



## **FACULTY OF ENGINEERING**

### **DEPARTMENT OF TEXTILE AND GINNING ENGINEERING**

#### **FINAL YEAR PROJECT**

#### **DEVELOPMENT OF A RELIABILITY CENTERED MAINTENANCE BASED EARLY WARNING SYSTEM FOR A ZINSER 660**

#### **SPEED FRAME MACHINE.**

COMPILED BY:

**OCITI INNOCENT OLUR**

**BU/UG/2016/1725**

**Email: innociti@gmail.com**

**SUPERVISORS: MR. KASEDDE ALLAN**

**DR.NIBIKORA ILDEPHONSE**

A REPORT SUBMITTED TO THE DEPARTMENT OF TEXTILE AND GINNING  
ENGINEERING FOR THE AWARD OF BACHELORS DEGREE IN TEXTILE  
ENGINEERING

## **ABSTRACT**

One third of all maintenance costs are wasted as a result of unnecessary or improper maintenance activities since unlike production and manufacturing problems, maintenance receives little attention, which explains why the productivity of textile machineries like the speed frame machine suffers due to high end breaks which are mainly as a result of the tendency of the flyer to vibrate during production which stems from anomalies of parts like the bolster pinions, gears, the flyer spindle pinions and rolling bearings. To tackle this issue, this paper proposes a Reliability Centered maintenance based Early Warning System for a Zinser 660 speed frame machine. One of the most powerful algorithmic tools for vibration analysis is the time synchronous average (TSA).

Time synchronous averaging is a signal processing technique that extracts periodic waveforms from noisy data. The TSA is well suited for gearbox analysis, where it allows the vibration signature of the gear under analysis to be separated from other gears and noise sources in the gearbox that are not synchronous with that gear. With this, it is easier to distinguish between a healthy and unhealthy speed frame machine by inspecting the waveform thus giving the maintenance crew ample time to decide on the maintenance strategy to solve that specific anomaly.

The decision on whether to recommend this Early Warning System will be based on performing a cost benefit analysis of implementing the system.

**Keywords:** Reliability Centered Maintenance; Zinser 660 speed frame machine; Early Warning Systems; Time Synchronous Averaging.

**DECLARATION**

I OCITI INNOCENT OLUR, a student of Busitema University in the Department of Textile and Ginning Engineering hereby confirm and certify that the information in this project proposal report is an original account of what I paraphrased after reading several research papers in the field of reliability engineering, Textile machineries (speed frame machine) and early warning systems.

Signature: .....

Date: .....

**APPROVAL**

This project proposal report has been submitted for examination with the approval of the following supervisors.

Signature: .....

Date: .....

Mr. Kasedde Allan

Signature .....

Date.....

Dr. Nibikora Ildephonse

# Table of Contents

<b>ABSTRACT</b> .....	i
<b>DECLARATION</b> .....	ii
<b>APPROVAL</b> .....	iii
<b>TABLE OF FIGURES</b> .....	vi
<b>CHAPTER ONE: INTRODUCTION</b> .....	1
<b>1.0 Title</b> .....	1
<b>1.1 Background of the study</b> .....	1
<b>1.2 problem statement</b> .....	2
<b>1.3 Objectives of the study</b> .....	2
1.3.1 Main objective.....	2
1.3.2 Specific objectives.....	2
<b>1.4 Justification of the study</b> .....	3
<b>1.5 Significance of the study</b> .....	3
<b>1.6 Scope of the study</b> .....	3
1.6.1 Conceptual scope.....	3
1.6.2 Geographical scope.....	3
1.6.3 Time scope.....	3
<b>CHAPTER THREE: LITERATURE REVIEW</b> .....	4
<b>2.0 Introduction</b> .....	4
<b>2.1 Reliability Centered Maintenance</b> .....	4
2.1.1 Key speed frame machine components.....	5
2.1.2 Failure modes of the components.....	5
2.1.3 Detection of the failures.....	5
2.1.4 Instrumentation for monitoring the parameters.....	6

<b>2.2 Early Warning Systems</b> .....	7
2.2.1 Techniques for developing Early Warning Systems.....	7
<b>2.2.1.1 Support Vector Machine (SVM)</b> .....	7
<b>2.2.1.2 Hierarchical Clustering</b> .....	8
<b>2.2.1.3 Fuzzy c-Means</b> .....	8
<b>2.2.1.4 k-Means</b> .....	8
<b>2.2.1.5 Self-Organizing Maps</b> .....	8
<b>2.2.1.6 Principal Component Analysis (PCA)</b> .....	9
<b>2.2.1.7 Time Synchronous Averaging (TSA)</b> .....	9
2.2.3 Needs for Early Warning Systems.....	10
<b>CHAPTER THREE: METHODOLOGY</b> .....	11
<b>3.0 Introduction</b> .....	11
<b>3.1 Materials and Equipment</b> .....	11
<b>3.2 Establishing the various failure modes of the Speed frame</b> .....	11
3.2.1 Age-Related Failure Mode.....	11
3.2.2 Non-Age-Related Failure Mode.....	11
3.2.3 Infant Mortality Failure Mode.....	12
<b>3.3 Developing a Reliability Centered Maintenance based Early Warning System</b> .....	12
3.3.1 Data acquisition, preparation and preprocessing.....	13
3.3.2 Performing Time-Synchronous Averaging and Envelope Spectra.....	13
3.3.3 Recognizing patterns in data.....	15
3.3.4 Validation of the early warning system.....	16
3.3.5 Implementation.....	16
<b>3.4 Performing a Cost Benefit Analysis of implementing the Early Warning System</b> .....	16
<b>CHAPTER FOUR: RESULTS AND DISCUSSION</b> .....	17

<b>4.0 Introduction.....</b>	<b>17</b>
<b>4.1 Failure mode of the critical speed frame parts.....</b>	<b>17</b>
<b>4.2 Reliability Centered Maintenance based Early Warning System for Zinser 660 speed frame machine. .....</b>	<b>19</b>
<b>4.3 Cost Benefit Analysis of implementing the Early Warning System.....</b>	<b>24</b>
<b>CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS.....</b>	<b>25</b>
<b>5.0 Conclusion.....</b>	<b>25</b>
<b>5.1 Recommendation.....</b>	<b>25</b>
<b>REFERENCE LISTS AND APPENDICES.....</b>	<b>26</b>
<b>Introduction.....</b>	<b>26</b>
<b>Appendices.....</b>	<b>26</b>
<b>Reference lists.....</b>	<b>33</b>

**TABLE OF FIGURES**

Table depicting how to establish failure mode of speed frame 1.....	12
---	----

**LIST OF ACRONYMS**

RCM	Reliability Centered Maintenance
EWS	Early Warning Systems
PCA	Principal Component Analysis
CSV	Comma Separated Values
PM	Preventive Maintenance
RTF	Run-to-failure
Nytil	Southern Range Nyanza Industries Limited
ISO	International Organization for Standardization
SOM	Self Organizing Maps

SVM	Support Vector Machines
TC	Technical Committee
OQS	Oil Quality Sensors
HP	Hewlett-Packard
MATLAB	Matrix Laboratory
TSA	Time Synchronous Averaging
CBA	Cost benefit analysis
CBR	Cost benefit ratio