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# The design of a field failure data feedback system

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# THE DESIGN OF A FIELD FAILURE DATA FEEDBACK SYSTEM

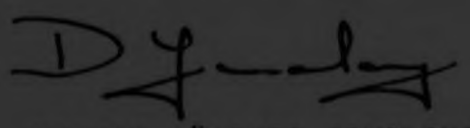
Dieter Günther Zimmons

A dissertation submitted to the Faculty of Engineering, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Engineering.

JOHANNESBURG 1984

**DECLARATION**

I declare that this dissertation is my own, unaided work. It is being submitted in partial fulfilment of the requirements for the degree of Master of Engineering in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



DIETER GÜNTHER ZIMOLONG

31 ST DAY OF JANUARY, 1984

The writer wishes to record his grateful appreciation
to his parents for their support

## ABSTRACT

This dissertation describes the design of a field failure data feedback system. Such a system is valuable in organisations who find it difficult to monitor the quality and reliability of their product once these have been distributed to the user.

By determining the precise requirements and constraints the nature of the problem was defined as well as the objective of the system. The writer developed three possible solutions. These solutions are presented by defining all sub-systems, the inputs into each sub-system, the output out of each sub-system and the function within each sub-system.

A system was selected by weighing the advantages and disadvantages of data collection, hardware involved, data validity, system size, communication factors, human elements, sampling methods, costs involved and the systems effect on the wider system. This system was then developed in detail considering communication techniques, data analysis techniques etc. The dissertation includes a sample of a report generated by the use of realistic dummy data.

## PREFACE

It is of great interest to a manufacturer to know how his products are performing after they have left the factory. There are various methods to achieve this, and the one that was used for this specific study, was a closed loop field failure data feedback system. Obtaining reliable feedback on products can be used to improve weak products, perform value engineering techniques on products, update marketing strategies etc. to eventually increase profitability.

This data feedback system was developed for a large organisation, where the ergonomics and reliability of the range of products was important.

The development of such a system is presented in this dissertation. The approach followed is that of a design. There is an information search, an identification of the problem, an analysis of the size and boundaries, the development of three possible solutions and a detailed developed final solution. The purpose of this was to show how such a system can be identified and developed for any organisation.

Acknowledgement is made to my supervisor Mr J Bicheno for his assistance and Mrs M le Roux for typing this dissertation

CONTENTS


| | | PAGE |
|---|---|---|
| PREFACE | | iv |
| LIST OF FIGURES | | viii |
| LIST OF TABLES | | xii |
| 1. | INTRODUCTION | 1 |
| 2. | INFORMATION SURVEY | 4 |
| | 2.1 What a data feedback system should consist of | 7 |
| | 2.2 Guidelines to develop a data feedback system Problem | 8 |
| | 2.3 Problem areas to be aware of | 9 |
| 3. | SYSTEM OBJECTIVES AND BOUNDARIES | 9 |
| | 3.1 Requirements and constraints | 10 |
| | 3.2 The results and deductions | 11 |
| | 3.3 Concise statement of the objective | 13 |
| 4. | DEFINITION AND APPROACH | 13 |
| | 4.1 Definition | 13 |
| | 4.2 The approach to the development of the system | 15 |
| | 4.3 The existing system | 17 |
| | 4.4 The scope of the data and reports required | 19 |
| | 4.5 Initial outline of a data feedback system | |

5. POSSIBLE SOLUTIONS 21

5.1 System I 21
5.2 System II 25
5.3 System III 28
5.4 Conclusion 31
5.5 Selection 34

6. FINAL DEVELOPED SOLUTION 36

6.1 The final solution 39
6.2 Data capture sub-system 52
6.3 Data analysis sub-system 71

7. SAMPLE REPORT 93

7.1 A continuous histogram 94
7.2 A cumulative sum of failures 98
7.3 A Pareto analysis 100
7.4 Failures per user venue 103
7.5 Cost analysis 104
7.6 Spares usage 106

8. CONCLUSION 107

APPENDIX I (Requirement and constraint questionaires) 109

APPENDIX II (Symbols used) 120

APPENDIX III (Proposed system I) 121

APPENDIX IV (Proposed system II) 129

APPENDIX V (Proposed system III) 136

APPENDIX VI (Mil. St '4) 145

APPENDIX VII (Data used for a dummy run) 149

APPENDIX VIII (A list of parts failed in order of part numbers) 166

APPENDIX IX (A list of new and used failures per part) 170

APPENDIX X (A list of locations per part number) 179

APPENDIX XI (A list of parts failed in order of months) 188

REFERENCE LIST 199

BIBLIOGRAPHY 202

LIST OF FIGURES


| | | PAGE |
|---|---|---|
| FIG. 1 | MODEL OF OPTIMUM QUALITY COSTS/OPTIMUM SEGMENT OF QUALITY COST MODEL | 2 |
| FIG. 2 | LOOP OF DEFECT DATA ANALYSIS | 5 |
| FIG. 3 | GLOBAL REPRESENTATION OF A DATA FEEDBACK SYSTEM | 6 |
| FIG. 4 | BLOCK DIAGRAM OF ORGANISATIONS INVOLVED IN THE FIELD FAILURE DATA FEEDBACK SYSTEM | 9 |
| FIG. 5 | BLOCK DIAGRAM OF ORGANISATIONS INVOLVED WHEN DATA IS OBTAINED DIRECTLY FROM THE PRODUCER | 14 |
| FIG. 6 | BLOCK DIAGRAM OF THE EXISTING FEEDBACK SYSTEM IN THE "USER" ORGANISATION | 15 |
| FIG. 7 | BLOCK DIAGRAM OF A FIELD FAILURE DATA FEEDBACK SYSTEM IN BROAD OUTLINE | 18 |
| FIG. 8 | BLOCK DIAGRAM OF THE COMMUNICATION CHANNELS WHEN EACH PRODUCER COLLECTS DATA FROM EACH USER | 22 |
| FIG. 9 | BLOCK DIAGRAM OF THE COMMUNICATION CHANNELS WHEN THE DATA COLLECTION BY THE PRODUCER FROM THE USER IS CENTRALISED BY THE DISTRIBUTOR | 22 |
| FIG. 10 | BLOCK DIAGRAM OF THE PROPOSED SYSTEM I | 24 |
| FIG. 11 | BLOCK DIAGRAM OF THE PROPOSED SYSTEM II | 25 |

FIG. 12 BLOCK DIAGRAM OF THE PROPOSED SYSTEM III 30

FIG. 13 BLOCK DIAGRAM OF THE FINAL SOLUTION OF THE FIELD FAILURE DATA FEEDBACK SYSTEM 38

FIG. 14 FLOW DIAGRAM OF THE DATA CAPTURE SUB-SYSTEM 40

FIG. 15 FLOW DIAGRAM OF THE DATA ANALYSIS SUB-SYSTEM 44

FIG. 16 AN EXAMPLE OF A DATA CAPTURE CARD 67

FIG. 17 BAR CHARTS TO IDENTIFY THE CORRECT AND FAULTY DATA RETURN CARDS RECEIVED PER MONTH PER LOCATION 76

FIG. 18 A CONTROL CHART FOR THE NUMBER OF DEFECTIVES 78

FIG. 19 BAR GRAPH OF NUMBER OF MONTHS FREQUENCY RANGE WAS RECORDED VERSUS FREQUENCY RANGE OF FAILURES PER PRODUCT AND PER PART 79

FIG. 20 A BAR GRAPH OF THE FRACTION OF PARTS DEFECTIVE PER PRODUCT PER MONTH 80

FIG. 21 A GRAPH OF CUMULATIVE FAILURES PER PART PER PRODUCT PLOTTED AGAINST TIME 81

FIG. 22 A PARETO ANALYSIS OF THE PARTS PER PRODUCT AND THE COMPLETE PRODUCT RANGE 82

FIG. 23 A BAR GRAPH OF FAILURES PER PRODUCT VS USER VENUE 83

FIG. 24 A LIFE CURVE OF PRODUCT FAILURE RATE VS. TIME FOR EACH PRODUCT 85

FIG. 25 A PARETO ANALYSIS OF THE COSTS OF PARTS PER PRODUCT AND THE COSTS OF PRODUCTS PER PRODUCT RANGE 88

FIG. 26 BAR GRAPHS OF NUMBER OF MONTHS FREQUENCY RANGE WAS RECORDED VERSUS FREQUENCY RANGE OF FAILURES PER PRODUCT PER PART AND PRODUCT 97

FIG. 27 A GRAPH OF CUMULATIVE NUMBER OF FAILURES PER PART PER MONTH PLOTTED AGAINST TIME 99

FIG. 28 A PARETO ANALYSIS OF THE "PARTS PER PRODUCT" 102

FIG. 29 A BAR GRAPH OF FAILURES PER PRODUCT PER MONTH VERSUS USER VENUE 103

FIG. 30 A PARETO ANALYSIS OF THE COSTS OF PARTS PER PRODUCT 105

FIG. 31 A PROGRAM TO FORMAT THE DATA INPUT AND OUTPUT. 94

LIST OF TABLES


| | | |
|---|---|---|
| ABLE | ABLE OF REQUIREMENTS AND IMPLICATIONS A FEEDBACK SYSTEM OBTAINED BY INTERVIEW | |
| ABLE 2 | A TABLE OF THE MOST IMPORTANT ADVANTAGES AND DISADVANTAGES OF THE THREE PROPOSED SOLUTIONS | 3 |
| AB | ABLE OF TYPES OF REPORTS TO BE CONSIDERED | 43 |
| ABLE | OMPARISON OF MEDIA CHARACTERISTICS | 64 |
| ABLE | ABLE OF THE PARTS IN EACH PRODUCT | 85 |
| ABLE | A LISTING OF THE SPARE PARTS USAGE PER PRODUCT | 89 |
| ABLE | A LIST OF THE REPORTS WHICH WILL BE GENERATED | 92 |
| ABLE | A LIST OF THE NUMBER OF PARTS FAILED PER PART NUMBER PER MONTH FOR FOUR PRODUCTS | 95 |
| ABLE | A TABLE OF CUMULATIVE FAILURES PER PART PER MONTH | 98 |
| ABLE 10 | A LIST OF FAILURES PER PARTS | 101 |
| ABLE 11 | A LIST OF FAILURE COSTS OF PARTS PER MONTH | 104 |

## 1. INTRODUCTION

The purpose of this project is to determine the performance and reliability of products which have been distributed and are being operated by the user. This need arose since in this particular case, there was no feedback except that of after sales service which tended to be subjective. There was no "data" available to perform cost or reliability calculations on. What was really needed was a continuous data capture of some sort to monitor the products.

Failure data feedback systems are not a new development. Large consulting companies have been implementing these for more than 10 years in Europe. Although not so frequently used in the R.S.A. there exists a need for them.

The objective of this dissertation is to design a feedback system such that the maximum information can be obtained from the user at minimum cost. The interference with the users work must be kept as low as possible to ensure that the system will not collapse. The data captured by this system is the real test of the products performance in the field.

The system will be such that it can form part of a larger system. The system in this case will stretch across three organisations namely the:

1) "Producer" which is the company that manufactures products A, B, C, D, E etc.
2) "Distributor" which is the company that buys the products and distributes them.
3) "Users" which are a number of smaller com-

2 ...

panies and workshops, who belong to the same organisation.

The design and presentation refers mainly to product A, which was also used for a numeric example. The amount of data to be captured and processed were ver, carefully analysed, since the quality costs involved and the savings achieved show an optimum as indicated by Juran/Gryna (1) (See Fig. 1)




Fig.1. MODEL OF OPTIMUM QUALITY COSTS AND OPTIMUM SEGMENT OF QUALITY COST MODEL

3/...

The system that has been designed is that of a closed loop feedback system. The plan used to design this system is as follows:

1.1 An information and literature survey was undertaken including discussions with consultants in this field, computer searches through the CSIR and library searches.

1.2 The system analysis in detail using Murdoch (2) as a guideline.

- Determining the exact requirements of the system
- Determine the constraints
- Defining the system
- Defining the wider system
- Defining the objectives
- Organising the project

1.3 The development of various possible solutions to the problem.

1.4 The selection of a solution and the detailed development thereof including a complete formalised description of the system.

1.5 The use of a set of dummy data to generate sample reports.

The implementation and operation of the above system is not part of this dissertation, but will be undertaken since this system was designed for an existing organisation.

4/...

## 2. INFORMATION SURVEY

The survey was undertaken as a guide to obtain more information on what such a system should consist of and to see where the particular problems exist.

2.1 What a data feedback system should consist of. -"A well-organized data system makes it possible to identify those failures which are repetetive rather than isolated" Juran (3). The basic information United States Army Material Command (4) found, is that a feedback system should provide the part that failed, the time, why it failed,and how it failed. This can be achieved by designing a system to capture the basic performance data, process and analyse it to provide managers with reports suitable to take corrective action. The communication in such a system must be well planned since the human element is involved. A project of this nature needs not only management approval but also management support and a steering committee. The security system is vital and can be achieved by data verification, selective capability to access the file, comparing codes and names against master files and the correction of error inputs. More information about this can be found in Juran (5).

Juran (3) and United States Army Material Command (4) demonstrates that reports generated should be considered very carefully by investigating which details will be required, the frequency at which these should be distributed, the timing required, the persons who will receive them, the volume

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since a lengthly report may loose its appeal and to check if the purpose has been accomplished.

The system should be a closed loop and some global representations of such a system are shown below in Fig. 2 and Fig. 3 were developed by FEG. (6).

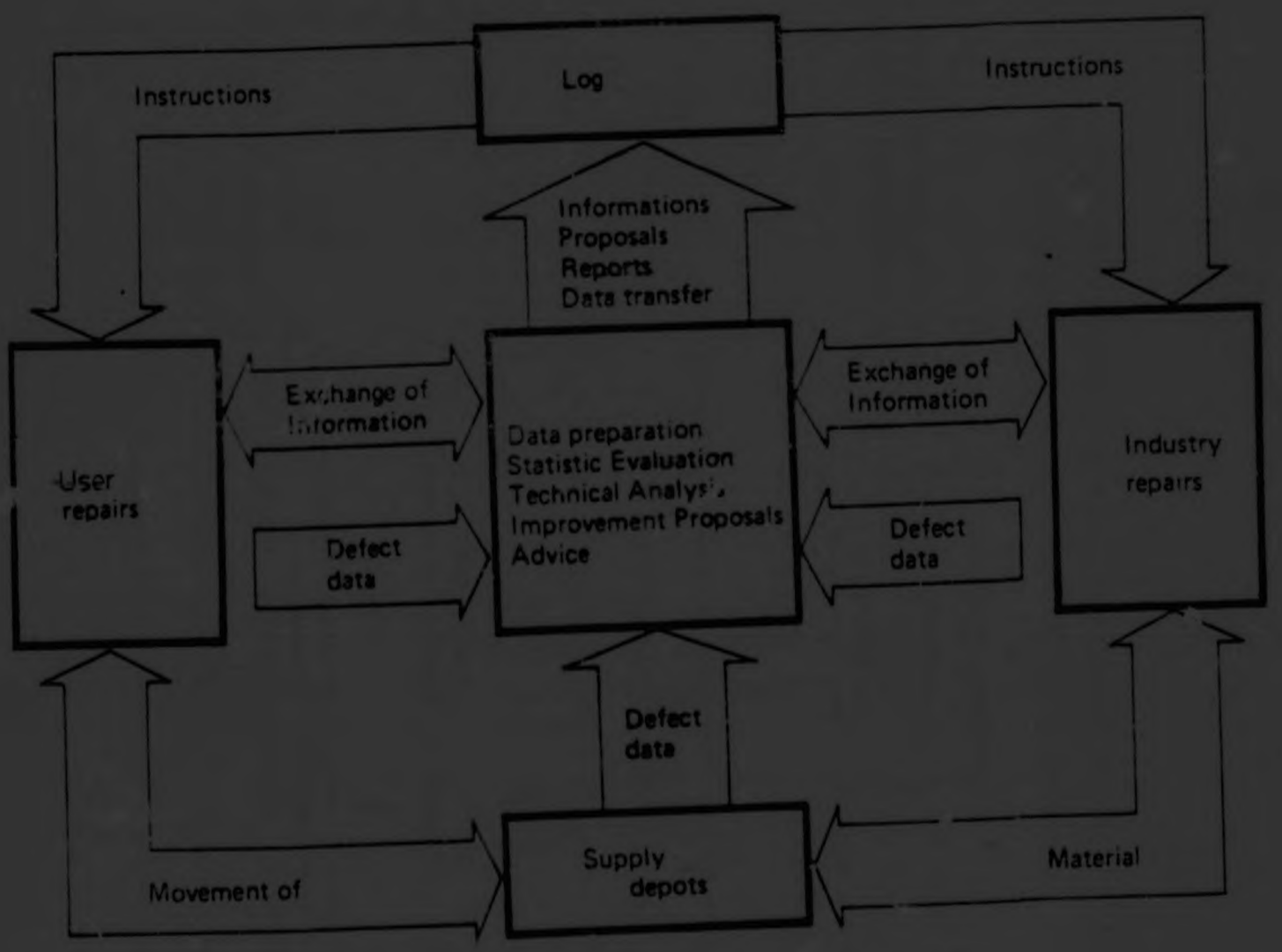



Fig.2 LOOP OF DEFECT DATA ANALYSIS

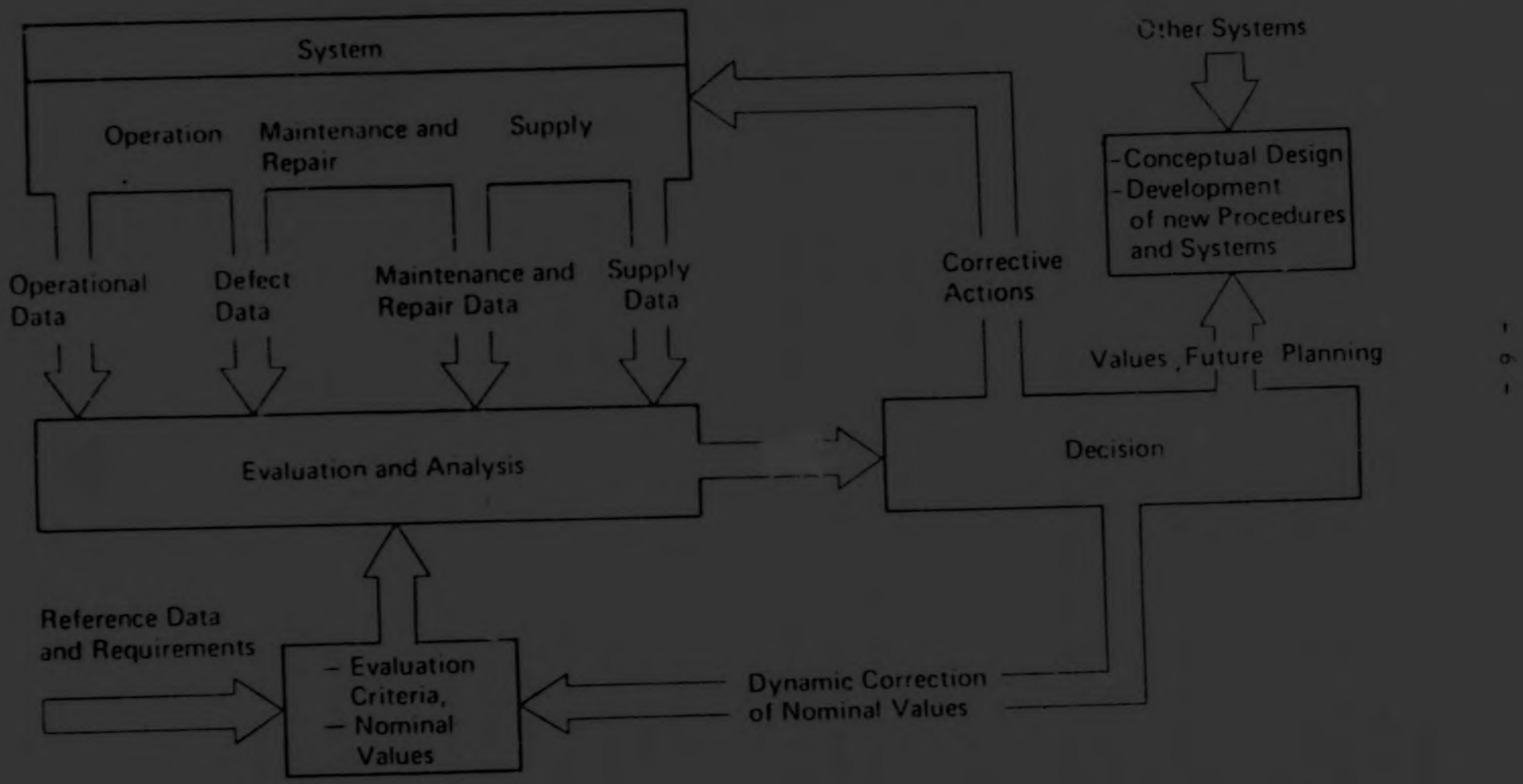



Fig.3. GLOBAL REPRESENTATION OF A DATA FEEDBACK SYSTEM

2.2 Some guidelines to develop a data feedback system - The communication within the system must be designed and structured as Fourie (7) descibed as "Communication by objectives".

The data capture system is the most sensitive, since if we collect faulty or wrong data, the whole system cannot perform its function. Thus the minimum data that should be captured is:

- The date
- The location
- The exact part reference and description
- The exact product reference and description
- The nature of failure

This data must be captured as accurately as possible by determining the minimum data elements required for a specific system and synthesize these into a composite form from which the data can then be extracted. The data capture system should never be implemented before the data to be measured has been carefully analysed and determined how it will be interpreted. Ishikawa (8) mentioned some very important points to keep in mind if large volumes of data are involved when the use of a computer should be considered. The reports generated should be such that some type of life curve as described by Besterfield (9) can be deduced and that there is some warning limit above which the tendencies and critical components can be identified. Different limits can be determined for the parts according to their

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classification. A list of "repeaters" in order of frequency is a very important report as described in Juran (3).

## 2.3 Problem areas to be aware of

Most problems arise in the data capture area where faults are not being reported. Juran/Gryna (10)describes these as unimportant, (can be repaired easily, very low costs involved) the assumption "a fate, not a problem" and "the sheer distastefulness of it all." Often data is distorted by factors such as shelf life instead of operational life. When sampling techniques are used to capture data, care must be taken to have a sample representing the data in order to ensure statistical accuracy. Juran/Gryna (;) deals with this in more detail and mentions in Juran (12) that no sampling at all can be an error.

A problem that can often be overlooked is a "software fault" in the case of a computerised system. To prevent such occurance, a fault detecting ability can be inserted into the software.

## 3 SYSTEM OBJECTIVES AND BOUNDARIES

This part of the development is very important since, if the system does not fulfill the needs of the personnel that make use of it, it will fail. Thus it is very important to determine the requirements and constraints of the system.

### 3.1 Requirements and constraints

To determine these, the first step was to identify who will be involved. This was performed at two levels,- namely the organisations and the people. Starting with the organisations involved, the situtions was as shown in Fig. 4.

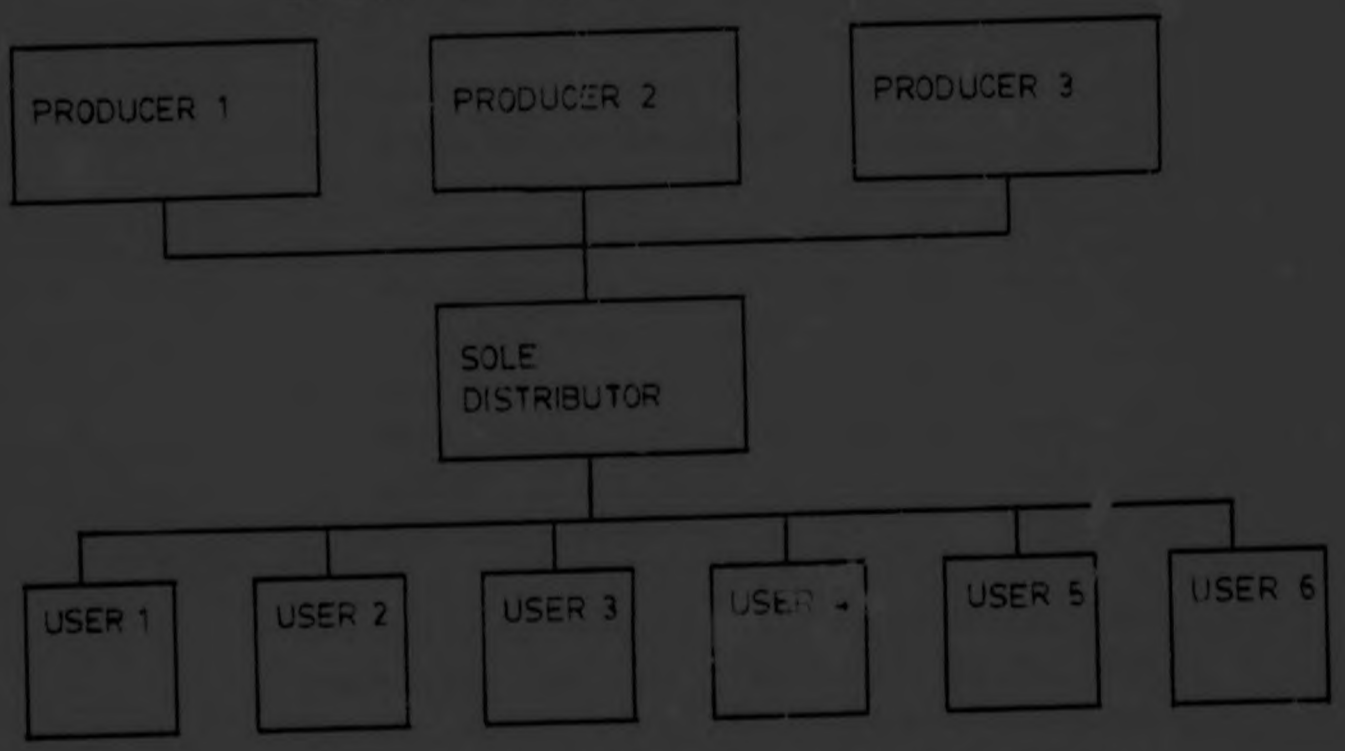



Fig. 4. BLOCK DIAGRAM OF ORGANISATIONS INVOLVED IN THE FIELD FAILURE DATA FEEDBACK SYSTEM

The system was designed for Producer 1 but must be such that it can be used by Producer 2 and Producer 3 as well. Thus the organisations involved are Producer 1, the

10/...

Sole Distributor and all Users. Producer 2 and Producer 3 are not involved, but must be considered.

The most important requirements were those of Producer 1 who was primarily interested in improving its products and profit. Implementing such a system would mean that the distributor and users would also have to benefit from it, otherwise it would be too difficult to obtain their co-operation. Thus a questionnaire (See Appendix 1) was used to obtain the information from se ior people in the departments of Producer 1, the Distributor and the User. Every person interviewed was asked about the following:

- Person interviewed
- Organisation/Department
- Does he see a need for such a system?
- What is the reason for this decision?
- What reports and information would be required from the system?
- How important is the time aspect?
- What data does exist which could be used?
- Any other comments

The detailed requirements and needs would be identified as well as the extent and boundaries of the project. The information was summarized in Table 1 which follows.

## .. Results and deductions

All views expressed were those of the people interviewed and not necessarily the requirements for this particular system.

the objective of the system will be to capture as much of the required data in the field as possible, not interfering with the user's activities unnecessarily and analysing it in such a way that the maximum information is reported with an acceptable reliability as United States Army Material Command (13) points out. The boundaries for the system are the "Producer 1", the "Sole Distributor" and all the "Users". The maximum amount of information captured and reports to be generated are given in Table 1 under "Reports". It does not follow that all the information and reports will necessarily be generated by the system designed, but not more than those mentioned in Table 1 will be generated.

## 3.3 Consise statement of the objective

A system to feed back reliable and accurate failure data from the "User" to the "Producer" timeously and analyse this data in order to improve the products and to obtain inputs for future designs.

# 4. DEFINITION AND APPROACH

## 4.1 Definition

The wider system and the overall objective will now be defined.

The failure data feedback system will operate in the organisations of "The Producer", "The Distributor" and "The User". All of these organisations will benefit from a closed loop system which should have a continuous flow of information.

The system should be such that it can be used by any other "Producer" who makes use of the same "Distributor" and "Users" without changing anything.

The objective of the system is to be as simple and short as possible, monitoring the products and generating information to benefit every organisation involved and fulfilling the specific needs of the "Producer".

## 4.2 Initial outline of a data feedback system

At this stage the basic idea of a field failure data feedback system was drawn up in a block diagram as shown in Fig. 5. The complete system was split up into eight sub-systems.

This is a rough idea which will be developed further in the following chapter by developing outlines of various possible solutions

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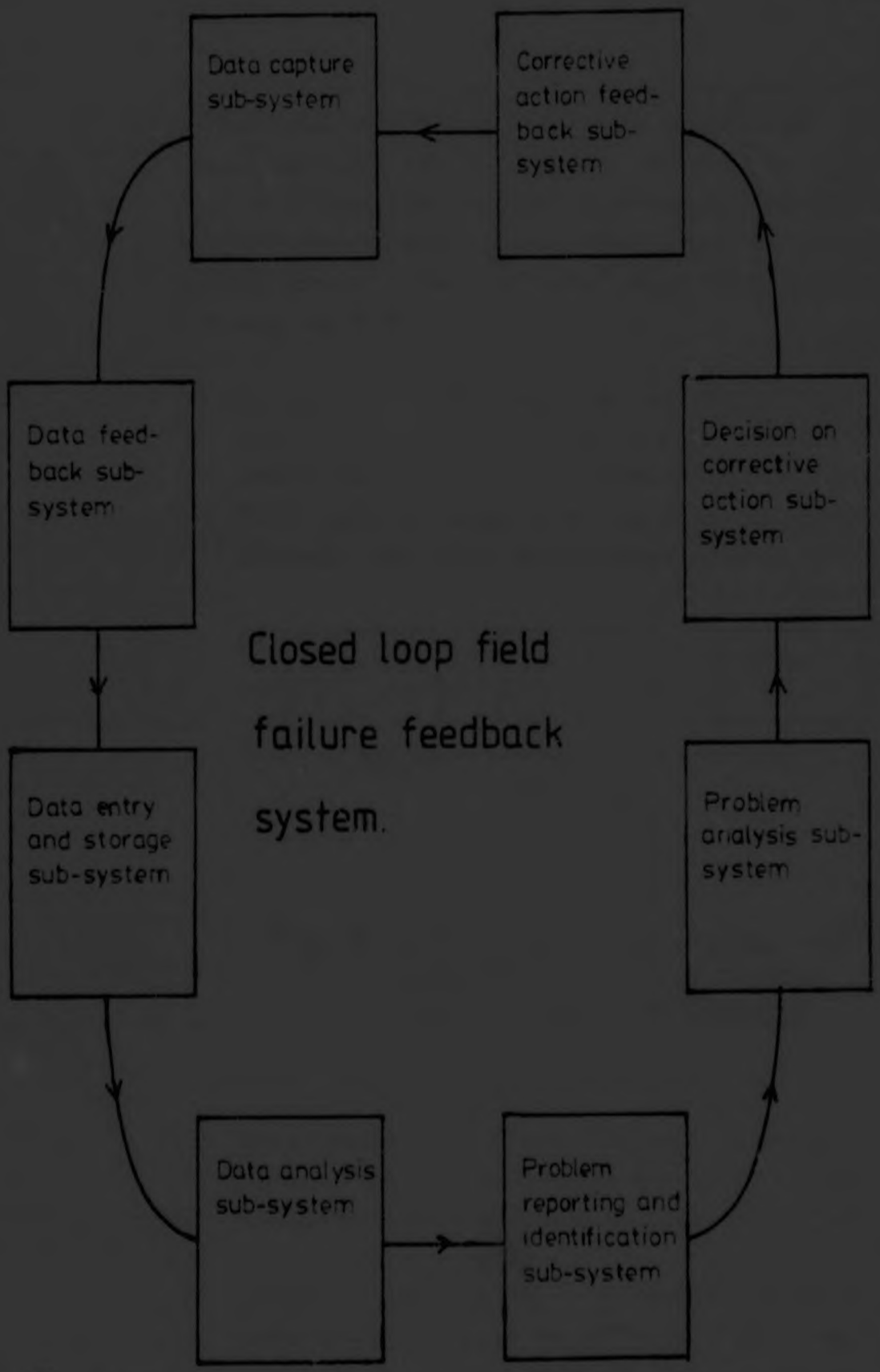



Fig. 5. Block diagram of a field failure data feedback system in broad outline

15/...

4.3 The approach to the development of the system

After the definition, the objectives and the boundaries of the system were discussed in broad outline (Ch 3) and illustrated in Fig 5. A literature survey was conducted and brainstorming techniques were used to generate ideas. Some of the important ideas are listed below.

- Obtain the information directly from user to keep the communication chain as short as possible as shown in Fig. 6. This would mean not having to work through the area representative.

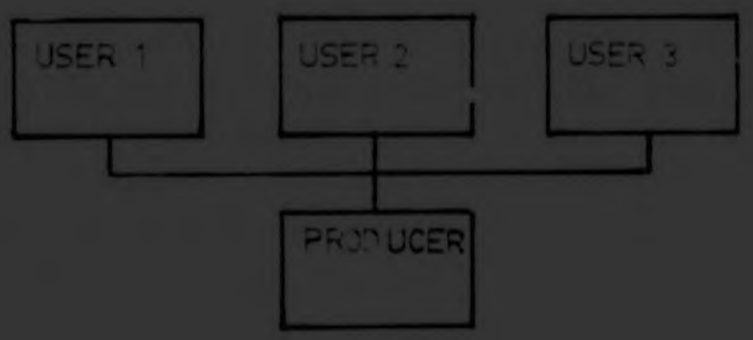



Fig. 6. BLOCK DIAGRAM OF ORGANISATIONS INVOLVED WHEN DATA IS OBTAINED DIRECTLY FROM THE PRODUCER

- Make deductions from stocks of spares, spares orders, spares usages and direct failures to obtain data. (See Juran 14)

- Consider motivating the "User" to support such a system by offering training, guarantees in the case of faulty parts, marketing a feedback system or even of-

16/...

fering some kind of financial reward. (See Juran 12)

- Operate the system in such a way that only a percentage of the "Users" failure information which represents the scope of applications and all environments can be used to analyse the products.

- Use reports from other failure capture systems as well as reliability and inspection data from the "Producer".

- Review previous attempts to design such a system. (i.e. try to obtain literature on a previous attempt.)

- Keep the communication chain as short as possible and conduct a survey into communication techniques.

- Data captured in different environments should be kept separate.

- Only specific data should be identified where there is absolutely no subjective influence whatsoever.

- The Pareto principle should be used to identify problems (i.e. by classification of parts and number of defects as described by Juran 14)

Most of these ideas were used or considered in the development of the system.

## 4.4 The existing systems

Before any further development takes place, all existing systems that fulfil a similar function were scrutinised.

Two such systems exist. One was the after-sales service which was an informal system run by the "Programs" Department of the producer. But no data or data history was available, since it was very subjective. There was no system description or such like available.

The other system was a formal system presented in Fig. 7 operated by the "User" which was very lengthy.

Various people who were actively involved in this system were interviewed. The general view was that the system did not work effectively for the following reasons:

- The communication chain of this system was too long.

- There were too many decision points where information could be stopped. For example the area representative could decide to classify the problem as mishandling of equipment.

- The data capture form consisted of five A4 sheets to be filled in by a mechanic which resulted in incidents not being reported.

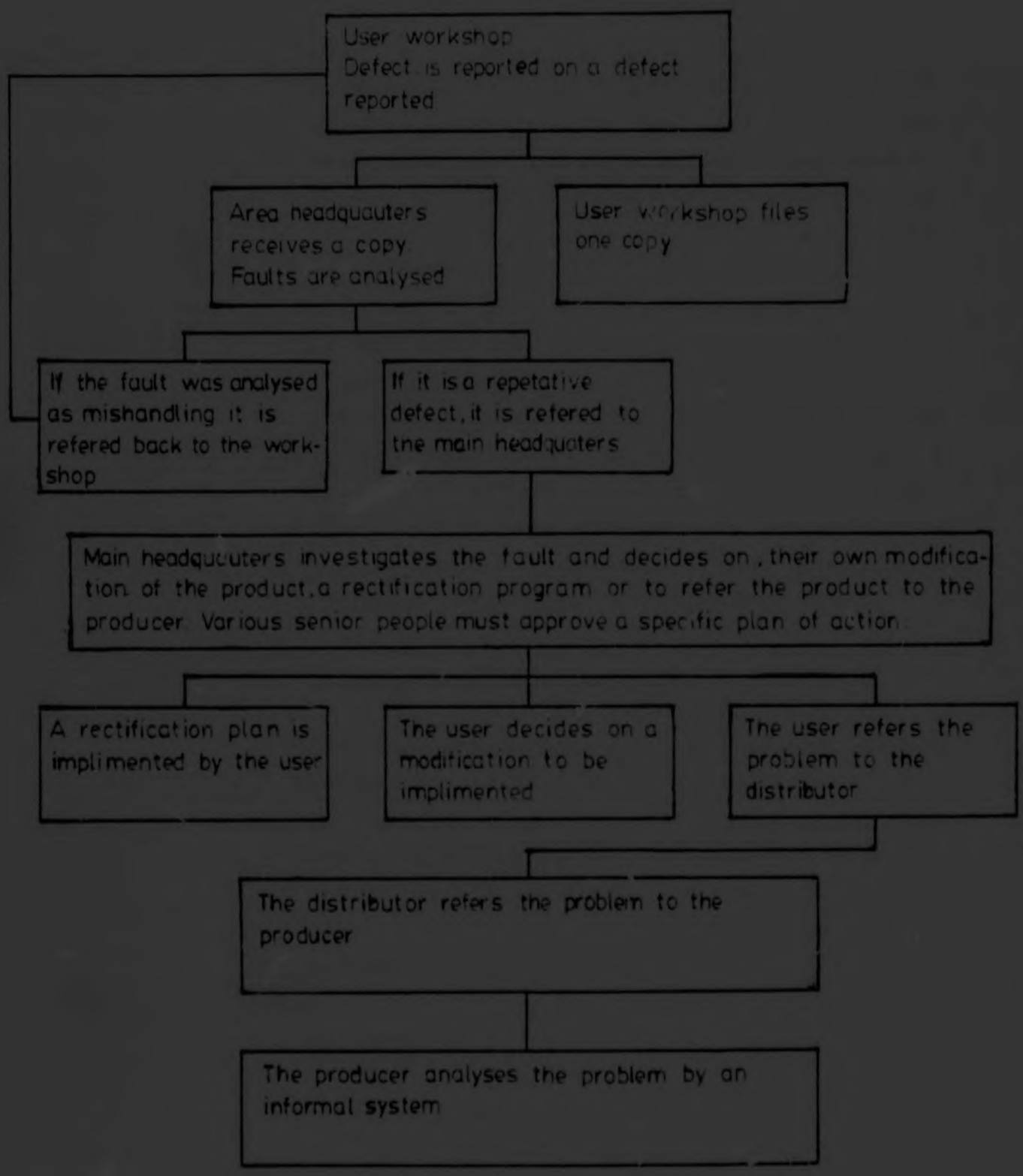



Fig. 7. BLOCK DIAGRAM OF THE EXISTING FEEDBACK SYSTEM IN THE USER ORGANISATION

19/...

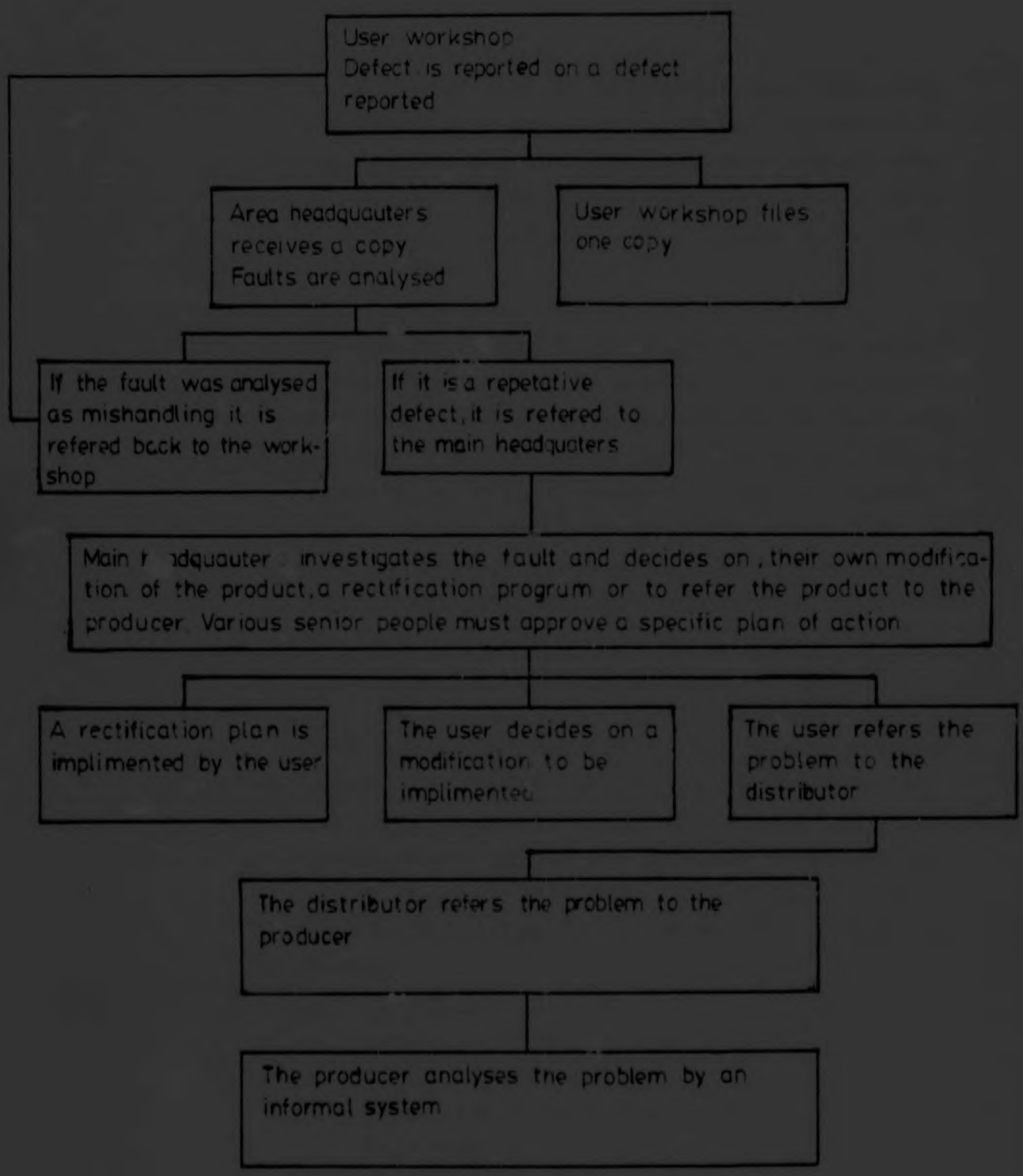



Fig. 7. BLOCK DIAGRAM OF THE EXISTING FEEDBACK SYSTEM IN THE USER ORGANISATION

19/...

Very few problems actually came to light in this system and if a problem was reported, it was found that by the time it had filtered through the system, there was already a crisis. This system did not capture specific data to be used in a proper data feedback system.

It was concluded that a complete new system should be developed, but that the results of the two previous systems should be compared to the results of a new system to get a measure of effectiveness in the new system. (i.e. if the same problems are identified, a new system is redundant) Thus one system can be measured against another.

## 4.5 The scope of data and reports

From the determination of the objectives and boundaries (3.2) the following data and report requirements could be identified. The table below gives the maximum requirements which could be included in the final system. Arinc (15) lists requirements for a similar system.

- Wear
- Product failure
- Mean time between failures
- Environment
- Location
- Life
- History of product
- Spares
- Consumables
- Functioning problems

- Reliability
- Actions taken
- Requirements exceeded
- User satisfaction
- Part numbers
- Part descriptions
- Product numbers
- Product description
- Date of defect
- Person responsible
- Manufacturer
- Age
- Parts replaced
- Nature of failure

The reports required are listed as:

- Location of failures
- Failed part lists
- Environment
- Products
- Replaced parts
- Spares usage
- Consumables
- Actions
- Responsible persons
- Descriptions
- Manufacturers
- Age
- Problems

## POSSIBLE SOLUTIONS

All the information which has been gathered up to this stage was coordinated to generate possible solutions. Again brainstorming and similar techniques were used. The aim was to analyse possible solutions in order to obtain one final solution.

Possible solutions were not developed in full detail, but such that a system diagram could be drawn up describing sub-systems and the activities between them addressed as links. (i.e. the activities from sub-system 1 to sub-system 2 are addressed under the heading Link 12). All three systems are presented with a short introduction preceded by a diagram.

### System 1

The system is developed in such a way that one central body collects the data from all the "Users" and sends it to the respective "Producer". To avoid cost incurring by every "Producer" collecting data from each "User" as shown in Fig. 8, this system was developed in such a way that this activity is centralized with the "Distributor" illustrated in Fig. 9.

The primary advantage of an centralized system is that each "User" will only be involved with one person collecting the data. Thus the degree of interference is kept as low as possible.

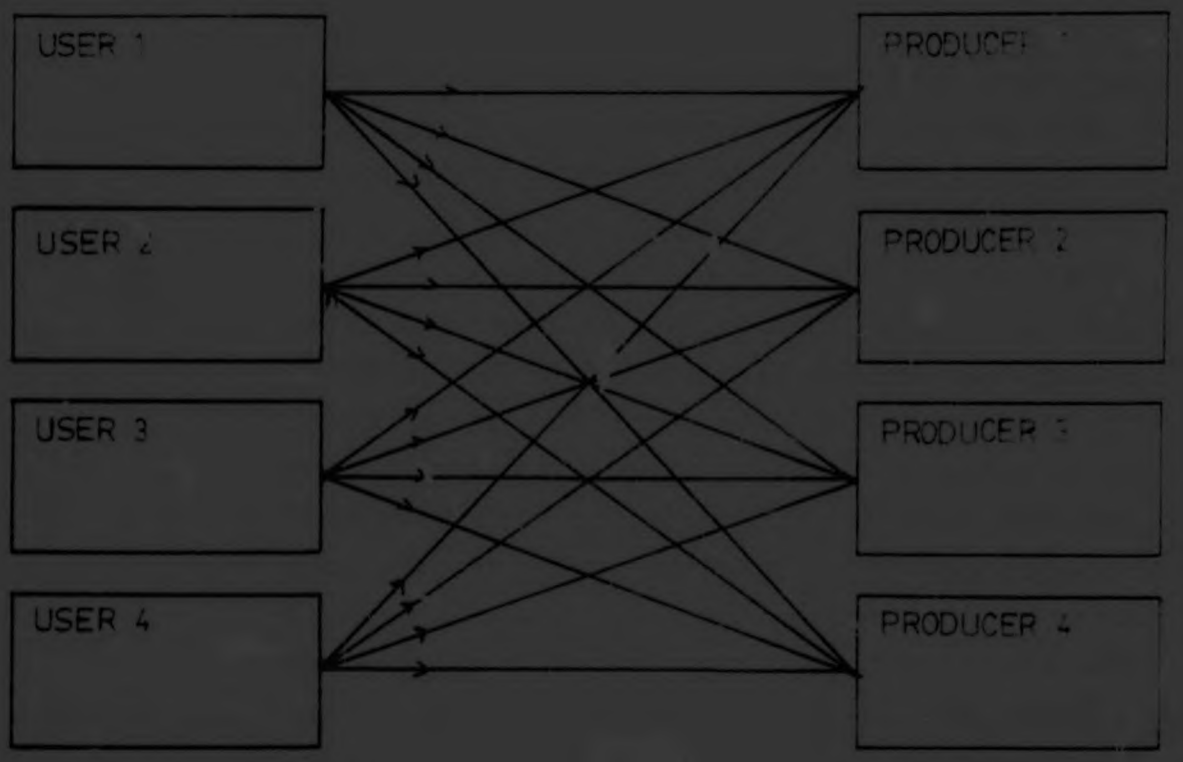



Fig. 8. BLOCK DIAGRAM OF THE ... CATION CHANNELS WHEN EACH PRODUCER COLLECTS DATA FROM EACH USER

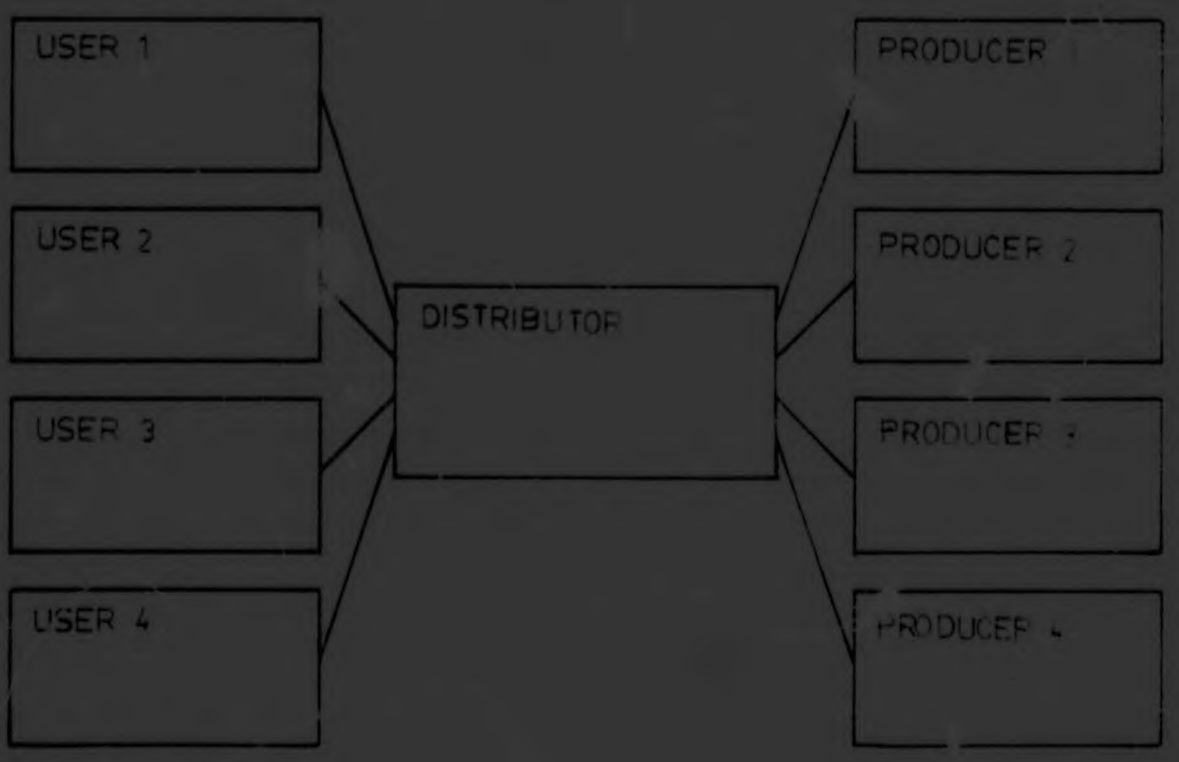



Fig 9. BLOCK DIAGRAM OF THE COMMUNICATION CHANNELS WHEN THE DATA COLLECTION BY THE PRODUCER FROM THE USER IS CENTRALISED BY THE DISTRIBUTOR

The data will thus be received by the "Producer's" Programmes Department (All external negotiations, letters etc have to be channelled through Programmes in this particular company.) which immediately refers it to the Quality Department. They analyse the data, generate reports and send them to the "Programmes" Department's project managers. The reports are then sent to "Engineering" who refers them to "Manufacturing", "Procurement" or "Quality" if the problem lies within their respective responsibilities. The problem will then be analysed and if there is a need to obtain hardware (parts or products) or speak to the "User", this will be arranged by "Programmes" through their normal channels. Once a problem area and a possible solution have been found, they are presented to "Programmes" which will take a decision by consulting the "User" and "Distributor" if required. The resultant action will then be implemented into the products, system etc. which will be monitored by the data feedback system.

The system was developed to be as short as possible and to fit best into the existing organisation as represented in Fig. 10. This system (Fig. 10.) is described in detail in Appendix (III).

24/...

## 5.2 SYSTEM II

This system is developed such that the "Producer's" Programmes department collects data directly from the "User". The data will not be the same as in the previous system. In this case the sample from the "Users" locations will be very small since the data will be collected by the "After Sales Service" staff on their regular visits to the "User". This will mean that no additional organisation or personnel will required to collect the data, but the data analysis will be a lot more complicated and perhaps less reliable since less data is available. The data is received by Quality, including any hardware that was obtained by "Programmes". Quality analyse the data, generate reports and send them to the "Programme's"Project Managers. The reports are then sent to "Engineering" who refer the reports to "Manufacturing", "Procurement" or "Quality" if the problem lies within their respective responsibilities. The problem will then be analysed by the responsible department. Once a problem area and a possible solution have been found, they are presented to "Programmes" who will take a decision by consulting the "User" and "Distributor" if required. The resulting action will then be implemented into the products, system etc. which will be monitored by the data feedback system.

This system was designed to give the "Producer" immediate feedback from the "User" but probably not as reliably as the previous system and is represented in Fig. 11. The

system (Fig. 11.) is described in detail in Appendix (IV).

system (Fig. 11.) is described in detail in Appendix (IV).

## 5.3 SYSTEM III

This system was developed in such a way that it fits into a system presently operated by the "User". The "User" has a defect reporting system whereby a defect is reported by filling in a defect report. (7 page questionnaire) The defective product is labeled and kept in a store for later reference. The report is then sent to the organisation via three distinct levels. At each level in the organisation the head can decide to send it on or take some other type of action. If the defect is worth reporting, then the head of the user organisation will ensure that the problem is brought to the attention of the "Distributor". The defect report is then sent from the "Distributor" to the "Producer". "Programmes" receives the report and immediately refer it to the "Quality" Department. Quality analyse the data based on the type of analysis envisaged for "System II". Reports are generated by Quality, which are sent to the Programmes Project Managers. The reports are then sent to "Engineering" which refer the reports to "Manufacturing", "Procurement" or "Quality" if the problem lies within their respective responsibilities. The problem will then be analysed by the responsible department and if there is a need to obtain hardware (parts or products) or contact the "User", this will be arranged by "Programmes" through their normal channels. Once a problem area and a possible solution have been identified, they are presented to "Programmes", which will take a decision by consulting the "User" and

"Distributor" if required. The resulting action will then be implemented into the products, systems etc. which will be monitored by the data feedback system.

This system was developed to link into an existing system thus not interfering with the "User's" operations during the data capture as represented in Fig. 12. The system (Fig. 12.) is described in detail in Appendix (V).

## 5.4 Conclusion

The solutions thus generated were drawn up and discussed with the people involved as to how they felt about such a system. The opinions of the "Distributor" and "User" were taken into consideration. Then all this information was used as an aid to identify advantages and disadvantages of the proposed solutions. Other techniques including value management as described by Van Heerden (16) were also used to identify these. Then Table 2 was drawn up of the most important advantages and disadvantages only.

| SYSTEM I | Advantages | Disadvantages |
|---|---|---|
| | The data collection is short and originates direct from the "User" organisation. | No subjective information can be captured by this system (e.g. ergonomics aspects of the products) |
| | The system is not long (i.e. not as lengthy as system III) | Data capture is the responsibility of the "Distributor" and does not fall within the Producer's control |
| | The system only captures concrete data (i.e. no subjective or human influence on the data capture). | The hardware has to be traced back to the "User". This |
| | The system only refers to products (or hardware) once a definite problem | |

32/...

| | | |
|---|---|---|
| | has been identified which requires the inspection of hardware. (There is no hardware moving in the system, only information) This cuts out additional costs.<br>The system can have various monitors built in to check the validity of the data.<br>A number of these systems can conveniently be implemented in a parallel situation. (For a number of "Producers")<br>The "Producer is in control of most of the system. | activity consumes a considerable time The user is only informed about the action at a later stage.<br>The "Distributor" has to interfere with the "User's" operation to obtain the data.<br>Costs are incurred to train the "Users" involved in the data capture.<br>Data capture will be performed by various people of different standards of education. |
| S Y S T E M II | This system has the shortest, cheapest and most direct data capture subsystem.<br>The time to capture the data and have it available to the "Producer" is very short.<br>The hardware is immediately available to the "After Sales Service" staff of the Producer.<br>Subjective data is ob- | The "User" is only informed about action to be taken at a late stage.<br>If the "User" has too many different "Producers", the "User" might have to sacrifice too much time.<br>Most of the data is subjective.<br>To obtain sensible |

33/...

| | | |
|---|---|---|
| | tained.<br>There is much personal contact with the "User".<br>The complete system is driven by the producer.<br>The data capture interferes very little with the "Users" work.<br>The system on the whole is the shortest. | reliability and spares information is very difficult since sample sizes are very small.<br>The validity of the data is very difficult to verify.<br>A lot of "human element" is involved. |
| SYSTEM III | The "User" has his own immediate feedback.<br>The "User" can decide if action is required before proceeding and making a detailed analysis.<br>The hardware is immediately available.<br>A number of "Producers" can make use of this system without any difficulty.<br>Subjective data as well as technical data can be obtained.<br>The data capture activity does not interfere with the work in the User organisation at all. | This is a very lengthy system and action might only be initiated at a critical stage.<br>A lot of information which might be of interest to the "Producer" is lost in the system.<br>This system can be very costly.<br>Difficult to control the time in this system.<br>Data capture is completely up to the "User" who is not always technically orientated.<br>The "User" takes decisions about discarding some of the data captured.<br>It is not possible |

34/...

| | |
|---|---|
| | to obtain reliability or spares information from the data since it is collected very biased. It is a large system, therefore the producer can only control a very small part of this system. |

Table. 2. A TABLE OF THE MOST IMPORTANT ADVANTAGES AND DIS-ADVANTAGES OF THE THREE PROPOSED SOLUTIONS

5.5 Selection

It was decided to develop System I further after many discussions with the "User" and "Distributor" and careful consideration of all aspects. The future use, practical aspects of the systems, human elements, size, communication aspects and many more were taken into account. The major disadvantage of system III was the length and the bias in the data captured. The major disadvantage of system II was the difficulty to obtain spares and reliabiltiy information from the data captured. Although system I has a number of disadvantages, it was decided that it was the best system since very useful data could be obtained to analyse the products with reference to reliabilities, spares, future designs, failures etc. which would be very valuable for the company. This system has the best potential to fulfil the objectives

35/...

## 6. DEVELOPMENT OF THE FINAL SOLUTION

The final solution (fig. 11) is the further development of the proposed system 1. The system was kept as short as possible to avoid unnecessary work and operating costs. The description of the final solution which follows in this chapter was developed such that the "data capture" and "data analysis" sub-systems were developed in detail in chapters 6.2 and 6.3 respectively and the remaining system was developed in chapter 6.1. The sub-systems described in chapter 6.2 and 6.3 involve the most important activities of a field failure data feedback system since the data capture sub-system must be well planned as mentioned by Juran (16) to capture the correct data accurately; and the data analysis sub-system which is closely related to the data capture sub-system must perform an analysis on the data in order to obtain accurate and meaningful reports. The remaining system as described in chapter 6.1 was developed so as to fit into the existing organisation as easily as possible. It was, therefore, decided that the activities performed in the system should be the responsibility of the departments or organisations involved. The departments or organisations will only be given information which enters the sub-system for which they are responsible, information which is required to leave the sub-system, the time in which such tasks must be performed and the functions within the sub-system. This approach was used to assure the successful implementation of the system, since the departments are responsible for their own sub-system and develop the sub-system according to their own procedure. This is important, since for example the Engineering department would know best how to

analyse a product failure and it would cause dissatisfaction if someone else would dictate to the Engineering department how to perform their analysis. Thus in summary the only restrictions laid down for each sub-system are the input, output, duration and function which have to be adhered to.

6.1 The final solution is presented in the plan on the previous page in Fig. 13, followed by a description of each sub-systems input, output, duration and function in this chapter. (The symbols used can be referred to in Appendix II.)

Sub-system 1

- The function of this sub-system is the data capture performed by the "Distributor" who records any information required by him and sends the data captured to the "Producers" Programmes Department. There is a channel to enter this sub-system to inspect or obtain hardware.

- The duration in which to send captured data from the "User" to the "Producer" via the "Distributor" should not be more than four days.

- The input into the system is the implementation of the corrective action as identified by the system.

- The output will be defect reports from the "User's" system and the data captured for this system.

This sub-system is represented in Fig. 14.

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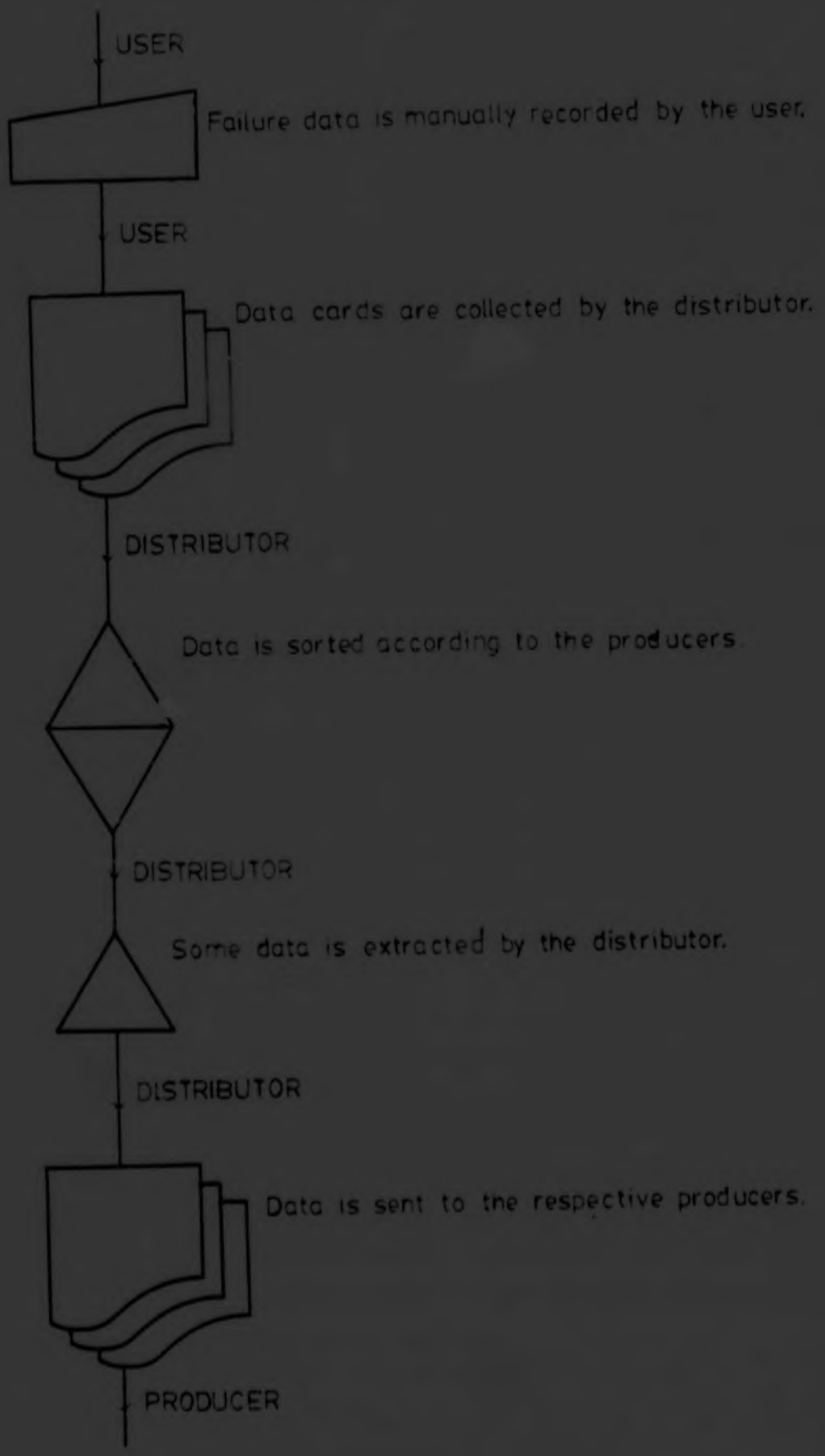



Fig. 14. FLOW DIAGRAM OF THE DATA CAPTURE SUB-SYSTEM.

41/...

Sub-system 2

- The function of thi, sub-system is to see that the information (data captured by 'ne "Distributor") is being receiv d by the "Producer" and is sent Jirectly to the Quality Departme'c.

- The duration is zero since the doc,ments will not be handled.

- he outputs and inputs are the data capture sheets

Su' -system 3

The fu ction of this system is the analysis of the data so that meaningful reports can be generated.

- The inputs into the sub-system consist of the data collected on the forms (designed by the "Producers" Quality Department) and a report from Programmes (complaints received from their "After Sales Service" or defect reports from the "User.") Other inputs are the history of the product which is available tc Quality (including the plans with reference to all part numbers etc.) The inputs will be from the list below:

  - Date
  - Location of failure
  - Venue
  - Part no.
  - Part description

- Environment
- Product no. (serial no.)
- Part replaced
- New
- Old
- Medium
- Product description
- Nature of damage
- The number of productr inspected
- Parts description
- Part no.
- When the batch was issued
- Number of card (form)
- Its locatio
- The time sent away
- The time received
- Model of product's number

From Programmes the input will be a report of any problems that were identified by the "After Sales Service" or by the defect reports which will be compared to the reports generated.

- The <u>output</u> of this system will be selected reports from Table 3. These were determined when the objective and boundaries of the system were identified

This sub-system is represented in Fig. 15.

| CONTROL CHART OR TYPE OF REPORT | DEPARTMENTS WHO RECEIVE REPORTS | | | | | FREQUENCY |
|---|---|---|---|---|---|---|
| | ENGINE | PROGRAMMES | QUALITY | PROC. | MAN | |
| 1. Control charts | | | | | | |
| a) Control in dividual parts | | | | | | |
| i Average X and range R | | | X | | | Weekly |
| ii Average X and standard deviation G | | | X | | | Weekly |
| iii Individual X | | | X | | | Weekly |
| iv Cumulative FAILURES | | | X | | | Weekly |
| b) Control of % overall fraction defective | | | | | | |
| i % Defective p | | | X | | | Weekly |
| ii Number of deviations np | | | X | | | Weekly |
| c) Control of overall number of defects | | | | | | |
| i Defects per unit u | | | X | | | Weekly |
| ii Number of defects c | | | X | | | Weekly |
| 2. Frequency distribution | | | X | | | Weekly |
| 3. Correlation with other data | | | X | | | Weekly |
| 4. Comparison with standards or previous average | | X | X | | | |
| 5. Ranges | | X | X | | | Weekly |
| 6. Tabulations by defect type | X | X | X | X | X | Monthly |
| 7. Defect matrics | X | X | X | | | 2 Weekly |
| 8. Failure patterns (failure ratios tive; life) | X | X | X | | | 2 Weekly |
| 9. Relationship between part and system | X | X | X | | | Monthly |
| 10 Reliability | X | X | X | | | Monthly |
| 11. Field failure as factory reject | X | X | X | X | | 2 Weekly |
| 12. Complaint in dices | X | X | X | X | X | Weekly |
| 13. List in order of importance | X | X | X | | X | Monthly |
| 14. Cost analysis | X | X | X | | X | Monthly |
| 15. Spares usage | X | X | X | X | X | Monthly |
| 16. Comparison for problem reports | | X | X | | | Monthly |
| 17. Problem report | X | X | X | X | X | When applicable |

Table 3. Table of the type of reports to be considered.

44/...

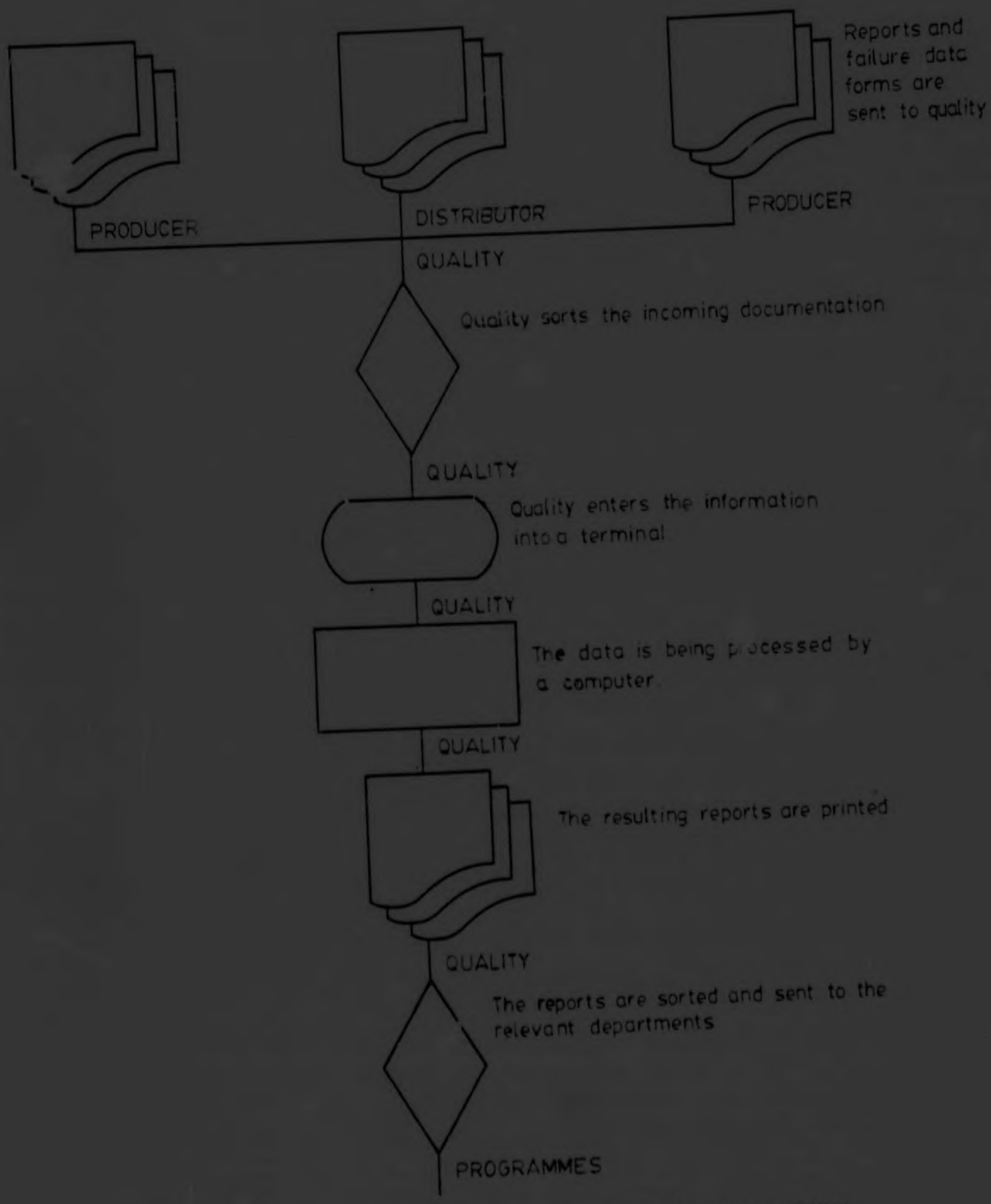



Fig. 15. FLOW DIAGRAM OF THE DATA ANALYSIS-SUB SYSTEM

45/...

Sub-system 4

- The function of this sub-system is to receive all the reports (for Programmes, Procurement, Manufacturing and Engineering) from Quality and either pass them on to the relevant department if the reports are not of interest to Programmes or to evaluate the report and decide on any action required. The way in which this sub-system operates is entirely the responsibility of Programmes. Programmes will have to formalize their procedures within one month and pass a copy to Quality. Programmes will have to operate according to their procedure..

- The time to handle the reports should not be more than two days.

- The inputs are the reports from Quality.

- The outputs are the reports / or memos from Quality describing an action to be taken or reasons for delays

Sub-system 5

- The function of this sub-system is to receive the reports from Programmes and to evaluate and analyse the problem reported on. To decide on some type of corrective act on plan, the Engineering Department can work via Programmes to visit the user and view, test or obtain any hardware. The Engineering Department should then

write a short proposed corrective action report to hand to Programmes. The way in which this sub-system operates is entirely the responsibility of Engineering. Engineering will have to formalize their procedures within one month and pass a copy to Quality. Engineering will have to work according to their procedure.

- The time in which to handle reports should not be more than two days.

- The inputs will be the reports from Programmes with any memos if required, as well as hardware if required.

- The outputs will be the reports as well as a proposed corrective action report to Programmes.

Sub-system 6

- The function of this sub-system is to receive the reports from Programmes and evaluate and analyse the problem reported on. To decide on some type of corrective action plan, the Quality Department can work via Programmes to visit the user and view, test or retain any hardware. The Quality Department should then write a short proposed corrective action report to hand to Programmes. The way in which this sub-system operates is entirely the responsibility of Quality. Quality will have to formalise their procedures within one

month and pass a copy of them to Quality. Quality will have to work according to their procedures.

- The time in which to handle reports should not be more than two days.

- The inputs will be the reports from Programmes with any memo's if required, as well as hardware if required.

- The output will be the reports as well as a proposed corrective action report to Programmes.

Sub-system 7

- The function of this sub-system is to receive the reports from Programmes and evaluate and analyse the problem reported on. To decide on some type of corrective action plan, the Manufacturing Department can work via Programmes to visit the user and view, test or obtain any hardware. The manufacturing Department should then write a short proposed corrective action report to hand to Programmes. The way in which this sub-system operates is entirely the responsibility of Manufacturing. Manufacturing will have to formalise their procedures within one month and pass a copy of them to Quality. Manufacturing will have to work according to their procedure.

The time in which to handle reports should not be more than two days.

The inputs will be the reports from Programmes with any memo's if required, as well as hardware if required.

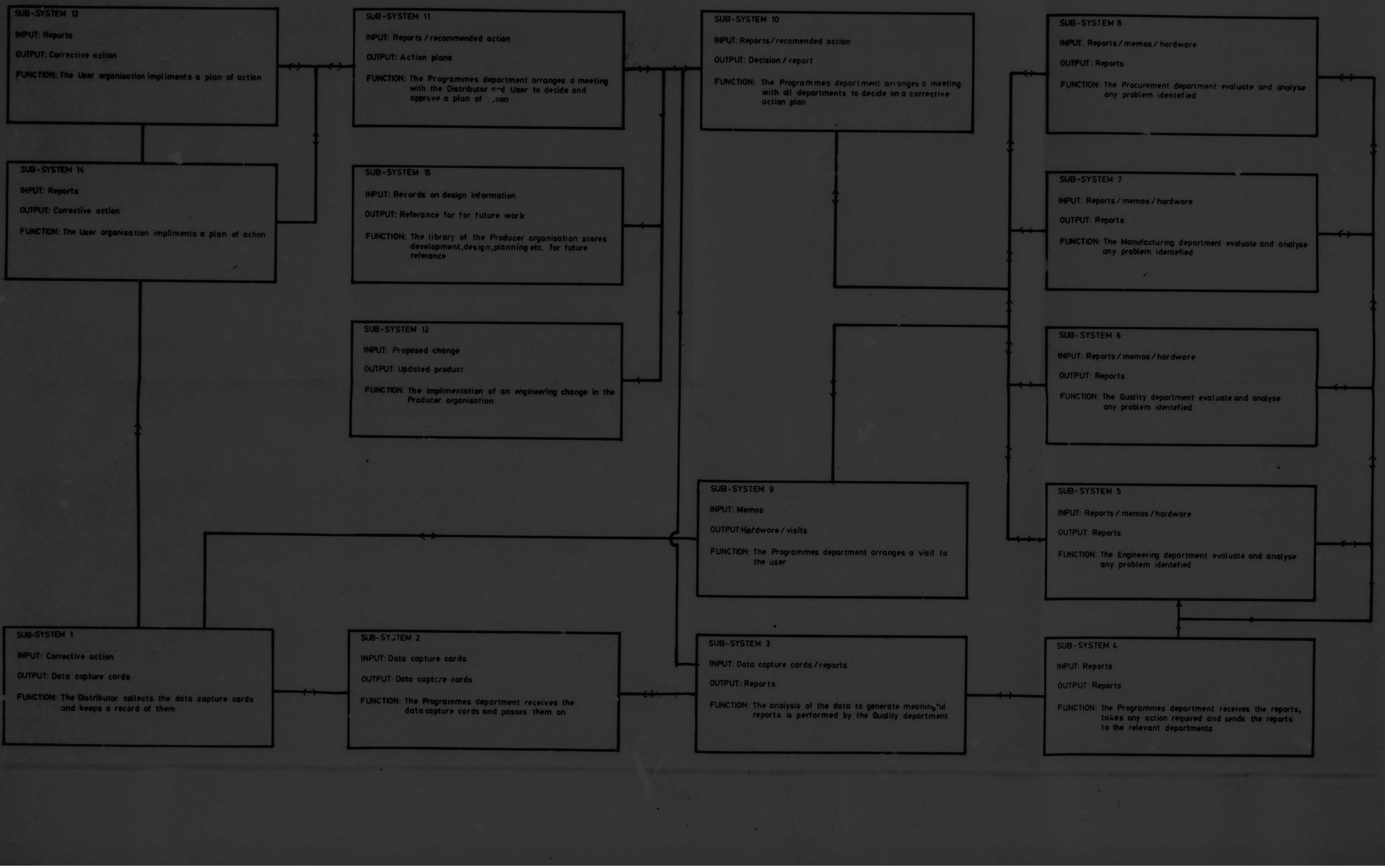
The outputs will be the reports as well as a proposed corrective action report to Programmes.

(ii) System 2

The function of this sub-system is to receive the reports from Programmes and evaluate and analyse the problem reported on. To decide on some type of corrective action plan, the Procurement Department can work via Programmes to visit the user and view, test or obtain any hardware. The Procurement Department should then write a short proposed corrective action report to hand to Programmes. The way in which this sub-system operates is entirely the responsibility of Procurement. Procurement will have to formalise their procedures within one month and pass a copy of them to Quality. Procurement will have to work according to their procedures.

The time in which to handle reports should not be more than two days.

The inputs will be the reports from


SUB-SYSTEM 13
INPUT: Reports
OUTPUT: Corrective action
FUNCTION: The User organisation impliments a plan of action
SUB-SYSTEM 11
INPUT: Reports / recommended action
OUTPUT: Action plans
FUNCTION: The Programmes department arranges a meeting with the Distributor and User to decide and approve a plan of action
SUB-SYSTEM 10
INPUT: Reports / recomended action
OUTPUT: Decision / report
FUNCTION: The Programmes department arranges a meeting with all departments to decide on a corrective action plan
SUB-SYSTEM 8
INPUT: Reports / memos / hardware
OUTPUT: Reports
FUNCTION: The Procurement department evaluate and analyse any problem identefied
SUB-SYSTEM 14
INPUT: Reports
OUTPUT: Corrective action
FUNCTION: The User organisation impliments a plan of action
SUB-SYSTEM 15
INPUT: Records on design information
OUTPUT: Referance for for future work
FUNCTION: The library of the Producer organisation stores development,design,planning etc. for future referance
SUB-SYSTEM 7
INPUT: Reports / memos / hardware
OUTPUT: Reports
FUNCTION: The Manufacturing department evaluate and analyse any problem identefied
SUB-SYSTEM 12
INPUT: Proposed change
OUTPUT: Updated product
FUNCTION: The implimentation of an engineering change in the Producer organisation
SUB-SYSTEM 6
INPUT: Reports / memos / hardware
OUTPUT: Reports
FUNCTION: The Quality department evaluate and analyse any problem identefied
SUB-SYSTEM 9
INPUT: Memos
OUTPUT: Hardware / visits
FUNCTION: The Programmes department arranges a visit to the user
SUB-SYSTEM 5
INPUT: Reports / memos / hardware
OUTPUT: Reports
FUNCTION: The Engineering department evaluate and analyse any problem identefied
SUB-SYSTEM 1
INPUT: Corrective action
OUTPUT: Data capture cards
FUNCTION: The Distributor collects the data capture cards and keeps a record of them
SUB-SYSTEM 2
INPUT: Data capture cards
OUTPUT: Data capture cards
FUNCTION: The Programmes department receives the data capture cards and passes them on
SUB-SYSTEM 3
INPUT: Data capture cards / reports
OUTPUT: Reports
FUNCTION: The analysis of the data to generate meaningful reports is performed by the Quality department
SUB-SYSTEM 4
INPUT: Reports
OUTPUT: Reports
FUNCTION: The Programmes department receives the reports, takes any action required and sends the reports to the relevant departments

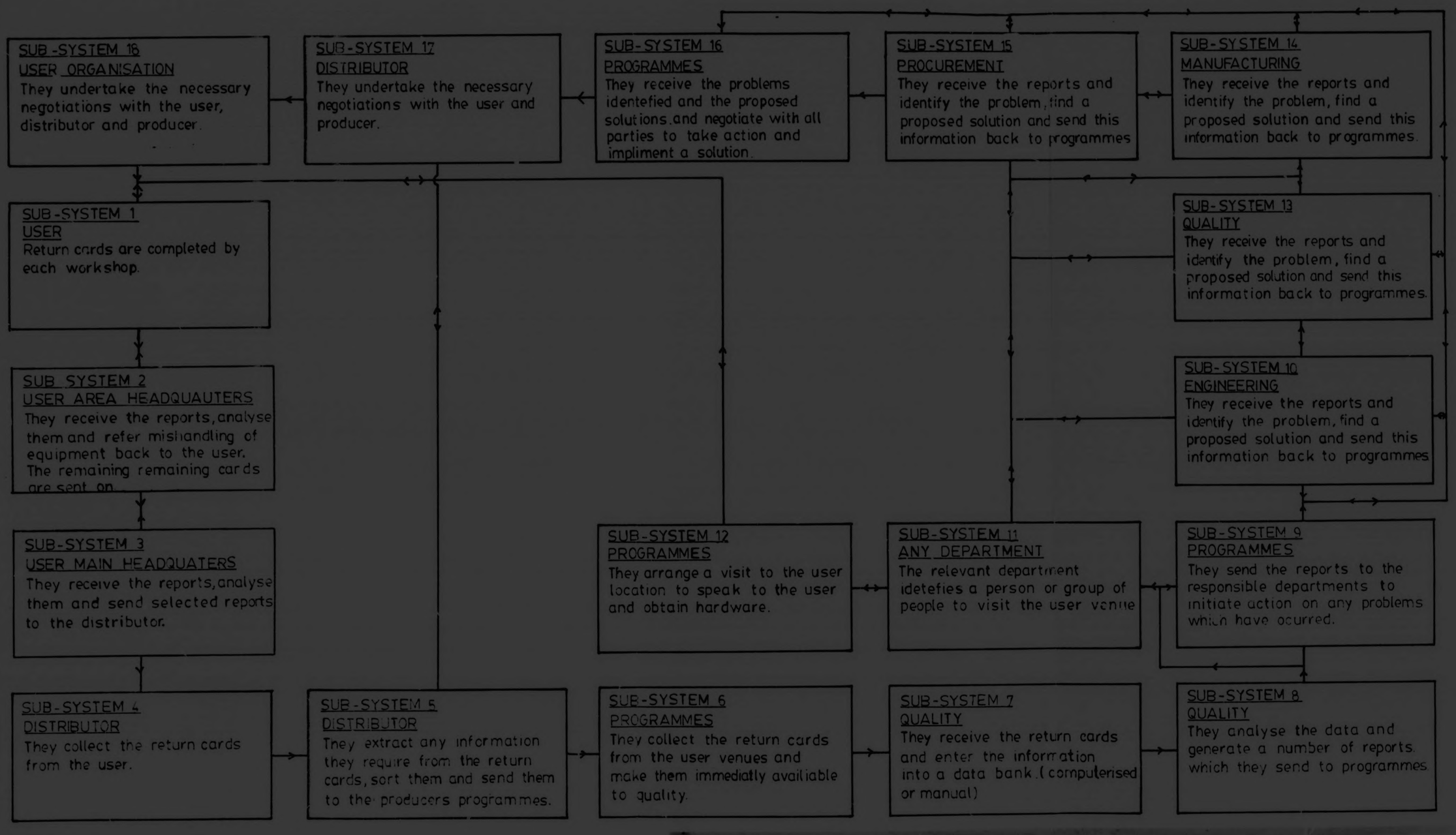



Fig. 12. BLOCK DIAGRAM OF THE PROPOSED SYSTEM III

31/...

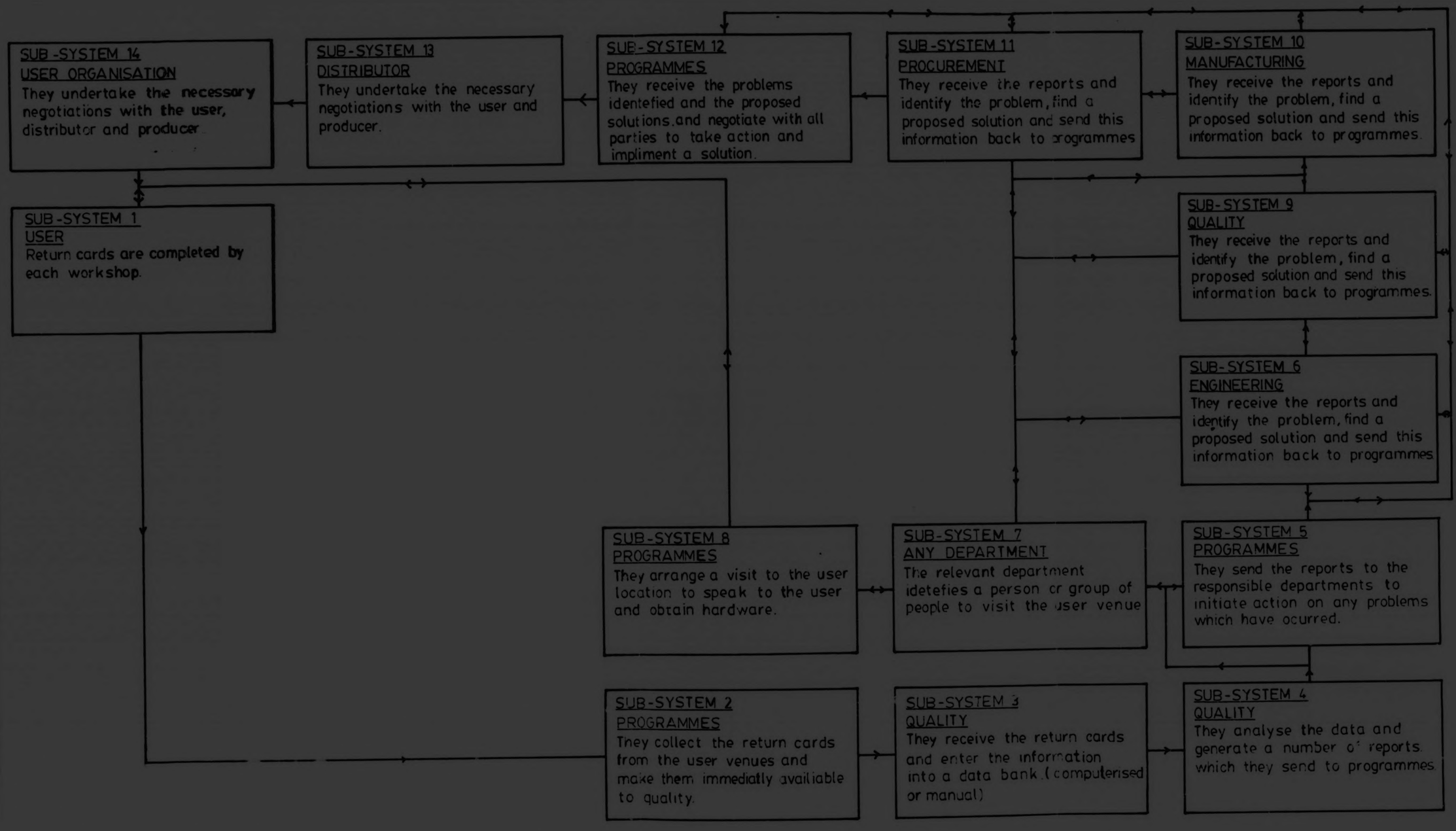



Fig. 11. BLOCK DIAGRAM OF THE PROPOSED SYSTEM II

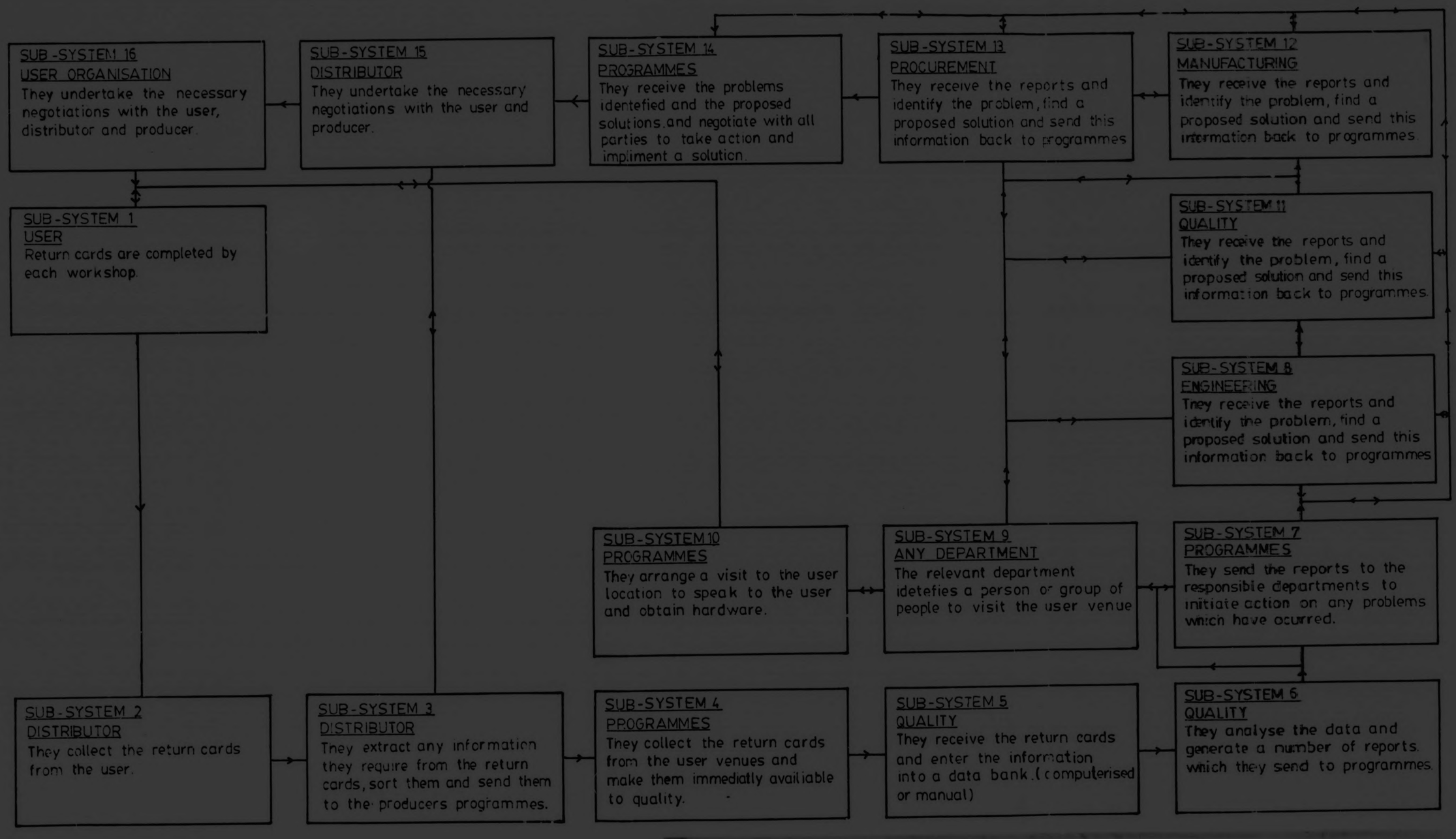



Fig. 10. BLOCK DIAGRAM OF PROPOSED SYSTEM I

| NAME INTERVIEWED | ORGANISATION | NEED | REASON FOR A NEED | REPORTS AND INFORMATION REQUIRED | TIME IN WHICH REQUIRED | DATA EXISTING | COMMENTS |
|---|---|---|---|---|---|---|---|
| 1. | Producer I Programmes Department | No | Such a system exist | None | Not applicable | Defect reports | No co-operation |
| 2. | Producer I Manufacturing Department | Yes | To obtain safety, functionability, interchangeability, logistic and cosmetic information | An analysis by the Quality Department and a defect analysis by engineering | As soon as possible | Build book per lot per product | There is a definite need for the syste |
| 3. | Producer I Procurement Department | Yes | To trace material faults for their origin and to trace faulty externally procured parts.<br>To monitor any system problems. | Reports on material and vendor supplied components. | As soon as possible | None | There is a need for such a system |
| 4. | Producer I Engineering Department | Yes | Since there exists no logistic and design feedback. | All design and logistic information | The information must be continuous | None | None |
| 5. | Producer I Quality Department | Yes | Need to know the problems, defects, quality reports and contract shortcomings to take corrective action. | Reports on quality costs, failure data, reliability data, maintainability and product safety. | As soon as possible and immediate action in the case of critical defects | Build books and the classification of defects are available | Immediate action must be taken in the case of critical defects |
| 6. | Producer I Engineering Department | Yes | To improve the existing system | Information required will be the mean time between failure, the environment, the action, the cause and reliability of the products and its parts. | As soon as possible | In house reliability information | Cannot see how any reliability data can be captured |
| 7. | Distributor Department | Yes | Need information since the present system is not very effective | Information on reliability, spares used and repairs made is needed. | As soon as possible | None except for some very informal data exists | The present system is too complicated |
| 8. | Producer I Engineering Department | Yes | Since life information can not be obtained for large products and there exists too little design feedback | Reports are required on reliability, traceability, life, logistics, maintenance and spares usage. | As soon as possible | Data received presently is not sufficient | The present system is not sufficient |
| 9. | User Representative | Yes | Since at this moment only the incident failures are recorded. | Information is required on spares usage, rework, replacements and modifications. | Continuous data is required | The defect report system | The communication chain is too long in the existing system |
| 10. | Product Programmes Department | Yes | If there are more concurrent systems it is easier to identify a problem | Information on deficiencies, technical data and where the requirements are exceeded | As soon as possible | The defect report system | Any system should work via "Programmes" |

Table 1. TABLE OF REQUIREMENTS AND LIMITATIONS OF A FEEDBACK SYSTEM OBTAINED BY INTERVIEWS

quired, as well as hardware required.

- The output will be the reports as well as a proposed corrective action report to Programmes.

Sub-system 9

- The function of this sub-system is to arrange a visit to the User. The respective department should identify a person/group, time and venue to visit the User. Hardware can be inspected, viewed at or obtained. Programmes will arrange these actions with the User and the way this sub-system operates is entirely the responsibility of Programmes. Programmes will have to formalise their procedures within one month and pass a copy to Quality. Programmes will have to work according to this procedures.

- The time in which to handle such an action is limited to one week.

- The inputs are requests by the relevant departments in the form of a memo.

- The outputs are the request of a visit, to obtain hardware etc.

Sub-system 10

- The function of this sub-system is to decide on action to be taken. Programmes receive the proposed corrective action reports as well as the original reports. Programmes then arrange with all parties (user, client, producer etc.) about a plan of action and includes whoever they require. They can do this through technical committee meetings etc. Then a decision is taken and Programmes is responsible to initiate it (by delegating to the responsible department or organisation etc.). Internally any changes take place by Engineering Change Process (ECP). Programmes will arrive at decisions in the sub-system which they are responsible for. Programmes will formalise their procedures within one month and pass a copy of the procedure to Quality. Programmes will have to work according to these procedures. Programmes must also advise Quality on any action taken in the form of a report.

- The time in which to handle such action should be one month.

- The inputs are the proposed corrective action reports as well as memo's.

- The outputs will be the decision taken by management and a report to Quality

51/...

Sub-system 10

- The function of this sub-system is to decide on action to be taken. Programmes receive the proposed corrective action reports as well as the original reports. Programmes then arrange with all parties (user, client, producer etc.) about a plan of action and includes whoever they require. They can do this through technical committee meetings etc. Then a decision is taken and Programmes is responsible to initiate it (by delegating to the responsible department or organisation etc.). Internally any changes take place by Engineering Change Process (ECP). Programmes will arrive at decisions in the sub-system which they are responsible for. Programmes will formalise their procedures within one month and pass a copy of the procedure to Quality. Programmes will have to work according to these procedures. Programmes must also advise Quality on any action taken in the form of a report.

- The time in which to handle such action should be one month.

- The inputs are the proposed corrective action reports as well as memo's.

- The outputs will be the decision taken by management and a report to Quality

on the problem as well as the solution. Outputs might implement changes in other organisations involved.

Sub-system 11

- The function of this sub-system is a meeting where user, client and producer are present to discuss or take action on any problems. This will be arranged by Programmes. Thus Programmes is responsible for this sub-system and they will also formalise their procedures.

- The time duration of such a meeting should not be longer than a day.

- The inputs are the reports, problems and recommended action.

- The ouputs are action plans formalised by Programmes.

Sub-system 12

- The function of this sub-system is to implement an engineering change and the procedures for such an action are laid down in the Producer organisation.

- The time duration is a week to a month to implement a change.

- The input is a change on paper or in the design.

- The output is an updated product. (Software and hardware)

- The function of this sub-system is the action, implementation of corrective action and negotiation about a product. This is the responsibility of the "Distributor" over which the "Producer" has no control.

Sub-system 13 / Sub-system 14

- The function of this sub-system is the action, implementation of corrective action and negotiation about a product. This is the responsibility of the "Distributer"/"User" about which the "Producer" has no control.

Sub-system 15

- The function of this sub-system is to store information on development, design, planning etc. for future referance. The library will be used to store the information.

- The inputs are any changes to products, systems etc.

- The ouputs are references for future work

## 6.2 Data capture sub-system

This sub-system is of great importance since inadequate and faulty data inputs would make the system useless. Thus data and infor-

mation capture form the basis of the system. In this sub-system it is of importance that one has a good picture of the problem, that one communicates well with the users and have a background of statistical techniques. But never-the-less, the most difficult task is to obtain timely, accurate and complete data from the field. This will best be achieved if one advises field operators as to what data must be captured, how it is to be captured and how it will be reported as described by AMCP (4). But while collecting data, continuous track must be kept of the cost involved to determine the effectiveness of the system.

### 6.2.1 Objective of the data capture sub-system

The objective is to clarify the purpose of the data collection as a basis for actions, to include everything into the data and to take action according to the data collected. This can be achieved by:

- Planning a system to receive information in any form.
- To provide for new data needs.
- To provide for the elimination of data no longer required.
- To design a standard language for data recording.
- To capture data on successful operations as well as failures.
- To include plans for incorporating statistical methods for evaluating data.

54/...

- To determine minimum data requirements.

6.2.2 Scope of the data capture sub-system

It is most important to provide only the facts required, to achieve this in a reasonable time span, to have data representing the true situation (will data captured reveal the facts?) and to only use countable data for this specific system as Kaoru (8) points out. An reference to use when designing the data capture system is the B. S. 5760 Part 1.

6.2.3 Identification of data to be captured

It is important to mention again that an effective data capture plan must be co-ordinated to reduce the data capture activity to a routine activity. Ideally the number of failures should be recorded adequately to determine the cause of failures as stated by Juran/Gryna (18). In such a situation it is more useful to analyse a small sample in detail than to process large volumes of data. In this case there are different conditions under which data is captured, but if the data capture action differs, the data capture will remain the same.

Two sources of data are the field failures and in-house records available. Since the in-house records exist and only have to be entered into a data base, this will not be formalised.

The field data to be captured as determined previously as:

- Wear information
- Product failure
- Mean time between failures
- Environment
- Location
- Life
- History of the product
- Spares
- Consumables
- Functioning problems
- Action taken
- Requirements included
- Satisfaction
- Part numbers
- Part descriptions
- Product descriptions
- Date
- Person responsible
- Manufacturer
- Age
- Parts replaced
- Nature of failure

Apart from this list, the following should also be considered:

- Reporting activity
- Drawing number

56/...

- Operating time
- Number of cycles
- Accumulated operating time
- Accumulated cycles
- Date maintenance started
- Date maintenance ended
- Effect of malfunction of equipment
- Symptoms of malfunction
- Condition of failed part

It was decided to only capture the following data from the "User":

- Date
- Part number
- Part description
- Environment
- Product number
- Product description
- Part number replaced
- Age
- Reason for failure

The reason for collecting only the above data are given in chapter 6.2.4 and 6.3.

6.2.4 Capture of acceptable and realistic data

Once it has been established what data is required, the important question is: how will it be captured? It is important to mention that this activity can only be successfully performed using communication theory which is very

often neglected.

6.2.4.1 Introduction to communication

The most effective communication will be achieved by planning the communication, thus an approach of communication by objectives was used.

It is important to identify the need of communicating since people communicate for numerous reasons such as wishes, creative desires, ideas, needs etc. Maslow, ranked the human needs as physicological, security, social, ego and self actualisation in decending order of importance. Fourie (19) illustrates that communication problems are caused by trying to satisfy different communication needs (listed by Fourie (19) as informational, emotional, entertainment, motivational and ideological.) at the same time. Thus the specific need to communicate in this case was identefied as: To obtain accurate and reliable

field failure data for the use of a data bank from which meaningful reports can be generated.

6.2.4.2 Objectives, constraints and problems to be aware of

The user of the system must know why he is performing certain tasks and how the system operates. This is of importance since it may cause a possible resistance to communicate. Thus when developing the communication, the above must be kept in mind as well as the cost of the effort to capture the data.

- The objective and constraints for the communication were determined as follows:

Objective: To have a person respond in the best possible manner to perform the data capture and feed it to the "Distributor".

Constraints: The communicator will be the person repairing the products and the communica-

tion should interfere with this work as little as possible while he captures the data for the "Distributor". All the data capture will take place in the "User" organisation.

5.4.3 Approach and circumstances

Fourie (20) is a good guideline to determine these. In this particular situation the data capture takes place in the "User" organisation which is large and offers many different means to capture data. The circumstances under which the data is captured can have a great influence on the eventual success of the data capture and it was thus decided to try and control the circumstances where possible (i.e. the data capture card and procedures will be designed for the "User")

There are four approaches when communicating nameley rational, humorous, serious or emotional. For this specific case the approach is purely rational and serious since there

are cost involved and the topic is purely technical. This was very important to consider in chapt. 6.2.4.6 where a return card was designed.

6.2.4.4 Analysis of the communicator

The communicator was analysed by determening the demographic profile of the people involved which was performed by the method described by Fourie (20) and van Schoor (21). In this case the people were the mechanics with the following characteristics:

Sex - Males
Age - Between 18 and 50 years
Nationality - South African
Occupation - Technician (mechanics)
Education - Std 8 to T3 technician
Income - R500-00 to R 1300-00 p.m.
Living area - R.S.A.

Having identified the above, the man's capacity for comprehension(ability

to encode messages) is known. To ensure correct data capture it was thus decided to only capture as little data as possible and in a manner which can easily be understood by a technical person.

The communication habits were established in the list below to determine how the communication should take place.
Media preference - speech or writing
Media competition - speech preferrence since practical, technical people normally communicate little by writing)
Channels - This will be kept as short as possible within the organisations.
Code preferences - None
Time preference - Not on Wednesday afternoons since most of the employees take part in the orgaisations organised sporting activities.
Time available - As little as possible

Apart from the facts mentioned above it must be kept in mind that com-

municator and destination are removed far from each other. they are widely dispersed and they represent a great number of people.

6.2.4.5 Media selection

This selection was performed according to Fourie (22) keeping in mind what was determined in chapter 6.2.4.4. The first step was to make a code analysis to determine which of the seven catagories could be used to convey the message as shown below:

Retu.n cards
Telephone
Installation
Sampling
Test results
Letters
Pamphlets
Telex
Computers

The next step was to select a media keeping in mind the codes which can be used. The media is anything used to actually convey the message and the media which could be made use of in this situation

were:

| | |
|---|---|
| Language | Yes |
| Visual | Yes |
| Sound | To a very small extent |
| Touch | No |
| Smell | No |
| Taste | No |
| Kinesthetic | No |

The only media considered practical from the above were return cards, telex, telephone and computors. To select the media to be used the media characteristics of these four were compared in Table 4.

| Characteristic | Telex | Telephone |
|---|---|---|
| Hardware cost | High | Low |
| Storage required | Medium | Low |
| Reliability | Less 100 % | Less 100% |
| Transportability | Medium | Medium |
| Obsolescence | NA | NA |
| Versatility | Medium | High |
| Encoding possibility | Good | Very good |
| Space | Medium | Medium |
| Geographic range | Large | Large |
| Speed | Fast | Very fast |
| Operating procedure | Medium | Simple |
| Permanence | Medium | Medium |

64/...

| Characertistic | Computor | Card |
|---|---|---|
| Hardware cost | Very high | Low |
| Storage required | High | Low |
| Reliability | Less 100 % | Less 100 % |
| Transportability | High | Low |
| Obsolescence | NA | NA |
| Versatility | Medium | Low |
| Encoding possibility | Good | Very good |
| Space | High | Low |
| Geographic range | Large | Large |
| Speed | Fast | Slow |
| Operating procedure | Complicated | Simple |
| Permanence | High | Low |

Table 4. A COMPARISON OF MEDIA CHARACTERISTICS

It was decided to use Return Cards to capture data since the costs involved is low, there is no encoding cost and no trained personnel is required.

6.2.4.6 The design of the return card

When designing a return card (see Fig. 16.) it is better to use a glossary of standardised words and to accept some loss of accuracy and detail resulting from the coarseness of codes on it. The return card must be of convenient size and it was

thus decided to use a post card size. The post card was designed so as to have a brief, rational and serious article format as described in more detail by Fourie (22).

The return card was designed using devices mentioned by Fourie (22):

The page layout was such that information was spread evenly and more blank space was availiable where a heavy typeface was used. The colour was chosen keeping the communicator in mind mainly european technical and yellow seemed to be the best colour since it signals alertness. ( It must be mentioned that if more Africans use the return cards, the colour has to be revised since yellow may indicate illness or converdice to them). Finally the type-faces were looked at and it was decided to use an "easy to read" face for the heading and "solid" lower case letters elsewhere since these were more legible than only capital letters.

66/...

Once these return cards (see Fig. 16.) are used in large volumes it must be assured that they are legitle and the colour is bright.

0001

## RETURN CARD

Date:
Part number:
Part description:
Environment: Storage ☐
Operational ☐
Training ☐
Part number replaced:
Product number:
Product description:
Age: Old ☐
New ☐
Used ☐
Reason for failure: Functional
Breakage

67/...

1. This card will only be used to capture data to improve the product.
2. These cards will be collected every Thursday by a person sent from the distributor.
3. For any enquiries or queries about this card please phone: Mr. X
   Tel: yy-yyyy

Fig. 16. AN EXAMPLE OF A DATA CAPTURE CARD (FRONT AND REVERSE SIDE)

6.2.4.7 Technical content of card

Every card contains an identification number (see Fig. 16. top right hand corner) and the following data which must be completed by the user of the card:

- Date
- Part number
- Part description
- Environment
- Product number
- Product description
- Part number replaced
- Age
- Reason for failure

The reverse side of the card contains three paragraphs explaining their use, where and when they will have to be returned and who can be contacted if there are any queries (see Fig. 16.).

6.2.4.8 The sub-system

In this sub-system the "Distributor" receives printed return cards from the "Producer" which he has to distribute and keep a reliable record of. It will be the "Distributor's" duty to train the

"User" of these cards as to its function. The "User" will be required to complete these cards continuously to be collected by the "Distributor" on a weekly basis.

The "Distributor" will extract any information which he requires for his own purpose and will then send the return cards to the respective "Producers". The "Distributor" will always let the "Producer" know what numbers of cards were distributed.

A block diagram of the sub-system is shown in Fig. 14.

"User" of these cards as to its function. The "User" will be required to complete these cards continuously to be collected by the "Distributor" on a weekly basis.

The "Distributor" will extract any information which he requires for his own purpose and will then send the return cards to the respective "Producers". The "Distr.butor" will always let the "Producer" know what numbers of cards were distributed.

A block diagram of the sub-system is shown in Fig. 14.

70/...

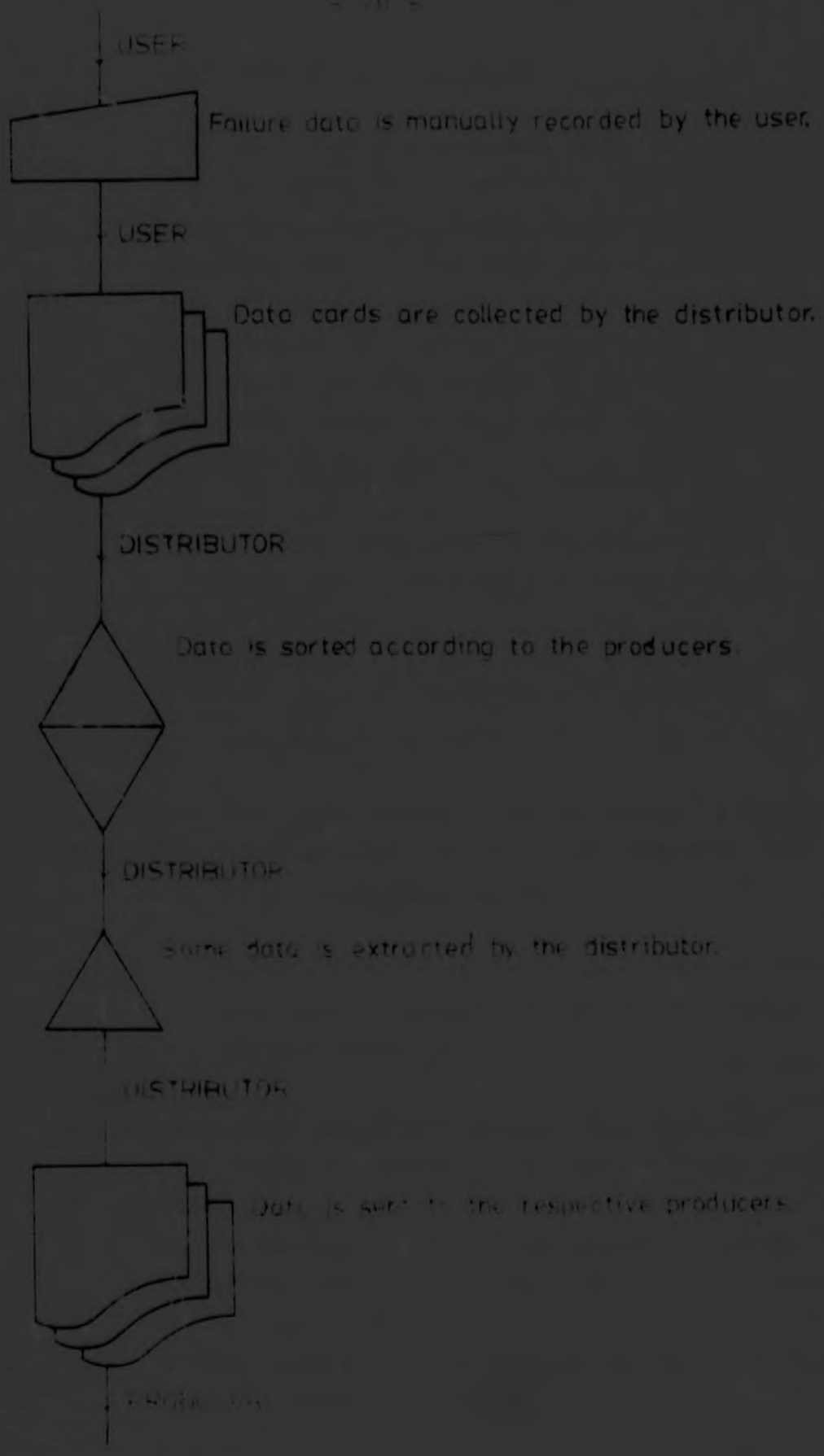



Fig. 14. FLOW DIAGRAM OF THE DATA CAPTURE SUB-SYSTEM

21/...

## 6.3 Data analysis sub-system

This sub-system generates reports to assist the manufacturer to improve product designs, processes, tests, field services, marketing strategy etc. The steering committee for the feedback system should monitor the activities in this sub-system closely. There are various points to be aware of when analysing feedback data which are mentioned by Juran/Gryna (18):

- A low complaint rate by the customer does not necessarily mean that he is satisfied.

- The user is involved and concerned with the entire service life of the product.

- The user suffers costs directly caused by failures as well as indirect costs (i.e. late deliveries)

- During the "wear in" phase, the failures are highly complaint-prone as compared to the later life.

The most important aspect for the user are the user's costs and low effectiveness involved, such as repair costs, effectiveness loss, additional capacity required due to product downtime, damage resulting from failures, lost profits and safety costs. This should be kept in mind when analysing the data.

### 6.3.1 Objective

There are several objectives to this analysis. The major ones are the

identifcation of problems, measurement of the product performance, spares usages and inputs for future designs.

6.3.2 Scope

The inputs and outputs determined previously are the boundaries of this sub-system. The inputs will be the information captured on the turn cards, the information supplied by the "Distributor" (e.g. the card numbers and locations, the stocks at the "User" venues etc.) and the "Producer's" information (e.g. the dates when batches were released, inspection reports on batches etc.)

The reverse side of each report will present the mathematical method of how the results were calculated, so that anyone making use of the report knows how the results were derived.

The analysis will only be performed on a sample of data, thus statistical tools and standards such as Mil-std 414 (see Appendix VI) should be used to check the validity of the analysis. Depending on the amount of data to be processed, it is recommended to make use of computer facilities for the analysis.

6.3.3 System errors

The validity of the data capture analysis will be controlled by the

use of the following techniques.

6.3.3.1 If use is made of a computer facility for the analysis, checks have to be built into the software to perform the analysis. The following information will be available:

USER -

Date of repair
Part number
Part description
Environment
Product number
Product description
Part replaced
Age of product
Reason for failure

DISTRIBUTOR -

Location
Number of products at the location
Card number
Responsible person at location
Number of cards per location

PRODUCER -

Dates of batch numbers when they left the factory
Inspection reports of the batches
Details about the product

The defect reports which "After Sales Service"

receive, are also an input which will be used to compare to the data analysis findings. This enables the "Producer" to compare the effectiveness of the two systems.

The reports which can be generated are listed in 6.1 to show up any problems in the software itself.

6.3.3.2 The validity of the data on the return cards will be monitored by comparing part numbers with the part descriptions, checking the length of part numbers, comparing product numbers with product descriptions, checking dates (i.e. no future date etc.) and assuring that all the cards have been completed fully.

6.3.3.3 The response by the workshops will be monitored by keeping a record of the number of return cards sent in every month, what locations (persons) sent them in and if this flow is continuous and reasonable. The forms which were filled in incorrectly per month, per location

will also be monitored. Quality will then generate a bar chart as shown in Fig. 17. for each location on a monthly basis.



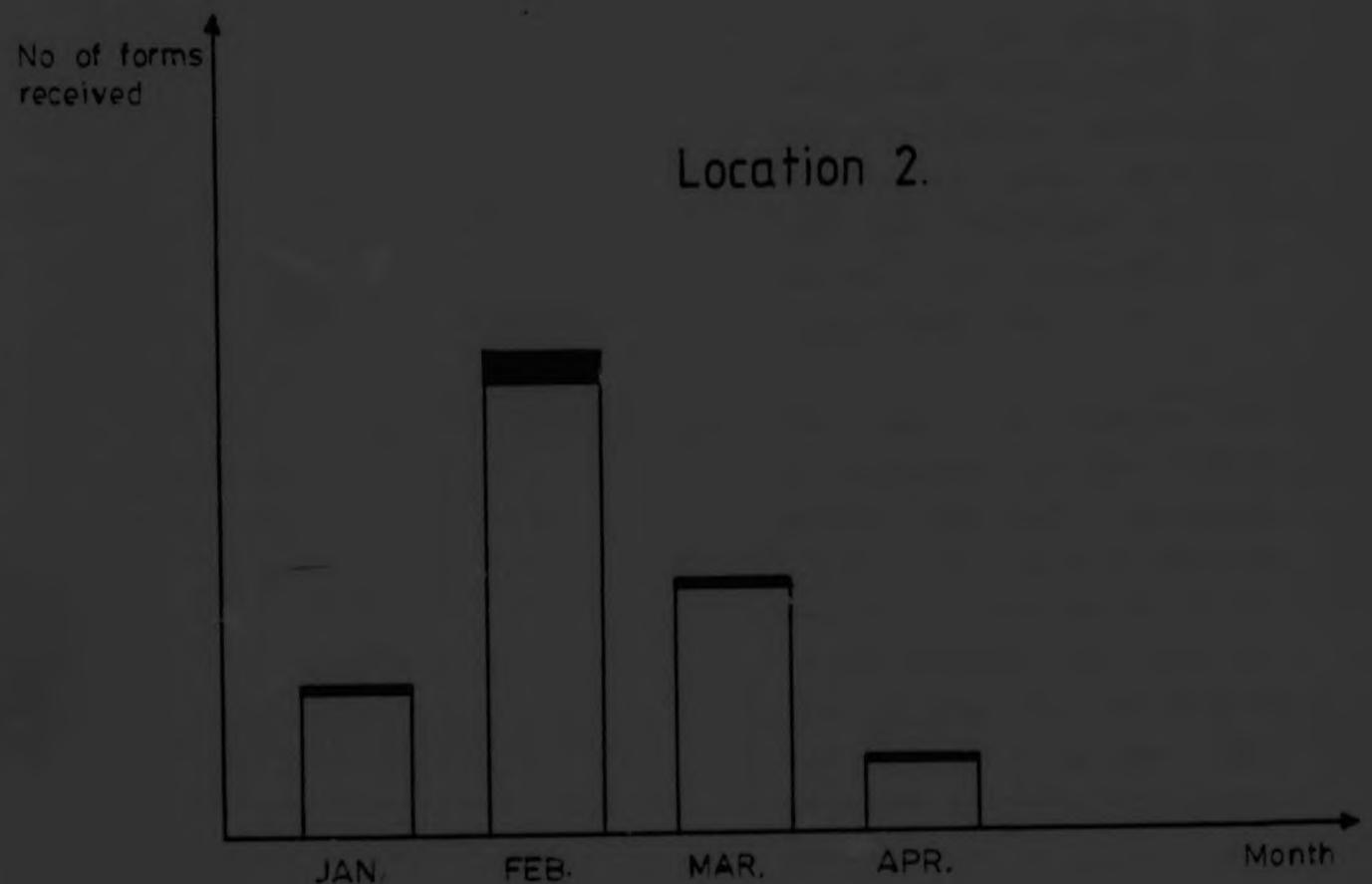



Fig. 17. Bar chart to identefy the correct and faulty data return cards received per month per location

Thus it can easily be monitored which locations are reporting satisfactorily so that problems can be followed up to improve the situation of data reporting.

6.3.3.4 The resulting reports can be compared to the "After Sales Service" problems identified and the "Defect Reports" received from the "Distributer" to see if the system is effective and if there is any connection between different complaints.

6.3.4 The reports

Refering to the list of possible reports (Table 3.) only a number of selected reports will be generated from the analysis and used in the system. At a later stage , additional or other reports can be generated, but up to this point in time only a few reports will be required.

Critical parts will be printed in bold throughout the reports so that any critical part (identified by the "Producers" design records) can immediately be identified.

6.3.4.1 A control chart of number of defectives

Reports will be generated for each product as shown in Fig. 18.

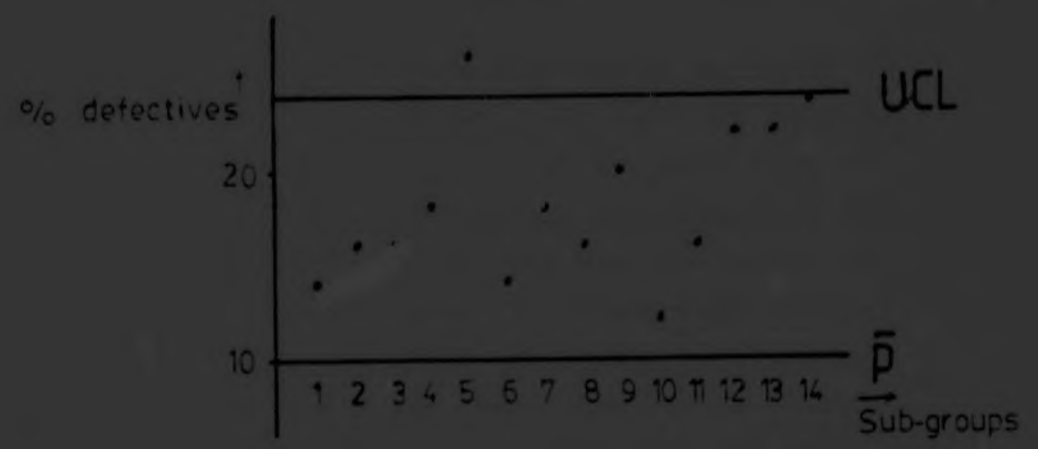



Fig. 18. A CONTROL CHART FOR THE % DEFECTIVES

n - number of products at the "User" venue

p - percentage of failures of the product per week

$$p = \frac{\text{number of failures}}{n} = \frac{pn}{n}$$

$$\bar{p} = \frac{\Sigma pn}{\Sigma n}$$

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Reference was made to Kaoru (23) on control charts for these reports

79/...

which will be generated for each product with all the new and old products discarded.

6.3.4.2 A continuous histogram

This histogram as shown by Juran (24) will be plotted to determine some type of frequency distribution per part and per product. It must be noted that this will be under conditions of the "User" (i.e. how he really sees the failures in his application). The histogram (Fig. 19.) can be used to determine the mean failure rate. These reports are only on failed parts and products. If a large amount of data is available a mean and standard deviation can be calculated for the distribution.

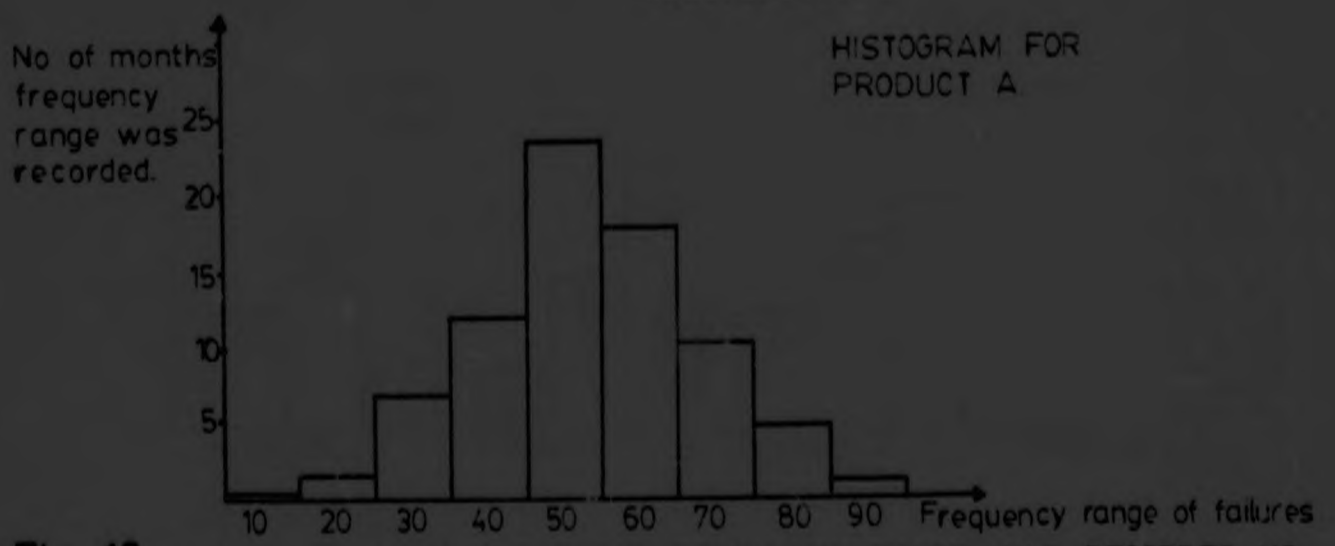



Fig. 19. BAR GRAPH OF NO OF MONTHS FREQUENCY RANGE WAS RECORDED VS. FREQUENCY RANGE OF FAILURES PER PRODUCT

80/...

6.3.4.4 A bar graph of fraction defective per month

The number of defects per part can be captured and if the part is an A, B or C item.

A - Serious effect on fitness for use.
B - Critical effect on fitness for use.
C - Minor effect on fitness for use.

Fraction defective =

$$\frac{\text{no. defective}}{\text{no. of products}}$$

Reports as shown in Fig. 20. will be generated for each product.

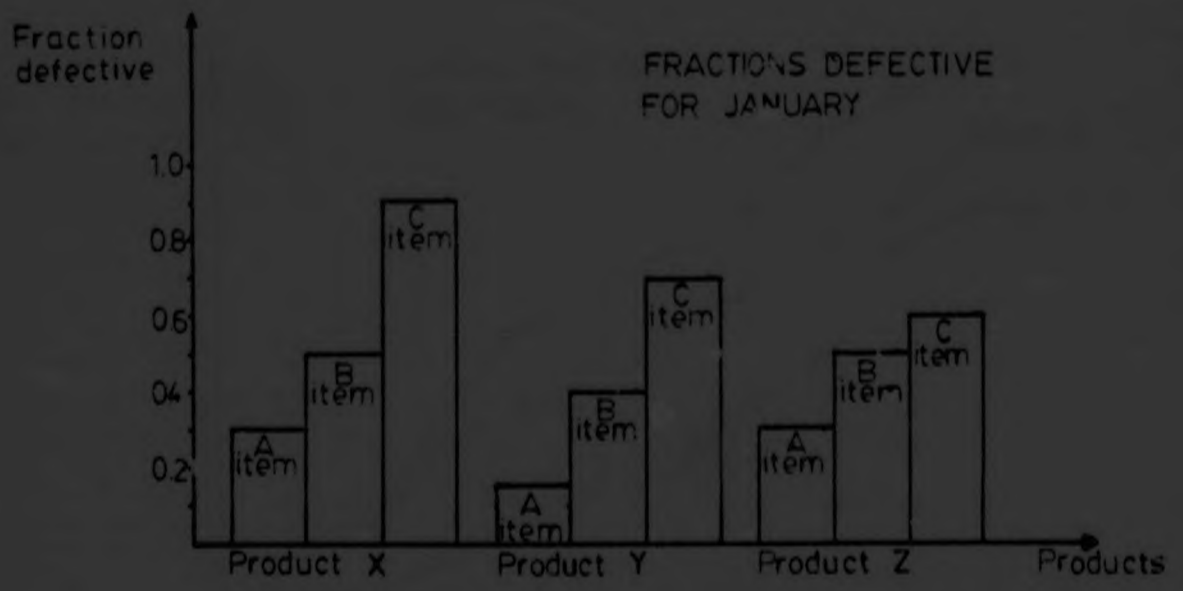



Fig. 20. A BAR GRAPH OF THE FRACTION OF PARTS DEFECTIVE PER PRODUCT PER MONTH.

81/...

6.3.4.5 Cumulative failures

Cumulative failures will be plotted per part and per product as shown in Fig. 21. Further reference material about cumulative failures can be obtained from Juran (25) and Murdoch (26) . By analysing the slope of the graph, averages and trends, problems can be identified.

At a later stage one can cumulatively add the difference between the value recorded and an approximate average value but at this stage nothing is known about the products (i.e. no averages at all).

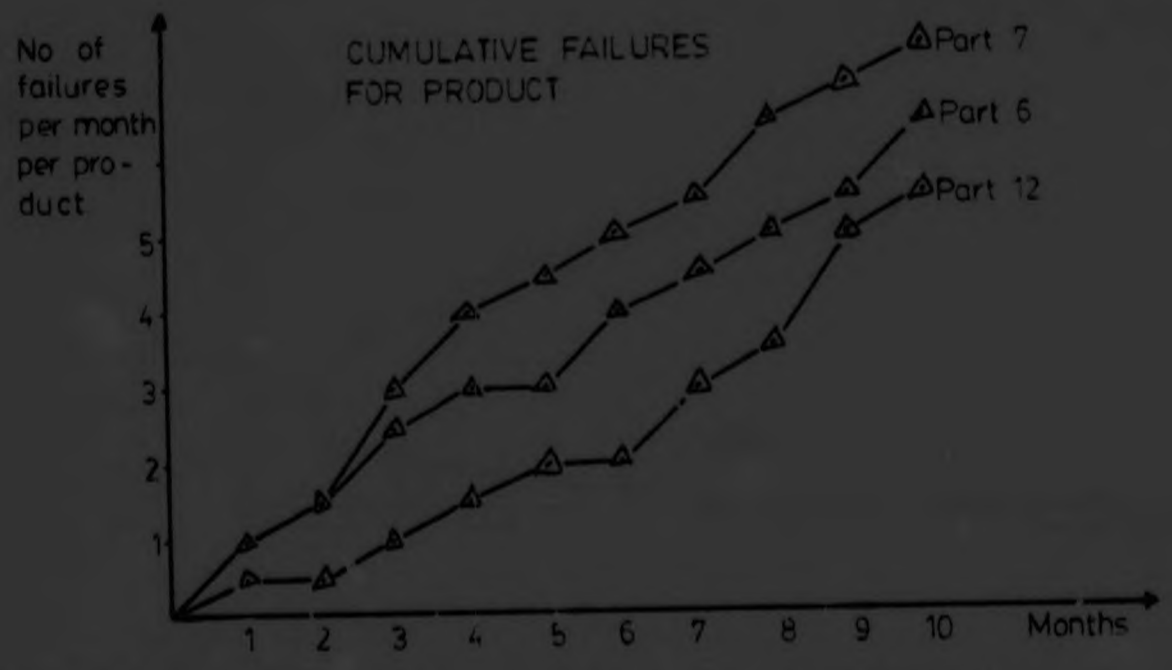
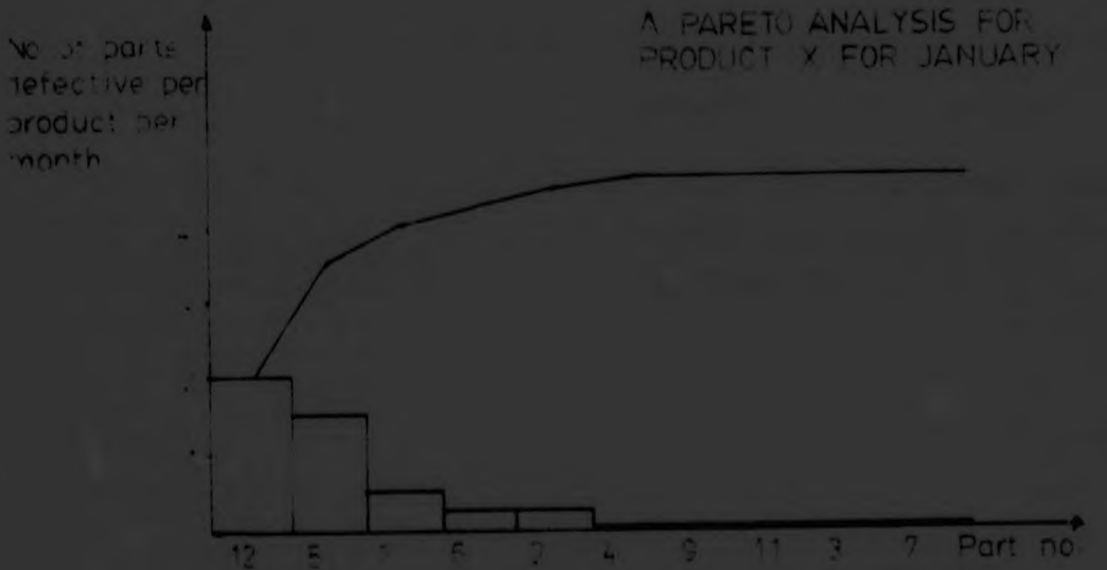



Fig. 21. A GRAPH OF CUMULATIVE FAILURES PER PART PER PRODUCT PLOTTED AGAINST TIME

82/...

Pareto analysis

This analysis is the record of failures per part of the products and of all the products as shown in Fig. 22. based on the Pareto principle described by Juran (14).



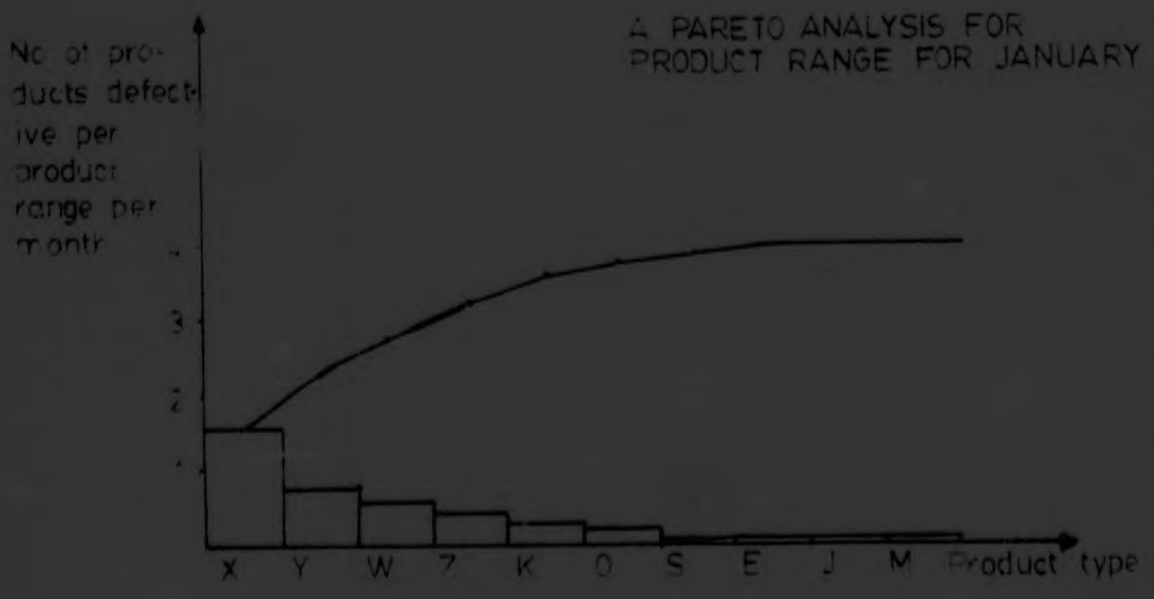
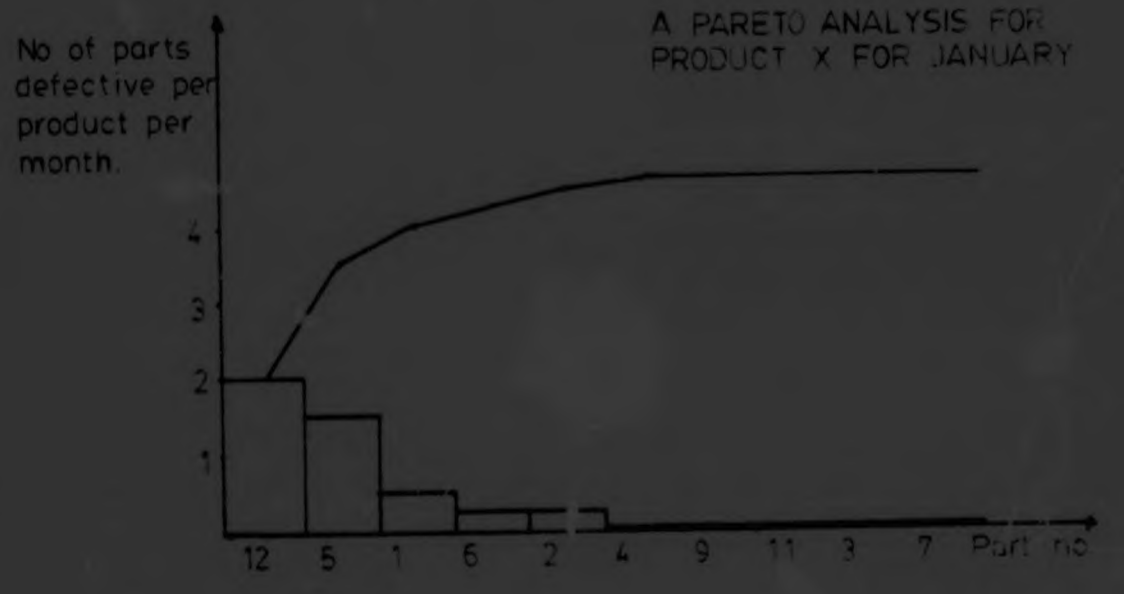




Fig. 22. A PARETO ANALYSIS OF PARTS PER PRODUCT AND THE COMPLETE PRODUCT RANGE.

83/...

Pareto analysis

This analysis is the record of failures per part of the products and of all the products as shown in Fig. 22. based on the Pareto principle described by Juran (14).



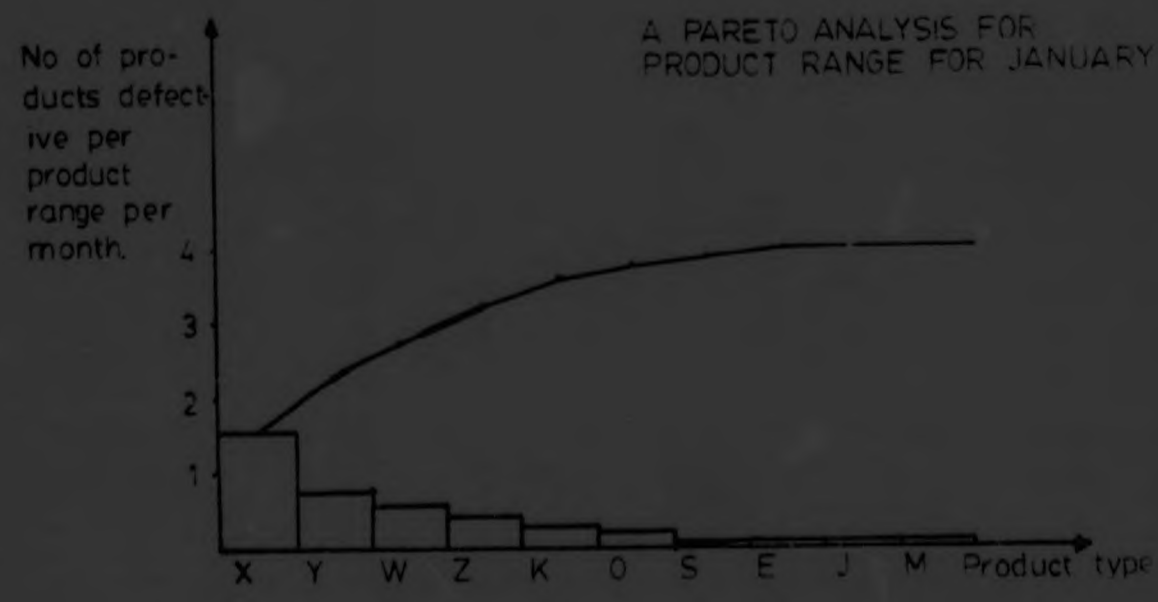




Fig. 22. A PARETO ANALYSIS OF PARTS PER PRODUCT AND THE COMPLETE PRODUCT RANGE.

83/...

6.3.4.7 Field failure versus factory reject

This repcrt compares principal field failures with the principal factory rejects. It is a list of both and these can be compared periodically.

6.3.4.8 The failures per "User" venues

These are compared every month per product as shown in Fig. 23.

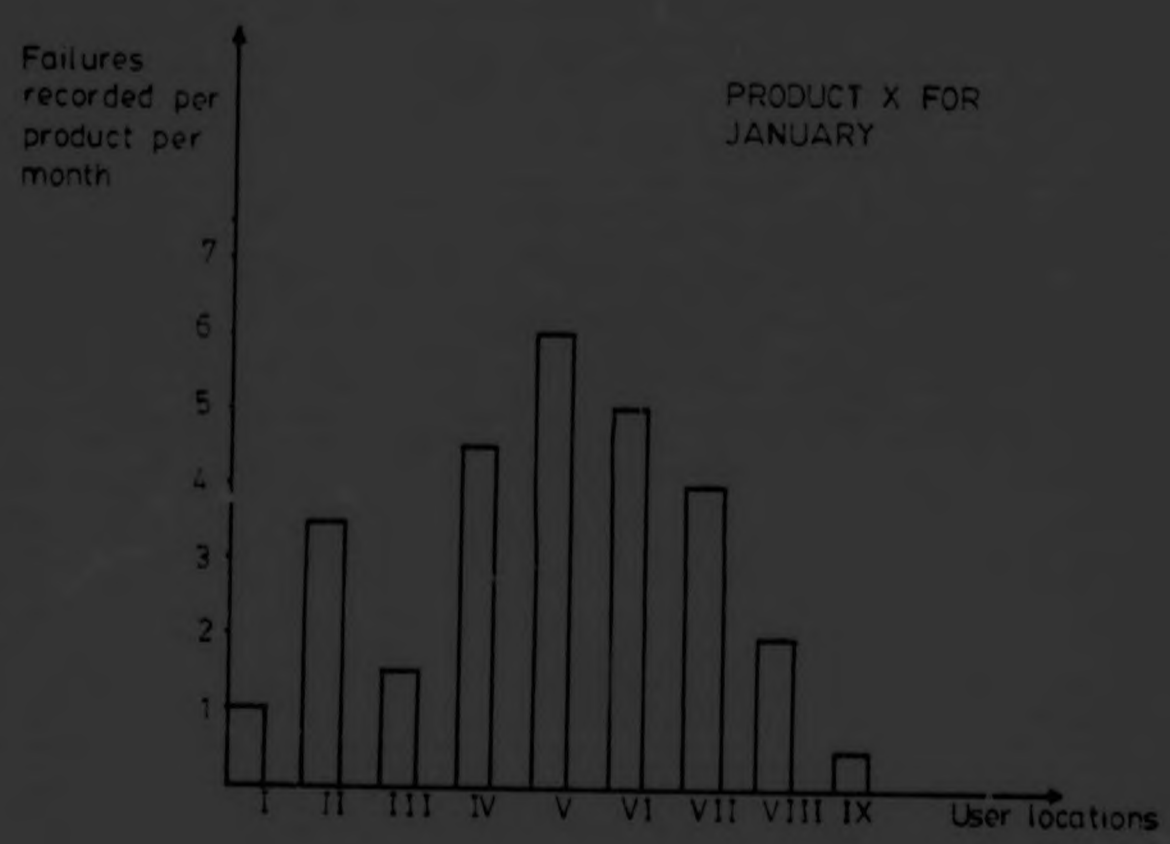



Fig. 23. A BAR GRAPH OF FAILURES PER PRODUCT VS. USER VENUE.

84/...

6.3.4.9 Tabulations

A listing can be made of the failure rate by defect type per part per product in order of importance as performed by Juran/Gryna (27).

6.3.4.10 Failure patterns

The only information availiable is the time when the batch left the "Producer" and if the product is new, old or normally used. Thus life curves can be plotted to obtain a "bathtub" curve as described by Besterfield (9) but they include transport, storage, use etc. as shown in Fig. 24. This will again be the life which the "User" experiences of the product in its environment which can be of value to the "Producer".

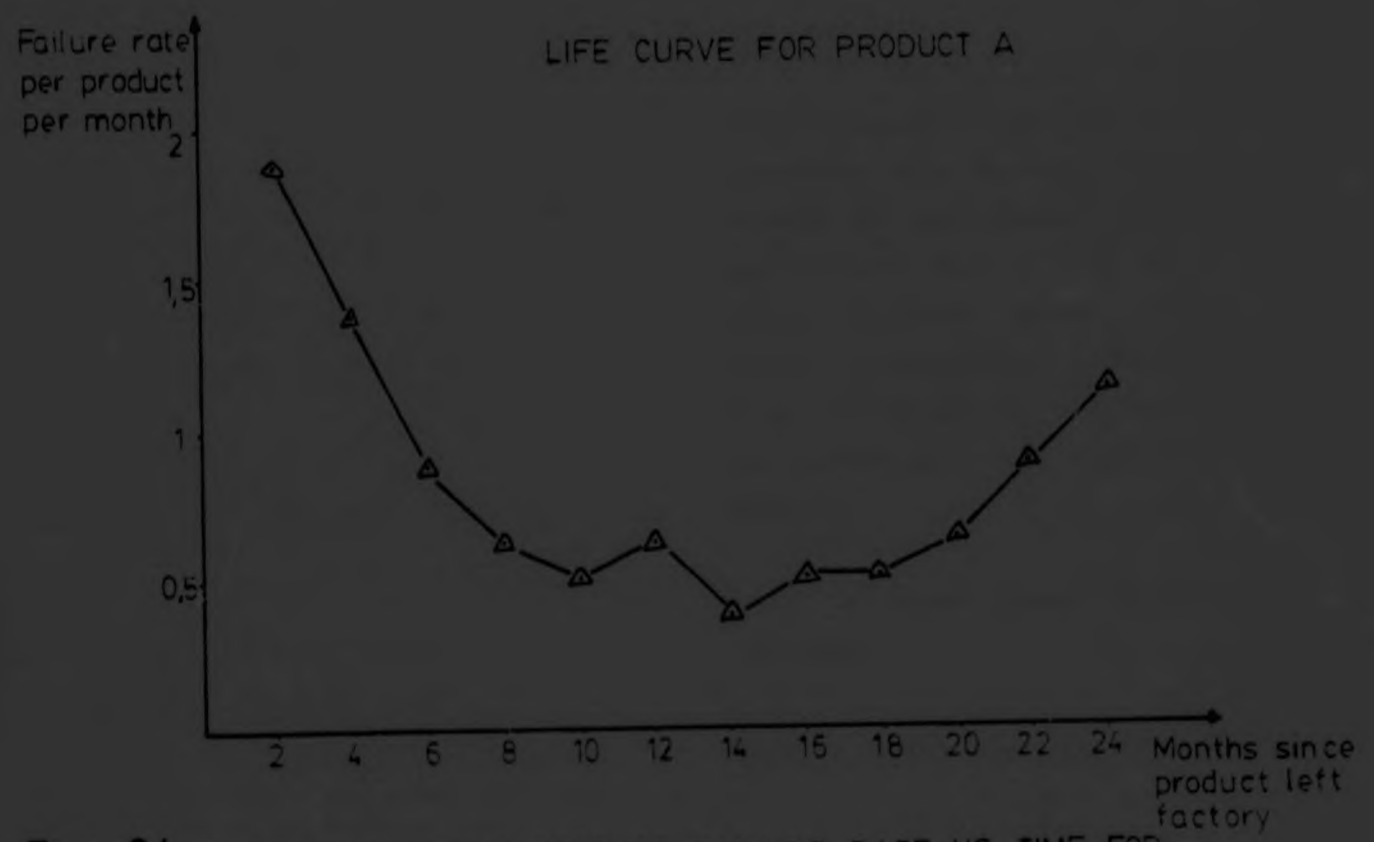



Fig. 24. A LIFE CURVE OF PRODUCT FAILURE RATE VS TIME FOR EACH PRODUCT

6.3.4.11 A list of parts per product

A list can be generated which gives the A, Band C Parts per product as shown in Table 5.

| PRODUCT | A PART | B PART | C PART |
|---|---|---|---|
| X | 3 | 1 | 7 |
| | 2 | 3 | 8 |
| | | 4 | 10 |
| | | 5 | 12 |
| | | | 6 |
| | | | 13 |
| | | | 15 |
| Y | 6 | 7 | 9 |
| | . | : | : |

Table 5. TABLE OF PARTS IN EACH PRODUCT

86/...

6.3.4.12 Reliability

The reliability and the availability can be determined if the products and parts are identefied which have failed more than once. Detailed information refering to the above is presented by Anderson (29).

MTBF = Mean time before failure

MTTR = Mean time to repair

$$\text{Reliability} = e^{-\int_0^t \lambda(x)\,dx}$$

$$\text{Availiability} = \frac{\text{MTBF}}{\text{MTBF+MTTR}}$$

$$\frac{1}{\text{MTBF}} = \lambda$$

t = Time

. = is a function of x at any point in time t.

Thus a reliability and MTBF can be determined for the products and parts where repetative failures occur.

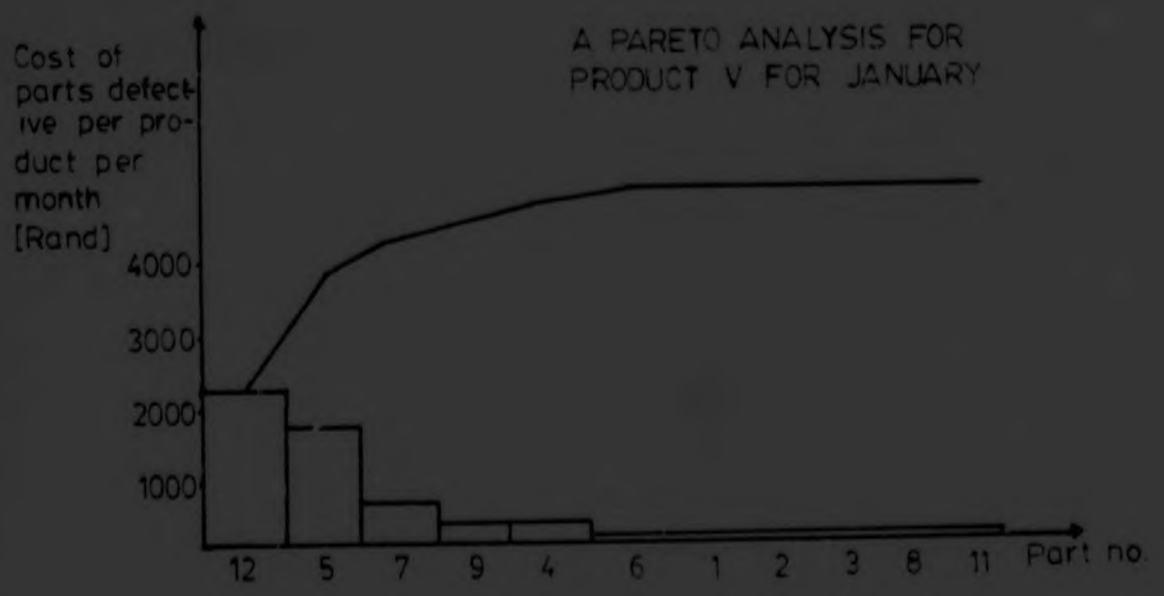
6.3.4.13 Cost analysis

The cost per part is recorded with the producer, thus the total cost per product or part can be determined and represented in a Pareto diagram as shown in Fig. 25.

Product cost = Number of products failed x cost of that product.

Part cost = Number of parts failed x cost per part

Thus an analysis per product and of the complete product range can be generated.



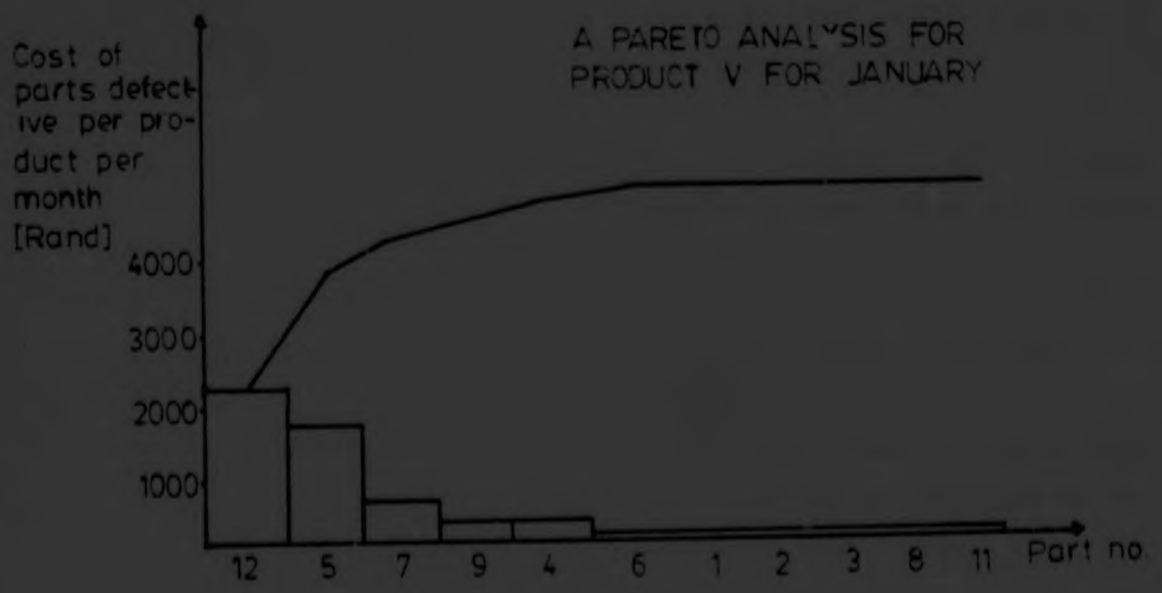
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Part cost = Number of parts failed x cost per part

Thus an analysis per product and of the complete product range can be generated.



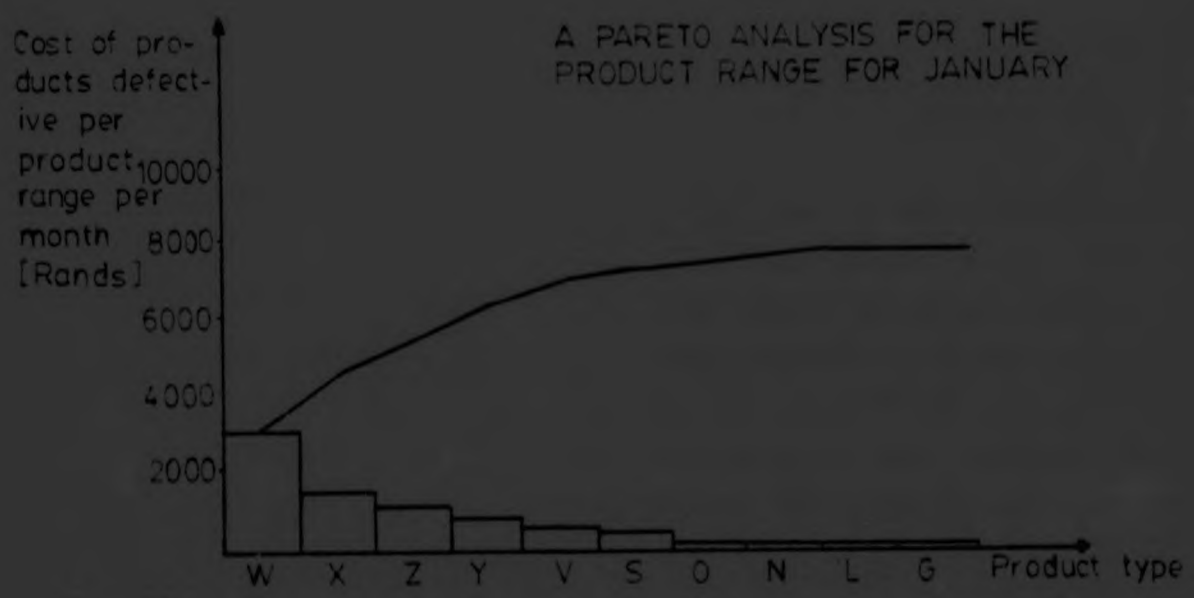



Fig. 25. A PARETO ANALYSIS OF THE COST OF PARTS PER PRODUCT AND THE COST OF PRODUCTS PER PRODUCT RANGE

6.3.4.14 Spares usages

The spares usage required for logistic purposes will be determined by one of Juran/Gryna (27)'s methods every month (spares per product per month). For example for 1000 products per month:

$N_j$= number of failed parts i per 1000 products per month

j = the number of months

Then for that product the average usage of spares as seen by the "User" will be

89/...

$$N = \frac{N_{ij}}{jx1000}$$

Thus as time proceeds, this estimate will more and more closely reflect the expected spares usage by the "User" A list will be printed per product as shown in Table 6.

| PRODUCT | PART NO | USAGE (per month per product-N) |
|---|---|---|
| A | 16 | 27 |
| | 27 | 10 |
| | 3 | 5 |
| | 1 | 3 |
| | 6 | 2 |
| | 9 | 1 |
| | 4 | 1 |
| | 10 | 1 |
| | 15 | 0 |
| | 4 | 0 |
| | 1 | 0 |
| | 13 | 0 |
| | 14 | 0 |
| | 17 | 0 |
| | 18 | 0 |
| B | 23 | 29 |
| | 1 | 17 |
| | 3 | 9 |
| | 6 | 3 |
| | 2 | 3 |
| | : | : |

Table 6. A LISTING OF THE SPARE PARTS USAGE PER PRODUCT

90/...

5.3.4.15 List

A list of repeaters per part in order of frequency will be generated for each product.

Examples of computer programmes to evaluate histograms, $\bar{x}$ and R charts, np charts and cusum charts are given in "Journal of Quality Technology" Jan. 1969, April 1969, July 1969 and Jan. 1970 respectively.

4.3.5 The sub-system

This sub-system will operate as follows: The "Producer" (Quality Department) receives information from "Programmes" (After Sales Service), the "Distributor" (return cards and defect reports) and from the Manufacturing Department. Quality receives this information and enters it into their data bank. The data is then analysed and reports are generated. These reports are then sent to Programmes for further handling.

The sub-system can be represented as shown in Fig. 15.

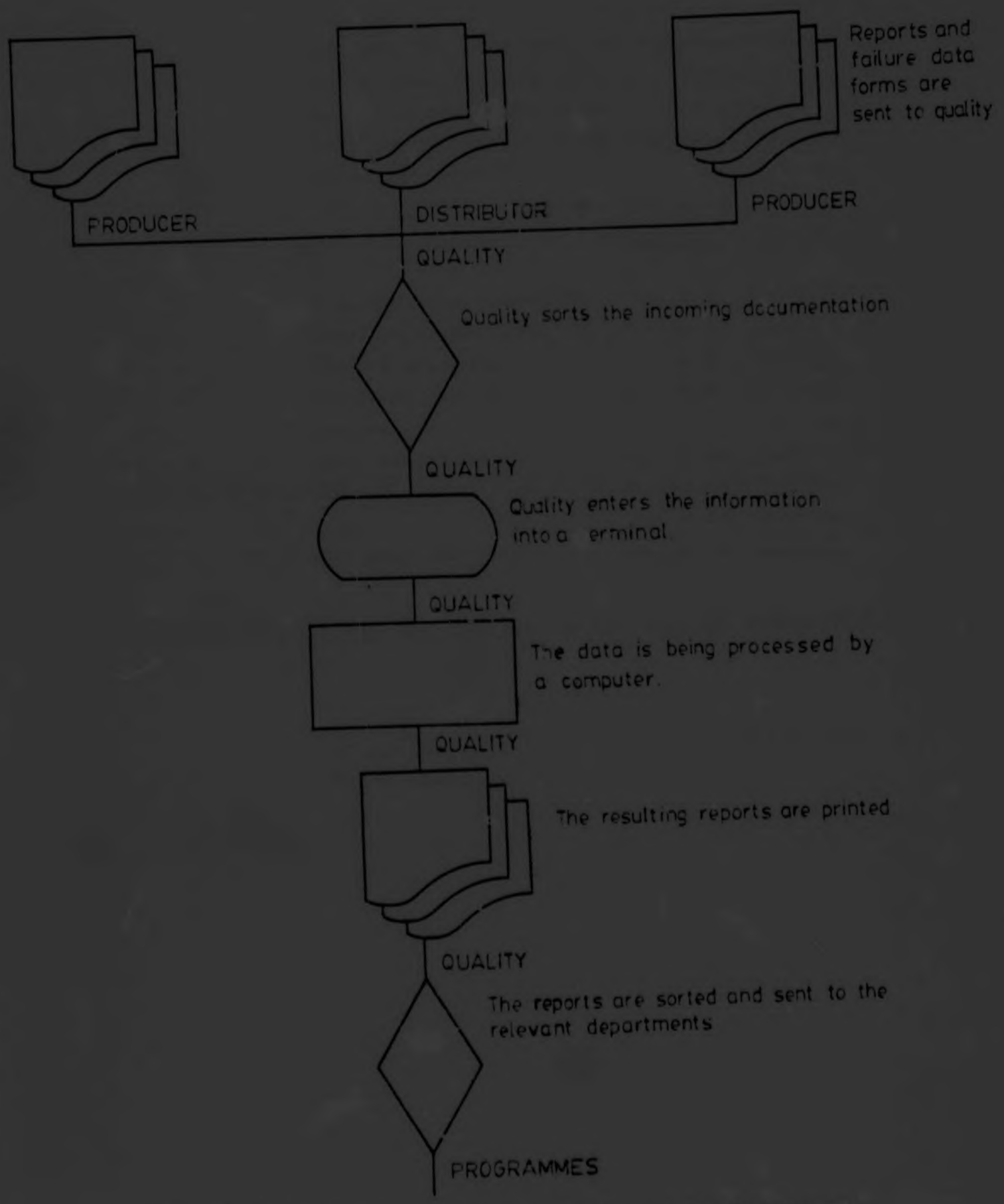



Fig. 15. FLOW DIAGRAM OF THE DATA ANALYSIS-SUB SYSTEM

92/...

The reports to be generated will not be all the reports mentioned in 6.3.4 since most of these reports will only be generated if they are specially requested. The reports which will be generated on a regular basis are as shown in Table 7.

| report | Chapter | Frequency |
|---|---|---|
| A continuous histogram | 6.3.4.2 | Monthly |
| Cumulative failures | 6.3.4.5 | Monthly |
| Pareto analysis | 6.3.4.6 | Monthly |
| Failures per user | 6.3.4.8 | Monthly |
| Venues | | |
| Cost analysis | 6.3.4.13 | Monthly |
| Spares usage | 6.3.4.14 | Monthly |
| List | 6.3.4.15 | Monthly |
| Reliability | 6.3.4.12 | Monthly |

Table 7 : LIST OF THE REPORTS WHICH WILL BE GENERATED

The following chapter will be a sample reports of the above.

## 7. SAMPLE REPORT

This chapter shows how the reports were obtained. A set of realistic dummy data are generated as required on the "Return card". (See Appendix VI) This data is sorted by the computer and a number of printed lists are generated. (See Appendix VIII-XI) Then the required reports are derived or calculated and the results are shown in the latter part of this chapter. Any action to be taken will be as based on these reports.

The sort on the computer was performed using software of the Beta Graphics Cad Cam. It was necessary to enter two short programmes as shown in Fig. 31. to select and format the data input and the data output on the printouts.

```
FBCBD                                  CR# 1-      ID =
  1     $CONTROL LIST,ROOT,TABLE,SET;
  2     BEGIN DATA BASE FBCAS;CR015;11;  <<FEEDBACK DATA BASE>>
  3     LEVELS:
  4           1   REPORT;
  5           15  UPDATE;
  6     ITEMS:
  7           DATE,U8(1,15);
  8           PAR,U2(1,15);
  9           DESC,U10(1,15);
 10           ENV,U2(1,15);
 11           PRODNO,U2(1,15);
 12           PRODES,U2(1,15);
 13           PARREP,U2(1,15);
 14           AGE,U2(1,15);
 15           FAIL,U2(1,15);
 16           FORM,U4(1,15);
 17     SETS:
 18           NAME: FBSET,D,CR015;
 19           ENTRY:DATE,
 20           PAR,
 21           DESC,
 22           ENV,
 23           PRODNO,
 24           PRODES,
 25           PARREP,
 26           AGE,
 27           FAIL,
 28           FORM;
 29           CAPACITY: 500;
 30     END.
EOF
```

94 ...

```
FBRP1                                        CR# 15      ID =
  1      REPORT H1,"FAILURE DATA",36;
  2      H1,"(FBRP1)",76,SPACE A1;
  3      H2,"  PAR  PRODUCT  PAR    DATE    ENV  PROD  DESC.  FORM
  4      H2,"  PART  AGE  FAILURE",72;
  5      H3,"NO.     REP",19;
  6      H3,"NO.     DES",58,SPACE A1;
  7      D,PAR,5;
  8      D,PRODNO,11;
  9      D,PARREP,19;
  10     D,DATE,29;
  11     D,ENV,34;
  12     D,DESC,46;
  13     D,FORM,52;
  14     D,PRODES,57;
  15     D,AGE,63;
  16     D,FAIL,69;
  17     S3,PAR;
  18     S2,PRODNO;
  19     S1,DATE;
  20     T3,PAR,80,SPACE A1,COUNT;
  21     T2,PRODNO,90,COUNT;
  22     END;
EOF
```

Fig. 31. A PROGRAM TO FORMAT THE DATA INPUT AND OUTPUT

Once this had been completed, the printouts were obtained and used to generate reports. Each report is introduced by giving a short description of how these were derived.

## 7.1 A CONTINUOUS HISTOGRAM

Table 8. was obtained from the parts which failed during April (04), May (05), June (06) and July (07) which are given on the printout in APPENDIX (XI). (i.e. the PART TOTAL for each part number).

$$\text{Failure rate} = \frac{\text{No failures}}{\text{No of parts}}$$

| MONTH | PART NO | NO OF FAILURES | TOTAL |
|---|---|---|---|
| April | 1 | 2 | |
| | 2 | 5 | |
| | 3 | 2 | |
| | 4 | 2 | |
| | 5 | 1 | |
| | 7 | 2 | |
| | 11 | 1 | |
| | 10 | 2 | |
| | 21 | 2 | |
| | | | 19 |
| May | 1 | 2 | |
| | 2 | 3 | |
| | 3 | 4 | |
| | 6 | 3 | |
| | 7 | 1 | |
| | 8 | 1 | |
| | 11 | 2 | |
| | 12 | 1 | |
| | 16 | 1 | |
| | 17 | 1 | |
| | 22 | 1 | |
| | 26 | 1 | |
| | | | 21 |

| MONTH | PART NO | NO OF FAILURES | TOTAL |
|---|---|---|---|
| June | 1 | 1 | |
| | 3 | 9 | |
| | 7 | 3 | |
| | 9 | 2 | |
| | 10 | 2 | |
| | 11 | 5 | |
| | 13 | 1 | |
| | 15 | 1 | |
| | 16 | 1 | |
| | 23 | 1 | |
| | | | 36 |
| July | 1 | 8 | |
| | 2 | 1 | |
| | 3 | 18 | |
| | 7 | 4 | |
| | 10 | 3 | |
| | 11 | 2 | |
| | 12 | 4 | |
| | 13 | 2 | |
| | 16 | 2 | |
| | 18 | 2 | |
| | 19 | 2 | |
| | 25 | 1 | |
| | | | 49 |

**Table 8.** A LIST OF THE NUMBER OF PARTS PER PART NUMBER PER MONTH FOR FOUR PRODUCTS

From Table 8. the average failure rate per month per product A is :

APRIL : Failure rate = 19/4 = 4.75
MAY : Failure rate = 21/4 = 5.25
JUNE : Failure rate = 36/4 = 9.00
JULY : Failure rate = 49/4 = 12.25

Similarly for part 1 of product A:

APRIL : Failure rate = 2/4 = 0.50
MAY : Failure rate = 2/4 = 0.50

96/...

JUNE : Failure rate = 1/4 = 0.25
JULY : Failure rate = 8/4 = 2.00

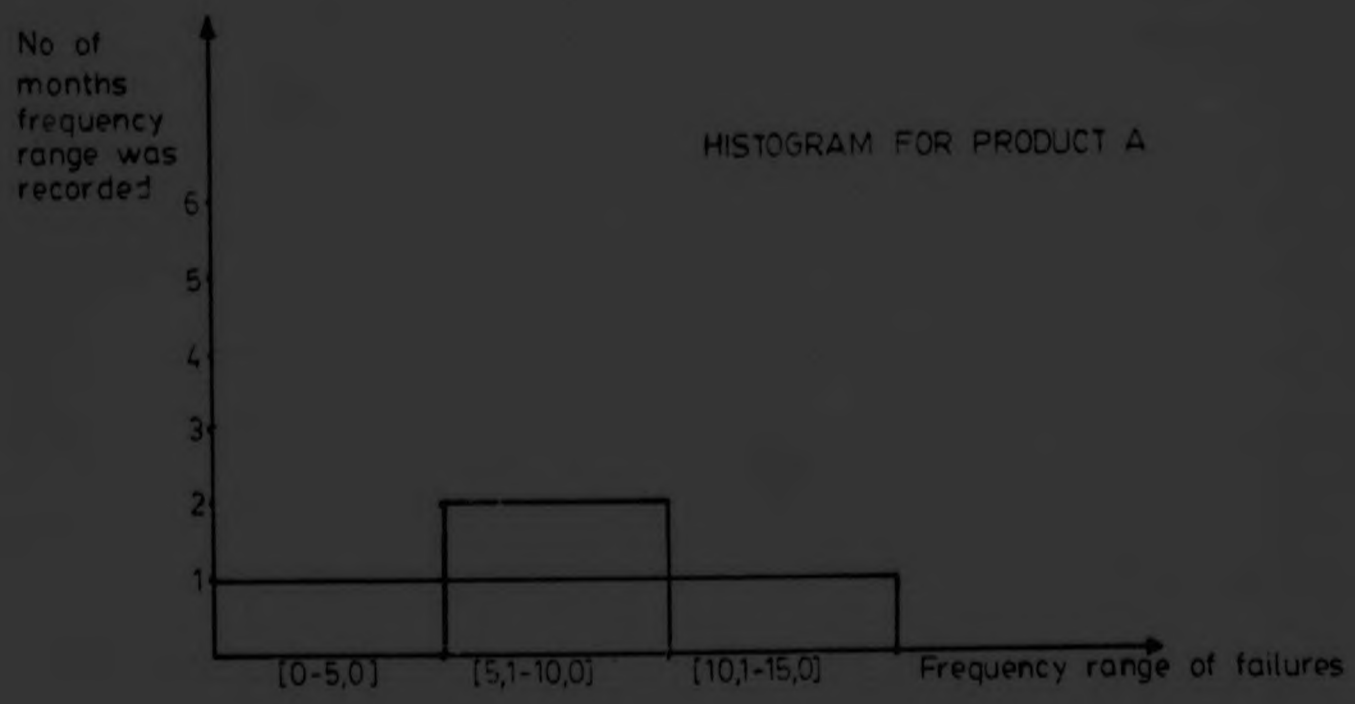
Similarly for part 3 of product A:

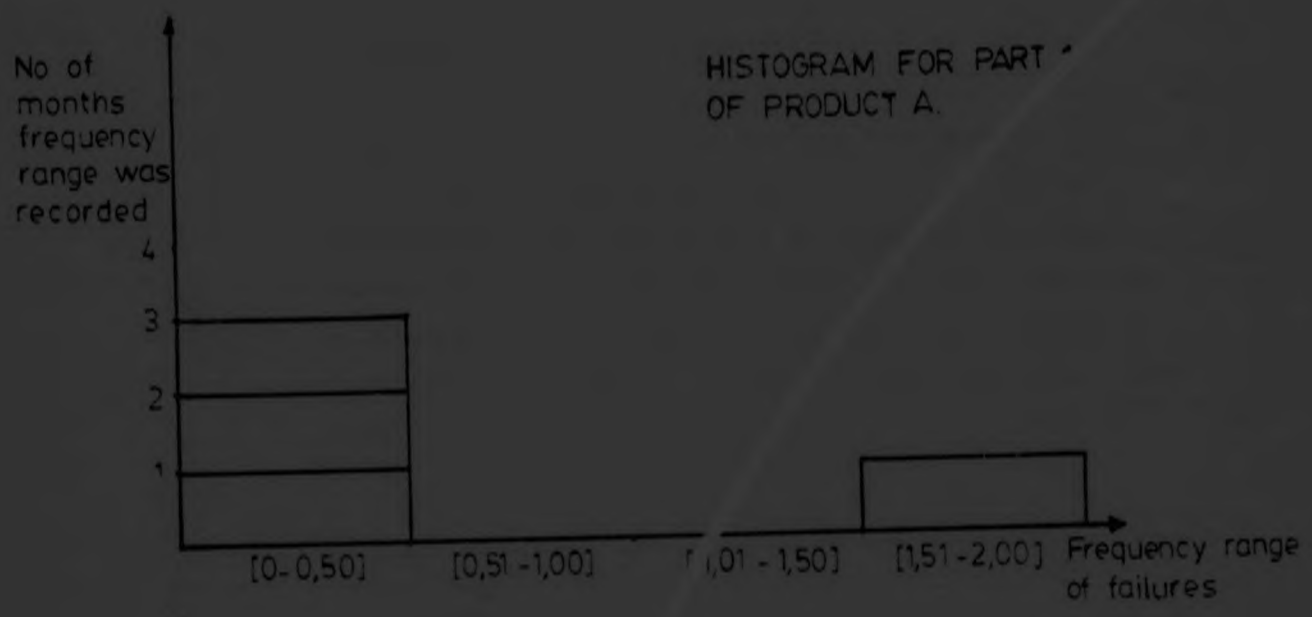
APRIL : Failure rate = 2/4 0.50
MAY : Failure rate = 4/4 = 1.00
JUNE : Failure rate = 9/4 = 2.25
JULY : Failure rate = 18/4 = 4.5

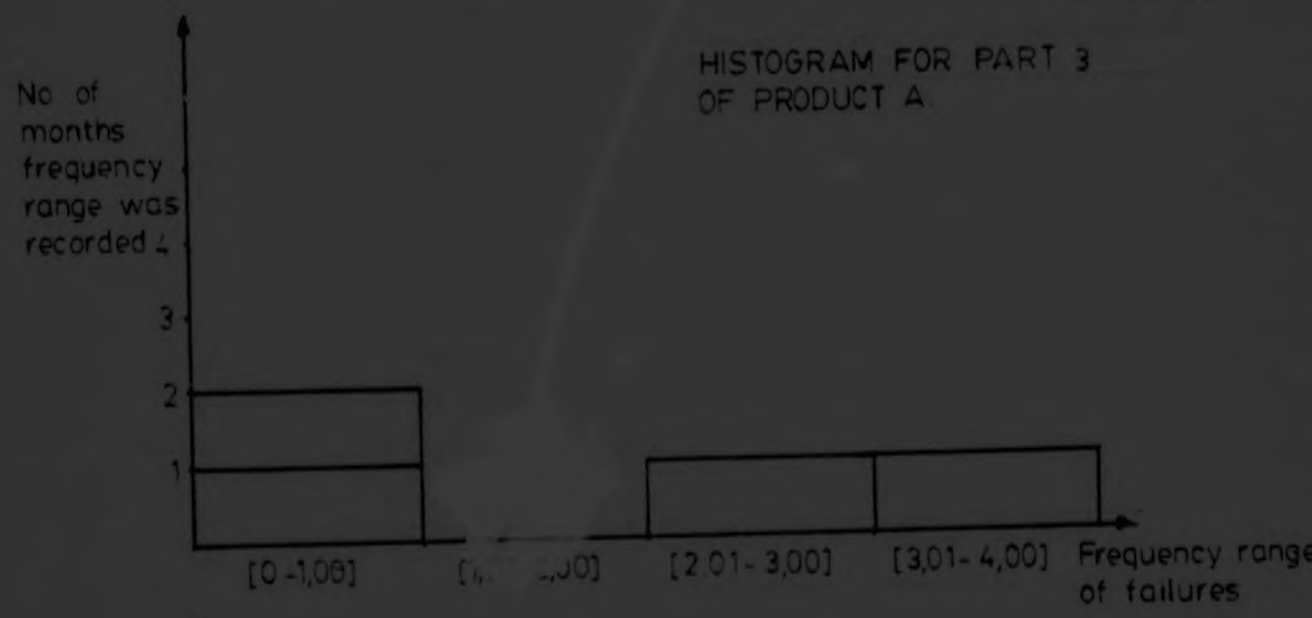
Similarly for part 11 of product A:

APRIL : Failure rate = 1/4 = 0.25
MAY : Failure rate = 1/4 = 0.25
JUNE : Failure rate = 5/4 = 1.25
JULY : Failure rate = 2/4 = 0.50

To plot bar graphs of 'no. of months frequency range was recorded' versus 'frequency range of failures' very little data was availiable (i.e. only 4 months from which no real distribution can be identefied) but they were plotted as shown in Fig. 26.





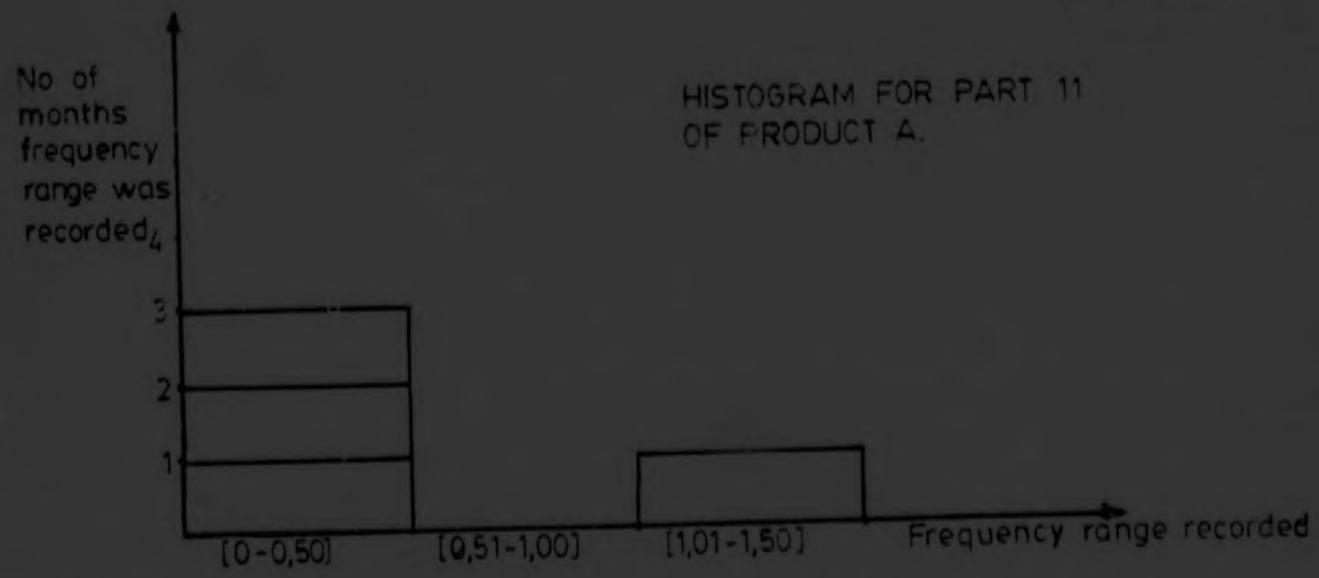




FIG. 26. BAR GRAPHS OF NUMBER OF MONTHS FREQUENCY RANGE WAS RECORDED VERSUS FREQUENCY RANGE OF FAILURES PER PART AND PRODUCT.

98/...

## 7.2 CUMULATIVE SUM OF FAILURES

The information required is the number of failures per part per month which can be obtained from Table 8. in chapter 7.1 and sumarised as shown in Table 9. The data is plotted in a graph of 'cumulative average failures per part' versus 'time' as shown in Fig. 27.

| PART NO. / MONTH | 1 | 2 | 7 | 11 | 16 |
|---|---|---|---|---|---|
| | No. of failures | | | | |
| April | 2 | 5 | 2 | 1 | 0 |
| May | 2 | 3 | 1 | 2 | 1 |
| June | 1 | 9 | 3 | 5 | 1 |
| July | 8 | 1 | 4 | 2 | 2 |
| | Cumulative no. of failures | | | | |
| April | 2 | 5 | 2 | 1 | 0 |
| May | 4 | 8 | 3 | 3 | 1 |
| June | 5 | 17 | 6 | 8 | 2 |
| July | 13 | 18 | 10 | 10 | 4 |
| | Cumulative average no. of failures.(=Cumulative no. of failures devided by 4) | | | | |
| April | 0.50 | 1.25 | 0.50 | 0.25 | 0.00 |
| May | 1.00 | 2.00 | 0.75 | 0.75 | 0.25 |
| June | 1.25 | 4.75 | 1.50 | 2.00 | 0.50 |
| July | 3.25 | 4.50 | 2.50 | 2.50 | 1.00 |

Table 9. A TABLE OF CUMULATIVE FAILURES PER PART PER MONTH.

99/...

## 7.2 CUMULATIVE SUM OF FAILURES

The information required is the number of failures per part per month which can be obtained from Table 8. in chapter 7.1 and sumarised as shown in Table 9. The data is plotted in a graph of 'cumulative average failures per part' versus 'time' as shown in Fig. 27.

| PART NO. / MONTH | 1 | 2 | 7 | 11 | 16 |
|---|---|---|---|---|---|
| | No. of failures | | | | |
| April | 2 | 5 | 2 | 1 | 0 |
| May | 2 | 3 | 1 | 2 | 1 |
| June | 1 | 9 | 3 | 5 | 1 |
| July | 8 | 1 | 4 | 2 | 2 |
| | Cumulative no. of failures | | | | |
| April | 2 | 5 | 2 | 1 | 0 |
| May | 4 | 8 | 3 | 3 | 1 |
| June | 5 | 17 | 6 | 8 | 2 |
| July | 13 | 18 | 10 | 10 | 4 |
| | Cumulative average no. of failures.(=Cumulative no. of failures devided by 4) | | | | |
| April | 0.50 | 1.25 | 0.50 | 0.25 | 0.00 |
| May | 1.00 | 2.00 | 0.75 | 0.75 | 0.25 |
| June | 1.25 | 4.75 | 1.50 | 2.00 | 0.50 |
| July | 3.25 | 4.50 | 2.50 | 2.50 | 1.00 |

Table 9. A TABLE OF CUMULATIVE FAILURES PER PART PER MONTH.

99/...

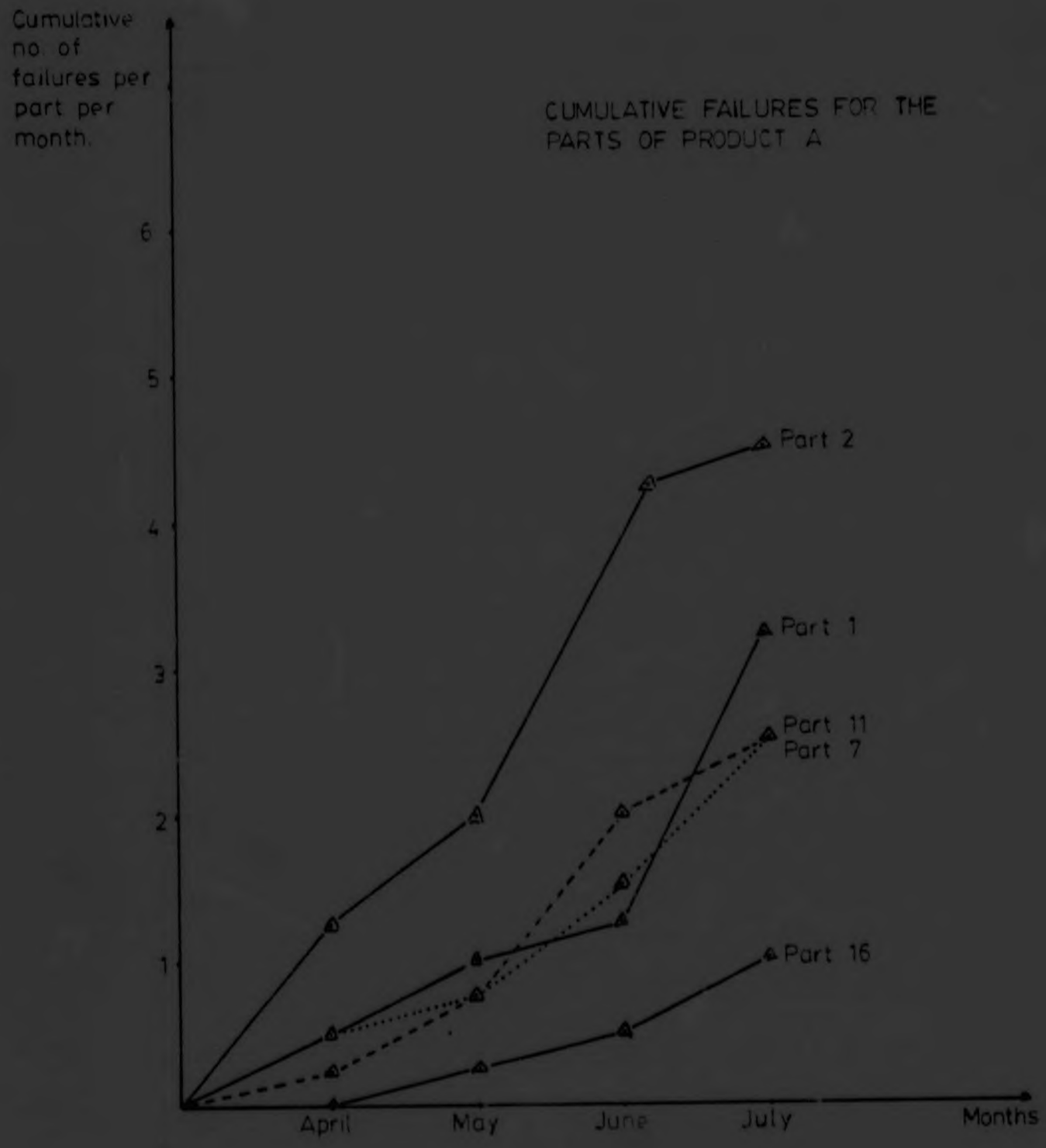



Fig. 27. A GRAPH OF CUMULATIVE NO. OF FAILURES PER PART PER MONTH VS. TIME.

100/...

## 7.3 A PARETO ANALYSIS

| PART NO. | NO. OF PARTS FAILED. | AVERAGE FAILURES PER PART PER MONTH. |
|---|---|---|
| 1 | 13 | $\frac{13}{4 \times 4} = 0.81$ |
| 2 | 9 | $\frac{9}{4 \times 4} = 0.56$ |
| 3 | 40 | $\frac{40}{4 \times 4} = 2.50$ |
| 4 | 2 | $\frac{2}{4 \times 4} = 0.13$ |
| 5 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 6 | 3 | $\frac{3}{4 \times 4} = 0.19$ |
| 7 | 10 | $\frac{10}{4 \times 4} = 0.63$ |
| 8 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 9 | 3 | $\frac{3}{4 \times 4} = 0.19$ |
| 10 | 5 | $\frac{5}{4 \times 4} = 0.31$ |
| 11 | 9 | $\frac{9}{4 \times 4} = 0.56$ |
| 12 | 5 | $\frac{5}{4 \times 4} = 0.31$ |
| 13 | 4 | $\frac{4}{4 \times 4} = 0.25$ |
| 14 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 15 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 16 | 4 | $\frac{4}{4 \times 4} = 0.25$ |
| 17 | 1 | $\frac{1}{4 \times 4} = 0.06$ |

101/...

## 7.3 A PARETO ANALYSIS

| PART NO. | NO. OF PARTS FAILED. | AVERAGE FAILURES PER PART PER MONTH. |
|---|---|---|
| 1 | 13 | $\frac{13}{4 \times 4} = 0.81$ |
| 2 | 9 | $\frac{9}{4 \times 4} = 0.56$ |
| 3 | 40 | $\frac{40}{4 \times 4} = 2.50$ |
| 4 | 2 | $\frac{2}{4 \times 4} = 0.13$ |
| 5 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 6 | 3 | $\frac{3}{4 \times 4} = 0.19$ |
| 7 | 10 | $\frac{10}{4 \times 4} = 0.63$ |
| 8 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 9 | 3 | $\frac{3}{4 \times 4} = 0.19$ |
| 10 | 5 | $\frac{5}{4 \times 4} = 0.31$ |
| 11 | 9 | $\frac{9}{4 \times 4} = 0.56$ |
| 12 | 5 | $\frac{5}{4 \times 4} = 0.31$ |
| 13 | 4 | $\frac{4}{4 \times 4} = 0\ 25$ |
| 14 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 15 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 16 | 4 | $\frac{4}{4 \times 4} = 0.25$ |
| 17 | 1 | $\frac{1}{4 \times 4} = 0.06$ |

101/...

| PART NO. | NO. OF PARTS FAILED. | AVERAGE FAILURES PER PART PER MONTH. |
|---|---|---|
| 18 | 2 | $\frac{2}{4 \times 4} = 0.13$ |
| 19 | 2 | $\frac{2}{4 \times 4} = 0.13$ |
| 20 | 2 | $\frac{2}{4 \times 4} = 0.13$ |
| 21 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 22 | 3 | $\frac{3}{4 \times 4} = 0.19$ |
| 23 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 24 | 0 | $\frac{0}{4 \times 4} = 0.00$ |
| 25 | 1 | $\frac{1}{4 \times 4} = 0.06$ |
| 26 | 1 | $\frac{1}{4 \times 4} = 0.06$ |

Table 10. A LIST OF FAILURES PER PART

Table 10. was obtained by recording the product number and PART TOTAL in APPENDIX VIII.

Average failures per part per month = $\frac{\text{No. of failures}}{\text{No. of months * No. of products}}$

102/...

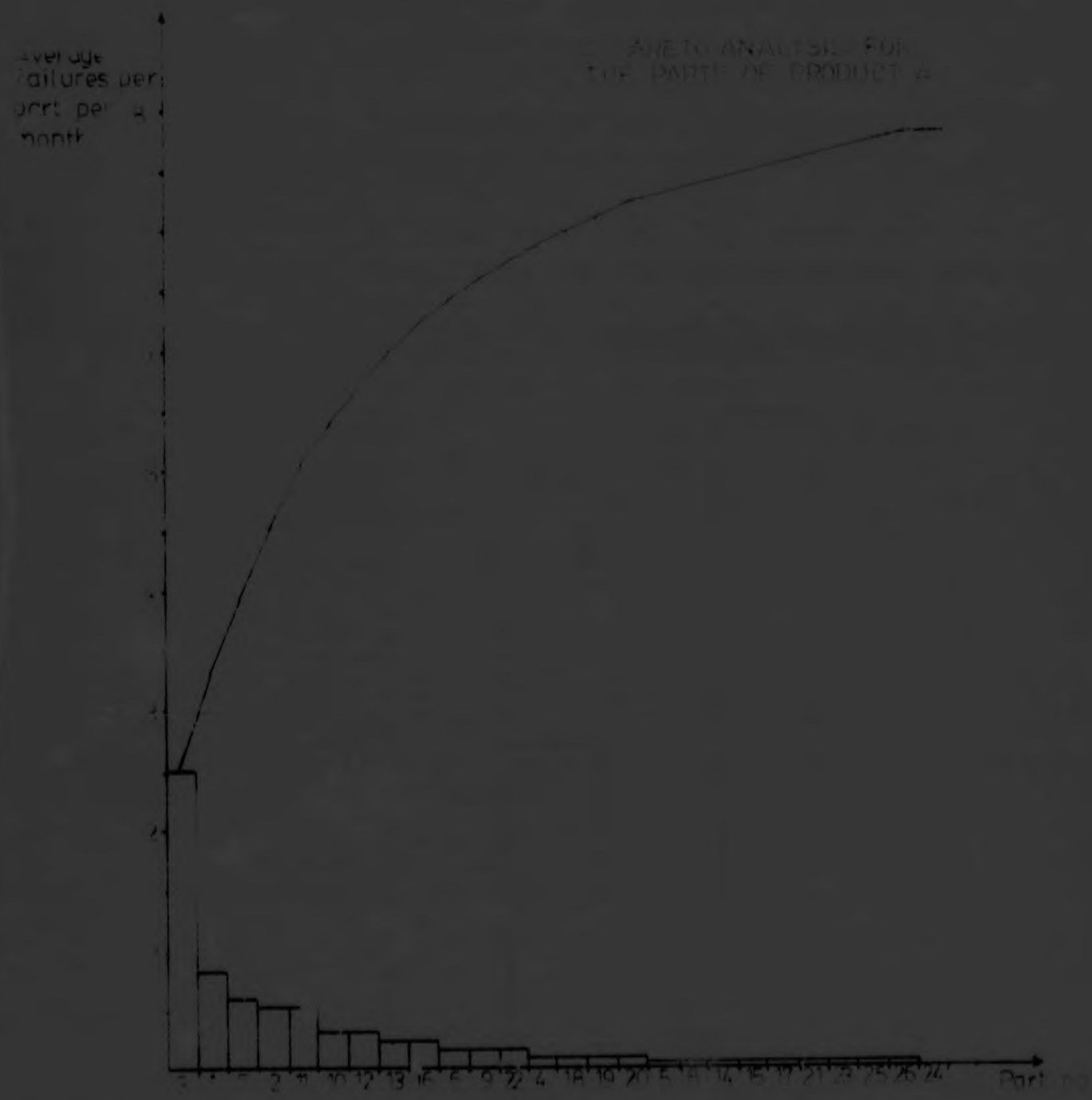



Fig. 28 PARETO ANALYSIS OF THE PARTS PER PRODUCT

7.4 FAILURES PER USER VENUE

From APPENDIX X the PART TOTALS of training (TR) was added and the operational (OP) were added to give 45 and 89 respectively. A bar chart of 'failures per product per month' versus 'user venue' was plotted as shown in Fig. 29.

Failures per product = $\frac{\text{No. product failures}}{\text{No. months}}$

In this case only two venues were used namely training (TR) and operational (OP).

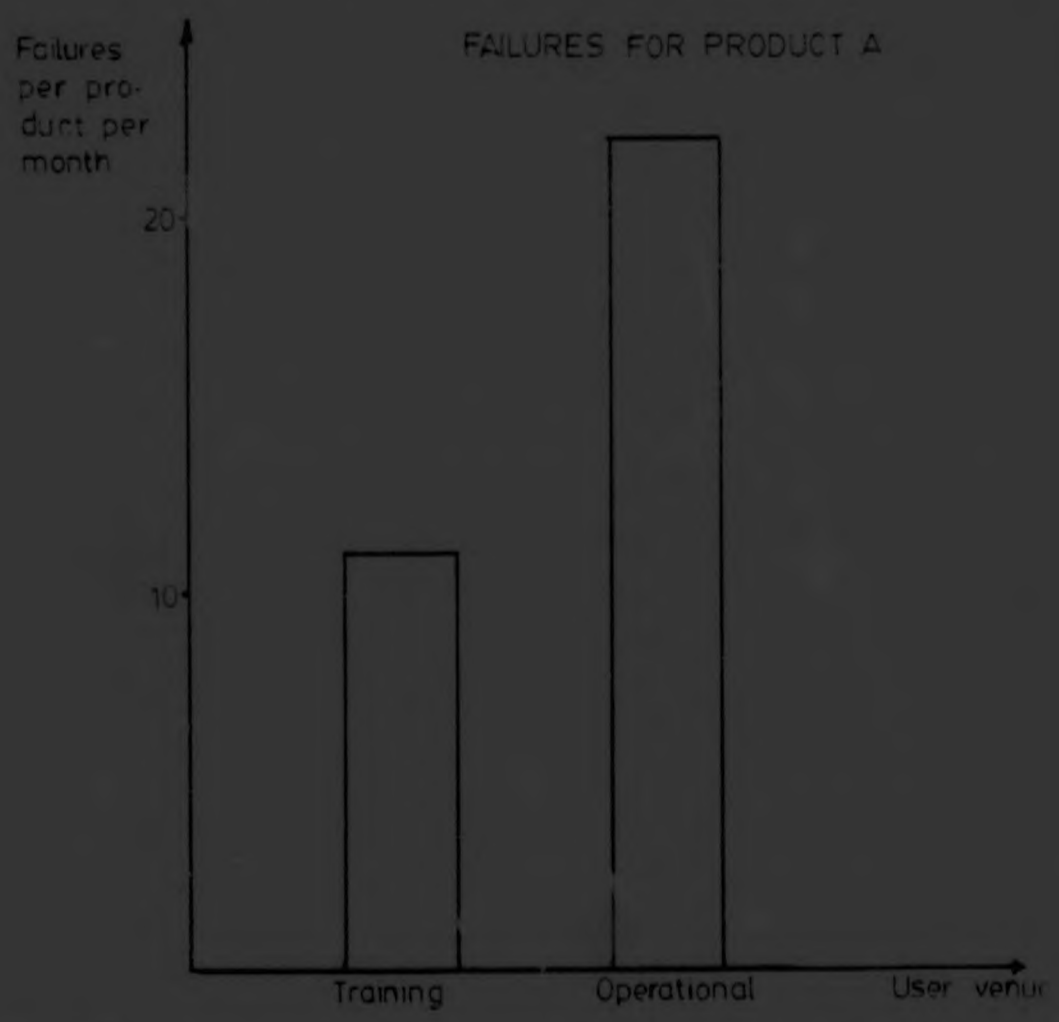



Fig. 29. A BAR GRAPH OF FAILURES PER PRODUCT PER MONTH VS. USER VENUE.

## 7.5 COST ANALYSIS

The cost per failure per part per month was obtained by multiplying the average 'failures per part per month' as obtained in Table 10. chapter 7.3 by 'the cost of the spare part' as shown in Table 11. A Pareto diagram was then obtained by plotting 'costs per failures of parts per month' versus 'the parts' as shown in Fig. 30.

| PART NO. | NO. FAILED | COST PER PART | TOTALL COST |
|---|---|---|---|
| 1 | 0.81 | R 0.50 | R 0.41 |
| 2 | 0.56 | R 0.20 | R 0.11 |
| 3 | 2.50 | R 0.80 | R 2.00 |
| 7 | 0.63 | R 1.20 | R 0.76 |
| 10 | 0.31 | R15.00 | R 4.65 |
| 12 | 0.31 | R 5.20 | R 1.61 |
| 4 | 0.13 | R 2.00 | R 0.26 |
| 5 | 0.06 | R 2.00 | R 0.12 |
| 6 | 0.19 | R 3.00 | R 0.57 |
| 8 | 0.06 | R 5.00 | R 0.30 |
| 9 | 0.19 | R15.00 | R 2.85 |
| 11 | 0.56 | R20.00 | R 11.20 |
| 13 | 0.25 | R18.00 | R 4.50 |
| 14 | 0.06 | R50.00 | R 3.00 |
| 15 | 0.06 | R 1.00 | R 0.06 |
| 16 | 0.25 | R 3.00 | R 0.75 |
| 17 | 0.06 | R 2.00 | R 0.12 |
| 18 | 0.13 | R 2.00 | R 0.26 |
| 19 | 0.13 | R 2.00 | R 0.26 |
| 20 | 0.13 | R 5.00 | R 0.65 |
| 21 | 0.06 | R 1.00 | R 0.06 |
| 22 | 0.19 | R 1.00 | R 0.19 |
| 23 | 0.06 | R15.00 | R 0.90 |
| 24 | 0.00 | R89.00 | R 0.00 |
| 25 | 0.06 | R 5.00 | R 0.06 |
| 26 | 0.06 | R 0.80 | R 0.06 |

Table 11. A LIST OF FAILURE COST PER PART

105/...

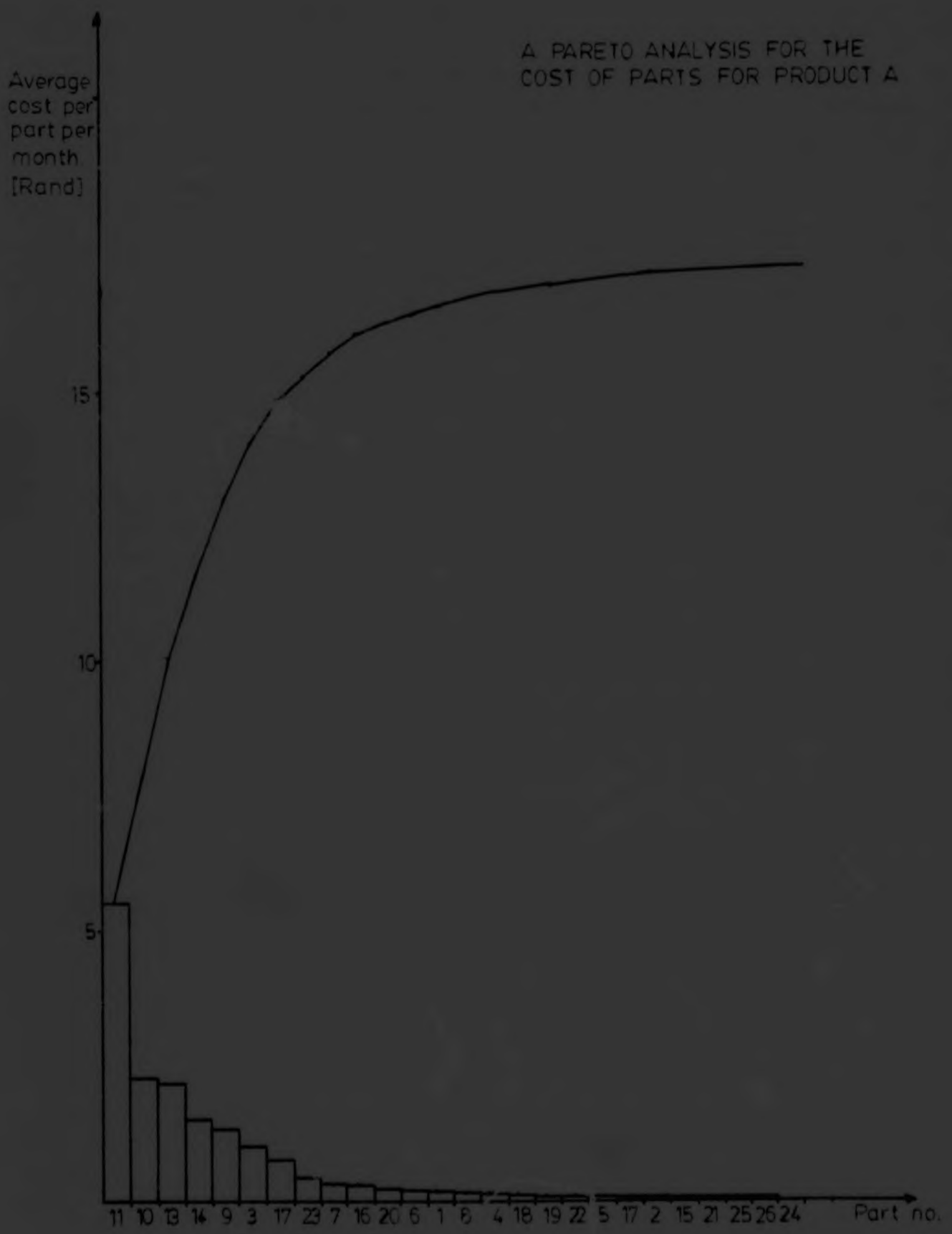



Fig. 30. A PARETO ANALYSIS OF COST OF PARTS PER PRODUCT.

106/...

## 7.6 SPARES USAGE

The spares usage will be the same as Table 10. in chapter 7.3.

## 8. CONCLUSION

A data feedback system such as the one described in this document, will improve the products and give management a realistic measure of the product performance. The failure analysis must identify if they are due to maintenance, design of the specific product, quality, material or operating procedures. Apart from such information about the product, the following will be identified (as observed by the "User" during his operations):

- failure rate
- life
- spares required
- costs involved

This system has been developed with the above-mentioned points in mind, but the real test is the implementation.

The company for whom this system was developed has never operated such a system. Thus it is a new concept which should be marketed. To implement it, this report will be sent to management and all the relevant people who will be directly involved. Having made the system known, a design review will be held and the system will then be updated if required. Once management approval has been obtained, preparations will be made to implement the system for a trial period at two or three "User" venues. This will be carefully monitored and after such a trial period a report will be made, on the basis of which a second design review will be held.

An approach of this nature is required since there are costs involved which should be kept as low as

108/...

possible, also one must consider the need for eliminating as many problems as possible before implementing the system on a large scale.

APPENDIX I

The forms which follow are the results of interviews conducted. The following information is a summary of the more important facts obtained during the interview.

Questionaire

1. Name:

   1

2. Organisation:

   Producer 1 (Programs)

3. Is there a need for a data feedback system?

   No

4. What is the reason for the decision made in 3?

   A similar system controlled by the "Programmes"department exists. By a formal system defect reports are received from the "User" which are referred to the Producer 1 "Engineering" department.

5. What reports and information would be required by you?

   Not applicable

6. Is the time that information is received important?

   Not applicable

7. What data/information is avail able which can be used by such a system?

   Defect reports

8. Comments:

   The person interviewed was not co-operating fully since he felt that I was interfering with his work.

111/...

Questionaire

1. Name:

   2

2. Organisation:

   Producer 1 (Manufacturing)

3. Is there a need for a data feedback system?

   Yes

4. What is the reason for the decision made in 3?

   We know too little about the areas of safety, functionability, logistics and cosmetics of our products.

5. What reports and information would be required by you?

   An analysis by Quality
   Defect analysis by Engineering
   A cost analysis must be made available

6. Is the time that information is received important?

   The information should be received as soon as possible

7. What data/information is avail able which can be used by such a system?

   Defect reports are available from the User

   Build books are available per lot per weapon of the products which leave the factory

8. Comments:

   Sees a definite need for such a system

112/...

Questionaire

1. Name:
   3

2. Organisation:
   Producer 1 (Procurement)

3. Is there a need for a data feedback system?
   Yes

4. What is the reason for the decision made in 3?
   To trace any faults that have occurred in material.
   To trace any bad quality in externally procured parts.
   To pick up system problems of the User.

5. What reports and information would be required by you?
   Reports on material which has failed
   Reports on failure of vendor supplied components. The nature of failure of these sub-contracted items should be known.

6. Is the time that information is received important?
   As soon as possible

7. What data/information is avail able which can be used by such a system?
   None since "Procurement" does not keep any records.

8. Comments:
   "Procurement" feels a need for such a system, since just because no failures were reported, does not imply that there were none which concerned them.

113/...

Questionaire

1. Name:

   4

2. Organisation:

   Producer 1 (Engineering)

3. Is there a need for a data feedback system?

   Yes

4. What is the reason for the decision made in 3?

   There is no feedback and important inputs for Logistics and Design available.

5. What reports and information would be required by you?

   All information which can be used for design and logistics.

6. Is the time that information is received important?

   The information capture and the generated reports must be continuous.

7. What data/information is avail able which can be used by such a system?

   None of this kind

8. Comments:

   None

114/...

Questionaire

1. Name:

2. Organisation:

Producer | Quality

3. Is there a need for a data feedback system?

Yes

4. What is the reason for the decision made in 3?

To decrease problems caused by inferior quality. To identify contract shortcomings.

To identify problems and make them known so that corrective action can be taken.

To monitor all products presently.

5. What reports and information would be required by you?

Quality cost reports

Product safety such reports

Reliability reports

Maintainability reports

Failure lists

6. Is the time that information is received important?

As soon as possible

7. What data/information is avail able which can be used by such a system?

Build books

Classification of defects

8. Comments:

The analysis should be based on how critical a part is. If it is a very critical part any failures recorded should be followed up by immediate action.

Questionaire

1. Name:

   6

2. Organisation:

   Producer 1 (Engineering)

3. Is there a need for a data feedback system?

   Yes

4. What is the reason for the decision made in 3?

   Need feedback of the products performance in the field. Although such a system exists, which is claimed to be working well, one should try to imporve it.

5. What reports and information would be required by you?

   A report of Mean Time Between Failures, would be the most important, but is its not believed that this can be achieved. Defect/Environmenmet reports are important for analysis. Reliability, Defects, Cause, Environment, Action etc must be captured.

6. Is the time that information is received important?

   As soon as possible; through the present channel information is lost or delayed for too long.

7. What data/information is available which can be used by such a system?

   Yes, reliability is tested on sample sizes of new products. But these data is only captured at Producer 1, and not once the User has obtained it.

8. Comments:

   It cannot be seen how any valuable reliability data can be captured by such a system.

116/...

Questionaire

1. Name:

   7

2. Organisation:

   Distribution

3. Is there a need for a data feedback system?

   Yes

4. What is the reason for the decision made in 3?

   Many unsuccessful attemps have been made to develop such a system, since the present system is not working properly.

5. What reports and information would be required by you?

   Reliability feedback is required. Other logistic problems that are existing should also benefit from this information. Store, spares, repairs etc. can benefit.

6. Is the time that information is received important?

   As soon as possible

7. What data/information is avail able which can be used by such a system?

   None except for some very informal information.

8. Comments:

   Difficult to obtain information since the system is so long and a lot of information is lost and distorted.

117/...

Questionaire

1. Name:

   8

2. Organisation:

   Producer 1 (Engineering)

3. Is there a need for a data feedback system?

   Yes

4. What is the reason for the decision made in 3?

   For many products life is not qualified in house and data should be used as design feedback

5. What reports and information would be required by you?

   Reliability information coupled to life including traceability of faults. Information on logistic, life, spares and maintenance.

6. Is the time that information is received important?

   As soon as possible

7. What data/information is avail able which can be used by such a system?

   The data that is available is not sufficient

8. Comments:

   The present system is not working properly.

118/...

Questionaire

1. Name:

   9

2. Organisation:

   User representative

3. Is there a need for a data feedback system?

   Yes

4. What is the reason for the decision made in 3?

   Only incident of failures are recorded at this stage.

5. What reports and information would be required by you?

   From the feedback action must be taken such as spares used, rework made, replacemnts made and modifications.
   One requires failure data as well as subjective opinions about the products.

6. Is the time that information is received important?

   The data capture should be continuous

7. What data/information is avail able which can be used by such a system?

   All parts are numbered and the locations and environment where they are situated should not be difficult to determine.

8. Comments:

   In the present system the communication chain is too long.

119/...

Questionaire

1. Name:
   1C

2. Organisation:
   Producer 1 (Programs)

3. Is there a need for a data feedback system?
   Yes

4. What is the reason for the decision made in 3?
   If there are more systems it will be easier to identify existing problems

5. What reports and information would be required by you?
   What deficiencies exist, where requirements are exeeded and technical data.

6. Is the time that information is received important?
   As soon as possible

7. What data/information is avail able which can be used by such a system?
   A system of defect reporting

8. Comments:
   All systems should work via "Programs" department.

120/...

APPENDIX II

Symbols used in the flow charts.



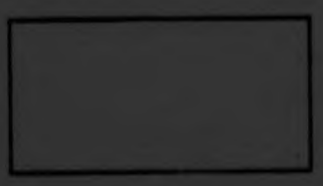
DOCUMENTATION



MANUAL INPUT



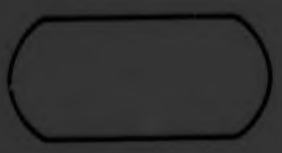
SORTING



PROCESS



EXTRACT INFORMATION



ENTER INFORMATION INTO TERMINAL

APPENDIX III

Proposed system I.

Each sub-system is addressed in more detail as well as the activities between the two sub-systems. (i.e. activities between sub-system 1 and sub-system 2 were addressed as link 1,2)

Sub-system 1

This is the data capture which takes place in the "Users" organisation by the "Distributor". The information (determined very roughly in 4.4) 1 be captured by the "Distributor" as wel as any other information about the "User" (i.e. his stocks, size of business etc.) The system will include some means of motivation to obtain the data as well as a carefully designed method of minimal interference with the "Users" activities. This will be achieved by making use of psychological and communication techniques and to collect only necessary data in order to achieve the overall objective.

Link 1,2: This is the physical data capture by the "Distributor" from the "User".

Sub-system 2

The "Distributor" receives the data, extracts whatever he requires by use of his own system to do so.

Link 2,3: This is only a dummy link.

122/...

Sub-system 3

At this stage the "Distributor" organises the data according to the different Producers. The sorted data will then be sent away to the respective "Producers" on forms designed by them.

Link 34: The data is sent from the "Distributor" to the "Producer".

Sub-system 4

The "Programmes" Department of the "Producer" receives the data (it is company policy that all external activities or information must operte through Programmes) and passes it immediately to the Quality Department.

Link 45: The data is immediately passed onto the Quality Department.

Sub-system 5

The Quality Department records the data in a computer data bank or in ledgers thus entering the information into an analysis system.

Link 56: This is only a dummy link.

Sub-system 6

The data which has been recorded will be analysed resulting in a number of reports for various departments and organisations.

123/...

This is a complete sub-system which will be developed in more detail at a later stage and will be achieved by a computer aided data processing system. The data bank will also include information generated by the "Producer" (i.e. inspection reports, batch numbers, dates of delivery etc.) The reports will then be sent to Programmes for further action on them.

Link 6,7: The reports are sent to Programmes.

Sub-system 7

Programmes receives the reports and sorts out the reports which are ment specifically for Programmes. The other reports are then sent to the departments and organisations for which they were intended. Eg. Logistics obtains information about spares, Engineering about product reliability and respective failures etc.

Links 7,8; 7,9; 7,10; 7,11; 7,12; 7,13: The reports are sent to various departments who attach a "Recommended Action" report and send these back to Programmes.

Sub-system 8

The Engineering Department receives their report and they analyse any problems using their own system. To develop such a system is the responsibility of Engineering. There is a provision in the system enabling Engineering to visit the "User" venue and inspect products, defective parts, environ-

ment etc. Engineering analyses the specific problem and writes a short "Recommended Action" report which is sent to Programmes. If the problem turns out not to be an engineering problem, the report should be sent to the department responsible.

Link 8,9: This is only a dummy link.

Link 8,11; 8,12; 8,13: In these links the reports are being sent from Programmes to the relevant departments.

Link 8,14: In this link the report as well as the "Recommended Actions" are sent to Programmes.

Sub-system 9

In this sub-system a department identifies a specialist or a group of people to investigate a specific failure at the "User" end. Programmes will in due course be informed as to who the people are, what their plan of action is to be and where t eir investigation is to take place.

Link 9,10: This is a memo to be sent to Programmes to inform them about the details of a visit to the "User".

Sub-system 10

In this sub-system Programmes negotiates and arranges with the "User" for a specialist or group of people to visit the "User" location in the shortest time possible. Programmes will make use of their "After

Sales Service" staff to fulfill this function. During these arrangements, "After Sales Service" should also feedback summary of the data captured, resulting actions and thank the "User" for his co-operation.

The information which the "After Sales Service" Department captures during the course of their work must be fed back to Quality so that the results of the feedback systems can be compared to those of the "After Sales Service" Department.

Link 10.7: These are the findings of "After Sales Service" sent to Quality.

Link 10.1: These are visits by the "Producer" to the "User"

Sub-system 11

The Quality Department receives their report and they analyse any problems by using their own system. To develop such a system is the responsibility of Quality. There is a provision in the system enabling Quality to visit the "User" venue and inspect products, defective parts, environment etc.

Quality analyses the specific problem and write a short "Recommended Action Report" which is sent to Programmes . If the problem turns out not to be a quality problem, the report should be sent to the department responsible.

126/...

Link 11,9: This is only a dummy link.

Link 11,14: In this link the report as well as the "Recommended Action Report" are sent to Programmes.

Sub-system 12

The Manufacturing Department receives their report and they analyse any problems using their own system. To develop such a system is the responsibility of Manufacturing. There is a provision in the system enabling Manufacturing to visit the "User" venue and inspect products, defective parts, environment etc. Manufacturing analyses the specific problem and writes a short "Recommended Action" report which is sent to Programmes. If the problem turns out not to be a manufacturing problem, the report should be sent to the department responsible.

Link 12,9: This is only a dummy link.

Link 12,14: In this link the report as well as the "Recommended Action Report" are sent to Programmes.

Sub-system 13

The Procurement Department receive their report and they analyse any problems using their own system. To develop such a system is the responsibility of Procurement. There is a provision in the system enabling Procurement to visit the "User" venue and inspect products, defective parts, environment etc. Procurement analyse the specific

problem and write a short "Recommended Action" report which is sent to Programmes. If the problem turns out not to be a procurement problem, the report should be sent to the department responsible.

Link 13,9: This is only a dummy link.

Link 13,14: In this link the report as well as the "Recommended Action Reports" are sent to Programmes.

Sub-system 14

Programmes receives the "Recommended Action" reports and takes action based on the recommendations of the reports. The Programmes department can arrange internal meetings, external meetings or negotiate with the "User" and "Distributor" to decide on what action could be taken. After Programmes have decided on a definite action, the "User", the "Distributor" and all departments in the "Producer" organisation have to be informed.

Link 14,15: Programmes informs the "Distributor" about any action taken.

Sub-system 15

The "Distributor" evaluates the report and gives his inputs, or takes any action required.

Link 15,16: The "Distributor" informs the "User" about any actions taken.

Sub-system 16

Necessary negotiations are undertaken and any actions which has been decided on, will be fed back into the system.

Link 16.1: The "Users" are informed by their organisation about the changes to be implemented.

APPENDIX IV

Proposed system II.

Each sub-system is addressed in more detail as well as the activities between the two sub-systems.(i.e. activities between sub-system 1 and sub-system 2 were adressed as link 12)

Sub-system 1

This is the data capture which takes place in the "User" organisation by the "Producer's", "After Sales Service" Department. The failure or complaint data will be captured in more detail than for System I

Link 1,2: This is the physical data capture by the "Producer" from the "User"

Sub-system 2
(same as sub-system 4 in system I)

The "Programmes" Department receive the data feedback reports from their "After Sales Service " staff and extracts any information they would require from it. This data will be passed to "Quality" immediately.

Link 2,3: The data is immediately passed onto the Quality Department.

Sub-system 3
(same as sub-system 5 in system I)

The Quality Department record the data in a computer data bank or in ledgers thus

130/...

entering the information into an analysis system.

Link 34: This is only a dummy link.

Sub-system 4
(same as sub-system 6 in system I)

The data which has been recorded will be analysed, resulting in a number of reports for various departments and organisations. This is a complete sub-system which will be developed in more detail at a later stage and will be achieved by a computer aided data processing system. The data bank will also include information generated by the "Producer" (i.e. inspection reports, batch numbers, dates of delivery etc.) The reports will then be sent to Programmes for further action on them.

Link 45: The reports are sent to Programmes.

Sub-system 5
(same as sub-system 7 in system I)

Programmes receive the reports and sort out the reports which are meant specifically for Programmes. The other reports are then sent to the departments and organisations for which they were intended. E.g. Logistics obtains information about spares, Engineering about product reliability and respective failures etc.

Links 56; 57; 59; 510; 511; 58: The reports are sent to various departments who attach a

"Recommended Action" report and send these back to Programmes.

Sub-system 6
(same as sub-system 8 in system I)

The Engineering Department receive their report and they analyse any problems using their own system to do so. To develop such a system is the responsibility of Engineering. There is a provision in the system enabling Engineering to visit the "User" venue and inspect products, defective parts, environment etc. Engineering analyses the specific problem and write a short "Recommended Action" report which is sent to Programmes. If the problem turns out not to be an engineering problem, the report should be sent to the department responsible.

Link 6,7: This is only a dummy link.

Link 6,9; 6,10; 6,11: In these links the reports are being sent from Programmes to the relevant departments.

Link 6,12: In this link the report as well as the "Recommended Actions" are sent to Programmes.

Sub-system 7
(same as sub-system 9 in system I)

In this sub-system a department identifies a specialist or a group of people to investigate a specific failure at the "User" end. Programmes will in due course be informed

132/...

as to who the people are, what their plan of action is to be and where their investigation is to take place.

Link 7.8: This is a memo to be sent to Programmes to inform them about the details of a visit to the "User".

Sub-system 8

(same as sub-system 10 in system I)

In this sub-system Programmes negotiates and arranges with the "User" for a specialist or group of people to visit the "User" location in the shortest possible time. Programmes will make use of their "After Sales Service" staff to fulfill this function. During these arrangements, "After Sales Service" should also feed back a summary of the data captured, resulting actions and thank the "User" for his co-operation.

The information which the "After Sales Service" capture during the course of their work must be fed back to Quality so that the results of the feedback systems can be compared to those of the "After Sales Service" Department can be warned.

Link 8,5: These are the findings of "After Sales Service" which are sent to Quality.

Link 8,1: These are visits by the "Producer" to the "User"

Sub-system 9
(same as sub-system 11 in system I)

The Quality Department receive their report and they analyse any problems by using their own system. To develop such a system is the responsibility of Quality. There is a provision in the system enabling Quality to visit the "User" venue and inspect products, defective parts, environment etc.

Quality analyse the specific problem and write a short "Recommended Action Report" which is sent to Programmes. If the problem turns out not to be a quality problem, the report should be sent to the department responsible.

Link 9,7: This is only a dummy link.

Link 9,12: In this link the report as well as the "Recommended Actions Report" are sent to Programmes.

Sub-system 10
(same as sub-system 12 in system I)

The Manufacturing Department receive their report and they analyse eny problems using their own system. To develop such a system is the responsibility of Manufacturing. There is a provision in the system enabling Manufacturing to visit the "User" venue and inspect products, defective parts, environment etc. Manufacturing analyses the specific problem and write a short "Recommended Action" report which is sent to Programmes. If the problem turns

134/...

out not to be a manufacturing problem, the report should be sent to the department responsible.

Link 10,7: This is only a dummy link.

Link 10,12: In this link the report as well as the "Recommended Action Report" are sent to Programmes.

Sub-system 11
(same as sub-system 13 in system I)

The Procurement Department receive their report and they analyse any problems using their own system. To develop such a system is the responsibility of Procurement. There is a provision in the system enabling Procurement to visit the "User" venue and inspect products, defective parts, environment etc. Procurement analyses the specific problem and write a short "Recommended Action" report which is sent to Programmes. If the problem turns out not to be a procurement problem, the report should be sent to the department responsible.

Link 11,7: This is only a dummy link.

Link 11,12: In this link the report as well as the "Recommended Action Report" are sent to Programmes.

Sub-system 12
(same as sub-system 14 in system I)

Programmes receive the "Recommended Action Reports" and take action based on the recom-

mendations of the report. The Programmes department can arrange internal meetings, external meetings or negotiate with the "User" and "Distributor" to decide on what action to be taken. After Programmes have decided on a definite action, the "User", the "Distributor" and all departments in the "Producer organisation have to be informed.

Link 12,13: Programmes informs the "Distributor" about any action taken.

Sub-system 13
(same as sub-system 15 in system I)

The "Distributor" evaluate reports and gives his inputs, or takes any action required.

Link 13,14: The "Distributor" informs the "User" about any actions taken.

Sub-system 14
(same as sub-system 16 in system I)

Necessary negotiations are undertaken and any action which has been decided on, will be fed back into the system.

Link 14,1: The "Users" are informed by their organisation about the changes to be implemented.

136/...

mendations of the report. The Programmes department can arrange internal meetings, external meetings or negotiate with the "User" and "Distributor" to decide on what action to be taken. After Programmes have decided on a definite action, the "User", the "Distributor" and all departments in the "Producer" organisation have to be informed.

Link 12,13: Programmes informs the "Distributor" about any action taken.

Sub-system 13

(same as sub-system 15 in system I)

The "Distributor" evaluate reports and gives his inputs, or takes any action required.

Link 13,14: The "Distributor" informs the "User" about any actions taken.

Sub-system 14

(same as sub-system 16 in system I)

Necessary negotiations are undertaken and any action which has been decided on, will be fed back into the system.

Link 14,1: The "Users" are informed by their organisation about the changes to be implemented.

136/...

APPENDIX V

Proposed system III.

Each sub-system is addressed in more detail as well as the activities between the two sub-systems. (activities between sub-system 1 and sub-system 2 were addressed as link 12)

Sub-system 1

Information about a defect or equipment shortcomings are reported on a defect report form in the "User" workshops. The product concerned is labled with the defect report number and is stored such that it can be referred to at a later stage. The report includes a number of carbon copies which are sent to the specified departments in the "User" organisation.

Link 1.2: A number of copies of the defect report are sent to the area head office.

Sub-system 2

At area headquarters, the reports are analysed and if the defects are the results of mishandling of equipment they are referred back to the "User". A plan of action is decided on. This action will be implemented in the workshops and the defect report will be considered as taken care of. If the above situation does not prevail, copies of the report are sent to the main headoffice.

137/...

Link 2,3: A number of copies of the defect report are sent to the main headoffice.

Sub-system 3

The defect reports are received by the main head office where a decision about action to be taken is made, based on the defect report and inputs by the area headoffice. The main headoffice can decide to either repair, modify or replace parts or products or to refer the defect back to the "Distributor". In the latter case a copy of the complete defect report with inputs from the area and main headoffice are sent to the "Distributor".

Link 3,4: The defect reports is sent from the "User" main headquarters to the "Distributor".

Sub-system 4
(same as sub-system 2 in system I)

The "Distributor" receives the data and extracts whatever he requires.

Link 4,5: This is only a dummy link.

Sub-system 5
(same as sub-system 3 in system I)

At this stage the "Distributor" organises the data according to the different Producers. The sorted data will then be sent away to the respective Producers on forms designed by them.

Link 5,6: The data is sent from the "Distributor" to the "Producer".

Sub-system 6
(same as sub-system 4 in system I)

The "Programmes" Department of the "Producer" receive the data and pass it immediately to the Quality Department.

Link 6,7: The data is immediately passed onto the Quality Department.

Sub-system 7
(same as sub-system 5 in system I)

The Qu epartment record th data in a compu a bank or in ledgers thus entering the information into an analysis system.

Link 7,8: This is t ly a dummy link.

Sub-system 8
(same as sub-system 6 in system I)

The data which has been recorded will be analysed, resulting in a number of reports for various departments and organisations. This is a complete sub-system which will be developed in more detail at a later stage and will be achieved by a computer aided data processing system. The data bank will also include information generated by the "Producer" (i.e. inspection reports, batch numbers, dates of delivery etc.) The report will then be sent to Programmes for further action on them.

Link 8,9: The report is sent to Programmes.

Sub-system 9

(same as sub-system 7 in system I)

Programmes receives and sorts out the reports which are meant specifically for Programmes. The other reports are then sent to the departments and organisations for which they were intended. E.g. Logistics obtains information about spares, Engineering about product reliability, and respective failures etc.

Links 9,10: 9,11; 9,12; 9,13; 9,14; 9,15: The reports are sent to various departments who attach a "Recommended Action" report and send these back to Programmes.

Sub-system 10

(same as sub-system 8 in system I)

The Engineering Department receive their report and they analyse any problems using their own system to do so. To develop such a system is the responsibility of Engineering. There is a provision in the system enabling Engineering to visit the "User" venue and inspect products, defective parts, environment etc. Engineering analyses the specific problem and writes a short "Recommended Action" report which is sent to Programmes. If the problem turns out not to be an engineering problem, the report should be sent to the department responsible.

Link 10,11: This is only a dummy link.

140/...

Link 10,13; 10,14; 10,15: In these links the reports are being sent from Programmes to the relevant departments.

Link 10,16: In this link the report as well as the "Recommended Actions Report" are sent to Programmes.

Sub-system 11

(same as sub-system 9 in system I)

In this sub-system a department identifies a specialist or a group of people to investigate a specific failure at the "User's" end. Programmes will in due course be informed as to who the people are, what their plan of action is to be and where their investigation is to take place.

Link 11,12: This is a memo to be sent to Programmes to inform them about the details of a visit to the "User".

Sub-system 12

(same as sub-system 10 in system I)

In this sub-system Programmes negotiates and arranges with the "User" for a specialist or group of people to visit the "User" location in the shortest possible time. Programmes will make use of their "After Sales Service" staff to fulfill this function. During these arrangements, "After Sales Service" should also feed back a summary of the data captured, resulting actions and thank the "User" for his co-operation.

The information which the "After Sales Service" captures during the course of their work must be fed back to Quality so that the results of the feedback systems can be compared to those of the "After Sales Service" Department.

Link 12,9: These are the findings of "After Sales Service" sent to Quality.

Link 12,1: These are visits by the "Producer" to the "User"

Sub-system 13

(same as sub-system 11 in system I)

The Quality Department receive their report and they analyse any problems by using their own system. To develop such a system is the responsibility of Quality. There is a provision in the system enabling Quality to visit the "User" venue and inspect products, defective parts, environment etc.

Quality analyse the specific problem and write a short "Recommended Action Repo-t" which is sent to Programmes . If the problem turns out not to be a quality problem, t e report should be sent to the department responsible.

Link 13,11: This is only a dummy link.

Link 13,16: In this link the report as well as the "Recommended Actions Report" are sent to Programmes.

Sub-system 14
(same as sub-system 12 in system I)

The Manufacturing Department receive their report and they analyse any problems using their own system. To develop such a system is the responsibility of Manufacturing. There is a provision in the system enabling Manufacturing to visit the "User" venue and inspect products, defective parts, environment etc. Manufacturing analyses the specific problem and write a short "Recommended Action" report which is sent to Programmes. If the problem turns out not to be a manufacturing problem, the report should be sent to the department responsible.

Link 14,11: This is only a dummy link.

Link 14,16: In this link the report as well as the "Recommended Actions Report" are sent to Programmes.

Sub-system 15
(same as sub-system 13 in system I)

The Procurement Department receive their report and they analyse any problems using their own system. To develop such a system is the responsibility of Procurement. There is a provision in the system enabling Procurement to visit the "User" venue and inspect products, defective parts, environment etc. Procurement analyses the specific problem and write a short "Recommended Action Report" which is sent to Programmes. If the problem turns out not to be a

procurement problem, the report should be sent to the department responsible.

Link 15,11: This is only a dummy link.

Link 15,16: In this link the report as well as the "Recommended Actions Report" are sent to Programmes.

Sub-system 16
(same as sub-system 14 in system I)

Programmes receive the "Recommended Action Reports" and takes action based on the recommendations of the report. The Programmes department can arrange internal meetings, external meetings or negotiate with the "User" and "Distributor" to decide on what action could be taken. After Programmes have decided on a definite action, the "User", the "Distributor" and all departments in the "Producer" organisation have to be informed.

Link 16,17: Programmes informs the "Distributor" about any action taken.

Sub-system 17
(same as sub-system 15 in system I)

The "Distributor" evaluates reports and gives his inputs, or takes any action required.

Link 17,18: The "Distributor" informs the "User" about any actions taken.

144/...

Sub-system 18

(same as sub-system 16 in system I)

Necessary negotiations are undertaken and any action which has been decided on, will be fed back into the system.

Link 18,1: The "Users" are informed by their organisation about the changes to be implemented.

Sub-system 18

(same as sub-system 16 in system I)

Necessary negotiations are undertaken and any action which has been decided on, will be fed back into the system.

Link 18,1: The "Users" are informed by their organisation about the changes to be implemented.

APPENDIX VI

The following 4 pages are a summary by Prof. A.D. Sparrius (University of Pretoria) of MIL-STD-414 :

## PLANS FOR VARIABLES SAMPLING

PLANS FOR VARIABLES SAMPLING ARE GENERALLY TAKEN FROM MIL-STD-414: SAMPLING PROCEDURES AND TABLES FOR INSPECTION BY VARIABLES FOR PERCENT DEFECTIVE.

MIL-STD-414 IS CHARACTERISED BY

- INDEXED TO AQL
- LOT-BY-LOT ACCEPTANCE SAMPLING
- NORMAL, TIGHTENED AND REDUCED INSPECTION LEVELS

MIL-STD-414 IS BASED ON THE IMPORTANT ASSUMPTIONS THAT THE MEASURED QUALITY CHARACTERISTICS ARE INDEPENDENT, IDENTICALLY DISTRIBUTED GAUSSIAN RANDOM VARIABLES, AND THAT ITS PARAMETERS DO NOT CHANGE

THREE MEASURES OF VARIABILITY CAN BE USED:

- KNOWN STANDARD DEVIATION $\sigma$
- ESTIMATED STANDARD DEVIATION S
- AVERAGE RANGE $\bar{R}$

146/...

**Comparison of Attributes and Variables Sampling Plans for Percent Defective**

| Feature | Attributes | Variables |
|---|---|---|
| Inspection | Each item classified as defective or nondefective. Go no-go gages may be employed | Each item measured. Inspection more sophisticated. Higher inspection and clerical cost |
| Distribution of individual measurements | Need not be known | *Must* be known (normal usually assumed) |
| Type of defect | Any number of defect types can be assessed by one plan | Separate plan required for each type of defect |
| Sample size | Depends on protection required | Smaller sample size for same protection as attributes (at least 30% smaller*) |
| Process information | Percent defective | Percent defective plus valuable information on process average and variability for corrective action |
| Severity | Weights all defectives of a given kind equally | Weights each unit inspected by its proximity to specifications |
| Evidence to supplier | Defectives available as evidence | Possible for lot to be rejected on sample containing no defectives |
| Measurement errors | Measurements not recorded | Measurements available for review |
| Screened lots | No effect on performance of plan | Screened lots may be rejected in error even though they contain no defectives |

* Bowker, A. H., and H. P. Goode, "Sampling Inspection by Variables," pp. 32–33, McGraw-Hill Book Company, New York, 1952. Assumes single sample of one characteristic.

**Comparison of Variables and Attributes Sample Sizes***

$p_1 = 0.0109 \qquad \alpha = 0.05$
$p_2 = 0.0535 \qquad \beta = 0.10$

| Plan | Sample size |
|---|---|
| Single-sampling attributes | 125 |
| Variables: | |
| $\sigma$ known | 19 |
| $\sigma$ unknown (s) | 58 |
| $\sigma$ unknown ($\bar{R}$ of groups of 5) | 75 |
| Sequential sampling, $\sigma$ known (ASN at $p_1$) | 10.3 |

Based on MIL-STD-105D, Code K, 1% AQL.
*Specifications assumed to be $> 6\sigma$ apart if two-sided. ASN (Average Sample Number), $p_1$, and $p_2$ as defined in Section 24.

147/...

Application of MIL-STD-414*

| Step | Section | Form 1 | Form 2 |
|---|---|---|---|
| Preparatory | | Obtain $k$ and $n$ from appropriate tables | Obtain $M$ and $n$ from appropriate tables |
| Determine criteria | Section B ($s$) | $T_U = \frac{U - \bar{X}}{s}$<br>$T_L = \frac{\bar{X} - L}{s}$ | $Q_U = \frac{U - \bar{X}}{s}$<br>$Q_L = \frac{\bar{X} - L}{s}$ |
| | Section C ($\bar{R}$) | $T_U = \frac{U - \bar{X}}{\bar{R}}$<br>$T_L = \frac{\bar{X} - L}{\bar{R}}$ | $Q_U = \frac{(U - \bar{X})c}{\bar{R}}$<br>$Q_L = \frac{(\bar{X} - L)c}{\bar{R}}$ |
| | Section D ($\sigma$) | $T_U = \frac{U - \bar{X}}{\sigma}$<br>$T_L = \frac{\bar{X} - L}{\sigma}$ | $Q_U = \frac{(U - \bar{X})v}{\sigma}$<br>$Q_L = \frac{(\bar{X} - L)v}{\sigma}$ |
| Estimation | | | Enter table with $n$ and $Q_U$ or $Q_L$ to get $p_U$ or $p_L$ |
| Action | Single specification | Accept if<br>$T_U \geq k$ or $T_L \geq k$ | Accept if<br>$p_U \leq M$ or $p_L \leq M$ |
| | Double specification | Accept if†<br>$T_U \geq k, T_L \geq k$<br>and $s <$ MSD<br>or $\bar{R} <$ MAR | Accept if<br>$p_U + p_L \leq M$ |

$c$ = scale factor.

$$v = \sqrt{\frac{n}{n-1}}$$

*E. G. Schilling, Variables Sampling and MIL-STD-414, *Transactions of Twenty-sixth Quality Control Conference of the Rochester Society for Quality Control*, Mar. 30, 1970, pp. 175–188.

†Not official procedure.

TYPICAL AOQL VALUES FOR CRITICAL DEFECTS (IE INOPERATIVE OR UNUSABLE PRODUCT) AND MAJOR DEFECTS (IE SERVICE CALL REQUIRED) OF ASSEMBLY OPERATIONS ARE (1974):

| ASSEMBLY GRADE | PRODUCTS | AOQL(%) |
|---|---|---|
| SIMPLE | IRONS, MIXERS, HEATERS, SMALL RADIOS, CLOCKS, CLOCK RADIOS, CAR RADIOS, IGNITION SYSTEMS, BATTERIES, ALTERNATORS | 0,1-1 |
| INTERMEDIATE | MONOCHROME TV SETS, STEREO AM-FM, STOVES, REFRIGERATORS, FREEZERS, AIR CONDITIONERS, COLOUR CATHODE RAY TUBES | 1-1,75 |
| COMPLEX PRODUCTS | SINGLE UNITS OF LARGE ELECTRONIC SYSTEMS, TRANSMITTERS, CARS, COLOUR TV SETS, MINICOMPUTERS, NUMERICAL CONTROL UNITS, MOBILE COMMUNICATION SYSTEMS | 1,75-3 |
| COMPLEX SYSTEMS | ASSEMBLIES OF COMPLEX PRODUCTS, RADAR, SONAR, FIRE CONTROL SYSTEMS, | 5 |

APPENDIX VII

Data used for dummy run.

Data was generated for the return cards, and then entered into a computer to sort the information. The detailed information which was entered is given in this appendix.

```
DATE   =83/04/20
PART   =01
DESC   =PIN
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=01
AGE    =NE
FAIL   =99
FORM   =001

DATE   =83/04/20
PART   =02
DESC   =NUT
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=02
AGE    =NE
FAIL   =FU
FORM   =002

DATE   =83/04/26
PART   =03
DESC   =BOLT
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=
AGE    =NE
FAIL   =99
FORM   =003

DATE   =83/04/26
PART   =04
DESC   =LEVER
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=
```

```
AGE    =NE
FAIL   =FU
FORM   =004

DATE   =83/04/26
PART   =02
DESC   =NUT
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=02
AGE    =NE
FAIL   =99
FORM   =005

DATE   =83/04/27
PART   =05
DESC   =CAP
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=
AGE    =NE
FAIL   =FU
FORM   =006

DATE   =83/05/03
PART   =06
DESC   =CHAIN
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=
AGE    =NE
FAIL   =99
FORM   =007

DATE   =83/05/03
PART   =07
DESC   =PIPE
```

```
DATE   =83/05/25
PART   =08
DESC   =CYLINDER
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=08
AGE    =US
FAIL   =BR
FORM   =012

DATE   =83/06/25
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =013

DATE   =83/06/25
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =014

DATE   =83/06/25
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =011

ENV    =TR
PRODNO=1
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =003

DATE   =83/05/03
PART   =02
DESC   =NUT
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=02
AGE    =US
FAIL   =BR
FORM   =009

DATE   =83/05/03
PART   =06
DESC   =CHAIN
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=06
AGE    =US
FAIL   =BR
FORM   =010

DATE   =83/05/05
PART   =01
DESC   =PIN
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =011
```

151/...

```
AGE    =US
FAIL   =BR
FORM   =013


DATE   =83/06/25
PART   =C3
DESC   =BOLT
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=C3
AGE    =US
FAIL   =BR
FORM   =014


DATE   =83/06/25
PART   =09
DESC   =DRIVE
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=09
AGE    =US
FAIL   =BR
FORM   =015


DATE   =83/06/28
PART   =03
DESC      LT
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =016


DATE   =83/06/29
PART   =01
DESC   =PIN
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =018


DATE   =83/06/28
PART   =10
DESC   =CONTROLS
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=10
AGE    =US
FAIL   =BR
FORM   =017


DATE   =83/06/29
PART   =07
DESC   =PIPE
ENV    =TR
PRODNO=1
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =019


DATE   =83/06/29
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=1
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =020
```

152/...

```
AGE    =US
FAIL   =BR
FORM   =079


DATE   =83/06/28
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =080


DATE   =83/06/28
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =081


DATE   =83/06/28
PART   =10
DESC   =CONTROLS
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=10
AGE    =US
FAIL   =BR
FORM   =082


DATE   =83/06/29
PART   =23
DESC   =HEATING
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=23
AGE    =US
FAIL   =BR
FORM   =083


DATE   =83/06/29
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =084


DATE   =83/06/29
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =085


DATE   =83/06/29
PART   =16
DESC   =CABLE
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=16
AGE    =US
FAIL   =BR
FORM   =086
```

153/...

```
DATE   =83/06/30
PART   =07
DESC   =PIPE
ENV    =OP
PRODNC=3
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =098

DATE   =83/06/30
PART   =03
DESC   =BOLT
ENV    =OP
PRODNC=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =099

DATE   =83/07/01
PART   =01
DESC   =PIN
ENV    =OP
PRODNC=3
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =090

DATE   =83/07/01
PART   =11
DESC   =WHEEL
ENV    =OP
PRODNC=3
PRODES=A
PARTREP=11
AGE    =US
FAIL   =BR
FORM   =091

DATE   =83/07/04
PART   =03
DESC   =BOLT
ENV    =OP
PRODNC=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =092

DATE   =83/07/05
PART   =19
DESC   =U TUBE
ENV    =OP
PRODNC=3
PRODES=A
PARTREP=19
AGE    =US
FAIL   =BR
FORM   =093

DATE   =83/07/06
PART   =01
DESC   =PIN
ENV    =OP
PRODNC=3
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =094

DATE   =83/07/06
PART   =03
DESC   =BOLT
```

154/...

```
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =096


DATE   =83/07/06
PART   =12
DESC   =AXEL
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=12
AGE    =US
FAIL   =BR
FORM   =097


DATE   =83/07/06
PART   =18
DESC   =OUTLET
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=
AGE    =US
FAIL   =BR
FORM   =098


DATE   =83/07/07
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =099


DATE   =83/07/07
PART   =12
DESC   =AXEL
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=12
AGE    =US
FAIL   =BR
FORM   =100


DATE   =83/07/07
PART   =07
DESC   =PIPE
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =101


DATE   =83/07/08
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =102


DATE   =83/07/09
PART   =12
DESC   =AXEL
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=12
```

155/...

```
AGE    =US
FAIL   =BR
FORM   =103


DATE   =83/07/09
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =104


DATE   =83/07/09
PART   =01
DESC   =PIN
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =105


DATE   =83/07/10
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =106


DATE   =83/07/10
PART   =01
DESC   =PIN
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =107


DATE   =83/07/10
PART   =01
DESC   =PIN
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =108


DATE   =83/07/10
PART   =10
DESC   =CONTROLS
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=10
AGE    =US
FAIL   =BR
FORM   =109


DATE   =83/07/11
PART   =25
DESC   =SLEEVE
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=25
AGE    =US
FAIL   =FU
FORM   =110
```

156/...

DATE =83/07/13
PART =03
DESC =BOLT
ENV =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE =US
FAIL =BR
FORM =111

DATE =83/07/13
PART =13
DESC =CAM
ENV =OP
PRODNO=3
PRODES=A
PARTREP=13
AGE =US
FAIL =BR
FORM =112

DATE =83/04/21
PART =02
DESC =NUT
ENV =TR
PRODNO=4
PRODES=A
PARTREP=02
AGE =NE
FAIL =BR
FORM =113

DATE =83/04/26
PART =07
DESC =PIPE
ENV =TR
PRODNO=4
PRODES=A
PARTREP=07

AGE =NE
FAIL =BR
FORM =114

DATE =83/04/26
PART =20
DESC =DOOR
ENV =TR
PRODNO=4
PRODES=A
PARTREP=20
AGE =NE
FAIL =BR
FORM =115

DATE =83/04/26
PART =21
DESC =LIGHT
ENV =TR
PRODNO=4
PRODES=A
PARTREP=21
AGE =NE
FAIL =BR
FORM =116

DATE =83/09/29
PART =02
DESC =NUT
ENV =TR
PRODNO=4
PRODES=A
PARTREP=02
AGE =US
FAIL =BR
FORM =117

DATE =83/05/03
PART =03
DESC =BOLT

157/...

```
ENV    =TR
PRODNO=4
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =118

DATE   =83/05/03
PART   =03
DESC   =BOLT
ENV    =TR
PRODNO=4
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =119

DATE   =83/05/03
PART   =12
DESC   =AXEL
ENV    =TR
PRODNO=4
PRODES=A
PARTREP=12
AGE    =US
FAIL   =BR
FORM   =120

DATE   =83/05/03
PART   =26
DESC   =SEALS
ENV    =TR
PRODNO=4
PRODES=A
PARTREP=26
AGE    =US
FAIL   =BR
FORM   =121

DATE   =83/05/03
PART   =01
DESC   =PIN
ENV    =TR
PRODNO=4
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =122

DATE   =83/05/06
PART   =17
DESC   =INLET
ENV    =TR
PRODNO=4
PRODES=A
PARTREP=17
AGE    =US
FAIL   =BR
FORM   =123

DATE   =83/05/05
PART   =16
DESC   =CABLE
ENV    =TR
PRODNO=4
PRODES=A
PARTREP=16
AGE    =US
FAIL   =BR
FORM   =124
```

158/...

DATE =83/06/83
PART =11
DESC =WHEEL
ENV =OP
PRODNO=1
PRODES=A
PARTREP=11
AGE =US
FAIL =BR
FORM =021

DATE =83/06/31
PART =11
DESC =WHEEL
ENV =OP
PRODNO=1
PRODES=A
PARTREP=11
AGE =US
FAIL =BR
FORM =022

DATE =83/07/04
PART =03
DESC =BOLT
ENV =OP
PRODNO=1
PRODES=A
PARTREP=03
AGE =US
FAIL =BR
FORM =023

DATE =83/07/04
PART =10
DESC =CONTROLS
ENV =OP
PRODNO=1
PRODES=A
PARTREP=10
AGE =US
FAIL =BR
FORM =024

DATE =83/07/07
PART =01
DESC =PIN
ENV =OP
PRODNO=1
PRODES=A
PARTREP=01
AGE =US
FAIL =BR
FORM =025

DATE =83/07/07
PART =03
DESC =BOLT
ENV =OP
PRODNO=1
PRODES=A
PARTREP=03
AGE =US
FAIL =BR
FORM =026

DATE =83/07/10
PART =03
DESC =BOLT
ENV =OP
PRODNO=1
PRODES=A
PARTREP=03
AGE =US
FAIL =BR
FORM =027

DATE =83/07/10
PART =03
DESC =BOLT

159/...

ENV =CP
PRODNO=1
PRODES=A
PARTREP=C3
AGE =US
FAIL =BR
FORM =028

DATE =83/04/20
PART =02
DESC =NUT
ENV =TR
PRODNO=1
PRODES=A
PARTREP=02
AGE =NE
FAIL =BR
FORM =029

DATE =83/04/20
PART =04
DESC =LEVER
ENV =TR
PRODNO=2
PRODES=A
PARTREP=04
AGE =NE
FAIL =BR
FORM =030

DATE =83/04/26
PART =11
DESC =WHEEL
ENV =TR
PRODNO=2
PRODES=A
PARTREP=11
AGE =US
FAIL =BR
FORM =031

DATE =83/04/26
PART =02
DESC =NUT
ENV =TR
PRODNO=2
PRODES=A
PARTREP=02
AGE =US
FAIL =BR
FORM =032

DATE =83/05/03
PART =02
DESC =NUT
ENV =TR
PRODNO=2
PRODES=A
PARTREP=02
AGE =US
FAIL =BR
FORM =033

DATE =83/05/06
PART =03
DESC =BOLT
ENV =TR
PRODNO=2
PRODES=A
PARTREP=03
AGE =US
FAIL =BR
FORM =034

DATE =83/06/23
PART =13
DESC =CAM
ENV =CP
PRODNO=2
PRODES=A
PARTREP=13

160/...

```
DATE    =93/06/30
PART    =13
DESC    =CAM
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=13
AGE     =US
TAIL    =8P
CORP    =OAL
```

```
DATE    =93/06/29
PART    =03
DESC    =BOLT
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=03
AGE     =US
TAIL    =8P
CORP    =O3C
```

```
DATE    =93/06/28
PART    =13
DESC    =WHEEL
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=11
AGE     =US
TAIL    =8P
CORP    =O3C
```

```
DATE    =93/06/27
PART    =03
DESC    =BOLT
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=03
AGE     =US
TAIL    =8P
CORP    =O3C
```

```
DATE    =93/06/26
PART    =07
DESC    =PIPE
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=07
AGE     =US
TAIL    =8P
CORP    =O3C
```

```
DATE    =93/06/25
PART    =03
DESC    =BOLT
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=03
AGE     =US
TAIL    =8P
CORP    =O3C
```

```
DATE    =93/06/24
PART    =13
DESC    =EXHAUST
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=13
AGE     =US
TAIL    =8P
CORP    =O3C
```

```
DATE    =93/06/23
PART    =01
DESC    =WHEEL
ENV     =OP
PRCONO=2
PRCDES=A
PARTREF=11
AGE     =US
TAIL    =8P
CORP    =O3C
```

```
DATE   =83/06/30
PART   =15
DESC   =SUPPORT
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=
AGE    =US
FAIL   =BR
FORM   =043


DATE   =83/07/04
PART   =01
DESC   =PIN
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =044


DATE   =83/07/04
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =045


DATE   =83/07/05
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =046


DATE   =83/07/05
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =047


DATE   =83/07/05
PART   =10
DESC   =CONTROLS
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=10
AGE    =US
FAIL   =BR
FORM   =048


DATE   =83/07/06
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =049


DATE   =83/07/06
PART   =12
DESC   =AXEL
```

```
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=12
AGE    =US
FAIL   =BR
FORM   =050


DATE   =83/07/06
PART   =16
DESC   =CABLE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=16
AGE    =US
FAIL   =BR
FORM   =051


DATE   =83/07/03
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =052


DATE   =83/07/09
PART   =07
DESC   =PIPE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =053


DATE   =83/07/09
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =054


DATE   =83/07/09
PART   =13
DESC   =CAM
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=13
AGE    =US
FAIL   =BR
FORM   =055


DATE   =83/07/13
PART   =07
DESC   =PIPE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =056


DATE   =83/07/13
PART   =07
DESC   =PIPE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=07
```

163/...

```
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=12
AGE    =US
FAIL   =BR
FORM   =050

DATE   =83/07/06
PART   =15
DESC   =CABLE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=15
AGE    =US
FAIL   =BR
FORM   =051

DATE   =83/07/03
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =052

DATE   =83/07/09
PART   =07
DESC   =PIPE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =053

DATE   =83/07/09
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =054

DATE   =83/07/09
PART   =13
DESC   =CAM
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=13
AGE    =US
FAIL   =BR
FORM   =055

DATE   =83/07/13
PART   =07
DESC   =PIPE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=07
AGE    =US
FAIL   =BR
FORM   =056

DATE   =83/07/13
PART   =07
DESC   =PIPE
ENV    =OP
PRODNO=2
PRODES=A
PARTREP=07
```

163/...

```
AGE    =US
FAIL   =BR
FORM   =C57


DATE   =83/07/13
PART   =03
DESC   =BOLT
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =C58


DATE   =83/07/13
PART   =11
DESC   =WHEEL
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=11
AGE    =US
FAIL   =BR
FORM   =C59


DATE   =83/07/13
PART   =01
DESC   =PIN
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=01
AGE    =US
FAIL   =BR
FORM   =C60


DATE   =83/07/13
PART   =15
DESC   =CABLE
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=15
AGE    =US
FAIL   =FU
FORM   =C61


DATE   =83/07/13
PART   =18
DESC   =OUTLET
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=18
AGE    =US
FAIL   =BR
FORM   =C62


DATE   =83/07/13
PART   =19
DESC   =U TUBE
ENV    =CP
PRODNO=2
PRODES=A
PARTREP=19
AGE    =US
FAIL   =BR
FORM   =C63


DATE   =83/04/20
PART   =01
DESC   =PIN
ENV    =TR
PRODNO=2
PRODES=A
PARTREP=01
AGE    =NE
FAIL   =BR
FORM   =C64
```

164/...

DATE =83/04/26
PART =11
DESC =WHEEL
ENV =TR
PRODNO=3
PRODES=A
PARTREP=
AGE =US
FAIL =BR
FORM =066

DATE =83/04/28
PART =20
DESC =DOOR
ENV =TR
PRODNO=3
PRODES=A
PARTREP=
AGE =US
FAIL =BR
FORM =067

DATE =83/04/28
PART =21
DESC =LIGHT
ENV =TR
PRODNO=3
PRODES=A
PARTREP=
AGE =US
FAIL =BR
FORM =068

DATE =83/04/28
PART =07
DESC =PIPE
ENV =TR
PRODNO=3
PRODES=A
PARTREP=07
AGE =US
FAIL =BR
FORM =069

DATE =83/05/03
PART =11
DESC =WHEEL
ENV =TR
PRODNO=3
PRODES=A
PARTREP=11
AGE =US
FAIL =BR
FORM =070

DATE =83/05/04
PART =03
DESC =BOLT
ENV =TR
PRODNO=3
PRODES=A
PARTREP=03
AGE =US
FAIL =BR
FORM =071

DATE =83/05/04
PART =06
DESC =CHAIN

165/...

```
ENV    =TR
PRODNO=3
PRODES=A
PARTREP=06
AGE    =US
FAIL   =BR
FORM   =072

DATE   =83/05/04
PART   =22
DESC   =INDICATOR
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=22
AGE    =US
FAIL   =BR
FORM   =073

DATE   =83/05/04
PART   =11
DESC   =WHEEL
ENV    =TR
PRODNO=3
PRODES=A
PARTREP=
AGE    =US
FAIL   =BR
FORM   =074

DATE   =83/05/06
PART   =02
DESC   =NUT
ENV    =TR
PRODNO=3
PRODES=A
PARTREP=02
AGE    =US
FAIL   =BR
FORM   =075

DATE   =83/06/20
PART   =03
DESC   =BOLT
ENV    =TR
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =07?

DATE   =83/06/24
PART   =03
DESC   =BOLT
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=03
AGE    =US
FAIL   =BR
FORM   =077

DATE   =83/06/27
PART   =09
DESC   =DRIVE
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=09
AGE    =US
FAIL   =BR
FORM   =078

DATE   =83/06/25
PART   =09
DESC   =DRIVE
ENV    =OP
PRODNO=3
PRODES=A
PARTREP=09
```

166/...

## APPENDIX VIII

A sort of the part's failure per product.

| PART NO. | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD. DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 1 | 01 | 83/04/20 | TR | PIN | 001 | A | NE | BR | | |
| 01 | 1 | 01 | 83/05/06 | TR | PIN | 011 | A | US | BR | | |
| 01 | 1 | 01 | 83/06/29 | OP | PIN | 018 | A | US | BR | | |
| 01 | 1 | 01 | 83/07/01 | OP | PIN | 025 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 4 |
| 01 | 2 | 01 | 83/04/20 | TR | PIN | 069 | A | NE | BR | | |
| 01 | 2 | 01 | 83/07/04 | OP | PIN | 044 | A | US | BR | | |
| 01 | 2 | 01 | 83/07/13 | OP | PIN | 060 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 3 |
| 01 | 3 | 01 | 83/07/01 | OP | PIN | 093 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/06 | OP | PIN | 094 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/09 | OP | PIN | 105 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/10 | OP | PIN | 107 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/10 | OP | PIN | 108 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 5 |
| 01 | | 01 | 83/05/03 | TR | PIN | 122 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 13 |

| PART NO. | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 02 | 1 | 02 | 83/04/20 | TR | NUT | 002 | A | NE | FU | | |
| 02 | 1 | 02 | 83/04/20 | TR | NUT | 029 | A | NE | BR | | |
| 02 | 1 | 02 | 83/04/26 | TR | NUT | 005 | A | US | BR | | |
| 02 | 1 | 02 | 83/05/03 | TR | NUT | 009 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 4 |
| 02 | 2 | 02 | 83/04/26 | TR | NUT | 032 | A | US | BR | | |
| 02 | 2 | 02 | 83/05/03 | TR | NUT | 033 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 02 | 3 | 02 | 83/05/06 | TR | NUT | 075 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 02 | 4 | 02 | 83/04/21 | TR | NUT | 113 | A | NE | BR | | |
| 02 | 4 | 02 | 83/09/29 | TR | NUT | 117 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| | | | | | | | | | | PART TOTAL | 9 |

FAILURE DATA (FBRP11)

| TRCT | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | |
|---|---|---|---|---|---|---|---|---|---|---|
| C3 | 1 | 00 | 83/04/26 | TR | BOLT | 003 | A | NE | BR | |
| 03 | 1 | 03 | 83/06/25 | OP | BOLT | 013 | A | US | BR | |
| C3 | 1 | 03 | 83/06/25 | OP | BOLT | 014 | A | US | BR | |
| 03 | 1 | 03 | 83/06/25 | OP | BOLT | 011 | A | US | BR | |
| C3 | 1 | 03 | 83/06/25 | OP | BOLT | 014 | A | US | BR | |
| 03 | 1 | 03 | 83/06/28 | OP | BOLT | 016 | A | US | BR | |
| 03 | 1 | 03 | 83/06/29 | OP | BOLT | 020 | A | US | BR | |
| 03 | 1 | 03 | 83/07/04 | OP | BOLT | 023 | A | US | BR | |
| 03 | 1 | 03 | 83/07/07 | OP | BOLT | 026 | A | US | BR | |
| C3 | 1 | 03 | 83/07/10 | OP | BOLT | 027 | A | US | BR | |
| C3 | 1 | 03 | 83/07/10 | OP | BOLT | 028 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 11 |
| C3 | 2 | 03 | 83/05/06 | TR | BOLT | 034 | A | US | BR | |
| 03 | 2 | 03 | 83/06/23 | OP | BOLT | 036 | A | US | BR | |
| 03 | 2 | 03 | 83/06/28 | OP | BOLT | 039 | A | US | BR | |
| C3 | 2 | 03 | 83/06/29 | OP | BOLT | 041 | A | US | BR | |
| 03 | 2 | 03 | 83/07/05 | OP | BOLT | 047 | A | US | BR | |
| 03 | 2 | 03 | 83/07/05 | OP | BOLT | 046 | A | US | BR | |
| C3 | 2 | 03 | 83/07/06 | OP | BOLT | 049 | A | US | BR | |
| 03 | 2 | 03 | 83/07/09 | OP | BOLT | 054 | A | US | BR | |
| C3 | 2 | 03 | 83/07/13 | OP | BOLT | 058 | A | US | BR | |
| C3 | 2 | 03 | 83/07/13 | OP | BOLT | 052 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 10 |
| C3 | 3 | 00 | 83/04/26 | TR | BOLT | 066 | A | US | BR | |
| 03 | 3 | 03 | 83/05/04 | TR | BOLT | 071 | A | US | BR | |
| C3 | 3 | 03 | 83/06/20 | TR | BOLT | 076 | A | US | BR | |
| 03 | 3 | 03 | 83/06/24 | OP | BOLT | 077 | A | US | BR | |
| 03 | 3 | 03 | 83/06/28 | OP | BOLT | 081 | A | US | BR | |
| C3 | 3 | 03 | 83/06/28 | OP | BOLT | 080 | A | US | BR | |
| 03 | 3 | 03 | 83/06/29 | OP | BOLT | 085 | A | US | BR | |
| 03 | 3 | 03 | 83/06/29 | OP | BOLT | 094 | A | US | BR | |
| 03 | 3 | 03 | 83/06/30 | OP | BOLT | 089 | A | US | BR | |
| 03 | 3 | 03 | 83/07/04 | OP | BOLT | 045 | A | US | BR | |
| C3 | 3 | 03 | 83/07/04 | OP | BOLT | 092 | A | US | BR | |
| C3 | 3 | 03 | 83/07/06 | OP | BOLT | 096 | A | US | BR | |
| 03 | 3 | 03 | 83/07/07 | OP | BOLT | 099 | A | US | BR | |
| 03 | 3 | 03 | 83/07/09 | OP | BOLT | 102 | A | US | BR | |
| 03 | 3 | 03 | 83/07/09 | OP | BOLT | 104 | A | US | BR | |
| C3 | 3 | 03 | 83/07/10 | OP | BOLT | 106 | A | US | BR | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 03 | 3 | 03 | 83/07/13 | OP | BOLT | 111 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 17 |
| 03 | 4 | 03 | 83/05/03 | TR | BOLT | 118 | A | US | BR | |
| 03 | 4 | 03 | 83/05/03 | TR | BOLT | 119 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| | | | | | | | | | | PART TOTAL 40 |

FAILURE DATA (FBRPT1)

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | |
|---|---|---|---|---|---|---|---|---|---|---|
| 07 | 1 | 07 | 83/05/03 | TR | PIPE | 0C8 | A | US | BR | |
| 07 | 1 | 07 | 83/06/29 | TR | PIPE | 019 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| 07 | 2 | 07 | 83/06/29 | OP | PIPE | 040 | A | US | BR | |
| 07 | 2 | 07 | 83/07/09 | OP | PIPE | 053 | A | US | BR | |
| 07 | 2 | 07 | 83/07/13 | OP | PIPE | 056 | A | US | BR | |
| 07 | 2 | 07 | 83/07/13 | OP | PIPE | 057 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 4 |
| 07 | 3 | 07 | 83/04/28 | TR | PIPE | 069 | A | US | BR | |
| 07 | 3 | 07 | 83/06/30 | OP | PIPE | 088 | A | US | BR | |
| 07 | 3 | 07 | 83/07/07 | OP | PIPE | 101 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 3 |
| 07 | 4 | 07 | 83/04/26 | TR | PIPE | 114 | A | NE | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 10 |

FAILURE DATA (FBRPT1)

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 1 | 10 | 83/04/28 | OP | CONTROLS | 017 | A | US | BR | |
| 10 | 1 | 10 | 83/07/04 | OP | CONTROLS | 024 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| 10 | 2 | 10 | 83/07/05 | OP | CONTROLS | 043 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| 10 | 3 | 10 | 83/06/28 | OP | CONTROLS | 082 | A | US | BR | |
| 10 | 3 | 10 | 83/07/10 | OP | CONTROLS | 109 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| | | | | | | | | | | PART TOTAL 5 |

FAILURE DATA (FBRP1)

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 1 | 11 | 83/06/31 | OP | WHEEL | 022 | A | US | BR | | |
| 11 | 1 | 11 | 83/06/83 | OP | WHEEL | 021 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 11 | 2 | 11 | 83/04/26 | TR | WHEEL | 031 | A | US | BR | | |
| 11 | 2 | 11 | 83/06/29 | OP | WHEEL | 038 | A | US | BR | | |
| 11 | 2 | 11 | 83/07/13 | OP | WHEEL | 059 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 3 |
| 11 | 3 | ** | 83/04/26 | TR | WHEEL | 065 | A | US | BR | | |
| 11 | 3 | 11 | 83/05/03 | TR | WHEEL | 070 | A | US | BR | | |
| 11 | 3 | ** | 83/05/04 | TR | WHEEL | 074 | A | US | BR | | |
| 11 | 3 | 11 | 83/07/01 | OP | WHEEL | 091 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 4 |
| | | | | | | | | | | PART TOTAL | 9 |



| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 2 | 12 | 83/07/06 | OP | AXEL | 050 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 12 | 3 | 12 | 83/07/06 | OP | AXEL | 097 | A | US | BR | | |
| 12 | 3 | 12 | 83/07/07 | OP | AXEL | 100 | A | US | BR | | |
| 12 | 3 | 12 | 83/07/09 | OP | AXEL | 103 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 3 |
| 12 | 4 | 12 | 83/05/03 | TR | AXEL | 120 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 5 |

APPENDIX IX

A sort to count the new and used failures per part per product.

| | | | | | |
|---|---|---|---|---|---|
| | | | | | 1 |
| A | NE | BR | | PRODUCT TOTAL | 1 |
| A | NE | BP | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 2 |
| A | NE | FU | | | |
| A | NE | BR | | | |
| | | | | PRODUCT TOTAL | 2 |
| A | NE | BR | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 3 |
| A | NE | BR | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 1 |
| A | NE | FU | | PRODUCT TOTAL | 1 |
| A | NE | BR | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 2 |
| A | NE | BR | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 1 |
| A | NE | FU | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 1 |
| A | NE | BR | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 1 |

FAILURE DATA

| PART NO. | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FC NO |
|---|---|---|---|---|---|---|
| 01 | 1 | 01 | 83/04/20 | TR | PIN | CC |
| 01 | 2 | 01 | 83/04/20 | TR | PIN | 06 |
| 02 | 1 | 02 | 83/04/20 | TR | NUT | 00 |
| 02 | 1 | 02 | 83/04/20 | TR | NUT | 02 |
| 02 | 4 | 02 | 83/04/21 | TR | NUT | 11 |
| 03 | 1 | 03 | 83/04/26 | TR | BOLT | 00 |
| 04 | 1 | 03 | 83/04/26 | TR | LEVER | 0C |
| 04 | 2 | 04 | 83/04/20 | TR | LEVER | C3 |
| 07 | 4 | 07 | 83/04/25 | TR | PIPE | 11 |
| 20 | 4 | 20 | 83/04/20 | TR | DOOR | 11 |
| 21 | 4 | 21 | 83/04/25 | TR | LIGHT | 11 |

171/...

## APPENDIX XX

A sort to count the new and used failures per part per product.

FAILURE DATA

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | BRPIT | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 1 | 01 | 83/04/20 | TR | PIN | 001 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 01 | 2 | 01 | 83/04/20 | TR | PIN | 064 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 2 |
| 02 | 1 | 02 | 83/04/20 | TR | NUT | 002 | A | NE | BR | | |
| 02 | 1 | 02 | 83/04/20 | TR | NUT | 029 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 02 | 4 | 02 | 83/04/21 | TR | NUT | 113 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 3 |
| 03 | 1 | 00 | 83/04/26 | TR | BOLT | 003 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 04 | 1 | 00 | 83/04/26 | TR | LEVER | 004 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 04 | 2 | 04 | 83/04/20 | TR | LEVER | 030 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 2 |
| 07 | 4 | 07 | 83/04/25 | TR | PIPE | 114 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 20 | 4 | 20 | 83/04/26 | TR | DOOR | 115 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 21 | 4 | 21 | 83/04/25 | TR | LIGHT | 116 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |

FAILURE DATA (FDRP1)

| FORM | PRODUCT NO. | PART REF | DATE | ENV | PART DESC. | FORM NO. | MOD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 1 | [illegible] | 83/05/06 | TR | PIN | 011 | A | US | BR | | |
| 01 | 1 | 01 | 83/06/29 | OP | PIN | 018 | A | US | BR | | |
| 01 | 1 | 01 | 83/07/07 | OP | PIN | 025 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 3 |
| 01 | 2 | 01 | 83/07/04 | OP | PIN | 044 | A | US | BR | | |
| 01 | 2 | 01 | 83/07/13 | OP | PIN | 060 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 01 | 3 | 01 | 83/07/01 | OP | PIN | 090 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/06 | OP | PIN | 094 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/07 | OP | PIN | 105 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/10 | OP | PIN | 107 | A | US | BR | | |
| 01 | 3 | 01 | 83/07/10 | OP | PIN | 108 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 5 |
| 01 | 4 | 01 | 83/05/03 | TR | PIN | 122 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PARTTOTAL | 11 |
| 02 | 1 | 02 | 83/04/26 | TR | NUT | 005 | A | US | BR | | |
| 02 | 1 | 02 | 83/05/03 | TR | NUT | 009 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 02 | 2 | 02 | 83/04/26 | TR | NUT | 032 | A | US | BR | | |
| 02 | 2 | 02 | 83/05/03 | TR | NUT | 033 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 02 | 3 | 02 | 83/05/06 | TR | NUT | 075 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 02 | 4 | 02 | 83/09/29 | TR | NUT | 117 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 6 |
| 03 | 1 | 03 | 83/06/25 | OP | BOLT | 014 | A | US | BR | | |
| 03 | 1 | 03 | 83/06/25 | OP | BOLT | 015 | A | US | BR | | |
| 03 | 1 | 03 | 83/06/25 | OP | BOLT | 013 | A | US | BR | | |
| 03 | 1 | 03 | 83/06/25 | OP | BOLT | 013 | A | US | BR | | |
| 03 | 1 | 03 | 83/06/29 | OP | BOLT | 016 | A | US | BR | | |
| 03 | 1 | 03 | 83/06/29 | OP | BOLT | 020 | A | US | BR | | |
| 03 | 1 | 03 | 83/07/04 | OP | BOLT | 023 | A | US | BR | | |
| 03 | 1 | 03 | 83/07/07 | OP | BOLT | 026 | A | US | BR | | |
| 03 | 1 | 03 | 83/07/10 | OP | BOLT | 028 | A | US | BR | | |
| 03 | 1 | 03 | 83/07/10 | OP | BOLT | 027 | A | US | BR | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | PRODUCT TOTAL 10 |
| C3 | 2 | 03 | 83/05/06 | TR | BOLT | C34 | A | US | BR | |
| 03 | 2 | 03 | 83/06/23 | OP | BOLT | 035 | A | US | BR | |
| C3 | 2 | 03 | 83/06/28 | OP | BOLT | 039 | A | US | BR | |
| 03 | 2 | 03 | 83/06/29 | OP | BOLT | 041 | A | US | BR | |
| 03 | 2 | 03 | 83/07/05 | OP | BOLT | 047 | A | US | BR | |
| C3 | 2 | 0 | 83/07/05 | OP | BOLT | C46 | A | US | BR | |
| 03 | 2 | 03 | 83/07/06 | OP | BOLT | 049 | A | US | BR | |
| C3 | 2 | 03 | 83/07/09 | OP | BOLT | C54 | A | US | BR | |
| 03 | 2 | 03 | 83/07/13 | OP | BOLT | 059 | A | US | BR | |
| 03 | 2 | 03 | 83/07/83 | OP | BOLT | 052 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 10 |
| 03 | 3 | ** | 83/04/26 | TR | BOLT | 066 | A | US | BR | |
| 03 | 3 | 03 | 83/05/04 | TR | BOLT | C71 | A | US | BR | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | PRODUCT TOTAL | 10 |
| 03 | 2 | 03 | 83/05/06 | TR | BOLT | 034 | A | US | BR | |
| 03 | 2 | 03 | 83/06/23 | OP | BOLT | 035 | A | US | BR | |
| 03 | 2 | 03 | 83/06/28 | OP | BOLT | 039 | A | US | BR | |
| 03 | 2 | 03 | 83/06/29 | OP | BOLT | 041 | A | US | BR | |
| 03 | 2 | 03 | 83/07/05 | OP | BOLT | 047 | A | US | BR | |
| 03 | 2 | 03 | 83/07/05 | OP | BOLT | 046 | A | US | BR | |
| 03 | 2 | 03 | 83/07/06 | OP | BOLT | 049 | A | US | BR | |
| 03 | 2 | 03 | 83/07/09 | OP | BOLT | 054 | A | US | BR | |
| 03 | 2 | 03 | 83/07/13 | OP | BOLT | 059 | A | US | BR | |
| 03 | 2 | 03 | 83/07/83 | OP | BOLT | 052 | A | US | BR | |
| | | | | | | | | | PRODUCT TOTAL | 10 |
| 03 | 1 | ** | 83/04/26 | TR | BOLT | 066 | A | US | BR | |
| 03 | 1 | 03 | 83/05/04 | TR | BOLT | 071 | A | US | BR | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | PRODUCT TOTAL | 10 |
| C1 | 2 | 03 | 83/05/06 | TR | BOLT | C34 | A | US | BR | |
| 03 | 2 | 03 | 83/06/23 | OP | BOLT | 035 | A | US | BR | |
| C3 | 2 | 03 | 83/C6/28 | OP | BOLT | 039 | A | US | BR | |
| 03 | 2 | 03 | 83/06/29 | OP | BOLT | 041 | A | US | BR | |
| 03 | 2 | 03 | 83/07/05 | OP | BOLT | 047 | A | US | BR | |
| C3 | 2 | 03 | 83/C7/05 | OP | BOLT | C45 | A | US | BR | |
| 03 | 2 | 03 | 83/C7/06 | OP | BOLT | 049 | A | US | BR | |
| 03 | 2 | 03 | 83/07/09 | OP | BOLT | C54 | A | US | BR | |
| 03 | 2 | 03 | 83/C7/13 | OP | BOLT | 059 | A | US | BR | |
| 03 | 2 | 03 | 83/C7/83 | OP | BOLT | 052 | A | US | BR | |
| | | | | | | | | | PRODUCT TOTAL | 10 |
| 03 | 3 | ** | 83/C4/26 | TR | BOLT | 066 | A | US | BR | |
| 03 | 3 | 03 | 83/05/04 | TR | BOLT | C71 | A | US | BR | |

FAILURE DATA (FBRP1)

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | |
|---|---|---|---|---|---|---|---|---|---|---|
| 03 | 3 | 03 | 83/06/2C | TR | BOLT | 075 | A | US | BR | |
| 03 | 3 | 03 | 83/06/24 | OP | BOLT | 077 | A | US | BR | |
| 03 | 3 | 03 | 83/06/28 | OP | BOLT | 081 | A | US | BR | |
| 03 | 3 | 03 | 83/06/28 | OP | BOLT | 080 | A | US | BR | |
| 03 | 3 | 03 | 83/06/29 | OP | BOLT | 085 | A | US | BR | |
| 03 | 3 | 03 | 83/06/29 | OP | BOLT | 084 | A | US | BR | |
| 03 | 3 | 03 | 83/06/3C | OP | BOLT | 089 | A | US | BR | |
| 03 | 3 | 03 | 83/07/04 | OP | BOLT | 092 | A | US | BR | |
| 03 | 3 | 03 | 83/07/04 | OP | BOLT | 045 | A | US | BR | |
| 03 | 3 | 03 | 83/07/06 | OP | BOLT | 096 | A | US | BR | |
| 03 | 3 | 03 | 83/07/07 | OP | BOLT | 099 | A | US | BR | |
| 03 | 3 | 03 | 83/07/09 | OP | BOLT | 102 | A | US | BR | |
| 03 | 3 | 03 | 83/07/09 | OP | BOLT | 104 | A | US | BR | |
| 03 | 3 | 03 | 83/07/10 | OP | BOLT | 105 | A | US | BR | |
| 03 | 3 | 03 | 83/07/13 | OP | BOLT | 111 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 17 |
| 03 | 4 | 03 | 83/05/03 | TR | BOLT | 118 | A | US | BR | |
| 03 | 4 | 03 | 83/05/03 | TR | BOLT | 119 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| | | | | | | | | | | PART TOTAL 39 |
| 05 | 1 | ** | 83/04/27 | TR | CAP | 006 | A | US | FU | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 1 |
| 06 | 1 | ** | 83/05/03 | TR | CHAIN | 007 | A | US | BR | |
| 06 | 1 | 06 | 83/05/03 | TR | CHAIN | 010 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| 06 | 3 | 06 | 83/05/04 | TR | CHAIN | 072 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PARTTOTAL 3 |
| 07 | 1 | 07 | 83/05/03 | TR | PIPE | 008 | A | US | BR | |
| 07 | 1 | 07 | 83/06/29 | TR | PIPE | 019 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| 07 | 2 | 07 | 83/06/29 | OP | PIPE | 040 | A | US | BR | |
| 07 | 2 | 07 | 83/07/09 | OP | PIPE | 053 | A | US | BR | |
| 07 | 2 | 07 | 83/07/13 | OP | PIPE | 056 | A | US | BR | |
| 07 | 2 | 07 | 83/07/13 | OP | PIPE | 057 | A | US | BR | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C7 | 3 | 07 | 83/04/28 | TR | PIPE | 069 | A | US | BR | |
| 07 | 3 | 07 | 83/06/30 | OP | PIPE | 088 | A | US | BR | |
| 07 | 3 | C7 | 83/C7/07 | OP | PIPE | 1C1 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 4 |
| | | | | | | | | | | PRODUCT TOTAL 3 |
| | | | | | | | | | | PART TOTAL 9 |
| 08 | 1 | 08 | 83/05/25 | OP | CYLINDER | C12 | A | US | 3L | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 1 |
| 09 | 1 | 09 | 83/06/25 | OP | DRIVE | 015 | A | US | FU | |
| 09 | 1 | 09 | 83/06/27 | OP | DRIVE | 078 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| C7 | 3 | 07 | 83/04/28 | TR | PIPE | 069 | A | US | BR | |
| 07 | 3 | 07 | 83/06/30 | OP | PIPE | 088 | A | US | BR | |
| 07 | 3 | 07 | 83/07/07 | OP | PIPE | 1C1 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 4 |
| | | | | | | | | | | PRODUCT TOTAL 3 |
| | | | | | | | | | | PART TOTAL 9 |
| C8 | 1 | 08 | 83/07/25 | OP | CYLINDER | 012 | A | US | AK | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 1 |
| 09 | 1 | 09 | 83/06/25 | OP | DRIVE | 015 | A | US | FU | |
| 09 | 3 | 09 | 83/06/27 | OP | DRIVE | 078 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |

FAILURE DATA (F3RP11)

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 09 | 3 | 09 | 83/06/28 | OP | DRIVE | 079 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| | | | | | | | | | | PART TOTAL | 3 |
| 10 | 1 | 10 | 83/06/28 | OP | CONTROLS | 017 | A | US | BR | | |
| 10 | 1 | 10 | 83/07/04 | OP | CONTROLS | 024 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 10 | 2 | 10 | 83/07/05 | OP | CONTROLS | 048 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 10 | 3 | 10 | 83/06/28 | OP | CONTROLS | 082 | A | US | BR | | |
| 10 | 3 | 10 | 83/07/10 | OP | CONTROLS | 109 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| | | | | | | | | | | PART TOTAL | 5 |
| 11 | 1 | 11 | 83/06/31 | OP | WHEEL | 022 | A | US | BR | | |
| 11 | 1 | 11 | 83/06/83 | OP | WHEEL | 021 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 11 | 2 | 11 | 83/05/28 | OP | WHEEL | 038 | A | US | BR | | |
| 11 | 2 | 11 | 83/07/12 | OP | WHEEL | 059 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 3 |
| 11 | 3 | ** | 83/04/26 | TR | WHEEL | 065 | A | US | BR | | |
| 11 | 3 | 11 | 83/05/03 | TR | WHEEL | 070 | A | US | BR | | |
| 11 | 3 | ** | 83/05/04 | TR | WHEEL | 074 | A | US | BR | | |
| 11 | 3 | 11 | 83/07/01 | OP | WHEEL | 091 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 4 |
| | | | | | | | | | | PART TOTAL | 9 |
| 12 | 2 | 12 | 83/07/06 | OP | AXEL | 050 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 12 | 3 | 12 | 83/07/06 | OP | AXEL | 097 | A | US | BR | | |
| 12 | 3 | 12 | 83/07/07 | OP | AXEL | 100 | A | US | BR | | |
| 12 | 3 | 12 | 83/07/09 | OP | AXEL | 103 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 3 |
| 12 | 4 | 12 | 83/05/03 | TR | AXEL | 120 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 5 |
| 13 | 2 | 13 | 83/06/23 | OP | CAM | 035 | A | US | BR | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 2 | 13 | 83/06/30 | OP | CAM | 042 | A | US | BR | |
| 13 | 2 | 13 | 83/07/09 | OP | CAM | 055 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 3 |
| 13 | 3 | 13 | 83/07/13 | OP | CAM | 112 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 4 |
| 14 | 2 | 14 | 83/06/21 | OP | EXHAUST | 037 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 1 |
| 15 | 2 | ** | 83/06/30 | OP | SUPPORT | 043 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 1 |

FAILURE DATA (FBRP1)

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FCRP NO. | PROD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 2 | 16 | 83/07/06 | OP | CABLE | 051 | A | US | BR | | |
| 16 | 2 | 16 | 83/07/13 | OP | CABLE | 061 | A | US | FU | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 16 | 3 | 16 | 83/06/29 | OP | CABLE | 086 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 16 | 4 | 16 | 83/05/06 | TR | CABLE | 124 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 4 |
| 17 | 4 | 17 | 83/05/06 | TR | INLET | 123 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 18 | 2 | 18 | 83/07/13 | OP | OUTLET | 062 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 18 | 3 | ** | 83/07/06 | OP | OUTLET | 099 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 2 |
| 19 | 2 | 19 | 83/07/13 | OP | U TUBE | 063 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 19 | 3 | 19 | 83/07/15 | OP | U TUBE | 093 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 2 |
| 20 | 3 | ** | 83/04/28 | TR | DOOR | 067 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 21 | 3 | ** | 83/04/28 | TR | LIGHT | 068 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 22 | 3 | 22 | 83/05/04 | OP | INDICATOR | 071 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 23 | 3 | 23 | 83/06/29 | OP | HEATING | 083 | A | US | BR | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | PRODUCT TOTAL | 1 | |
| | | | | | | | | | | | PART TOTAL | 1 | |
| 25 | 3 | 25 | 83/07/11 | UP | SLEEVE | 110 | A | US | FU | | | | 1 |
| | | | | | | | | | | | PRODUCT TOTAL | 1 | |
| | | | | | | | | | | | PART TOTAL | 1 | |
| 26 | 4 | 26 | 83/05/03 | TR | SEALS | 121 | A | US | BR | | | | 1 |
| | | | | | | | | | | | PRODUCT TOTAL | 1 | |
| | | | | | | | | | | | PART TOTAL | 1 | |

APPENDIX A

A sort of the location (training or operational) of the workshops of part numbers per product.

(FORP11)

| ERP CL. | PROD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|
| 01 | A | NE | BR | | |
| 01 | A | US | BR | | |
| | | | | PRODUCT TOTAL | 2 |
| 05 | A | NE | BR | | 1 |
| | | | | PRODUCT TOTAL | 1 |
| 07 | A | US | BR | | 1 |
| | | | | PRODUCT TOTAL | 1 |
| | | | | PART TOTAL | 4 |
| 09 | A | NE | BR | | |
| 09 | A | NE | EU | | |
| 09 | A | US | BR | | |
| 09 | A | US | BR | | |
| | | | | PRODUCT TOTAL | 4 |
| 12 | A | US | BR | | |
| 13 | A | US | BR | | 2 |
| | | | | PRODUCT TOTAL | 2 |
| 15 | A | US | BR | | 1 |
| | | | | PRODUCT TOTAL | 1 |
| 17 | A | NE | BR | | |
| 17 | A | US | BR | | |
| | | | | PRODUCT TOTAL | 2 |
| | | | | PART TOTAL | 9 |
| 23 | A | NE | BR | | 1 |
| | | | | PRODUCT TOTAL | 1 |
| 26 | A | US | BR | | 1 |
| | | | | PRODUCT TOTAL | 1 |
| 26 | A | US | BR | | |
| 26 | A | US | BR | | |
| 26 | A | US | BR | | |
| | | | | PRODUCT TOTAL | 3 |
| 28 | A | US | BR | | |
| 29 | A | US | BR | | |
| | | | | PRODUCT TOTAL | 2 |
| | | | | PART TOTAL | 7 |
| 34 | A | NE | EU | | 1 |
| | | | | PRODUCT TOTAL | 1 |

FAILURE DATA

| ERP CL. | PRODUCT NO. | PART REP | DATE | ENV | PART | DESC. | FO |
|---|---|---|---|---|---|---|---|
| 01 | 1 | 01 | 83/04/20 | TR | PIN | | CO |
| 01 | 1 | 01 | 83/05/06 | TR | PIN | | 01 |
| 01 | 2 | 01 | 83/04/20 | TR | PIN | | CO |
| 01 | 4 | 01 | 83/05/03 | TR | PIN | | 12 |
| 07 | 1 | 02 | 83/04/20 | TR | NUT | | 02 |
| 02 | 1 | 02 | 83/04/20 | TR | NUT | | 00 |
| 02 | 1 | 02 | 83/04/26 | TR | NUT | | CO |
| 02 | 1 | 02 | 83/05/03 | TR | NUT | | 00 |
| 02 | 2 | 02 | 83/04/26 | TR | NUT | | 03 |
| 02 | 2 | 02 | 83/05/03 | TR | NUT | | 03 |
| 02 | 3 | 02 | 83/05/06 | TR | NUT | | 07 |
| 02 | 4 | 02 | 83/04/21 | TR | NUT | | 11 |
| 02 | 4 | 02 | 83/03/29 | TR | NUT | | 11 |
| 03 | 1 | 03 | 83/04/26 | TR | BOLT | | CO |
| 03 | 2 | 03 | 83/05/06 | TR | BOLT | | 03 |
| 03 | 3 | 03 | 83/04/26 | TR | BOLT | | 06 |
| 03 | 3 | 03 | 83/05/04 | TR | BOLT | | 07 |
| 03 | 3 | 03 | 83/06/20 | TR | BOLT | | 07 |
| 01 | 4 | 03 | 83/05/03 | TR | BOLT | | 11 |
| 01 | 4 | 03 | 83/05/03 | TP | BOLT | | 11 |
| 04 | 1 | 04 | 83/04/26 | TR | LEVER | | 00 |

180/...

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 04 | 2 | 04 | 83/04/20 | TR | LEVER | 030 | A | NE | 3R | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 2 |
| 05 | 1 | 05 | 83/04/21 | TR | LAP | 006 | A | US | FU | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 1 |
| 06 | 1 | 06 | 83/05/03 | TR | CHAIN | 007 | A | US | BR | |
| 06 | 1 | 06 | 83/05/03 | TR | CHAIN | 010 | A | US | BR | |
| | | | | | | | | | | PRODUCT TOTAL 2 |
| 06 | 3 | 06 | 83/05/04 | TR | CHAIN | 072 | A | US | 3R | |
| | | | | | | | | | | PRODUCT TOTAL 1 |
| | | | | | | | | | | PART TOTAL 3 |

FAILURE DATA (FARPT)

| PART | PRODUCT NO. | PART REP | DATE | ENV | PART DESC. | FORM NO. | PROD DESC | AGE | FAILURE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 07 | 1 | 07 | 83/05/03 | TR | PIPE | 008 | A | US | BR | | |
| 07 | 1 | 07 | 83/06/29 | TR | PIPE | 019 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 2 |
| 07 | 3 | 07 | 83/04/28 | TR | PIPE | 069 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 07 | 4 | 07 | 83/04/26 | TR | PIPE | 114 | A | NE | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 4 |
| 11 | 2 | 11 | 83/04/26 | TR | WHEEL | 031 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 11 | 3 | ** | 83/04/26 | TR | WHEEL | 065 | A | US | BR | | |
| 11 | 3 | 11 | 83/05/03 | TR | WHEEL | 070 | A | US | BR | | |
| 11 | 3 | ** | 83/05/04 | TR | WHEEL | 074 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 3 |
| | | | | | | | | | | PART TOTAL | 4 |
| 12 | 4 | 12 | 83/05/03 | TR | AXEL | 120 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 16 | 4 | 16 | 83/05/06 | TR | CABLE | 124 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 17 | 4 | 17 | 83/05/06 | TR | INLET | 123 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 1 |
| 20 | 1 | ** | 83/04/28 | TR | DOOR | 067 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 20 | 4 | 20 | 83/04/26 | TR | DOOR | 115 | A | NE | FU | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | PART TOTAL | 2 |
| 21 | 1 | ** | 83/04/28 | TR | LIGHT | 068 | A | US | BR | | |
| | | | | | | | | | | PRODUCT TOTAL | 1 |
| 21 | 4 | 21 | 83/04/26 | TR | LIGHT | 116 | A | NE | BR | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | | | PART TOTAL | 2 |
| 26 | 4 | 26 | 83/05/03 | TR | SEALS | 121 | A | US | BR | | | | |
| | | | | | | | | | | | | PRODUCT TOTAL | 1 |
| | | | | | | | | | | | | PART TOTAL | 1 |



183/...

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