REMOTE MONITORING AND MAINTENANCE SYSTEM FOR CNC MACHINE TOOLS
Collaboration started in March 2009

GILDEMEISTER AG:
- Headquarters: Bielefeld, Germany
- Establishment: 1st Oct. 1870
- 6,032 employees worldwide (consolidated)
- Capital: 151.7 million Euro
- Sales Revenue: 1,687.7 million Euro
- Total Assets: 1,371.8 million Euro
- Order intake 2011: 1,939 (Europe)

MORI SEIKI Co., LTD.:
- Headquarters: Nagoya, Japan
- Establishment: 26th Oct. 1948
- 4,045 employees worldwide (consolidated)
- Capital: 391 million Euro
- Sales Revenue: 1,350 million Euro
- Total Assets: 1,765 million Euro
- Order intake 2011: 714 (Europe)

Production, Procurement, Joint Development and Sales & Service on a common Global Basis
Trends in Machine Tool Consumption

USD Mill

Source: GARDNER PUBLICATION
Background

- Machine tool shipments keeps growing
- Average life of machine tools over 15 years
- Service man must visit customers for troubleshooting
- To reduce customer service cost
  - Improve product quality
  - Improve service efficiency
- Keep technical availability > 92%
- *Ideal solution for customer service* ?……
Ideal solution is to acquire operating status of customers’ machine tools, perform diagnostic and analysis remotely at manufacturers’ service base and conduct necessary preventive maintenance online, instantly and before breakdown.

Remote Monitoring and Maintenance System (RMMS) for machine tools has been established.
Requirements of RMMS

• Problem should be notified to manufacturer immediately
• Automatic notification during unmanned operation is a key
• Details of the problem should be available from a remote location worldwide
• Network access security must be guaranteed
• Quality analysis should be possible based on collected machine operating status
• Collected data can be used by customers for better production management
• Timely preventive maintenance is very important and can be indicated
Network and system structure of RMMS

• Communication between manufacturers’ server and customers’ machine is the key for establishing a successful RMMS. Three options available:
  – Use customers’ Internet connection, suitable for large and reasonably well-equipped factories
  – Use mobile phone network by mounting a wireless communication device on each machine tool, more flexible for most customers but needs good mobile connectivity
  – Use data security by ISDN or Internet VPN access
Global development of MORI-NET GE wireless network system

System Structure
• Use a service network which provides world wide communication carriers
• Adopt communication terminal to collect data
Mobile Phone connection between customers factory and machine tool manufacturer

Mobile Phone Carrier

Service Center

Data Server

Exchange Unit

Factory

Wireless communication device

Spare Parts Service Man Service Card

Factory Corner

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www.moriseiki.com

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Example:

Machine tool’s status changes, such as "Cycle Start/Stop", "Alarm occurred", etc., Record the operating information, time and attribute information in CNC buffer.

If one of following three condition is met:
- Buffer reaches a specified level;
- A specified amount of time has passed;
- An emergency situation occurs.

Data transfer to machine tool manufacture starts
Data communication snapshot of RMMS

Data from Machine Tools

... <M_MCNSTS>
423C4C80,"O7220",3
423C5C80,"O7220",2
423C6C80,"O7220",3
423C7C80,"O7220",2
423C8C80,"O7220",3
423C9C80,"O7220",2
423CAC80
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<M_MNFRSL>
423C4C80,404ee762,"O7220"
423C6C80,404ee82b,"O7220"
423C8C80,404ee8f2,"O7220"
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"P277", "N/O-HOLE-SMALL 10", 423C8C80
</M_ALMHIS>

The database of the machine status

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</table>

Gant Chart

Operation Ratio (Running time / 24 (h))

Machining Result

Alarm History
Regularly scheduled E-Mail Status Reports

The number of finished parts

- Operation time
- The number of finished parts

www.dmgoriseiki.com
www.moriseiki.com
Communication process for Maintenance

Service center

Generate the received memo

Machine card system

Received mail

MORI-NET

Send the mail

Alarm mail

Contact by phone

Factory

Send the mail

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Remote Maintenance

Service request to machine tool manufacture

INTERNET / mobile phone line

Monitor machine tool status remotely

Screen information

User’s Plant

Problem

Machine Tool Manufacturer’s Service Center

Operate and monitor CNC screen
Preventive maintenance

- Monitoring the operating status
  - spindles, ATC, turret indexing, NC batteries,
- Prediction of the potential malfunction of service parts
- Spindle lifetime prediction equation

\[
L_{dec} = L_{std} \cdot \left( \frac{\int_{t_1}^{t_2} n dt / \int_{t_1}^{t_2} F^p \cdot ndt}{\frac{L_{std}}{\int_{0}^{n_0} dt} / \frac{L_{nd}}{\int_{0}^{F_0^p \cdot n_0 dt}}} \right)
\]

$L_{dec}$: Estimated spindle life (hours), $L_{std}$: spindle life time (hours), $n$: spindle speed (min$^{-1}$), $F$: spindle load (N), $n_0$: maximum spindle speed (min$^{-1}$), $F_0$: no-load running load at maximum spindle speed (N), $p = 3$ (ball bearings), 10/3 (roller bearings)
DMG Netservice

Highlights:
- Immediate analysis and technical support for DMG machines
- Obvious increase of machine availability
- Reduced service, personnel and travel costs
- Highest data security per ISDN or Internet VPN access
- Fast, bi-directional data-exchange

Keyfacts:
- Over 10 years of experience
- Almost 10,000 machines world-wide
- Safety and speed through VPN
- Remote-service by local hotline or central service and production plants on demand
- Since April 2010 included in delivery
- Free of charge during warranty, following minor charge per month
VPN – connection (virtual private network):

client:

on board:

ISDN-connection (optional):
Monitoring Functions (DMG Messenger)

E-mail service

- Constant online monitoring of the machine tool
- Web applications for all common smart phones
- Notification by e-mail feature
- Machine control station on a large monitor in production area or on a screen at your workplace
- Live display of machine status with signal lamp
- Detailed status information i.e. program completion, machine stopping, alarm etc.
- Increased part numbers via reduced downtimes
DMG Messenger System Availability

- **Supported Controls:** Siemens 840D solutionline, Heidenhain iTNC 530, Heidenhain Millplus, MAPPS IV with MT connect
- **Smartphone:** Resolution 320 x 320px min., Internet access, Web browser with HTML 4.01, CCS and Javascript (HTTPS recommended)
- **Operating system:** Windows XP Professional/ Windows 7/ Windows server 2003. Internet access has to be configured manually by the customer.
Result

- Developed RMMS is running in Japan connecting over 14,000 Mori Seiki machines worldwide – our counterpart in DMG is connecting 10,000 DMG machines worldwide.
- Average downtime rate of all machine connected to the RMMS had been reduced by about 40%.
- Increase of productivity in service as incoming requests are well prepared for field service.
- Build up TCO information of machines in production.
- Service call by net are stored in electric manner and data are used for new developments.
- Analyze behavior (i.e. wear) of components over long term in production and use for improvements.
Operating ratio and machine downtime ratio

<table>
<thead>
<tr>
<th>Date</th>
<th>The number of service man</th>
<th>The number of installed machine</th>
<th>The number of machine / 1 service man</th>
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<td>2007/04/01</td>
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<td>78800</td>
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Summary

• Equipment is available and in some cases already used but the potential is not exhausted.
  – Reasons, Problems:
    • Network security – privacy - confidential know-how
    • Access availability (customers Internet connection)
    • No mobile phone network

• 24,000 machines of DMG and Mori Seiki are connected to the network.
  – Enable better planning of service calls
  – Problem identification before machine breakdown
  – Early information to the customer
(1) A system to remotely monitor an operation status of machine tools was developed for customer productivity efficiency.

(2) A remote maintenance service by using a mobile phone network can further enhance the efficiency of maintenance services.

(3) Today's mobile technologies and the already given acceptance in the private area allow a further utilisation and extension on well known platforms. In the consumer field as well as in the external communication mobile internet technologies are “state of the art” but in production the big potential is still underestimated.

(4) Risks in terms of IT security and network availability of mobile connections can be an issue. It will be essential to increase mobile network availability also in remote areas to further enhance utilization of RMMS.
Out view

• Condition monitoring to avoid unscheduled machine down time is one of the key factors for remote diagnostics and its acceptance

• Next to monitoring of machine availability and performance it will be essential that the average between sensors inside a machine tool and their information given to the diagnostic system is targeting the best up time level of a machine tool. Here is the key for the manufacturer as well as the customer

• Next to the remote monitoring of each single machine tool new Apps for complex cases like maintenance, calibration, programming of work pieces with parametric inputs will be one of next steps in development.
Next: DMG Mori Seiki Messenger

DMG Messenger

Mori Seiki Report Functions

Modern Surface Design

DominicSchindler Creations

DMG – Mori Seiki Messenger

: joint development
Thank You!