# MAINTENANCE MANAGEMENT IN NIGERIAN AVIATION INDUSTRY:

## A CASE STUDY OF THE NIGERIAN COLLEGE OF AVIATION TECHNOLOGY, ZARIA

**BY**

EMMANUEL OBURU. ONWUKA
(MBA/ADMIN/5456/1992-93)

SUBMITTED TO THE FACULTY OF
ADMINISTRATION AHMADU BELLO UNIVERSITY, ZARIA
IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTERS
DEGREE IN BUSINESS ADMINISTRATION (MBA)

JUNE, 1999

# DECLARATION

I hereby declare that this project os my work and has, to the best of my knowledge, never been presented for any degree. All sources of information have been dully acknowledged.

| ONWUKA, EMMANUEL OBURU | | JUNE,1999 |
|---|---|---|
| Name of Student | Signature | Date |

# CERTIFICATION

This Project Titled"MAINTENANCE MANAGEMENT IN NIGERIAN AVIATION INDUSTRY. (A Case study of the Nigerian College of Aviation Technology, Zaria)" by ONWUKA, EMMANUEL OBURU meets the regulation governing the award of Degree of Masters in Business Administration (MBA) of the Ahmadu Bello University (ABU), Zaria and is approved for its contribution to knowledge and literary presentation.

PROJECT SUPERVISOR: _____ 7.7.99
SIGNATURE DATE

EXTERNAL EXAMINER: _____ 19-5-2000
SIGNATURE DATE

HEAD OF DEPARTMENT: _____ 4/9/2000
SIGNATURE DATE

DEAN OF POSTGRADUATE: _____ 03/12/02
SIGNATURE DATE

# ACKNOWLEDGEMENT

I acknowledge with thanks all those friends and colleagues who by word of encouragement and provision of special aids such as seminar papers assisted me during the writing of this thesis.

My special thanks go to Mr. M.M. Mirza mu project supervisor and Mr. Uhuegbo Kole Osaretin for their constructive suggestions and guidance throughout the writing of the thesis, and to Mr James E. Uche for his tireless efforts in typing the final manuscript.

Finally, I wish to express appreciation to Mr. J. Obasi for technical editing and correction of the original manuscript. May God reward you all abundantly.

# DEDICATION

This thesis is dedicated to my beloved wife Mrs. N.O. Onwuka who encouraged me spiritually, morally and financially throughout the course work especially during the writing of this thesis.

# ABSTRACT

Civil Aviation, all over the world is a capital intensive industry that is propelled by high technological advances. The aviation industry in Nigeria is vast, dynamic and is constantly responsive to modern technology which dictates policy formulation on the application of new equipment, operating procedures and safety standards. Although it is an economic catalyst, it is not an all comers industry.

However, advances in aviation technology, which we enjoy, have not been matched by improvements in the way we organize, manage and maintain the aircraft, equipment and machinery used in the industry.

There is certainly a maintenance back-up gap. Rather than ensuring the serviceability of their fleet through effective maintenance management, managers of resources in the industry have become insatiable in the

acquisition of new aircraft, equipment and machinery to the detriment of ageing and aged aircraft which, unfortunately are abandoned and ignored without maintenance.

The consequences of this attitude is the existence of a mortuary of rotting and rotted aircraft of which heavy finance have been committed. They are abandoned at the airports without attention. This situation aroused my curiosity and I become compelled by it to conduct an investigative study into the maintenance management in the Nigerian Aviation industry.

The basic question on my mind is why are managers of aviation establishments averse to equipment maintenance. In answering this question there will be an indepth definition of equipment maintenance and the description of the levels of maintenance. The paper will consider the maintenance techniques used and their impact on the productive performance of the

establishment mentioned above. It will also analyse the constraining factors to equipment maintenance in the Nigerian College of Aviation Technology (NCAT) Zaria and will appraise its performances in the aviation industry.

Finally, I will proffer solutions on key problem areas and highlight the benefit of equipment maintenance management in the aviation industry.

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# CHAPTER ONE

## 1.1 INTRODUCTION

The performance of the productive sector of the Nigerian economy has been quite unimpressive for the last decade. The nation has experienced continuous economic recession due to and a general decline in the growth of our national output.

This situation is attributable to the socio-political uncertainties that dominate the country's body polity which, as a consequence, has become a major obstacle to improved national productivity record. Politically the business environment has been characterized by turbulence due mainly to the frequent and unorthodox changes in government, and ethnic rivalry. Consequently declining investment and productivity have become a part of our daily experience. Socially, the situation is terrifying; our core values seems to have eroded overtime. Moral bankruptcy; indiscipline, dishosnety, neglect, fraud and other societal ills such as bribery and corruption are afflicting our country. Our cultural diversity, rather than serve as a source of strength and power, has become a ready armour of division and hate amongst the peoples of our country today.

In the midst of all these are poor and inadequate infrastructural services which have further halted investment opportunities, and national productivity. These infrastructures suffer from neglect and abandonment and have as a result deteriorated considerably across the country. To further compound the situation, rapid technological developments have often compelled managers of resources to invest heavily in the acquisition of new machinery and equipment without adequate logistic support today leaving behind a mortuary of abandoned machines and equipment that could easily become serviceable through effective maintenance management.

It is precisely for the foregoing reasons that I now appraise our country's current maintenance management in the Nigerian Aviation Industry with particular reference to the Nigerian College of Aviation Technology, Zaria (NCAT).

## 1.2 STATEMENT OF THE PROBLEM

In the society today there is an incalculable wastage of national wealth. There is hardly any direction one looks without seeing signs of neglect, absolute abandonment and waste. On the

highways, behind the walls of industrial establishment; in Government and private business premises; business centres; factories; tertiary institutions; military barracks, airports etc materials and infrastructural facilities cry for attention.

Buildings and public facilities; cars, lorries buses, earth moving vehicles and machines, etc are abandoned and allowed to rot away. Fleet of unserviceable aircraft of various sizes and makes rot away in the open and in Aircraft hangers at various airports nationwide.

Reasons for abandonment are as insignificant as changing as park plug or replacing a worn-out tyre or replacing a defective unit in the case of a motor vehicle; or carrying out routine maintenance checks for airworthiness in the case of aircraft, or simply repair and maintenance in the case of infrastructural facilities.

Instead of effecting maintenance in order to retain these wealth at serviceability conditions managers of resources prefer to be indifferent only to create an anomaly for personal

aggrandizement through outright purchase of a fleet or the construction of new edifices. In places where they are available, large stock of spare parts pile up in the stores of various establishments untampered and unused until their technical life span expires. This is wastage indeed.

In managing any business, private or public for higher productive performance, a culture of maintenance must be imbibed in order to keep the buildings and facilities used for production; (plants, machinery, and equipment) in constant state of revenue earning capacity over an extended period of time and even beyond the stated technical life span of the machinery.

There is scarcely any business outfit (service or manufacturing) that does not have one type of equipment and machine or another that directly or indirectly form the revenue earning capacity of that business concern. Infact the fortunes of business is greatly influenced by the technological changes of our time. Each new piece of equipment or machinery installed for productive purpose has its own peculiar operational and maintenance protocols that must be adhered to if it must achieve

the purpose for which it was designed. Yet one wonders why most managers of resources prefer to ignore maintenance management.

In the course of this research I found out that resource managers consider cost and availability of finance to carry out maintenance schedules. Second, they worry about technical manpower utilization. Thirdly, they think of the personal benefits in effecting maintenance. If it offers minimal or zero benefit, it is usually neglected and ignored. If the maintenance operation does not favour the maintenance team, signs of unwillingness often impedes the maintenance effort.

Most business establishments prefer to employ staff without the requisite skill, aptitude and experience required to institutionalize maintenance culture. I also found that major industrial installations (plants and machineries) in Nigeria are "TURN-KEY" projects with or without maintenance agreement embedded in the contract of understanding between the manufacturer/supplier and end-users.

It is common knowledge that five years after the first successful "Test-Run" and hand-over, ceremonies, signs of Mal-function and failure begin to set-in. Usually action is not taken to restore the system to a satisfactory operational condition through repairs and maintenance due to obvious constraints mentioned earlier. Operation often becomes erratic; failure and mal-function become too frequent to control until a final breakdown occurs. The plants and machinery are incapacitated. Production processes grinds to a complete halt and the industry or business enterprise goes out of production leaving behind a mortuary of abandoned machinery and equipment whose spares cannot be sourced because of the accelerated pace of technological change. Such has been the Nigerian situation.

Policy and decision makers, are faced with the dichotomy of increased managerial complexity and production performance, and decreasing investable funds and resources. According to Olusegun Osunkeye ('95) the major constraining factors to maintenance management are

- High inflation
- Unstable exchange rate of the naira

- Importation of plants and machinery from abroad. Subsequently it has become extremely difficult, if not impossible, for some industries to replace their plants and machineries:

For instance in 1986, one United States dollar exchanged for eighty naira and rising; it follows that to replace those imported plants and machinery twelve years later it will require at least eighty times what it would have cost at the time; this new cost value excludes inflation, tariffs, import duties etc. This situation has become a major constraint in achieving the targeted level of performance. Usually an industry may well have adequate stock of spare parts, but the psyche of the Nigerian man, (whites do it better) and the inadequacy of the local maintenance team makes maintenance mangement ineffective and none existent. The obvious consequence of this constraint is that the machinery and spare parts supplied by manufacturers, of which heavy finance have been committed, are abandoned and allowed to waste away.

The situation I have presented in the preceding paragraph has prompted me to raise some basic question as to whether, managers of resources and movers of the Nigerian economy are giving adequate, and right attention to equipment, machinery and infrastructural maintenance. It may not be out of place to infer that they really don't.

## 1.3 PURPOSE OF THE STUDY

The purpose of the study is to analyse the maintenance Management practices in Nigerian with particular emphasis on the aviation industry using the Nigerian College of Aviation Technology, Zaria as a test case. Hopefully the study would ensure the undermentioned objectives.

1. To analyse the various approaches to maintenance and their impact on the maintenance procedure.
2. Identify the causes of poor performance of infrastructural facilities in the society especially the aviation industry.
3. Evaluate the effects of poor work-ethics and inefficient financial management to maintenance programmes/practices.
4. To investigate the different types of environments that affect maintenance management.

5. Proffer solutions and advance recommendations towards establishing maintenance culture and management in the aviation industry based on findings.

## 1.4 HYPOTHESES

Having outlined the statement of the problem and established the purpose of the study vis-avis the objectives to be pursued I have adopted the following hypotheses.

1. Regardless the maintenance Management strategies adopted, poor work ethics and inefficient financial Management will lead to poor performance and negligence.
2. In every maintenance operation, rather than follow the recommended maintenance procedure, ad-hoc approaches are preferred.
3. Maintenance and culture go paripassau with the utilization of available technical manpower.

## 1.5 SIGNIFICANCE OF THE STUDY

Maintenance personnel in many departments of the aviation industry are often faced with the challenge of changing

technology and increased requirements for testing, evaluating, analyzing and other operational specifications. In a desperate effort to satisfy these requirements and be able to operate at the expected optimum revenue earning capability, vital aspects of their operation such as system routine maintenance which quarantees operational effectiveness are overlooked and subsequently ignored.

If all actions necessary for retaining an item (system, equipment, facilities, building etc) in serviceable condition are not strictly followed, like culture, such item will be prone to malfunction and failure.

As a high-tech, industry, the operation of aviation related businesses are still dependent on imported machinery and equipment; test gears and tools; workbenches and instruments. Therefore outright replacement of ageing aircraft, plants machinery and equipment has become extremely difficult if not impossible due to high inflationary trends. Rather than surrendering to the unprofitable business climate, it is cost

effective to repair and maintain so that equipment and/or machinery can be operated over a period of time for which the demand exist without failure.

This means that unless a maintenance concept, which matures into a maintenance culture, is actualized it will be difficult to enjoy the advantages of maintenance management.

## 1.6 SCOPE OF THE STUDY

This study on maintenance Management focuses on the maintenance Management practices and their impact on the serviceability, reliability and maintainability of plants, equipment, machinery and infrastructural facilities used in industrial operations.

Different types of environmental constraints that affect maintenance Management will be considered. Also the critical human factor elements of maintenance such as technical skill, aptitude, experience and dexterity required to effectively carryout the maintenance principles will be covered.

The study concentrates on a "High-Tech". industry such as Aviation, where man and machine interaction is vital to its survival and growth.

## 1.7 LIMITATIONS OF THE STUDY

This study is subject to the following limitations

1. Restricted to a High-Tech. service-oriented industry
2. The Nigerian College of Aviation Technology, Zaria is the institution under focus because it is a key player in the aviation industry.
3. Data collection, sampling and analysis are based on questionnaire of which respondents may not have based their responses on proven facts. Others such as oral interviews, observations etc may be full of assumptions except in the case of personal experience.
4. Technical inputs from on-the-Job field men who are end-users of operational equipment are included.
5. Though the institution is a key player and could serve the purpose of the study in the industry, data gathered may not give a true reflection of the maintenance Management practices in the Industry when one considers the fact that airline operations and classroom approaches differ greatly.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 INTRODUCTION

Every engineering product be it a large equipment or a simple mechanical device is designed to perform a specific function or a wide-range of functions depending on the engineering complexities of the product.

Often the manufacturer(s) of the product attaches a quarantee which states that the equipment will operate over a period of time without failure, and is capable of performing its intended functions effectively and satisfactorily in the chosen environment. Regardless the validity of such statements, equipment-failure due majorly to mechanical fault or malfunction invariably occurs in the operational life-cycle of the equipment.

The consequences of failure of any engineering product are numerous; financial loss, material loss; production-time loss; man-power loss etc. Failures do not just occur. They are the

resultant of some factors in the chosen environment traceable to Malfunction of parts; manufacturing defects, mal-operation by unskilled labour, environmental influence that causes degrading mechanism like wear, corrosion or chemical attack, others are metal fatigue due to stress mismatch or over load, and many other attacks like ageing all of which take time to become noticeable to produce a failure, a physical defect or damage.

When a failure actually occurs it could be complete or permanent in which case the equipment is discarded. It could be partial failure due to a fault that has occurred internally which invariably produces a damage in the equipment. A breakdown could also occur due to sudden temporary demand in excess of normal operating capacity.

A Typical example of a permanent failure is found in an incandescent lamp (light bulb), which suddenly ceases to produce a glow in the specified environment even in the presence of an electric current. The electric bulb is commonly described as "dead" and must be replaced with a new one in order to restore the illumination of the specified environment.

Maintaining such electric-bulb is not practicable.

Opinions however differ as to the actual cause(s) of such failure in the case of a bulb which suddenly ceases to glow. The most favoured explanation is that the tungsten filament inside the evacuated tube is fatigued and can no longer produce a glow because it has reached its limit of resistivity which is equivalent to its expected life span. At this point it becomes very brittle and breaks up thereby creating an open-circuit.

Similarly if a defective fuel-injection mechanism of an automobile engine is not checked and repaired, a major fault arising from a degraded engine performance may occur. Failure of any kind is caused by a combination of factors. Maintenance management is all about keeping such factors in check.

When the whole life-profile of an engineering product is x-rayed, it is discovered that there are variations in the rate at which an equipment or a simple component fails in its entire life-cycle. Some engineering products are prone to failure at its early-life resulting from manufacturing defect and/or mal-operation due to

wrong handling. At such levels, the failure rate could be high but decreases with modification and repairs. Others will operate satisfactorily for a greater part of their life-span and it is only when ageing sets in that it breaks down more frequently until it is discarded despite repair and maintenance efforts applied.

It is interesting to mention here that the human life and human beings exhibit this type of failure pattern from childhood to old age. All equipment manufacturers know this trend, hence under normal conditions, manufacturers of an engineering product provides a general maintenance protocol. They also suggest the likely fault that would occur in the cause of operation; the procedure for identifing a particular fault and how it could be cleared. When a major fault occurs that necessitates putting away the equipment or shutting down a manufacturing plant for long period, then a maintainability protocol, designed and packaged by the manufacturer must be applied using, in most cases expertise maintenance personnel who is very familiar with the design and operation of that equipment. Let me therefore briefly dwell on the equipment life-cycle in order to support my argument.

### 2.1.1 EQUIPMENT LIFE-CYCLE

In discussing maintenance either in terms of policy formulation or philosophy to be adopted in an industrial environment, it is important to understand in great details the various stages of an equipment lifecycle which to my mind affords maintenance officers or managers the opportunity to determine or select the best course of maintenance action on any particular equipment.

According to the Training Manual for the INDUSTRIAL TRAINING FUND (ITF) on "Organization and Control of Industrial Maintenance", equipment life-cycle represents the various stages an equipment or engineering product must pass through in the entire life-span.

It spans from Design to Manufacture, Installation, commissioning and operation. The other stages are the wear-out, obsolescence and eventual replacement. See figure 2.0 EQUIPMENT LIFE-CYCLE

Usually, there is an interaction between these stages which leads to the overall development in the performance operation of the equipment. A clear understanding of current developments in each stage such as history of overhauls and other major work involving dismantling or otherwise of the equipment is needed in selecting the most appropriate maintenance system to meet the requirements of the equipment.

Although the equipment life-cycle serves a useful tool in predicting the failure pattern of an entire system, the primary concern lies on the following aspects;

1. How will the equipment fail?
2. When is it likely to fail?
3. What could be done to minimize the effects of failure?
4. What could be the possible preventive or corrective measure?
5. What maintenance strategy/policy could be put in place to guarantee its effectiveness and reliability in performing its intended functions satisfactorily in the specified environment?

Often times there are no ready solutions to the technical challenges posed by these primary concerns. Solutions to such challenges lie in the ability to think through difficult problems posed by technology and simply come-up with answers. To achieve this, efforts must be geared towards studying the design of the equipment in great details; noting how the equipment works and how to keep it working effectively throughout its operation life-cycle for the purpose of minimizing failures and avoiding work disruptions mentioned earlier.

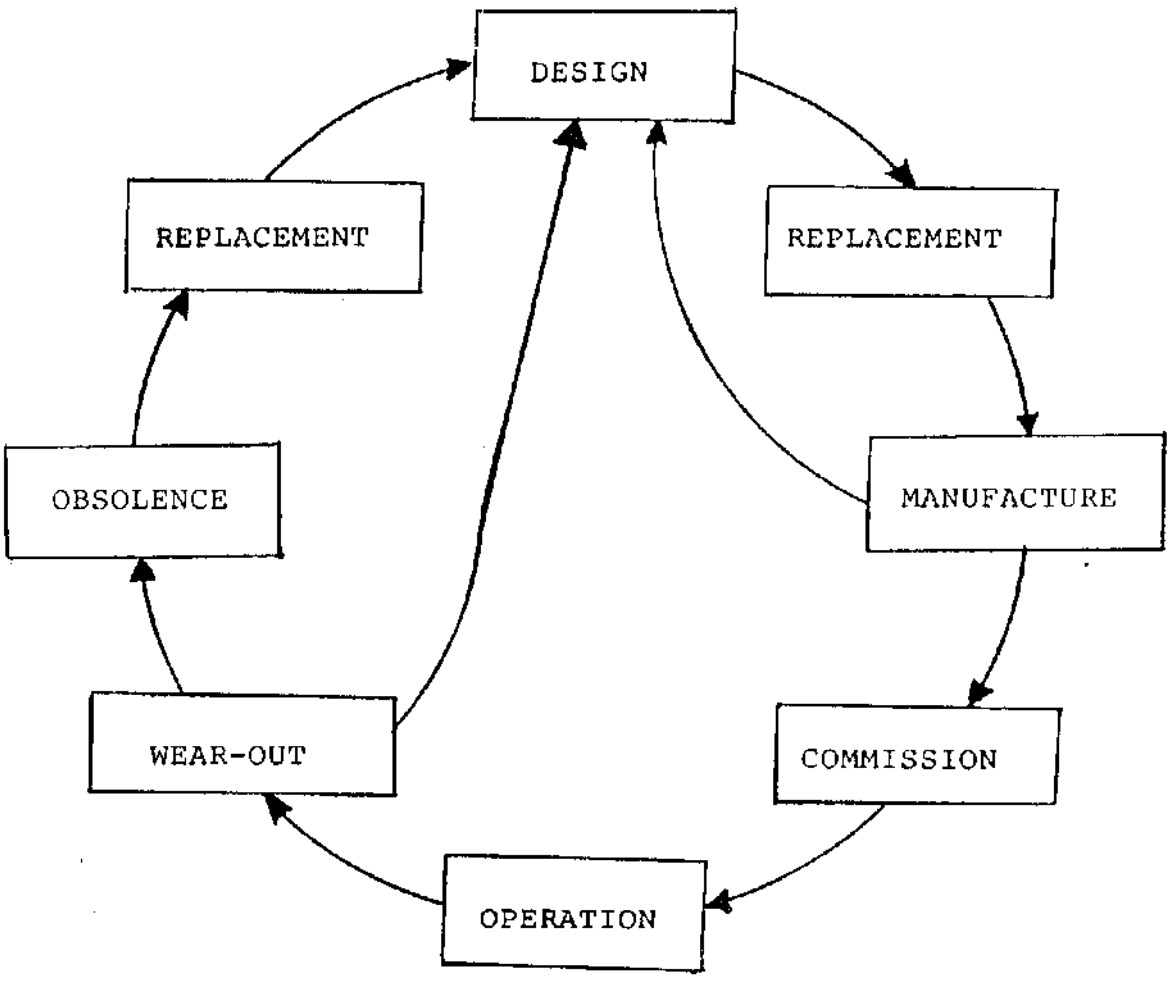



Figure 2.0 EQUIPMENT LIFE CYCLE.

## 2.2 MAINTENANCE CONCEPT AND MAINTAINABILITY

This is a statement and/or illustrations made in abstract terms which define, in theory, the technically related approaches of maintaining an equipment. It relates to task definitions, techniques, tools, personnel quantities, and cost schemes required to accomplish the goal.

### 2.2.1 DEFINITION OF MAINTENANCE

As with any discipline built upon the foundation of science and technology, an understanding of maintenance begins with a definition of maintenance. Owing to the fact that so many misconceptions of this definition exist, I wish to erase these misconceptions which are so deeply rooted in the minds of management and many maintenance practitioners by paying attention to such negatives first.

Maintenance is not merely preventive maintenance, although this aspect is an important ingredient. Maintenance is not lubrication, although lubrication is one of its functions. Nor maintenance simply a fren-tic rush to repair broken machine past or building separately, although this can sometimes be a dominant maintenance activity.

In a more positive vein, maintenance is a methodological problem-solving approach involving a combination of all necessary actions carried out in accordance with specified procedure to retain a working system(s) or restore a broken down system in a satisfactory performance. The activities must be carefully fitted to the operation of the organization it serves as a "FINE SUIT OF CLOTHES IS FITTED TO ITS WEARERS"

### 2.2.2 MAINTAINABILITY

This is the probability that a failed item in an equipment will be retained or restored to a specific satisfactory operating condition within a given period of time when maintenance is performed in accordance with prescribed procedure and resources[1].

### 2.2.3 MAINTENANCE OBJECTIVE

The major objective of every maintenance activity is basically to retain an equipment in a serviceable condition and ensure that its performance does not fall below acceptable pre-established level in a given period of time so that total production does not decrease with increase in cost due to down-time or idle time.

To achieve this objective, effective maintenance management is essential because the percentage of time a production unit operates or that a total system is available for the manufacture of the product will directly affect the amount of profit generated. Hence the function of maintenance management in any industry must be to keep the plant and equipment running at the required level of productive efficiency at the most economic cost.

Stewart, H. V. M. is his book titled "Guide to Efficient Maintenance Management" expressed the functions of Maintenance Management in practical terms as being the following:

1. To Determine the economic value of maintenance work to be done;
2. To Undertake Maintenance requirements at the right time;
3. To Reduce the labour and material cost of all jobs to the lowest possible level consistent with safety requirements and budgetary allocations .

For an effective execution of these functions, maintenance departments are often established in most organizations.

## 2.3 CHARACTERISTICS OF MAINTENANCE WORK

Maintenance work is characterized by essential activities that must be carefully tailored to suit the specific, technical, geographical and personnel situations. These activities included;

1. Planning and organization;
2. Maintenance activity
3. Resource sourcing
4. Cost determination
5. Training.

### 2.3.1 PLANNING AND ORGANIZATION OF MAINTENANCE

Any maintenance activity such as repairs and overhauls of machinery and equipment will be quicker and most economically executed if carefully planned and managed. There are, however, maintenance jobs such as minor breakdowns that are impossible to plan because there is no time available for planning. Such jobs are usually comparatively small and hence they do not account for many manhours, but they nearly always create difficulties.

In maintenance context, the function of management is to make arrangements today for tomorrow's work by a well-established work planning department or unit whose duty it is to map-out and schedule the maintenance activity and job specifics. However, the amount of planning and scheduling will vary from one maintenance job to another.

Before any maintenance job can be effectively completed, the maintenance department or maintenance officer in the job-line must state or determine the following:

- What is to be done;
- How it is to be done;
- Approximate manhours required.

When a maintenance is planned, it must be scheduled and adequately organized, this means that it has to be placed in the correct time-relationship to other jobs competing for attention, and also that one or more persons be selected to execute the job. Therefore scheduling specifies:-

- Who is going to do the work;

- What tools, instruments and aids are needed;
- When it should be done;
- Expected completion time.

Scheduling involves the following activities as well;

- Determining the placing of one job in relation to another,
- Placement of different operations in the best possible sequence,
- Determining the person or the group who is to do the job,
- Determination of the time to start.

Organizing on the other hand involves the combination of operations done by different persons or units and to coordinate the entire work.

### 2.3.2 MAINTENANCE ACTIVITY

Maintenance activity is the repair work carried out on an equipment by the maintenance personnel in accordance with the organization's maintenance procedure to keep a working system working satisfactorily or to put back a breakdown equipment in a satisfactory working order in a designated site, location, workshop and/or maintenance facility. The repair work may call for preventive maintenance or operational maintenance, or

corrective maintenance depending on the level of equipment complexity and state. Detailed discussion on operational, preventive, corrective maintenance etc will be found in paragraph 2.4.

The repair work situations can be represented by a flow chart as shown in figure 2.1 overleaf.

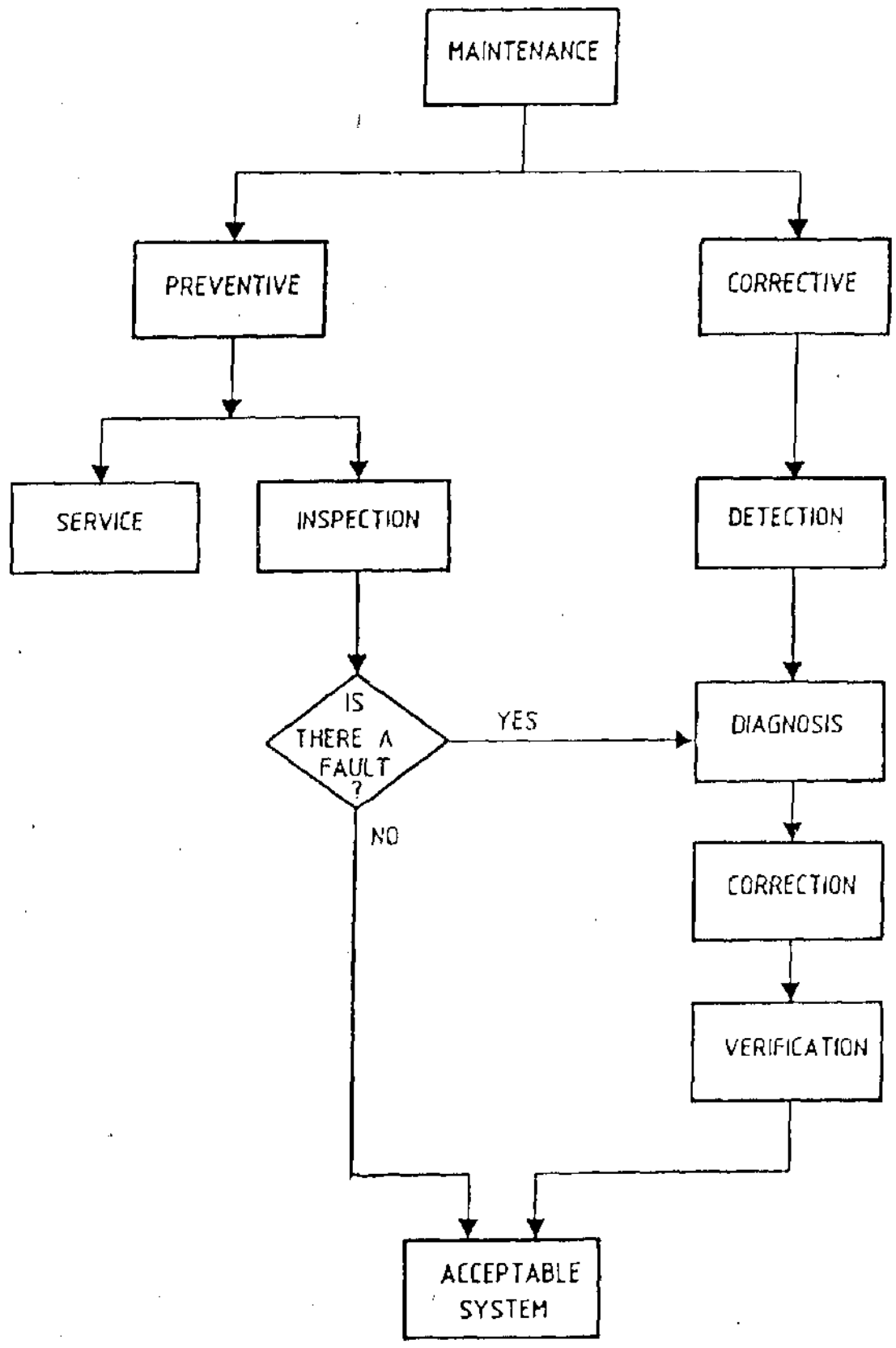



Fig. 2.1 Maintenance Flow Chart.

### 2.3.3 RESOURCE SOURCING

Resources represent the fundamental support elements that must be organized at the maintenance site or location to enhance the planned maintenance activities. Typical resources are:

1. Personnel
2. Support equipment
3. Technical documentation
4. Spare parts.

#### 2.3.3.1 PERSONNEL

Every aspect of the maintenance activity requires the specification of the technical skills and competence levels of the manpower quality and quantity required to perform the repair work

#### 2.3.3.2 SUPPORT EQUIPMENT

This defines all standard and specific test equipment, test instruments, tools, test stations, work stations/Benches required for test performance monitoring of equipment conditions; and maintenance.

#### 2.3.3.3 TECHNICAL DOCUMENTATION

Technical documentations are manufacturer's description or manual which contains technical information and ordered

instructions which are necessary for correct installation, operation and maintenance of the equipment.

2.3.3.4 SPARE PARTS

Spare parts are components, assemblies, sub-assemblies that are completely interchangeable with like-items installed or in use, which are, or can be used to replace faulty items removed during maintenance.

Spare parts may be differentiated according to the applied maintenance and repair policy of an organization: They fall under two categories:

(a) Replaceable and reparable Unit (RU)

(b) Consumable parts.

Replaceable units (RU) includes units, assemblies, sub-assemblies normally of modular construction which when faulty or damaged are entirely repaired or replaced. Consumable parts are these materials used-up during the products operation. For an aircraft detection equipment such as Radar, Magnetion, thyration, cathede-ray tube, fuses and similar items are categorized as consumables.

### 2.3.4 MAINTENANCE COST

Maintenance cost is the actual expenditure incurred in the process of keeping a working system working satisfactorily or putting back a breakdown equipment in a satisfactory working order. Common cost categories which maintenance Management is concerned about are;

1. Cost of purchased engineering equipment,
2. Cost of purchased materials/parts needed to keep the machine/plant running,
3. Labour cost of jobs done,
4. Maintenance overhead cost such as workshop, portable tools, bills, storekeepers wages, sweepers and cleaners.

#### 2.3.4.1 DETERMINATION OF MAINTENANCE COSTS

Historically, operation and maintenance costs incurred by users over the life of an engineering product have always exceeded the initial procurement cost by significant margins: This phenomenon has an adverse multiplication effect on the cost of services for which the equipment is employed.

Airline operators, for example fix higher fares so that what is accrued from ticket sales would more than offset the huge maintenance and running cost incurred. It is therefore pertinent that necessary steps be taken to first and foremost determine the maintenance repair cost before actually embarking on the maintenance service. In doing this, certain significant parameters such as Mean-Time-Between-Failure (MTBF), and Mean-Time-To-Repair (MTTR) would be given prime consideration. In an article titled "Maintenance Service Planning on Digital systems, Harrison, F.R. (Texas Instrument) stated that:

"Once the necessary MTBF's and MTTRs have been calculated the monthly maintenance cost can be determined by the following formular" (Harper 8-47)

Monthly Maintenance Costs = (Failure/Month x Cost/Failure)

or

$$\text{MMC} = \frac{\text{Failure}}{\text{Month}} \times \frac{\text{Cost}}{\text{Failure}}$$

$$\text{Where Failure/month} = \frac{\text{hours/month}}{\text{MTBF (hours)}}$$

$$\text{Failures/month} = \frac{(365 \text{ days/year} \times (24\text{h/day})/12 \text{ months/year}}{\text{MTBF (hours)}}$$

Definition of Terms:

1. Mean Time between Failure (MTBF): The total functioning of a population of "system divided by the numbers of failures within the population during the measurement interval.
2. Mean Time to Repair (MTTR): The total corrective maintenance time divided by the total number of corrective maintenance action during a given period of time.

If after maintenance cost incurement, the system is available and can successfully meet an operational demand with a clear margin of profitability, then there is system cost-effectiveness.

System availability is a function MTBF and MTTR

$$SA = \frac{MTBF}{MTBF + MTTR}$$

where MTBF = Means time between Failure

MTTR = Means Time To repair (active

In summary, there should be sufficient maintenance cost information. This is necessary so that maintenance managers will know the Naira (₦) implications and whether the maintenance cost can be justified.

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### 2.3.5 TRAINING

Training involves the identification of a course of instruction, to attain operators and technician skill and proficiency levels necessary for the equipment operation and maintenance. There are several methods for training personnel in a maintenance department for maintenance purposes. A typical maintenance training normally requires the following types of courses:

a) Formal classroom - operator training

b) Formal classroom - maintenance training

c) Short course On-The-Job-Training (OJT) programmes - designed for operators Training

d) Short course On-The-Job Training (OJT) programme - designed for maintenance training

e) Apprentice - Training programme.

In the Aviation industry courses a-d above are the most accepted form of training. However, the simplest and most effective is the apprenticeship Training programme. In Nigeria it is recognized and established as a traditional approach which appeals to various cadres of craftsmen. This traditional approach is being eroded. However, in seeking to keep up-to-

date with the emerging maintenance concepts and techniques a national programme known as INDUSTRIAL TRAINING has been established with a Funding Scheme known as the INDUSTRIAL TRAINING FUND - (ITF). It's objective is to attract and sensitize prospective candidates in the art of specialization in fields of industry and in the various maintenance - repair discipline. Apprenticeship - training has no formalized training programme rather candidates depend entirely upon exposure, supervisory job coaching, and association with experienced workmen for their training; and in-between there is a whole-range of possibilities including On-the-Job-Training, qualification and skill development evaluation, promotional programmes based on either formal or informal evaluations.

## 2.4 CLASSIFICATION OF MAINTENANCE

It is difficult to establish a clear distinction between the types or classes of maintenance. However, the types of maintenance activities could be classified into six.

1. Operational maintenance
2. Predictive maintenance
3. Repairs maintenance

4. Preventive maintenance
5. Corrective maintenance
6. Breakdown maintenance.

### 2.4.1 Operational Maintenance

This consist of putting back in working orders, as rapidly as possible, the configuration of a set of equipment which has become deficient. The role of the maintenance personnel requires the replacement of the faulty equipment by the standby-equipment.

In the case of highly complex systems such as automated system for data processing or distribution, the maintenance personnel is expected to:

- locate the fault rapidly;
- cut off the faulty section within the equipment itself;
- replace it with the standby equipment
- re-establish the operational status of the system.

To perform this task in the most efficient manner, the maintenance personnel must:

- be well acquainted with the equipment structure and processing system,
- be informed on the overall inter-connections from one equipment to another,
- know the degree of priority required by the operating constraints.

### 2.4.2 Predictive Maintenance

Recognizing that a change in the physical condition of any equipment is the principal reason for maintenance it becomes logical to consider the use of professional instrumentation;

- Sensing device
- measuring device
- monitoring device or
- micro processor

To determine significant changes, Predictive maintenance technique minimizes the need for disassembly and inspection of internal parts, and through periodic measurement or monitoring, it is possible to identify conditions that require correction before a major problem develops.

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Predictive maintenance takes advantage of some commercial equipments that are available for such purposes. These included;

- Portable vibration analyzers and amplitude meters
- Vibration amplitude and axial-displacement monitors
- Ultrasonic equipment for wall-thickness measurement and other non-destructive testing or measuring devices;
- optical tooling and non-contracting sensors for monitoring alignment and conventional vacuum flow.
- Temperature and load measuring device.

With such equipment, condition can be measured and recorded periodically and appropriate steps taken to rectify any fault before it paves the way for a major breakdown. By this, the maximum service life can be assured without increasing the risk of failure. To cite an example, one plant had some large turbo-generators that were originally dismantled for inspection every year, and later, once every three (3) years. Using predictive-maintenance monitoring equipment, they operated continuously-and satisfactorily for over 7 years.

### 2.4.3 REPAIRS MAINTENANCE (AS REQUIRED)

Repairs maintenance which is also referred to as "As Required Maintenance is simply doing maintenance work as the need develops. This elementary approach has sometimes been replaced by periodic overhauls and other preventive-maintenance practices. No matter how elementary this course of action might be, it has often become the most logical approach to maintaining noncritical equipment such as individual units or parts of a production system. "As-Required Maintenance" might be a better choice when compared with preventive maintenance for equipment that is classifical "noncritical" rather than "critical".

### 2.4.4 PREVENTIVE MAINTENANCE

Preventive maintenance is a course of action which is undertaken before the need develops to minimize the possibility of unanticipated production interruption or major breakdowns.

Preventive Maintenance requires the periodic check of operational equipment so as to offset a certain number of subsequent failures. It also requires the complete shutdown of the equipment concerned while "normal" operation is sustained by a standby equipment. Although this type of maintenance

seems to be a sound maintenance idea, it may be found that when such planned preventive-maintenance programme are developed and followed religiously, the time required to perform this maintenance leads to certain decline in performance particularly because the operating practices to reduce maintenance work downtime required to effect the replacement by a standby unit and extent of overhauling result in loss of production.

For example aircraft surveillance Radar preventive maintenance schedule requires that the maintenance personnel must:

- Be fully acquainted with the material whose operation he has to check the general structure and the status of entry and exit signals.
- Know the functions which exist concerning the cards themselves as well as their interconnections.

Due to the fact that the downtime required to perform the work results in loss of production, it is a good precautionary measure to consider preventive maintenance only when:

- Corrective maintenance cannot be justified
- Predictive maintenance cannot be applied
- "As required" maintenance cannot be tolerated.

### 2.4.5 CORRECTIVE MAINTENANCE

This cause of action calls for the putting back into normal operating order the equipment which has broken down. The repair work can be carried out;

- either on the site itself (when dual equipment does not exist) or when it cannot be displaced.
- In the workshop with workbenches or station well aligned with facilities and test instruments.

The actual repair work consists of;

- detecting the faulty part
- locating the deficient element in this part
- Replacing the faulty part or parts
- Checking and deciding, if necessary, to put it back into service.

In corrective maintenance the maintenance personnel intervenes directly when a breakdown occurs in the overall system or a sub-system or in the components themselves.

### 2.4.6 BREAKDOWN MAINTENANCE

This course of action implies that the equipment is allowed to continue operation until it cannot perform its normal function any longer, and the production department is compelled to call on the maintenance engineer to rectify the defect. After repairing the defect the maintenance engineer do not attend to the equipment again until another failure occurs.

## 2.5 MAINTENANCE AND REPAIR CONSTRAINTS

Until recently Maintenance Management was considered insignificant and a somewhat neglected field but only reflected in the accounting processes or records of organizations. Rather than incuring some cost in improving Maintenance activities to ensure efficient and adequate utility services in their organization, Managers of resources diverted their interest to the acquisition and erection of new plants and equipment. They leave behind a mortuary of abandoned and unserviceable plants and equipment that rot away at undesignated corners of their premises.

Consequently, maintenance standards in Nigeria became woefully inadequate without any discernable sign of improvement in the services provided. It is not out of place to infer that the poor performance of plants, equipment and machinery used for productive purposes is mainly due to the product of:

- lack of Maintenance
- Poor work ethic
- Inefficient Financial Management

Some constraining factors as x-rayed by Onyemelukwe et al have been identified below:

1 Diversion of scarce capital.

2 Lack of skilled operators combined with inadequate care and attention shorten the life of many machines;

3 Much of capital equipment used in our productive endeavours are basically designed for temperate countries using extrapolation of design data to stimulate conditions in tropical countries. Experience has shown that when such equipment are subjected to the rigorous temperature and rainfall, humidity conditions termite and other parasitic attacks, need stricter maintenance.

Industrial motors for example are known to require regular attention in conditions of high humidity. Power shortages and loss of industrial production have sometimes been due to rats, and other times, cobwebs, usts, which caused short-circuits on industrial switchgear. Extra efforts are needed to guard against rust in metallic parts. Other factors included;

4 Problem of spare parts: For simple maintenance requirements, it may prove more economical to repair a damaged part and save on the spares. On the other hand, for the more complicated maintenance for which highly skilled and sometimes costly expatriate labour may be needed, it may be cheaper automatically to replace defective parts. Organizations could weigh this action with the long-term advantages of training skilled indigenous maintenance personnel.

5 Out - of stockspares: It is a common experience that certain spare parts cannot be easily obtained because they are not being manufactured anymore by the original

exporters. To get this parts the overseas manufacturer may set up special production runs with the result that the price of the spares is very high. A properly equipped workshops on the spot could help solve this problem.

## 2.6 MAINTENANCE SITUATION IN NIGERIAN AVIATION INDUSTRY

The level of maintenance efforts in Nigeria is pathetic. As a consummer nation a lot of aged aircraft and equipment are dumped on us which quickly become obsolete due majorly to the inexistence of logistic support and maintenance management. Maintenance and repair in Nigeria are further constrained by:

(a) Reluctance to invest in maintenance effort which do not promise visible and immediate financial returns to the investor.

(b) Sheer ignorance. There is a subconscious notion often exhibited among Nigerians that anything mechanical has been so robustly constructed and manufactured that they assign to it, mystic strength and durability.

(c) Others regard aged equipment as obsolete and valueless and so threat it carelessly. The result of

these attitudes is loss of quality and intermitent breakdown, in addition to the difficult operating conditions that go with badly maintained equipment.

Onyemelukwe further stresses that

> *"In the few indigenous Nigerian plants where a claim is made for high maintenance standards, it was commonly found that maintenance was controlled and carried out by the production foreman as he thought necessary. In other instances maintenance was done when there was a breakdown; or maintenance was confined to periodic lubrication and other minor operation".*

(d) - Increased equipment complexity and performance. Due to changing technology, modern maintenance approaches call for organized maintenance such as inspection and overhauls at regular and scheduled intervals. For this purpose a plan has to be established to indicate periodicity of inspection and overhauls, and the work to be done in such case.

(e) Absence of Rigid inspection and quality control. A few reasons advanced by Onyemelukwe, pp 211-214 on why rigid inspection and quality control are not commonly practiced in Nigeria are;

(i) The ordinary consumer cannot distinguish between good and sub-standard product.

(ii) Nigeria has no acceptable standards in many industrial fields, hence industrial firms do not feel obliged to work to any standard specification. Even when there is a claim to work or produce in accordance with an internationally recognized standards, there are practically not enough facilities to check compliance;

(iii) The absence of national standards in Nigeria and the tendency of foreign firms especially Multinational Corporations to import what ever equipment they want according to the technical standards of their home country do not help the position. I recommend that a co-

ordination at the national level would be a big step forward.

### 2.6.1 ENVIRONMENTAL EFFECTS ON MAINTENANCE AND REPAIR

Improvements in Maintenance and repair activities in the Aviation Industry are severely hampered by environmental factors and other effects.

1 - economic environment,

2 - social environment,

3 - political environment and,

4 - cultural environment;

Other effects are;

5 - Government policy

6 - Law and order

#### 2.6.1.1 ECONOMIC ENVIRONMENT

Olusegun Osunkeye p.9 in his article titled "Managing for higher productivity in a volatile environment published in "MANAGEMENT" Journal scanned the economic environment and I quote;

"In the last decade, the Nigerian economy has performed below expectation. The nation has experienced continuous economic recession which has culminated into a prolonged and painful episode of rising prices, high level of unemployment, increases in bankruptcy and general decline in the growth of our national Output."

This kind of situation impedes long term planning and breeds negligence of maintenance of plants and equipment. The Nigerian Aviation Industry is not an exception to this.

2.6.1.2 Social Environment

In the Nigerian visioning process; Chief (Dr) E.A.O. Shonekan Chairman Vision 2010 made a pathetic remark that our core social values, indeed what make us unique as a people seem to have eroded overtime. Moral bankruptcy, indiscipline, dishonesty, fraud and the associated cankerworm of bribery and corruption are among the social problems afflicting our country. Infact when management loses confidence on the integrity of its staff, it may prefer to "do nothing" in any maintenance and

repair proposal. Hence plants and machinery for industrial or economic use are neglected and carelessly abandoned. Of course they litter everywhere one turns. Airport and Aircraft hangers around the country is a classical example.

2.6.1.3 Political Environment

Changes are bound to occur in the political environment. But when such changes become erratic and frequent, there is bound to be uncertainty. Politically, the environment has been characterized by turbulence manifested by frequent and unorthodox changes in government; ethnic rivalry and bickering among others. Indeed political instability and fluidity of the machinery of Government has caused far reaching consequences which I have summarized below;

- makes economic planning difficult
- erodes investors confidence
- introduces capital flight
- encourages disinvestment.

2.6.1.4 Cultural Environment

If mundane cultural practices, belonging to ancient times which are no longer relevant in today's world are allowed to creep into the present and still guide and govern our behaviour and judgment. It will block the development of the mind and clouds our imagination especially in the area of scientific research investigation.

A people's allegiance to their social, customs, traditions and religious structures, intellectual and artistic practices handed down from generation to generation that guide and governs their behavioural pattern and judgement, has the tendency of adversely affecting the development of the mind or body by formal education or training.

In such environment, where behaviour and lifestyles have been conditioned by what they saw and heard, advanced development of the power of the mind through research for new and easier ways of getting things done is taken for granted. Naturally, it does not appeal to them. A society characterized by active cultural influence can hardly lend itself to cognitive and psycho-

motor learning that induces the of culture of innovation and maintenance.

2.6.1.5 Government Policy

In Nigeria, the main feature of government economic policies lack consistency and suffers from lack of complimentarity with the strategic interest of corporate institution. With policies so unstable it is difficult to predict in which direction the economy is going.

Apart from policies that are never consistent, there are bureaucratic controls of exchange and interest rate which in-turn results in instability. The exchange rate of the Nigerian currency, the Naira, has been a victim of frequent depreciation in the last decade. This trend has exacerbated the inflationary situation in Nigeria. The Ministry of Aviation is the aeronautical authority of Nigeria. It is responsible for the formulation and implementation of aviation policies, while its agencies, the parastatals sets standards monitors them and ensures

that operators of aviation activities comply with the standards.

2.6.1.6 Law and Order

Law and Order are indispensable to the creation of a conducive environment that is attractive for investment. Where this is lacking, the legal environment becomes less facilitative of a healthy investment climate and business activities. Adamu, H. in his paper titled "Management of Resources in an unstable environment" describes such a situation as a conducive atmosphere of general insecurity to life and property which is a major threat to investors and corporate existence.

## 2.7 MAINTENANCE REPAIR POLICY

If maintenance activities are to be operated so that the plants, machinery and/or equipment are running at the required level of productive efficiency and cost, there must be basic mandatory policies that guide that operation. These policies cover the following aspects of the maintenance activities:

1. Policies with respect to a failure event,
2. Policies with respect to schedule of maintenance;
3. Policies with respect to maintenance contracting;

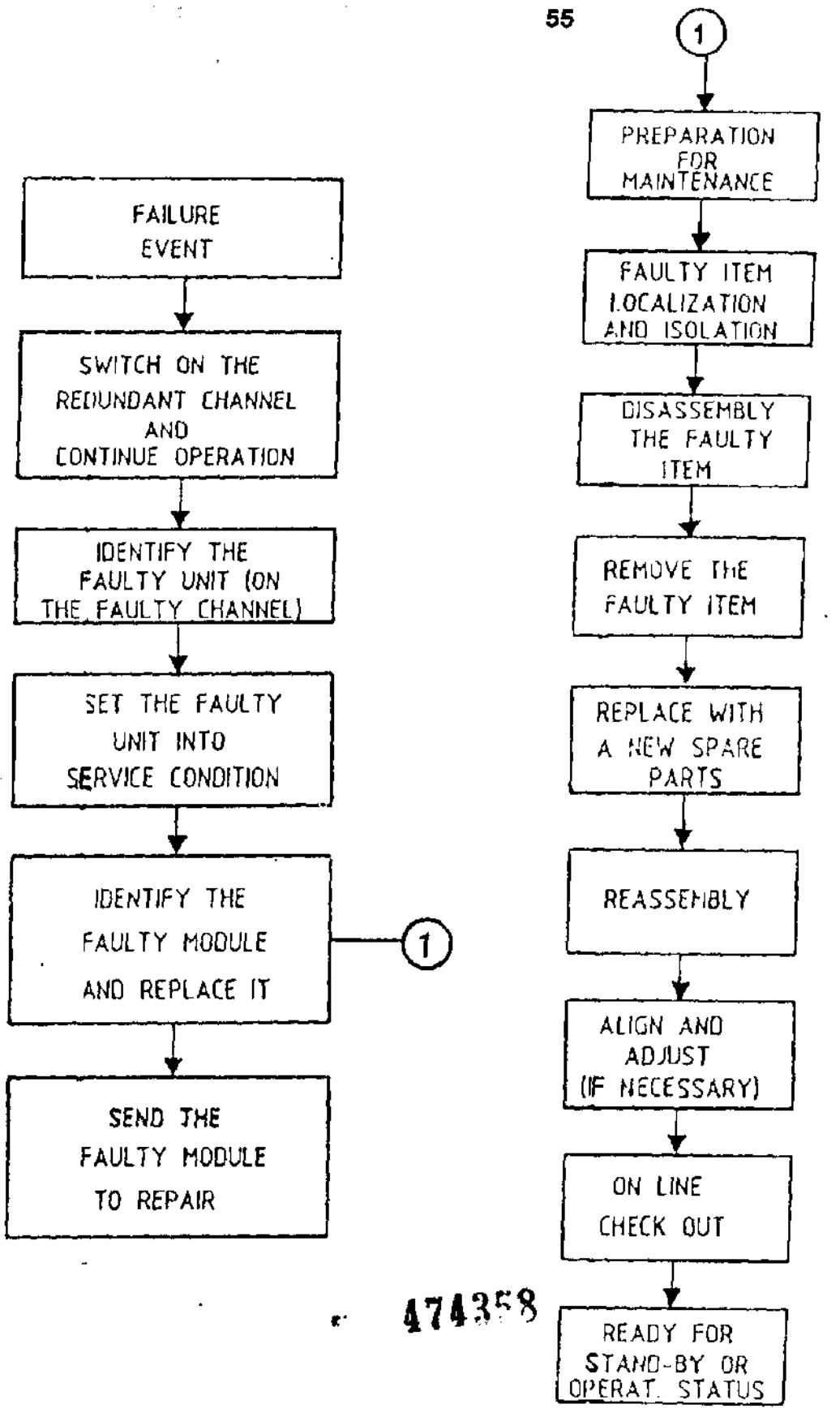
4. Policies with respect to maintenance cost;
5. Policies with respect to manpower quality of maintenance personnel.

2.7.1 Policies with Respect to A failure event:

A typical maintenance repair policy of SELENIA (now ALCATEL), an Italian company that specializes on the design of Radar and Telecommunication systems is shown in a flow chat below:

2.7.2 Policies with respect to schedule of maintenance:

This aspect requires the placing of the different operations in the best possible sequence. It takes care of the choice as to whether it will be conducted at Site location or workshop or at manufacturer's facility.




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Fig. 2.2 Typical Repair Policy.

2.7.3 Policies with respect to *maintenance contracting*:

This aspect deals with who conducts the maintenance activity; end-users of the equipment; external maintenance organization and/or the manufacturer's facility. The primary factor in deciding whether to use an outside contractor is cost.

2.7.4 Policies with respect to *maintenance cost*:

Naturally the annual maintenance cost should be fixed at a certain percentage of the investment. Knight Charles E, in his article titled "Operating Policies by which management should be guided" gave an insight of some percentage that had been tasted elsewhere. He advanced, the opinion that annual cost of maintenance should run between 7 and 15 percent of the investment so that the approximate rate of return on the investment would not fall below the level of gain expected.

For example on January 6, 1994 the Nigeria Airway B707 Cargo aircraft (5N-ABK) was seized at Kent, United Kingdom for two years for maintenance debts. Another Nigerian Airways Airbus A310 (5N AUH) impounded in the same year at Heath Row Airport London for the airlines debt to BAA and Euro Control.

These incidences had threatened the corporate existence of Nigeria Airways Adequate maintenance cost policy would have eliminated such embarrasment.

2.7.5 Policies with respect to Manpower quality:

Most organisations especially those engaged in the operation of heavy duty plants and machinery or highly complex equipment, such as aircraft, places sharp restrictions on the criteria for maintenance personnel selection.

When this is the case, the criteria for selection should be education, general intelligence, mechanical aptitude, past experience and age. To ensure relative efficiency of the maintenance operation where the labour costs do not exceed the total maintenance bill, there must be an established minimum and maximum number of maintenance employees necessary to maintain a plant, machinery or a fleet of Aircraft properly.

## 2.8. CHOICE OF MAINTENANCE SYSTEM

Several maintenance systems have evolved over the years as enumerated and analyzed in 2.4 above. The choice of a

particular maintenance system must be compatible with the peculiarities of the plant, machinery and equipment to be maintained.

In a developing country like Nigeria, with seemingly first generation of engineers, technologists, industrialists etc, where industrial development is at the embryonic stage, the general practice is the "fire-fighting or "Ad-hoc approach". In this approach, the equipment is operated after the installation and handing-over ceremonies, until a breakdown point. It is then repaired and operated till another round of breakdown occurs. Airlines skip the routine maintenance of their aircraft until a point of grounding is reached.

There is the "don't touch" attitude; which is founded on the concept that since the equipment is functional whether it is operating optimally according to the manufacturer's specification or minimally due to unidentified degradation you need not tamper with it. This is a very wrong concept. Maintenance, if any, is usually conducted in a haphazard and frustrating manner giving rise to an unproductive effort and a huge economic waste.

Unfortunately, advances in aviation Technology have not been matched by improvement in the way we organize the maintenance people who maintain aircraft. Hence as the aircraft become more and more complex, operators must strive to apply relevant maintenance approaches that would improve aircraft performance. A more scientific approach is called for. The choice of a maintenance system is facilitated by an understanding of a maintenance repair history.

## 2.8.1 MAINTENANCE REPAIR HISTORY

Scientific data on the maintenance repair history of any equipment are necessary ingredients in choosing the course of maintenance action. Components of the maintenance history are;

- Repairs carried out to ensure system availability
- Periodic inspection to identify nature of fault
- History of overhauls carried out.
- Other major work involving dismantling of the equipment.

When such data are collected and analyzed, choice can reasonably be made regarding the most logical and economic maintenance action that would restore the equipment into a satisfactory operating performance. It should be noted here that data collection is of little, value unless there is systematic analysis of such data.

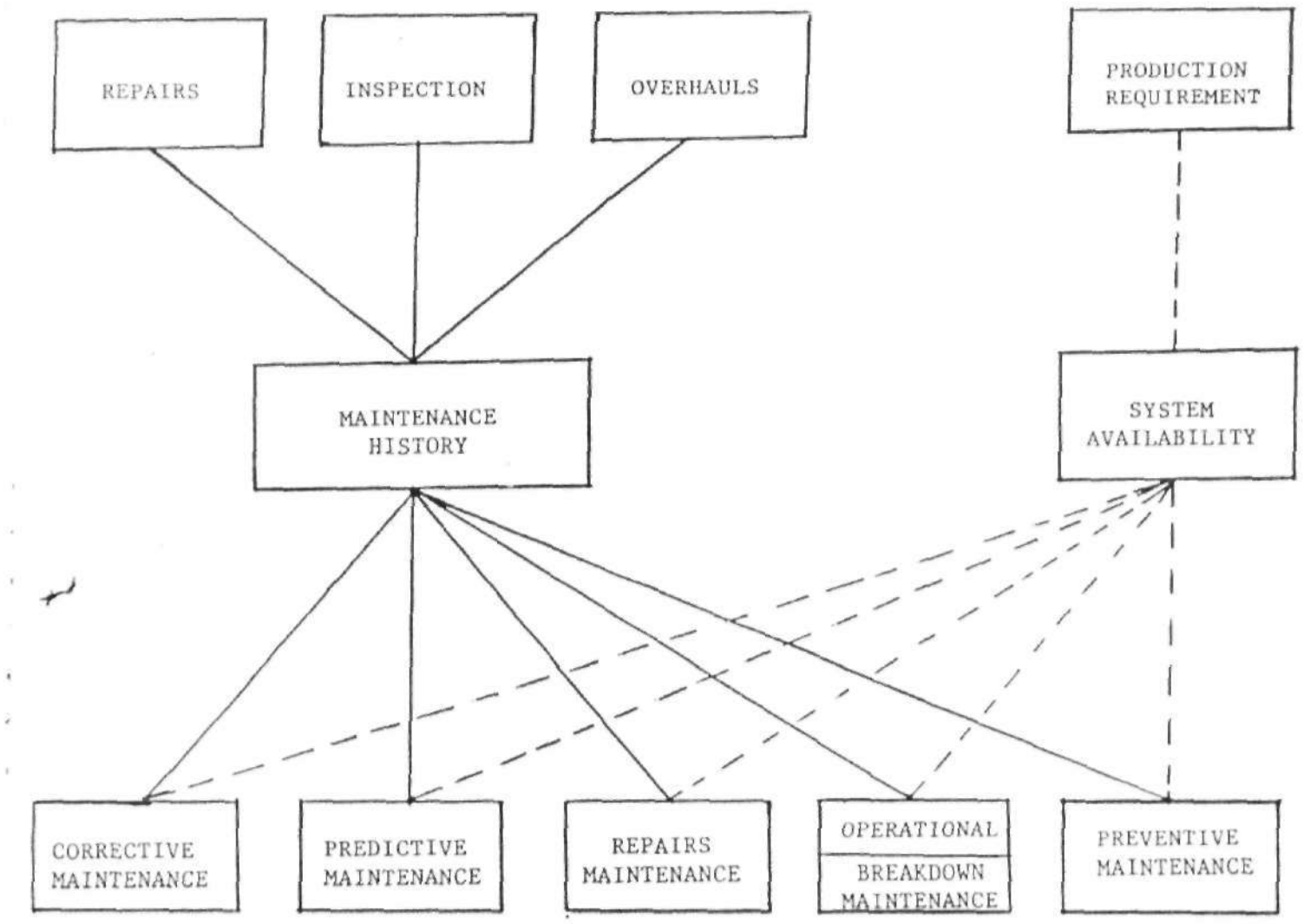



Figure 2.3 Flow Chart For The Establishment of a Course of Maintenance action.

System availability as I stated earlier on, is the primary objective in every maintenance effort, so that the system (equipment) is serviceable and available for production activities.

As indicated in Fig. 2.3 analysis of maintenance history as well as current production requirement are needed to establish course (s) of action. Logically if a maintenance problem can be eliminated or if the service life of units or components that are defective can be extended, corrective action should be considered. Or, if it is evident that a problem will have to be tolerated because the cost of modifications cannot be justified preventive or predictive maintenance may be considered.

In some cases, particularly when non critical equipment is involved, repairing equipment as the need becomes evident, could be the logical course of action.

## 2.9 BUDGETING FOR MAINTENANCE

Maintenance budgets are financial forecasts of items of manufacturing or production cost for the purpose of overall financial planning. Generally such forecasts are rough estimates for the upcoming year based on historical data usually

established for the period of one year. Nevertheless quarterly adjustments in maintenance budget are found to be necessary and sometime more realistic.

It is the responsibility of the maintenance department to ensure that the expenditure, even when justifiable by management does not cause an abnormal deviation.

### 2.9.1 OPTIMUM VOLUME OF MAINTENANCE COST

Although large companies have, however continued to budget based on historical data, Stewart, H.V.M P 124 opined that if the optimum volume of maintenance were assessed along with the standard cost of the materials and labour, the overall cost of maintenance could be budgeted more accurately thereby providing a suitable measure of maintenance management efficiency. In summary, therefore budget should not be used to guide maintenance effort in the same way as controls are used but ought to be treated as temporary restriction in expenditure.

## 2.10 INFRASTRUCTURAL AND TECHNOLOGICAL SITUATION IN THE AVIATION INDUSTRY

The Aviation Industry and indeed airline operations expanded

rapidly since the application of the deregulation policy in 1989. This policy broke the monopoly of Government owned Nigeria Airways, and opened the floodgate for private sector participation and infrastructural development.

Consequently, the number of airports and aerodromes increased to well-over 20 in the last two decades while the registration of airlines rose to well-over 200 between 1989 to 1997; expanding flight operations and airlines services to many parts of the country which hitherto were not served by Nigeria Airways. Unfortunately only a few of these airlines are operating today.

A careful analysis of the infrastructural situation in the Nigerian Aviation Industry reveals 24 problems that affects the industry today.

- Inadequate navigational Aids facilities
- Undulating runway
- Poor standard Terminal building
- Lack of fire-fighting and service equipment
- Faulty screening device
- Erratic power supply

- Inadequate standby power sources
- Inadequate fencing facilities/exit gate in case of emergency
- Touting
- Inadequate security flood lights
- Inadequate communication equipment
- Absence of Intra International Transportation link.
- Illegal and uncontrolled vehicular movement across runways.
- Obsolete facilities and no spare parts
- Weak Radar coverage or surveillance equipment
- faulty Flight information Display unit
- Broken luggage conveyor belts.
- Water shortage
- Uncalibrated signal equipment.
- Lack of search and rescue equipment
- Inadequate Bird-strike prevention measures
- Noise abatement/Environmental Pollution
- Lack of Maintenance of available facility
- Inadequate V.H.F coverage.

Similarly, the nation's airline operator are adversely affected by multi-dimensional socio-economic problems, prevailing low level of economic activities and the less-than-average technological development. Investigation reveals eight reasons why majority of the airlines have collapsed:

- Income/Expenditure mismatch due to Exchange Rate and Low Regulated airfares
- Difficulties in acquisition-financing, acquiring older aircraft as the only alternative.
- Operation of aged aircraft with high maintenance cost, although low acquisition cost.
- Lack of maintenance facilities in the country which causes all major maintenance repair work to be done abroad.
- Inability of Nigeria Airways Limited, and inaccessibility of private operators to lucrative international routes (BASA).
- Poor spirit of competition resulting in lack of cooperation
- Poor marketing strategy
- Managerial incompetence.
- Work around - performing maintenance tasks without all the necessary equipment.

Indeed, the survival of the Aviation Industry rests squarely in the hands of government to provide the facilities and systems needed to meet the growth requirement of the aviation industry in the years ahead.

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One commendable giant step taken by Government is the establishment of a training institution - The Nigerian College of Aviation technology Zaria charged with the keeping of maintenance standards through training.

# CHAPTER THREE

## 3.0 METHODS OF PROCEDURE OR METHODOLOGY

The methodology adopted in this study are

- Personal interviews
- Questionnaires
- Literature review
- Personal Experience

## 3.1 PERSONAL INTERVIEW

A total of five maintenance engineers, who are conversant with the maintenance activities of the College, were interviewed. This interview was a conversation carried out with the aim of obtaining or gathering valid and reliable information through the responses of the interviewed. It was conducted in an informal manner in their offices. Out of the 5 interviewed 4 gave valid and reliable responses while one of them felt threatened and so withheld his responses to some questions.

## 3.2 QUESTIONNAIRE

To further gain an indepth knowledge of the maintenance

activities of NCAT, a questionnaire was designed and distributed to maintenance personnel in seven maintenance department in NCAT.

## 3.3 LITERATURE REVIEW

Several books on maintenance management, Aviation journals, magazines, articles, Handbooks on Maintenance personal class notes etc were consulted.

## 3.4 PERSONAL EXPERIENCE

As a Radar maintenance personnel, resources were drawn from the maintenance activities and practices conducted in Radar Maintenance department of the Aero Telecommunication School.

This thesis titled Maintenance Management in Nigerian Aviation Industry (A case study of NCAT) is the result of this research effort.

# CHAPTER FOUR

## 4.0 HISTORICAL BACKGROUND OF THE NIGERIAN COLLEGE OF AVIATION TECHNOLOGY, (NCAT) ZARIA

### 4.1 INTRODUCTION

The rapid expansion of Civil Aviation activities in the West African Sub-region in the 40's and 50's, coupled with the attainment of Independence in Nigeria in 1960, prompted early consultations between the Federal Government of Nigeria and experts of two International bodies: United Nations Development programme (UNDP), and the International Civil Aviation organization (ICAO), for the establishment of a Civil Aviation training project in Nigeria. Being convinced of Nigeria's ability to join the global expansion of Civil Aviation, a United Nations Special Fund was approved for the project in January 1963.

The bill (Act) establishing the "Training Centre" was passed and signed into Law by the Nigerian House of Representative (Parliament) on September 29, 1963. The Nigerian Civil Aviation Training Centre came into being on October 25, 1964 and

actually took-off in 1966 in conformity with global standards laid down by ICAO for establishing similar institutions in the world.

The project was formulated as a Joint Venture between the Federal Government of Nigeria, the United Nations Development Programme (UNDP) and the International Civil Aviation Organization. Considering the scope of training conducted (ab-initio and advanced), and that envisaged for the future, the Federal Government of Nigeria effected a change of Name from Nigerian civil Aviation Training Centre (NCATC) to Nigerian College of Aviation Technology (NCAT) in 1986.

At the inception of the Nigerian Civil Aviation Training Centre (now NCAT) the Federal Government of Nigeria, under a tripartite arrangement, provided the following:

- Infrastructure;
- Counterpart Instructional Staff;
- Furniture facilities;
- Transportation facilities;
- Insurance coverage, and
- Operating expense.

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The UNDP, on the other hand, provided the EXPERTS and most of the Training Equipment over the period 1964-1974. On the strength of agreements reached with the Nigerian Government, UNDP appointed the International Civil Aviation Organization (ICAO) as the executing agency responsible for all its obligations and commitments during their period of assistance.

The joint programme of assistance from UNDP and ICAO came to an end on December 31, 1974. From then onward, the Government of the Federal Republic of Nigeria assumed full responsibility for the continued existence, Management and Operation of the institution.

## 4.2 OBJECTIVES OF NCAT

Two objectives were distinctively spelt out:

- SHORT-TERM
- LONG-TERM

### 4.2.1 Short-Term Objective

The short-term objective was for the International Experts to train and transfer technological skills and Instructional technique to Nigerian counterpart instructional staff.

4.2.2 Long-Term Objective

The long term objective for establishing the institution is:

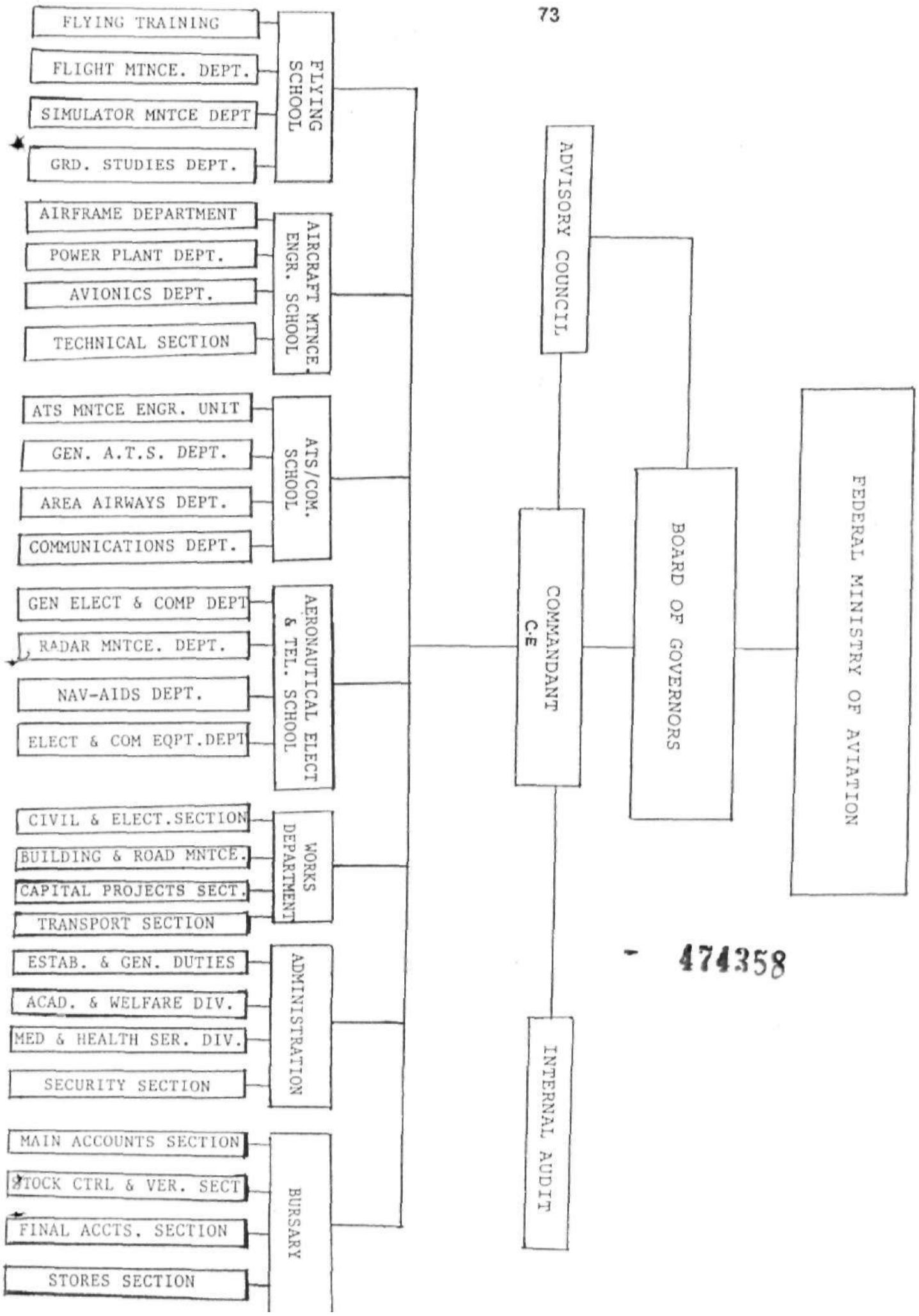
1. To train and supply skilled Manpower requirements in such specialized areas as:
   - Aircraft Pilots;
   - Aircraft Maintenance engineers;
   - Air Traffic Controllers;
   - AeroTels maintenance engineers;
   - Aviation Research;
   - Aviation management;

   on a continued basis for the civil Aviation Industry as a whole.
2. To promote civil aviation operations in order to assure safe and orderly growth.

4.3 ORGANIZATIONAL STRUCTURE AND TRAINING ACTIVITIES

The Nigerian College of Aviation Technology is organized into four schools and three service departments namely:

- Flying School; ((FS)
- Aircraft Maintenance engineering School; (AMES)
- Air Traffic Services and Communication School; (ATS/COM SCHOOL)


FEDERAL MINISTRY OF AVIATION
BOARD OF GOVERNORS
ADVISORY COUNCIL
COMMANDANT C.E
INTERNAL AUDIT
FLYING SCHOOL
FLYING TRAINING
FLIGHT MTNCE. DEPT.
SIMULATOR MNTCE DEPT
GRD. STUDIES DEPT.
AIRCRAFT MTNCE ENGR. SCHOOL
AIRFRAME DEPARTMENT
POWER PLANT DEPT.
AVIONICS DEPT.
TECHNICAL SECTION
ATS/COM. SCHOOL
ATS MNTCE ENGR. UNIT
GEN. A.T.S. DEPT.
AREA AIRWAYS DEPT.
COMMUNICATIONS DEPT.
AERONAUTICAL ELECT & TEL. SCHOOL
GEN ELECT & COMP DEPT
RADAR MNTCE. DEPT.
NAV-AIDS DEPT.
ELECT & COM EQPT.DEPT
WORKS DEPARTMENT
CIVIL & ELECT.SECTION
BUILDING & ROAD MNTCE.
CAPITAL PROJECTS SECT.
TRANSPORT SECTION
ADMINISTRATION
ESTAB. & GEN. DUTIES
ACAD. & WELFARE DIV.
MED & HEALTH SER. DIV.
SECURITY SECTION
BURSARY
MAIN ACCOUNTS SECTION
STOCK CTRL & VER. SECT
FINAL ACCTS. SECTION
STORES SECTION

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- Aeronautical Telecommunication Engineering School; (ATES)
- Works Department;
- Administration;
- Bursary Department.

All the four schools conduct standard as well as specialized courses.

4.3.1 FLYING SCHOOL

The flying School conducts Standard courses in the following areas:

- Flight Training for commercial Pilot Licence (CPL) with Instrument and multi-engine ratings on fixed wing Aircraft.
- Airline Transport Pilot Licence
- Jet simulator conversion
- Refresher courses for graduate pilots and senior pilots from airlines
- Simulated flight Training.

### 4.3.2 AIRCRAFT MAINTENANCE ENGINEERING SCHOOL (AMES)

The AMES conducts standard courses in the following areas:

- Aircraft engineering courses on Airframe and Powerplant
- Aircraft engineering course on Avionics

### 4.3.3 AIR TRAFFIC SERVICES AND COMMUNICATION SCHOOL

(ATS/COM SCHOOL)

The ATS/Com School conducts Standard courses in the following areas.

- Air Traffic Control
- Aeronautical Communication
- Area/Airways Procedural Control
- ATC Radar Simulated training

### 4.3.4 AERONAUTICAL TELECOMMUNICATION ENGINEERING SCHOOL (ATES)

The ATES conducts standard courses in the following areas;

- Aerotels maintenance engineering
- Navigational Aids Equipment maintenance; VOR, DME, ILS
- ATC Radar Equipment Maintenance

The levels of knowledge and skill attainable at the successful completion of all the standard and specialized courses conform with the minimum standard and recommended practices outlined in Annex 1-Personnel licensing and other relevant annexes to the Convention on International Civil Aviation. The Syllabi and course curriculae are based on the material contained in the relevant ICAO training manuals and the specialized equipment manufacturer's manuals.

## 4.4 PAST AND PRESENT OPERATIONAL ACTIVITIES OF NCAT

The Nigerian college of Aviation Technology was established and equipped to perform the role of satisfying the manpower requirements of the aviation industry through manpower training development and supply.

As a high technology industry, new technologies are constantly changing the modes of aviation operations. To keep abreast of these technological growth, the NCAT offers qualitative training programme and also conducts retraining programmes for all cadre of aviation profession especially in areas where deficiency exist; Pilots; aircraft maintenance Engineers;

AeroTelecommunication Maintenance Engineers; Air Traffic Controllers; Air crew; Air Traffic Management; Airport Management; Aviation Security and Safety Management; Aviation Law and other related management training programmes.

## 4.5 ACHIEVEMENTS OF NCAT

Since training commenced in May 1967, the NCAT has graduated about 4,200 students in various areas of aviation disciplines as at April 1997. Out of this number that successfully completed various courses and have been supplied to the industry, a total of 200 graduates were drawn from other countries of the African and Indian Ocean Regional Air Navigation (AFIRAN.

In a bid to maintain high standards in student training and also keep pace with the technological trends in the industry, NCAT has over the years acquired additional training equipment and infrastructural facilities for the schools as follows:

- ATC 33A Selenia Radar System installed and commissioned in 1979;

- A Jet simulator building for 2 Jet aircraft simulator of Boeing 737 Category was completed in 1980
- A Thomson-CSF ILS Navigational aids equipment was installed in 1983;
- Two (2) New Frasca 141 flight simulator were acquired and installed for formal training of pilots in 1985;
- Area Airways Procedural simulator was installed in 1985;
- A third Hanger building to accommodate Helicopter and small jet aeroplanes intended for Helicopter training and initial Jet Training was completed in 1986;
- Advanced Radar simulator from Thomson-CSF of France was installed and commissioned in 1989
- Purchase and installation of Personal computers in 1995;
- Three (3) New Beach Baron 58 aircraft were acquired in 1996 for flight training;
- 12 Single engine aircraft were acquired for student pilot training
- On internal staff development, Overseas study - Fellowships, and local courses such as manufacturers courses for engineers and technicians; Management

courses of various cadre and licence courses for instructors are organized and executed at various times.

## 4.6 PROBLEMS AND CONSTRAINTS OF NCAT

Although NCAT occupies an important position in the development of Aviation Industry, it is noteworthy that its role as a National manpower provider is being hampered by various problems and constraints currently being experienced.

- Shortage of enough experienced professional aviators
- Inadequate funding to support projects
- Equipment obsolescence and increased cost of maintenance;
- Insufficient data for effective planning and monitoring of the technological trends in the industry
- Preference of other training institutions to NCAT by airlines and operators of the industry.
- Absence of facilities for Aviation Research and development projects
- Acquisition of new machines and equipment without the complementary training programmes that would enhance its utility and productivity.

## 4.7 FUTURE PROSPECTS OF NCAT

As the principal source of aviation technical training for Nigeria, NCAT envisages to provide adequate personnel training to meet national expectations in the supply of Manpower requirements for the various establishments within the Aviation Industry in the following ways:

- Upgrading and modernization of the Basic Training facilities in all the schools; as contained in ICAO Masterplan for Rehabilitation of NCAT UNDP/ICAO Project NIR/82/011" of February 1983:
- Raising the entry qualifications for admission into all the schools of the College to University Degree and/or H.N.D due to falling standard of education and advancement in Aviation technology
- Formalizing the conversion of NCAT as an ICAO Regional Centre for Aviation studies.
- Encouragement of private sector participation in student sponsorship, and funding of some projects in the College.
- Joining the TRAINAIR Programme of ICAO.

## 4.8 MAINTENANCE IN NIGERIAN COLLEGE OF AVIATION TECHNOLOGY (NCAT)

Two distinct maintenance practices are found in NCAT. They are

1. General infrastructural Maintenance.
2. Equipment Maintenance.
   - Aircraft.
   - Communication, Navigational and Surveillance Equipment.

I am going to dwell more on Aviation equipment maintenance with brief explanations on General maintenance.

### 4.8.1 GENERAL MAINTENANCE.

General maintenance in NCAT is the primary responsibility of Works Department whose maintenance crew perform Repairs - Maintenance or As Required maintenance as the case may be, on the physical structures and installations; buildings, furniture, roads, Electrical generation and distribution network, electrical appliances, office equipment, motor Vehicles and motorized equipment.

The Maintenance Crew who perform maintenance tasks in the Works Department possess Craft or artisan skills; technical skill; technological skills and even Engineering skills but not aviation professional equipment maintenance qualifications and Certification.

The maintenance tasks are often performed at the location of damage or breakdown site on a daily, weekly, monthly and annually as may be required. Infact, the crew, like medical doctors, are on-standby throughout the day-light hours, always making themselves available for any maintenance duty. Their trade marks (tools, instruments, etc) are usually secured on their hands or elsewhere on their uniforms.

### 4.8.2 AVIATION EQUIPMENT MAINTENANCE

Aviation equipment are in a class of their own. These are specialized equipment used solely for Civil Aviation Purposes and cannot be effectively utilized for any useful operation outside the Aviation Industry.

These equipment included:

- Aircraft of various capacities and makes.

- Aircraft Simulators.
- Aeronautical Telecommunication Equipment.
- Air Traffic Control Radar Equipment.
- ATS Radar Simulator.
- Area Airways Simulator.
- Navigational Aids Equipment:
- VOR
- DME
- ILS

Others back-up equipment are:

- Fire fighting Vehicles.

Computer networks for Research Analysis:

These items of equipment fall under two broad Categories:-

- Cat 1 -Aircraft.
- Cat 2 -Communication, Navigational and Surveillance Equipment.

Each of the four Schools has specialized maintenance Department that performs all the maintenance tasks on the equipment unique to them. See table 1.0.

Table 1.0 Schools and their Maintenance Departments.

| NAME OF SCHOOL | MAINTENANCE DEPT | MAINTENANCE TASK |
|---|---|---|
| Flying School | - Flight Mtce. Dept.<br>- Aircraft Simulator Department | Pre-flight inspections and A/C servicing<br>Aircraft Simulator Maintenance. |
| Aircraft maintenance Engineering school | - Aircraft Mtce. | Servicing of Aircrafts. |
| Aeronautical Telecommunication engineering School | - ATC Radar Mtce. Dept.<br>- Navigational Aids Department.<br>- Com. Equip Maintenance Dept. | Radar Equipment maintenance.<br>VOR, DME, ILS maintenance.<br>Telecom Equip. Maintenace |
| Air Traffic Services School | - ATC Radar Simulator Mtce. Department<br>- Communication Equipment Department | Radar Simulator Maintenance. |

Officers who perform maintenance tasks on Aviation equipment posess professional qualifications on Aviation related disciplines;

- Aircraft Maintenance Engineering;
- Simulator maintenance Engineering;
- AeroTels Maintenance Engineering;
- ATC Radar Maintenance Engineering;
- Navigational Aids Maintenance Engineering;

in addition to their basic Engineering related discipline acquired at a recognized university or polytechnic.

To qualify as a maintenance personnel Officer in NCAT you must have successfully completed a core equipment maintenance training programme either through formal classroom instructions in NCAT and/or at the Manufacturer's training facilities usually organised abroad.

To actually operate and maintain any equipment, your competence and proficiency levels would have been tested and certified and a license issued.

These Officers bear job titles; such as:

- Aircraft Maintenance Engineers.
- Radio Maintenance Technicians.
- Airborne instrument Maintenance Technicians.
- Flight Simulator Maintenance Engineers
- ATC Simulator Maintenance Engineers
- Aerotels Maintenance Engineers.
- Navigational Aids maintenance Engineers.

In the process of my investigation, I found out that Aviation Equipment maintenance activities are complimentary to one another with the common objectives of ensuring a safe and expeditions aircraft traffic. This has made the aircraft/Airline Operations the most dominant activities in Aviation industry. For this reason, I will move on to Aircraft maintenance procedures and Communication, navigational and Surveillance equipment maintenance.

4.8.3 AIRCRAFT MAINTENANCE.

For Aircraft Maintenance purposes, use is made of:

(a) Maintenance schedules approved by the Nigerian Civil Aviation Authority or DSRAM in the approved document for:

(i) Periods at which each part of the aircraft, its components, accessories, equipment, instruments, electrical and radio apparatus shall be inspected together with the type and degree of inspection.

(ii) Periods at which the items in (i) above shall, as appropriate, be checked, cleaned, lubricated, adjusted and tested.

(iii) Periods at which overhauls and\or replacements shall be made.

(b) Maintenance, Repair, and Overhaul manuals:

The Manuals contain information and recommendations as well as spare part lists.

The philosophy of aircraft maintenance is divided into three groups:

(1) Scheduled Maintenance

(2) Unscheduled Maintenance

(3) Flight Servicing.

4.8.3.1 SCHEDULED MAINTENANCE.

Under the scheduled Maintenance, work is carried out at prescribed intervals based on flying hours as recommended in the Approved Maintenance Schedule by the National Civil Aviation Authority. There are three stages of checks.

(a) Check A: The maintenance task here includes examination of the aircraft for obvious defects, together with essential functional checks.

(b) Check B: This maintenance task requires the examination for defects, deterioration, corrosion and wear, the lubrication of some parts to a greater degree than in Check A. It affords the Maintenance Crew the opportunity to carry out modifications which may not have been implemented during unscheduled maintenance.

(c) Check C: The maintenance task here includes a detailed examination of the aircraft, the changing of worn-out parts or calibration of equipment necessary to maintain the required standards in addition to the work which is normally done at check B. after Check 'C', the aircraft begins a maintenance cycle.

The overhaul of the aircraft is applied progressively by undertaking a portion of the overhaul at each check 'C' maintenance or as a reconditioning programme at say alternate check 'C' maintenance.

By the time the cycle is completed, the Certificate of Airworthiness should be renewed by the NCAA if satisfied. This is called "STAR INSPECTION" applicable to aircraft, MTWA of which is less than 2730kg.

4.8.3.2 UNSCHEDULED MAINTENANCE.

During this maintenance all known defects on the aircraft are cleared. Use is made of the Technical log in order to know the defects to be cleared. Mandatory modifications are made. Instructions and recommendations emanating from the aircraft and engine constructors and equipment manufacturers are implemented.

4.8.3.3 FLIGHT SERVICING

Flight Servicing is the preparation for and recovery after flight on a day to day basis.

It has two components:

1. After flight servicing;
2. Before flight servicing

1. After Flight servicing.

This service is conducted after every flight and it consists of two operations:

- replacement and
- checking for obvious damage especially on those items which are subject to wear or are prone to defection, e.g. tyres. In this situation, the aircraft is grounded for a considerable length of time before it is due to fly again. While on ground, activities such as fitting locks, covers and blanks are carried out to further protect the aircraft.

2. Before Flight Servicing.

A before flight servicing is necessary when an aircraft, which has previously had an after flight servicing is required for flight. It requires the removal of the locks, covers and blanks, etc. which are fitted on and after flight servicing and a specific check to ensure that the aircraft is in a flyable state.

4.8.4 MAINTENANCE CERTIFICATION

At the end of this type of maintenance (scheduled and unscheduled), a Certificate is issued by an appropriately licensed Aircraft Maintenance Engineer. A Certificate of Maintenance is issued at the end of every scheduled maintenance as a guarantee of airworthiness of the aircraft, while a Certificate of compliance is issued at the end of unscheduled maintenance.

4.8.5 AIRCRAFT DOCUMENTATION: LOG BOOK AND TECHNICAL LOG

(1) LOG BOOK: A Standard log Book is usually provided for the aircraft, engine, and propeller constructor who enters essential data such as:

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- Name of Constructor;
- Type of aircraft;
- Engine or propeller as appropriate;
- Serial number assigned to the constructor;
- Date of construction;

Other essential data to be entered in the Log Book include:

- Nationality;
- Registration Mark;
- Name and address of Operator;
- Date and duration of each flight;
- Particulars of any defects;
- Details of inspection;
- Overhauls;
- Repairs;
- Replacements and modifications.

Each entry in the aircraft log book is made as soon as practicable after the occurrence to which it relates but not later than seven (7) days after the expiration of Certificate of Maintenance in respect of the aircraft at the time of occurrence. In the engine and propeller log books,

aggregate entries may be made, each occasion that any maintenance, overhaul, repair replacement, modification or inspection is undertaken on the engine or propeller.

(2) TECHNICAL LOG.

On the termination of every flight, the Captain of the aircraft flight is expected to enter into the Technical log:

- The times at which the flight began and ended;
- Particulars of any defect known to him;
- All entries is to be signed and dated by him.

Other essential information in the Technical Log include:

- A valid Certificate of Maintenance;
- A Certificate of Compliance in respect of work done for the rectification of defects;
- Details of deferred defects;
- A record sheet for entering the quantities of fuel and oil uplifted and the quantity available in each tank or combination of tanks at the beginning of the flight; (ENDURANCE)
- A statement of signatories (i.e. Licensed Aircraft Maintenance Engineers) required for the Certification of the Maintenance.

4.8.6. CONDITION MONITORED MAINTENANCE PROGRAMME

In order to enhance reliability which stands out as the most essential requirements of Aircraft Maintenance, three primary maintenance processes have been developed by aircraft operators and recognised by Nigerian Civil Aviation Authority. These processes are Hard-Time, On-Condition and Condition Monitoring.

Therefore, a maintenance programme which provides for the application of Hard-time, On-Condition, and Condition Monitoring is known as Condition Monitored Maintenance programme. The programme has two basic functions:

a) To provide a summary of aircraft fleet reliability and this reflect the effectiveness of the way in which maintenance is being done by means of statistical reliability element.

b) To provide significant and timely technical information by which improvements of reliability may be achieved through changes to the programme or to the practice for implementing it.

### 4.8.7 COMMUNICATION, NAVIGATION AND SURVEILLANCE EQUIPMENT MAINTENANCE.

To maintain a standard of serviceability as laid down by the Manufacturers and ICAO for Communication (Radio link, Satellite, wire) Navigation and Surveillance equipment, two types of maintenance procedures are performed periodically for all CNS equipment. There are:

1. Routine Maintenance
2. Curative Maintenance

#### 4.8.7.1 ROUTINE MAINTENANCE

Routine Maintenance schedule is divided into the following parts:

1. Daily Routine maintenance
2. Weekly Routine Maintenance
3. Monthly Routine Maintenance
4. Quarterly Routine Maintenance
5. Bi-annual Routine Maintenance
6. Annual Routine Maintenance

During Routine Maintenance, readings are recorded from all functional equipment. The data collected are compared against

the manufacturer's Specification stipulated at commissioning of the equipment. Such readings are used as Reference Vectors in determining the state of the units, panels, modules and racks that make up the equipment. If a reading in a particular unit or panel is low, the duty Maintenance Officer finds out why. The defect or fault is rectified to bring the unit or rack or module to its optimum level of operation.

At the Quarterly or bi-annual routines, some components may be changed, if they are showing signs of deterioration.

In yearly routine, components must be changed, due to ageing (i.e. they have exceeded their useful life span).

Annual maintenance involves a complete general overhauling. This, however is rarely practiced in NCAT.

4.8.7.2 CURATIVE MAINTENANCE.

Curative maintenance, is aimed at diagnosing a fault that has actually occurred. Here the duty maintenance officer removes the faulty card or part and sends it to the Workshop. A repair is

conducted with a team of technologists or technicians as the case may be. The faulty equipment which was MAIN is switched off and a standby equipment is switched on to maintain operation.

After a successful rectification of the fault, the unit is replaced and the equipment is switched on and put on test for a period of time before it is made operational again. In the event of a major breakdown, operation is changed from main to standby, the faulty card, or unit or module is extracted and sent to a Central workshop locally or abroad for repairs maintenance depending on the severity of the fault.

Such maintenance approach is often stipulated in the maintenance contract agreement signed with the Manufacturers of the equipment. It affects aircraft engines and sensitive modules in all Communication, Navigation and Surveillance equipment. Usually, such repaired part are returned to sender. But for the past decade such arrangement had been ineffective as most modules or parts were not returned.

4.8.7.3 REQUIREMENTS FOR ADEQUATE MAINTENANCE.

(1) properly trained manpower

(2) Well-equipped Workshop

(3) Adequate Test Instrument

(4) Adequate tools.

(5) A good supply of spare parts

(6) A safe where the temperature is conducive for the items and components stored

(7) Calibration equipment

4.8.7.4 FOLLOW-UP ACTION

(1) The Test Instruments are calibrated every (2) years, otherwise they will give false readings.

(2) Navigation and Surveillance Equipment are flight checked every six (6) months to ensure accurate signal transmission.

(3) Maintenance staff are trained and retrained in accordance with the change in technology.

(4) Spare parts for the equipment is expected to be manufactured locally to prevent acute shortage and eventual short-down of the facilities.

(5) All cooling systems (airconditioners) in the Stores, the Workshops and Equipment rooms are active and operating at maximum capacity.

(6) Adequate back-up power supply to NEPA.

(7) All Communication, Navigation and Surveillanvce equipment has dual installation - MAIN and STANDBY, to guarantee continuity of operation, i.e. if the MAIN is faulty, the Standby equipment automatically takes over.

(8) The stock of spares in the store does not fall below MINIMUM stock before fresh orders are made. In this way, each Department does not run out of vital spare.

4.8.8 DEFINITIONS OF TERMINOLOGIES

VOR - Very High Frequency Omnidirectional Range

DME - Distance Measuring Equipment, measures the distance of the aircraft

ILS - Instrument Landing System - aids in localizing aircraft position and landing.

| | |
|---|---|
| Hard-Time on-condition | Meant to increase the reliability of the fleet in-terms of component changes and replacement Condition Monitoring |

**M.T.W.A** Maximum Total Weight Allowable

**Covers** Protector for intake and exhaust

**Blanks** For protecting the component from foreign bodies

**Fitting locks:**For protection of the system

**DSRAM** Department of Safety Regulation And Monitoring.

# CHAPTER FIVE

## 5.0 DATA COLLECTION AND ANALYSIS

### 5.1 INTRODUCTION

In this survey, twenty seven (27) maintenance personnel made up of professionally trained and licensed engineers; technologists, technical officers, and technicians drawn from Seven maintenance departments were sampled.

The departments x-rayed were:

- Aircraft Maintenance
- Flight Maintenance
- Flight Simulator
- Communication Equipment Maintenance
- ATC Radar equipment maintenance
- ATS Radar Simulator Equipment Maintenance
- Navigational Aids Maintenance

### 5.2 TOOLS OF DATA COLLECTION

The major tools employed in my data collection were -

- questionnaires and

- informal personal interviews
- personal experience drawn from maintenance operations conducted by me.

Each questionnaire comprised of thirty-eight questions requiring short answers such as options, Fill-in, Tick one, Yes/No, enumerate etc.

The informal personal interviews were granted by flight Simulator and Aircraft Maintenance Engineers on the basis of co-worker relationship; hence I can infer that their responses were devoid of coloration and falsification. Each questionnaire was personally delivered to respondents.

### 5.2.1 NUMBER OF RESPONDENTS

Out of the 27 questionnaires sent out to the targeted respondents, 24 questionnaires were completed and returned; One (1) was returned blank while the remaining two (2) were not returned back to me.

- 171250

Therefore the percentage of respondents is calculated thus;

Total No issued out : 27

Total No completed and returned 24

Total no of blanks : 1

Total no of withheld : 2

$$\therefore \%\ \text{respondents} = \frac{24}{27} \times 100$$

$$= 88.9\%$$

Table 2.0 DISTRIBUTION BY SPECIALIZATION

| AREA OF SPECIALIZATION | NO. OF QUESTIONNAIRES SENT OUT | NO. COMPLETED AND RETURNED | NO LEFT BLANK | NO WITH HELD |
|---|---|---|---|---|
| Flight Maintenance | 8 | 7 | - | 1 |
| Aircraft Maintenance | 5 | 4 | 1 | - |
| Flight Simulator Maintenance | 2 | 2 | - | - |
| Com. Equipment Maintenance | 4 | 4 | - | - |
| Aircraft Radio Maintenance | 2 | 2 | - | - |
| Avionics | 1 | - | - | 1 |
| ATC Radar Maintenance | 1 | 1 | - | - |
| Navigational Aids maintenance | 2 | 2 | - | - |
| Electrician | 2 | 2 | - | - |
| TOTALS | 27 | 24 | 1 | 2 |

$$\%\ \text{BLANK} = \frac{1}{27} \times 100 = 3.7\%$$

$$= 3.7\%$$

$$\%\ \text{withheld} = \frac{2}{27} \times 100 = 7.4\%$$

$$= 7.4\%$$

SUMMARY OF PERCENTAGE DISTRIBUTION

| | |
|---|---|
| % Respondents | 88.9% |
| % Blank | 3.7% |
| % Withheld | 7.4% |
| | 100.00% |

5.2.2 MAINTENANCE ACTIVITIES AND DETERMINING FACTORS

The main activities of the seven (7) maintenance Departments sampled and x-rayed, and the factors that determined each activity are tabulated overleaf.

Table 3.0: Maintenance Activities performed by School

| NAME OF DEPARTMENT SAMPLED | MAIN ACTIVITIES PERFORMED (Type of Maintenance) | DETERMINANT FACTOR |
|---|---|---|
| Flight Maintenance Department | 1. Pre/After flight inspections | Misalignment due to operational handling |
| | 2. aircraft instrumentation: Checking, testing & Calibration | Elapse time/calendar period. |
| | 3. Repairs to Damaged systems | Ageing of components/units |
| | 4. Scheduled/Unscheduled maintenance inspection | Daily serviceability demand of Aircraft |
| | 5. 50 hrs maintenance | Airworthiness retention |
| | 6. 100 hrs maintenance | Flight hours |
| | 7 Draining and refilling of Engine oil | Power fluctuations from NEPA |
| | 8. Mandatory modification | To avoid loss of material and lives |
| | 9. Rectification of fault | Pilot report or inspection |
| | | Mandatory practice from regulatory bodies |

| | | |
|---|---|---|
| Flight simulator Maintenance Department | 1. Calibration of the simulator<br>2. Replacement of damaged component<br>3. Fault finding | Serviceability demand |
| Radar Maintenance Department | 1. Realignment of system<br>2. Trouble shooting<br>3. Repairs and maintenance<br>4. Maintenance Training | Maintainability schedules |
| Communication Equipment Maintenance | 1. Trouble shooting/fault finding<br>2. Repairs and Maintenance | Availability of necessary Tools, spares and instruments Regular usage |
| Navigational Aid Maintenance department | 1. Routine/Periodic inspection/checks<br>2. Fault finding<br>3. Replacement and repairs | Operational status of equipment<br>Malfunction of Equipment due to use<br>Identification and rectification of fault minor and major repair demand |
| ATS Radar Simulator Maintenance | 1. Routine and Periodic Inspection and checks<br>2. Fault finding<br>3. Replacement and repairs | Serviceability Demands<br>Breakdown of fault ident. |
| Works Department | 1. Fault location/clearing<br>2. Phase distribution/ clearing | Open circuity within/outside mechanical faults<br>Burntout feeder fuses<br>Breakdown |

## 5.3 ANALYSIS OF DATA

Data collected from respondents regarding the current operational status of equipment and the maintenance protocols are analysed in tables 3.1 -3.10.

| 3.1 | STATE OF THE EQUIPMENT | | | TOTAL |
|---|---|---|---|---|
| | SERVICEABLE | UNSERVICEABLE | OBSOLETE | |
| % RESPONDENT | 8 | --- | 4 | 12 |
| | 66.7% | 0% | 33.3% | |

N/B: Equipment Highly serviceable although obsolescence is a big treat.

| 3.2 | FAILURE RATE/BREAKDOWN | | | TOTAL |
|---|---|---|---|---|
| | NOT QUITE OFTEN | OFTEN | SYSTEM FAILURE PROOF | |
| % RESPONDENT | 18 | 4 | - | 22 |
| | 81.8%% | 18.2%% | 0% | |

N/B: Failure is minimum but system not failure proof.

| 3.3 | COMMON CAUSES OF FAILURE | | | | | TOTAL |
|---|---|---|---|---|---|---|
| | POWER INADEQUACY | AGEING | LACK OF SPARES | IMPROPER OPERATION | OBSOLENCE | |
| % RESPONDENTS | 2 | 12 | 4 | 4 | - | +- 22 |
| | 9% | 54.5% | 18.2% | 18.2% | 0% | |

N/B: Essentially ageing is a major cause of failure.

| 3.4 | EQUIPMENT RELIABILITY | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | HIGH | AGEING | LOW | ZERO | OTHERS | REASON | |
| % RESPONDENTS | 14 | - | - | - | | HIGH QUALITY IS GUARANTEED IN THE INDUSTRY | 14 |
| | 100% | 0% | 0% | 0% | 0% | | |

N/B: Aviation Equipment have high reliability

| 3.5 | ADHERENCE TO RECOMMENDED MAINTENANCE PROTOCOL | | | TOTAL |
|---|---|---|---|---|
| | YES | NO | REASON | |
| % RESPONDENT | 10 | 4 | REQUIREMENT BY ICAO | 14 |
| | 71.4% | 28.6% | | |

N/B: Strict Adherence to recommended maintenance protocol is practiced.

| 3.6 | AVAILABILITY OF TOOL AND TEST INSTRUMENTS | | | TOTAL |
|---|---|---|---|---|
| | YES | NO | REASONS INFAVOUR AND AGAINST | |
| % RESPONDENTS | 10 | 6 | 1. To maintain effective operation in TAKE OFF AND LANDING | 16 |
| | 62.5% | 37.5% | 2. Test gears are supplied at purchase<br>3. Lack of funds to procure test instrument | |

N/B: Test Instrument and maintenance Tools are barely available

| 3.7 | SPARES AVAILABILITY | | | | TOTAL |
|---|---|---|---|---|---|
| | READILY AVAILABLE | NOT ALWAYS AVAILABLE | OUT OF PRODUCTION | REASONS | |
| % RESPONDENTS | 10 | 6 | - | CONTINUOUS SUPPLY OF SPARES GUARANTEED | 16 |
| | 62.5% | 37.5% | 0% | | |

N/B: Spares are available but often a major constraint.

| 3.8 | MAINTENANCE APPROACHES | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | PREV. | OPERATIONAL | AS-REGD | BREAK DOWN | CORRECTIVE | PREDICTIVE | AD HOC | |
| % RESPONDENTS | 8 | 10 | 2 | 1 | 10 | - | 10 | 24 |
| | 33.3% | 41.7 | 8.3% | 4.2% | 41.7 | 0 | 41.7 | |

N/B: Except predictive all other approaches are adopted.

| 3.9 | OPERATIONAL CONTINUITY | | | TOTAL |
|---|---|---|---|---|
| | HOT STANDBY PROVISION | COLD STANDBY PROVISION | REDUNDANCY PROVISION | |
| % RESPONDENTS | 6 | 2 | 2 | 10 |
| | 60% | 20 | 20 | |

N/B: Dual installation of equipment and machines is practiced.

| 3.10 | LOGISTIC SUPPORT MANAGEMENT | | | | | TOTAL |
|---|---|---|---|---|---|---|
| | MAINTENANCE PERSONNEL | SUPPORT EQUIPT. | TECHNICAL DATA | TRAINING RECENCY | SPARES | |
| % RESPONDENTS | 6 | 4 | 4 | 4 | 6 | 24 |
| | 25% | 16.7 | 16.7 | 16.7 | 25% | |

N/B: System logistic support management is essentially ineffective. Therefore the probability that the system can successfully meet an operational demand within a given time is low.

## 5.4 SUMMARY OF FINDINGS

5.4.1 Maintenance operations on aircraft and aviation equipment are essentially a blend of operation, Breakdown, Repairs and preventive (Ad-hoc, As-Required) maintenance which are made possible through the help of maintenance manual.

5.4.2 Predictive and Corrective maintenance, on the other hand, are least practiced due to the lack of appropriate hardware and spares. As a consequence delicate aircraft and engineering hardware have suffered structural failure or other engineering failures due to fatigue, corrosion, creep

and wear are rather shipped to manufacturer's facilities overseas for qualitative maintenance realignment and re-calibration.

5.4.3 Maintenance tasks are performed daily in all the departments mentioned. Infact preventive maintenance is the most convenient. It has an easy-to-follow procedure with minimum cost and experience. Maintenance personnel are not in any pressure or haste to get an aircraft back into service as is the case in operation and Breakdown maintenance tasks. The reason adduced is that aircraft and equipment in the College are used only for training purposes and not for commercial.

5.4.4 Due to the apparent lack of major spares, the operating demand on serviceable fleet of aircraft is sustained by maintenance personnel through cautious cannibalization of older and abandoned aircraft for spares.

5.4.5 As aircraft and equipment design become more and more complex, maintenance personnel who are experts in older

system maintenance are handicapped and cannot effectively offer quality maintenance on modern aircraft. This situation exposes a dearth of maintenance personnel who have the expertise knowledge to perform maintenance tasks effectively on modern aircraft and equipment.

5.4.6 Human errors arising from poor motivation, frustrating situations, lack of exposure of maintenance personnel through training are powerful forces which are affecting the quality of maintenance and the airworthiness of aircraft in the industry.

5.4.7 Other human side maintenance problem include

- Work around
- Expertise error
- Pressure or haste
- Lack of tools or equipment or spares
- Memory lapse

5.4.7.1 Work around is the performing of a maintenance task without all the necessary equipment or in a more convenient manner than the approved procedure.

5.4.7.2 Expertise Error: happens when someone doesn't have the knowledge, skill or experience to do all aspects of their job.

5.4.7.3 Pressure or haste: as aircraft become more and more complex and operators strive to reduce the amount of time that aircraft spends in maintenance presence is a growing fact of life for maintenance personnel engineers.

25.4.7.4 Lack of tool or equipment or Many work around occurs in response to a lack of appropriate hardware or spares.

5.4.7.5 Memory laspse: Occurs when a person is interrupted to go and do something else, sought of juggling maintenance tasks on several aircraft is common situation which can lead to a memory lapse.

5.4.8 All the aircraft maintenance personnel are licenced others are certified

5.4.9 Many maintenance Engineers agree that the maintenance policy is adequate except that there was need for logistic support to boost it.

# CHAPTER SIX

## 6.0 OBSERVATION, RECOMMENDATION AND CONCLUSION

### 6.1 OBSERVATION

6.1.1 The Nigerian College of Aviation is well-equipped with the necessary facilities and equipment that enhances its capacity to train and supply the required technical manpower of the aviation industry.

Hence every aviation facility and equipment installed at the field is duplicated in the College. The only difference lies in the size, weight and capacity of aircrafts used for training operation.

6.1.2 The protocol of maintenance for aircraft, Radar, Flight Simulator, Navigational aids, communication equipment is essentially the same as that obtaining in the industry.

6.1.3 There are maintenance difficulties in every-day operations due to;

a) lack of constant practice,

b) Shortage of maintenance and qualified human resources,

c) Inadequate training programmes for maintenance personnel,

d) growth in technology is not matched with the training of maintenance personnel hence the quality of maintenance is badly affected,

e) Absence of adequate hardware spares,

f) Insufficient acquaintance with modern computer-based maintenance approaches limit the performance of maintenance personnel,

6.1.4 A great number of the equipment currently being used are more than twenty years old. Even those that are newer are soon becoming obsolete because of the rapid advances in technological development especially in Aviation.

6.1.5 There is sufficient literature materials and technical manuals that maintenance personnel can easily refer to while performing maintenance tasks.

6.1.6 Except for very rare occasions when, due to structural fatigue of an engine part or a major fault on a unit or part

of, an equipment is shipped abroad, every other maintenance operation is performed by the maintenance personnel.

6.1.7 In every maintenance task it is either the rule or recommended maintenance protocol or nothing. There is little room for innovation or creativity.

6.1.8 Absence of shuttle vehicles that facilitate the movement of maintenance personnel between aircraft or Hanger impede maintainability.

6.1.9 Theft or pilfering of aircraft parts by unidentified persons also impede maintainability.

6.1.10 Trespass by unauthorized persons causes distraction during maintenance operations.

6.1.11 It was noted that most of the surveillance installations are not serviceable. The major reasons are that the system had not been accorded commensurate priority in allocation of funds and a lack of adequate training for maintenance personnel.

## 6.2 RECOMMENDATIONS

Considering the vital role effective maintenance management plays in ensuring safe and expeditious air traffic, coupled with my experience as a maintenance personnel, I recommend thus;

6.2.1 That managers of resources should expand the scope of training for the maintenance personnel to include;

- Technical training at Manufacturer's training facilities;
- Type course on the aircraft in use;
- continuous On-The-Job Training and familiarization in view of changing technology,
- Formal classroom training, and
- adequate allocation of funds to carry out or implement maintenance tasks.

6.2.2 New equipment should be acquired to supplement old and unserviceable ones since Nigeria does not have the capacity to manufacture aircraft.

6.2.3 There should be inward integration of ideas by setting up home-based facilities for the maintenance of large and small aircraft. This approach could reduce wastage of economic resources.

6.2.4 The crave for new equipment can be tamed if an effective and workable engineering policy (such as reward of innovation and creativity) is enacted and vigorously pursued.

6.2.5 Misplacement of priorities interms of human and material resources allocation should be halted by the policy implementing organs of the Aviation Industry i.e Federal Ministry of Aviation.

6.2.6 Human factor is not just about people, it is also concerned with improving systems effectiveness particularly Human machine interactions that have the potential for human error.,

6.2.7 System logistic support management is an essential ingredient that allows a system achieve its full potential and cost effectiveness. This is lacking in most maintenance protocols and needs to be incorporated if we are to establish effective maintenance management in the Aviation Industry.

## 6.3 CONCLUSION

I have critically examined this topic on maintenance management in Nigerian Aviation Industry taking cognizance of system maintainability potentials, characteristics of maintenance work; maintenance classification; maintenance constraints; and the maintenance situation in Nigeria vis-a-vis the Nigerian College of Aviation Technology and have drawn the following inferences.

There is still an unprecedented reluctance to perform maintenance tasks according to prescribed procedure when once there are no personal benefits. This attitude results in the neglect and waste of human and material resources.

Nigeria has a lot of intelligent men and resources and often proposes good policies, maintenance and otherwise, but usually lacks the WILL, COMMITMENT and DETERMINATION for effective implement of the laws. This is the biggest obstacle to the country's rapid advancement in establishing maintenance culture through effective maintenance management in the aviation industry and other spheres.

Finally maintenance operations are not accorded commensurate priority in allocation of fund, and if maintenance personnel are adequately trained and regularly re-trained a lot of gain would have been achieved in the area of quality maintenance management.

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SLENIA TRAINING MANUAL (1970) ON ATC 33A Radar Italy pp 42-56 Workshop Paper on Organization and control Industrial Maintenance, ITF.

# QUESTIONNAIRE FOR MAINTENANCE PERSONNEL NCAT, ZARIA

DEPARTMENT: _____

1. The main activities in your maintenance schedule are:
   a. _____
   b. _____
   c. _____
   d. _____

2. What factor(s) determine each of the activities listed above?
   a. _____
   b. _____
   c. _____
   d. _____

3. List the logistic support resources vital to your maintenance schedule.
   a. _____
   b. _____
   c. _____
   d. _____

4. Identify the Technical skills necessary for effective maintenance operations.

5. ☐ Aircraft _____
   ☐ Communication equipment _____
   ☐ Simulator equipment
   ☐ Radar System
   ☐ Infrastructure (Runway, electrical Installation, Recreational facility, building, etc
   ☐ Motor Vehicle
   ☐ Power Generator
   ☐ Others; specify

6. What schedule of maintenance do you have? Tick the correct one
   ☐ Daily
   ☐ Weekly
   ☐ Monthly
   ☐ Quarterly
   ☐ Annual

5. Select the term on which you carryout your Maintenance operations.

7. Is it done at where?
   - ☐ Site location
   - ☐ Workshop (i.e centralized workshop)
   - ☐ Manufacturer's facility

8. The maintenance is conducted by:
   - ☐ End Users (i.e Maintenance Personnel in your School/Dept.
   - ☐ External Maintenance Organization
   - ☐ Manufacturer.

9. Identify the type of maintenance you have always carried out:
   - ☐ Prevention Maintenance
   - ☐ Operational Maintenance
   - ☐ Corrective Maintenance

10. List the Key activities you have ticked in question No. 9 above

    _____

    _____

    _____

11. How often do you experience failure in your system?
    - ☐ Very Often
    - ☐ Often
    - ☐ Not quite often
    - ☐ System is failure proof.

12. The common causes of failure are:
    - ☐ Power inadequacy
    - ☐ Ageing
    - ☐ Lack of spares
    - ☐ Lack of technical skill
    - ☐ Obsolescence
    - ☐ Other; specify

14. Rate your equipment spares availability;

- ☐ Readily available
- ☐ Not always available;
- ☐ Out of production

Reasons are: _____

_____

15. Are test gears, (test equipment, test instrument, test tools, test stations, etc readily available for use by your repairs team? [ ] Yes [ ] No

_____

_____

_____

_____

16. What is y our altitude toward the approach to maintenance in your department/School

_____

_____

_____

17. Is your personnel requirement for effective system maintenance schedule always met? [ ] Yes [ ] No

17b Are the personnel given to you all fit?

- ☐ Skilled
- ☐ Unskilled
- ☐ Adequate
- ☐ Inadequate

Tick one

18. If yes in (17) state the repair constraints that impede maintainability of the system.

_____

_____

_____

19. The equipment/facilities under y our care are;

- ☐ Serviceable
- ☐ Unserviceable
- ☐ Obsolete

20. In question 19 above; how many are?

- ☐ Serviceable
- ☐ Unserviceable
- ☐ Obsolete

21. Does your system still have the ability to do the job for which it was designed

[ ] Yes [ ] No

22. If yes in No. 21 above, state probable cause.

_____

_____

23. If "no" in No. 21 above state probable cause;

_____

_____

24. What type of training do you consider necessary to establish effective system maintenance approach;

_____

_____

25. The rate of growth in new technology is affecting your maintenance capability. Comment.

_____

_____

26. Do you always follow the maintenance protocol specified in the maintenance manual of y our system or do you adopt an adhoc approach for convenience?

[ ] Yes [ ] No

27. Does your maintenance require a complete "Shutdown" of the equipment concerned.

a) [ ] Yes [ ] No
b) [ ] How often

_____

_____

28. Which is applicable to your school/department in allowing continuity of operation?

- ☐ Hot standby set
- ☐ Cold stand-by set
- ☐ Redundancy provision

29. The logistic support scheme employed in your School/Department to ensure continuity of system operation is/are;

- ☐ Support equipment
- ☐ Spares availability
- ☐ Training recency
- ☐ Technical data
- ☐ Field support
- ☐ System installation
- ☐ Modification
- ☐ Revision

30. What is "C" and 'D' checks in an aircraft?

_____

_____

31. Why are the two in No. 30 important in aircraft operation?

_____

_____

32. State your personal views about the maintenance Policy adopted in your school/department

_____

_____

33. Regular installation of new equipment/facilities for strategic operation without instituting effective routine maintenance for the old ones is a wasteful exercise. Your comment on this.

_____

_____

34. In a technologically backward country like Nigeria, what do you recommend as the prevention against our crave for new "THINGS" only to be neglected and abandoned for yet a newer one a few years after use.

_____

_____

_____

35. Suggest a cost-saving measure that could help eliminate wastes in our economy.

_____

_____

KASHIM IBRAHIM LIB

36. How many times have you received shipment of new equipment in the last five years?

37. Enumerate the cost-benefits of preferring outright purchase of a new aircraft/equipment to keeping ageing aircraft/equipment serviceable.

38. What checks must be carried out before you certify an equipment or aeroplane fit for use by operators.