go	T.F.S
- X1	28.54700	-27.54700	T
- Y1	9.78100	-8.78100	
Z1	688.48100	0.00000	
A1	101.93600°	0.00000	F 100.000
B1	28.51200°	0.00000	100.000 mm/min 100%
C1	0.00000°	0.00000	S1 1000
			Master 1000 100%

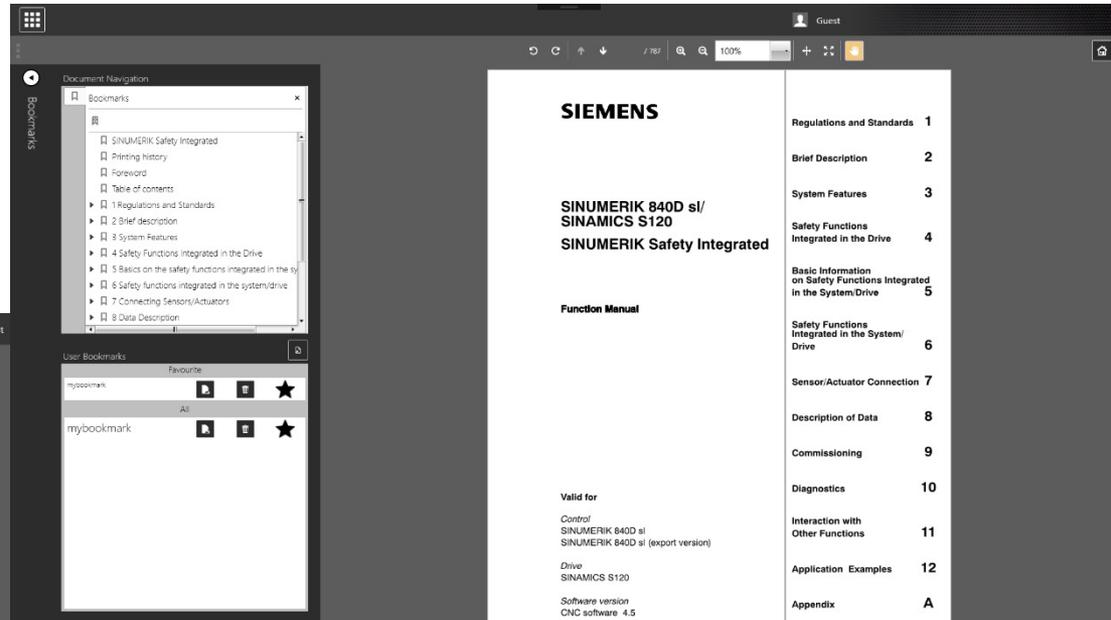
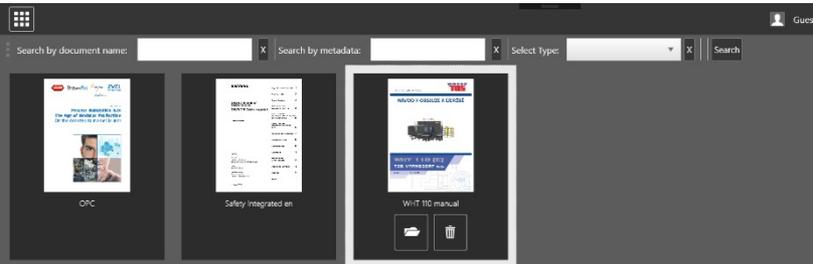


TOS Control – Dokumenten

Category: BASIC APP

State: **READY**

- PDF document reader
- Document access control based on user group
- Favorite documents
- Bookmarks
- Smart document search based on title, type, and keywords



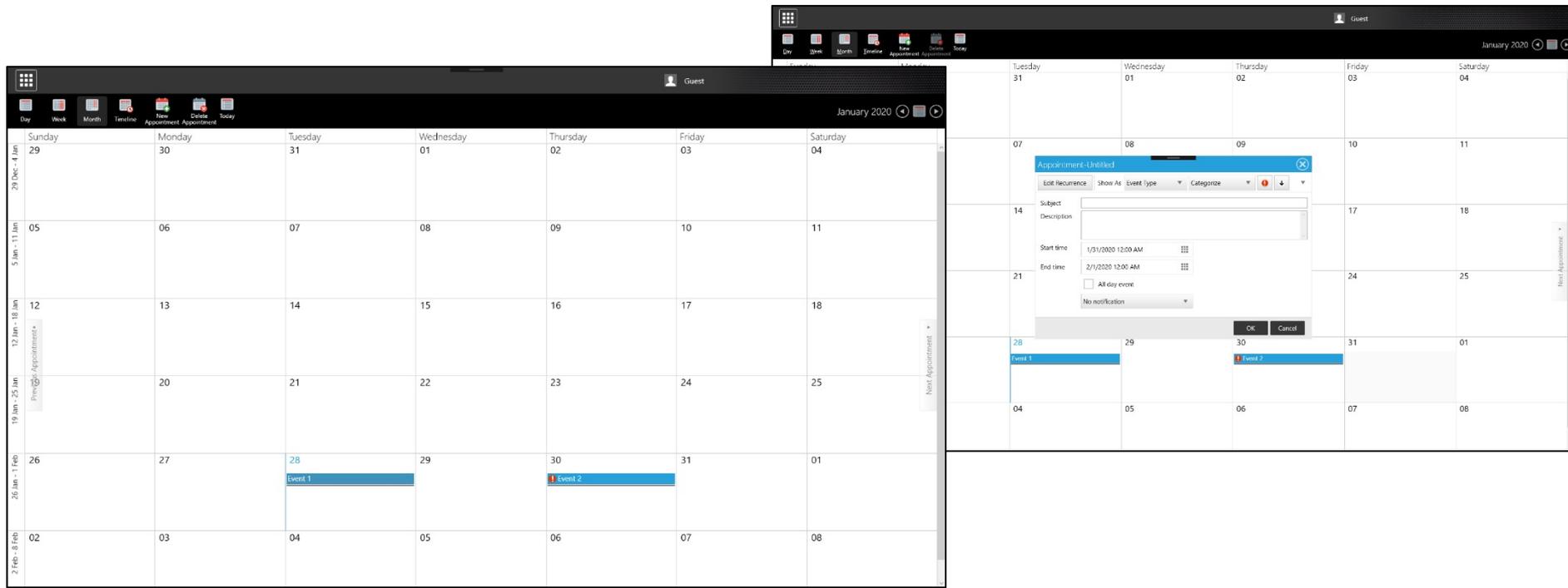


TOS Control – Calendar

Category: BASIC APP

State: **READY**

- Standard **calendar** view – day, week, month
- **User appointment** – add, modify, delete
- Machine tool producer appointment – **service events**
- Event types based on user needs
- Calendar **reminder**
- All data stored in the **local database**



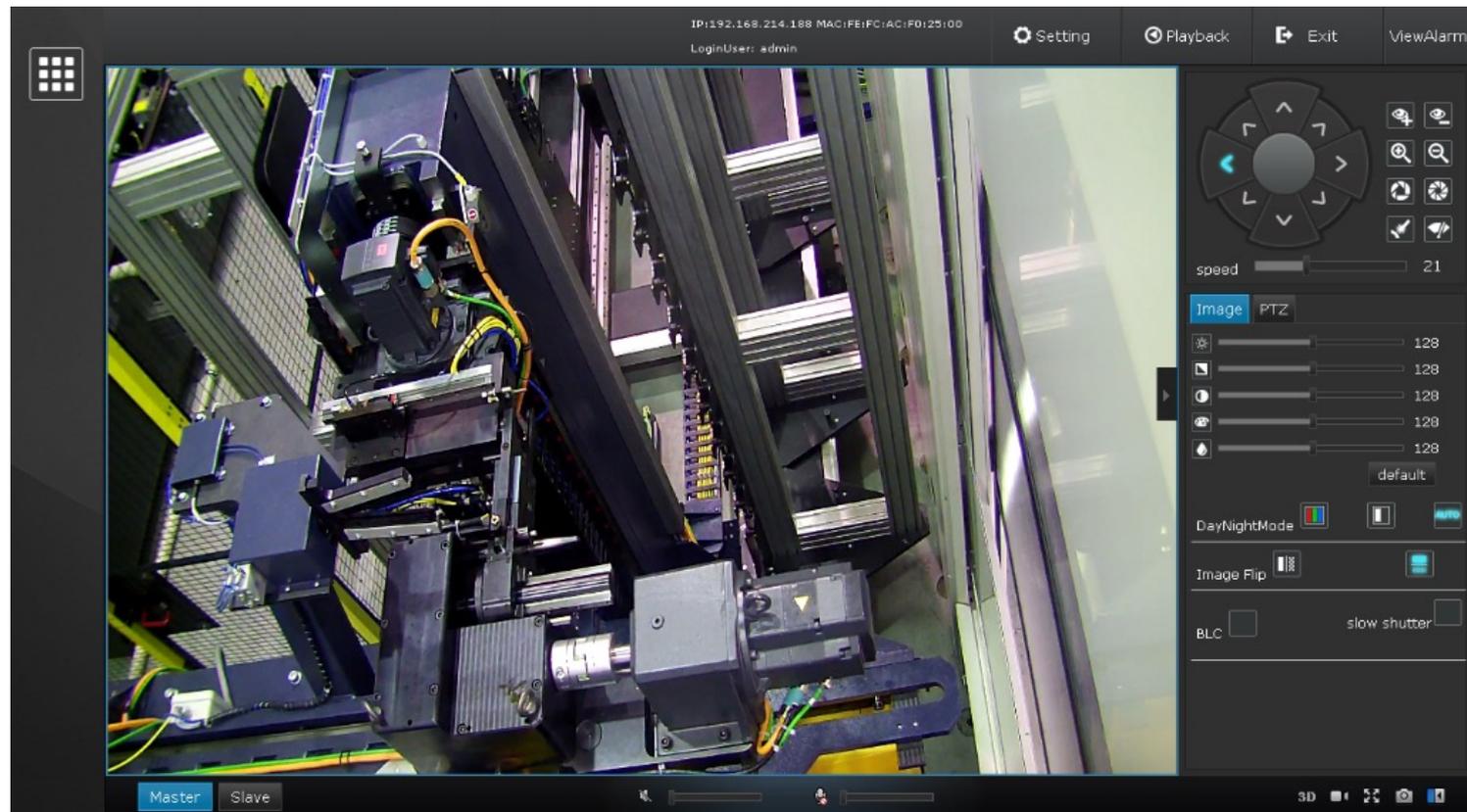


TOS Control – IP cam

Category: EXTRA APP

State: **READY**

- Integration of **IP camera view**
- Motorized camera control





TOS Control – Technology calculation

Category: EXTRA APP

State: **Development**

- **Technological advisor** for selected tool
- Support for the selection and check of **cutting conditions**:
 - Cutting speed determination
 - Feed per tooth/revolution
 - Feed speed
 - Theoretical machining time per operation
 - Material removal rate for selected depth of cut
 - Prediction of cutting force and spindle load

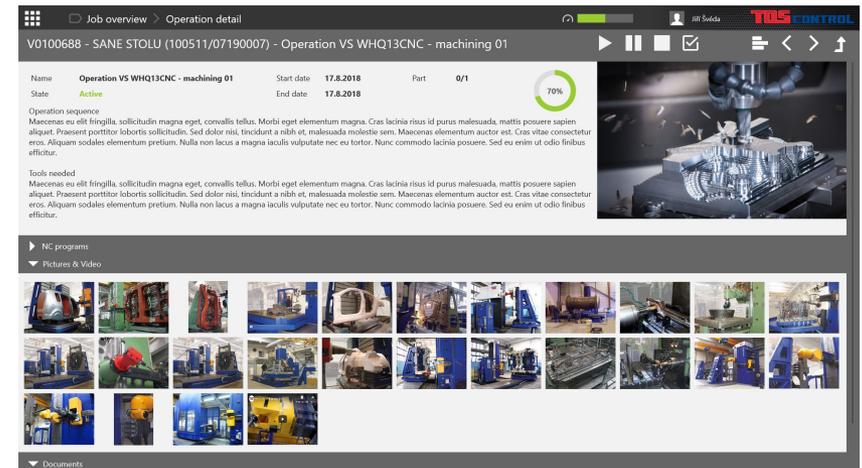
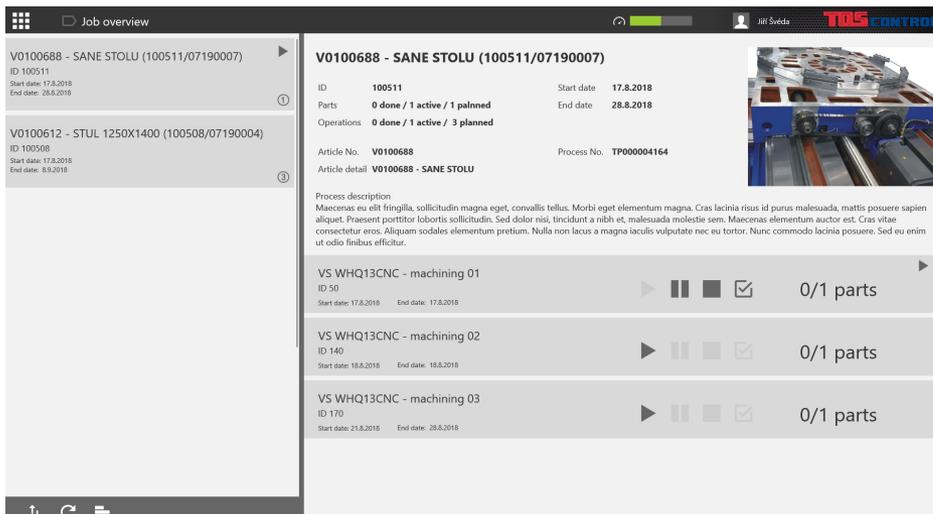


TOS Control – Job management 1/2

Category: EXTRA APP

State: **Development**

- View of **Work order and Operation overview** directly on machine tool control panel
- **Connected with ERP**
- Logging operation, pause, stop, done
- Work order time line view
- **Connection** with other documents
 - WO/Operation description
 - NC programs
 - Photos
 - Other documents – pdf, doc, xls, cad ...



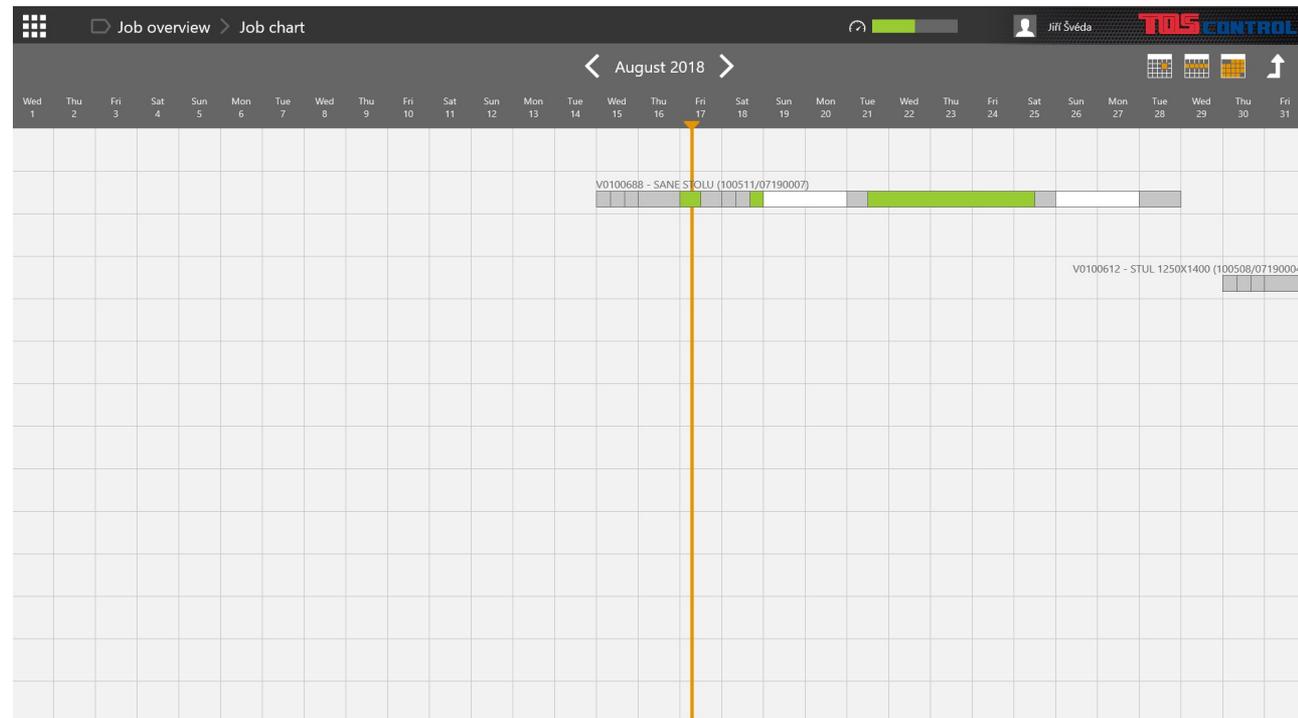


TOS Control – Job management 2/2

Category: EXTRA APP

State: **Development**

- Connection to ERP / MES system
- It can automatically assign tasks to a machine of the same type
- When entering the machine status, takes into account also this parameter for action selection
- Production optimization using logic algorithms





TOS Control – Machine monitor

Category: EXTRA APP

State: **Development**

- Integration of a system for **monitoring the history of machine tool use**
 - data logging to database, show trends
- **Time line** view of machine tool basic states
 - Production
 - Production slow (override < 100%)
 - Ready
 - Error
 - Power off
- Log of **other variables**
 - Temperature
 - Acceleration
 - Load
- Possible assignment to single operation





TOS Control – Inspection and compensation 1/2

- Integration of **CMM with touchprobe** into the machine tool
 - Integration of **metrology software** to machine control
 - Implementation of **additional measurement** for machine error compensation during workpiece inspection
- Automatic compensation for consequent machining based on measured data**

Category: EXTRA APP

State: **READY**

The screenshot displays the TOS Control software interface, divided into four main functional areas:

- Main Menu:** A central panel with four large buttons: "Measure" (with a CMM icon), "Compensate" (with a bar chart icon), "Tracking" (with a probe icon), and "Settings" (with a gear icon).
- 3D Measurement View:** A 3D visualization of a touchprobe measuring a pink rectangular workpiece. The interface includes a top toolbar with various icons and a bottom toolbar with more detailed controls.
- Volumetric compensation:** A 3D grid with a blue mesh overlaying it, representing the compensation data. To the right, an "Entity info" panel lists technical data:

Entity info	
11-09-2017 16:54:18	
Name: PLN1	
Entity type: PLANE	
Name of element: 16	
X:	-41.971
Y:	41.971
Z:	104.437
I:	-0.014
J:	0.014
K:	1.000
E:	-0.120

X:	-11.971
Y:	41.971
Z:	104.733
I:	-0.014
J:	0.014
K:	1.000
E:	-0.120

X:	14.029
Y:	41.971
Z:	105.026
I:	-0.014
J:	0.014
K:	1.000
E:	1.200

X:	42.029
Y:	-41.971
Z:	105.153
I:	-0.014
J:	0.014
K:	1.000
E:	-0.120
- Laser tracker:** A panel titled "Laser tracker" showing alignment data for a machine and a tracker.

Laser tracker	
machine	tracker
X:	0.000 [mm]
Y:	0.000 [mm]
Z:	0.000 [mm]

X:	0.000 [mm]
Y:	0.000 [mm]
Z:	0.000 [mm]

 Below this is a "stationary measurement" section with similar X, Y, Z values. At the bottom, there are buttons for "Connect to tracker", "Initialize tracker", and "Start measure". An image of the AT960 laser tracker is shown on the right.



TOS Control – Inspection and compensation 2/2

Category: EXTRA APP

State: **READY**

- **Main advantages**

- It is not necessary to move and clamp the workpiece between CMM and machine tool
- Machine tool is controlled directly from a **metrology software – comfortable**
- Measured data can be automatically activated as a **correction in CNC – no NC program modification** for consequent machining
- Machine tool knows the workpiece real shape



- **Additional measurement**

- Correction of the touch coordinates
- Integrated optical measurement of TCP
- Or external measurement – laser tracker

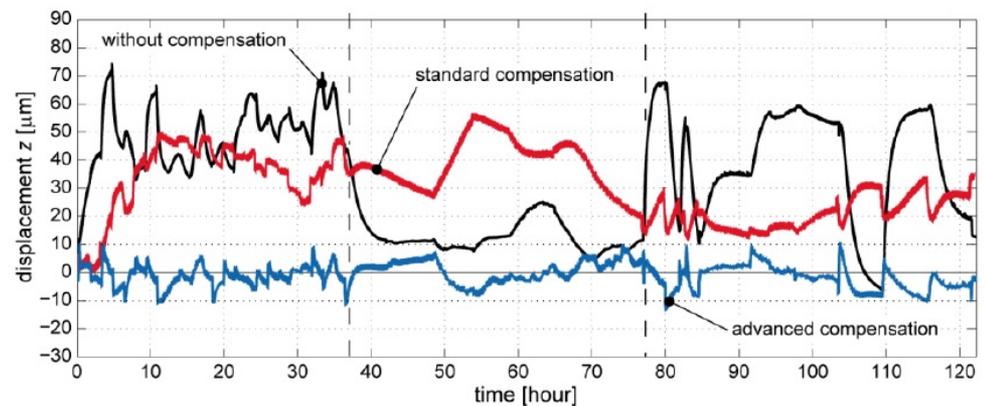
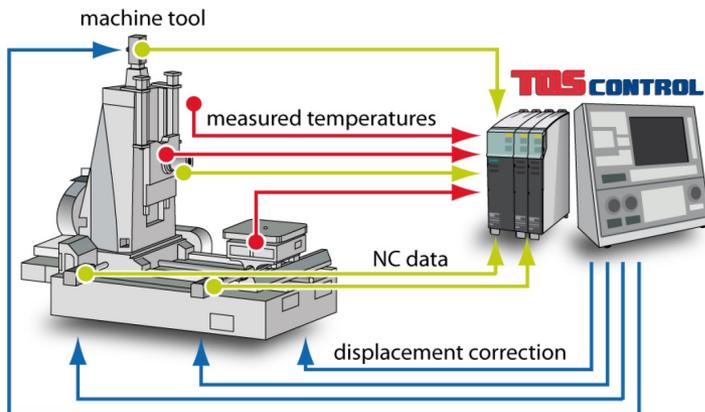


TOS Control – Thermal compensation

Category: EXTRA APP

State: **Development**

- **Virtual model** of the thermal behavior of the machine tool (based on thermal transfer functions)
- Runs simultaneously with real machine and **identifies the thermal error**
- **Respects the history of thermal loading**
- Model inputs
 - Temperature sensors
 - Spindle and feed axis load
 - Other NC data
- **The main advantage is high reliability and accuracy**
- **Top level** of thermal error compensation



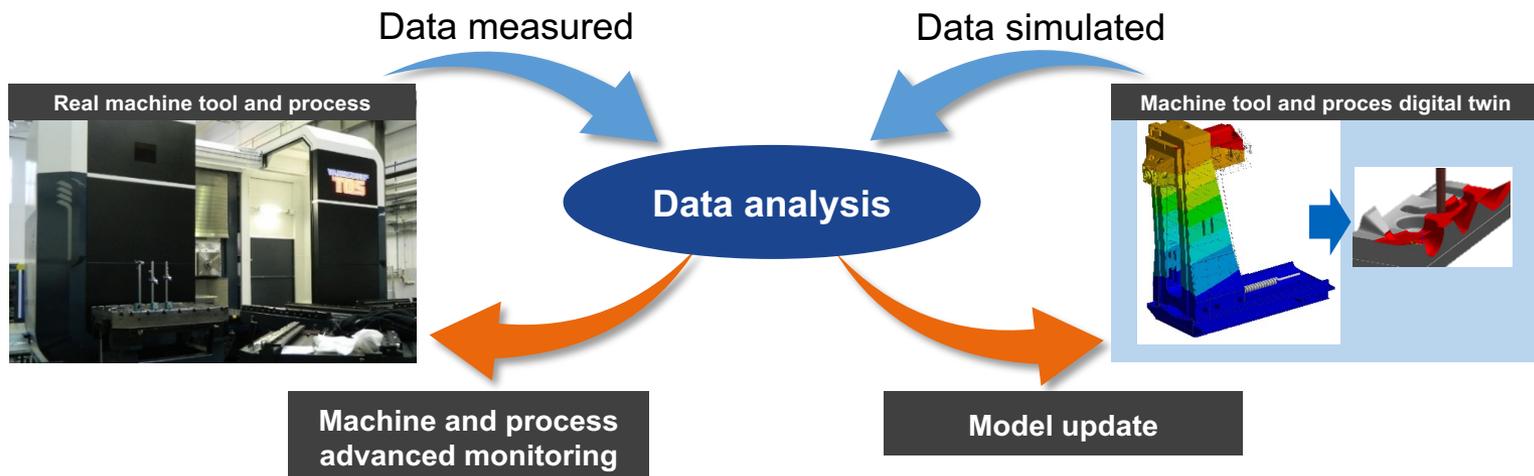


TOS Control – Predictive maintenance

Category: EXTRA APP

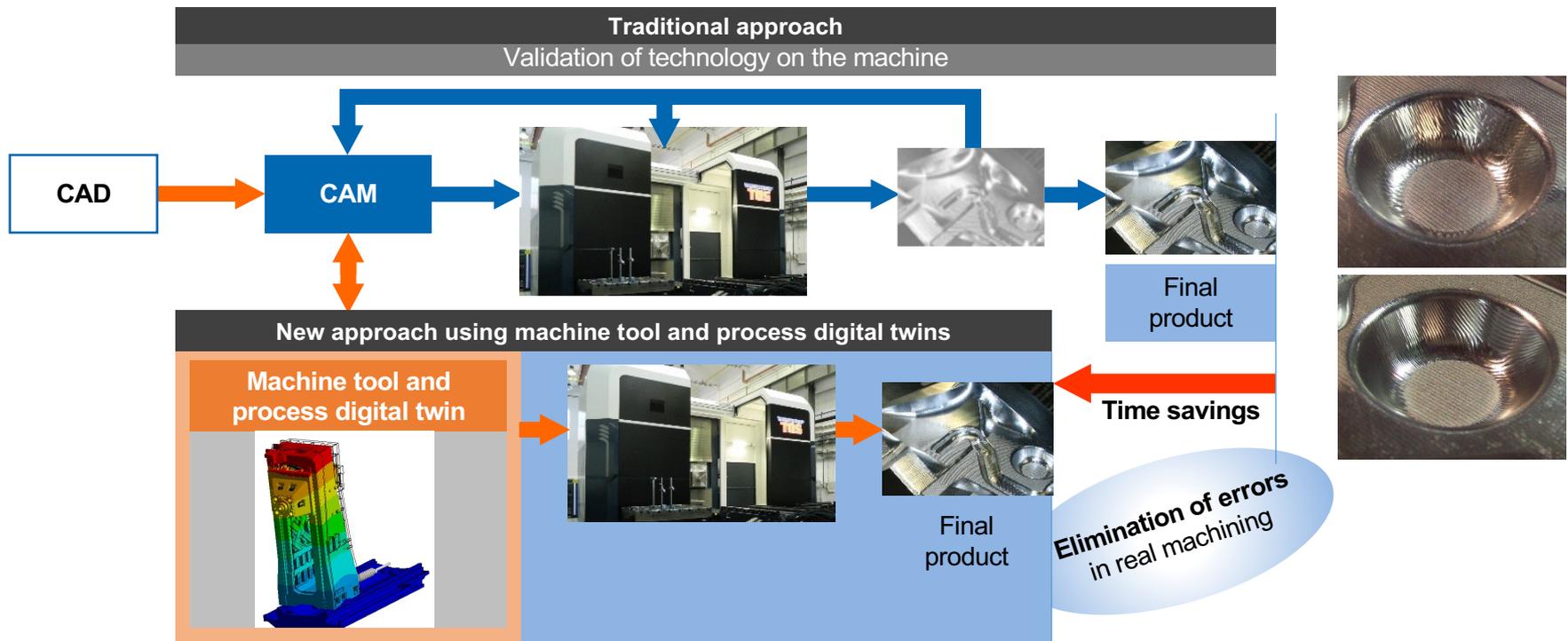
State: **Development**

- Extension of Machine monitor app
- Monitored parameters are **compared with**
 - **Digital twin (virtual machine model)**
 - Model obtained by **machine learning technology**
- Prediction of **service events**
- Focused on selected machine key parts, especially:
 - **Spindle**
 - Milling head
- **Reduction of service costs**, increase of machine operation time



Machine tool digital twin (virtual machine model)

- Common approaches of machining preparation using **standard CAM systems** does not exploit full potential of the machine and technology
- Adjustment of machining technologies is only implemented by trial tests
- **Machine tool and process digital twins** provide effective tools for **higher reliability** and **optimization of real machining processes**
 - Time and cost reduction



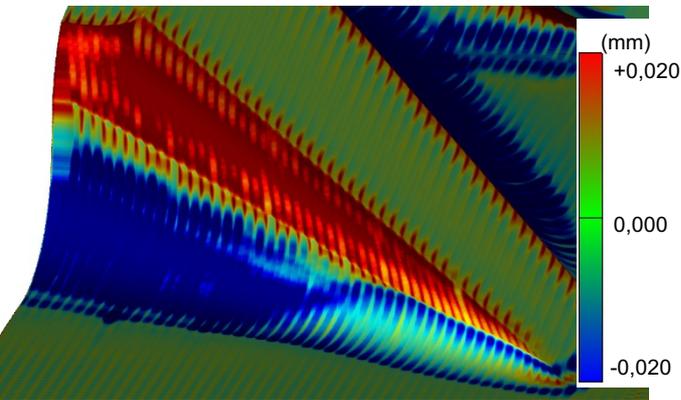
Machine tool digital twin (virtual machine model)

Applications:

- Exact **time studies**
- Check of the **NC data quality**
- Prediction of **machining accuracy and quality**
- Identification of **machining errors**

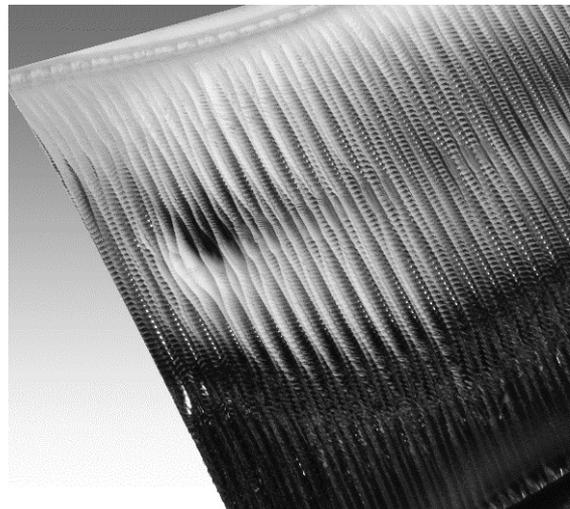
Virtual machine model
integrated in the TOScontrol

Virtual machine model as
technology support



Errors caused by CNC interpolation
and feed drive vibrations

Real workpiece



Virtual simulation

