Rhombus

Measuring OEE

using the

Rhombus Factory Information System

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Introduction

This document explains how you can use the Rhombus Factory Information System to measure the OEE (Overall Equipment Effectiveness) of the machines in your factory.

What is OEE?

OEE stands for Overall Equipment Effectiveness. It is a single number between 0 and 100 which measures how well you are using the machines in your factory.

An OEE value is always linked to a period of time, for instance last week, this month, year to date.

The formula for calculating OEE is simple:

$$\text{OEE} = \frac{\text{Actual quantity of good parts made in period}}{\text{Maximum possible quantity of parts made in period}} \cdot 100$$

In order for this information to be useful, you need to know why you are not producing the theoretical maximum number of parts. There are three reasons for this:

- Downtime
- Slow running
- Scrap

The influence of each of these reasons on the OEE is calculated as a separate number.

Utilisation

Utilisation measures the amount of time the machine was running compared with the duration of the period. It is reduced by downtime.

$$\text{Utilisation} = \frac{\text{Running time}}{\text{Duration of period}} \cdot 100$$

Performance

Performance measures how the speed or cycle time of the machine compares with the maximum possible speed or cycle time. It is reduced when the machine slows down.

$$\text{Performance} = \frac{\text{Actual parts produced}}{\text{Maximum possible parts produced during running time}} \cdot 100$$

Scrap

Scrap measures the proportion of parts produced which are scrap. It is reduced when less scrap is produced.

$$\text{Scrap} = \frac{\text{Scrap parts produced}}{\text{All parts produced}} \cdot 100$$

These intermediate ratios are given different names by the various proponents of OEE. Within the Rhombus Factory Information System you can use names you are familiar with.

The complications

The basic OEE calculations are simple, but in reality things are more complicated.

The first complication is that it is very difficult to get machine operators to record running time and downtime accurately.

The second complication occurs when a machine makes more than one part during the period of the calculation. The chances are that the planned cycle time for each part is different. The performance must be based on the planned cycle for each part and the influence of each part on the total OEE weighted according to how long each part was on the machine. The Rhombus Factory Information System handles these problems automatically.

The third complication occurs when you try to decide how much time in a period you actually expect your machines to run. For example in a week, you may not work on Saturdays and Sundays, although some machines may run during an overtime shift on Saturday morning. Some machines may only have work for three days in a week, and so you wish to exclude the other two days from your OEE calculation. You may have a floating meal break in each shift, which is not taken at the same time by all operators. The Rhombus Factory Information System has solutions to all these problems, and we are confident that we can configure it to calculate OEE exactly the way you want.

The fourth complication is the volume of accurate data you must collect to calculate your OEE and to work out how to improve it. The Rhombus Factory Information System automates the collection of these data.

The elements of OEE in a diagram

Figure 1 shows a diagram produced by the Rhombus Factory Information System which shows how the elements of the OEE calculation relate to each other. In the diagram all the elements have been expressed as times, rather than quantities.

Figure 1: BLOM diagram showing the elements of OEE

Total time is the total time available in the week covered by the report.

Total operations time is the time you intend to run the machine.

Not scheduled is the time at the weekends when you do not intend to run the machine.

Loading time is the time for which you have work planned to run on the machine.

Unscheduled is the time when you have no work for the machine**.**

Running time is the time the machine was actually running.

Downtime is the time the machine was stopped

Actual output is the time the machine was running at the planned speed.

Reduced speed is the time the machine was running at reduced speed

Good is the time the machine was making good parts.

Scrap is the time the machine was making scrap parts.

OEE is **Good/Loading time** * 100

Machine monitoring

You can use the Machine Monitoring module of the Rhombus Factory Information System to measure directly all the information you need to calculate OEE accurately and instantly. Perhaps more importantly, the system will show you clearly why you are not achieving 100% OEE, and allow you to target the problems which will most quickly improve your OEE.

What does the Machine Monitoring module do?

A machine monitoring system uses sensors on a machine to measure its output, cycle time, and downtime automatically.

It relates this information to the part which the machine is making, and the operator who is running the machine, in order to analyse machine performance, and highlight waste of materials and machine time.

The information it produces is accurate and it is up-to-date. Problems can be identified as they happen and corrective action taken immediately.

By measuring accurately the activity of your machines, a machine monitoring system gives you real control of your production process. You can use this information to reduce waste and increase the capacity of your plant using existing resources.

Is it suitable for my business?

The Machine Monitoring module is suitable for a business using any type of machine with a reasonably constant cycle time. This definition encompasses all fully automatic and most semi-automatic machines. Machine monitoring will not work on manual machines such as toolroom lathes and milling machines.

Most of our customers make parts in medium to high volumes, but some use machine monitoring because their machines have a very high capital cost and they wish to ensure that they are earning their keep.

We have successfully monitored all the following types of machine.

- Automatic lathes
- CNC lathes
- CNC machining centres
- Cold heading machines
- Presses
- Transfer lines
- Tapping machines
- Thread rolling machines.
- Diecasting machines
- Injection moulding machines
- Compression moulding machines
- Thermoforming machines
- Assembly machines
- Packing and filling lines
- Tube bending machines

What equipment do I need?

Machine monitoring PC

A monitoring PC is fitted to each machine.

Each monitoring PC is fitted with a digital I/O card which allows it to receive signals from the machine, and to control output relays to inhibit the machine, or control lamps. The keyboard is removed, and the mouse can be replaced with a touch screen or light pen. This arrangement allows the operator to use the familiar Windows user interface, but the lack of keyboard prevents him from shutting down programs and switching between tasks. Data entry is performed using the pointing device and a soft keyboard displayed on the screen.

It runs software which uses the signals from the machine to perform the following functions.

- Count parts made.
- Measure the cycle time of the machine.
- Detect when the machine begins to produce parts.
- Detect when the machine stops producing parts.

The PC’s clock allows it to record the exact time at which the machine starts and stops.

When the machine stops, the monitoring PC prompts the operator to choose a reason for the downtime from a list on the screen. In some circumstances it may be possible to provide additional signals from the machine to determine the cause of downtime automatically.

The I/O card in the PC contains a relay output which can be used to stop the machine or prevent it being started.

Some customers have the monitoring PC interlocked with the machine so that the machine cannot be started until a reason for the downtime has been selected from the list on the screen.

Server to store and analyse information

The information collected by the monitoring PCs is stored in a central database on a server. Production managers use their desktop PCs to get reports from the database.

Software to produce reports and manage system

The reports produced by the system fall into four main categories.

Current status of machines

These reports show the current status of one or a group of machines. They are refreshed automatically so that you can always see which machines are running, which are stopped, and why they are stopped. This information can be displayed as a plan of your factory.

Downtime analysis

These reports provide summaries of downtime for a machine or a group of machines over any time period. The system includes predefined periods such as a shift, day, week, and month. You can start by displaying a summary report for a group of machines and then 'drill down' into the data in increasing detail to find out the cause of downtime and poor performance.

Operation analysis

These reports allow you to examine the performance of a particular works order operation or all the operations for one part on one machine or a group of machines. You can use them to check the performance of different machines making the same part, to find operations which result in low machine performance, and to cost works orders accurately. The system allows you to enter the earnings for each part and thus will produce reports showing factory earnings in money terms.

Operator Analysis

These reports allow you to examine the performance of a machine while it was under the control of a particular operator. The system will produce operator time-sheets showing how an operators time was used, and the performance of the machines he was using. This can form the basis of individual or group bonus schemes. It will show who worked on a particular machine or job, thus enabling responsibility to be established for scrap or for good performance.

What are the benefits of a machine monitoring system?

Measurement gives control

You cannot control what you cannot measure.

Most companies try to control their production with minimal or out-of-date information on what is actually happening on the shop-floor.

A machine monitoring system gives you fast and accurate measurement of what is happening on your shop-floor. This information puts you in real control of your factory.

Accurate parts counting

The system counts parts accurately. It allows machine operators and production managers to compare the quantity made with the quantity required at any time. This avoids under-production which leads to customer dissatisfaction, and over-production which wastes material and ties up capital in unwanted stock.

Constant monitoring of cycle times

The system continuously monitors the cycle time of the machine. It allows machine operators to set the machine to the planned cycle time, and see immediately the effect on cycle time of any adjustments they have made. On mechanically controlled machines such as Wickmans and single spindles, a discrepancy between the planned and actual cycle time may indicate an incorrect set up, or may indicate a machine fault, such as a slipping clutch. On CNC machines the operator usually has much more control over the cycle time of the machine and may have slowed down the speeds and feeds without good reason.

In both these cases the system allows you to spot these discrepancies and eliminate them. Small increases in a short cycle time soon accumulate into many lost components.

Record of duration and reasons for downtime

Accurate recording of the duration of and reasons for downtime allow you to reduce or eliminate it. This can often be achieved by simple measures such as ensuring that machines run immediately at the start of a shift, and are not shut off until the end of the shift. Analysis of downtime often shows failures in the services to your machines, such as material issue, tooling, and maintenance. A machine monitoring system eliminates arguments about the causes of downtime and forces everyone to contribute to its reduction.

Record of works order changes

A record of works order changes allows you to follow operations and work-in-progress around your factory. The system records machine performance against each operation, which enables you to identify products which are unprofitable, and conversely those which have particularly low costs.

Record of operator changes

If you operate a bonus scheme, a machine monitoring system will eliminate most of the time required to perform bonus calculations. Bonus information can be made available to operators during each shift so that they know what they have to do to achieve their desired level of bonus.

Instant calculation of OEE

The system calculates OEE immediately for any time period, and for any operation. It shows you why your OEE is not as high as you would like it to be.

Increase capacity without buying new machines.

Armed with the reasons why your machine OEE is not as high as it should be, you can set about eliminating downtime, improving cycle times and reducing scrap. You will often find that services to machines, such as stores, toolroom, and maintenance are the cause of much of your downtime. Armed with accurate information you can tackle these problems.

The result of this is that you can increase the capacity available from your machines without the need to buy new machines or take on extra staff. An increase of 5% in the utilisation of 20 machines is equivalent to buying a new machine, but does not require extra floor space, operators, or the capital to buy the machine. Such an improvement in utilisation can often be achieved simply by ensuring that machines are run for the whole of a shift, and that material and tooling are available when they are required.

Investment appraisal

In addition to its use for daily production management, a machine monitoring system gives you vital information for investment appraisal and machine replacement decisions.

Identify worn-out machines

Any factory has a folklore about certain jobs which can and cannot be run on certain machines. The information from a machine monitoring system gives you the facts you need to prove or disprove such theories.

You can carry out comparative studies of breakdowns on your machines over a long period to decide when a machine should be replaced or reconditioned.

Check that new machines are meeting specification

New machines are often sold on the basis that they will meet strict performance targets for cycle time, utilisation and availability.

A machine monitoring system allows you to check that the machine is meeting the targets you were promised, and allows problems to be identified if targets are not being met. Since the system measures machine performance directly it is fair to both you and your machine tool supplier.

System Overview

Monitoring PC operation

Figure 2 shows the screen seen by the operator at the machine.

Figure 2: Monitoring PC machine status screen

The Book scrap button allows the operator to enter the quantity of and reason for any scrap parts.

The Change W.O. button pops up a work-to-list for the machine and allows the operator to select the next works order operation. The monitoring software then downloads the information it needs to monitor the new operation, and puts the machine into tool change mode. In this state it ignores signals from the machine while the tool is being changed. When setting is finished and the machine is making good parts, the operator presses the Good production button and the software monitors running and downtime in the usual way.

The Slow running button allows the operator to give a reason why the machine is running slowly.

The red and green bars across the middle of the screen are a map of the running and downtime on this machine during the current shift.

The performance measures apply to this shift, because they can be influenced by the operator.

We offer two basic types of monitoring scheme, one for monitoring short-cycle machines, such as automatic lathes, presses, and packaging machines, and one for long-cycle machines such as CNC machine tools and knitting machines.

Short-cycle monitoring scheme

This scheme is designed to monitor machines with cycle times up to perhaps three minutes. Such machines have the characteristic that they can be regarded as running if components are being produced at regular intervals, and stopped if there is no output for more than one machine cycle.

The monitoring PC requires a signal from the machine every time a component is made. If signals occur regularly then the PC will record the machine as running. When the signals cease, the machine is deemed to be stopped. Rules are built in to the monitoring software to cope with the short runs of a few components associated with setting and adjusting the machine. These rules ensure that very short running periods are ignored and the quantity produced recorded as setting scrap.

Long-cycle monitoring scheme

This scheme is designed to monitor machines with cycle times longer than about three minutes, where the machine may stop once or many times within the cycle required to make one component.

The monitoring PC requires two signals, one to indicate when the machine is running and when it is stopped, the other to indicate when a component has been made. The unit can record the time at which each individual component was made, measure its cycle time, and provide a manufacturing history for it. This can be very useful for traceability in an aerospace environment.

Entering downtime reasons

When a machine goes from running to stopped, the monitoring software tries to find a reason for the downtime. Some systems present the monitoring software with reasons automatically. If this is the case then these reasons will be used. If there are no automatic reasons then the screen will display a list of downtime reasons for the operator to choose from. If the system is monitoring a line of machines the reasons can be grouped against each item of plant in the line. As soon as the operator has selected a reason the screen shows why the machine is stopped. The reason that is entered is assumed to be the reason for the whole of the downtime period up to the time that the reason is selected. If the reason for downtime changes then the downtime reason can be altered. The new reason becomes effective from the moment of entry. If no downtime reason is given for the whole downtime period then it is recorded as a 'reason not given' period.

Operator Booking

An operator can book onto a machine either by using a bar-coded badge, by selecting his name from a list or by entering his clock number using a pop-up keypad. This enables the system to calculate OEE for an operator. This information has been used by some customers as the basis for a payment system. An operator signs off a machine by entering his clock number again. More than one operator can book onto a machine at the same time if this is required.

Machine setters and Maintenance fitter booking

In a similar way to an operator signing onto a machine it is possible to sign maintenance fitters and machine setters onto the machine at the same time as the operator. This allows any level of detail about who is doing what on any machine. It can be used as input to resource planning systems where setters and fitters are viewed as resources. When setters sign on to a machine they can be prompted for tool numbers and for gauge numbers. When maintenance fitters sign off a machine they can be prompted for a fault code. This allows accurate breakdown analysis to be performed for the machines.

Works order tracking

When a machine starts work on a new operation of a works order the operator can select the new works order number from a work-to-list or the information can be entered by bar-code. If the work in progress tracking needs to be tighter then each container of parts can be entered into the system as it arrives at or departs from a machine.

Connection to Programmable Logic Controllers

If the machine being monitored is controlled by a programmable logic controller (PLC), it is possible to connect the PLC to the monitoring software so that the reason for downtime can be determined automatically by the monitoring software from the PLC when the machine stops. This can be achieved either by programming the PLC to emit a stream of pulses which the monitoring software can count, or by connecting the PLC to your network, and using OPC to interrogate the internal registers of the PLC.

Hostile environments

Since the monitoring software runs under Windows, you can replace a standard PC with a ruggedised or industrial PC of your choice to suit the environment of your factory. Hose proof PCs in stainless steel enclosures are available for the food and pharmaceutical industries. Compact PCs with an LCD display and touch screen are available where space is limited.

Downtime Analysis

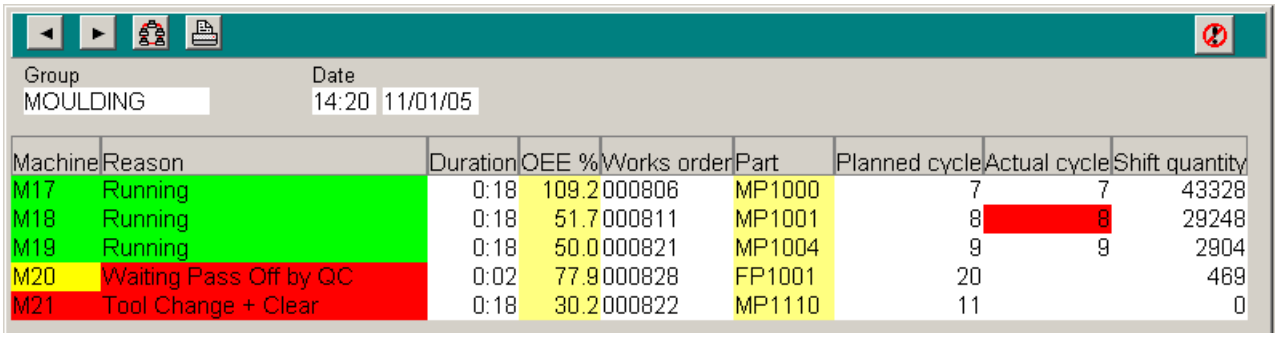
The downtime analysis software package provides all the facilities you need to set up a monitoring system, and to produce reports of machine performance for any time period you require.

The monitoring units record a list of events for each machine. All summary reports are built up from this list of events. A command is provided to allow you to store the list of events from the monitoring unit onto disc. It is then possible to prepare reports for long periods of time such as a week, month, quarter, or even a year. Since the information is stored on disc as a list of events you have complete flexibility in the way you retrospectively analyse the data. This powerful facility is unique to Rhombus Systems.

Descriptions and examples of the standard reports which we supply are given below. The reports can easily be tailored to your exact requirements, which will obviously vary according to the type of machine you wish to monitor.

Status of machines

Three reports are provided to show the current status of your machines. The Group Current Status report shows whether each machine is running or stopped, the reason for the downtime if the machine is stopped, and the current works order and part number. The report refreshes automatically every 30 seconds, thus you can always see the current state of your machines. An example of this report is shown in Figure 3. The Machine Status report shows the current status of a single machine with full details of current shift and job performance.



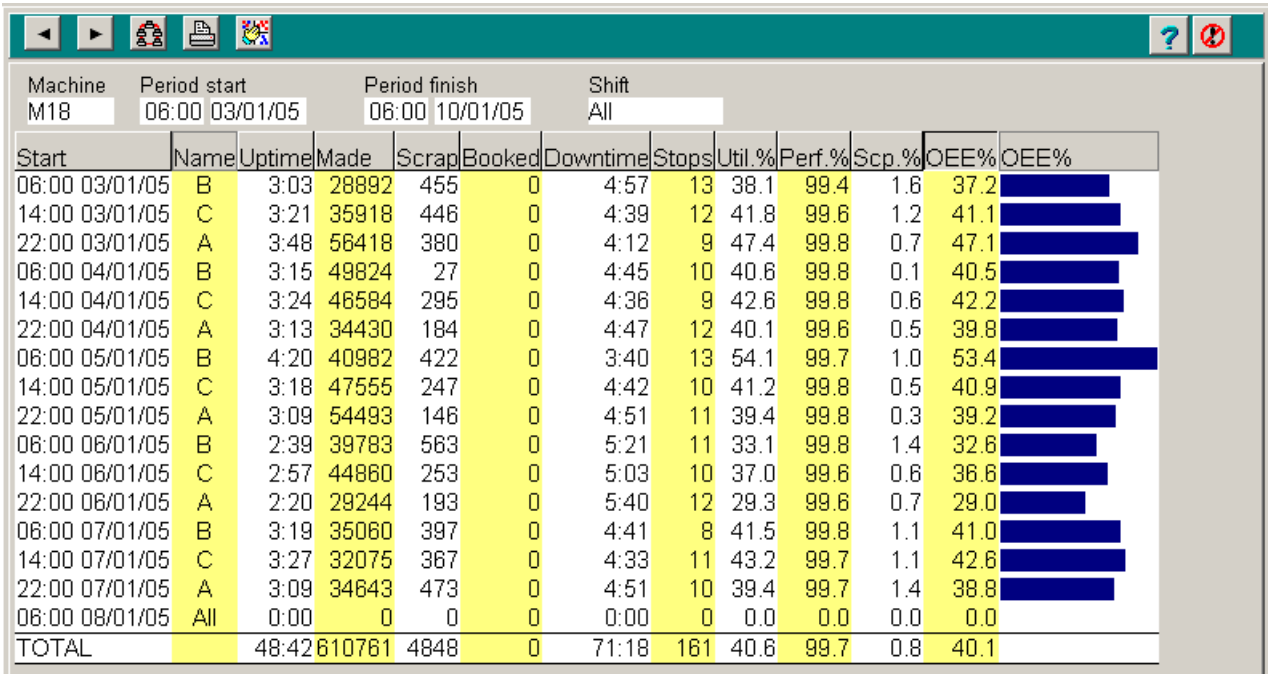
Group: MOULDING Date: 14:20 11/01/05

Machine	Reason	Duration	OEE %	Works order	Part	Planned cycle	Actual cycle	Shift quantity
M17	Running	0:18	109.2	000806	MP1000	7	7	43328
M18	Running	0:18	51.7	000811	MP1001	8	8	29248
M19	Running	0:18	50.0	000821	MP1004	9	9	2904
M20	Waiting Pass Off by QC	0:02	77.9	000828	FP1001	20		469
M21	Tool Change + Clear	0:18	30.2	000822	MP1110	11		0

Figure 3: Group current status report.

Period Summary

The Machine Performance by Week report displays a single line summary of the performance of the machine. It gives you an overview of trends in machine performance. You can double-click on a week of interest and display the Machine Performance by Shift report for that week, which displays a single line summary of each shift during the week. An example of this report is shown in Figure 4.



Machine: M18 Period start: 06:00 03/01/05 Period finish: 06:00 10/01/05 Shift: All

Start	Name	Uptime	Made	Scrap	Booked	Downtime	Stops	Util.%	Perf.%	Scp.%	OEE%	OEE%
06:00 03/01/05	B	3:03	28892	455	0	4:57	13	38.1	99.4	1.6	37.2	
14:00 03/01/05	C	3:21	35918	446	0	4:39	12	41.8	99.6	1.2	41.1	
22:00 03/01/05	A	3:48	56418	380	0	4:12	9	47.4	99.8	0.7	47.1	
06:00 04/01/05	B	3:15	49824	27	0	4:45	10	40.6	99.8	0.1	40.5	
14:00 04/01/05	C	3:24	46584	295	0	4:36	9	42.6	99.8	0.6	42.2	
22:00 04/01/05	A	3:13	34430	184	0	4:47	12	40.1	99.6	0.5	39.8	
06:00 05/01/05	B	4:20	40982	422	0	3:40	13	54.1	99.7	1.0	53.4	
14:00 05/01/05	C	3:18	47555	247	0	4:42	10	41.2	99.8	0.5	40.9	
22:00 05/01/05	A	3:09	54493	146	0	4:51	11	39.4	99.8	0.3	39.2	
06:00 06/01/05	B	2:39	39783	563	0	5:21	11	33.1	99.8	1.4	32.6	
14:00 06/01/05	C	2:57	44860	253	0	5:03	10	37.0	99.6	0.6	36.6	
22:00 06/01/05	A	2:20	29244	193	0	5:40	12	29.3	99.6	0.7	29.0	
06:00 07/01/05	B	3:19	35060	397	0	4:41	8	41.5	99.8	1.1	41.0	
14:00 07/01/05	C	3:27	32075	367	0	4:33	11	43.2	99.7	1.1	42.6	
22:00 07/01/05	A	3:09	34643	473	0	4:51	10	39.4	99.7	1.4	38.8	
06:00 08/01/05	All	0:00	0	0	0	0:00	0	0.0	0.0	0.0	0.0	
TOTAL		48:42	610761	4848	0	71:18	161	40.6	99.7	0.8	40.1	

Figure 4: Machine performance by shift.

Similar reports are available by month, week, day, shift and hour.

You can double-click on a shift and display the Machine Downtime Analysis report for that shift. This report is also available for any time period you choose, for example a week or month. You can see the reasons for machine downtime in detail from this report.

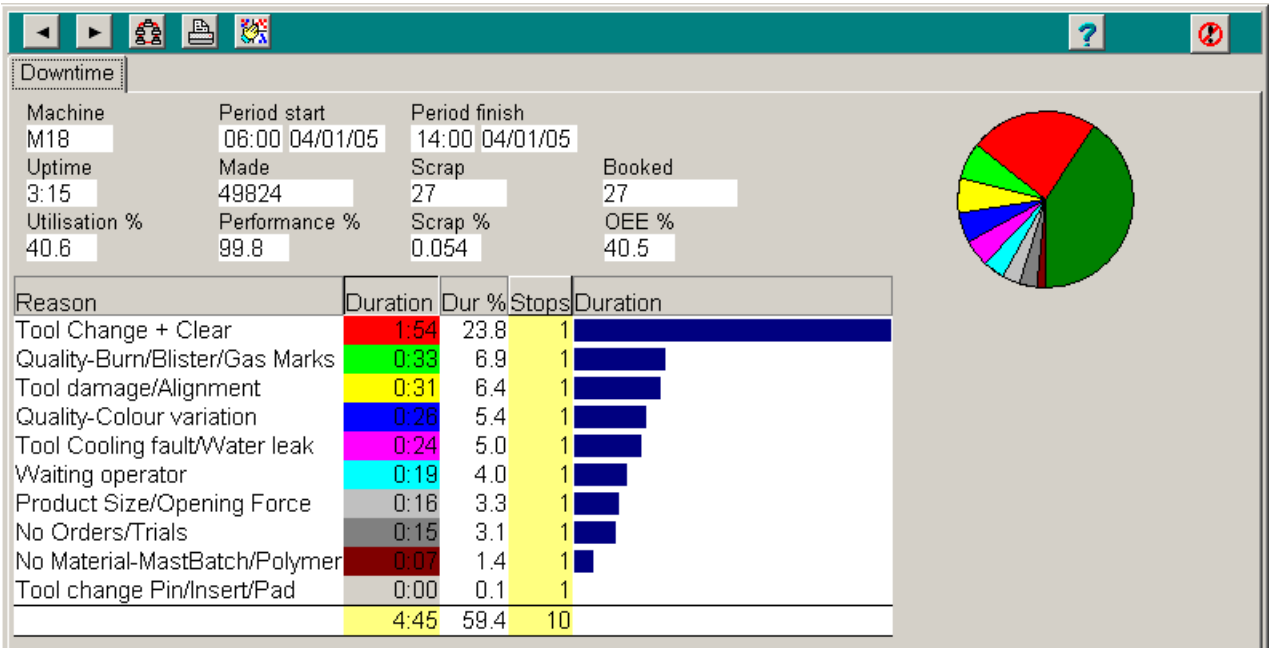
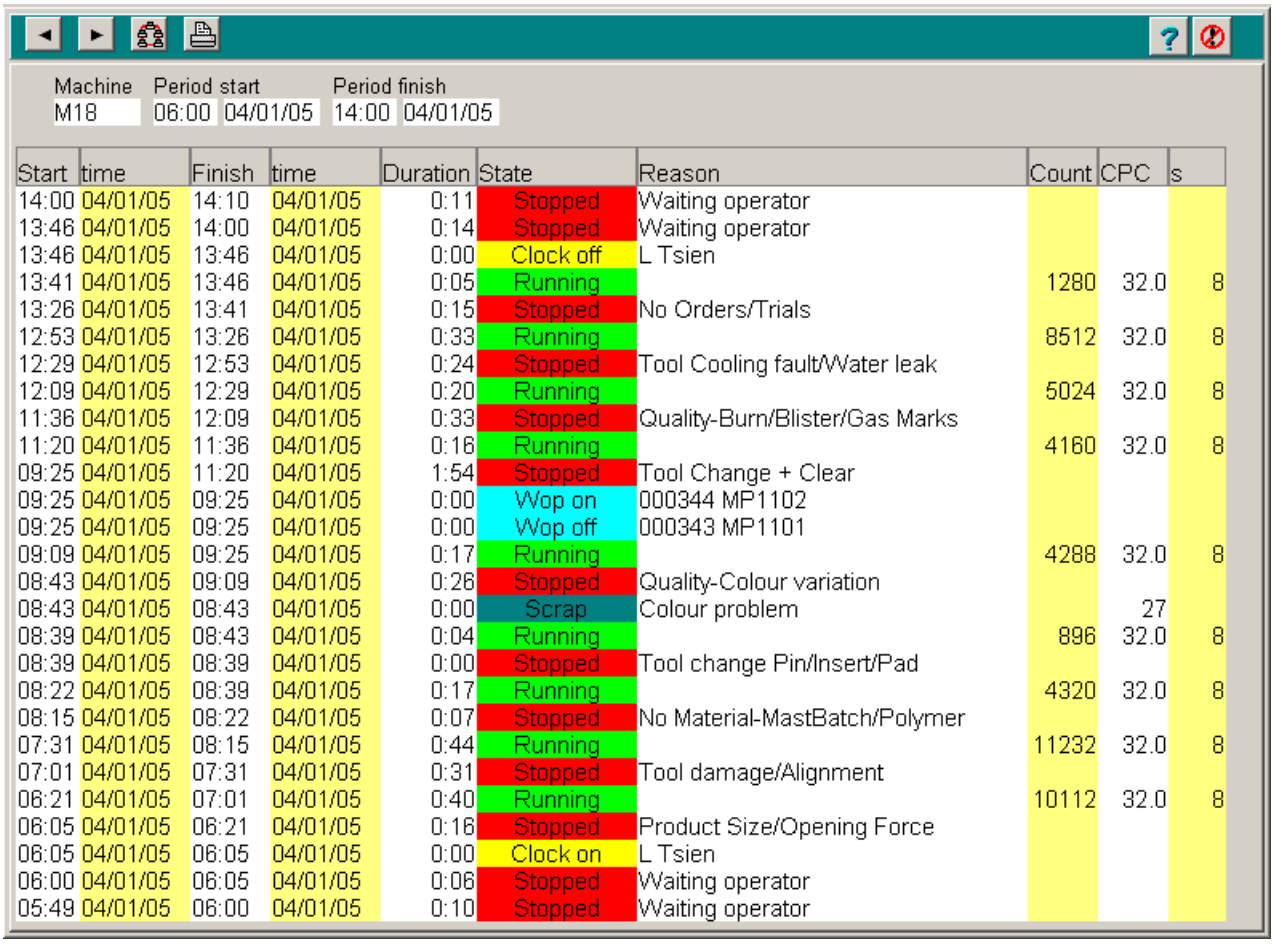


Figure 5: Machine downtime analysis report.

Event log

If you need to know exactly when a period of downtime occurred, you can use the Event Log report, which shows you exactly what the machine was doing at any time.



Machine M18 | Period start 06:00 04/01/05 | Period finish 14:00 04/01/05

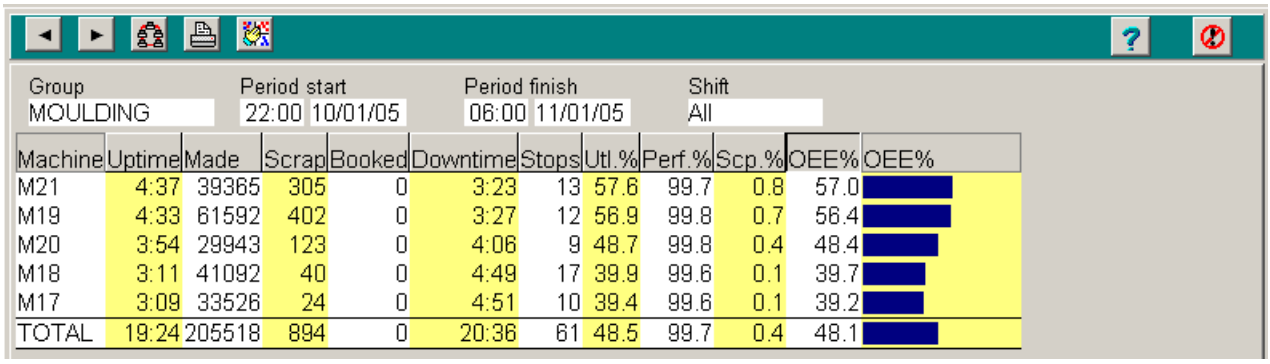
Start	time	Finish	time	Duration	State	Reason	Count	CPC	s
14:00	04/01/05	14:10	04/01/05	0:11	Stopped	Waiting operator			
13:46	04/01/05	14:00	04/01/05	0:14	Stopped	Waiting operator			
13:46	04/01/05	13:46	04/01/05	0:00	Clock off	L Tsien			
13:41	04/01/05	13:46	04/01/05	0:05	Running		1280	32.0	8
13:26	04/01/05	13:41	04/01/05	0:15	Stopped	No Orders/Trials			
12:53	04/01/05	13:26	04/01/05	0:33	Running		8512	32.0	8
12:29	04/01/05	12:53	04/01/05	0:24	Stopped	Tool Cooling fault/Water leak			
12:09	04/01/05	12:29	04/01/05	0:20	Running		5024	32.0	8
11:36	04/01/05	12:09	04/01/05	0:33	Stopped	Quality-Burn/Blister/Gas Marks			
11:20	04/01/05	11:36	04/01/05	0:16	Running		4160	32.0	8
09:25	04/01/05	11:20	04/01/05	1:54	Stopped	Tool Change + Clear			
09:25	04/01/05	09:25	04/01/05	0:00	Wop on	000344 MP1102			
09:25	04/01/05	09:25	04/01/05	0:00	Wop off	000343 MP1101			
09:09	04/01/05	09:25	04/01/05	0:17	Running		4288	32.0	8
08:43	04/01/05	09:09	04/01/05	0:26	Stopped	Quality-Colour variation			
08:43	04/01/05	08:43	04/01/05	0:00	Scrap	Colour problem		27	
08:39	04/01/05	08:43	04/01/05	0:04	Running		896	32.0	8
08:39	04/01/05	08:39	04/01/05	0:00	Stopped	Tool change Pin/Insert/Pad			
08:22	04/01/05	08:39	04/01/05	0:17	Running		4320	32.0	8
08:15	04/01/05	08:22	04/01/05	0:07	Stopped	No Material-MastBatch/Polymer			
07:31	04/01/05	08:15	04/01/05	0:44	Running		11232	32.0	8
07:01	04/01/05	07:31	04/01/05	0:31	Stopped	Tool damage/Alignment			
06:21	04/01/05	07:01	04/01/05	0:40	Running		10112	32.0	8
06:05	04/01/05	06:21	04/01/05	0:16	Stopped	Product Size/Opening Force			
06:05	04/01/05	06:05	04/01/05	0:00	Clock on	L Tsien			
06:00	04/01/05	06:05	04/01/05	0:06	Stopped	Waiting operator			
05:49	04/01/05	06:00	04/01/05	0:10	Stopped	Waiting operator			

Figure 6: Event log for a machine.

The ‘Wop off’ and ‘Wop on’ rows show a change of works order.

Performance of a Group of machines

The Group by Month, Group by Week, Group by Day, Group by Shift, and Group Downtime Analysis reports look the same as their single machine counterparts, but display summaries for a group of machines instead of just one machine. The Group Performance by Machine report displays a single line summary of the performance of each machine in a group over a specified time period. An example of this report is shown in Figure 7. In this case the user has clicked on the OEE column to display a bar chart of OEE, and has then clicked the sort button to sort the report by OEE.



Group: MOULDING | Period start: 22:00 10/01/05 | Period finish: 06:00 11/01/05 | Shift: All

Machine	Uptime	Made	Scrap	Booked	Downtime	Stops	Utl.%	Perf.%	Scp.%	OEE%	OEE%
M21	4:37	39365	305	0	3:23	13	57.6	99.7	0.8	57.0	
M19	4:33	61592	402	0	3:27	12	56.9	99.8	0.7	56.4	
M20	3:54	29943	123	0	4:06	9	48.7	99.8	0.4	48.4	
M18	3:11	41092	40	0	4:49	17	39.9	99.6	0.1	39.7	
M17	3:09	33526	24	0	4:51	10	39.4	99.6	0.1	39.2	
TOTAL	19:24	205518	894	0	20:36	61	48.5	99.7	0.4	48.1	

Figure 7: Group performance by machine report.

The Downtime Map report samples the activity of each machine in a group at regular intervals during a specified time period, and shows whether the machine was running or stopped at the start of each sample interval. In the example in Figure 8 the user has chosen to highlight tool changes in blue. This report give you an overview of how well each machine ran during the period and indicates which machines require attention.

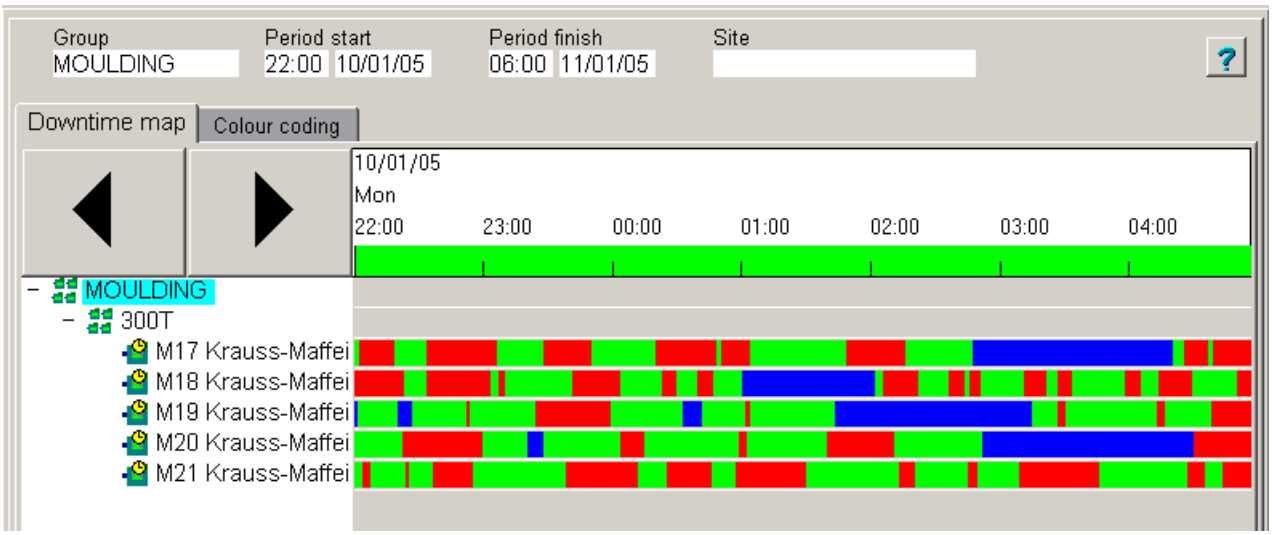


Figure 8: Downtime map report.

Shift Patterns

The system allows you to create up to two hundred different shift patterns and to allocate each machine individually to a shift pattern. This allows the system to cope with the situation where some machines are working three shifts, and others are on days only. A shift pattern is organised as a calendar so it can include arrangements where the shift pattern varies from day to day, and can cope with bank and works holidays. Each shift can be specified as working, overtime, or non-working. This enables the system to remove non-working shifts from utilisation and efficiency calculations.

Operation reporting

The Operation reporting package allows you to monitor machine performance against the works order and operation it is doing. Thus you can compare setting and running times with standards, and find out which operations cause problems which cause downtime and why.

The Works Order Processing module and the Finite Capacity Planner create a work-to list for each machine.

When an operation is started on the machine, the monitoring software can be loaded with the operation details, either by the supervisor from his terminal, or by the operator using the touch screen or bar-code reader at the monitoring PC. When this happens, the operation status is changed to running and the start time is recorded by the monitoring software. The planned cycle time and number of components per cycle are also updated. While an operation is running the system will predict when it will finish, based on the number of components made, and the OEE of the machine on this operation to date.

When the operation is complete it is unloaded from the monitoring unit and its status is changed to complete. The system will then compile a report on the performance of the operation. An example of such a report is shown in Figure 9.

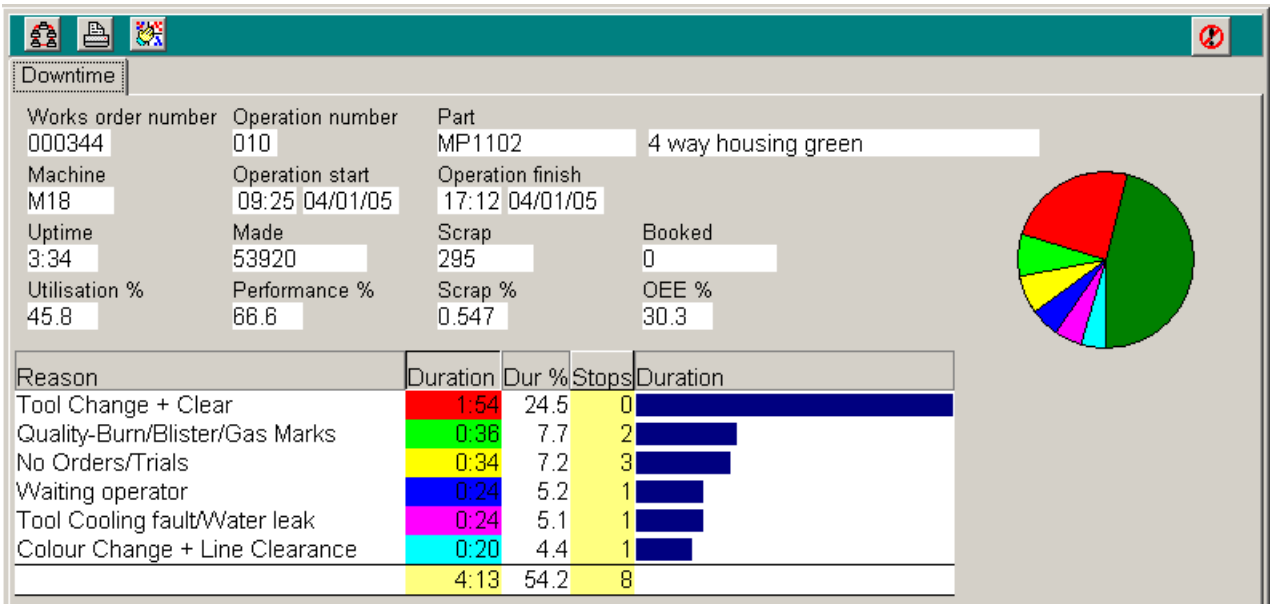
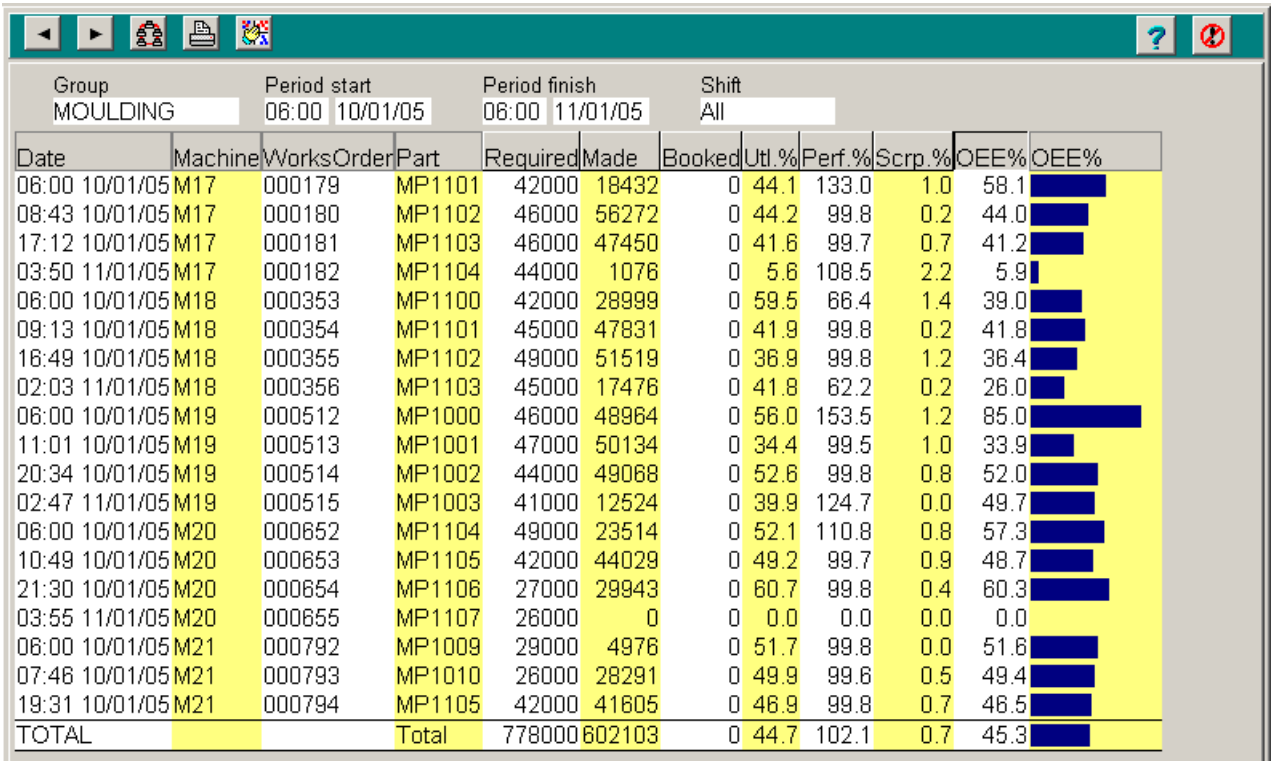


Figure 9: Operation downtime analysis report.

In addition to reports for a single job, the system can summarise jobs done by a machine or group of machines over a specified period. An example of such a report is shown below.



Group: MOULDING | Period start: 06:00 10/01/05 | Period finish: 06:00 11/01/05 | Shift: All

Date	Machine	WorksOrder	Part	Required	Made	Booked	Utl.%	Perf.%	Scrp.%	OEE%	OEE%
06:00 10/01/05	M17	000179	MP1101	42000	18432	0	44.1	133.0	1.0	58.1	
08:43 10/01/05	M17	000180	MP1102	46000	56272	0	44.2	99.8	0.2	44.0	
17:12 10/01/05	M17	000181	MP1103	46000	47450	0	41.6	99.7	0.7	41.2	
03:50 11/01/05	M17	000182	MP1104	44000	1076	0	5.6	108.5	2.2	5.9	
06:00 10/01/05	M18	000353	MP1100	42000	28999	0	59.5	66.4	1.4	39.0	
09:13 10/01/05	M18	000354	MP1101	45000	47831	0	41.9	99.8	0.2	41.8	
16:49 10/01/05	M18	000355	MP1102	49000	51519	0	36.9	99.8	1.2	36.4	
02:03 11/01/05	M18	000356	MP1103	45000	17476	0	41.8	62.2	0.2	26.0	
06:00 10/01/05	M19	000512	MP1000	46000	48964	0	56.0	153.5	1.2	85.0	
11:01 10/01/05	M19	000513	MP1001	47000	50134	0	34.4	99.5	1.0	33.9	
20:34 10/01/05	M19	000514	MP1002	44000	49068	0	52.6	99.8	0.8	52.0	
02:47 11/01/05	M19	000515	MP1003	41000	12524	0	39.9	124.7	0.0	49.7	
06:00 10/01/05	M20	000652	MP1104	49000	23514	0	52.1	110.8	0.8	57.3	
10:49 10/01/05	M20	000653	MP1105	42000	44029	0	49.2	99.7	0.9	48.7	
21:30 10/01/05	M20	000654	MP1106	27000	29943	0	60.7	99.8	0.4	60.3	
03:55 11/01/05	M20	000655	MP1107	26000	0	0	0.0	0.0	0.0	0.0	
06:00 10/01/05	M21	000792	MP1009	29000	4976	0	51.7	99.8	0.0	51.6	
07:46 10/01/05	M21	000793	MP1010	26000	28291	0	49.9	99.6	0.5	49.4	
19:31 10/01/05	M21	000794	MP1105	42000	41605	0	46.9	99.8	0.7	46.5	
TOTAL			Total	778000	602103	0	44.7	102.1	0.7	45.3	

Figure 10: Jobs by group report.

The system will cope with the following special situations.

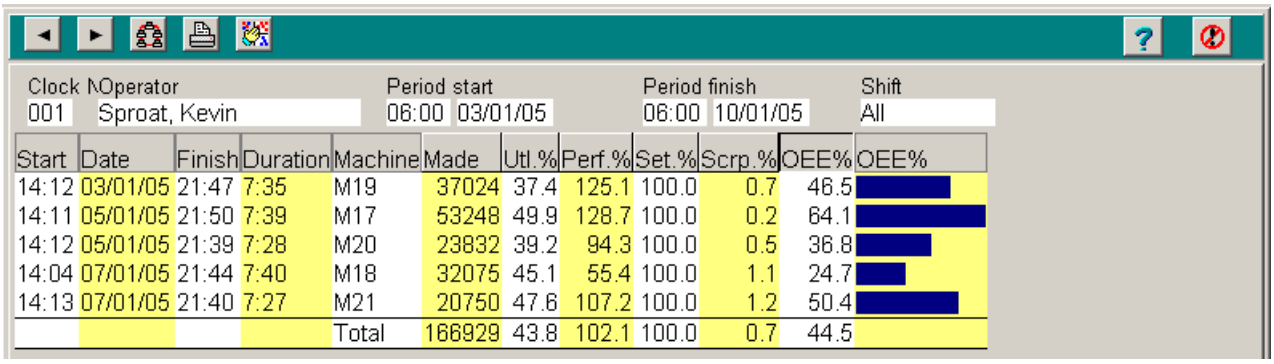
- You can load more than one operation onto one machine simultaneously. This allows the system to handle family moulding tools, and parts which are machined in handed pairs or kits.
- You can load one operation to two or more machines simultaneously. This is needed when you spread big batches over a number of machines to meet a deadline.
- If a machine breaks down during an operation, you can move the operation to another machine and resume monitoring on the new machine.

Operator Reporting

The Operator Reporting module allows you to produce timesheets for operators showing machine performance while under the control of each operator.

Operators book onto and off the machine at the monitoring PC using the touch screen or bar-coded badges. The monitoring software records the time and the operator's number. An operator file on the central computer links the operator's number with his name, and other details such as payment rates.

The software will produce a timesheet for each operator on each machine. The timesheet shows the operator's name, the machine, the time he booked on and off, and the machine performance and output during this period. You can print out timesheets for each operator, and perform all the calculations necessary to operate an individual bonus scheme based on machine performance.



Clock No | Operator | Period start | Period finish | Shift

001 | Sproat, Kevin | 06:00 03/01/05 | 06:00 10/01/05 | All

Start	Date	Finish	Duration	Machine	Made	Utl.%	Perf.%	Set.%	Scrp.%	OEE%	OEE%
14:12	03/01/05	21:47	7:35	M19	37024	37.4	125.1	100.0	0.7	46.5	
14:11	05/01/05	21:50	7:39	M17	53248	49.9	128.7	100.0	0.2	64.1	
14:12	05/01/05	21:39	7:28	M20	23832	39.2	94.3	100.0	0.5	36.8	
14:04	07/01/05	21:44	7:40	M18	32075	45.1	55.4	100.0	1.1	24.7	
14:13	07/01/05	21:40	7:27	M21	20750	47.6	107.2	100.0	1.2	50.4	
				Total	166929	43.8	102.1	100.0	0.7	44.5	

Figure 11: Operator timesheet report.

The module also provides reports of the operators who worked on a machine during a specified period, and of operators who worked on a particular operation.

The system allows one operator to book onto more than one machine, and more than one operator to book onto one machine where this is necessary.

OEE graphs

You can produce presentation quality graphs of OEE directly from the system.

Figure 12 shows the OEE for a group of machines for each day, with a best fit trend line showing an improving OEE.

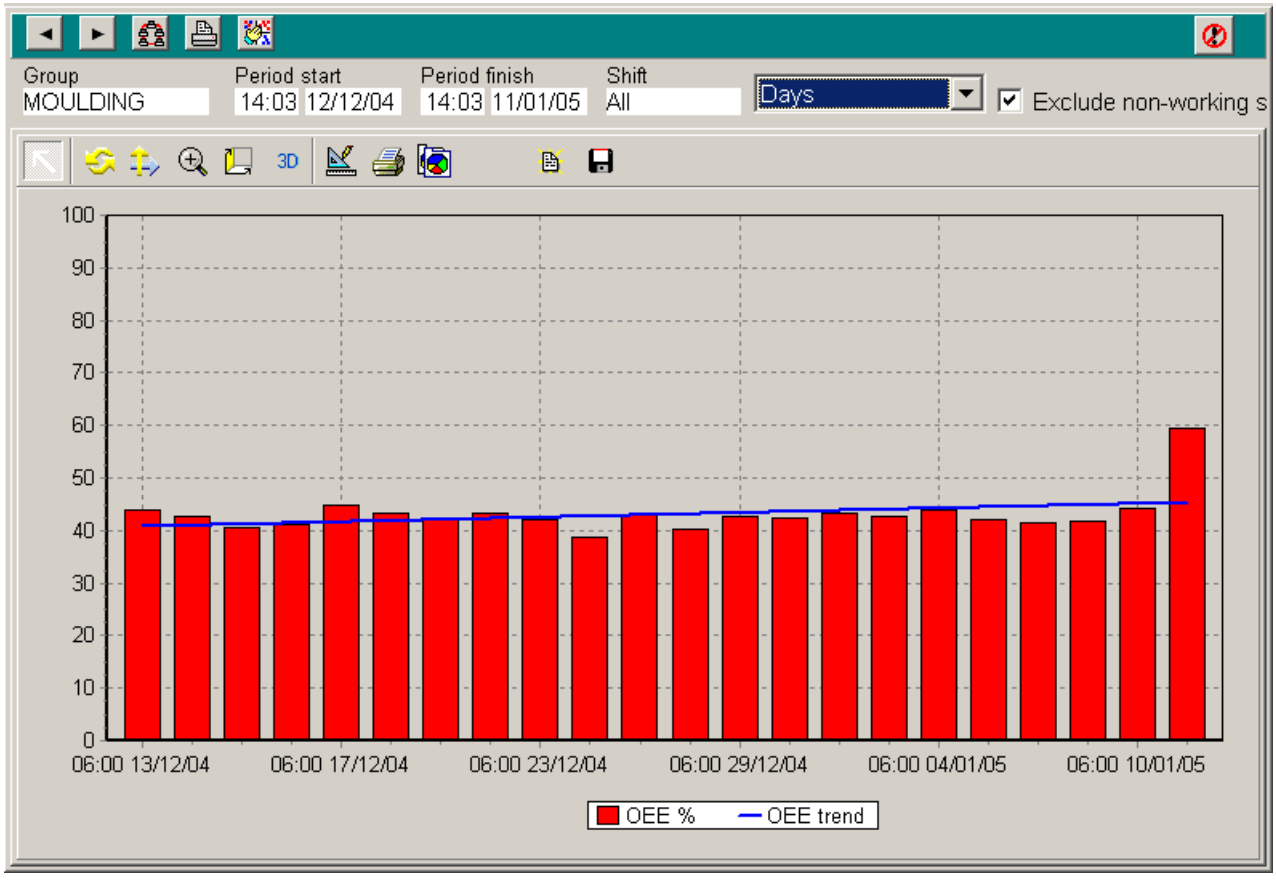


Figure 12: Group OEE trend graph

Why choose the Rhombus Factory Information System?

Experience

We have more than twenty years experience of designing and implementing machine monitoring systems in a wide variety of businesses.

We understand the particular problems experienced in different production processes, and we have solutions for these problems.

You can use our experience to guide your implementation of OEE measurement.

Sophisticated software

Our software is easy to use but is very sophisticated. It includes many detailed features to solve problems found in particular production processes. For example, support for family tools, support for blocked cavities in moulding tools, the use of PLC interfaces for automatic determination of downtime reasons, and support for floating meal breaks during a shift.

Proven and reliable

Our software is proven and reliable.

Companies such as Corus, Textron, Jaguar, Polynorm and Betts rely on our systems to measure OEE around the clock, seven days per week.

Some of these companies are now rolling out the Rhombus Factory Information System to their plants around the world, so that they can compare the performance of different factories.

Flexible

We have always recognised that different businesses and production processes have different requirements, and so have designed our software to be flexible enough to adapt to these requirements.