



# Modern Coach Factory (MCF)



**INDUSTRY 4.0**



**1<sup>st</sup> Digital  
Factory of IR**



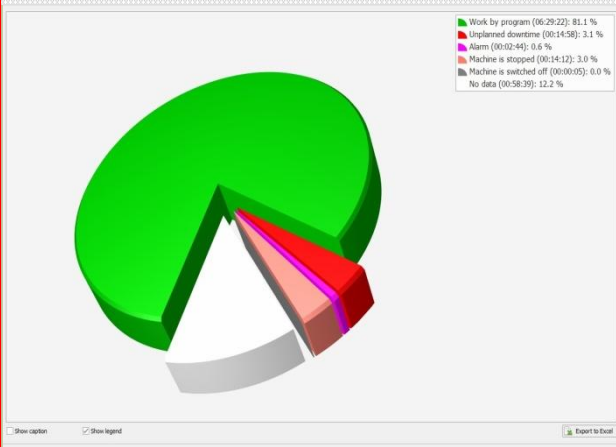
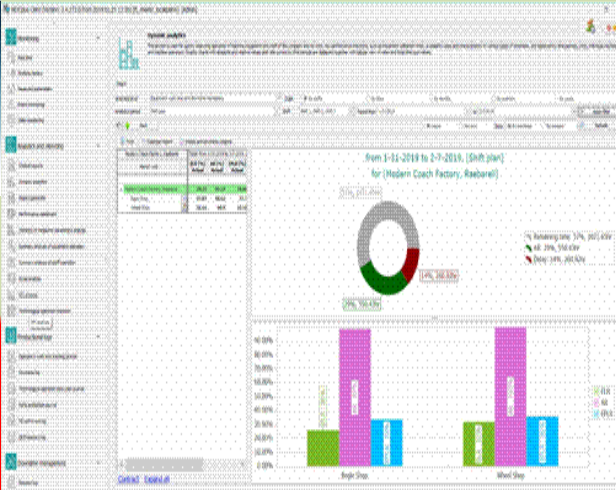


# INDUSTRY 4.0

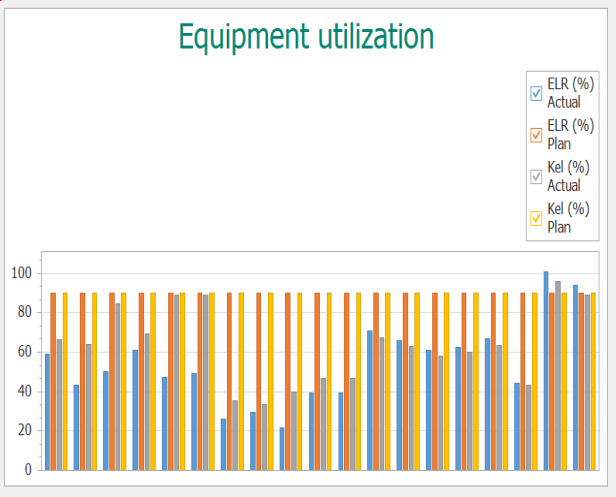


## BENEFITS OF INDUSTRY 4.0

- Connection to any machine
- Wide support for CNC controls
- Automatic / manual data collection
- Report generator
- EMAIL & SMS messaging
- CNC program management
- Job scheduling
- Computerized maintenance management system
- App for tablets and smartphones
- Energy and video monitoring
- Vibration Analysis
- ERP and MES integrations



All machines		Machines		Modern Coach Factory, Raebareilly/Wheel Shop	
Total number of 7		1-6 of 7		Wheel Production	
<b>END DRILLING, COUNTER SINK...</b>	Task No:1200001 Work by program 00:11:25 Wheel P. Wheelshop_production Drilling, Tapping, Countersinking Actual: 0.00% Plan: 0.00% Spindle corrector 000% Feed corrector 100%	<b>CYLINDRICAL GRINDING MAC...</b>	Task No:1200001 Work by program 00:17:27 Wheel P. Wheelshop_production cylindrical Grinding Actual: 0.00% Plan: 0.00% Spindle corrector 000% Feed corrector 100%	<b>SURFACE WHEEL LATHE MACHI...</b>	Task No:1200001 Unplanned downtime 02:43:08 Wheel P. Wheelshop_production wheel lathe Actual: 0.00% Plan: 0.00% Spindle corrector 000% Feed corrector 100%
<b>AXLE TURNING MACHINE</b>	Task No:1200001 Work by program 00:00:50 Wheel P. Wheelshop_production Axle Turning Actual: 0.00% Plan: 0.00% Spindle corrector 000% Feed corrector 100%	<b>VERTICAL TURNING LATHE MA...</b>	Task No:1200001 Unplanned downtime 05:43:55 Wheel P. Wheelshop_production Vertical Turning Actual: 0.00% Plan: 0.00% Spindle corrector 000% Feed corrector 100%	<b>SYNCHRONIZED GYNTRY-I</b>	Task No:12120001 Work by program 00:16:08 Wheel P. Wheelshop_production No technological operation Actual: 0.00% Plan: 0.00% Spindle corrector 000% Feed corrector 100%





# MCF 1st Digital Factory of IR

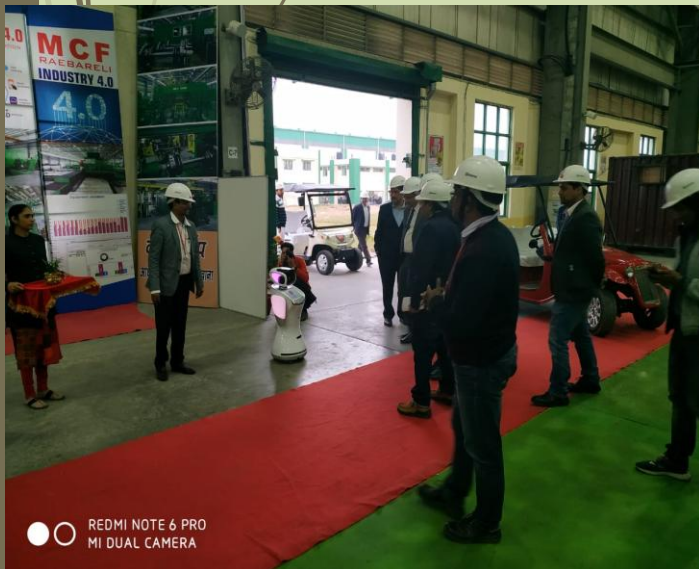
DEDICATED TO  
SERVICE

**INDUSTRY 4.0**

**SHRI RAJESH AGRAWAL**

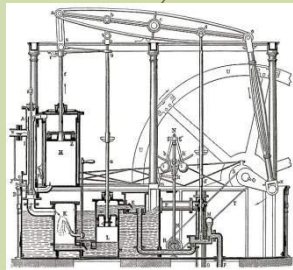
**Hon'ble Member (RS)  
RAILWAY BOARD**

02-03-2019  
MCF, RAEBARELI





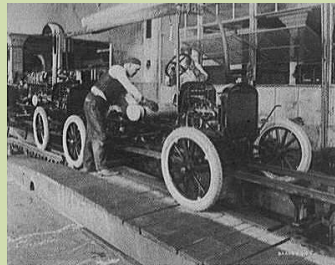
# Industrial Evolution



**1. Industrial revolution**  
Introducing mechanical production machines powered by water and steam

**Industry 1.0**

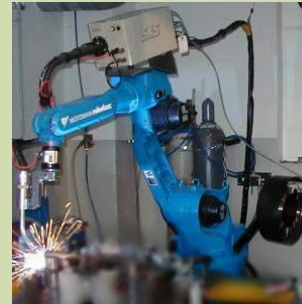
**End of the 18th century.**



**2. Industrial revolution**  
Introducing mass production lines powered by electric energy

**Industry 2.0**

**Beginning of the 20th century**



**3. Industrial revolution**  
Through the use of electronics and IT further progression in autonomous production

**Industry 3.0**

**Beginning of the 70th**



**4. Industrial revolution**  
Based on cyber-physical-systems

**Industry 4.0**

**Today**



**Level of complexity**



# Industry 4.0 at a glance



## Machine Data COLLECTION



Automatic / manual data collection

Use the existing network to monitor CNC machines, robots, PLCs

Display machine status on large TV screens, PCs, mobile devices

## Production OPTIMIZATION



Machine-based job scheduling improves utilization and production flow

Creation and configuration of new orders

100+ KPIs and Metrics

Customizable Reports and Charts

## Downtime MANAGEMENT



Unlimited number of data collection events

Track reasons for machine downtime

Predictive maintenance

Reduce unscheduled downtime

EMAIL & SMS messaging

Computerized maintenance management system

## Digital MANUFACTURING



Paperless production

Include all machine tools and employees in the same network

Assign and transfer jobs and NC programs to the machine

ERP and MES integrations





# How Industry 4.0 Software works





# Industry 4.0 Software hardware



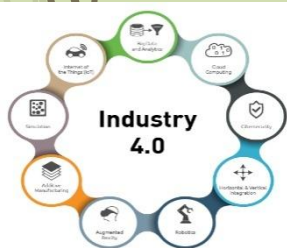
- HMI Operator touch monitor
- Monitoring terminal
- Adapters
- Barcode scanner
- RFID reader
- Interactive kiosk
- Serial Wi-Fi Adapter – RS232
- Xbee module
- Current sensor
- Vibration sensor



# Machines connected



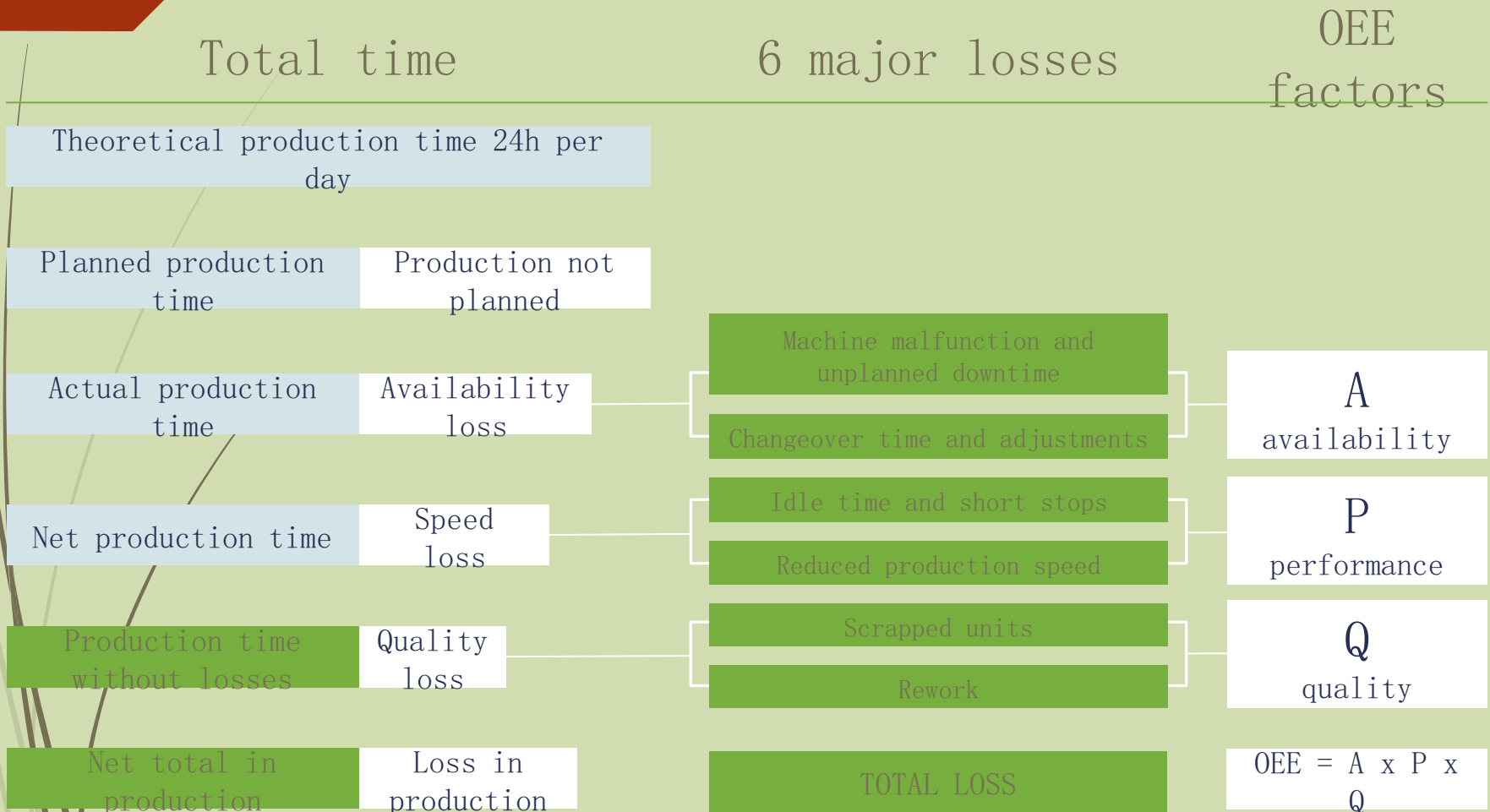
1. Edge milling machine = 01
2. Bed milling machine = 01
3. Bolster machining center = 02
4. Boogie frame machining center = 02
5. End dil tapping and counter sinking machine = 01
6. Axle turning machine = 01
7. Axle grinding machine = 01
8. Axle measuring machine = 01
9. Wheel turning machine = 01
10. Wheel press machine = 01
11. Wheel turning lathe = 01
12. Dynamic wheel balancing machine = 01
13. Automated wheel conveying system = 01
14. Automated axle conveying system = 01







# Let's find the bottlenecks in production



- **OEE (Overall Equipment Effectiveness)** is a globally accepted standard for measuring manufacturing productivity.
- In short: it identifies the share of the total manufacturing time that is truly productive.



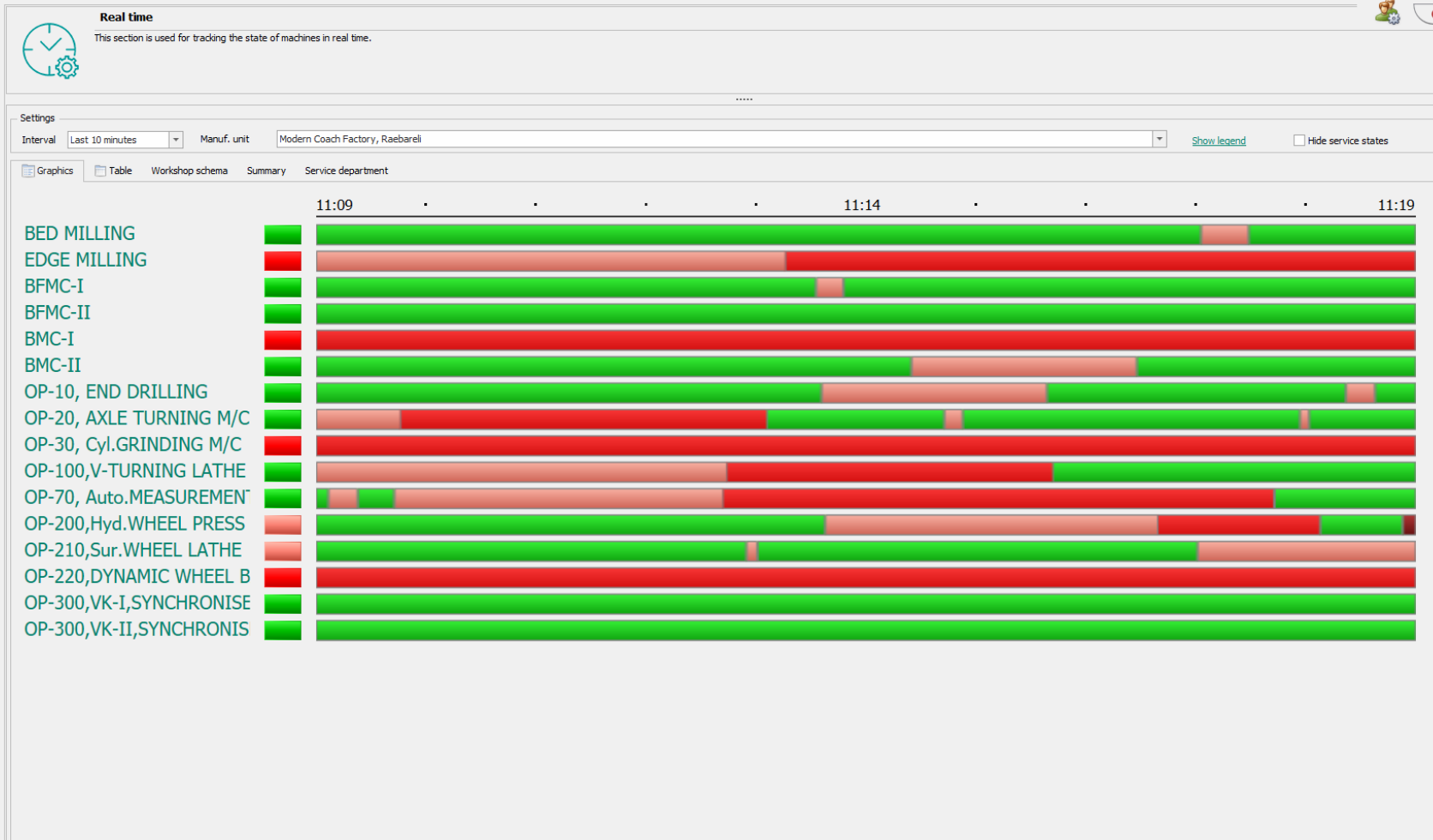


# Real Time Connected Machines



2.4.290.0 from 2019.02.28 17:49 [ft\_master\_localization] [Admin]

- Monitoring
- Real time
- Working history
- Measured parameters
- Event monitoring
- Video monitoring
- Analytics and reporting
  - Statistical reports
  - Dynamic analytics
  - Report generator
  - Performance dashboard
  - Statistics of measured parameters analysis
  - Summary analysis of equipment operation
  - Summary analysis of staff operation
  - Scrap analysis
  - KPI analysis
  - Technological operation statistics
- Productional logs
- Downtime management
- NC program management
- Production tasks management
- Settings
- Directories
- Technical directories





# Working History

MDCplus Client (Version: 2.4.290.0 from 2019.02.28 17:49) [ft\_master\_localization] [Admin]

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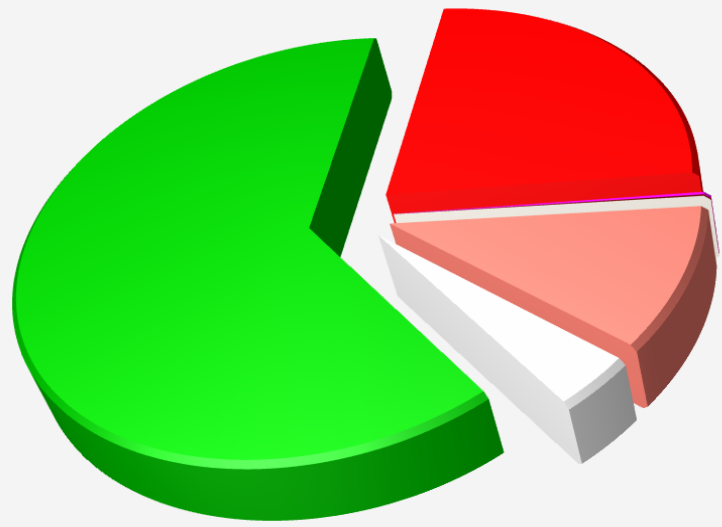
**Real time**  
This section is used for tracking the state of machines in real time.

Settings  
Interval: Work shift | Manuf. unit: Modern Coach Factory, Raebareli

Graphics | Table | Workshop schema | Summary | Service department

Filter by machine [EditValue is null] Refresh data Automatic update

Machine	State	Duration
▶ BED MILLING	Work by pr...	01:01:17
EDGE MILLING	Work by pr...	03:12:08
BFMC-I	Work by pr...	04:02:29
BFMC-II	Work by pr...	04:04:07
BMC-I	Work by pr...	01:40:29
BMC-II	Work by pr...	02:53:03
OP-10, END ...	Work by pr...	03:19:23
OP-20, AXLE...	Work by pr...	02:57:06
OP-30, Cyl...	Work by pr...	03:05:26
OP-100,V-T...	Work by pr...	02:54:38
OP-70, Auto...	Work by pr...	01:02:42
OP-200,Hyd...	Work by pr...	03:10:48
OP-210,Sur...	Work by pr...	02:11:49
OP-220,DYN...	Work by pr...	00:21:01
OP-300,VK-I...	Work by pr...	04:21:31
OP-300,VK-I...	Work by pr...	04:10:46
BED MILLING	Unplanned...	00:41:31
EDGE MILLING	Unplanned...	00:36:17
BMC-I	Unplanned...	02:19:58
BMC-II	Unplanned...	00:50:31
OP-10, END ...	Unplanned...	00:15:22
OP-20, AXLE...	Unplanned...	01:06:23
OP-30, Cyl...	Unplanned...	01:06:33
OP-100,V-T...	Unplanned...	00:51:22
OP-70, Auto...	Unplanned...	02:39:43
OP-200,Hyd...	Unplanned...	00:36:18
OP-210,Sur...	Unplanned...	01:31:40
OP-220,DYN...	Unplanned...	03:55:15
OP-300,VK-I...	Unplanned...	00:02:28
BED MILLING	Alarm	00:01:42
BMC-I	Alarm	00:00:20



- Work by program (44:28:43): 62.7%
- Unplanned downtime (16:33:21): 23.3%
- Alarm (00:07:04): 0.2%
- EMERGENCY (00:04:21): 0.1%
- On-load operation (00:00:13): 0.0%
- Operation on CNC Device (00:01:26): 0.0%
- Machine is stopped (07:07:49): 10.1%
- No data (02:33:03): 3.6%

Show caption Show legend





# Measured Parameters

MDCplus Client (Version: 2.4.290.0 from 2019.02.28 17:49) [ft\_master\_localization] [Admin]

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- Settings
- Directories
- Technical directories
- Equipment directories
- Admin. logs

### Measured parameters

This section is used for building charts and analyzing obtained measured parameters.

---

**Filters**

Machine:  Parameter:

Monitoring period from:   to    Current time   Refresh every  seconds

---

**Graphic** | **Table**

- Spindle speed
- Feed
- Spindel load
- X-Axis load
- Y-Axis load
- Z-Axis load
- Spindle speed corrector, 5%
- Feed corrector, F%
- JOG manual movement correction, %
- Part counter
- Cycle
- Machine is switched on
- Machine is stopped
- Operation on CNC Device
- MST functions performance
- Machine overload
- On-load operation
- Machine moving
- EMERGENCY
- Alarm
- Work by program

**Appearance properties** | Voltage dip/surge/cut-off

show machine states Number of signs after comma:

show cursor information  show legend

Additional parameters:

charts for all phases Color1:  Color2:  Color3:

voltage dip/surge/cut-off over fail:  Surge:  Cut-off:

show point captions on charts

**Average level**

chart with the average value Color:

chart of average value by state Color:

Allowed state interruption time (s):

**Relative level**

chart of values relative to level Color:

level value:

minimum time interval (sec):

**Fixed values**

fixed levels chart

level 1 value:  Color:

level 2 value:  Color:

level 3 value:  Color:

show cursor

zoom and scroll in Y-direction





# Dynamic Analytic - Equipment Work Time and Down Time

MDCplus Client (Version: 2.4.290.0 from 2019.02.28 17:49) [ft\_master\_localization] [Admin]

**Dynamic analytics**  
This section is used for quickly analyzing operation of machine equipment and staff of the company and its units. Key dynamic indicators, such as equipment utilization rates, availability rates and characteristics of various types of downtime, are displayed by time periods, units, individual machines and machine operators. Graphic charts with absolute and relative values and rate curves by time periods are displayed together with tabular view of rates and total time cost values.

Filters  
 Analytics level: Equipment work time and downtime monitoring | Scale:  By shifts |  By days |  By months |  By quarters |  By years  
 Analytics period: Shift plan | Shift: Shift 1, Shift 2, Shift 3 | Period from: 3-8-2019 | to: 3-9-2019 | Apply filter

States and downtime reasons

Manuf. unit	ELR (%) Actual	AR (%) Actual	EPLR (%) Actual
Modern Coach Factory, Raebareli	53.4	99.52	62.7
Bogie Shop	59.89	99.45	70.6
Wheel Shop	50.71	99.55	59.47

from 3-8-2019 to 3-8-2019, [Shift plan] for [Modern Coach Factory, Raebareli]

53%, 169.8hr  
 47%, 153.43hr

AR: 53%, 169.8hr  
 Delay: 47%, 153.43hr

90.00%  
80.00%  
70.00%  
60.00%  
50.00%  
40.00%  
30.00%  
20.00%  
10.00%  
0.00%

ELR: 60%  
AR: 99%  
EPLR: 71%  
Bogie Shop

ELR: 51%  
AR: 100%  
EPLR: 59%  
Wheel Shop

Contract Expand all





# Static Report - Work and Equipment Downtime

MDCplus Client (Version: 2.4.272.0 from 2019.01.23 13:26) [ft\_master\_localization] [Admin]

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  - Summary analysis of staff operation
  - Scrap analysis
  - KPI analysis
  - Technological operation statistics
- Productional logs
  - Operator's work time tracking journal
  - Downtime log
  - Technological operation execution journal
  - Parts production journal
  - NC unit event log
  - QCD master's log
- Downtime management
  - Request log

### Static reports

This section is used for viewing and creating report forms and to export them to Excel.

**Filters**

Report: Report on work and equipment downtime

By  By manuf. unit: Modern Coach Factory, Raebareli

By  By group of machine:

Machine: All machines

Scale:  By shifts  By days  By months  By quarters  By years

Shifts: Shift 1

Analytics period: Shift plan

Monitoring period from: 2-1-2019 to 2-7-2019

**Report**

Total | Calendar | Downtimes | Production | AUST | UDET | TDET | ODET

Name	ELR (%)	EPLR (%)	AR (%)	APT (hr)	AUST (hr)	UDET (hr)	UAUT (hr)	Fund (hr)
Modern Coach Factory, Raebareli	32.00	38.00	99.00	510.03	93.73	134.07	10.30	1594.50
Bogie Shop	25.00	33.00	99.00	161.22	50.14	64.83	9.17	649.50
Bogie Frame Machining Area	27.00	36.00	98.00	101.01	36.20	15.96	5.67	378.00
BED MILLING M/C	32.00	38.00	99.00	20.43	3.80	15.96	0.53	63.00
BOGIE FRAME MACHINING CENTER-I	25.00	37.00	97.00	40.67	18.10	0.00	4.87	157.50
BOGIE FRAME MACHINING CENTER-II	25.00	34.00	100.00	39.92	14.30	0.00	0.27	157.50
Bolster Machining Area	12.00	18.00	98.00	13.67	7.35	28.57	2.75	114.00
BOLSTER MACHINING CENTER-I	7.00	14.00	96.00	3.51	3.81	11.59	2.16	51.00
BOLSTER MACHINING CENTER-II	16.00	22.00	99.00	10.16	3.54	16.98	0.59	63.00
Edge Milling Area	30.00	34.00	100.00	46.54	6.60	20.30	0.75	157.50
EDGE MILLING	30.00	34.00	100.00	46.54	6.60	20.30	0.75	157.50
Wheel Shop	37.00	42.00	100.00	348.81	43.59	69.24	1.12	945.00
END DRILLING, COUNTER SINKING, TAPPING	24.00	31.00	100.00	32.94	8.41	23.37	0.00	135.00
AXLE TURNING MACHINE	34.00	41.00	100.00	46.53	9.16	8.38	0.36	135.00
CYLINDRICAL GRINDING MACHINE	36.00	39.00	100.00	47.97	4.95	10.50	0.56	135.00
VERTICAL TURNING LATHE MACHINE	40.00	44.00	100.00	53.78	5.39	7.21	0.20	135.00
SURFACE WHEEL LATHE MACHINE	27.00	35.00	100.00	36.74	11.07	17.40	0.00	135.00
SYNCHRONISED GYNTRY-I	48.00	49.00	100.00	64.16	2.48	1.91	0.00	135.00
SYNCHRONISED GANTRY-II	49.00	51.00	100.00	66.69	2.13	0.46	0.00	135.00

Show ELR     Show EPLR     Show AR

Legend:  Actual value,  Planned value

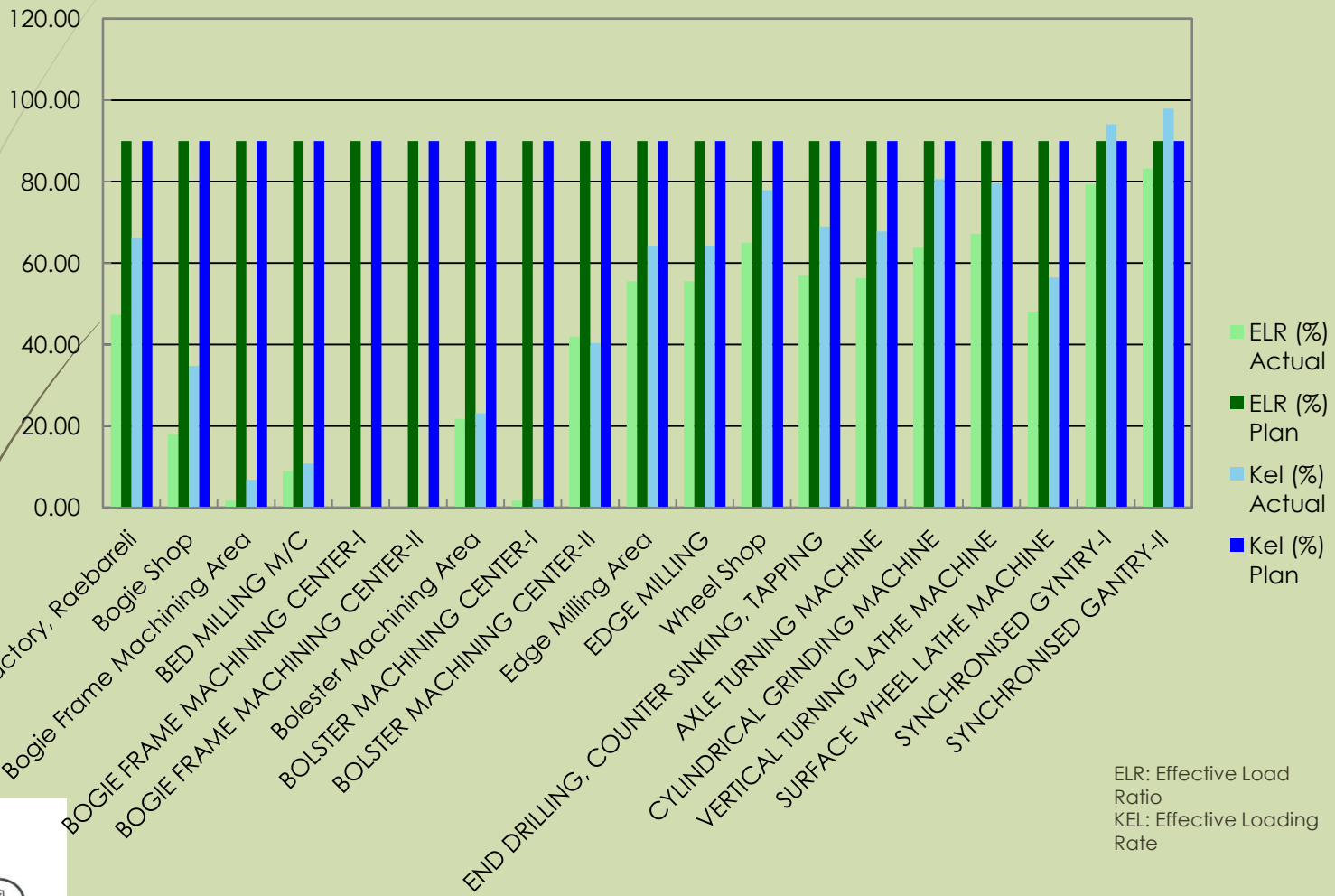
Approximate values from chart:

Metric	Actual value	Planned value
ELRa(%)	~32	~90
EPLRa(%)	~38	~90
AR(%)	~99	~100

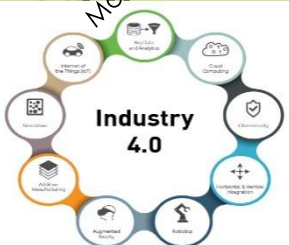
Display diagrams in Excel



# Reports on Equipment Utilization

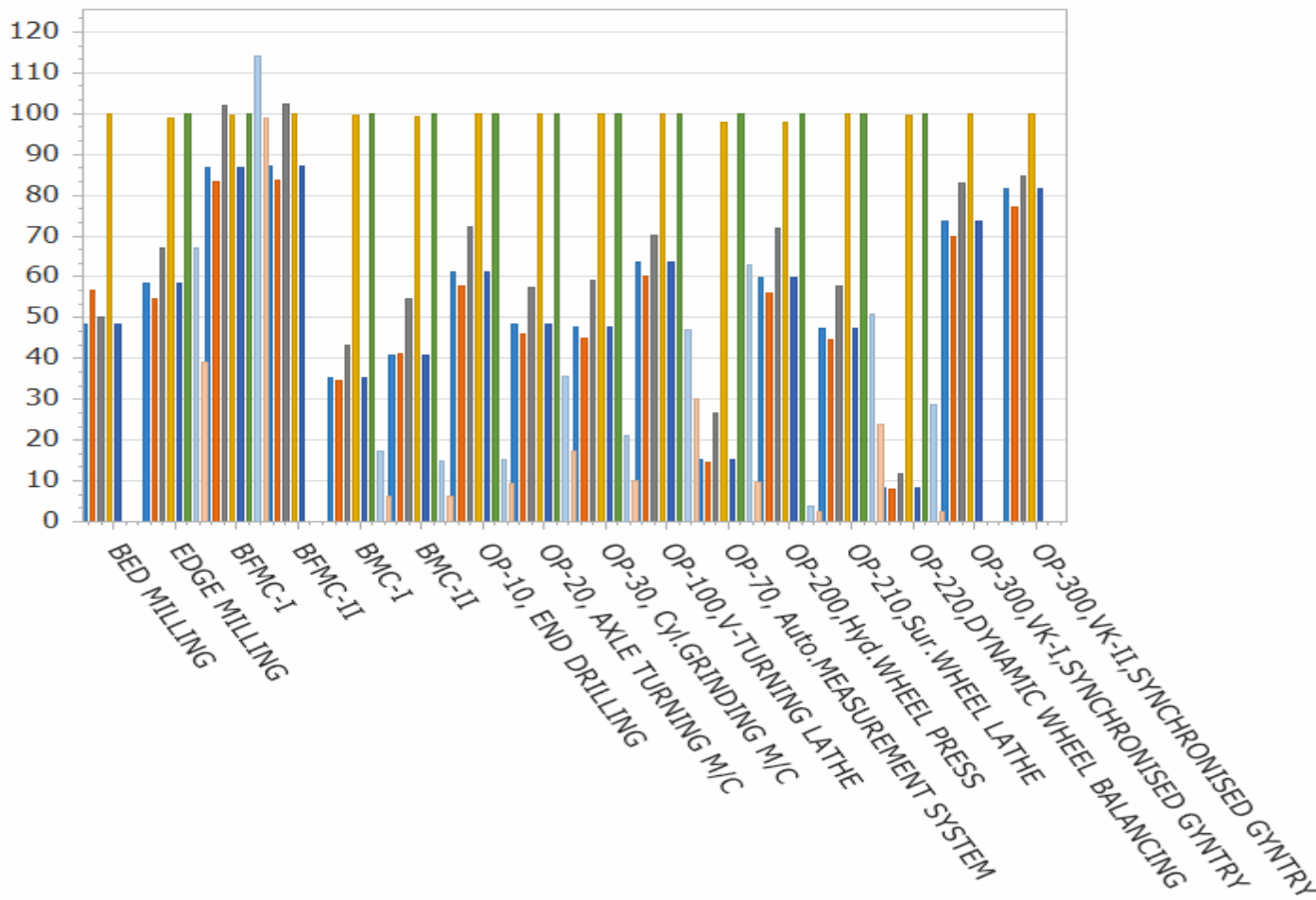


ELR: Effective Load Ratio  
 KEL: Effective Loading Rate





# KPI Analysis



- ELR
- Effective loading rate
- EPLR
- AR
- Availability rate
- Quality rate
- Productivity rate
- OEE







# Reports on Overall Equipment Efficiency



14.290.0 from 2019.02.28 17:49 [ft\_master\_localization] [Admin]

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### Statcal reports

This section is used for viewing and creating report forms and to export them to Excel.

**Filters**

Report:

By manuf. unit: 
 By group of machine:

Machine:

Scale:  By shifts  By days  By months  By quarters  By years
 Shifts: 
 Analytics period:

Monitoring period from:  to:

---

**Report**

Manuf. unit /machine	Final report						
	OEE	A	P	Q	Nparts	Nscrap	APT
Modern Coach Factory, Raebarell	0.15	0.53	0.29	1.00	184.00	0.00	169.8
Bogie Shop	0.28	0.60	0.46	1.00	27.00	0.00	55.70
CNC BED MILLING MACHINE	0.00	0.48	0.00	0.00	0.00	0.00	5.08
CNC EDGE MILLING MACHINE	0.39	0.58	0.67	1.00	23.00	0.00	13.13
CNC BOGIE FRAME MACHINING CENTER-I	0.99	0.87	1.14	1.00	2.00	0.00	13.00
CNC BOGIE FRAME MACHINING CENTER II	0.00	0.87	0.00	0.00	0.00	0.00	13.05
CNC BOLSTER MACHINING CENTER-I	0.06	0.35	0.17	1.00	1.00	0.00	5.31
CNC BOLSTER MACHINING CENTER-II	0.06	0.41	0.15	1.00	1.00	0.00	6.12
Wheel Shop	0.11	0.51	0.21	1.00	157.00	0.00	114.1
CNC END DRILLING, COUNTER SINKING, TAPPING & RE- CERTERING M/C(OP-10)	0.09	0.61	0.15	1.00	9.00	0.00	13.75
CNC AXLE TURNING MACHINE(OP-20)	0.17	0.48	0.36	1.00	13.00	0.00	10.91
CNC CYLINDRICAL GRINDING MACHINE(OP-30)	0.10	0.48	0.21	1.00	8.00	0.00	10.73
CNC VERTICAL TURNING LATHE MACHINE(OP-100)	0.30	0.64	0.47	1.00	27.00	0.00	14.34
AUTOMATED MEASUREMENT SYSTEM(OP-70)	0.09	0.15	0.63	1.00	26.00	0.00	3.44
CNC HYDRAULIC WHEEL PRESS (OP-200)	0.02	0.60	0.04	1.00	14.00	0.00	13.45
CNC SURFACE WHEEL LATHE MACHINE(OP-210)	0.24	0.47	0.51	1.00	34.00	0.00	10.63
DYNAMIC WHEEL BALANCING MACHINE (OP-220)	0.02	0.08	0.29	1.00	26.00	0.00	1.89
SYNCHRONISED & AUTOMATED WHEEL HANDLING & CONVEYING SYSTEM, WK-I (OP-300)	0.00	0.74	0.00	0.00	0.00	0.00	16.58
SYNCHRONISED & AUTOMATED WHEEL HANDLING & CONVEYING SYSTEM, WK-II (OP-300)	0.00	0.82	0.00	0.00	0.00	0.00	18.37
SMS	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M&P	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DANOBAT GROUP.	0.00	0.00	0.00	0.00	0.00	0.00	0.00

OEE  
 A  
 P  
 Q

Display diagrams in Excel



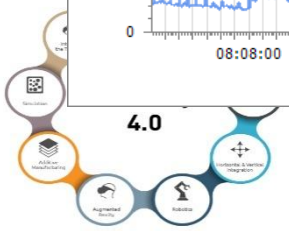
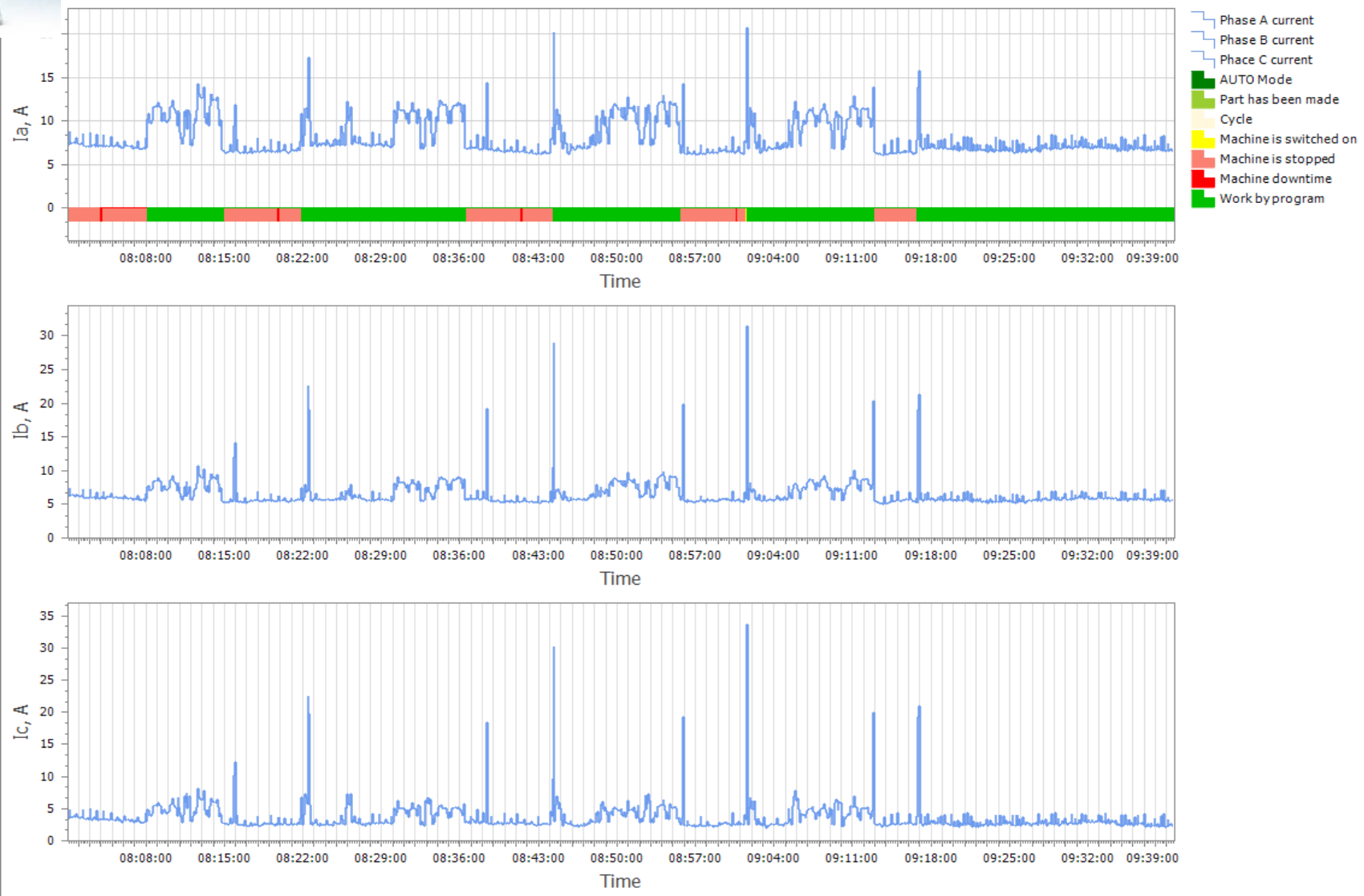
OEE: Overall equipment efficiency  
 A: Availability  
 P: Productivity  
 Q: Quality



# Current Monitoring



11-16-2018-11-16-2018 EDGE Milling Phase A current, Phase B current, Phase C current

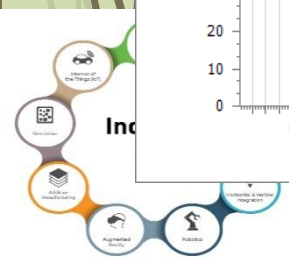
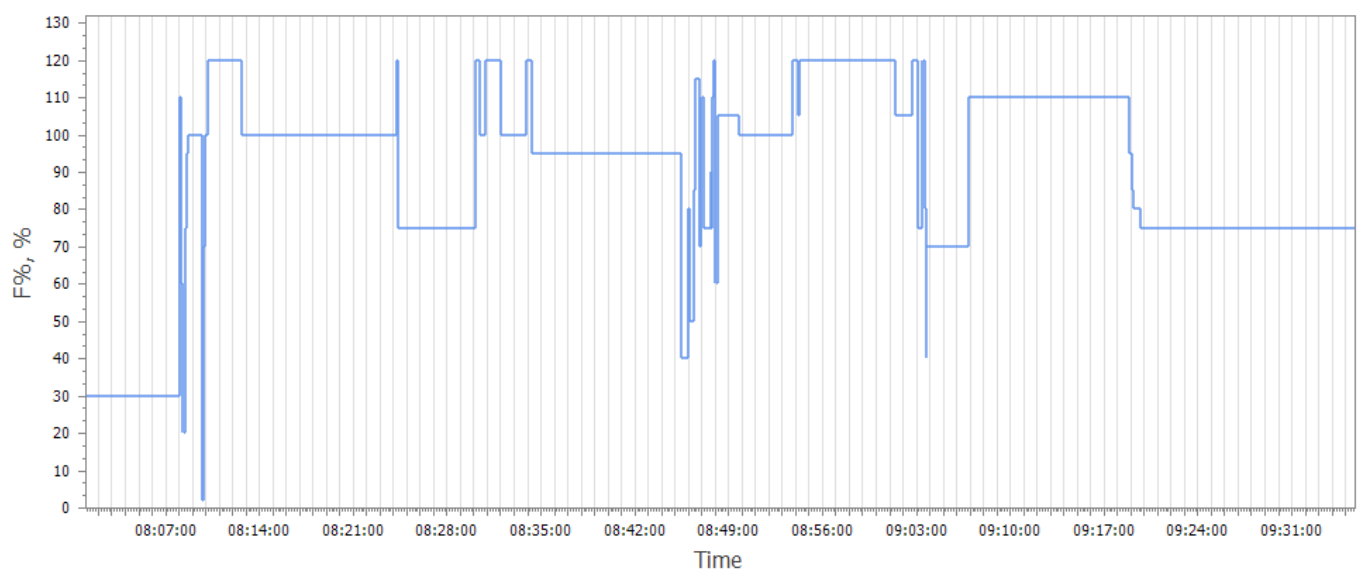
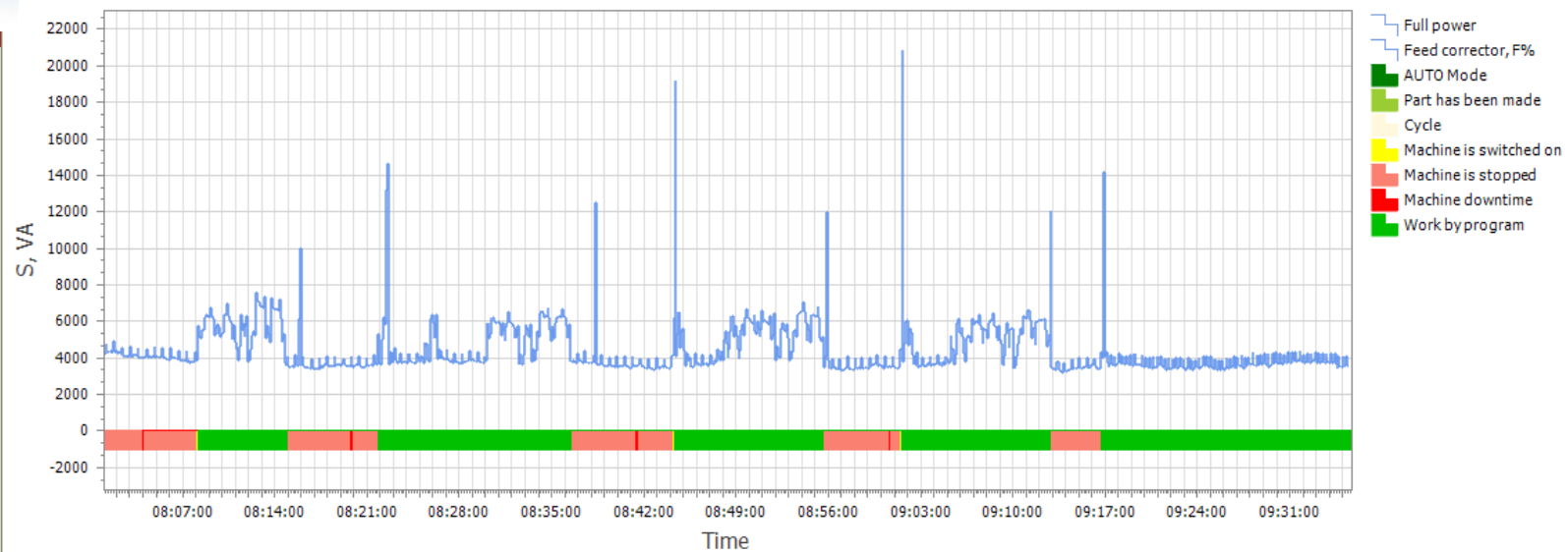




# Feed Correction



11-16-2018-11-16-2018 EDGE Milling Full power, Feed corrector, F%





## Railway can benefit from MCF Experience..

- Use of Industry 4.0 for optimisation of resources
- Understanding bottlenecks and under utilized M&P
- Monitoring actual production vis-a-vis planned
- Monitoring operator performance
- Online monitoring of maintenance activities
- Predictive maintenance
- Sending alert (SMS & Email)
- Online Integration of Design office and programming stations

