NUCLEONIC CONTROL SYSTEM (N.C.S.) IN PAPER INDUSTRIES

M. Quamruzzaman *

ABSTRACT

The N.C.S.is unique in modern control technology. Its future is very good because of many advantages it has over the other conventional system. Another advantage of N.C.S. is that it can be installed with any conventional machine by introducing an interface microprocessor in between.

The system is expensive no doubt but it's economic return is so fast that within a year it becomes a profitable concern by minimizing the losses and increase the production.

The system will be verv much helpful to increase and improve the quality of our industrial product, so it is wiser to introduce the system in Bangladesh as soon as possible.

Introduction

The Nucleonic Control System (N.C.S.) is the latest achievement in the field of industrial control system. The system was invented and developed in the U.S.A. during the period of 1954-56 and later in Canada and Western Europe. Japan was the first Asian country to introduce the system in 1966 and since then it was developed so much that they are now the only competitor with the U.S..A. companies. Other countries in the south east Asia region like South Korea, Taiwan, Phillipines, India and Thailand have also started to introduce the system.

* *Senior Engineer. Bangladesh Atomic Energy Commission.*

The system is quite new and unknown in Bangladesh. The UNDP/RCA held a training/demonstration workshop in Japan/Thailand for the first time in history in 1982 and since then the system is being rapidly introduced into other countries. The system can be introduced in various industries but this article will deal with application of the system specifically in paper industries.

Pulp and paper industries around the world manufacture two main paper products, i.e. industrial paper and cultural paper. Each of the products has been categorized into many grades of quality according to market requirements and limitation of each mill also varies from one to another. However, regardless of various processes and end products of each mill, the most important parameter in production is the control of basis weight. Since basis weight is the most frequently measured parameter in production, it is also used as the predetermined parameter to establish a standard of the required paper products (1, 2, 3,).

Therefore, to accurately measure and control the basis weight in a production line is a prime concern of paper manufacture. Hence, methodology and gauging system for basis weight measurement control have been constantly developed for higher accuracy and productivity.

In the past, there was no satisfactory method for determining the basis weight accurately. Therefore, the quality of paper products was either poor or the cost of good quality paper was high. With many years of research and development, the gauging and control system have been developed to the point where accurate measurement and control of basis weight can be satisfactorily obtained in pulp and paper industries. The sensor system has been greatly improved, and the control system has more sophisticated capability, enabling both qualitative of pulp and paper production to be improved. Such marked improvement of the system has been achieved through the incorporation of nucleonic sensing technology. The system has now been successfully utilised in various industries in improving productivity and quality of their products. Due to the high cost and technolcgy of both sensing and controlling units, the use of such system in pulp and paper productoin in developing countries has been highly discussed in terms of economical and technological benefits. However, it has been recently proved that the nucleonic control and instrumentation system can be successfully utilized in medium size paper industries (100 to 200 tons per day) in developing countries.

COMPONENTS OF NUCLEONIC CONTROL SYSTEM FOR PAPER MANUFACTURE

Various kinds of sensors as given below are used in paper mills to measure the quality of the paper.

1. Basis weight : Penetration and absorption of beta particles.

2. Moisture : Penetration and absorption of intrared rays or use of microprocessors based system.

3. Ash : Penetration and selected absorption of X-rays.

4. Caliper : Air pressure and electromagnetic induction.

Nucleonic Control System measures and controls basis weight and moisture in paper. B/M sensor scanner is installed between the calender and the reel. The scanner has two sensors, basis weight sensor (B sensor) and moisture sensor (M sensor). The sensors output are transmitted to a computer for processing. Computer then transmits control signals to adjust stock and steam to required amounts in such a way that the basis weight and moisture of the paper are maintained within target limits. Information of the system can also be monitored through video display on CRT, or printed output for hard copy records on system printer.

The system printer record can also be used for computerized programme maintenance.

The 1180 Micro System manufactured by AQUARAY CORPORATION OF U.S.A. is one of the best N.C.S. system. This system includes basic functions of the system as mentioned above with additional advance controls such as Basis weight and Moisture. Automatic Target Management Controls, Speed Optimization Control and Automatic Grade Change Control. (4, 5,)

The system consists of the following main components :

—Basic weight Sensor

—Moisture Sensor

—O-Frame Scanner

—Minicomputer and storage (diskette)

—Programmable Microcomputer Module (PMM)

—Operator Stations (2)

—System Printer

—Video Displays

—Necessary Interfating instruments

Nucleonic Control System can perform various functions as follows.

1. Digital Weight and Moisture Control
2. Dry Stock Flow Control
3. Co-ordinated Dryer Shutdown/Start Up Control
4. Automatic Target Management (ATM)
5. Digital Headbox Control
6. Speed Optimization Control
7. Co-ordinated Speed change
8. Automatic Grade Change Control

In addition, N.C.S., also can perform the following functions.

1. Refiner Control
2. Stock and Additive Blend Control
3. Cross-Machine Control

THE ECONOMIC BENEFITS OF PAPER MACHINE CONTROL.

Few years ago it was assumed that sophisticated computer control of paper machines could only be justified on very large machines. In recent years, however, the steadily increasing costs of raw material and energy together with a vast improvement in the technology, control systems have made feasible, if not essential, the application of paper machine control systems on virtually all paper machines.

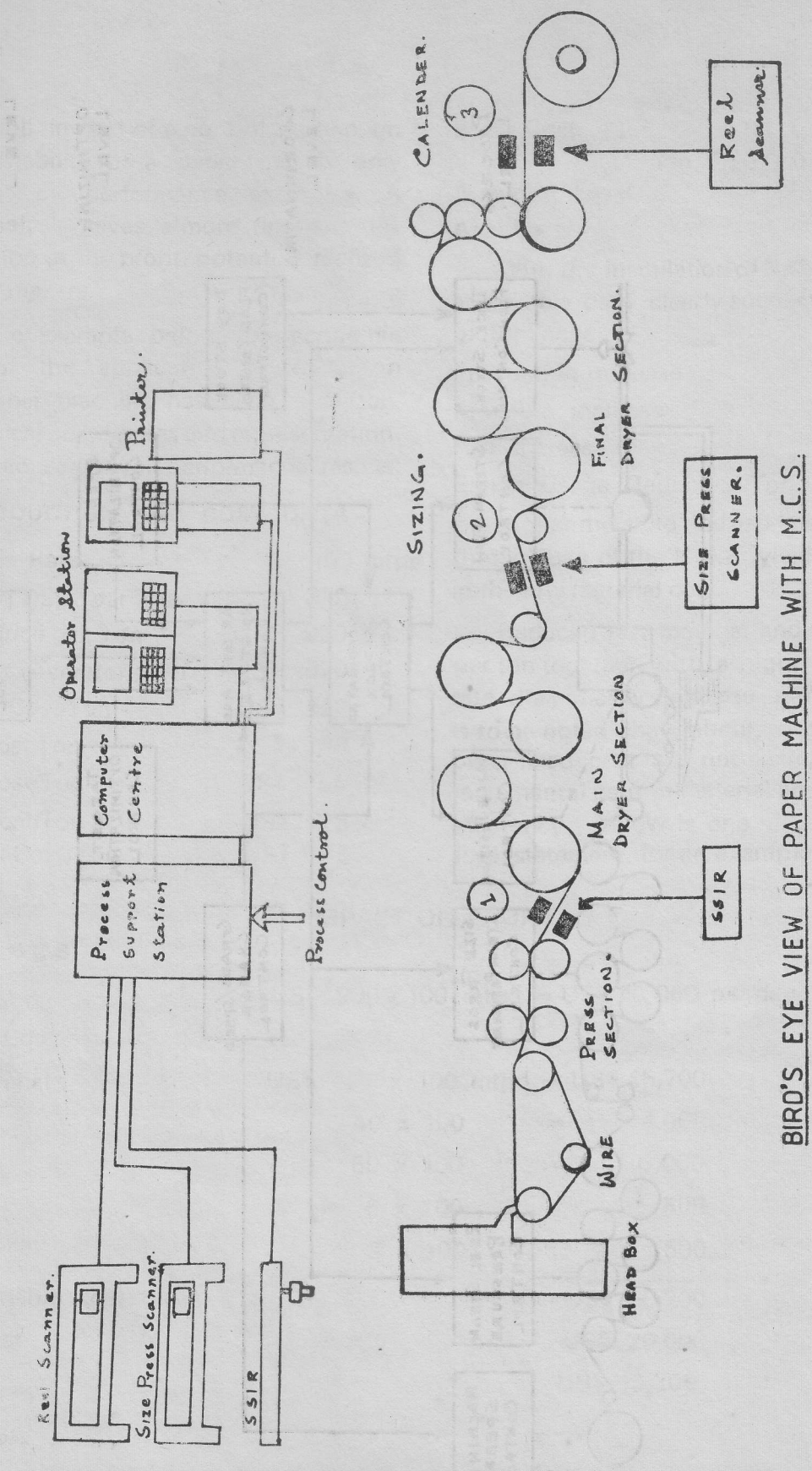
Long-term performance, and the resulting return on investment, are the central consideration in installing a control system. A System that provides accurate measurement and sophisticated control as well as high reliability and easy maintenance can pay for itself in less than one year. In fact, as the following analysis shows, the installation of such a system can be the single most profitable investment the papermaker can make. Question may be asked as to what level of performance is typical. If performance data for the paper industry is analyzed, the following results are found to be typical :

(The following data is a result of 10,000 systems installed in different countries in last 30 years) (6, 7, 8,)

Improved Product Uniformity	30 to 70 %
Increased Machine Speed	3 to 15 %
Reduced Additives	4 to 5 %
Reduced Time Losses	20 to 60 %
Improved Energy Efficiency	3 to 10 %
Reduced Product Losses	10 to 40 %

Specific examples, shown on the table below, demonstrate that performance is not limited by the grade type or the machine size on which the N.C.S. was installed.

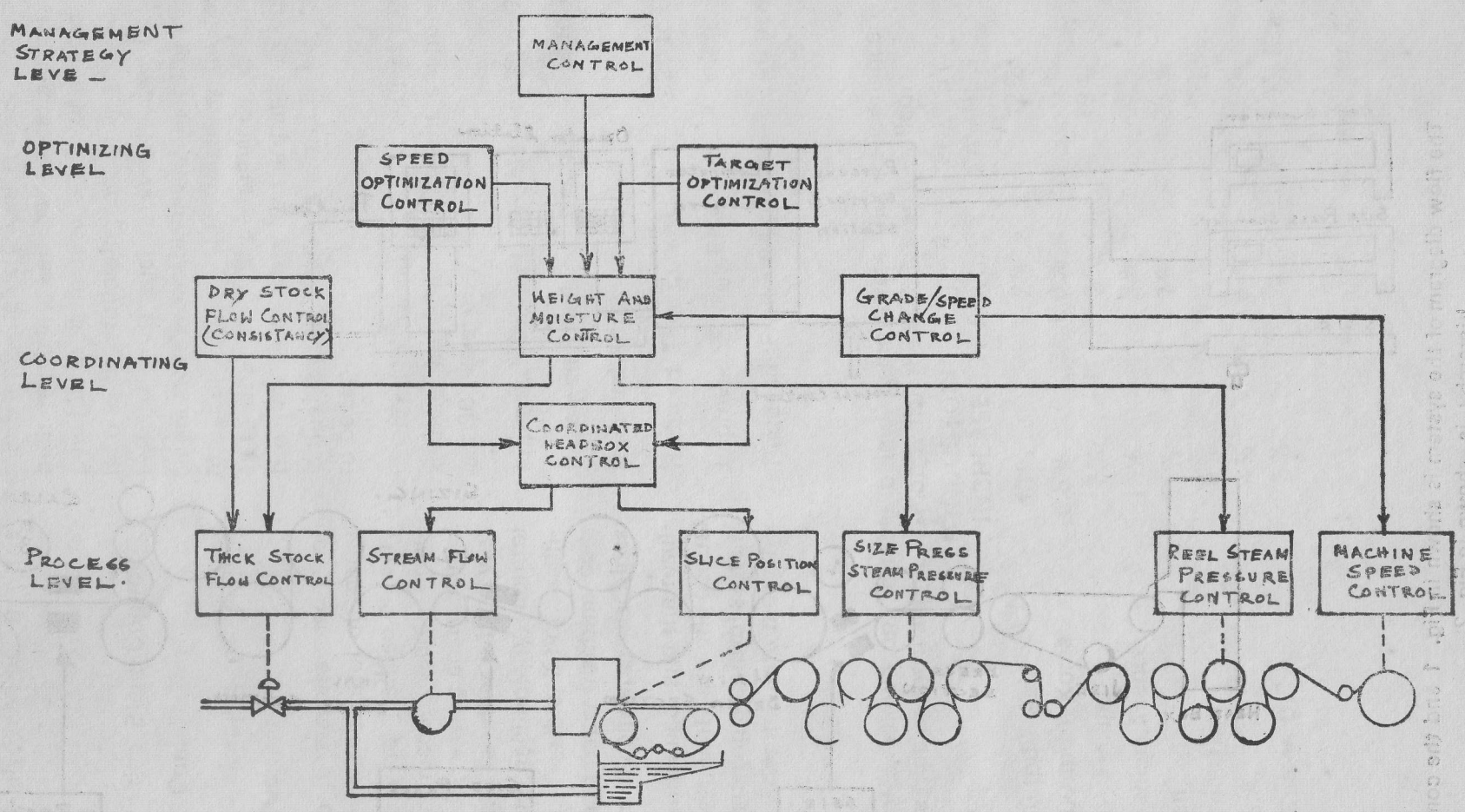
	PRODUCTOIN INCREASE	FIBER SAVINGS	ENERGY SAVINGS
Fine Paper (30 tpd), Asia	13 %	2 %	12 %
Fine Paper (100 tpd), Korea	5.5 %	5.9 %	4 %
Kraft Speciality, Finland	7 %	2 %	18 %
Corrugating Medium, France	17 %	3 %	6 %
Tissue, Sweden	11 %	7 %	1-23 %
Newsprint, Switzerland	5 %	1.3 %	5 %
Noxboard, U.S.A.	4 %	1.6 %	10 %
Off-machine Coater, U.S.A.	5 %	—	50 % (Gas)



BIRD'S EYE VIEW OF PAPER MACHINE WITH M.C.S.

Fig. 1

The flow diagram of the system is shown in Fig. 1 and the control hiererchy is shown in Fig. 2



Control Hierarchy

Fig. 2

The full impact of a control system on the profitability of a paper mill is only suggested by performance examples. A profit analysis gives a more dramatic demonstration of the profit potential realized by paper makers.

In the example below, the economic impact of the application of N.C.S. on a fine paper machine has been analyzed, using typical cost figures and representation. though conservative, performance results.

PRODUCTION AND COST DATA

Prodution Rate		100 mtpd
Operating Days per Year		350
Selling Price per Ton	US$	900
Pulp Cost (Averate) per Ton	US$	570
Clay/Talc Cost/Ton	US$	120
Steam Cost/Ton	US$	40
Power Cost/Ton	US$	60
Water Cost/Ton	US$	5
Chemical Cost/Ton	US$	5
Fixed Cost	US$	200 per ten, $ 20,000 per day
Moisture Level		4%
Ash Level		20%

With the installation of N.C.S. following achievable data clearly suggests improved performance.

Production Increase	5%
Moisture Increase	2%
Ash Increase	3%
Steam Usage Reduction/Ton	5%

Higher moisture and ash levels achieved through use of the N.C.S. yield a reduction in the raw material cost.

Reduced raw material and energy costs per ton together with a higher production rate dramatically increase profitability. It is to be noted that labour, overhead, and other fixed cost are not increased by this incremental gain in material and productive efficiency. Below is one days profit and loss statement for an example paper mill.

IMPACT ON PROFIT

Without N.C.S.

Revenue	US$ 900 x 100 mtpd =	US$ 90,000 per day
Variable Costs		
Raw Material	US$ 457 x 100 mtpd =	US$ 45,700
Steam	40 x 100 " =	4,000
Power	60 x 100 " =	6,000
Water	5 x 100 "	500
Chemical	5 x 100 "	500
Total variable cost		US$ 56,700
Fixed cost		US$ 20,000
Profit		US$ 13,300

With N.C.S.

Revenue	US$ 900 mtpd = US$ 94,500 per day	
Variable Costs		
Raw Material	US$ 432 x 105 mtpd =	US$ 45,360
Steam	38 x 105 " =	3,990
Power	60 x 105 " =	US$ 6,300
Water	5 x 105 "	525
Chemical	5 x 105 "	525
Total variable cost		US$ 56,700
Fixed cost		US$ 20,000
Profit		US$ 17,800 per day
Profit Increase = US$ 4,500 per day		34 % Increase
Profit increase over a year or Annual saving is this		US$ 1,575,000/-

To conclude the analysis, let us assume an N.C S. system Cost of US$ 700,000 with yearly system finance charges of US$ 150,000 over five years and a corporate tax rate of 33 %. The average after tax profit attributed to the N.C.S. system would be approximately US$ 1,00,000, over a five year period a net return of 5 million.

Conclusions

The N.C.S. is unique in modern control technology. Its future is very prospective because of many advantages it has over the other conventional systems, Another advantage of N.C.S. is that it can be installed with any conventional machine by introducing an interface microprocessor in between.

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References

References have been taken from 40 (Fourty) different papers presented by different authors in the first UNDP/IAEA/ RCA Training/Demonstration Worshop on Nucleonic Control System in Paper Industries held in Tokyo/Bangkok from February 8-26, 1982.

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