Upgrading rod and bar mills with state-of-the-art control technology

Profile mill control systems can be upgraded to give mill operators the flexibility and capability they need to meet future demand for high-quality finished products. The Advant Open Control System, developed by ABB to take full advantage of state-of-the art control technology, allows revamp kits to be easily integrated in outdated mill processes. Since the control is adaptive, optimum results are achieved even when the process parameters change. Also, when Advant OCS is installed, ABB Interstand Dimension Control (IDC) can be implemented. IDC continuously monitors the main bar and rod dimensions for direct control of the roll gap and interstand speed. As a result, mill scrap can be halved and stands can be recalibrated for new products much faster. Drive upgrade kits installed in the recently revamped Ovako steel mill in Hällefors, Sweden, give the mill's owner a competitive edge in the fiercely contested rolled products market.

Older generations of mill control systems were never designed to meet today's rigorous demands on product uniformity, quality, productivity and traceability. Even the earliest digital control systems do not have the necessary capability; based on first-generation microprocessors with limited memory and computing capacity (which may also make them susceptible to the 'millennium bug'), they have to be optimized for their specific tasks. Such systems were designed and built to work under narrowly defined conditions, and lack the functional versatility needed to respond quickly and accurately to new situations.

ABB offers advanced control systems which have all the capability required to handle even changing conditions. The Advant Open Control System (OCS), for example, was developed to take full advantage of state-of-the-art ABB control technology. With Advant OCS, revamp kits for drive systems can be easily integrated in older processes to ensure that they meet the highest requirements. Furthermore, it facilitates the installation of Interstand Dimension Control (IDC) in profile mills.

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Benefits of revamping

Operators of profile mills specializing in long products, such as rods and bars, are having to cope with a strong increase in demand for high-quality finished products. At the same time, steel prices are being kept down by the large-scale availability of low-grade products. Traditionally, this is the right time to upgrade plants to meet future market requirements.

The wisdom of revamping a functioning system can always be questioned, but there are many reasons for making such an investment. For example, failures are more likely to occur in older equipment. And while most of the electronic equipment which has survived until today can be considered to be fairly reliable, the relatively long time between failures means that maintenance crews have only limited trouble-shooting experience with the equipment. This is important as rolling mills depend more on the specific skills of maintenance crews than on organizations. Two other concerns of profile mill operators with older control systems are the availability and cost of spares. A minor fault can result in unnecessarily long and costly downtime.

Older equipment based on analogue technology requires a large number of adjustments for efficient and profitable mill operation. While this has the advantage that it makes the engineers familiar with the equipment, it comes at the expense of additional maintenance staff. Also, it is difficult to recruit new engineers to work with outdated equipment.

There are also differences in the demands made by 'today's' and 'tomorrow's' processes that have to be considered. In the past, operators used pushbuttons and potentiometers to control the mill, and the feedback from the process was shown on numerical dis-

Typical control desk in a profile mill. Pushbuttons and potentiometers dominate the scene. 1

State-of-the-art control room. The operator, who works in a Windows environment, supervises the process on-line. 2

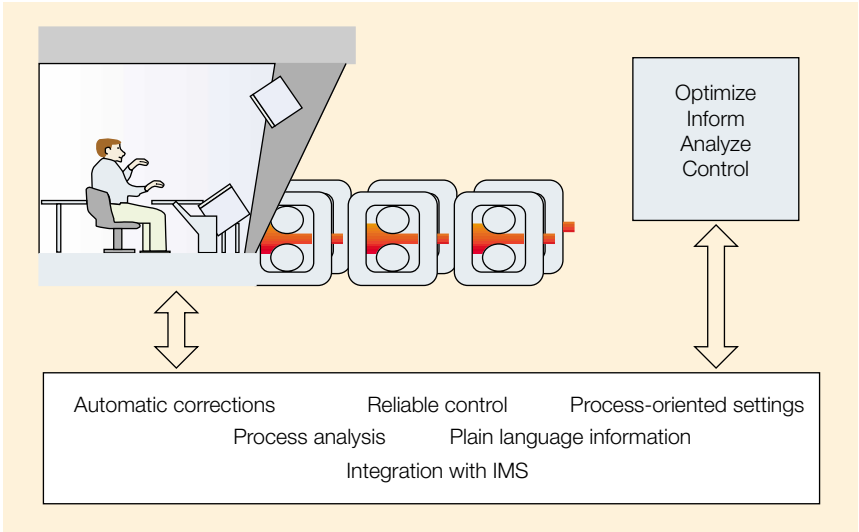
plays 1. Supervision of the actual rolling process was basically visual, and relied on the operators' observational abilities. Even the first generations of digital control systems were very restricted in terms of their flexibility and analytical capability.

Advant OCS and the latest operator station generations offer a completely new level of flexibility and depth of information. Control is adaptive, so that optimum results are achieved even when the process parameters vary. In a state-of-the-art mill control room, the role of the operator is more like that of a process engineer. Working in a Windows environment, he supervises the process on-line and selects functions (eg, logging, analysis, etc) as he needs them.

New control systems (2 to 4) improve mill performance and safety, ensure a higher and more consistent quality for the rolled end-products, and increase profitability.

A rationally organized workplace incorporating features that improve mill performance and safety ensures a consistently higher quality for the rolled products and increases profitability. 3

IMS *Information Management System*



Revamping in stages

Careful planning is a key factor in revamp projects. Downtimes have to kept as short as possible to minimize production losses. One solution is to revamp the control systems in stages, for example:

- Overall mill control, either analogue or digital
- Sequential logic, relay systems or programmable logic controllers (PLCs)
- Drive systems, mainly DC with analogue speed and current control

In addition, the revamp project can concentrate on one process area at a time, in the case of a profile rolling mill starting with the roughing mill area and then continuing with the intermediate and finishing mill areas 5.

The 'area' revamp is of special interest now that new control packages such as the Profile Mill IDC are available **5**.

Ovako steel mill revamp

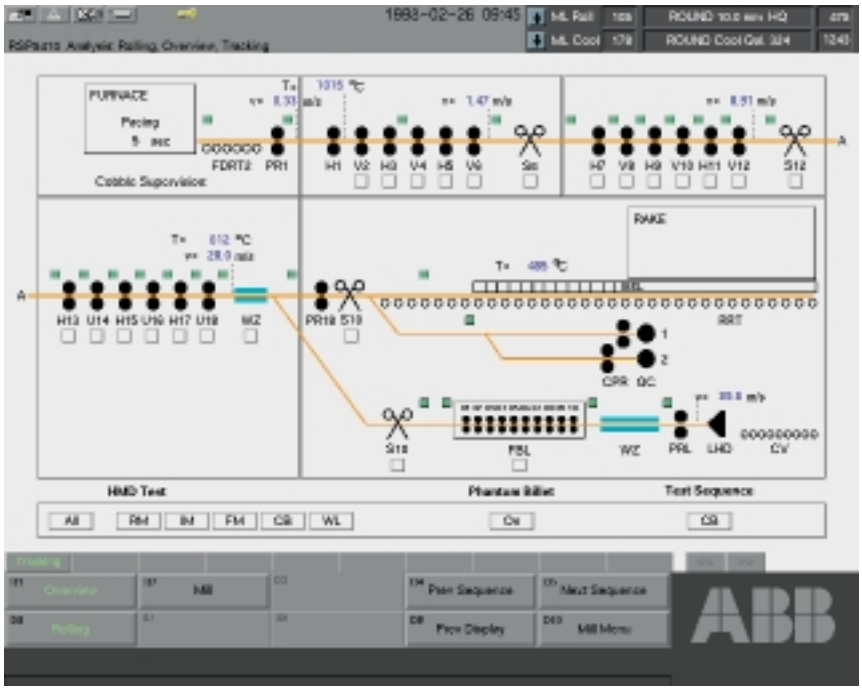
A typical example of a successful revamp carried out in stages is the bar and rod mill at SKF's Ovako steel mill in Hällefors, Sweden. This rolling mill, commissioned in 1977, was one of the world's first digitally controlled mills and was based on state-of-the-art technology at the time. It was designed to meet demand by the parent company for high-quality rolled products made of ball-bearing steel. Nearly two decades later, although still in good shape, the mill no longer met modern-day performance and competitiveness specifications. Key issues, such as improved mill supervision, auto product changeover, manufacturing instructions, production analysis and easier maintenance, subsequently played

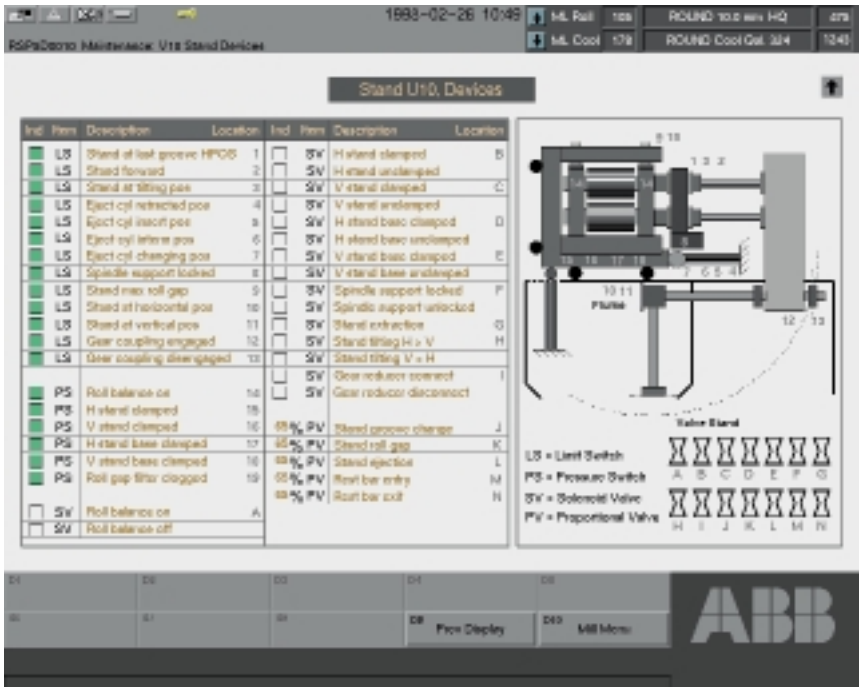
Some of the displays supporting the operator in decision-making **4**

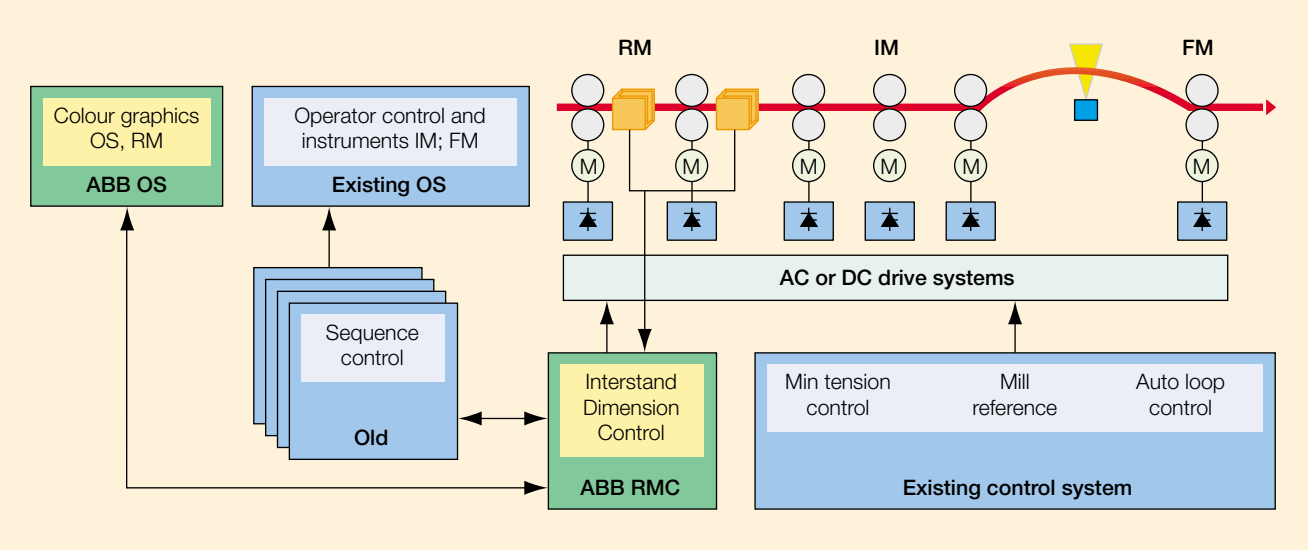
Top right — *Analysis of rolling with stand overview, providing operator with information on mill configuration, material tracking, test sequences, etc*

Bottom right — *Stand maintenance schedule informing maintenance crew about stand equipment statuses*

Left — *Analysis display showing snapshots of threading conditions, torque, loading, speeds, etc*







Revamping a profile mill area by area 5

RM *Roughing mill*
IM *Intermediate mill*
FM *Finishing mill*
OS *Operator station*
RMC *Rolling mill control*

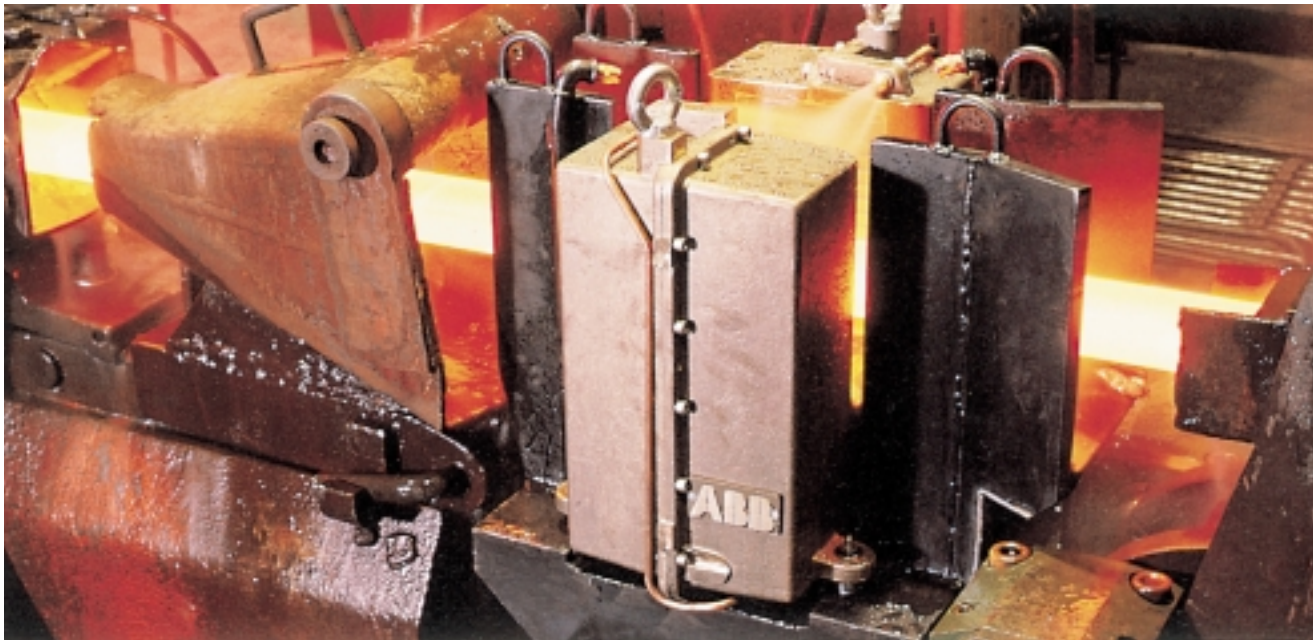
an important role in the decision by the mill owner to select ABB's new-generation Rolling Mill Control (RMC) system. The performance enhancement afforded by IDC was also a key factor leading to this decision.

A new 3-stand roughing mill was installed in 1995, increasing the original rolling capacity from 120 mm to 165 mm square billets. This addition also included the ABB RMC 200 system, one Advant Controller 450 and one Advant Operator Station from the 500 series. The mill is operated from the existing pulpit by means of remote control. In the following year, the control for the walking beam reheat furnace was replaced by an ABB Reheat Furnace Control (RFC) system to optimize performance and fuel consumption. Also, an ABB Automatic Dimension Control (ADC) system was added to achieve narrower final tolerances. The ADC system controls the roll gap of the final two or four stands based on feedback from a rotating ORBIS optical gauge meter.

New control room at SKF's Ovako steel mill in Hällefors, Sweden 6

Controls for the 21st century

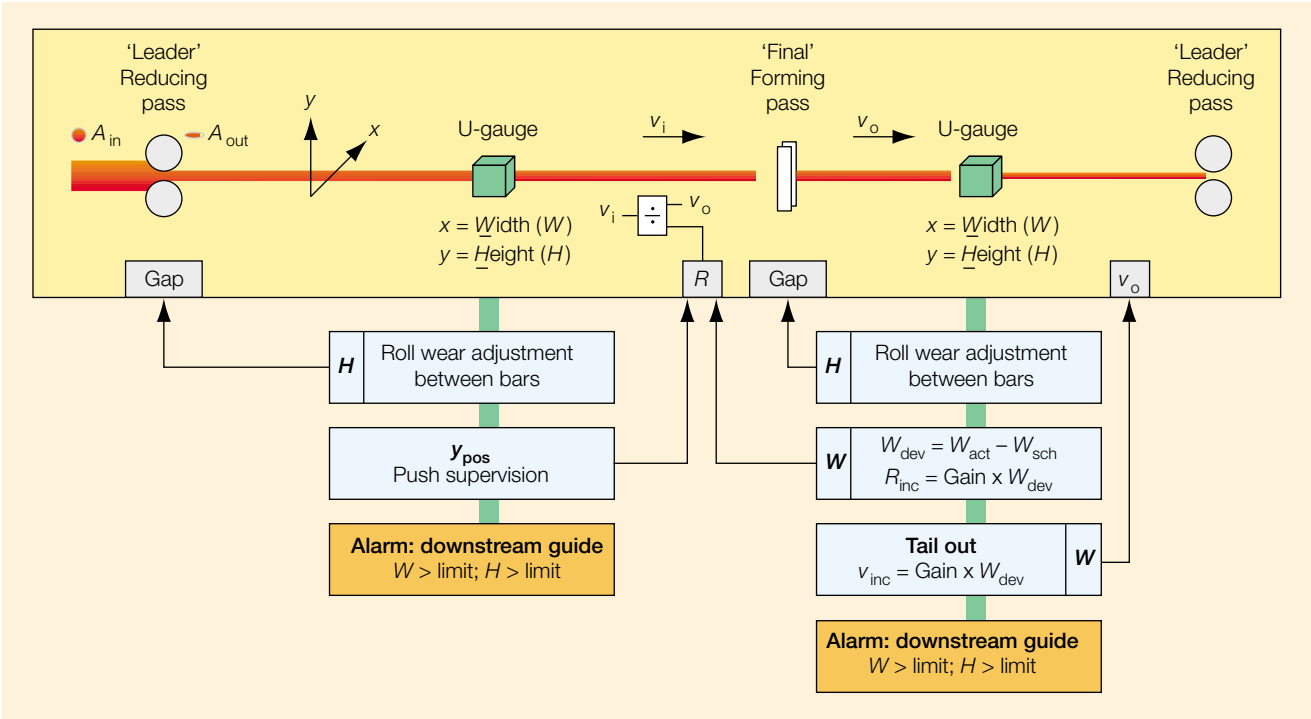
In 1997 it was decided to revamp the mill 6 to make it capable of meeting future demand for consistently high-quality production of low-tolerance rods and bars. The old control system was based on DS8, an 8-bit microprocessor system for control and numerical data presentation, PLC 700 logic control and TYRAK 73 analogue thyristor converters. The equipment chosen to replace it was the ABB RMC, DCV 700 digital drive upgrade kits and IDC.



Integrated, solid-state U-gauge sensors create magnetic fields which are distorted to a greater or lesser degree, depending on the dimensions of the steel bar or rod passing through them.
The IDC system automatically adjusts the set-up of the mill stands and interstand speed on the basis of the data received from these gauges. **7**

IDC control principle. Continuous supervision and control eliminates the risk of underfill and overfill rolling. **8**

A_{in} *Area in*
A_{out} *Area out*
v_i *Inlet speed*
v_o *Outlet speed*
R *Reduction factor*
R_{inc} *Reduction factor increment*
v_{inc} *Speed increment*
W_{dev} *Width deviation*
W_{act} *Actual width*
W_{sch} *Scheduled width*
y_{pos} *y-position (height)*



Simple installation of RMC

The RMC concept is designed for easy installation and upgrading. Since the new roughing mill was already equipped with an Advant Controller 450, the whole mill could be controlled from the same processor rack by adding more processor capacity, with the I/O units remotely located in the relevant process areas. The revamp was carried out in three stages.

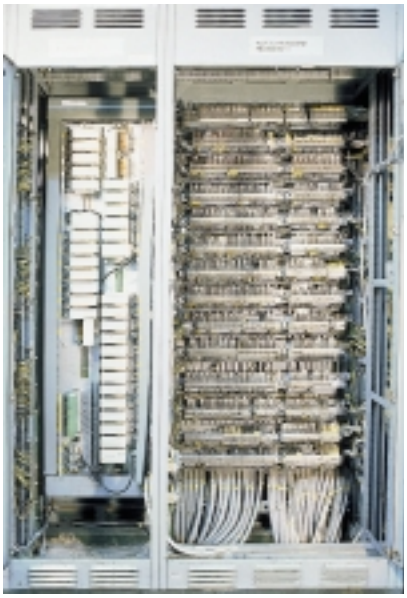
In the first stage the DS8 and its operator communication were replaced by adding software to the Advant OS for the roughing mill. The second stage involved revamping the analogue thyristor converters with digital control. By retaining the power supply and thyristor modules, it was possible to restrict the revamp work to replacement of the control systems, protection and field converters. All the components were mounted on a panel and pre-tested prior to fitting in the control cabinet door.

In the third stage the old PLC logic control was replaced by the Advant RMC. The existing PLC circuits were located in one cabinet with all process cabling terminated in an adjacent cabinet. This cabling was retained and wired to the new ABB S800 remote I/Os with bus communication to the Advant Controller.

This upgrade laid the foundation for the installation of the Interstand Dimensional Control (IDC) system, which brings a whole a new concept to rod and bar mill control.

Interstand Dimension Control – U-gauge sensors provide bar data on-line

A key element of control engineering is the accurate, rapid feedback of dimensional data and effective, continuous control of the mill stands. In the past, all control methods were based on the philosophy of maintaining a low, constant tension along the bar/rod. This approach generally works well, but does not allow for the adjustments needed to compensate for the deviations created by the temperature and dimensional variations along the bar/rod. In addition, there are certain shortcomings due to the lack of on-line feedback from process parameters, such as material dimensions and the speed. Rugged U-gauge solid-state sensors **7**, which are insensitive to the harsh conditions in mills, are required to provide accurate on-line information about the bar dimensions. Measurement data from these sensors are fed into the control system and used to control the bar dimensions by adjusting the interstand speed **8**. IDC also ensures maximum roll utilization, thereby increasing the mill capacity, as the material width is continuously supervised and controlled. This eliminates risks of under- and overfill rolling. The U-gauge measurement principle allows a wide measuring range, so that only a few different gauge sizes are needed. In-line installation of the gauge is simple on account of the specially designed inlet and outlet guides and the sensor base-plate. No on-site calibration is necessary.



The new controller is quickly connected, using existing process cabling, by bus communication to the Advant Controller. **9**

First step towards fully automated mills

The Interstand Dimension Control system is the first step on the road towards fully automated rolling mills. By integrating the data generated by the IDC with other operational information and then linking it into a mill-wide process control system, such as the ABB Advant system, steel mills could become self-monitoring and self-correcting. IDC improves mill performance in accordance with owners' requirements without having to modify the mechanical equipment **9**.

Short pay-back time

Although the cost of the electrical equipment amounts to only a small fraction of the total investment in a modern, highly automated rod and bar mill, the correct choice of systems helps to determine a mill's overall performance and profitability. It is estimated that the increase in productivity, plant yield and availability made possible by IDC will allow the cost of the investment to be paid back in most cases within one year.

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