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Automation - Your Tools to Papermaking Profitability

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Introduction

Pulp and paper industry is a capital intensive industry where a small saving in process inputs or an increase in operating efficiencies will leverage into a considerable positive cash flow to the bottom line. The realized profitability and higher product quality achieved by automation have increased automation level in the pulp and paper industry.

A modern high speed machine cannot be operated without automation. Paper machine automation consists of different applications. Automation level requested by the papermaker can be built using application packages with different options, Fig 1. Figure 2 presents an overview of the modern paper machine automation.

In conventional paper quality measurement systems there is a separate signal processing unit to convert an analog signal from sensors to digital form. In re-engineered paper quality measurement system - PaperIQ - this separate unit is eliminated and all signal processing takes place inside each sensor head. This is done to simplify the service considerably and to increase the reliability.

Kajaani PaperLab is an off-line paper testing laboratory serving the quality control of a paper mill by providing standardized, accurate, repeatable and traceable off-line quality measurements. Information applications are designed to present the existing data in a proper form to the operator so that he can make the decision as fast as possible.

Sensodec runnability monitoring systems have improved paper machine efficiency and reduced quality variations. Runnability monitoring system provides a powerful diagnostic tool to the paper maker. As machine speeds increase, these tools will become even more important for maintaining and improving efficiencies.

Technology push is strong in the process automation and numerous developments will be utilized on paper production in the near future.

Reliability in paper quality measurements

For many years, system designers have tried to integrate on-line gauging systems and distributed control systems (DCS) into a so-called "single window" concept. In many cases, systems of different vintages and design architectures have been linked by data transfer and the use of

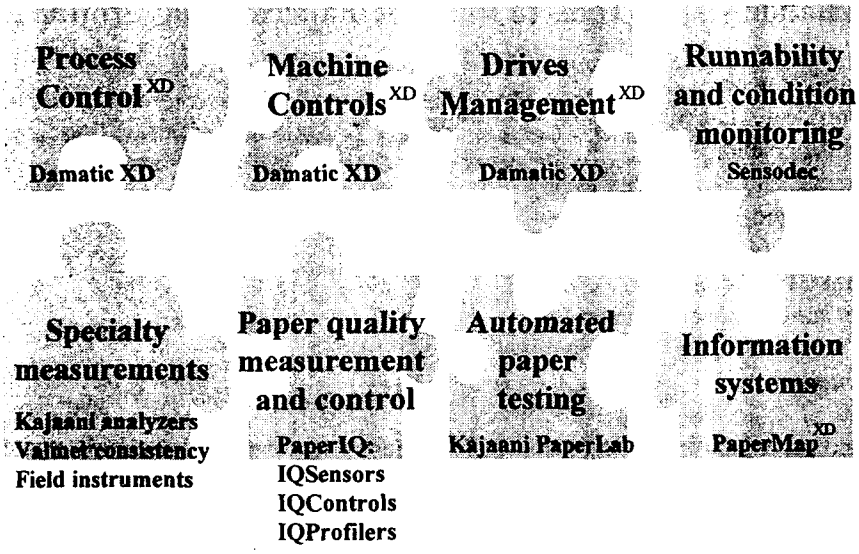

Fig. 1. Paper machine automation structure

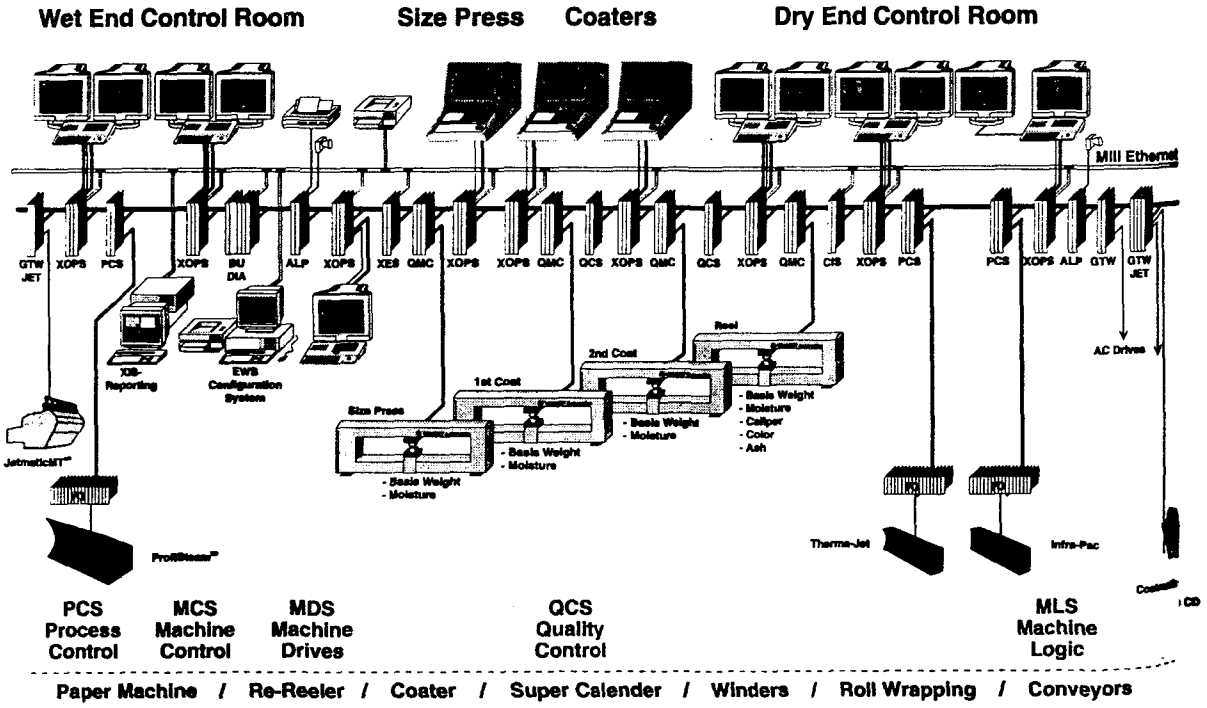

Fig. 2. Overview of paper machine automation.

graphical user interface standards like X-windows. While it is important for the user to work with uniform interface, there are many factors that contribute to the success of the integrated control system - factors such as on-line performance, reliability, ease of service, sensor performance diagnosis, interchangeable hardware and common engineering tools.

To advance beyond the single window concept and to transcend the linking of gauging and DCS systems, a concept of Distributed Measurement System (DMS) has been adopted for the paper quality measurement. In conventional paper quality measurement systems there is a separate signal processing unit to convert analog signal from sensors to digital form. In DMS this separate unit is eliminated and all signal processing takes place inside each sensor head like presented in Figure 3. By adding digital power directly into the sensor head and by creating a modular design structure, the paper quality measurements have been fully integrated into the DCS structure.

Modular sensor modules are normalized in manufacturing. This normalizing procedure ensures that every sensor is similar when they come from manufacturing and makes it possible to change the individual sensor head without lobsing its mill calibration. When sensor head is changed, system makes automatically downloading of mill specific parameters from the system.

For above mentioned reasons one can really talk about Distributed Measurement System (DMS). In addition the following features equal with DCS:
-Implement microprocessor technology right in the sensor head thus producing a pure signal at the source
-Quality Measurement Station (QMS) is same as Process Station (PCS)
-Scanner and sensor heads equal to I/O cards
-Bus communication in IQBus is similar to that of the field bus
-PaperIQ uses standard DCS software tools
-Every sensor is similar having one air (4bar), one power (28 VDC), one water (40 C, closed circulation) and one communication interface connection, Figure 4.
-Scanner is essentially another intelligent module with advanced diagnostics
-All sensors are modular in size. They have exactly the same mechanical dimensions

Service is based on changing modules to minimize the down-time. No mechanical alignment or software manipulation is needed even if a sensor head module is changed. Changing the module is easy like shown in Figure 5.

In addition to make the service easier PaperIQ contains several maintenance displays to help troubleshooting. Every piece of information from sensors and system is available in these specially designed displays to open the conventional "black box" approach of paper quality measurements.

Automated paper quality laboratory testing improves quality

Process data is continuously measured with on-line paper quality sensors. However, all basic properties of paper cannot be measured with on-line scanning systems. Kajaani PaperLab is an off-line paper testing laboratory serving the quality control of a paper mill by providing standardized, accurate, repeatable and traceable off-line quality measurements. Mills already

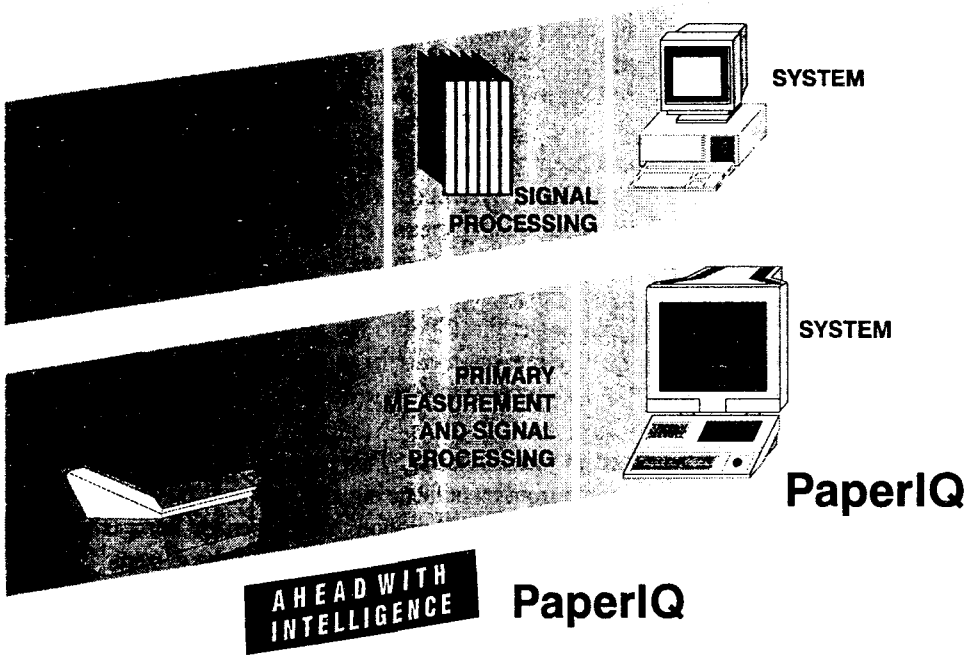

Fig. 3. DMS consolidates sensor signal processing and puts intelligence in the sensor head

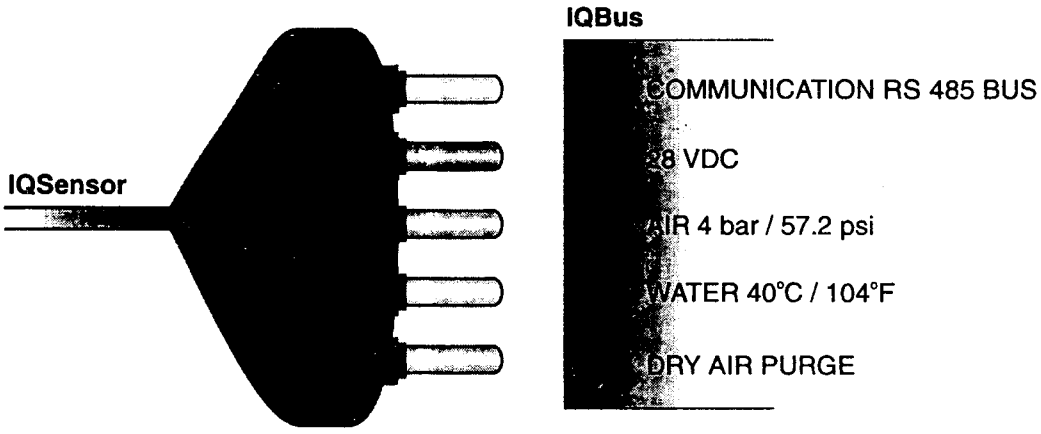

Fig. 4. All different sensors have the same connections.

utilizing the power of automated paper testing are realizing lower manpower cost per test, rapid information flow to operating personnel and accurate, believable test results.

Kajaani PaperLab is a fully automated paper testing unit, Figure 5. In one compact console, individual test modules can replace up to sixteen manual test instruments and provide information on up to eighty paper properties. The units measure for example following properties: Mullen type burst, Tear strength, Tensile strength and elongation, Smoothness Bendtsen, Smoothness Parker print surf, Smoothness Sheffield, Porosity Bendtsen, Porosity Gurley, Porosity Sheffield, Brightness/opacity/color diffuse, Brightness/opacity/color directional, Brightness/opacity, Gloss hunter, Caliper, Basis weight, and Fiber orientation Lippke. Measuring methods of modules adhere to international standards (such as ISO, Tappi, Scan, DIN, AFFNOR etc).

The modular construction allows the PaperLab capability to be custom tailored to an individual paper mill's needs. The console provides a controlled environment for the individual tests and is available with a manual or automatic sample feeding system.

Because of the automatic nature of the measurements, tests are performed exactly the same way every time with far better repeatability than can be obtained manually. The frequency and sequence of measurements can be programmed for individual grades or special reports and are recalled during testing. Thus one unit can handle several paper machines with differing testing requirements. PaperLab is fast and easy to operate, paper testing experience or specialized training is not required. Operators have the capability of a fully staffed laboratory twenty-four hours a day.

Operator confidence increases tremendously when quality results show immediately whether the product is on target or not. In many mills the testing is done on the machine floor by production personnel, providing instant feedback for fine tuning the process.

Information from testing unit can automatically be connected to mill information system thus enabling to have information automatically to production.

Shipping decisions are much easier when based on reliable data. Comparisons with previous runs can be made with confidence. PaperLab provides the information to help solve quality related problems effectively. Cross directional profiles from each roll can be compared and potential problems recognized before shipping. Quality assurance becomes a reality and test information in a concise and consistent form can be supplied to the end user as proof of the mill's commitment to quality.

The advantages of automated paper testing are: More tests can be done with greater frequency by reducing the labor intensive methods presently in use; Because the measurement and sample handling is totally automated, the results are more consistent than with manual or semi-automated testing equipment.; PaperLab results sent directly to a millwide computer system provide results within minutes of the reel leaving the machine. More timely process actions can be taken, from the stock preparation department to off-machine coating; The result is more salable paper and improved production efficiency.

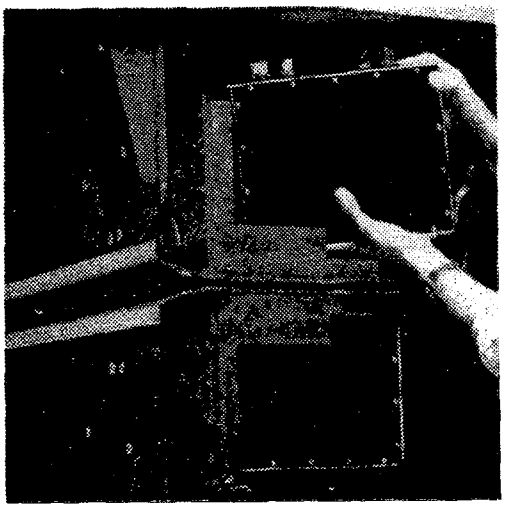

Fig. 5. Sensor modules can be changed easily

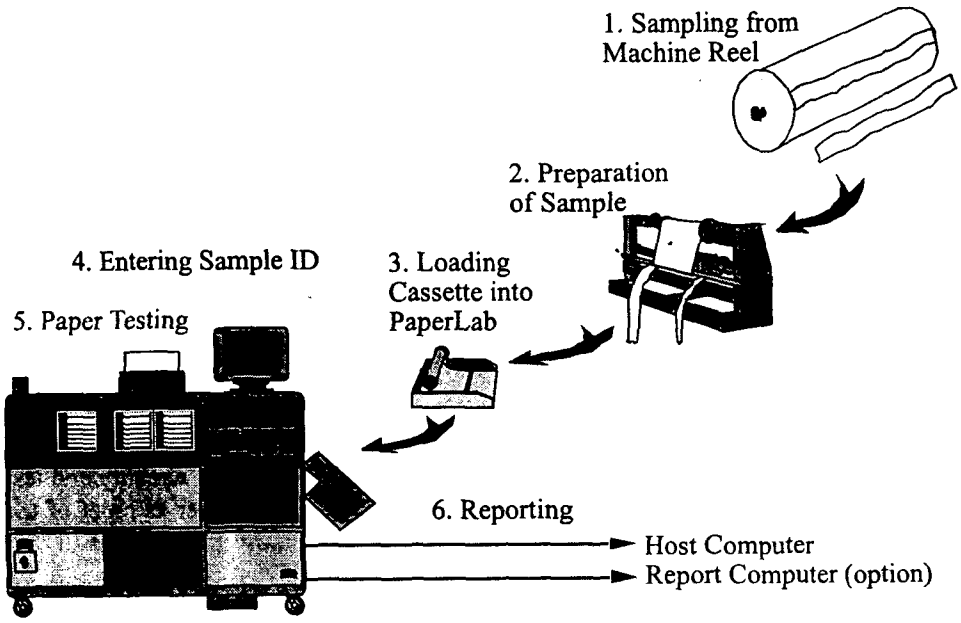

Fig. 6. Automated paper testing unit

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Maximize efficiency through runnability and condition monitoring

The purpose of runnability and condition monitoring is to find out the level and reasons for disturbances in production process and the mechanical condition of the machine and its components. Unplanned machine shutdowns can be thus avoided and wearing or failing components can then be changed during planned shutdowns. Paper quality MD unevenness can be analyzed and it is possible to make well planned actions to minimize these variations.

Runnability system uses high frequency signal sampling and signal analysis techniques to monitor the behavior of the process and machine. The condition of the machine components (bearings, gears, shafts, couplings, rolls, etc.) is monitored mainly using vibration measurement techniques. Temperature measurement can also be used if it indicates the condition of components. Oil flow in the circulating oil lubrication is monitored to make sure that all components get the specified amount of oil.

The short term mechanical disturbances which exist on all paper machines often go undetected until they result in a mechanical failure or a serious paper quality defect. Figure 7 presents potential contributors to tissue quality variations. These variations have often resulted in large amounts of unscheduled downtime and lost production. Process disturbances which may be related to mechanical components or machine operation may result in sheet quality problems causing poor converting or even to customer rejection. Sources of both process and mechanical disturbances can be identified by an on-line runnability system. Figure 8 presents a typical tissue machine on-line runnability monitoring concept which is based on fast measurements and signal analysis.

Runnability system make it possible to raise the paper machine efficiency. As an example Yankee dryer case on a tissue machine is presented.

The Yankee section of a tissue machine is extremely important to final sheet quality and has a significant effect on sheet uniformity. Normally, vibration sensors will be placed on the Yankee bearings and on both sides of the crepe blade holder. There is much to be learned from crepe blade vibration analysis.

Yankee crepe blade vibration behaviour seems to reflect many elements of the tissue machine especially the Yankee drying/creping process. Some of these are Yankee coating, surface condition, blade loading, blade angle, and MD variation.

A periodic weight variation caused by a pump or screen will create a variation in the creping force causing a blade to vibrate at the disturbing frequencies. Vibration of a pressure roll will cause variation in sheet adherence and blade vibration at that frequency. Certainly any variation in coating or Yankee surface will cause a crepe blade to vibrate. A marked increase in blade vibration is often a good indication of loss of coating. Incorrect blade loading, angle or material will generally result in much higher blade vibration levels. The crepe blade resembles a phonograph needle riding over a record surface. A surface defect creates a response like a record scratch with a single, sharp impulse.

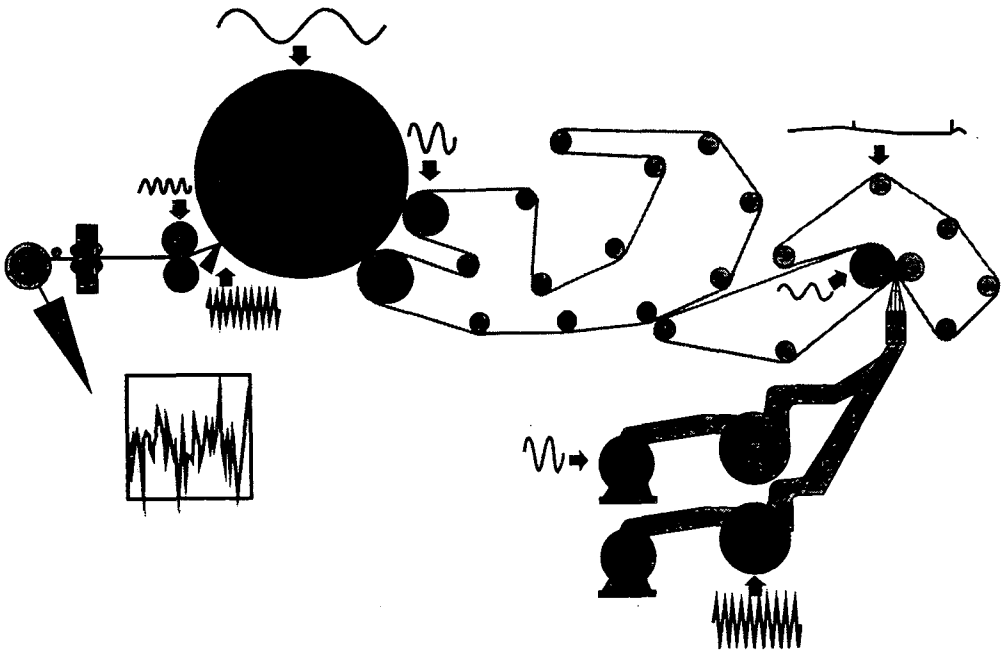

Fig. 7. Potential contributors to tissue quality variations.

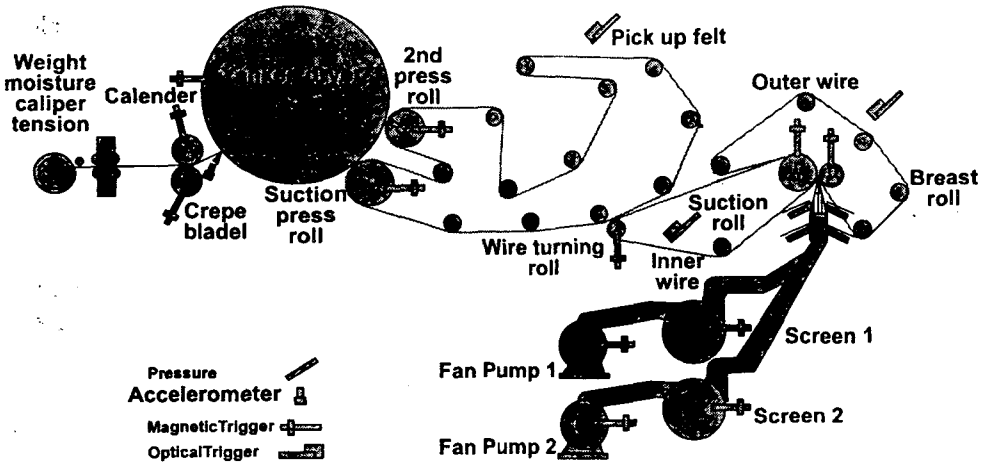

Fig. 8. Typical tissue machine on-line runnability monitoring concept

A crepe blade will respond to distortion of the Yankee cylinder as irregularities rotate past the blade position. Six cycles are clearly seen in one rotation of the Yankee cylinder, corresponding to the thermal and mass concentrations created by the condensate headers,

Figure 9. A corresponding weight and moisture variation are also created in the sheet as presented in Figure 10.

Excessive, inadequate or variable Yankee dryer coatings can cause sheet handling problems, excessive blade wear, dust, blade chatter and high vibrations. A good indication of coating condition is the vibration level of the Yankee crepe blade. When excessive levels of coating occur, the blade will tend to bite into the coating layer, causing high vibration levels and ultimately resulting in variable coating coverage. When inadequate levels of coating occur, the lubricating action of the coating is lost resulting in blade chatter and high levels of vibration. Both types of conditions are indicated to operators by crepe blade vibration alarms.

By experimenting with the coating application, an optimum addition can be found reducing or eliminating the associated problems and providing proper coating protection. The vibration alarms can be set at corresponding levels and provide a warning when the optimum conditions are not being met.

Runnability system is an effective tool to raise the paper machine efficiency. One customer for example has reported a payback time of six months to a runnability and condition monitoring system.

Trends in pulp and paper automation

The trends in the pulp and paper automation development are due to the technology push and market pull effects as presented in Fig. 11.

The strongest contributor in the market pull side is definitely environmental awareness. Environmental awareness has brought and will further bring changes that ultimately affect pulp and paper production. These changes affecting automation are for example recycling, environmental regulations and bleaching process modifications.

Rapid development of the computer technology is the strongest contributor in the market push side. It has made it possible for automation designers to concentrate on supporting the operator instead of solving purely technical problems. In the early days such issues as availability of processing power and memory, communication and connections to other systems were major problems to the designer. Now enormous processing power, various standards and integration of the systems have produced more flexible systems. Through the integration of basic automation systems it is possible to concentrate to optimise process and to support the operator's job with task-oriented applications.

What should be understood is that technology is not to be used just because of technology. There always needs to be a market demand and justification to use technology as a tool to implement applications that provide the return on investment required by normal business practise.

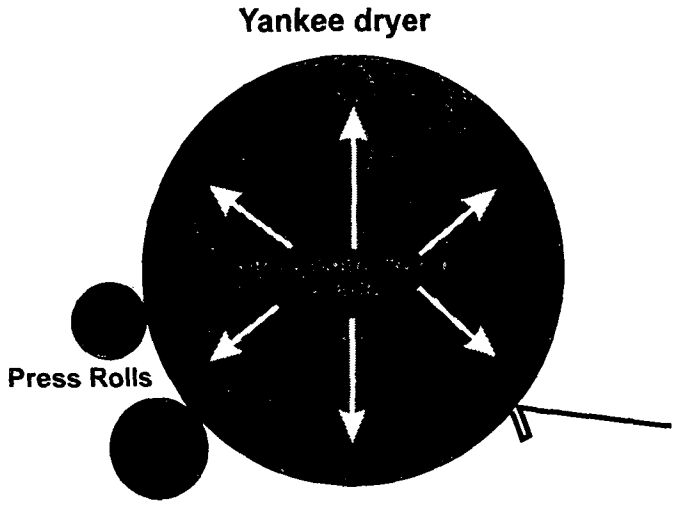

Fig. 9. Yankee dryer construction with six condensate removal headers.

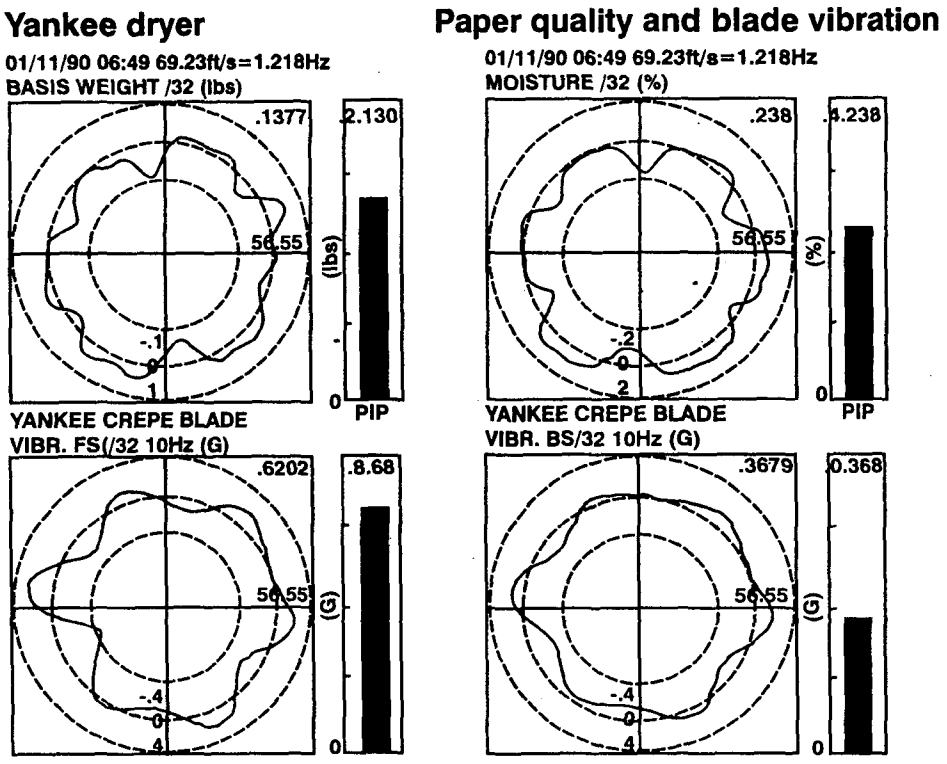

Fig. 10. Corresponding weight and moisture variation created by removal headers.

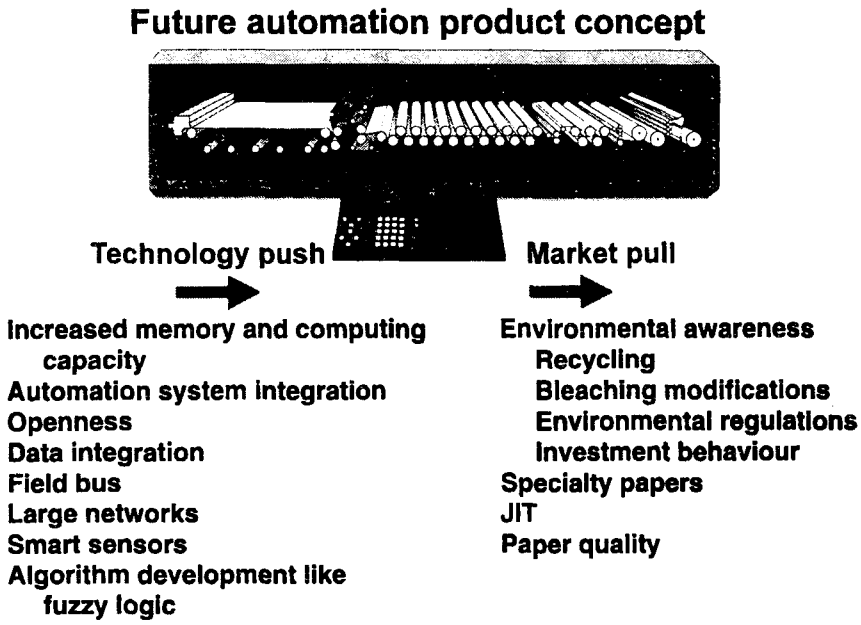

Fig. 11. Trends in the pulp and paper automation.

Conclusions

Distributed Measurement System concept for paper quality measurement system provides reliability and ease of service.

Mills already utilizing the power of automated paper testing are realizing lower manpower cost per test, rapid information flow to operating personnel, and accurate, believable test results.

Runnability monitoring systems have improved paper machine efficiency and reduced quality variations on many paper machines. As machine speeds increase, these tools will become even more important for maintaining and improving efficiencies.

Technology push is strong in the process automation and numerous developments will be utilised on pulp and paper production to achieve high machine speeds and efficiencies.