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INDIA

Technical report: First mission*

Prepared for the Government of India

by the United Nations Industrial Development Organization,

acting as executing agency for the United Nations Development Programme

Based on the work of Archie G. Campbell
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* This document has not been edited.

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1.0 Summary

This report is an accoun of the findings with recommendations from an investigation, over the period 2 February - 22 March 1990, of equipment developed by the Indian Jute Industries Research Association(IJIRA) for on-line monitoring and control in the jute mill. The investigation largely focused upon matters related to the longterm reliability of the auto-leveller interfaced with the Finisher Card in the manufacture of jute yarn.

The auto-leveller has the potential to improve overall productivity by approximately 10% per unit installed but its long term reliability is not secure unless modifications are made and implemented to the design, and procedures for acquisition and analysis of reliability data, installation, maintenance, operation, fault location and repair and training are documented and made readily available in a suitable format to appropriate staff.

Underpinning the auto-leveller implementation, consultancy and modification requirements is the dependence of the mill management upon the availabability, and the scientific and technical expertise of IJIRA staff. In the opinion of the author of this report the present needs of the industry for consultancy can hardly be met far less the larger needs of the implementation, modification and on-line development programmes. To obtain the necessary resource base and carry out this work may well require the possible restructuring of IJIRA administrative units to achieve the long term industrial aims and objectives of IJIRA.

2.0 Introduction

In Phase I of this mission I concentrated almost exclusively upon specific aspects of on-line monitoring and control developments initiated by the Indian Jute Industries Research Association (IJIRA). The Director of the Association and National Project Director of UNDP(IJIRA), Dr S.R. Ranganathan was particularly concerned that I mainly concentrate my attention on aspects related to securing the long term reliability of the auto-leveller. Hence this report and its appendices is primarily concerned with matters related to the long term reliability of the auto-leveller in the environment of the jute mill.

3.0 General comments

Eight auto-levellers to date have been installed by IJIRA staff with UNDP support in six jute mills and additionally privately owned mills have installed another 54. Another nine mills have requested IJIRA to assist with the initial installations for an eventual total exceeding 140 auto-levellers. Each auto-leveller installed at the Finisher Card, produces a tighter tolerance on the sliver count, less down time, sliver CV% reduced from 6-8% to 1.5-2.5%, decrease in end breaks at the spinning stage by some 30% and some 4% improvement in the production of the woven fabric.

Additionally the double production unit presently undergoing mill trials employ two auto-levellers on a split Finisher Card.

At IJIRA I was given every assistance to interview staff and visit the mills. I had many discussions with Mr R.K. Mukherjee, Project Leader for On-line development with 25 years mill experience who is largely responsible for the design and development of the sliver grist monitor and auto-leveller and holds two patents for these inventions; I also had several discussions with Mr S. Palit, Head of Mechanical Production Division also involved with design and implementation of the auto-leveller; with Mr U. Banerjee, assistant to Mr Mukherjee and with technical staff at IJIRA responsible for assembly and installation in the mills. I visited five jute mills: New Central and Kardha Jute Mills where one auto-leveller has recently been installed in each mill; Hastings (23 auto-levellers installed) and J.K. Jute Mills in Kanpur where two are installed but have components purchased for seven others; Ludlow Jute Mill where I had opportunity to conduct an experiment on the speed adjustment of the DC motor against missing jute rolls on the double production unit. At all of these mills I took the opportunity to discuss aspects of reliability with the management and technical staff involved in the day-to-day running of the auto-levellers.

Early on in my mission I became aware that while written data on operational parameters was available there was almost no written data on specific aspects of reliability (viz. functional failure rates etc). Hastings and J.K. Jute Mills had kept records but these were not sufficiently specific. Thus I was largely dependent for information upon discussion with staff and my own observations.

4.0 Findings

I wish to preface my remarks on the reliability of the auto-leveller with my confidence in its future. It will and presently does make an important contribution to productivity in those mills which have developed the technical and administrative infra-structure to install, maintain, fault find and repair as required.

4.1 Synchronisation

At the Finisher Card, assuming no loss, then the requirement for the infeed volume to equal the delivered volume leads to the following relationship of the input (M_F) and output (M_D) mass per unit length per unit time and the input surface speed (S_F) and output delivered speed (S_D)

$$M_F S_F = M_D S_D$$

With the auto-leveller interfaced to the Finisher Card the input surface speed (S_F) is controlled by the speed of the DC motor which is itself determined by the magnitude of the signal from the sensor of the thickness of the output delivered sliver and also upon the nature and magnitude of the frictional torque present in the feed bearings. The delivered surface speed (S_D) is determined by the speed of the AC mains driven motor hence is subject to fluctuations in the magnitude of the mains voltage and frequency. As the drive from the AC motor is belt driven then again the surface speed (S_D) is affected by the tensioning in this belt drive. To a lesser extent the S_D is affected by frictional torque in the finisher card bearings unless there is slackness in the belt drive.

As $M_D = M_F \frac{S_F}{S_D}$ then it is important that for a change where $\Delta M_F = 0$ that the ratio $\frac{S_F}{S_D}$ remain constant. With the present design this ratio is held constant at start-up and shut-down with the aid of a tacho-generator coupled to the AC drive, but there is no synchronisation outside of these periods. Operating experience has demonstrated that the ratio, S_F/S_D, for $\Delta M_F = 0$ varies sufficiently to cause unacceptable irregularity in the medium to long term count arising from changes to both S_F and S_D due to excessive friction in the feed bearings, slackness in the belt drive, mains fluctuations etc. Hence I recommend that synchronisation of the DC and AC drive systems be implemented when the ratio (S_F/S_D) goes beyond pre-set values for $\Delta M_F = 0$. The circuits given in appendix 1 are put forward for consideration as a solution of this problem.

4.2 Necessity for Prior Overhaul of Finisher Card

I would also recommend that prior to the installation of the auto-leveller there is an overhaul of the Finisher Card. To assist with this overhaul a manual should be prepared which clearly sets out the changes which should be made so as to ensure minimum frictional torque at the feed and delivery, (generally requires replacement of bush with roller bearings), replacement of flat belt drive with V-belt drive arrangement to ensure continuing belt tension and minimum belt oscillation, rigidity of the sliver conductor etc. I have observed in one mill where frictional torque was excessive leading to increased down time caused by jamming, excessive swings with feed speed leading to unacceptable irregularity in the count of the output sliver.

4.3 Effects of Vibration

It can be shown that the change in infeed surface speed is directly proportional to the change in the delivered count ΔMd. Such that

$$\Delta S_F = -K \times \Delta M_d.$$

Where the sensitivity K is the product of the sensitivity of the several functional elements of the auto-leveller. Thus ΔS_F is dependent upon the long term stability of these sensitivities.

$K = K_1 \; K_2 \; K_3 \; K_4$ where $K_1 = \dfrac{\text{change in sensor plunger displacement}}{\text{change in delivered mass/unit length}}$

$$K_2 = \frac{\text{change in sensor output voltage}}{\text{change in plunger displacement}}$$

$$K_3 = \frac{\text{change in DC motor applied voltage}}{\text{change in sensor output voltage}}$$

$$K_4 = \frac{\text{change in infeed surface speed}}{\text{change in DC applied voltage}}$$

Each of these sensitivities are subject to the effect of vibration. All are preset to obtain a given grist value. However sensitivity K_1 and K_2 are particularly sensitive to the effects of vibration. The Linear Variable Differential Transformer [LVDT] sensor plunger is displaced by a disc which is itself displaced by the radial displacement of the delivery pressing roller. Thus it is critically important that the mechanical coupling of the LVDT structure to the finisher card frame remains sound and that the maintenance is such as to ensure that dust and dirt are not allowed to accumulate in the sliding channels, that the wear on the disc is not allowed to interfere with the plunger displacement etc.

Sensitivity K_1 and K_2 may also be affected by the loosening of the mechanical coupling within the LVDT and the rusting of the surface of the LVDT plunger leading to jerking and irregular movement of the plunger.

Sensitivities K_2 and K_3 are set through potentiometes and these are subject to the effects of vibration and ingress of dust, fluff etc. which degrades operation over a period of time.

Sensitivity K_4 as already discussed is affected by frictional torque at the feed bearings. The increased load on the DC motor results in an increase in the armature and field currents which may cause thermal cut-out and or degrading of the field winding insulation and increased loading on the output components of the DC motor speed control. I would recommend that the DC motor be replaced by a drive circuit and motor which would be less prone to the effects of vibration and ingress of dust, fluff and be maintenance free.

An important feature of the versatility of the auto-leveller is that it may be interfaced with 90% of the Finisher Cards operating in the jute mills. However a significant proportion of these cards are upwards of 30 years old and suffering from the ailments of old age - eccentric motion, severe vibration, non-uniform drive etc. I have observed that not sufficient regard has been given in the design of the auto-leveller functional parts to the effects of vibration and recommend action is taken to remedy this situation and that installation and maintenance manuals be prepared.

4.4 Effects of mill physical environment

In the mills I have visited, dust and fluff extraction is not attempted on the mill floor. Ambient temperatures may reach 40-45°C over several months of the year. Relative humidity range between 60-100%. But the major effect arises from a combination of these physical factors upon the several auto-leveller functions.

All moving parts are subject to unacceptable wear and or blockage unless regularly serviced. Dust and fluff may ingress into: the LVDT, the sliding channels and become trapped in bearings, the commutator and brushes and the tracking surfaces of potentiometers. Where there is a water/oil content in the fluff shorting or partial shorting may result in complete or partial failure of the electrical circuitry. In my opinion the present measures to combat the effects of the physical environment of the mill are unsatisfactory and will result in long term unreliability.

5.0 Recommendations

5.1 Design feature: Synchronisation.
Research and development immediately set in hand to secure synchronisation of the AC drive with that of the DC motor drive under running conditions. (See appendix 1)

5.2 Design feature: DC Motor Replacement
Research and development undertaken to replace the DC motor with eddy current coupling to AC motor or a switched reluctance motor. (See appendix 2)

5.3 Design feature: To minimise effects of vibration.
It is recommended that appropriate action is taken to minimise the effects of vibration on the three main functional elements of the auto-leveller. (See appendix 3)

5.4 Design feature: To minimise effects of physical environment
It is recommended that appropriate action is taken to minimise the effects of the physical environment on the three functional elements. (See appendix 4)

5.5 Operational procedures
It is recommended that the following action is taken.

Agreed format for the acquisition of failure and operational data.

An installation manual prepared to include the nature of the overhaul which should be under-taken by the mill management prior to the installation of the auto-leveller.

A maintenance schedule prepared based on the critical nature of the functional elements exposed to vibration and physical environment

A manual to be prepared to assist both mill and central repair personnel to locate and repair faults

An agreed training programme be prepared for both in house and centralised training of operators. (See appendix 5)

6.0 Recommendations :Equipment

It is recommended that the following equipment be purchased. (see Appendix 2)

6.1	One switched reluctance motor with associated drive circuitry	£2250
	Plus One eddy current coupling drive to standard AC induction motor.	£ 980
6.2	One torque test rig to simulate dynamic torque conditions and equipment to measure resulting surge parameters.	£2200
6.3	A variety of speed sensors for secure attachment to the Finisher Card to measure AC drive speeds. Signal conditioning circuits to interface with the sensors.	£ 500
6.4	1 of $5^{1/2}$ digit multimeter with temperature surface testing probe and associated leads	£ 400
6.5	1 of PCB design and production facility to interface with a 19" chassis racking system to include 1 IBM XT/AT computer Soft ware for PCB design PCB fabrication facility PCB drill and locate facility PCB tinning facility	£5000

7.0 Recommendations: Fellowships

The fellowships undertaken by Mr R.K. Mukherjee and Mr U. Banerjee have been influential in the utilization of modern technological techniques applied in the textile industry.

Immediate need is for a greater informed resource base to achieve the reliability required while pursuing the installation programme already begun. The author is unable to match both the need for technological awareness of what is capable in the industrial environment while at the same time meeting the needs of the installation and reliability programmes with the personnel presently available. But I am in no doubt that appropriate Fellowships in the field of instrumentation technology is necessary. I would recommend that Mr R.K. Mukherjee be given the opportunity to undertake a fellowship at UMIST or Leeds University under general guidance of A.G.

Campbell, so as to work towards a higher degree for work undertaken at IJIRA and supervised from an appropriate university department funded through the UNDP programme and or through the offices of the British Council.

Thus to secure the reliability of the auto-leveller, undertake the necessary development work and carry out the consultancy and installation programmes will require additional staff grouped in an administrative unit whose aims and function are directly linked to on-line control and monitoring in the mill situation. At the time of writing three member of the technical staff employed to assist with the implementation programme have left to secure more permanent employment elsewhere. Those remaining with the present Instrumentation Service Centre are concerned to secure more permanent employment. Such a unit if suitably staffed or absorbed within a larger unit could undertake an enlarged on-line development progamme to bring to fruition some of the proposals suggested by Mr R.K. Mukherjee.(See appendix 7)

Finally, the management of many jute mills recognise the increase in productivity which maybe achieved with the installation of the auto-levellers. (Hastings Jute Mill is a good example). They are pressing IJIRA to assist them with initial installation, consultancy and training programmes. But this relatively rapid build-up of pressure has developed before the administrative structures are in place to secure the long term reliability and mount and maintain the installation consultancy and future development requirements. Thus I am not sanguine as to the long term success of the auto-leveller on a large scale unless administrative structures are in place to secure it. This would be most disappointing as the IJIRA development deserves to be successful.

8.0 Recommendation: On Line Development

I would also recommend that the following programme of research and development be mounted in addition to that outlined.

8.1 Fibre retention in the Finisher Card in several of the mechanical components causes malfunctioning of the card as well as the auto-leveller. Research and development should be undertaken to implement a scheme for the automatic cleaning of fibres from the pins. It is envisaged that electromechanical actuators, would under operator control actuate the positioning of faller-type bars populated with flexible pins to remove embedded fibres. Thus down time would be minimised and smoother operation ensue.

8.2 A constant source of operational problem arises from the fluctuations in the tension between the AC motor drive and the Finisher Card System of rollers. It is recommended that a belt fastner be actuated by electomechanical devices signalled from the AC parts sensor.

9. Future on-line development programme

The memorandum to Mr R.K. Mukherjee in appendix 7 is a summary of eight on line control and monitoring proposals which were proposed by Mr Mukherjee and discussed with Mr Campbell who wrote up the proposals as an aide memoire.

Appendix 1

Synchronisation

The development should have the following specification

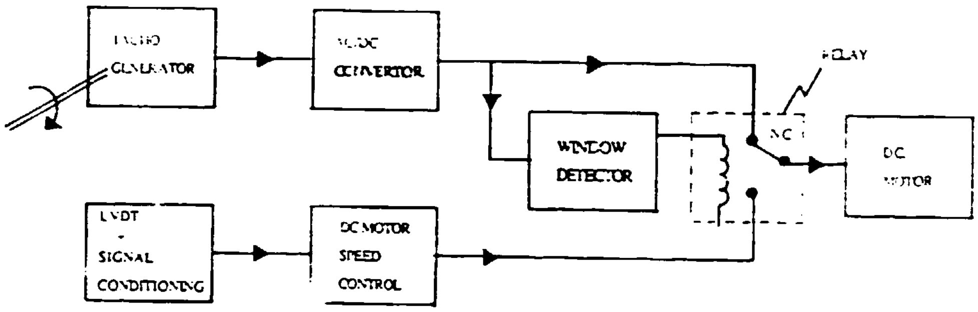
1 Start up. AC/DC synchronisation

2 When AC speed reaches set point value the speed of the DC motor is controlled by the LVDT thereafter

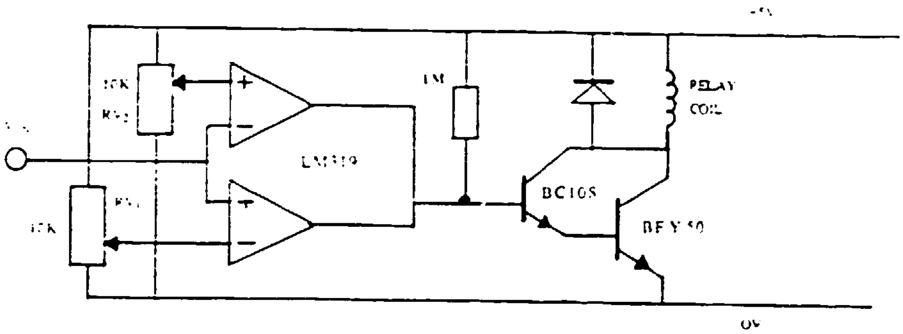
3 When AC speed increases by x% or decreases by y% the DC motor speed should revert to AC/DC synchronisation

4 At shut down AC/DC synchronisation.

The following schematic illustrates one suggestion whereby the above specification may be achieved while using the tacho-generator and speed control circuits already developed.



Window Dector

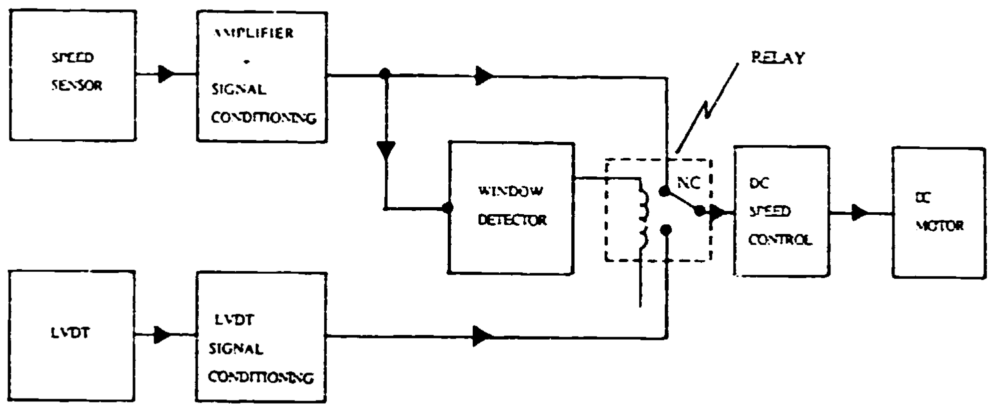


An attenuator maybe required before the Window Detector to obtain the correct range of input. Also some slight hysteresis built into the circuit to avoid relay chatter.

The lower trip voltage is set by RV1 and the upper trip voltage by RV2. The coil will only be energised when the input is between the two values set by the potentiometers and in this state only the LVDT will control the DC motor speed. Hence if the AC drive falls below or rises above set limits then the Tacho-generator will control the DC motor speed.

If the Tacho-generator was replaced with a speed sensor then the following configuration could be adopted.

The present system of control could be modified to sense the AC speed either with the Tacho-generator signal or that of a speed sensor and this signal amplified/conditioned so as to control either with an electro-mechanical actuator (solenoid) or pneumatic actuator the tension in the Ac motor drive. This system is OK if 99% of the AC speed changes arise from belt tension variation. But protection would have to be built in if the speed variation arose from mains voltage or frequency fluctuation. Or a sensor to sense the belt tension would be an alternative approach.



Appendix 2

DC motor replacement

There are two suggested solutions:

1. Eddy current coupling to a standard AC motor (supplied). This arrangement will provide variable speed drive, constant torque throughout the speed range; constant stall torque (no overheating), simplicity of electronic drive circuitry compared with drive for DC motor and it is maintenance free. I would recommend this solution.

2 The second approach is to use a switched reluctance motor with associated drive circuity. Again almost constant torque throughout speed range. The drive can be stalled against full torque for 30 minutes. The motor is brushless and maintenance free. The disadvantage is the greater complexity of the electronic drive, operating temperature range for motor -10° to 40°C and for the drive -10°C to 35°C. Also the tolerance of mains frequency drift is not so great as for the eddy current coupling system.

1	Eddy current coupling + motor		
	Unit number 100TR4/4		
	Control card + enclosure		
	Unit number	4200	£ 980
2	Switched reluctance motor		
	Unit number PLD1125/1		
	Controller	SL112L for 380V	
	or	SL112L for 415V	£2250

Appendix 3

Minimisation of the effect of vibration on the reliability of the auto-leveller

The following matters should be attended to

1 All bolting on the LVDT support structure should have shakeproof washers. The LVDT internal housing regularly inspected for loose coupling

2 The LVDT support bar $12^{1/2}$ mm thick and the hole for the LVDT threaded shank made a neat fit. Preferably the central hole in the support structure should be threaded to fit the LVDT thread. The LVDT manufactors given light specification for the lock nuts.

3 DC motor and reduction gear at ground level mounted upon a solid base, with suitable anti-vibration mountings

4 Neither electronic chassis or DC motor mounted on the Finisher Card frame.

5 Ante-vibration mounting on all electronic chassis cabinets.

6 All plugs and sockets to have positive self latching and cable anchoring points.

7 All cable chassis connectors to have securely anchored pins.

8 The present plugs and sockets are unsatisfactory for industrial environments and should be changed on all existing and future units.

9 Lock washers should be fitted together with a lock nut.

Each mill installation will have differing anti-vibration requirements dependent upon type of finisher card, LVDT support structure, age of finisher card; etc. Thus a guiding principle should be to identify the critical functions as outlined in section 4.3 and ensure that these functions are mechanically and electrically secure against vibration.

Appendix 4

Minimisation of the effects of the physical environment on the reliability of the auto-leveller

The following matters should be attended to

1 Dust, fluff, oil/water mixtures not allowed to accumulate on the sliding channels of the LVDT support structure.

2 The LVDT plunger shank not allowed to rust or become pitted and dust and fluff not allowed to accumulate in the plunger channel.

3 Dirt, fluff etc not allowed to accumulate on or ingress into the feed roller bearings and these should regularly be checked and kept suitably greased/oiled.

4 Freer air flow around the DC motor to minimise temperature increase and avoid the accumulation of dirt and fluff in the armature field slots.

5 DC motor commutator and brushes frequently inspected and appropriate action taken to maintain in efficient working order.

6 Electric circuits to be housed in industrially secure enclosures with positive internal air pressure and air inlet through readily cleaned filters.

Appendix 5

Operational procedures

It is recommended that immediate action is taken in regard to the following matters. The most frequent area of complaint by the operators, technical staff at the mill and technical staff at IJIRA lies in the availability of procedures for installation, maintenance, fault location and repair and appropriate training. I suggest the following approaches

Information acquisition
The questionnaires I have prepared may be used as a guide in the preparation of an appropriate questionnaire designed by IJIRA staff to obtain information on a regular basis. This information should be administered and processed centrally and analysed by a senior member of staff who initiates appropriate action.

Installation manual

1 The hand written inspection and installation procedures enlarged, modified, typed and printed in manual format.

2 Hook-up diagrams for signal and electrical power supply lines shown.

3 Clear recommendations on work to be carried out on the finisher card to minimise, frictional torque, secure reliable belt drive, minimise vibration; etc.

4 Clear recommendations for the location of DC motor, and tacho-generator and electronic circuitry to minimise effects of vibration.

Maintenance manual

1 The hand written instructions on maintenance procedures to be enlarged, modified, typed and printed in manual format.

2 A schedule of maintenance tasks set out with provision for amendment to suit the requirements of a given mill. The frequency of maintenance tasks to be determined by the critical nature of the functional element/component exposed to vibration and environmental factors.

3 A section should be included which should clearly show in diagrammatic or other suitable form the set up and calibration procedures with warnings as to which controls may be reset. Technical staff should be warned not to change the sensitivity of the LVDT by repositioning the mu-metal.

4 Safe operating procedures clearly set out.

Fault location and repair manual

1 The hand written notes should be enlarged, modified typed and printed in manual format.

2 A table should be included which sets fault causes against fault symptoms and suggests possible courses of action.

3 Circuit diagrams to include voltage/current values at test points should be included for each card.

4 An accompanying table of component values and component location included.

5 Safe testing procedures clearly set out.

6 A more full-proof method for the replacement of the electronic cards devised to avoid component failures.

Training programme

1 Unless a training programme is set up and appropriately located and funded then I could not be sanguine about the long term reliability of the auto-leveller.

Additionally each mill should have an auto-leveller staff unit comprised of mechanical and electrical engineer and statistical control staff. They should meet briefly daily in the initial period of installation. Each mill unit should be briefed on the procedures set out in the manuals discussed earlier. Each mill should maintain detailed records at fault location and action taken.

IJIRA staff should have an equipped testing laboratory to carry out appropriate testing and undertake development. I have set out in appendix 8 a listing of components required by the technical staff to undertake a complementary educational programme based on a standard test.

Appendix 6

QUESTIONNAIRE

AUTO LEVELLER - RELIABILITY ASSESSMENT

Please complete as appropriate.

1 Number of Auto Levellers presently installed ------

2 Number of Auto Levellers presently operational -----

3 Total ACTUAL/POTENTIAL operating hours for all machines installed -----

4 Your estimate of the degree of reliability (i.e. the ability to perform the required function without failure under mill operating conditions over the past year or part of year where appropriate -----

5 Please indicate your estimate with one of the letters A, B, C, D.

A) Mostly unreliable

B) A few only unreliable

C) Mostly reliable

D) or other (please state)

6 Average of Finisher Card Sliver CV% for the past seven day period CV%-----

7 Standard deviation of Finisher Card Sliver CV% for the past seven day period SD(Unit)--------

8 Average percentage change in productivity (+ or -) arising from installation of auto levellers %-----

9 Average percentage change in yarn end-breaks resulting from installation of auto leveller (+ve -ve) %age-----

10 It would be helpful if you would comment generally or specifically on these and other aspects relating to the operation of the auto leveller (maintenance requirements. Training of personnel, to what extent maintenance andtraining are to reliable operation.

The following questions refer to the reliability of specific functional units of the auto leveller system expressed in terms of the FREQUENCY of partial failure (A) complete failure (B) Partial failure is defined as repairable and complete failure whose functional unit had to be replaced.

11 LDVT + Support System
+ pressing roller mechanism
and set point setting

Frequency of failure (A & B)
(Times/months: all units) Probable cause of failure

12(i) Electronic System

	Frequency of failure (Times/months: all units)	Probable cause of failure
Card No.1	(A)	
	(B)	
Card No.2	(A)	
	(B)	
Card No.3	(A)	
	(B)	
Card No.4	(A)	
Card No.5	(A)	
	(B)	

Other (Please name).

12 ii Electronic Components which most frequently fail in rank order.
(Highest frequency A)

Rank Order	Approximate Number of Failures in past year	Name of Component
A		
B		
C		
D		

13 DC Motor

Frequency of Failure (Time/Months: All Units) — Cause of Failure

(A)

(B)

(B) would be where motor replaced.

14 Tachogenerator and Mechanical Transmission System

Frequency of Failure (Times/Months:) — Probable Cause of Failure

(A)

(B)

15 The following question is set to obtain information on the change in failure rate as a function of period installed.

(A) Partial Failure (B) Complete Failure

Frequency of failure after 6 months operation (Times/months: all units)	(A)	(B)
(12 months)		
(2 years)		
(3 years)		
(4 years)		
(5 years)		

16 Estimate of frequency of functional failures related to period installed

Period Installed	LDVT + Support Structure	Electronic Circuitry	DC Motor Plus Tachogenerator
6 Months			
12 Months			
2 Years			
3 Years			
4 Years			

17 It would be of assistance if you would indicate modifications which you have made to (i) the auto leveller and (ii) the Finisher Card to ensure reliable operation.

Thank you for your assistance. The summarised results will be submitted to all participants with the assurance that the information is confidential to IJIRA.

Appendix 7

Memorandum to Mr R.K. Mukherjee on a future on-line development proposal

21 March 1990

The following memorandum is an attempt to set in some order the issues that arose in our several discussions. In particular I have concentrated upon the listing and summary description of the proposal which you have put forward for on-line control and monitoring of the production of jute yarn. As you have indicated were these proposals to be implemented it would improve significantly the overall productivity with consequent reduction in costs.

As we discussed I have listed almost verbatim the agreed format of these proposals as this paper is substantially an aide memoire to form the basis for further discussion. I have not attempted to expand on the technical and resource implications implicit in each proposal. Naturally further detailed analysis of each proposal would be required by experts in this field.

As it is at the carding and early drawing stage that the greatest impact can be made on the quality and productivity, most of the proposals relate to these stages.

Proposals for Research, Development and Implementation for On-line Control and Monitoring of the Processing of Jute Yarn

2.1 Secure the operational reliability of the Finisher Card auto-leveller and sliver grist monitor.

2.2 Secure the operational reliability of the Finisher Card Double Production Unit.

2.3 Research, develop and implement a technique to sense and control fibre moisture levels at the Breaker Card.

2.4 Research, develop and implement a technique to automatically control optimum operating temperatures inside Finisher Card.

2.5 Research, develop and implement a technique for automatic control of the feed to the Breaker Card.

2.6 Research, develop and implement a technique to control fibre flotation at the three stages of drawing.

2.7 Research develop and implement a technique for the automatic identification of missing slivers at the three drawing stages.

2.8 Research, develop and implement a technique to control yarn acceleration and deceleration at commencement and termination of spinning operation.

2.9 Research, develop and implement a technique for productivity measurement at the spinning stage.

2.10 Research, develop and implement a supervisory computer control of yarn production under proposals 2.1 to 2.9.

3.0 To flesh-out these proposals I have set in summary form the development of each proposal in the format we discussed . ie under each proposal we ask the question "Why" "How" and "What Skill Resources". No attempt has been made to quantify the resource requirement or costing at this stage. If the proposals are not sound technically and particularly commercially they wont go ahead anyway quite apart from any other considerations.

3.1 <u>Secure the Operational Reliability of the Finisher Card Auto-leveller</u>

3.1.1

(i) <u>Why?</u> This development is presently operational in several jute mills but reliability is not secure

(ii) There is an overall productivity gain of 10% for each installed unit.

To secure reliability and maintain the productivity gain the following work must be undertaken

3.1.2. <u>How</u>

(i) Sensors installed to enable measurements of finisher card AC drive speed change and so synchronise these speeds with the feed drive. This synchronisation will ensure smooth functioning of the finisher card under variable load conditions.

(ii) Research, development and implementation of an alternative to the DC motor as feed drive.

(iii) Operational data retrieved on an agreed written format to be obtained from all UNDP supported auto-levellers systems.

(iv) Operational data on agreed format requested from non-UNDP supported mills which have auto-levellers installed.

(v) Anti-vibration mountings installed where appropriate to ensure long-term mechanical integrity of functional parts.

(vi) Installation of industrial type enclosures and cable termination to ensure long term integrity of electrical and electronic functional elements.

(vii) Mechanical overhaul of the finisher card to be undertaken which is agreed and specified prior to the installation of the auto-leveller.

(viii) An agreed and written maintenance schedule.
Intervals between maintenance and maintenance functions to be dependent upon the critical nature of the functional element and its exposure to the mill environment.

(ix) An installation manual to be prepared which graphically illustrates the hook-up wiring for signal and power cables.

(x) A fault location manual prepared which lays out causes with faults; has full wiring diagrams, test values against locations and component lay out diagrams.

(xi) Implementation of a training programme for technical mill staff, operators and managers.

<u>Skill Resource Requirements</u>

One mechanical engineer
One instrumentation engineer
One computer analyst

One assistant technical staff

3.2 Secure the operational reliability of the Double Production Unit at the split Finisher Card

3.2.1 Why

(i) Process costs are practically halved.

(ii) Fibre retention within the Finisher Card in several mechanical parts result in malfunctioning of the card as well as the auto-leveller leading to increased downtine and sliver irregularity.

(iii) Looseness of the AC motor belt drive poses service problems of synchronisation resulting in increased down time and greater sliver irregularity.

(iv) There is a need for improved response and operation from the drive to the feeder rollers.

3.2.2 How

(i) In regard to 2.1(ii) above an automatic periodic fibre cleaning using electro-mechanical actuators to position the cleaning pins.

(ii) Re 2.1 (iii) above an arrangement to sense and automatically adjust the belt tension by electro-mechanical or pneumatic techniques.

(iii) Re 2.1(iv) above. The replacement of the DC motor with eddy current system or a switched reluctance motor.

3.2.3. Skill Resource Requirement

One mechanical engineer
One technical assistant.

3.3 Research, development and implement a technique to measure and control fibre moisture levels at the Breaker Card

3.3.1 Why?

(i) Absolute levels of moisture concentration and the non-uniformity of moisture concentration distribution in the sliver critically affects process efficiency; contributing to weight variation in the woven product.

(ii) Absolute levels of moisture concentration and non-uniform distribution affects all stages of yarn processing and is the cause of unreliability in critical process parameters.

3.3.2 How?

(i) Moisture levels to be sensed at the delivery rollers of the Breaker Card.

(ii) Control of evaporation and moisture absorption within the Breaker Card using forced air and humidifying system through signals obtained from moisture sensor.

Skill Resource Requirement

3.3.3 One Instrumentation Engineer
One Mechanical Engineer
One Scientific/Technical Assistant

3.4 <u>Research, development and implement a technique to automatically control optimum operating temperature in the Finisher Card</u>

3.4.1 <u>Why?</u>
Heat generation in the Finisher Card housing leads to exposure of the fibre to non-optimum temperatures resulting in loss of fibre maturity viz: degradation of flexibility, tenacity etc.

3.4.2 <u>How?</u>
(i) Temperature sensing of Finisher Card active surface environment.

(ii) Control of temperature to maintain optimum value by forced air techniques using signals drived from temperature sensors.

<u>Skill Resource Requirement</u>

3.4.3 One Mechanical Engineer
One Scientific Assistant

3.5 <u>Research, develop and implement a technique for automatic control of the feed to the Breaker Card</u>

3.5.1 <u>Why?</u>
It is at the Breaker Card that the basis of yarn quality is largely determined. Present systems of feed control are dependent on human factors and controlled from the delivery stage leading to long term irregularity.

3.5.2 <u>How?</u>
(i) The sensing of feed weight on a conveyor system prior to deposition on the feed sheet.

(ii) Control of the speed of the apron feed sheet to the Breaker Card with signals derived from the weight sensor controlling the speed of the apron drive.

<u>Skill Resource Requirement</u>

3.5.3 One mechanical engineer
One instrumentation engineer

3.6 <u>Research, develop and implement a technique to control fibre flotation at the three stages of drawing</u>

3.6.1 <u>Why?</u>
Reduction in parallelism arising from flotation of fibres results in loss of yarn strength.

3.6.2 <u>How?</u>
(i) Control of the faller-bar using pneumatic or electrical actuators controlled from signals derived from level sensors.

<u>Skill Resource Requirement</u>

3.6.3 One mechanical engineer
One instrumentation engineer

3.7 Research, develop and implement a technique for the automatic identification of missing sliver with automatic shut down of the drawing ; age

3.7.1 Why?
Unidentified missing slivers result in loss of productivity.

3.7.2 How?
(i) Sensor installed to sense presence of slivers and signal conditioning to identify a missing sliver.
(ii) Automatic shut down actuated from the missing sliver signal.

Skill Resource Requirement
3.7.3 One Instrumentation Engineer

3.8 Research, develop and implement a technique to control yarn acceleration and deceleration at commencement and termination of spinning operations

3.8.1 Why?
The non-uniformity of rate of change of yarn through speed at commencement and termination of spinning results in approximately 6% of total end breaks.

3.8.2 How?
Automatic actuation with the use of stepper motors, or switched reluctance motors to control the acceleration and deceleration of yarn through-speeds at commencement and termination of spinning.

Skill Resource Requirement
3.8.3 One Instrumentation Engineer

3.9 Research, develop and implement a technique for automatic productivity measurement at the spinning stage

3.9.1 Why?
(i) There is a need for greater control of the weight of woven material which will result in increased cost control and reduction.

(ii) Present manual methods of control are costly and have long lead times.

3.9.2 How?
(i) Temperature compensated sensing of the tear weight of the yarn loading and optical sensing of the average speed of yarn through-put to give with signal conditioning processing an automatic measurement of linear density per bobbin, hence productivity.

Skill Resource Requirement
3.9.3 One mechanical engineer
One instrumentation engineer

3.10 Research, develop and implement supervisory computer control of process parameters under proposals 3.1 through 3.9 listed above

3,10.1 Lack of control of process parameters result in decreased efficiency and productivity. Early warning of such changes outside set limits, would provide specific knowledge of malfunctioning of identifiable process functions leading to less down time and more efficient maintenance. Centralised data storage and processing of data in suitable tabular and graphical format would assist in management decision making.

3.10.2 <u>How?</u>

The analogue signals from the process parameters measured under item 3.1 through 3.9 would be fed to a slave microcomputer for each appropriate stage. Each slave would carry out supervisory control of the process parameters of that stage. The slave stations would be interrogated under automatic and manual control and a centralised system would automatically store processed data and provide statistical manipulation of data for management and technical supervision.

<u>Skill Resource Requirement</u>
Instrumentation Engineer
Computer technologist
Computer analyst
Computer programmer

4.0 <u>Implement a programme of training for management, technical and process operating staff</u>

No single development of the proposals summarisedcould be reliably implemented, operated, maintained and managed without appropriate training in the relevant skills required. Thus it would be essential to underpin the proposed developments with a centralised training facility with staff intimately conversant with the real mill situation at all appropriate levels.

Appendix 8

Listing of components and equipment required for testing laboratory for technical staff.

1	Digital Multi-Meter	3.1/2 digit with diode test and continuity (bleeper) Transistor test
1	Digital Multi Meter	5.1/2 digit with temperature measurement facility (measure uA and uV AC/DC)
1	Function Generator	0.1 Hz to 2 MHz with sine/square/triangular wave with effect control. Fan-out 20 TTL mam's powered
	RELAYS	
1	2 pole 6V.DC Coil	5A contact
1	single pole 12 VD.C. Coil	10A contact
	Potentiometer	
4	10 K linear 1 watt	p.c.b mounting/cermet/element if cermet not obtainable then carbon

Resistor Fixed

Precision metal film	4.	1 K	1/4 watt	
	4	10 K	"	assorted
	4	100 K	"	range
Carbon high stability	2	100 Ω	1 watt	
	2	220 Ω	1 watt	
	2	470 Ω	1 watt	
	2	680 Ω	1 watt	
	2	1 K	1 watt	
	2	2.2 K	1 watt	

Capacitars	2 4700 μF	25 V wire end
Electro	2 1000 μF	25 V wire end

Capacitor	5	1 μF	Polycarbonate	encapsulated
	5	0.1 μF	"	"
	4	3300 pF	Polypropalene	
	4	10000 pF	63 V	
	4	100 pF		
	4	220 pF		
Semiconductor	4	LM 392 N	Comparator	
	4	LM 319 N		
	4	741 N	op-amp	
	4	747	(Dual version)	

5	op - amp	PCB Pu 741
10	BC107	NPN Transistor
10	BC109	NPN Transistor
4	BC108	NPN Transistor
4	BFY50	

10 Diodes - low voltage IN
5 Diodes - zener - 600 9V
4 2N3053 NPN Transistor

10 Lamps ( ) as loads
6 2N 3819 FFI

2	Light/Conductance device	ORP12 or similar	
	(Light dependent resistor)		
2	Temperature sensor	LM 35	
2	Temperature sensor	590 KH	
2	Thermistor (Stud)	1 x 80	1 x 120
1	Stepper motor	RS 332 - 953 size 2	
1	Stepper motor drive RS 332 - 098 + 32 way connector.		

Appendix 9

Details of manufacturers' addresses and costs for recommended items of equipment

6.1 Replacement of D.C. motor:

1 x Eddy current coupling + motor + drive	£ 980
1 x Switched reluctance motor + drive	£2250

Address

TASC Drives Ltd
Oulton Works
Lowestoft
NR33 9NA
England
U.K.

Tel. No. 0502 582411
FAX No. 0502 565861
TELEX 975022 TASC

6.2 Torque Test Rig:

1 x Torque transducer	50128 100 NM	£2153
1 x Display unit	400500	

Address

Norbar Torque Tools Ltd
Beaumont Road
Banbury
Oxon
OX16 7XJ
England
U.K.

Tel. No. 0295 270333
FAX No. 0295 269864
Telex 83517 NORBAR G.

Items for 6.3, 6.4 and 6.5 should be obtained in India.