SKF India case study :
Digital transformation for improved performance through Smart Manufacturing for Machine tool Industry

Sept 2018

SKF vision and mission

A world of reliable rotation

The undisputed leader
in the bearing business

SKF – a truly global company

• Established	1907
• Sales 2017	SEK 77,938 million
• Employees	45,678
• Manufacturing units	103
• SKF presence	in over 130 countries
• Distributors/dealers	17,000 locations
• Global certificates	ISO 90001 – Quality
	ISO 14001 – Environment
	ISO 50001 - Energy
	OHSAS 18001 – Health and Safety

SKF India

- In India since: 1923
- *Sales 2017/18: INR 28048 million
- Employees: +2500
- Production sites: 6 Manufacturing Sites
- Presence: All major cities
- Distributors/dealers: over 450 locations

SKF in India has 3 legal entities

SKF India Ltd, ; SKF Technologies Pvt. Ltd ; Lincoln Helios India Pvt. Ltd.

Sales represents SKF India Ltd only as per financial year ended on 31st March 2018

Invested for Making in India

1965 | 1984 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014

Haridwar DGBB factory

Gurgaon - Solution Factory – satellite

Ahmedabad LSB Factory

Jamshedpur -Solution Factory –Satellite

Pune – DGBB, TRB, HUB

Pune Solution Factory

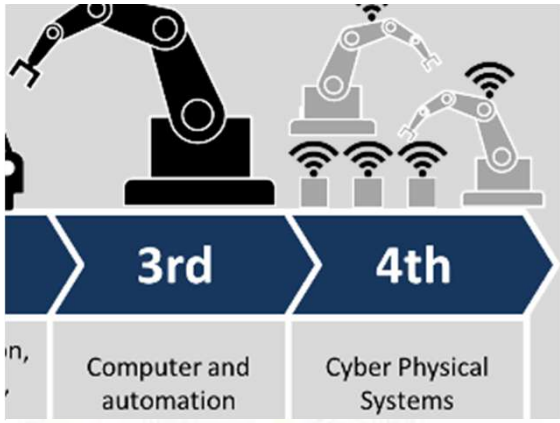
Bengaluru – DGBB

Bengaluru - Lincoln Lubrication Systems

Bengaluru – Global Technical Center

Mysore – Seals factory

Increased flexibility and higher efficiency

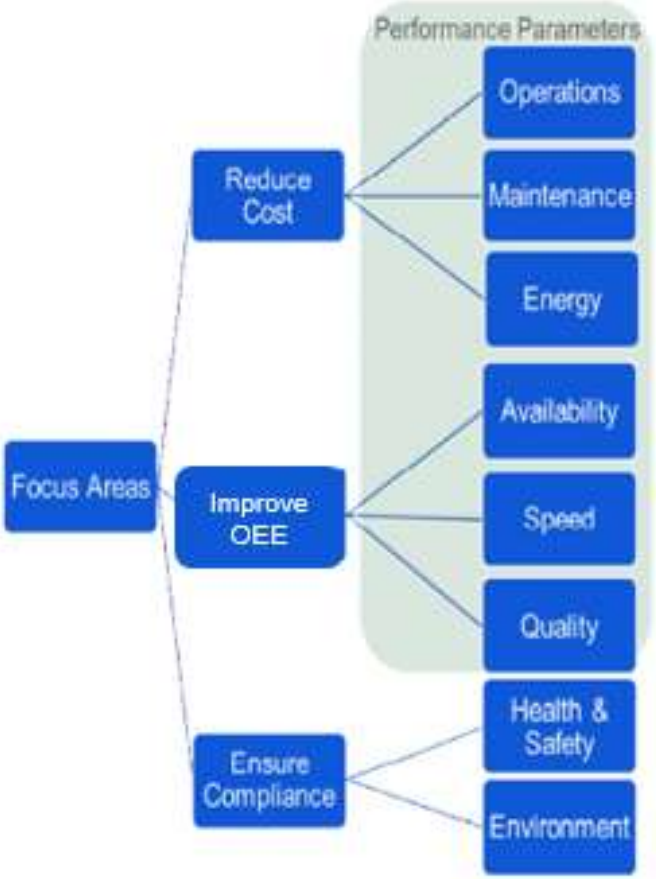


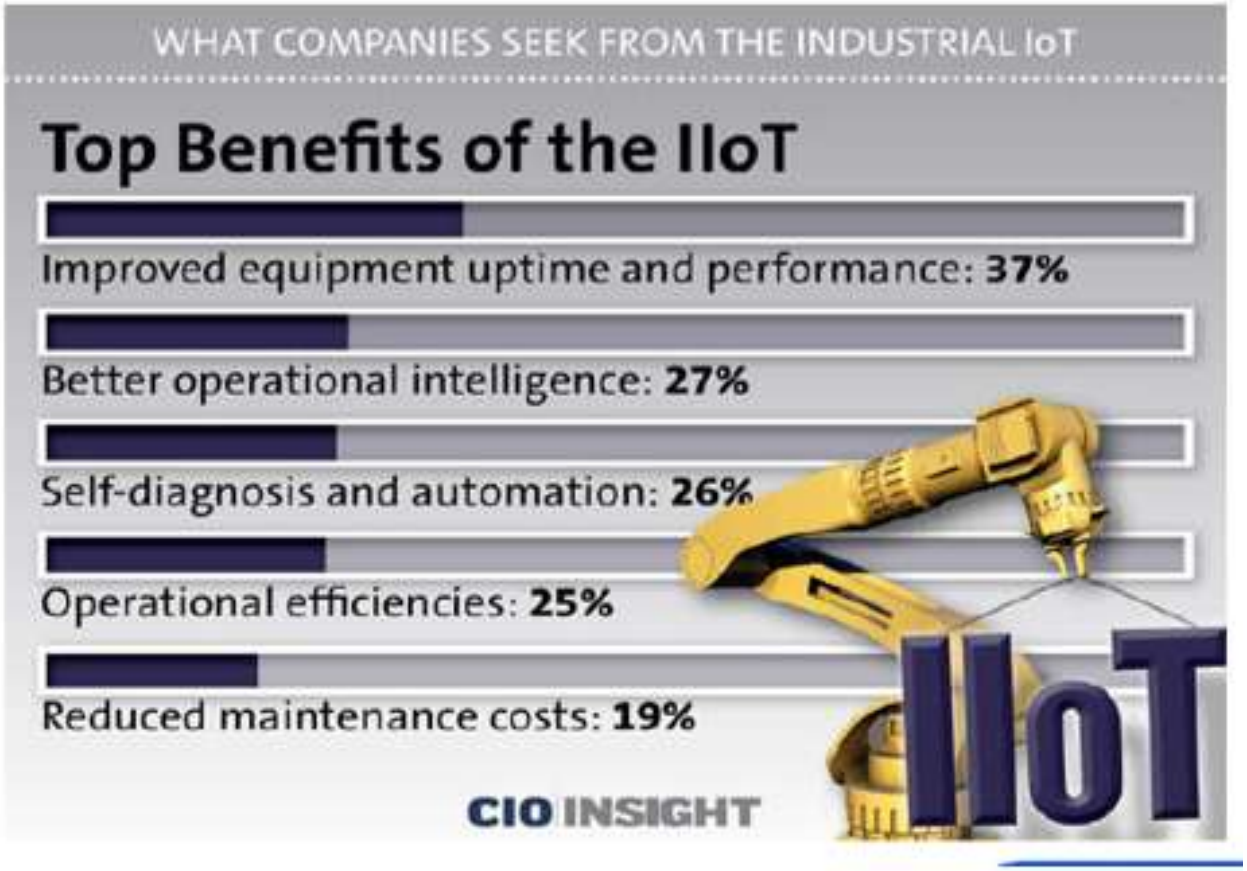
SKF digital transformation for Smart Manufacturing for Machine tool Industry

Lowest possible cost with shorter lead-times

SKF®

Increased customer focus – 3 main drivers





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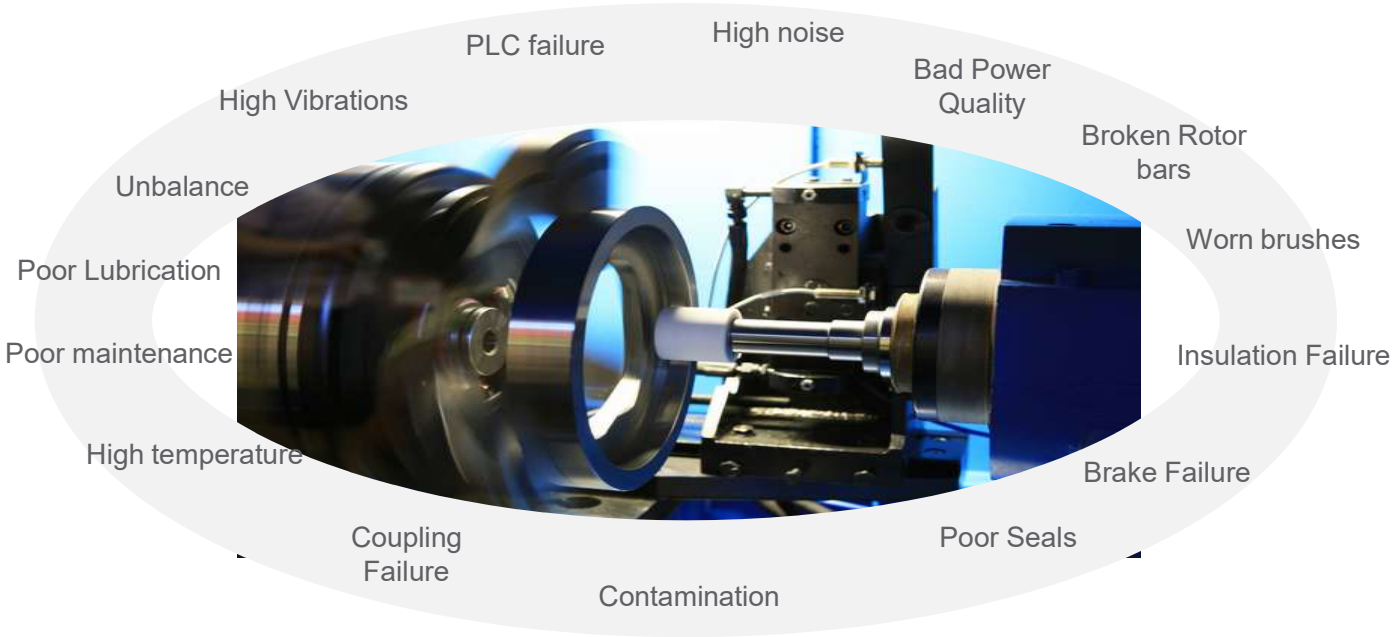
Machine Tool Spindle performance challenges…

- Will it fail suddenly?
- Why will it fail to function?
- When will it stop to function?
- How to find and fix the fault?
- How to eliminate failures?
- Are critical spares in stock?
- Impact on quality?
- Right & Skilled Labor?
- Business impact?



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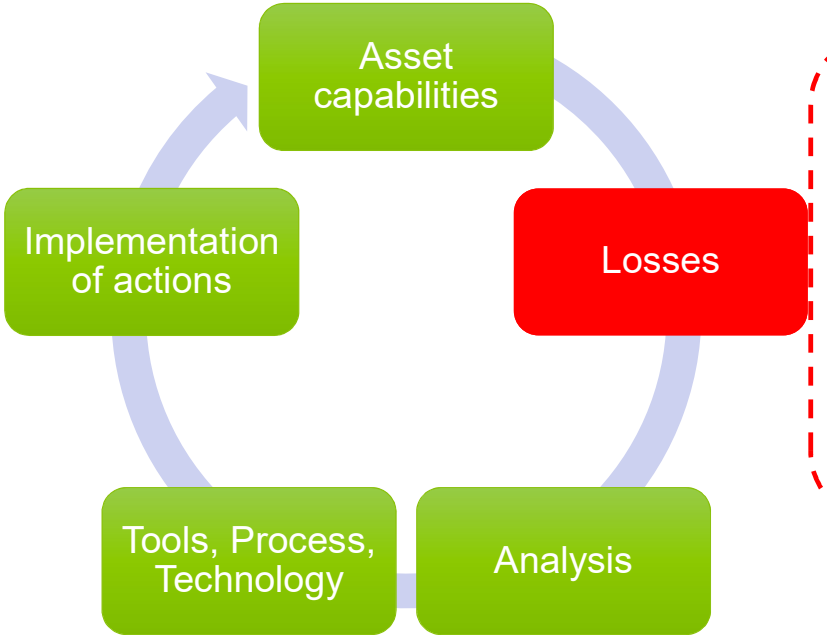
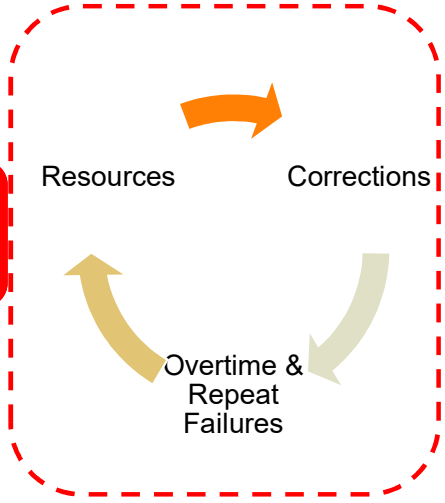
Conventional Maintenance approach

Proactive Maintenance Management

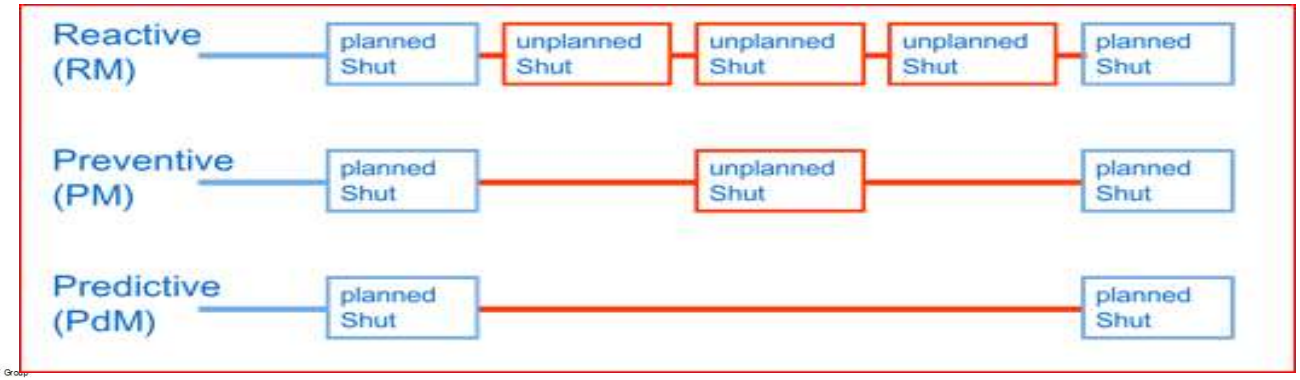




Reactive Approach/ Repair Philosophy

Conventional Method

1. Only Periodic monitoring
2. Components run till failure leading to unplanned downtime
3. CBM is done manually by stopping the machine leading to loss.
4. CBM Data is compiled and analyzed and decisions take long time .
5. Less readiness of resources and spares during surprise failure .



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Barriers and Losses in Offline Monitoring

Production Stop

Manual Intervention

Machine Data on No Load

Inconsistent Process

Faulty First Batch

Increased Rework/ Rejections

Safety Hazard

Causes Accidents

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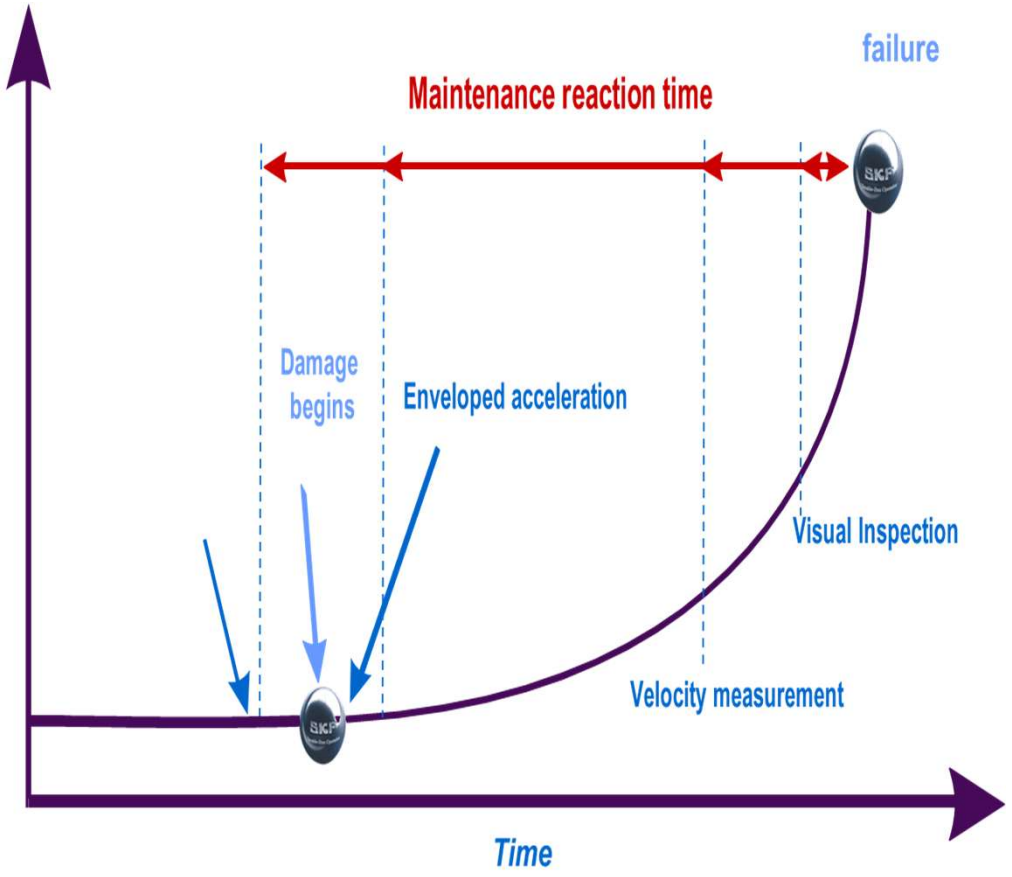
Monitoring methodology : OFFLINE Vs SEMI ONLINE Vs ONLINE

	OFF LINE	SEMI ONLINE	ON LINE
Data sampling in NO LOAD	√	√	√
Data sampling in LOAD	X	√	√
Data sampling of all bearing locations	X	√	√
Data Sampling without machine outage	X	√	√
Event Capturing	X	X	√
Live Monitoring	X	X	√
Data sampling without data collector	X	X	√
Data sampling without additional manpower	X	√	√

Vibration monitoring buys you time



SKF Services Approach for Asset Reliability and performance

Asset Health

Asset Reliability

- Microlog and Vibration pens
- System integration of “CoMo Projects”
- Motor Current Signature Analysis (Baker)
- Online systems and Portables

DETECT

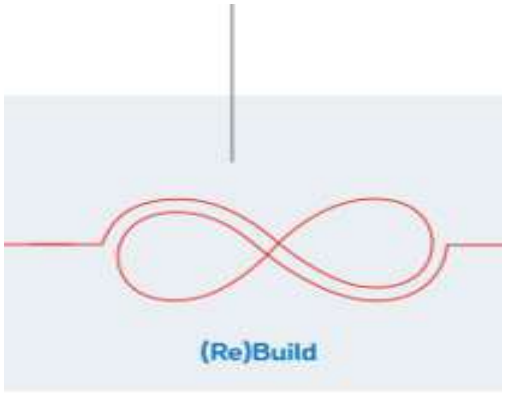
Rotating Equipment Performance (REP)

Products & Solutions

- Remote Diagnostics Service
- Predictive Maintenance
- Bundled reliability projects (IMS/PRM)
- Roll Shop Maintenance in Metals
- Training

SOLVE

Asset Improvement and Performance



- Spindles Re-Manufacturing
- Bearing & Units Remanufacturing (includes Railway)
  Customization & Pairing
  Caster rolls service
- Seals Manufacturing

RE (BUILD)

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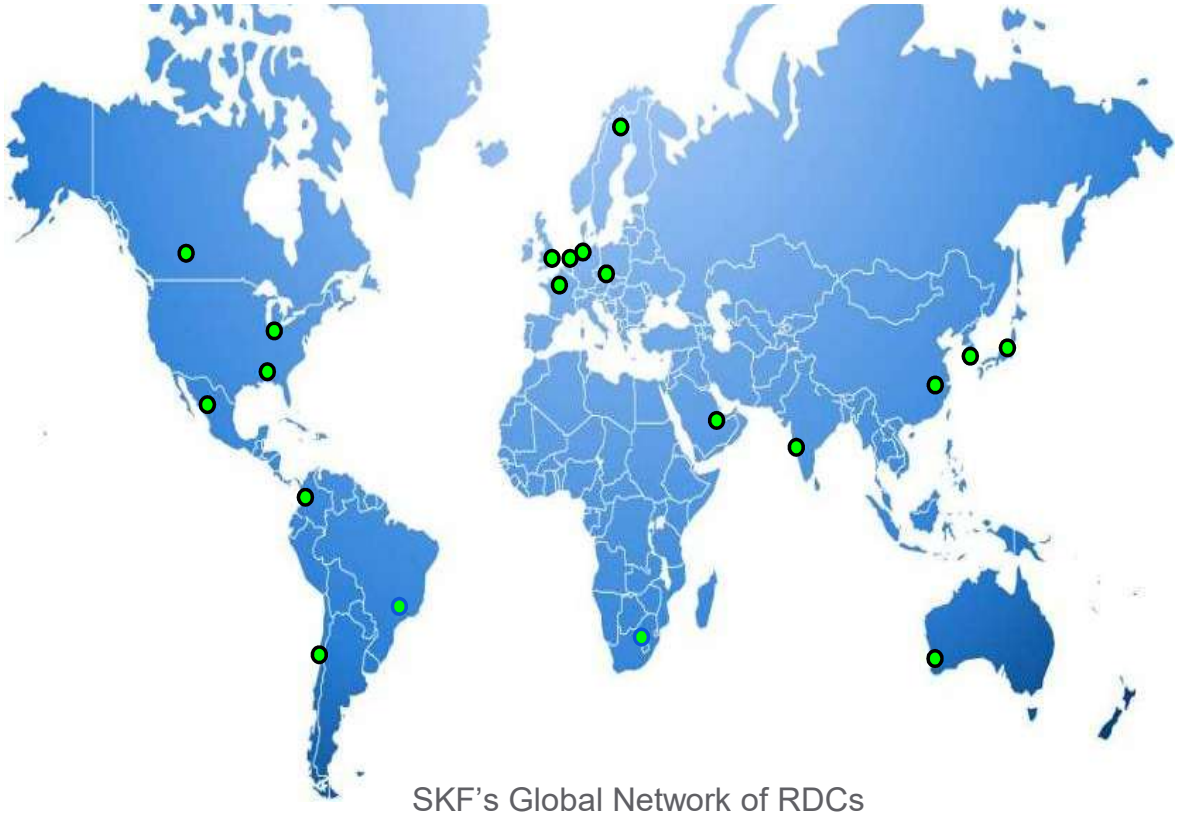
SKF Asset Reliability through Remote Diagnostic Center (RDC)

SOLVE

Asset Reliability

Number of customers in database approx. 2100 nos
Total number of Asset's in Data base > 130000

Global Presence



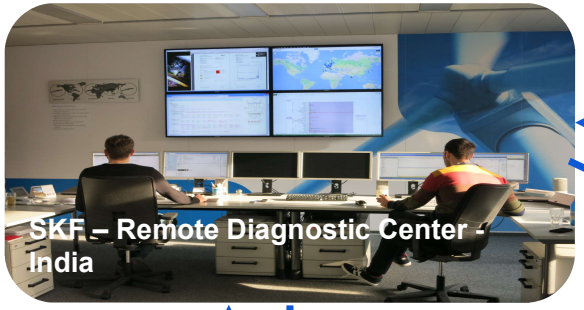
SKF's Global Network of RDCs
Several RDCs across the globe in all time zones

SKF

Remote Diagnostic Centre : Working methodology

SOLVE

Asset Reliability



8. SKF MULTILOG ONLINE DATA COLLECTION DEVICE FOR AUTOMATED DATA COLLECTIONS.

6. RDC ANALYSES THE DATA

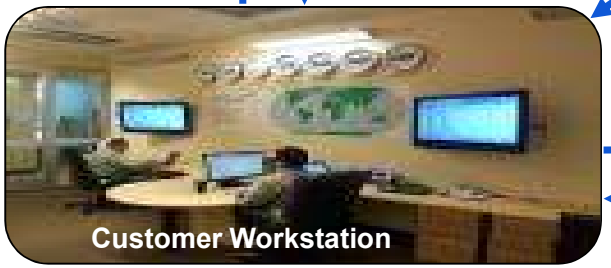
5. RDC SENDS DATA COLLECTION ROUTE TO CUSTOMER AFTER RECEIVING AIP SHEETS

Analysis

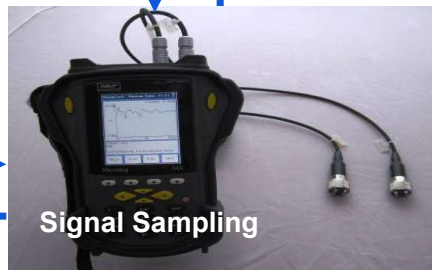
1. CUSTOMER COLLECTS VIBRATION DATA IN THEIR CRITICAL ASSETS

4.CUSTOMER SENDS THE DATA TO RDC

7. RDC REPORTS THE KEY FINDINGS TO CUSTOMER



2. CUSTOMER DOWNLOADS THE ROUTE DATA IN THE PORTABLE ANALYSER



3. CUSTOMER UPLOADS THE COLLECTED VIBRATION DATA TO THE WORKSTATION

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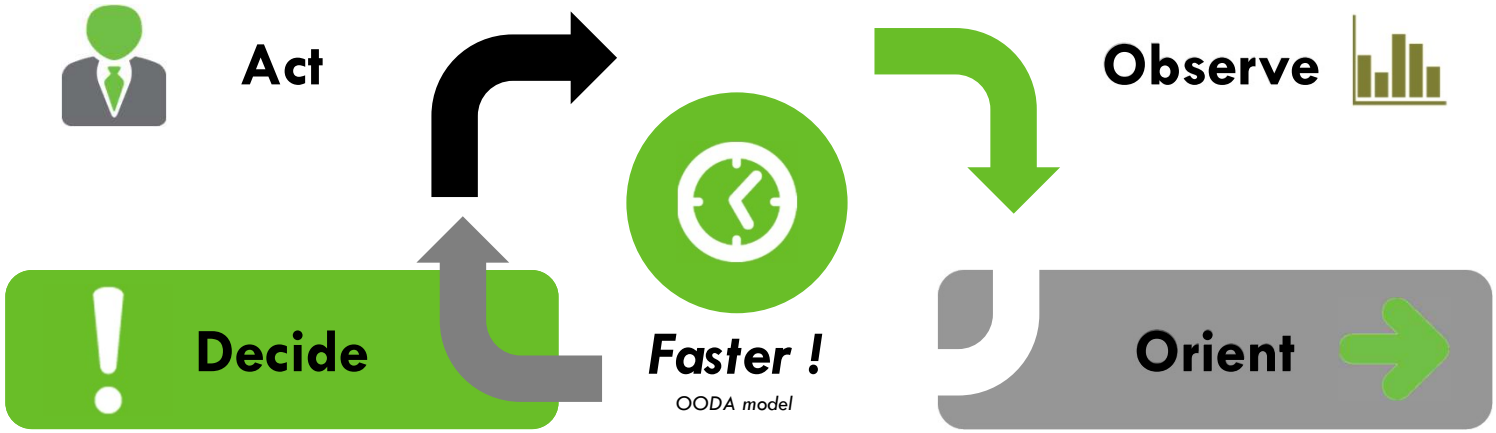
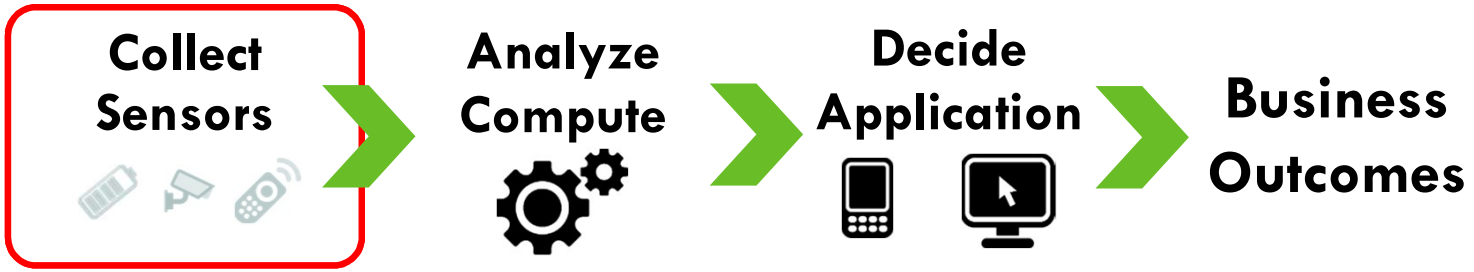
The RDC promise through IOT

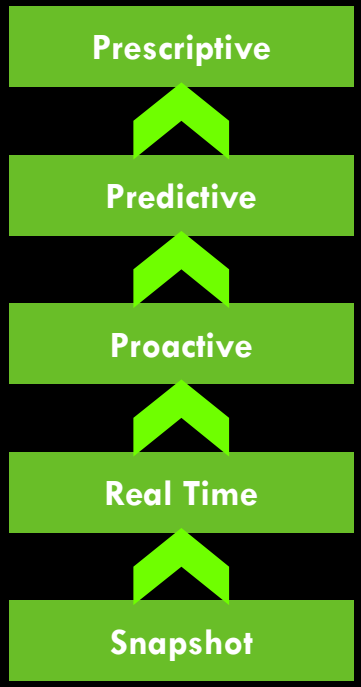
Why



How



IoT is Outcomes based



"Data is the new oil"

© SKF Group

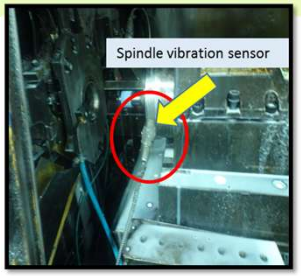
Case Study :
Spindle for life

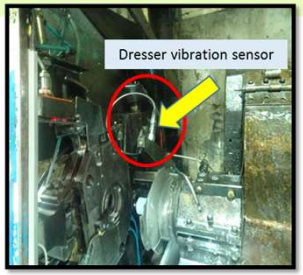
Grinding Machine : Online Monitoring System implementation for Predictive maintenance

Problem Statement :
Spindle Failure breakdowns on Ch-04 affects Productivity & Quality badly.

Solution : Adopt Predictive Maintenance approach through Industry 4.0 Technology Step up

How : Installation of Online Vibration Sensors through SKF RDC IMx-8 technology.





Benefits :

On Machine Control Panel through HMI Screen live vibration figures visible, this will help to know the status.

We get alerts from RDC Team with analysis through mails.

We can see the live status on Mobile App also.

Future Next development:

Get alert through SMS to Production, Maintenance & Spindle Room Team.

Machine will have interlock to show the alert on screen

©

Traditional Maintenance : Before Digitalization

Grinding Machine

Health Monitoring Method

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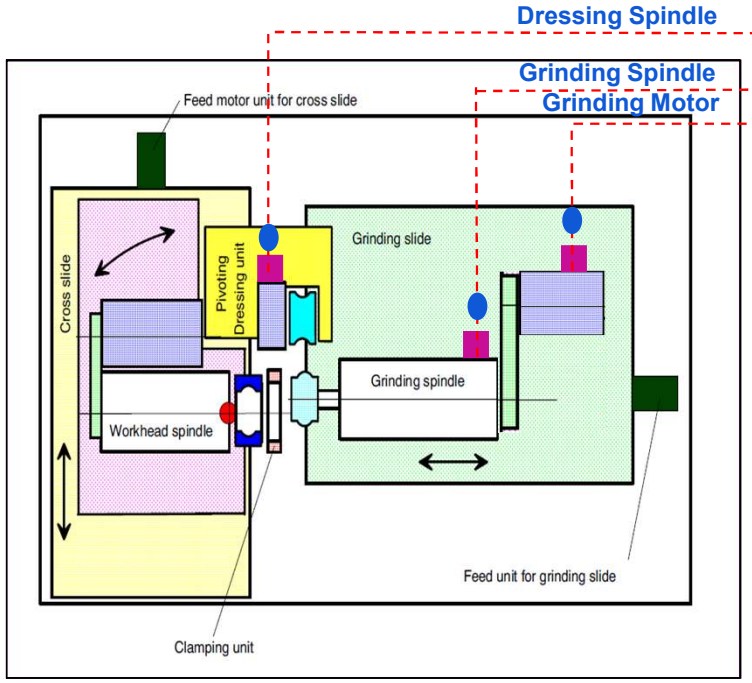
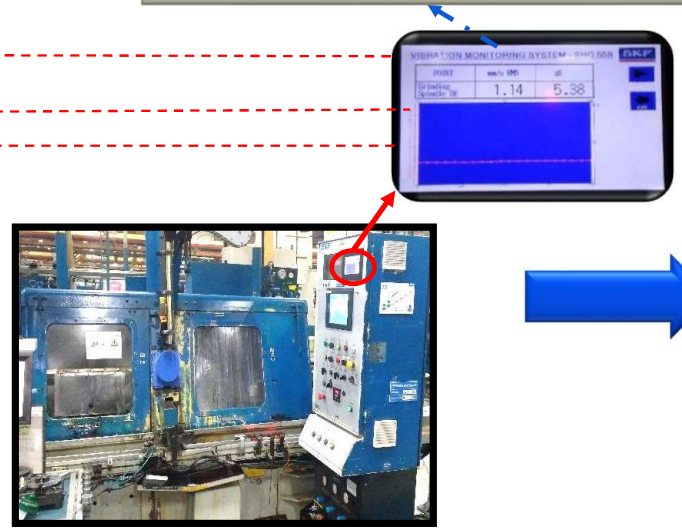
Grinding Machine : Spindle For Life Process Flow

MACHINE With IIOT Sensor



Data Transfer to HMI



Big Data from Transfer for Analysis to SKF Product

Remote Data Analytic at RDC

Real Time Action & Decision

- Normal
- Alert
- Alarm

SMS
E-Mail
Real Time Alert
Communication

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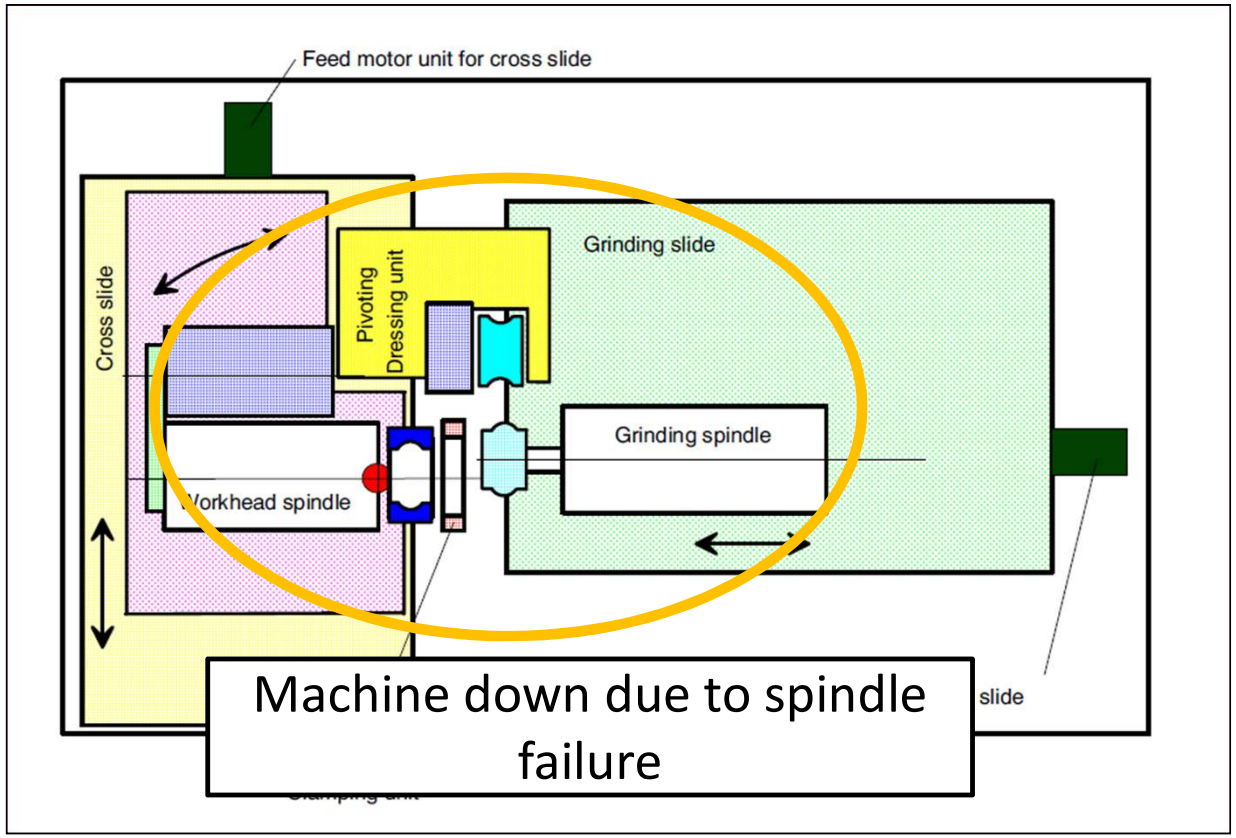
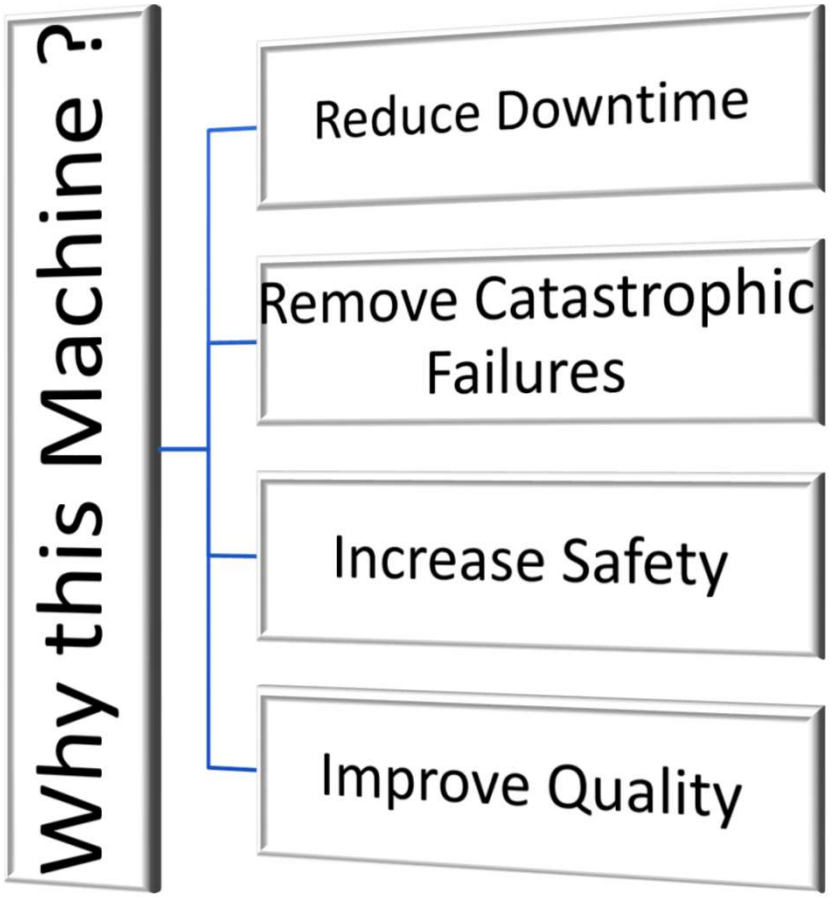
Spindle Selection Background





Grinding process is the key process in any Bearing Manufacturing Industry

© SKF Group

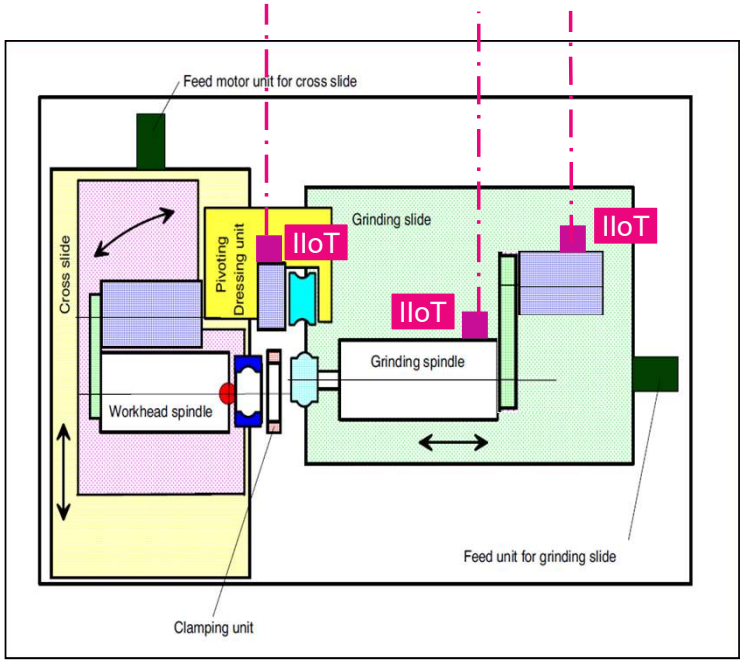
ONLINE - Spindle Monitoring

Process:

Vibration sensors are permanently mounted at all bearing locations and connected to IMX-8 (Wireless transmitter). Vibration Data will directly go live and stored in diagnosis software.

Advantages:

- Determine spindle health in NO LOAD & LOAD condition.
- Data sampling of all bearing locations.
- Data sampling can be done without production outage.
- Event based data is also captured.
- Data is live for 24x7 and frequency of data storing can be as per requirement, as data is storing automatically.
- Other engineering parameters i.e. motor current, speed, temperature etc. can be monitor continuously.
- No requirement of portable vibration analyser



Online monitoring at SKF Factory, Pune

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Spindle Vibration Analysis Report

DASH BOARD - OVERALL STATUS

Bearing / Product Type — 12-Mar-2018

Machine Name		Motor	Spindle	Dresser Wheel / ARM
		NORMAL / 2.5 (1.0 gE)	NORMAL / 0.1 (1.0 gE)	NORMAL / 0.2
	Action Required	-No immediate action is required, vibration trend to be monitor closely.	-No action required till further monitoring.	N/A
	Status / Vibration	N/A		NORMAL / 1.8 (4.3 gE)
	Action Required	N/A	Vibration sensor is not placed on spindle. (Last data taken on 8 Feb'18)	-In an opportunity inspect the dresser wheel bearings for minor bearing defects and ensure for proper lubrication.
SGH - 1001	Status / Vibration	N/A	ALERT /1.0 (7.1 gE)	N/A
	Action Required	N/A	-In an opportunity inspect / replace the spindle for bearing deteriorations.	N/A
SSB - 1011	Status / Vibration	NORMAL / 2.2 (2.3 gE)	ALARM /1.9 (6.7 gE)	N/A
	Action Required	-Check & correct the alignment between motor & spindle pulleys. -Inspect the belt condition & check for proper tension. -Closely monitor the vibration trend and in an opportunity inspect the spindle bearings		N/A
Machine Name		**Work Head Motor**	**Grinding Motor**	**Dresser Wheel / ARM**
SGB - 1003	Status / Vibration	NORMAL / 0.7 (0.7gE)		N/A
	Action Required	-No action required till further monitoring.	-Data shall be collected once speed input is provided.	N/A

Real Time Alert / Alarm Before

Real Time Causes

SSB – 1011 (Online Monitoring)

Motor	gE)	3		*Minor structural looseness & misalignment is indicated between motor and spindle pulley. *Enveloped acceleration is increased in spindle bearing with respect to last readings.
	1.9 (6.7 gE)	1	M	-Check & correct the alignment between motor & spindle pulleys. -Inspect the belt condition & check for proper tension. -Closely monitor the vibration trend and in

Surveillance Report 7

				an opportunity inspect the spindle bearings with respect to minor bearing defects.

Real Time Status After

DASH BOARD - OVERALL STATUS

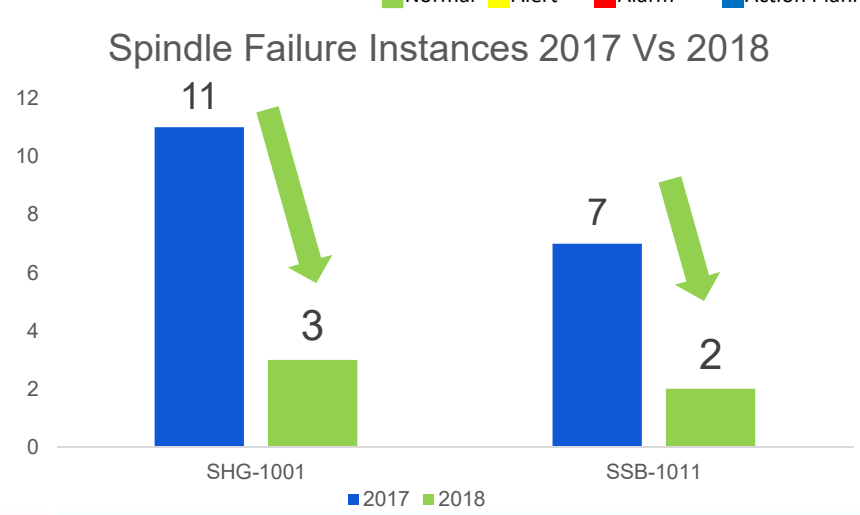
Bearing / Product Type — 19-Mar-2018

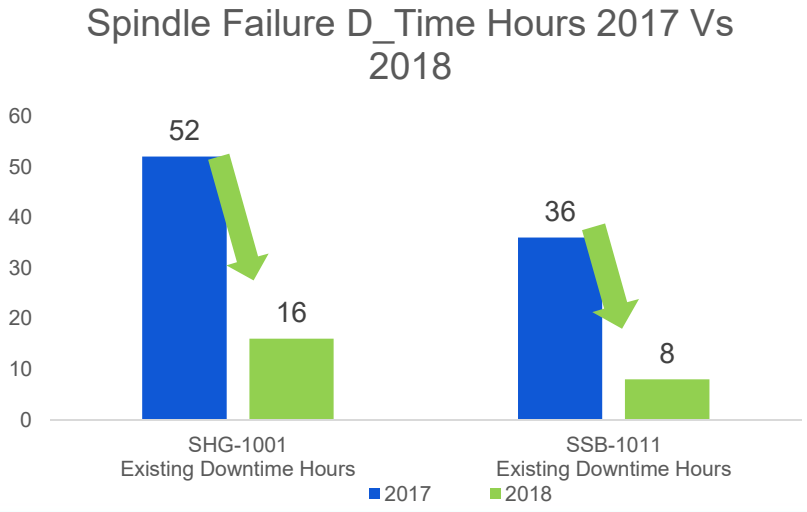
Machine Name		Motor	Spindle	Dresser Wheel / ARM
	Action Required	-Machine is not running (under maintenance)	-Machine is not running (under maintenance)	-Machine is not running (under maintenance)
	Status / Vibration	N/A		NORMAL / 1.7 (6.7 gE)
	Action Required	N/A	Vibration sensor is not placed on spindle. (Last data taken on 8 Feb'18)	-In an opportunity inspect the dresser wheel bearings for minor bearing defects and ensure for proper lubrication.
SGH - 1001	Status / Vibration	N/A	ALERT /1.0 (7.6 gE)	N/A
	Action Required	N/A	-Inspect / replace the spindle for bearing deteriorations.	N/A
SSB - 1011	Status / Vibration	NORMAL / 2.3 (4.4 gE)	ALERT /0.7 (6.0 gE)	N/A
	Action Required	-Ensure the motor bearings for proper lubrication.	-In an opportunity inspect / replace the spindle bearings with respect to raceway defects in bearings.	N/A
Machine Name		**Work Head Motor**	**Grinding Motor**	**Dresser Wheel / ARM**
SGB - 1003	Status / Vibration	NORMAL / 1.0 (0.8 gE)		N/A
	Action Required	-No action required till further monitoring.	-Data shall be collected once speed input is provided.	N/A

Health Tracker

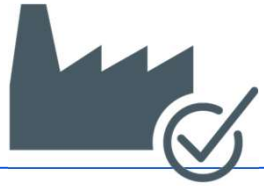
MACHINE HEALTH TRACKER @ DGBB CHANNEL-04																Before Breakdowns per quater	After Breakdowns per quarter
Machine Name	Asset Name	2017				2018											
		Month-1	Month-2	Month-3	Month-4	Month-1	Month-2	Month-3	Month-4	Month-5	Month-6	Month-7	Month-8				
SHG-845 Offline	B.D. Spindle															3	0
SHG-1001 Online	HF Spindle															3	0
SSB-1011 Online	B.D. Spindle															3	0
SSB-1080 Offline	HF Spindle															2	0
SGB-1003 Offline	Elect. Motor															2	0

Normal Alert Alarm Action Planned in Preventive Maintenance





ACTUAL BENEFITS POST IMPLEMENTATION



- **KPIs to be influenced**

1. To align Maintenance actions with business strategy to meet goals
2. Predictability for spindle performance – Goal - Zero surprise failure*
3. Reduction in unplanned downtime ,
4. Improve MTBF
5. Reduction in MTTR
6. Unplanned maintenance cost's reduction
7. Productivity enhancement support
8. Safety and Production stoppage for data capture

- **KPIs Actual Status**

1. Philosophy of Zero Surprises – Maintenance Goal
2. Zero Surprise failure from Sept 17 till date
3. Reduction in downtime by 8.2% in 4 mths
4. Improve MTBF – MTBF average increase by 45%
5. Reduction in MTTR – By 24%
6. Zero Unplanned maintenance cost
7. Asset runtime available online, Increase productivity by 0.6%
8. Safety of operations and savings in production stoppage for capturing data

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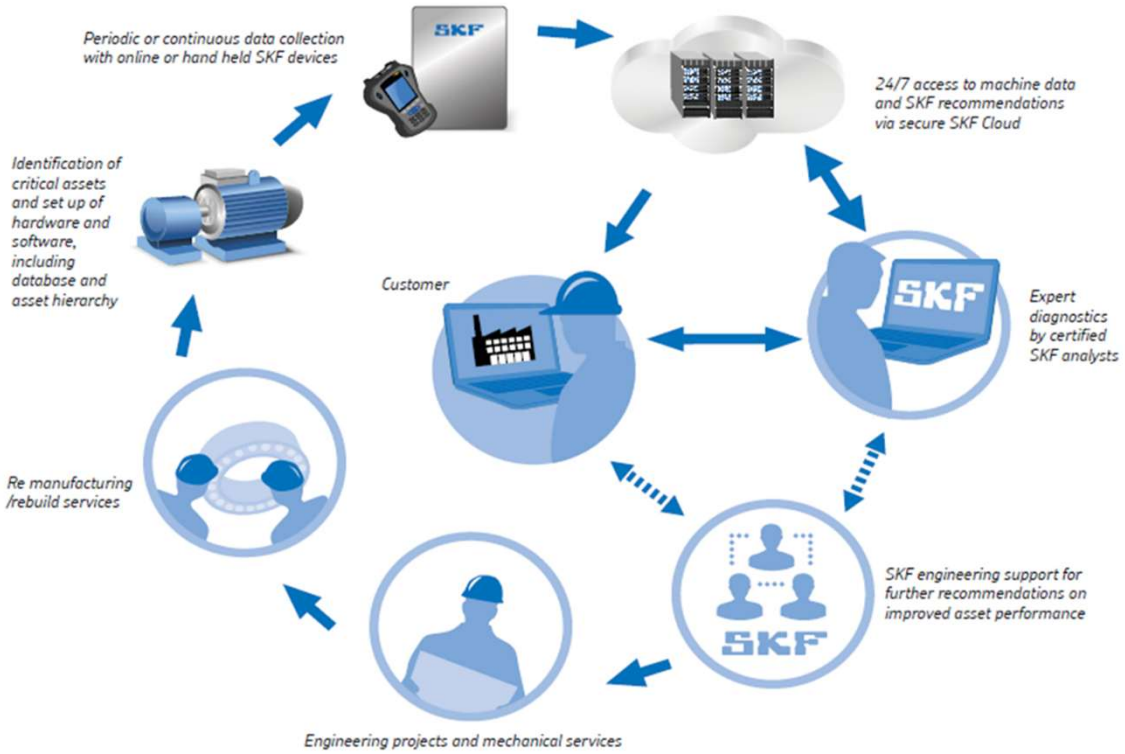
SMART SPINDLE : SKF services proposition for rotating equipment's

Smart Spindle



Detection Hardware	• Sensors • Communication Setup
Remote Diagnosis	• ISO Certified Analysts • Dominant Failure modes from Repair Factory database • Corrective action recommendations
Repair	• World Class spindle repair facility network across India (Pune, NCR & Bengaluru) • Global database of spindle makes and models
Engineering Support	• Root Cause Failure Analysis • Design & upgrade support
Maintenance Support	• Checklist formulation • Predictive Maintenance Program Design

© SKF Group

Smart Spindle : Business Case

Standard Repair	Smart Spindles
Repairs on case to case basis	18 months contract Zero surprise failure Fixed monthly fees, includes performance bonus
Standard 6 months warranty	Cloud based technology Online condition monitoring Automated notification Remote diagnostic support
Optional services: Mounting supervision Application up-grades, Machine inspection Vibration monitoring	18 months warranty. Client pays only for repair reasons not attributable to SKF
	Root cause failure analysis. Application Engineering Support and bearing upgrades as applicable
	Check list formulation and inspection Mounting supervision

* Certified Spindle Repairers , if applicable

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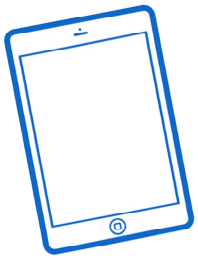
Smartifying industry



Mobility becomes the window

Machine Condition Notification (Mobile, Wearable device)

Maintenance

Machine Condition Check & Analysis

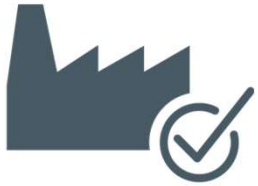
the Cloud becomes the infrastructure

Big Data management becomes the intelligence

Connected sensors/systems become the data feed

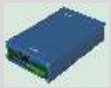
© SKF Group

Big Data Analytics- Why should I do it?



OEM

Listen to your machine real time
Get design inputs
Improve competitiveness



End User

Reduce breakdowns
Improve cost position
Build competitive advantage

SKF

Remote Diagnostic
Neutral feedback
Real-time Prognostics

- **KPIs to be influenced**

- To align Maintenance actions with business strategy to meet goals
- Improve MTBF
- Reduction in MTTR
- Predictability for spindle performance – Zero surprise failure*
- Unplanned maintenance cost's reduction
- Skill enhancement support

*: To be jointly finalized and implemented by Customer and SKF after C N A and baseline built up

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SKF Smart Spindle Reliability Program

+

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=

DETECT
On-Line Digitization

- On-line Sensor
- Live data monitoring
- Local display available

SOLVE
Asset Reliability Remote Diagnostic Centre

- Analysis of the data
- Trend monitoring
- Prediction of potential defects
- Actionable intelligence reports
- Technical support
- SKF Gear Box ReManufacturing

OPEX Model

- Provides predictable Cash Flow
- Quarterly review of KPIs and performance

ROTATING EQUIPMENT PERFORMANCE

- **Zero Surprise Failure** .
- Carbon footprint reduction.

Customer wants performance – Zero Surprise Failure

© SKF Group

Zero Surprise failure model- Rotating equipment

Smart Machines

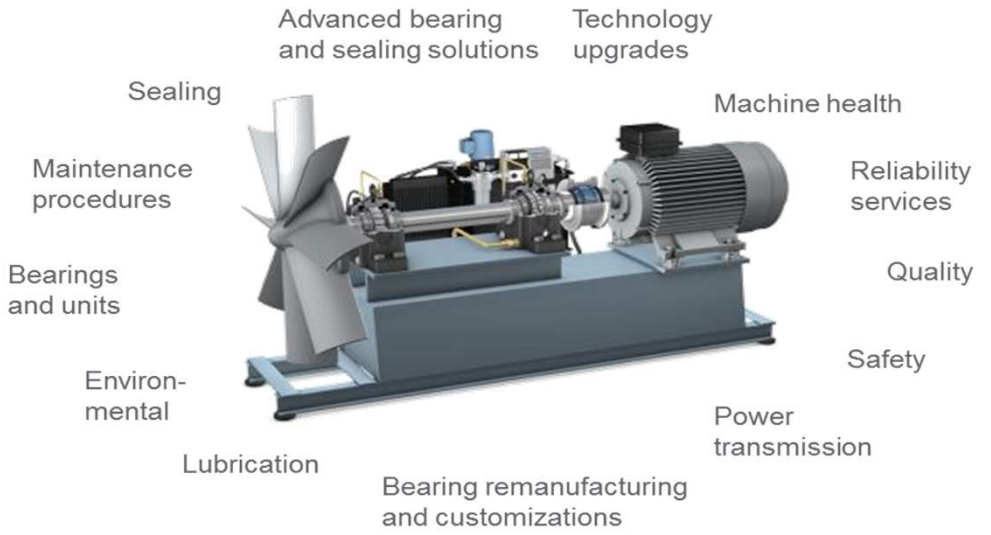
Supply of SKF bearings.
18 months contract
Fixed monthly fees, includes performance bonus

Cloud based technology
Online condition monitoring
Automated notification
Remote diagnostic support

Zero surprise failure

Root cause failure analysis. Application Engineering Support and bearing upgrades as applicable

Check list formulation and inspection
Mounting supervision



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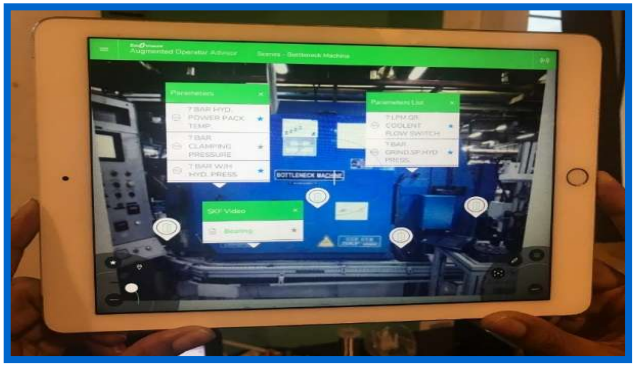
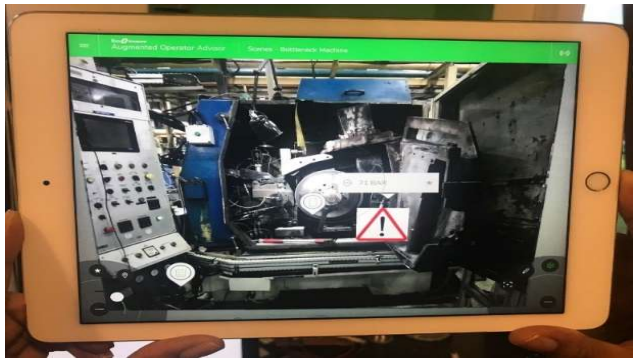
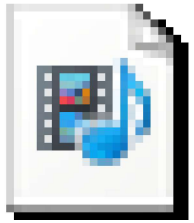
SMART Machine: Augmented Reality for SGB55(CH04)

- ✓ Real time error and event handling.
- ✓ Diagnostic from expert consultant from a remote location.
- ✓ Facilitate real time intervention.
- ✓ Virtual feel of equipment with diagnostic manuals and accurate forecasting of root cause.
- ✓ Operator/Maintenance technician need not ne the domain expert- Deskilling





SMART Machine: Augmented Reality for SGB55(CH04)



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