



# The software solution for improving production performance

Jari Kallela

Most plants work at well below their potential efficiency. Finding a way to raise productivity without investing in new lines or even a new plant can be of crucial importance to many company budgets. SCOPE® is an NT-based software solution that does precisely this. It improves production performance through measurement and analysis and by detecting sources of loss, failure and inefficiency.

**S**COPE® has been designed to work in conjunction with all major established methods for improving plant performance, eg OEE (Overall Equipment Effectiveness), RCA (Root Cause Analysis) and TPM (Total Productive Maintenance).

## Overall Equipment Effectiveness (OEE)

OEE is an indicator of how machines, production lines and processes are performing in terms of availability, speed (performance) and quality. In equipment improvement activities, the Overall Equipment Effectiveness is likely to be the best measure of performance.

## OEE = Availability x Performance x Quality

Equipment effectiveness is maximized through efforts to keep control of, and

then eliminate, the following 'six major losses':

- Availability (unplanned downtime losses)
  - Equipment failures (breakdown losses)
  - Setup and adjustment losses
- Performance (speed) losses
  - Idling and minor stoppages
  - Reduced speed
- Quality losses
  - Defects in process and reworking
  - Start-up losses

The benefits of OEE are that:

- The concept is simple, easy to use and easy to understand.
- It can be used in a variety of industries and production environments.
- It enables the production data of different products, shifts and plants to be compared.

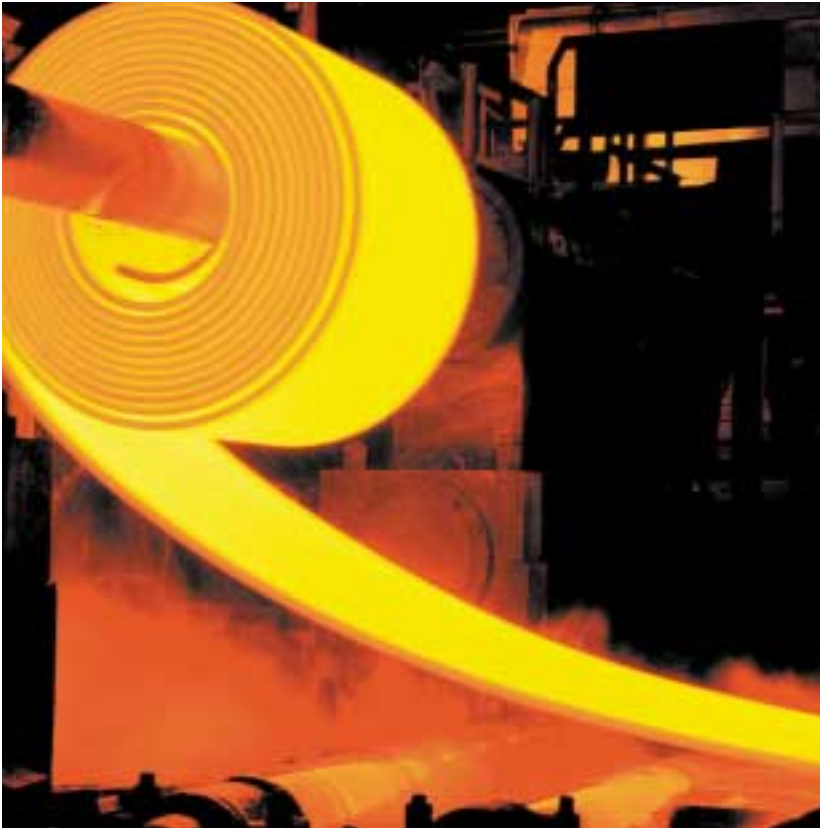
- Improvements in production can be tracked over time.

## Root Cause Analysis (RCA)

RCA comes into play whenever OEE measurements indicate poor plant performance. It is a structured approach to tackling failures and mistakes, both of which can have a significant effect on product quality, process performance and equipment availability.

In general terms, the RCA approach defines a failure as a situation in which the performance of a process does not meet expectations or goals. In more specific terms, it includes the following definitions of failure which are common to industrial plants:

- Failure is any loss that interrupts the continuity of production.
- Failure is a loss of asset availability.



SCOPE® is an NT-based software solution for improving production performance by detecting sources of loss, failure and inefficiency, for example in rolling mills.

- Failure is the unavailability of equipment.
- Failure is a deviation from the *status quo*.
- Failure is not meeting target expectations.

RCA is a systematic working procedure which guides the analyst from a failure event to its root causes. Root causes are the most basic causes of failure that can be identified within reason. They are either physical (components and machine parts that fail), human (somebody does something wrong or forgets to do something), or latent (What was the reason for the mistake? Why did it occur?). Once the root causes have been identified and

corrective action implemented, the failure should not occur again.

#### **Total Productive Maintenance (TPM)**

TPM is a comprehensive process of change that can be defined as 'a systematic way of working to create a production process free from loss, and to do so at the lowest possible cost and with the participation of all employees'. It is a long-term concern and not a project, even though the introduction of the concept can be handled as a project.

The process of change usually has a positive effect on the employees in the company concerned. Those who have participated are better equipped for the

future as a result of increasing their competence.

Increased competence results in greater competitiveness, which is of value to all parties. Increased competence and better insight into the issues which are of greatest importance to the future of the company motivates the employees to work for more change. This in turn increases the speed at which change can be introduced.

#### **SCOPE® – software for production performance measurement**

SCOPE is dedicated software for the online measurement and analysis of equipment effectiveness. It is easily installed in most production processes and has the following main functions:

- Automatic detection and recording of all losses in production.
- Calculation and display of performance data online.
- Supporting the analysis of production data and arriving at proposals for improving production.
- Printing reports and exporting data to other systems.

In performing these functions, SCOPE is able to provide all three plant performance methods (OEE, RCA and TPM) with solid performance data and advanced tools for analyzing that data. It makes it possible to identify, track and respond to problems that occur in production, while doing away with the time-consuming and flawed process of manually keeping logs. It has the further benefit of making performance data exportable to other systems which

**Table: SCOPE® system requirements**

	Server	Client
Processor	PII 400 MHz	PII 400MHz
Memory	128 Mb RAM	128 Mb RAM
Hard Disk	2 Gb free	–
Communication	10 Mb/s, TCP/IP	10 Mb/s, TCP/IP
Operating System	Windows NT4 SP5	Windows NT4 SP5
Other	CD drive, Serial ports for PLCs	CD drive

require accurate data on production efficiency.

The SCOPE system consists of three main modules **1**: data acquisition, data manipulation and storage, visualization and reporting. Each module can be distributed over the local area network using the TCP/IP protocol.

**Data acquisition**

SCOPE is able to read real-time signals from practically any Programmable Logic

Controller (PLC) or Distributed Control System (DCS)<sup>1</sup>. The speed of the communication depends on the protocol, PLC and computer in which SCOPE is installed. Normally one message per second is enough. The software does not limit the number of signals. Typically, 5 to 10 signals are needed per machine.

SCOPE is able to retrieve and export data to and from relational databases. It can also read values from text files, which makes it possible to get

production data automatically on such variables as current order and product.

**Data manipulation and storage**

SCOPE detects events in the production line such as machine starts and stops, and whenever a machine is running at reduced speed. These events are linked with signals from the PLC in the script, which is a small, dedicated programming language that classifies the events automatically. Whenever pre-defined conditions are met, the event is stored along with its context in an online database. It is also possible to store process measurements and other online signals in the database by using the script. This is the usual way to handle, for instance, signals recording the speed of the machine.

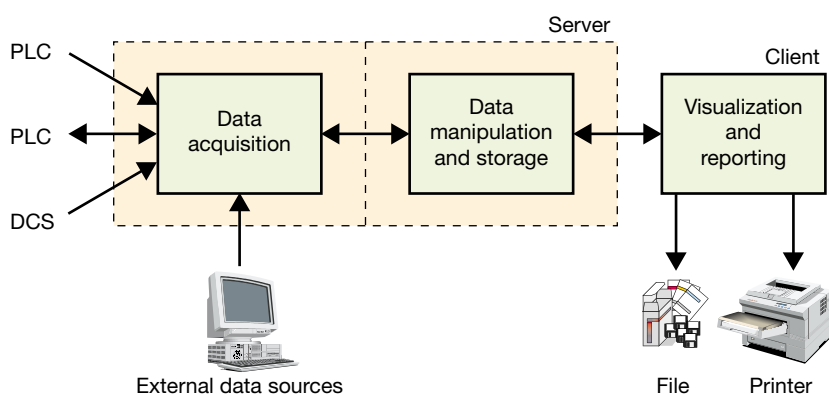
SCOPE automatically keeps track of the duration of events. Using these values, it calculates the efficiency rates and values for the various machines that make up the production line. Users may define their own online performance indicators by programming equations.

Online data is stored in a binary database to ensure fast response. SCOPE can handle events in the millisecond range, although a time accuracy of 0.5–1 second is usually more than sufficient. In a typical installation, there will be between 2000-3000 new records per machine in the database. Old records cannot be removed, but they can be archived.

**1 System architecture**

DCS *Distributed control system*

PLC *Programmable logic controller*



<sup>1</sup> In some cases, additional hardware and software may be required.

## Visualization and reporting

Users can create events and change classifications, products and orders using the keyboard, pushbuttons or bar code reader. They can modify or expand on the cause of a breakdown simply by clicking the mouse. It is also possible to access breakdown history and OEE data for a given period of time.

Using the quantity planned and current rate of production as categories, SCOPE can estimate when production will end and display the estimate on the screen. Alternatively, it can use the projected finishing time and current rate of production to estimate the quantity remaining to be produced.

SCOPE can provide a production trend screen, including the OEE or other user-defined performance indicator, for a

given period of time **2**. Each color represents a different production mode.

A dynamic PARETO chart reports the cumulative breakdowns according to category. It gives the ratio of shutdown causes occurring on the production line and classifies them in descending order of cumulative time. For each type of event, the chart presents its weighting in time, quantity, and percent with respect to the total production time (% IT), actual time in production (% EP), classification (type of operational shutdown) and the type of production currently in progress.

The operator or production manager can determine with the help of a chronology screen the overall situation on the line, and can focus on the most relevant events. This screen shows

a chronology of all the events tied to a particular machine, production line, product or lot within a given period of time. By selecting a color (each color corresponds to a class of operations and shutdowns), the user can see at a glance all the incidents that have occurred during a particular shift, day or week.

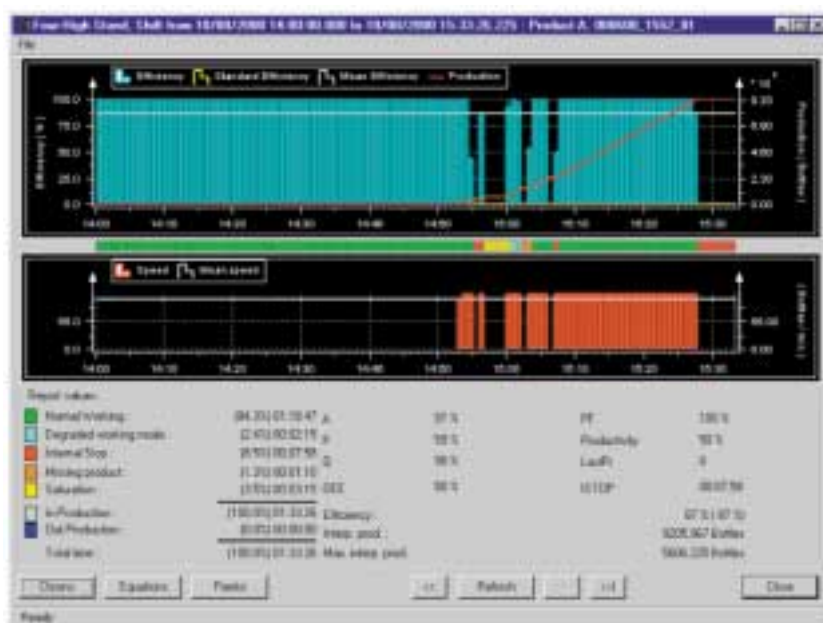
## Other features

SCOPE can print reports using other types of software for setting and formatting the layout. When used with a spreadsheet, the user can create macros and formulas that further enhance the degree of customization obtainable. Data can be exported on demand or automatically after pre-defined events such as changes in shift or product, or at the end of every working day, hour or five-minute period. It can also be exported to databases via ODBC or as XML files. There is also an additional module for web reporting.

Administrators can define the number of user groups and assign them different user rights. For instance, the right to change class can be restricted to supervisors; logging in for group members can be made dependent on their giving the password.

SCOPE screens are available in eight languages (English, Dutch, Finnish, French, German, Portuguese, Swedish and Spanish). Users can work on the same data using different languages and can change from one language to another online.

**2** Trend screen showing the evolution of production over a given period of time



Breweries are among the numerous industries and production environments that can benefit from dedicated SCOPE software.



SCOPE focuses on small, low-cost changes that together make a big impact on production process efficiency.



### Feedback from the field

By definition, improving the overall effectiveness of equipment means obtaining greater efficiency in production. One way of achieving this is to make large investments in machinery and automation. A more cost-effective approach is to focus on small, low-cost changes that, added together, make a big impact on efficiency. This is the approach of SCOPE.

What are these small modifications and inexpensive solutions? Below are four examples taken from existing installations, all of which were detected by SCOPE.

- In one plant, operators intentionally and regularly stopped production about 15 minutes before the end of their shift. They wanted to leave early, safe in the knowledge that the next shift would restart production.
- When the speed of a packaging machine was set according to the manufacturer's recommendation, the number of short breakdowns increased drastically. When the speed was reduced, production increased.
- A production manager noticed from the PARETO chart that a brand new machine tool had been stopped dozens of times with the emergency stop button during its first two weeks in operation. It turned out that, due to insufficient training, one operator did not know of any other way to stop the machine. If this had gone on for another two weeks, this million-dollar machine would have been destroyed.
- In another machine, the introduction of SCOPE meant that the old manual log was no longer kept. Breakdowns were classified automatically, and 10% of these were reported under 'Laser detection'.

But the machine no longer had a laser detector. An investigation revealed that there was a bug in the PLC program that caused the machine to stop at regular intervals.

One customer with long experience of using SCOPE is Dow Corning of Belgium. By enabling the company to identify problems much quicker, SCOPE helped to increase availability, production speed and the output quality of its equipment. An entire month of production was gained as a result.

### Author

**Jari Kallela**  
Maintenance-tv NV  
Belgicastraat 7  
BE-1930 Zaventem  
Belgium  
jari.kallela@be.abb.com  
Fax: +32 2 716 55 22