USING A SCADA PACKAGE FOR PAN FLOOR PROCESS CONTROL

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Abstract

Prior to the 1991/92 season, Noodsberg used a custom designed PC based system for pan boiling control. This system was abandoned in favour of a new supervisory control and data acquisition (SCADA) package, called Turbolink, mainly because of a lack of available support for the old system. The new package has proved to be extremely powerful and its scope of application has been extended to the provision of an overall pan floor management facility. The package is used to control the boiling of all raw house pans through the generation of set points for stand alone conductivity controllers. It also provides, amongst others, a logging and graphics trending facility for vacuum, temperature, conductivity and level of all pans. Through the use of a production report facility, it also automatically logs the time of each boiling and provides statistical information on these.

Historical Overview

In 1987 Noodsberg installed a custom designed automatic pan boiling system based on the Sugar Milling Research Institute (SMRI) automatic pan controller (Keen, 1986). The system, using dedicated SABUS hardware, controlled all nine raw house batch pans and in addition, provided an historical data logging capability for pan level, conductivity and vacuum. The basis of control was the generation of a remote set point triggered by using 16 predetermined level points. A valuable feature of the system was its stand alone capability with the remote conductivity signal driving individual panel mounted controllers so that in the event of any PC failure the pan boiler still maintained local automatic control via the controllers.

The SABUS system more than justified its original R20 000 investment by providing enhanced pan control for A-, B- and C-pans until hardware failure and lack of service support during the 1991/92 seasons prompted management to consider alternative systems. The factory staff already had experience with a cost effective SCADA package using a 286 IBM compatible PC for mill data logging and with relative ease the R12 000 Turbolink mini package with 128 analogue inputs was substituted for the SABUS system using the existing 286 IBM compatible PC.

The success of the mini package prompted mill staff in 1992 to upgrade the package to a midi Turbolink version with 256 analogue inputs and 256 digital inputs and at the same time the PC was upgraded to a 386 IBM compatible model. A schematic representation of how the system is set up is given in Figure 1.

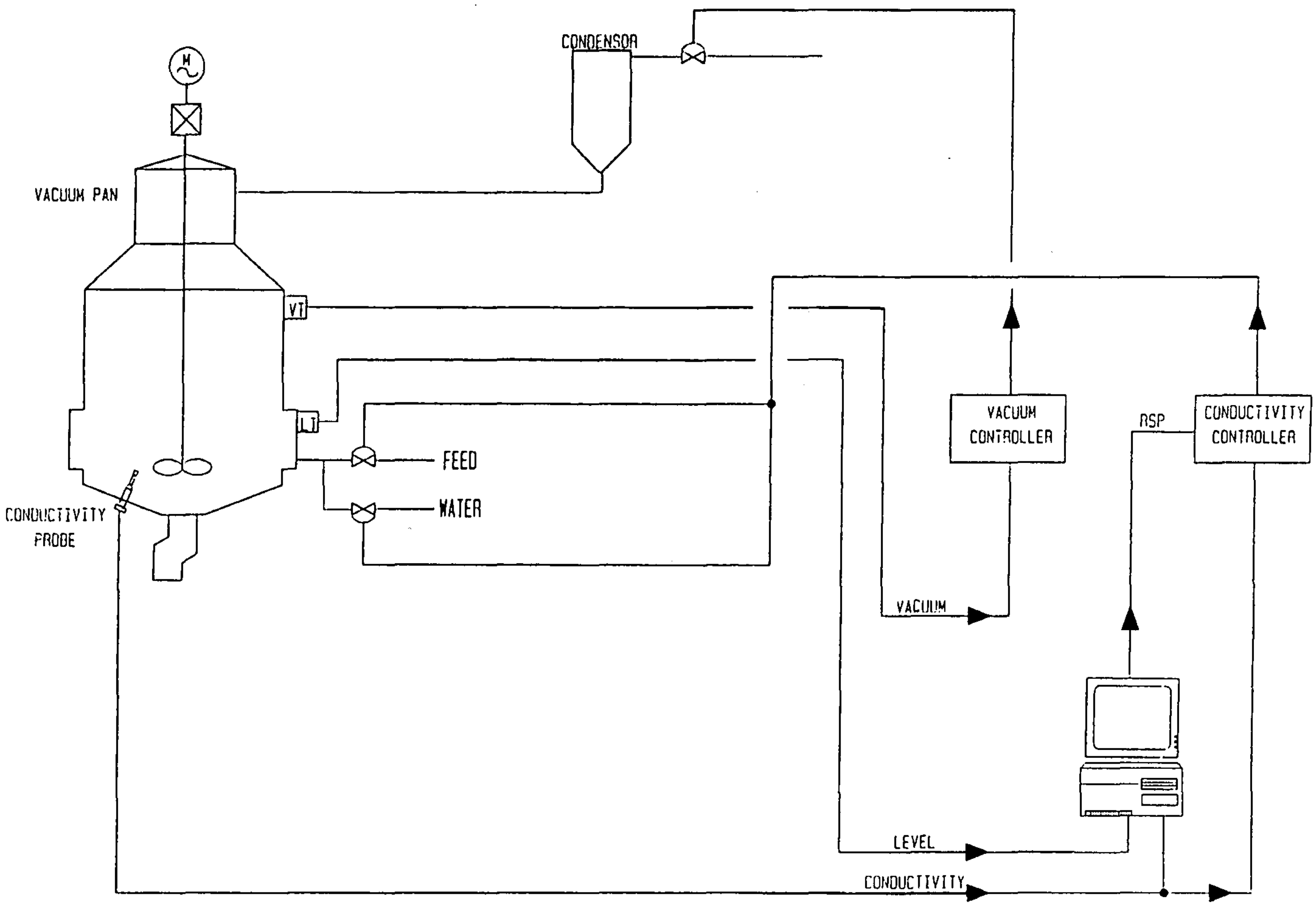

FIGURE 1 Schematic of pan automation loop.

Features of Turbolink System

Remote set point generation system

The ability of the Turbolink package to send a signal to a stand alone controller enables the generation of a remote conductivity set point. Traditionally batch pan conductivity set points have been generated on a stepped basis from the level signal. This has two disadvantages. In the first place it requires a great deal of programming to generate this, and secondly the steps result in a series of discrete jumps from one set point to the next. Experience has shown that most pan profiles of level versus conductivity are either linear or polynomial and therefore can be represented by the following equation:

$$y = ax^2 + bx + c$$

where y = conductivity
x = level
a, b and c are constants

The determination of the constants a, b and c is done by using a curve fitting regression analysis programme applied either to a graph of a good manual boiling or a predetermined curve. Using the constants obtained (from the regression calculation) the set point determination is simply programmed, in 10 short steps, using the quadratic equation approach. In addition to the simplicity of the programming this approach results in a smooth change in set point as the level changes.

Figure 2 is an example of a curve fitting calculation, applied to a level versus conductivity curve to determine the values of the constants in the quadratic equation.

Mill staff have been able to change the curves for A-, B- and C-massecuites by manipulating the constants. Experience has shown that the curves have to be adjusted from time to time in order to cater for seasonal variations in the conductivity versus brix relationship. The quadratic equation has also been successfully applied to the generation of refined sugar boiling curves using a capacitance signal instead of conductivity. The ease with

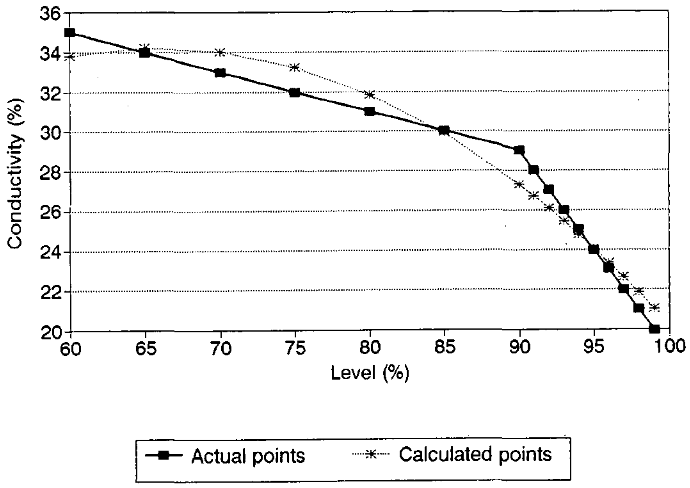

FIGURE 2 Level vs conductivity curves for Pan No. 4.

which boiling curves can be changed has allowed mill operational staff to experiment with many different curves.

Overview of pan station

The status of each of the nine batch pans can be viewed simultaneously (Figure 3). Pan level is graphically displayed with a change in colour at strike level as a prompt for end of boiling. In addition actual conductivity, remote set point, level, and vacuum are displayed.

Dynamic trending

Real time trending is available for each pan. This allows deviations to be spotted quickly and corrective action to be implemented. Mill staff have made extensive use of this facility to monitor various parameters for non pan floor equipment as well, e.g. syrup brix, steam pressure, temperatures, pH, stirrer motor current etc. .

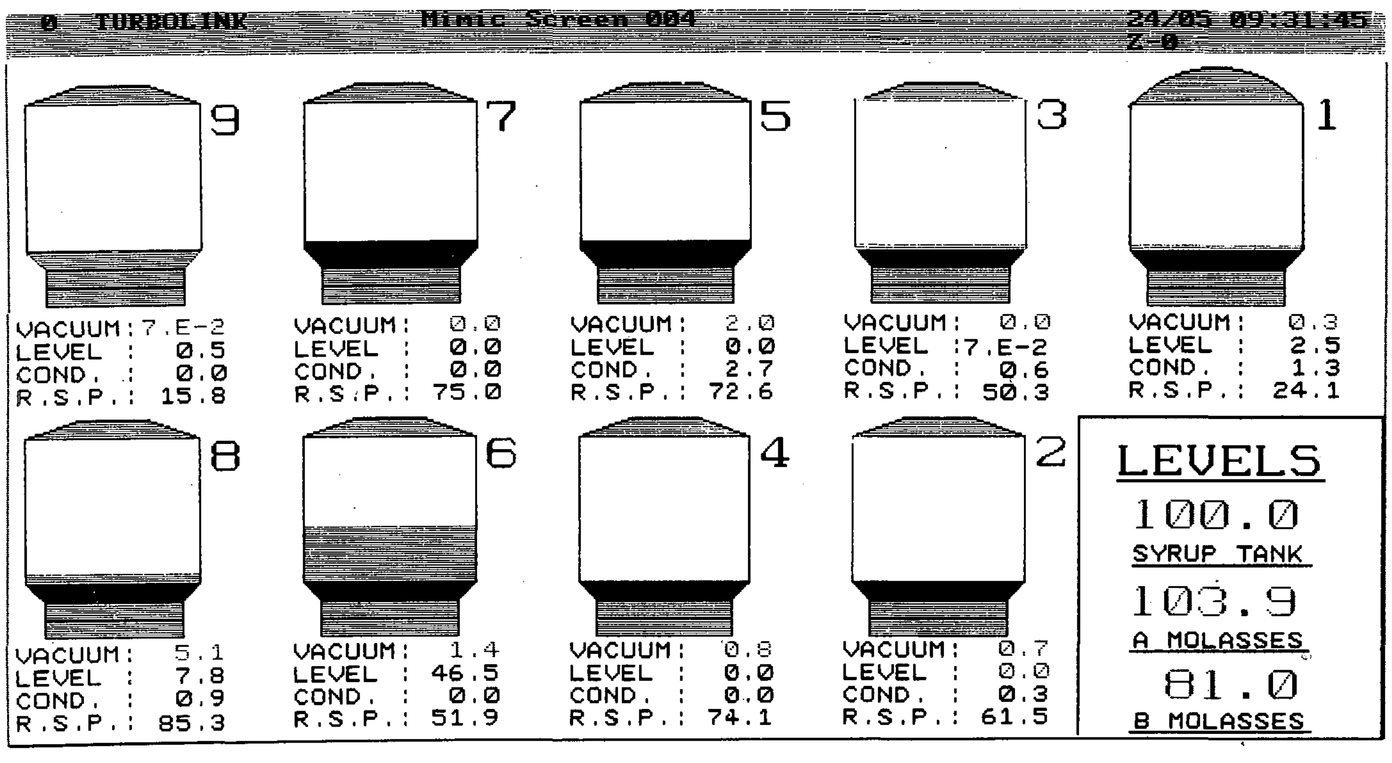

FIGURE 3 Typical pan station overview.

Historical graphical data

The upgraded Turbolink package currently has in storage over three months of data which can be easily accessed. Data are stored on a FIFO basis. In addition the system offers variable rate of sampling of input data. The data are stored in compressed format with a zoom facility allowing any section to be retrieved and amplified (see Figures 4 and 5).

Production report

This facility (Table 1) presents a summary of data as shown in Figure 3. Each boil is monitored using the change in level to signal the start of a new boiling. In addition the system allows summarised data to be extracted for a variable period. This has allowed operations staff to monitor trends and in particular monitor pan boiling times which in the past were manually and laboriously calculated.

Reprogramming

All minor changes to the database have been achieved by mill automation staff with ease. It must be emphasised that the system allows flexibility in manipulating data and therefore has tremen-

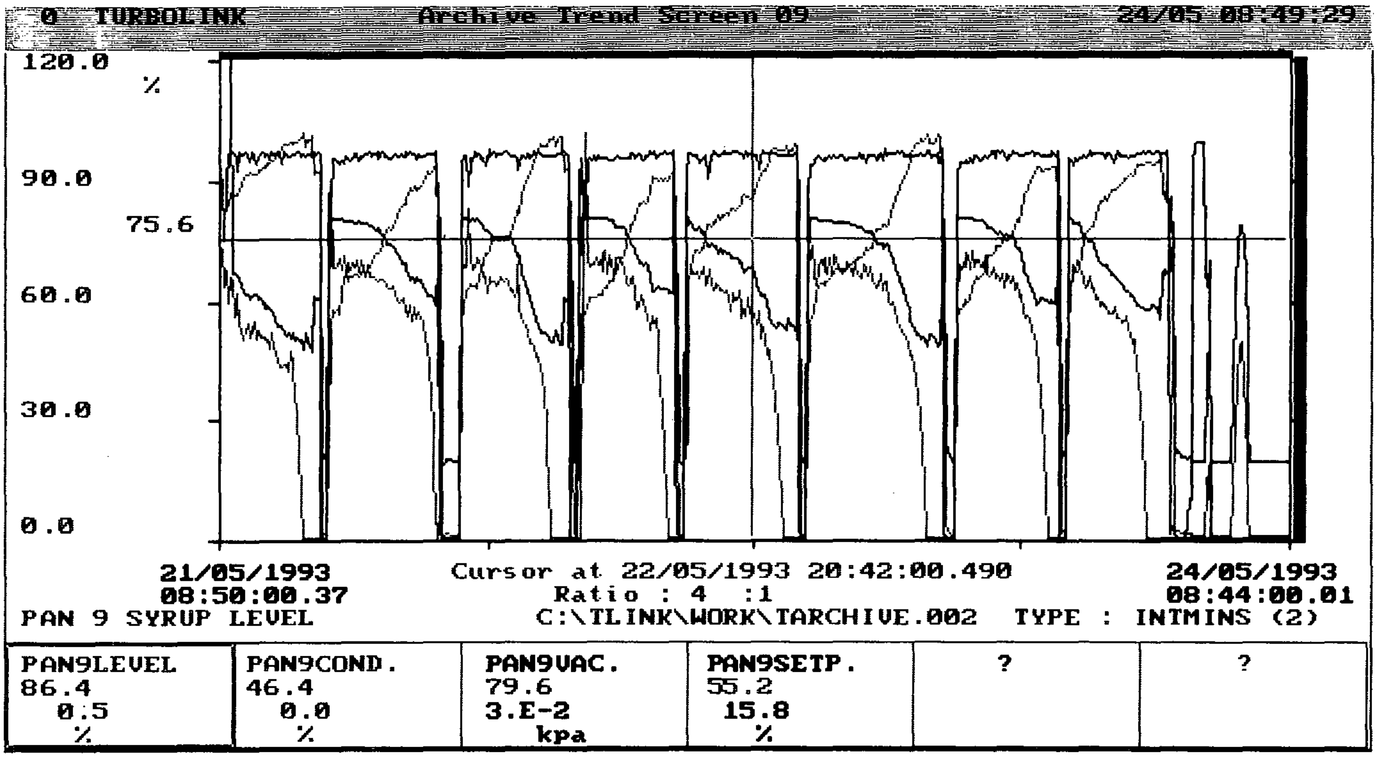

FIGURE 4 Typical archives data.

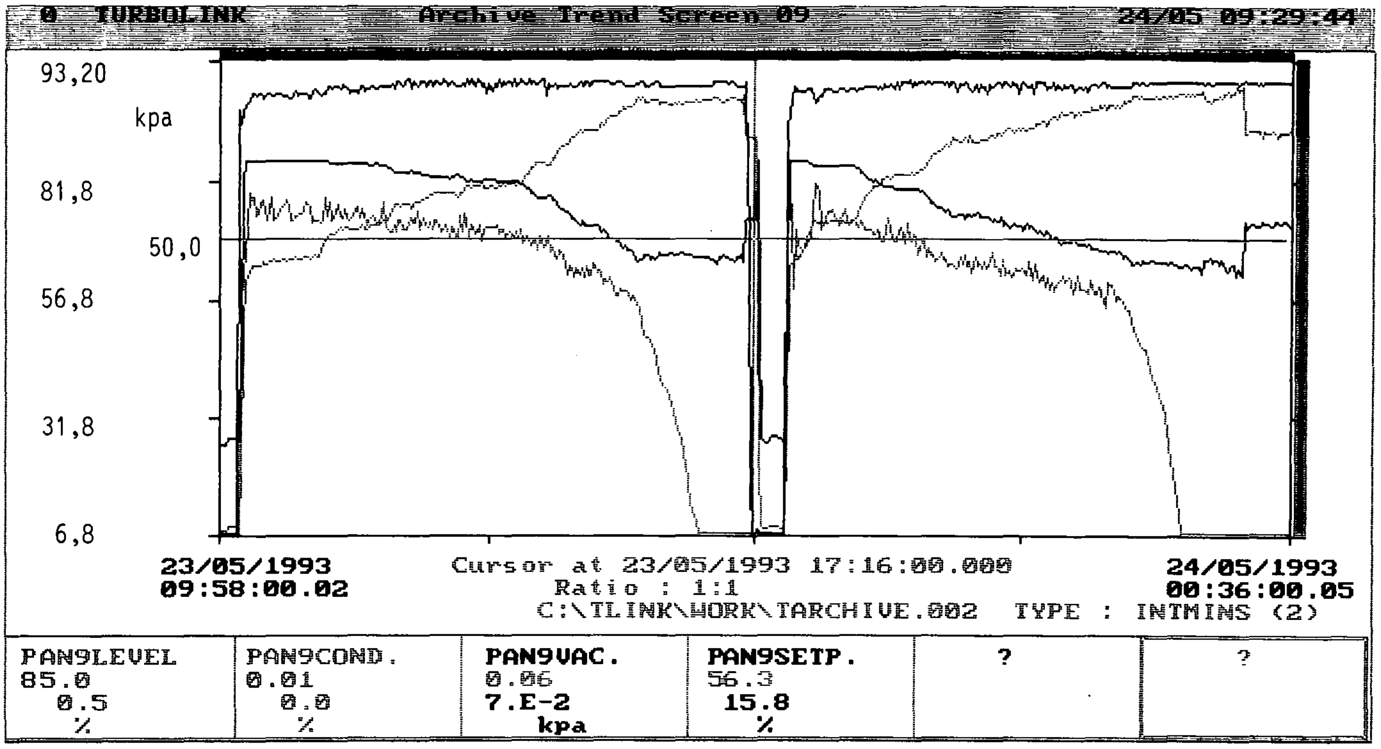

FIGURE 5 Typical amplified data extract from archive.

Table 1

Pan production report

Pan 8 Boiling cycles									
Cycle End Time	Boil Complete Time	Pan Empty Time	Pan Level Strike	Pan Conduct Strike	Pan Conduct Start	Strike Boiling Time	Striking Time	Total Off Time	Complete Cycle Time
<LOG 18>	8 Boil end	8 Time Emp	8 Lev Str	8 Con Str	8 Con Strt	8 Boil time	8 Str time	8 Off time	8 Tot time
06/10 13:09:04	0,00	0,00	79,51	39,75	51,93	85,00	0,00	0,00	0,00
06/10 15:35:58	15,11	15,18	90,28	0,00	40,88	122,00	7,00	24,00	146,00
06/10 21:00:25	20,37	20,42	93,75	0,66	62,84	301,00	5,00	23,00	324,00
07/10 02:59:40	2,36	2,42	90,97	0,00	65,35	336,00	6,00	23,00	359,00
07/10 09:34:33	9,11	9,16	90,82	0,00	61,45	372,00	5,00	23,00	395,00
07/10 16:27:42	15,59	16,05	94,44	0,62	68,64	385,00	6,00	28,00	413,00
07/10 22:41:35	22,20	22,27	95,49	0,62	69,80	353,00	7,00	21,00	374,00
08/10 05:21:14	4,55	5,03	95,02	0,00	73,23	374,00	8,00	26,00	400,00
08/10 11:42:50	11,19	11,24	94,11	2,95	68,85	358,00	5,00	23,00	381,00
08/10 18:00:48	17,36	17,41	92,41	14,08	81,11	354,00	5,00	24,00	378,00
09/10 00:23:03	23,48	23,55	95,81	0,00	68,27	348,00	7,00	35,00	383,00
09/10 06:31:09	6,05	6,10	0,00	0,00	70,13	342,00	5,00	26,00	368,00
09/10 12:35:47	11,52	12,05	89,01	0,00	75,35	321,00	13,00	43,00	364,40
09/10 19:13:44	18,50	18,56	97,40	0,58	71,33	374,00	6,00	24,00	398,00

dous development potential. Access codes ensure that only authorised persons can change data or reprogramme.

Energy management

Magnetic flow meter signals for water usage are processed on Turbolink (Table 2) and a production report generated each shift allows personnel to monitor and check deviations in consumption.

Table 2 : Water usage report

Turbolink Production Report **3 November 1992 10:50**

Water usage - 3 November 1992		
01	Filter Wash Water	8 666,0
02	Clear Juice make up water	11,0
03	Evaporator water	5 933,0
04	A & B molasses conditioning water	688,0
05	Gland sealing water-raw house	1 628,0
06	Jet brix	1 190,0
07	Filter sluicing water	167,0
08	Centrifugal wash water-refinery	9,0
09	Melter water	9 145,0
10	Upstream refinery pans water	900,0
11	Glands sealing water-total	4,0
12	Pans water-raw house	4 236,0
13	Downstream refinery pans water	159,0
14	Total water usage	32 577,00
15	Raw house total water usage	21 162,00
16	Refinery total water usage	11 415,00

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TAB	:	Select Item	Alt-L	:	Update log
Alt-C	:	Print	F6	:	Configuration

Other benefits

Noodsberg staff have been analysing the effects of low pressure steam boiling, at this stage only with reference to C-pans boiled on low pressure vapour 2 (20 kPa) and the other pans at normal vapour 2 pressure (55 kPa).

The Turbolink data logging and trending facility has proved extremely beneficial in storing data for this experiment. Initial results show no significant differences in boiling time or performance of the C-pans and in lieu of the steam saving potential of lower steam pressure boilings a fuller evaluation will be undertaken next year.

Costs

System cost excluding field equipment and controllers is:

Turbolink package with I/O cards	R12 000
386 PC with colour monitor plus printer	R 8 000
Total	R20 000

The Turbolink data acquisition system makes the conventional recorder and charts redundant and, more importantly, access to stored information for diagnostic purposes is facilitated.

Limitations

The SCADA package in use is compatible with programmable logic controller systems but not with distributed control systems due to lack of interface hardware. The present pan curve options only allow a single recipe, but mill staff are working on increased options for the coming season. The controller function available in this package has not been utilised mainly due to the fact that the existing stand alone controllers serve this purpose. Furthermore, a PC based system is not as reliable as a DCS system.

Conclusions.

The installation of the Turbolink package at Noodsberg has been successfully applied to generate remote conductivity set point for automatic pan boiling. In addition the enhanced graphics and easy access to stored information allows statistical analysis for improved pan floor management.

Acknowledgements

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