INTRODUCTION: „DIGITAL PRODUCTIVITY SOLUTIONS“
CERATIZIT is a high-tech engineering group specialised in tooling and hard material technologies.
MORE THAN 95 YEARS OF EXPERTISE: MERGING OF TWO CARBIDE PIONEERS

1921

Plansee Tizit, founded in Reutte, Austria

1931

CERAMETAL, founded in Bereldange, Luxembourg
MORE THAN 95 YEARS OF EXPERTISE: STRATEGIC AND DYNAMIC GROWTH

1987
WNT joins Plansee Tizit

2002
CERATIZIT
Merging of CERAMETAL & Plansee Tizit

2010
CB-CERATIZIT
Joint venture

2012
Günther Wirth
Joint venture

2014
Promax Tools
Acquisition

2015
Klenk & Cobra Carbide
Acquisitions

2016
Becker
Acquisition

2017
Best Carbide & KOMET GROUP
Acquisitions

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TOOLING THE FUTURE
APPLICATION AREAS OF OUR PRODUCTS

- Automotive
- Mechanical engineering
- Construction
- Medical
- Aerospace
- Consumer electronics
- Energy
INDUSTRY SOLUTIONS

Automotive (Chassis)  
Heavy Engineering  
Transportation

Aerospace  
Energy  
Medical

Automotive (Powertrain)  
Machine Tool Builder (MTB)  
Miscellaneous Industries

Digital  
Solutions

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OUTLINE

▲ Current status of ToolScope Digital Productivity Solutions

▲ Outlook next few years - developments

▲ How to create solutions for Industry
CERATIZIT creates custom monitoring solutions with ToolScope
- Heavy adaptability to the machining process and the production environment

Enabling lights out machining through monitoring solutions

Monitoring of single machining cells to machining lines with robot loading and unloading

Marking of defective parts and tools

Visualization of the production process

Adding traceability through machining documentation
BRINGING DIGITAL SOLUTIONS TO THE CUSTOMERS

- TS-PM Tool/Process Monitoring
- CD-xDim Collision Detection
- TS-CM Condition Monitoring
- TS-AFC Adaptive Feed Control
- Offline-Analysis
- TS-Wear Wear Monitoring
- TS-TCLlog Tool Change Log
- TS-QRep Quality Documentation
- TS-MDA Automatic Shift Log
- TS-DataPro
- TS-Connect Cloud Function
Reduction of tool costs
Reduction of tool breakages
Reduction of rework/scrap
Protection against overload
Protection against follow on damages
TS-PM: TOOL & PROCESS MONITORING

- Self learning tolerance ranges
- Patented 6-Sigma method
- Monitoring of signal curve by considering reference processes
Tool and process monitoring with ToolScope

Drilling
The process can be monitored safely, if the process performance is min. 0.5% of the nominal motor performance higher than the idle cut performance.

Case Study
-  D3 mm drilling in aluminium with 17 kW spindle
-  1.9 mm solid carbide milling cutter in steel with 27 kW spindle
-  Detection of smaller tools depends heavily on the machine configuration
The process can be monitored safely, if the process performance is min. 0,5% of the nominal motor performance higher than the idle cut performance.
Reduction of repair costs after a crash
Increase of machine availability
Cutting of force peaks
Documentation of collisions
Case Study I

<table>
<thead>
<tr>
<th>Exchange Spindle: 35kW, HSK 63</th>
<th>16.891€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service costs:</td>
<td>1.966.50€</td>
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<tr>
<td>Travelling costs:</td>
<td>425€</td>
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<tr>
<td>Total:</td>
<td>19.282.50€</td>
</tr>
</tbody>
</table>
Tool and process monitoring with ToolScope

Collision Detection
\ TS-CM: CONDITION MONITORING

▲ Visualize the state of the machine
▲ Early detection of worn machine parts
▲ Support when troubleshooting
▲ Support for planning maintenance actions
Monitor internal machine sensor values on the basis of a reference NC program

Process:
- Cyclic run of an NC program
- Monitoring the average process force of the feed axis
- High friction indicates worn machine parts

Standard: 5 axis
OPTIMIZE PROCESS LEVELS AND TOOLS

- TS-PM Tool/Process Monitoring
- CD-xDim Collision Detection
- TS-CM Condition Monitoring
- TS-AFC Adaptive Feed Control
- Offline-Analysis

- TS-Wear Wear Monitoring
- TS-TCLog Tool Change Log
- TS-QRep Quality Documentation
- TS-DataPro User defined Log-File
- TS-Connect Network Functions
\ TS-AFC: ADAPTIVE FEED CONTROL

▲ Reduction of machining costs
▲ Reduction of cycle times
▲ Protection against overload
▲ Inclusion of all relevant factors
▲ Simplifying NC programming
Learning the optimal torque
Automatic variation of feed override
Tool and process monitoring with ToolScope

Milling
Ambient Variables:

▲ Varying tool wrap angles
▲ Varying cutting depths
▲ Different workpiece dimensions
▲ Different material hardnesses
▲ Cavity
▲ Casting errors/ inclusions
▲ Etc.


**TS-AFC: ADAPTIVE FEED CONTROL**  
**TURBO WHEEL MACHINING**

<table>
<thead>
<tr>
<th></th>
<th>Without AFC</th>
<th>With AFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hourly rate of machine tool</td>
<td>95 €</td>
<td></td>
</tr>
<tr>
<td>Machining time per part</td>
<td>485 s</td>
<td>455 s</td>
</tr>
<tr>
<td>Machining costs per part</td>
<td>12.80 €</td>
<td>12.00 €</td>
</tr>
<tr>
<td>Parts per year</td>
<td>47,505</td>
<td>50,637</td>
</tr>
<tr>
<td>Increase of machine capacity</td>
<td>6.2 %</td>
<td></td>
</tr>
<tr>
<td>Reduction of machining costs</td>
<td>38,004 €</td>
<td></td>
</tr>
<tr>
<td>Surplus products/year</td>
<td>3132</td>
<td></td>
</tr>
</tbody>
</table>

- **Machining time per part**  
  - Without AFC: 485 s  
  - With AFC: 455 s  

- **Machining costs per part**  
  - Without AFC: 12.80 €  
  - With AFC: 12.00 €  

- **Parts per year**  
  - Without AFC: 47,505  
  - With AFC: 50,637  

- **Increase of machine capacity**  
  - 6.2 %

- **Reduction of machining costs**  
  - For 47,505 parts: 38,004 €

- **Surplus products/year**  
  - 3132
Offline analysis of process data
Optimization of cutting processes
OFFLINE ANALYSIS

- Import of .csv files which are generated at the machine
- Offline adjustment of ToolScope
- Analyzation of cutting processes
TS-WEAR: WEAR MONITORING

- Reduction of tool costs
- Reduction of machining costs
- Extension of tool life
- Monitoring of real tool wear
- Reduction of tool breakages
▲ Monitoring of average process force
▲ Setting of wear limit by considering of wear marks
▲ Agenda:
  – Wear limit
  – Missing limit
  – Dot = Average process force

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TS-WEAR: WEAR MONITORING
Example of a German Automotive Manufacturer

- Calculated tool life
- Originally achieved tool life
- Achieved tool life with Tool Scope
Process Characteristics:
- Machine: Komatsu NTC ZV4, VMC
- Controller: Fanuc Oi MD
- Spindle Power: 17.5 kW
- 3 Wheeler Cylinder Head-Aluminum
- Operations: Valve seat/guide reaming
- Cycle Time: 2 minute 42 Seconds

Production issue:
- Huge number of reamer breakages
- Component rejection due to tool breakages
- More cycle time due to mechanical tool breakage sensor
- No system to identify the tool wear
- Tool life not stable
Tool/Process Monitoring

Benefits of ToolScope:
- Detection of worn-out tool during the process
- Detection of already machined workpieces or workpieces with too high tolerances
Tool/Process Monitoring

Benefits of ToolScope:
- Easy analyzation of different cutting tool supplier due to color coded display
USE OF DATA (MACHINE, PROCESS, TOOL)

- TS-PM Tool/Process Monitoring
- CD-xDim Collision Detection
- TS-CM Condition Monitoring
- TS-AFC Adaptive Feed Control
- Offline-Analysis

- TS-Wear Wear Monitoring
- TS-TCLog Tool Change Log
- TS-QRep Quality Documentation
- TS-DataPro User defined Log-File
- TS-Connect Network Functions
Reduction of tool costs
Reduction of non-value adding tasks
Highlighting cost saving potentials
Optimization of tool utilization
▲ Replacement of paper related tooling cards
▲ Integrated tool life or tool life time counter
▲ Easy stating of tool change reasons
### TS-TCLOG: TOOL CHANGE LOG

- Documentation in standard .csv-Format
- Analysis with e.g. Microsoft Excel

<table>
<thead>
<tr>
<th>Time</th>
<th>Tool</th>
<th>Process counted</th>
<th>Tool life in minutes</th>
<th>Reason of tool change</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.05.2017 15:04</td>
<td>T20291</td>
<td>350</td>
<td>52,5</td>
<td>tool breakage</td>
</tr>
<tr>
<td>13.05.2017 15:05</td>
<td>T20184</td>
<td>491</td>
<td>98,2</td>
<td>tool worn</td>
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<tr>
<td>13.05.2017 15:07</td>
<td>T20535</td>
<td>351</td>
<td>87,75</td>
<td>Surface finish not OK</td>
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<tr>
<td>13.05.2017 15:21</td>
<td>T20212</td>
<td>200</td>
<td>60</td>
<td>tool worn</td>
</tr>
<tr>
<td>13.05.2017 15:21</td>
<td>T20001</td>
<td>200</td>
<td>70</td>
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</tr>
<tr>
<td>14.05.2017 00:31</td>
<td>T20291</td>
<td>407</td>
<td>162,8</td>
<td>tool breakage</td>
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<tr>
<td>14.05.2017 00:32</td>
<td>T426</td>
<td>846</td>
<td>380,7</td>
<td>tool worn</td>
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<tr>
<td>14.05.2017 00:32</td>
<td>T523</td>
<td>847</td>
<td>423,5</td>
<td>tool worn</td>
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</table>
Tool Life Analysis
min. / max. / average

63%
Tool change reasons of premature tool changes

- Tool worn
- Tool Breakage
- Dimensionally not OK
- Surface not OK
Quality report for monitoring of critical parameters
Complete documentation as PDF
Evidence of quality to customers
PDF-protocol for each monitored process
- Screenshots, time stamps, program names, tool names and other data, which is visible to the TS
- Enables real-time monitoring with real-time documentation of data
- In combination with network push: protocols are saved at a customer server
- Software options: monitoring with aerospace algorithms like GEP11TF12, MTV548-4
Process features:

- Series production, small batches
- Product: turbo wheel for aerospace industry
- High price workpiece
- Material: Inconel

Problems:

- High FAA-Regulations require monitoring and full documentation in each process
- Monitoring of lubricant quantity and pressure liable
Process features:

▲ Large scale production
▲ 5 Machines each production line
▲ Automatic loading of machine

Problems:

▲ Infrequent chip built at valve guide process.
▲ Causing valve guide damage or dimension problems
▲ Need of:
   100% verifying of workpiece at end of production
Cost savings against manual control:

▲ 100% detection is not required any longer

▲ Cost savings:
  approx. 150,000€ per year for a manual workpiece control in a 3 shift system
Tool to collect and generate data from the ToolScope
Custom generation from csv-data
Optional:

▲ Freely customisable column
▲ One row for each process

<table>
<thead>
<tr>
<th>Nummer</th>
<th>Datum</th>
<th>Zeit</th>
<th>Programm</th>
<th>TNr</th>
<th>Werkzeug ID</th>
<th>Drehmomen</th>
<th>Override MA</th>
<th>Override Mill</th>
<th>Prozess Läng gespart</th>
<th>Zeit gespart</th>
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</thead>
<tbody>
<tr>
<td>224</td>
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<td>09:07:27</td>
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<td>06.07.2016</td>
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<td>1</td>
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<td>125</td>
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<td>228</td>
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<td>229</td>
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<td>5</td>
<td>17,1</td>
<td>125</td>
<td>60</td>
<td>625,519996</td>
</tr>
</tbody>
</table>
APPLICATION EXAMPLES

- Analysis of cycle time reduction
- Manufacturing time per component
- Energy consumption per process
- Spindle utilisation
- Spindle idling
- Downtime during the process
- Tool change duration
- Rework time during the process
All data at a glance
Direct access to the machine
Data export in standard format
Automatic back-up function
Optional: save data in KOMET Cloud
\textbf{TS-CONNECT: NETWORK FUNCTIONS}

- Automatic Data-Push
  - Company server
  - Cloud solution
- Automatic back-up function
▲ ToolScope Net
   - Software, giving all ToolScope apps just as a server software
   - Instead of installing ToolScope devices, the customer installs a software

▲ Ceratizit Cloud
   - Central storage for ToolScope data
   - Can be installed locally as software or be leased hosted by KOMET

▲ ToolScope Cockpit
   - Access information on processes and machines - worldwide
   - Bases on the information in the KOMET Cloud

▲ All above mentioned components are offered as free download
▲ Central management, evaluation and visualization of machine data
▲ High transparency regarding processes in machines
▲ „Browsing“ through machine data
▲ Evaluation of machines without network possible (supports „sneakernet“s)
▲ See errors at machines in a live view
\TOOLSCOPE-COCKPIT: MACHINE STATES IN REAL-TIME

- Clear view
- Which programs are running
- Fast reaction on errors
- States are watchable per machine
- Each machine can be evaluated per mouse click

<table>
<thead>
<tr>
<th>Channel</th>
<th>Status</th>
<th>Duration</th>
<th>Program</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>production without monitoring</td>
<td>0 hr 0 min, 0 sec</td>
<td>P: Prog C</td>
<td>On</td>
</tr>
<tr>
<td>2</td>
<td>error</td>
<td>0 hr 0 min, 16 sec</td>
<td>P: Prog A</td>
<td>On</td>
</tr>
<tr>
<td>3</td>
<td>production</td>
<td>0 hr 0 min, 5 sec</td>
<td>P: Prog A</td>
<td>On</td>
</tr>
<tr>
<td>4</td>
<td>production</td>
<td>0 hr 0 min, 8 sec</td>
<td>P: Prog C</td>
<td>On</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channel</th>
<th>Status</th>
<th>Duration</th>
<th>Program</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>error</td>
<td>0 hr 0 min, 0 sec</td>
<td>P: Prog B</td>
<td>On</td>
</tr>
<tr>
<td>2</td>
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<td>0 hr 0 min, 36 sec</td>
<td>P: Prog B</td>
<td>On</td>
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<tr>
<td>3</td>
<td>error</td>
<td>0 hr 0 min, 10 sec</td>
<td>P: Prog B</td>
<td>On</td>
</tr>
<tr>
<td>4</td>
<td>production</td>
<td>0 hr 0 min, 0 sec</td>
<td>P: Prog C</td>
<td>On</td>
</tr>
</tbody>
</table>
Current status of ToolScope Digital Productivity Solutions

Outlook next few years - developments

How to create solutions for Industry
FUTURE DEVELOPMENTS

Productivity

Tools

Assistance
ToolScope

Process
Expertise

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TOOLSCOPE – ASSISTANCE SYSTEM
SELF LEARNING CONTROL OF CUTTING PROCESS

Model of self-Learning control of the tool cutting process based upon neuronal networks

- A Neuronal network makes decisions which are based on the correlation of input values
- Interdisciplinary mathematic tool with application fields of economics, technique, military etc.

Source:
Intelligente Verfahren – Identifikation und Regelung nichtlinearer Systeme. Schröder, D.
Energy Generation from the Spindle Rotation

Batteryless power supply for tools with sensors

With inertia wheel

Energy generation
Due to different rotational speeds
Energy Generation from the Spindle Rotation

Batteryless power supply for tools with sensors and wireless transfer

Tool adapter

Sensor interface

Microcontroller

Wireless controller

Antenna

Stationary Electronic

Energy transformer

i.e. inertia wheel

Energy storage

Potential transformer

Machine control
FUTURE DEVELOPMENTS

▲ Current status tools must be adjusted outside of the operating parameters of the machine.
▲ Goal to be able to move damping elements during the cutting of the workpiece for variations of conditions.
▲ This would include hormonics as well as vibration.
▲ Monitoring would also self adjust speeds and feeds of machine to stable zones of cutting to increase tool life and process stability.

Dynamic resistancy
Tool without damping effect

Dynamic resistancy
Tool with damping effect
KOMET tool concept

Draw bar setup in tool

Possible insert setup
- two rockers with finish inserts
- max. 4 semi finish inserts

optional measurement device
(depending on precision of draw bar system)

ABS interface for tool modularity

classic rocker finish setup

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FUTURE DEVELOPMENTS

Main Target 1

Development of a Self-Learning Control of Tool Temperature in Cutting Processes and influence of process parameters (e.g., of the tool cooling: pressure, volume flow, etc.)

Main Target 2

Development of tools with inner cooling system
Design and production of cutting inserts with an inner cooling structure and simple integration possibility in existing tool machines.

- Higher stability in cutting processes
- Higher tool life by reducing wear (e.g., thermo shock)
- Higher work piece quality
- Ecological advantage by coolant prevention
- More ecological processing of high-performance material
Integration of adaptive control

Dual control circuit of frequency inverter

via equipment cabinet:
- Possibility to control the coolant volume flow manual by using a potentiometer
- Safety functions (emergency stop)

via PC per USB- converter cable with LabView/ Matlab:
- Implementation of Self-Learning Control based on neuronal networks

Frequency inverter type VARMCA32 Co. Leroy Somer
OUTLINE

▲ Current status of ToolScope Digital Productivity Solutions

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THE DEVELOPMENT OF NEW BUSINESS MODELS
BUSINESS MODELS ARE SHAPING ENTIRE INDUSTRIES

BUSINESS MODEL COMPANY 1
- 40% market share
- 80 new products/year
- Renowned technology Enterprise
- High Expenditures for R&D

BUSINESS MODEL COMPANY 2
- No market share
- 1 Product
- Annual actualization/upgrade of product
- 10% R&D expenditures compared with company 1
- Premium price strategy

In which company would you invest?
BUSINESS MODELS ARE SHAPING ENTIRE INDUSTRIES

BUSINESS MODEL COMPANY 1
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BUSINESS MODEL COMPANY 2
- No market share
- 1 Product
- Annual actualization/upgrade of product
- 10% R&D expenditures compared with company 1
- Premium price strategy
A NEW BUSINESS MODEL IN ADVERTISING:

- No colored ads
- No color at all
- No pictures
- No movies
- Pure text ads with 95 characters max

Google Adwords: Sales approx. US $ 40 billion

Is this a valid business concept?
Digital Transformation Of The Supply Chain – Lean Meets Digital
Digitalization in all areas of the supply chain rapidly advancing
Digital Integration – Modular Cutting Tool Manufacturing
Transformation of the Supply Chain into an Orbit of Supply Spheres
Digitalization In the Development Process
Standardized, modular tool box

Technology Module
Chip Creation
- Dimension
- Substrate
- Coating
- Chip Forming

Technology Module
Chip Transportation
- Symmetry
- Internal Cooling
- Slope/Helix

Technology Module
Spindle Connection
- Type
- MMS
- Damping
Customer Orientation – Standard Products At Lot Size 1
Example Carbide Inserts
Digitalization For Total Customer Orientation
Everything's a standard and everything's a special!

▲ The Smart Factory stands out by preeminent customer orientation

▲ Product solutions are geared towards specific applications and optimized for performance

▲ Digital Technology Modules allow productivity even for small lot sizes

▲ For the first time customer requirements are directly implemented in the factory
THANK YOU