Container Crane Presentation
Customer Benefits

*Port Operators / Port Authorities*

- Impact on Direct maintenance costs
- Impact on Indirect maintenance costs
- Safety
- Time losses and delay in shipment
- Loss of Contribution
- Unplanned vs. planned breakdowns
- Penalties
- Port charges
- Return on investment
Equipment on Container Crane
Machine Room

Main Hoist

Trolley Drive

Boom Hoist
Main Hoist - up & down movement
Trolley Drive - horizontal movement
Boom Hoist - extension
Motor
Case Study

Container Crane online condition monitoring system
Technical application description

MSC Home Terminal
Antwerpen Belgium

March 2009
MSC Home Terminal Antwerp, Belgium

MSC Home Terminal is a joint venture between Mediterranean Shipping Company (MSC) and Hesse-Noord Natie NV, a subsidiary of the PSA Group. The container terminal is a busy terminal and has a quay length of 2.9 km. The total capacity of the terminal is 4.1 million tons. The containers are moved to and from the vessels by 22 quay cranes.

Delwaide dock
(north side of the Port of Antwerp)
Objectives
Crane application

“One of the most challenging machine condition monitoring applications you can imagine is probably the hoisting winch and trolley drive in a crane.”

The weight of the container, the hoist direction and hoisting speed will have an influence in the running condition of the crane.

All of these variables need to be controlled during the machine condition measurements to get stable, meaningful and trendable readings.
Objectives
Customer

The MSC Home Terminal company wants to have full control over the availability of the Quay cranes to serve their customers to the highest standards and to avoid unplanned downtime and secondary damage.

To reach this goal, all Kalmar cranes should be equipped with a machine condition monitoring system. The evaluated machine condition information from the system should be available for the Siemens Sicma Crane management system as status coded in green, yellow or red condition.

In March 2008, as a trial, SPM installed the Intellinova system on Quay Crane No. 16 in the Hoisting winch of MSC Home Terminal, Antwerp in Belgium. After more than 9 months of studying and fine tuning the system, the Intellinova system was proven to be successful in managing and controlling the operating condition of the cranes.
Hoisting winch
Machine layout
Hoisting winch
Measuring point positions -2
Main Hoist Gearbox - Kumira, Finland
Trolley Drive
(Future installation)
Boom hoist
Machine layout (no plans yet)
Crane specifications

Operating speeds and acceleration

Max. hoisting speeds
• with 80 tonnes on the ropes: 90 m/min - 2 sec. / 0.75 m/s²
• with 23 tonnes on the ropes: 180 m/min - 4 sec. / 0.75 m/s²

Max. trolley travel speed: 240 m/min - 4 sec. / 1.00 m/s²

Max. crane travel speed: 45 m/min - 8 sec. / 0.10 m/s²
Crane specifications

Machine speed Hoisting winch

Electromotor speed: 0 - 1992 rpm

Load vs RPM
15 T - 1992
28 T - 1590
40 T - 1380
43 T - 1330
45 T - 1280
60 T - 1150
Hoisting winch
Trial installation MSC Crane no. 16

In this trial installation, the equipment monitored is the Hoisting Winch, comprising the 2 electric motor drives and the gearbox. The SPM Commander Unit is equipped with two Bearing Monitoring Modules, one Vibration Monitoring Module and one Analogue Input module.

To ensure the repeatability of the measurements, two condition parameters (Load and Hoisting direction) are determined and measured. The triggered condition for machine speed (RPM) is used to start the measurement whenever the machine speed passes the trigger level.
Hoisting winch
Gearbox Kumera type LD-3600-16-E1 (Bearing types)
Installation of measuring points, load direction
Installation of measuring points
Hoisting winch
Electromotor Wölfer type ODRKF 400L-6T (Bearing types)
Hoisting winch
Pictures / transducer installation
Measuring techniques used

- Shock Pulse Method, for Bearing condition severity.
- SPM Spectrum, for Bearing spectrum analysis & evaluation.
- 9 EVAM Condition parameters for symptoms condition trending.
- Vibration severity.
- Vibration FFT spectrum analysis & evaluation (Acceleration, Velocity and Enveloping).
- Analogue input signal 0-10V for container weight/load measurement.
- Digital input signal for hoisting direction.
- RPM for machine speed measurement.
Transducers used
Vibration & Shock Pulse

Accelerometer type SLD 144b
100 mV/g , 2-10.000 Hz
Piëzo electric compression type sensor for vibration measurements in industrial applications.

Shock pulse transducer type 42.000
with built-in TMU (transducer matching unit) converts the shock pulses emitted by the bearing into an electrical signal.
Transducer used
Machine speed measurement

Inductive proximity switch
Generates pulses (V) when the teeths of the gearwheel passing the probetip.

Intellinova suitable for 4 Tacho inputs
Cabling & connections

Electrical cabinets

Crane operation overview

Intellinova Rack module, Load, Ethernet etc.

Multi core cable

Connection box, SPM, VIB, RPM
Measuring Logic Parameters for monitoring

“Splash Animation”
Intellilologic sequence, Container Crane

1. Measuring interval, check
2. Triggers, check
3. Conditions (Weight & Lifting), check
4. RPM stability, check
5. RPM within range, check
Intellilogic sequence

1. Trigger preparation
   1. Prepare the system prior to data aquisition
      1. Bias Power on, (Settling time)
      2. Stabilaising filters on the CU, fix amplification settings
      3. Make sure that the "Settling time" is completed
   2. Waiting for Trigger event to happen during "Max trigger window.

2. Check Conditions (less then 1 ms)
   1. Only measure when lifting
   2. Check if load is within range

3. Check RPM Stability
4. Check Bias voltage
5. Store value in Database if RPM is within RPM levels (By Linx)
Trigger window (Tw)
Time to wait for the RPM to pass the Trigger level

RPM

Trigger Level
eg. 1000 rpm

3 sec

20 sec

Max. Tw

Time
Trigger window (Tw)
Sometimes the Trigger Level is not reached
Retry Trigger Interval, how long time to wait before you restart the Trigger window

RPM

Trigger Level, eg. 1000

Tw | Tw | Tw | Tw

Retry Trigger Interval

Time
Retry Logic for Vibration & SPM Spectrum data acquisition

The time between VIB measurement retries depends on the RPM slope and maximum allowed deviation.

- Start measurement
- Deviation exceeded, stop
- Retry counter (Initialized to for example 30)
- Selected allowed RPM deviation

![Diagram showing the retry logic with RPM, trigger level, and time axes. The diagram includes points for retries at time 26, 27, 28, 29, and 30. The final point indicates SUCCESS! when the deviation is within the allowed range.]
Retry Logic for Vibration & SPM Spectrum data acquisition

*The time between measurement retries depends on the RPM slope and maximum allowed deviation*

The time between measurement retries depends on the RPM slope and maximum allowed deviation.

![Diagram showing retry logic and allowed deviation](image-url)
Trigger when RPM passes 1000 RPM
Lifting Up

DI1=Lifting
RPM vs. load

Speed (RPM)

Load Range

Load (t)
Lifting load is checked every second, range 30-80 ton
Condition check
If not fullfilled, then Retry Trigger Interval is used as measuring interval.

If Conditions is fullfilled, then check RPM stability.
Intellilogic
Difference between with and without Intellilogic

Without Intellilogic

With Intellilogic
Intellinova system architecture
Intellilogic

Data Flow and Alarms

**Alarm Logic**
- Absolute level
- Alarm delay
- Alarm filter
- Trend
- Criteria based (standard/flexible)
- Band Value

**Storing Logic**
- Time based
- Value level
- Value change
- When alarm

**Local Alarm Logic**
- Absolute level

**Measuring Logic**
- Time based
- Conditional
- Triggered
Intellicheck

Data buffers
- In case of communication failure

No Measurement
- Measuring results not received

Delayed Measurements
- The most delayed measurement task is reported
Configuration
Sequence files and buffered data via SD card

- Initial configuration like:
  - IP address
  - Choice of dynamic or static IP address
  - Commander unit name
  - Server name for LINX
  - Etc

Can be done either via a directly connected PC (crossed LAN cable) or via the SD card. FSS is used in both cases.

- A sequence file can be loaded to the Commander Unit from LINX via the SD card.

- Buffered measurements can be downloaded to LINX via the SD card.
Unique Features of

- Commander Unit
- Vibration & Shock Pulse Monitoring Unit
- Analog Input and Output Unit
- Condmaster Nova Software
- LinX Software
- Field Service Software
- OPC Data Access
- Web Access and SMS
- LAN or Wireless Ethernet
- Buffered Measurement via SD card
- Intellilogic:
  - Intellicheck
  - Measuring Logic
  - Storing Logic
  - Alarm Logic
  - Analysis Logic
Condmaster Software
Overview Crane condition
Crane condition monitoring
Overview Crane condition
Crane condition monitoring
Overview gearbox measurements
Fault Symptoms
Machine faults definitions

The SPM online monitoring system automatically evaluates the machine specific problems.

Pre-defined machine fault symptoms:

- Bearing defect frequencies: BPFO, BPFI, BSF and FTF
- Gear damage frequencies
- Unbalance
- Shaft misalignment
- Looseness
- Electrical problems on Electric motors
Symptoms
Gear damage – FFT Analysis

The FFT spectrum shows Input shaft Gearwheel damage markers. The amplitude and quantity of the side band frequency components are indicators for damage development.

1x Gear Mesh Frequency (28x rpm)
Symptoms
Gear damage – Trend graph

For every defined fault symptom like Gear damage in this case, we calculate the sum value of the matching frequencies for trending for each measurement.

Trend graph of Gear damage Z1 vibration components from FFT Spectrum
Symptoms
Bearing damage – Trend graph

Trend graph of bearing with damage development

Trend graph of bearing in good condition
Container Crane online condition monitoring system
Project Considerations
Supplier / Client

March 2009
Project Considerations

• **Project planning - who will take care of:**
  - network connection
  - brackets for tacho probe, junction box and Intellinova system
  - location of Intellinova system
  - power supply

• **Project planning – time table**

• **Define the Objective to achieve**

• **Database set-up and fine tuning of the system**

• **Training for different types of users:**
  - management, maintenance and operation

• **Support - service level agreement**
Technical information

- Average vibration level
- Average dBc, lubrication condition
- Per equipment
Statistics

- Distribution green-yellow-red
- Per measuring technique
- Per machine type
- Per manufacturer
Economics

- Direct maintenance costs
- Indirect maintenance costs
- Time losses
- Loss of contribution
- Unplanned vs. planned breakdowns
- Penalties
- Port charges
- Return on investment
At your service . . .