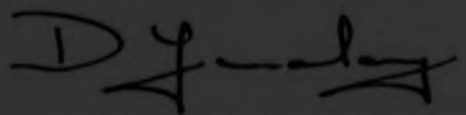




DECLARATION

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













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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 very carefully analysed, since the quality costs involved and the savings achieved show an optimum as indicated by Juran/Gryna (1) (See Fig. 1)

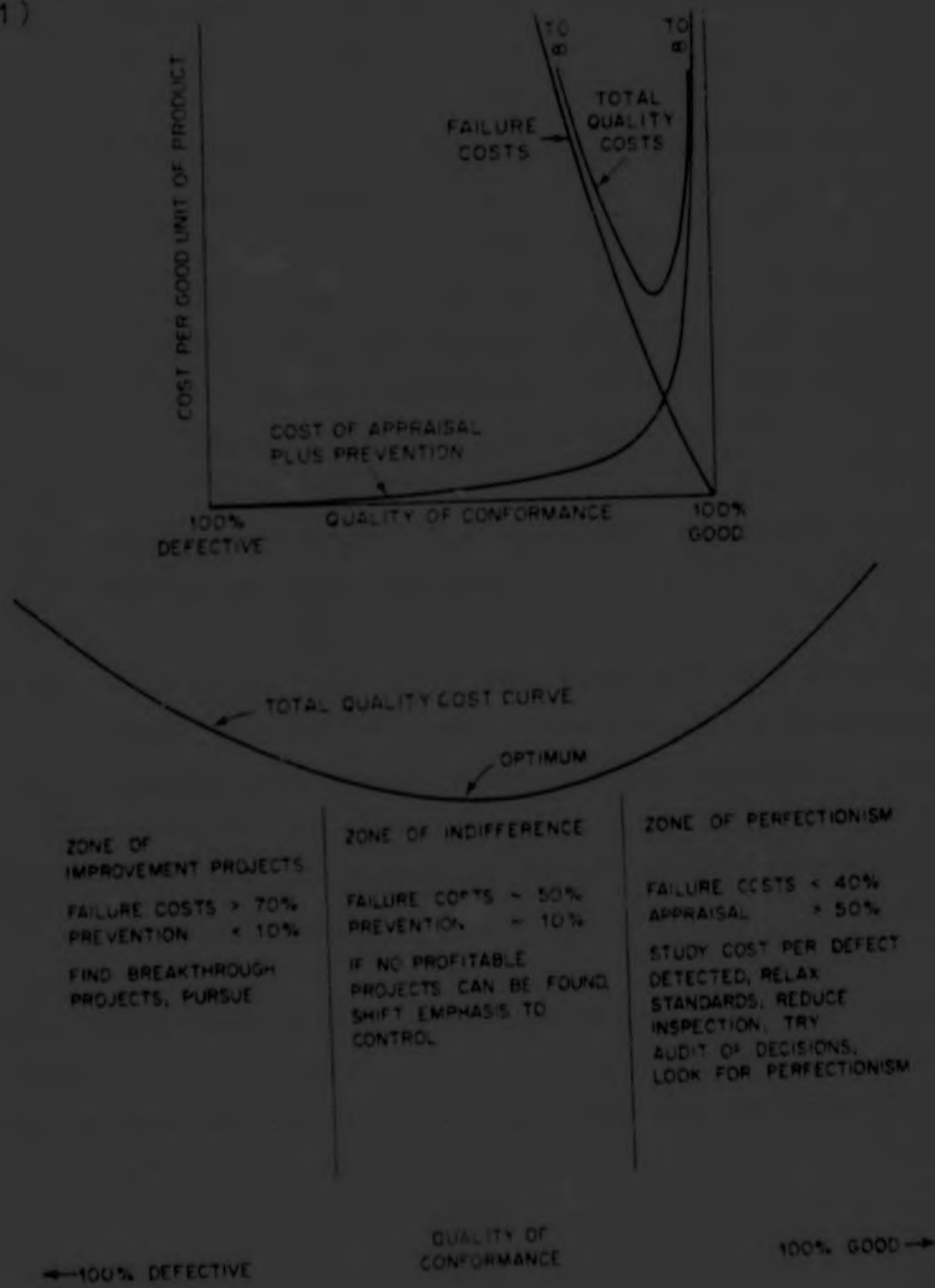


Fig.1. MODEL OF OPTIMUM QUALITY COSTS AND OPTIMUM SEGMENT OF QUALITY COST MODEL





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 repetitive 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

since a lengthy report may lose 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).

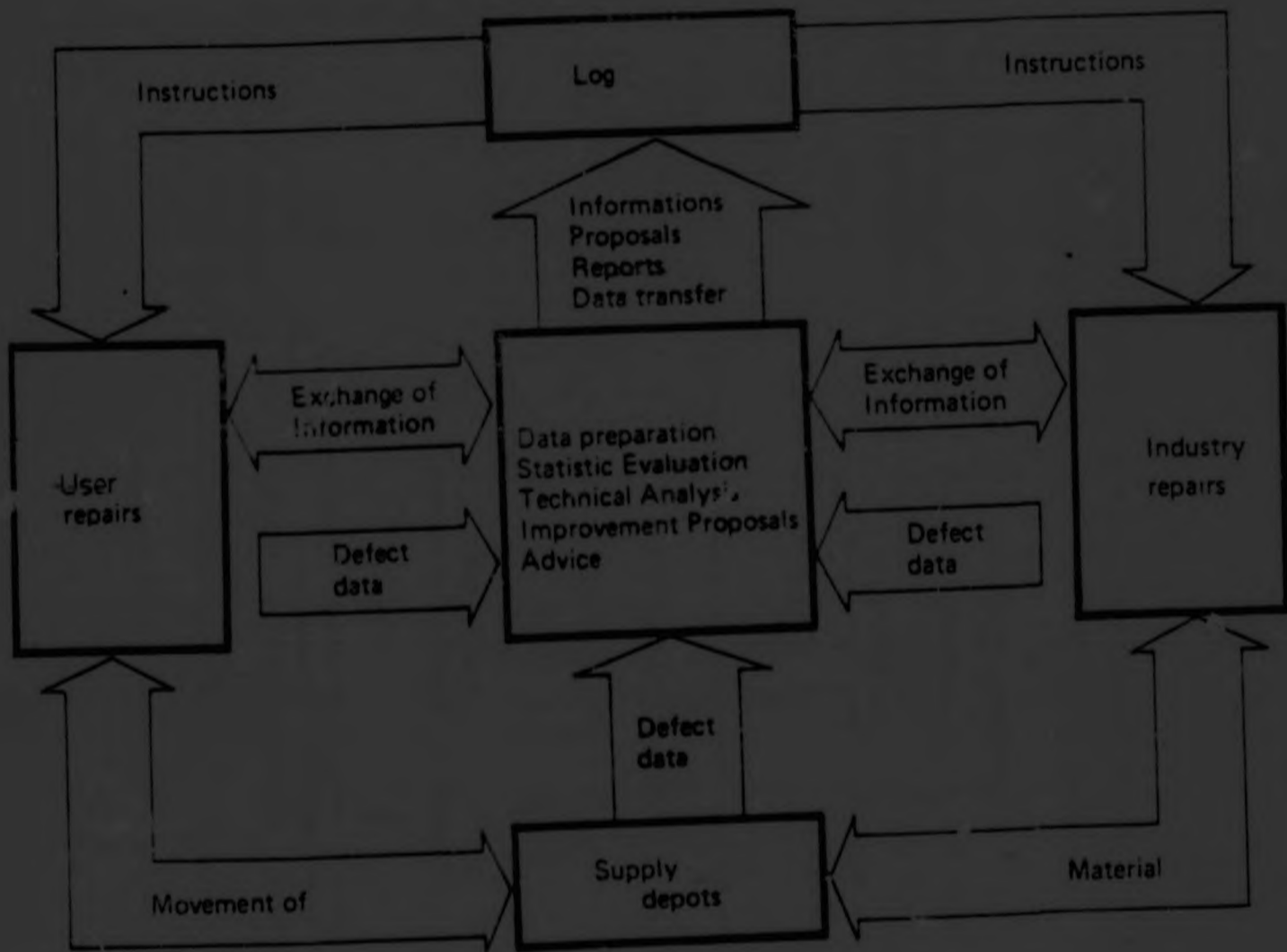


Fig.2 LOOP OF DEFECT DATA ANALYSIS

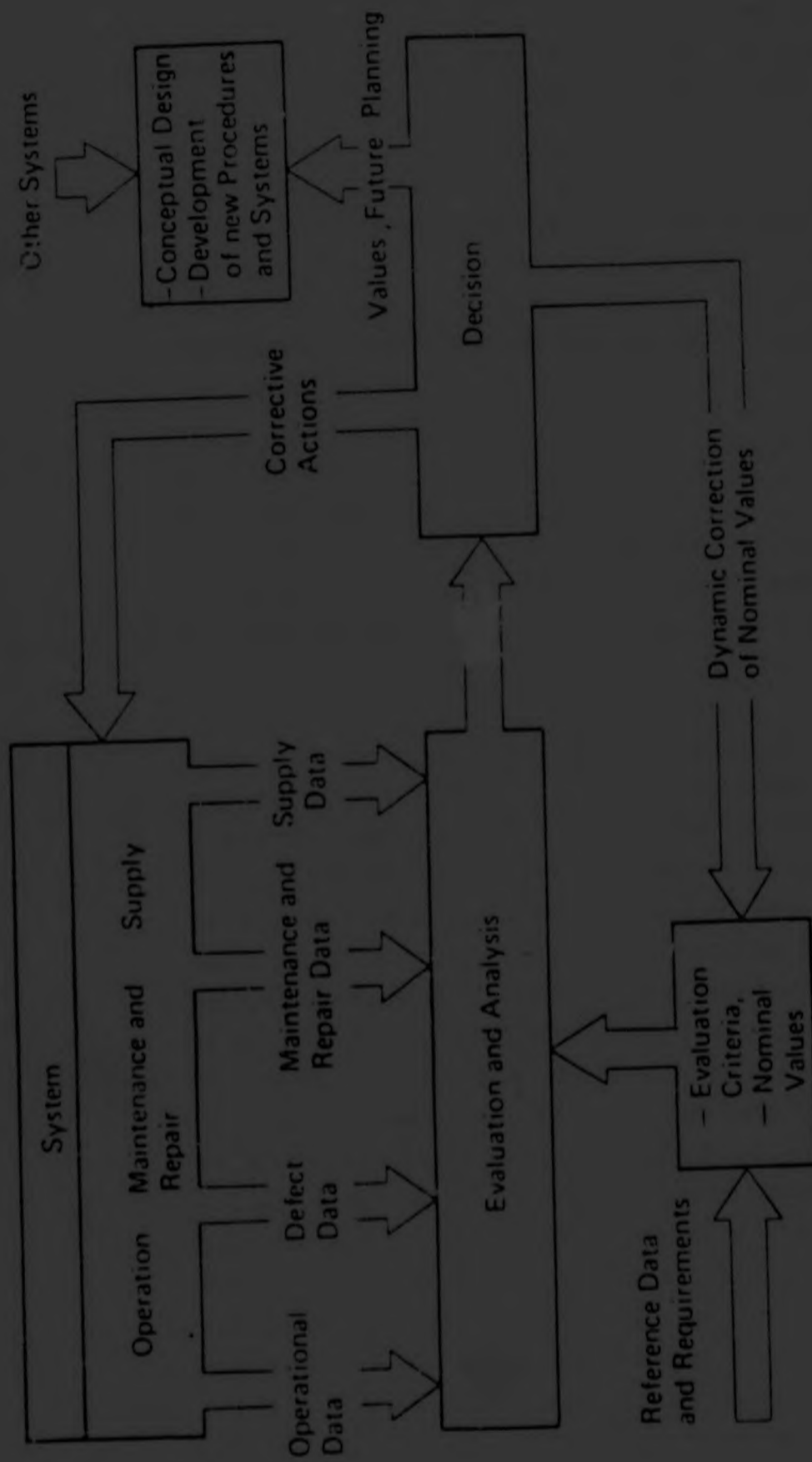


Fig.3. GLOBAL REPRESENTATION OF A DATA FEEDBACK SYSTEM

2.2 Some guidelines to develop a data feedback system - The communication within the system must be designed and structured as Fourie (7) described 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





### 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 situation was as shown in Fig. 4.

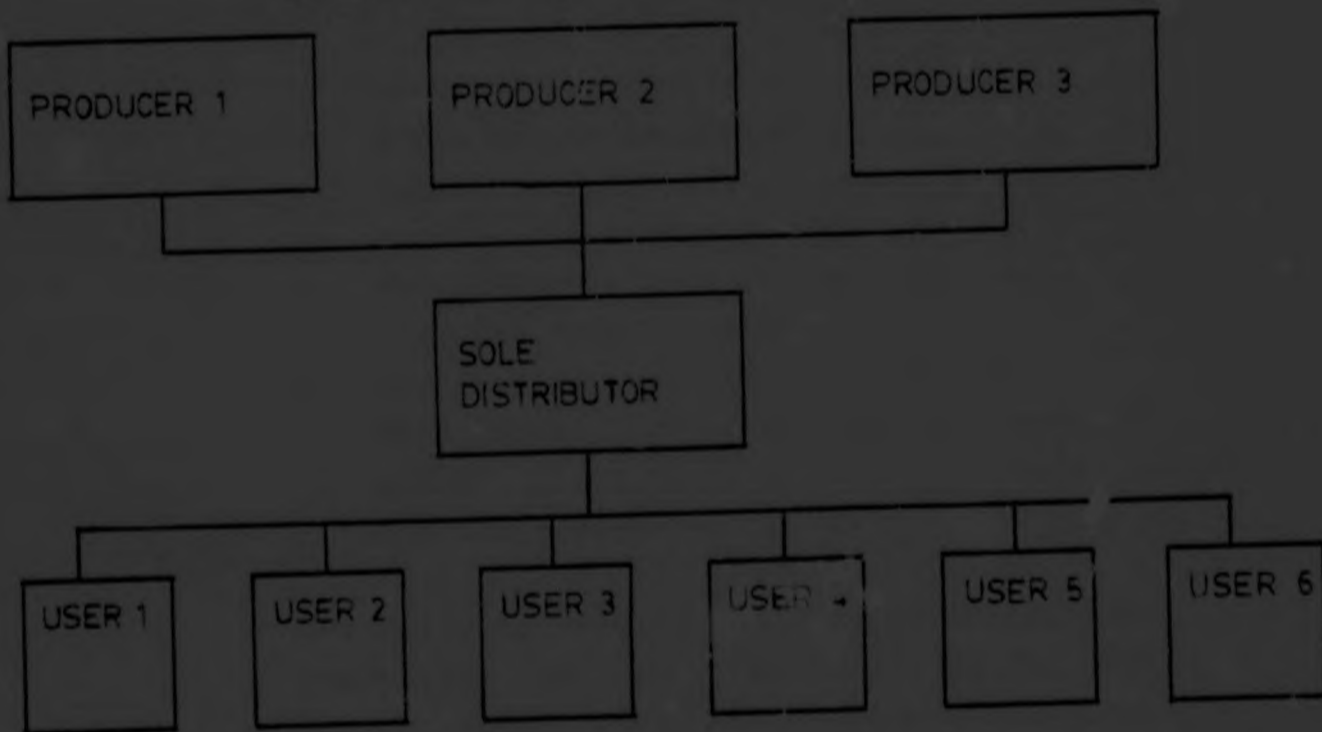


Fig.4. BLOCK DIAGRAM OF ORGANISATIONS INVOLVED IN THE FIELD FAILURE DATA FEEDBACK SYSTEM

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



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", the "Sales 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 Concise 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 will 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



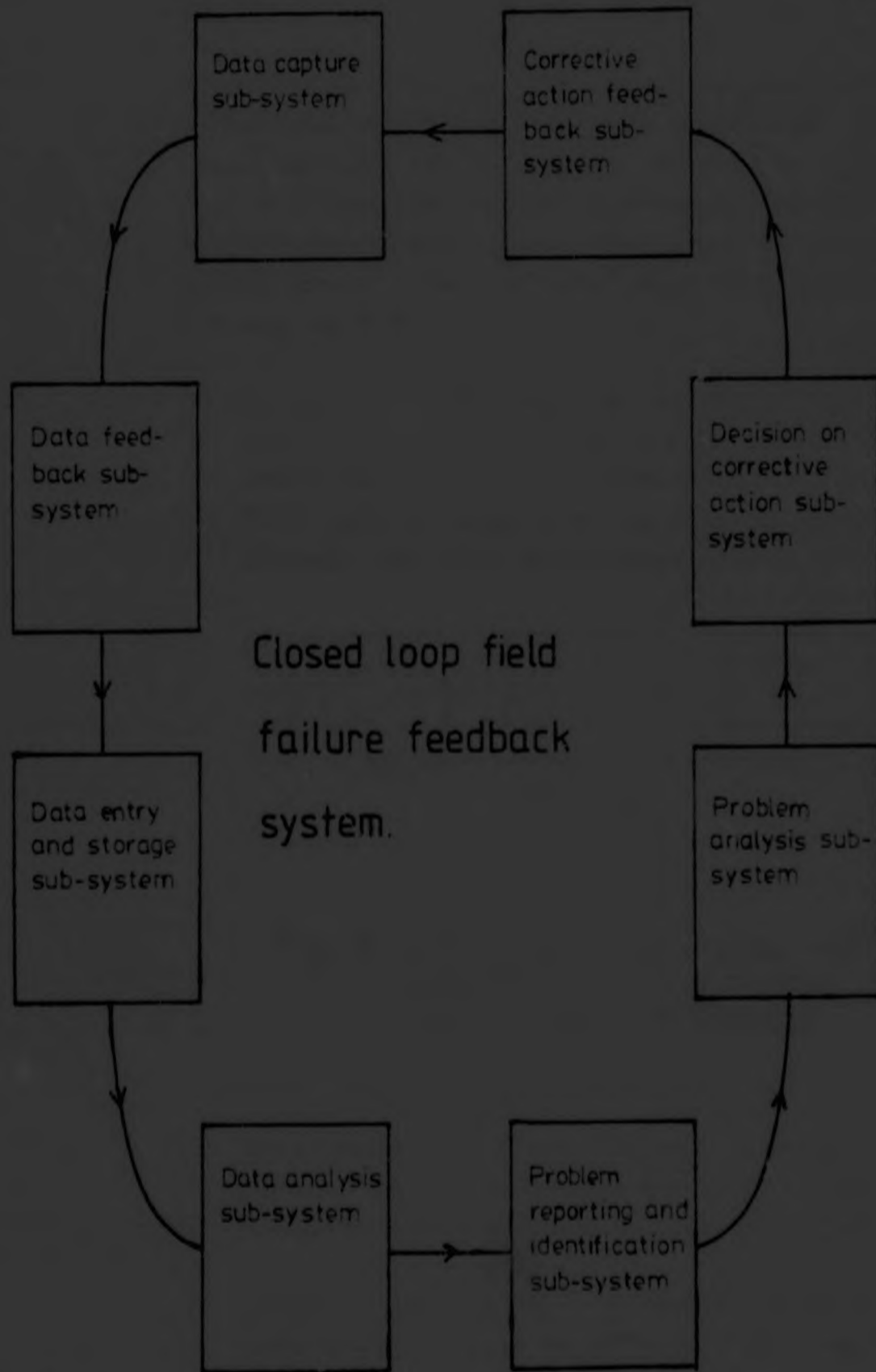


Fig. 5. Block diagram of a field failure data feedback system in broad outline

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-





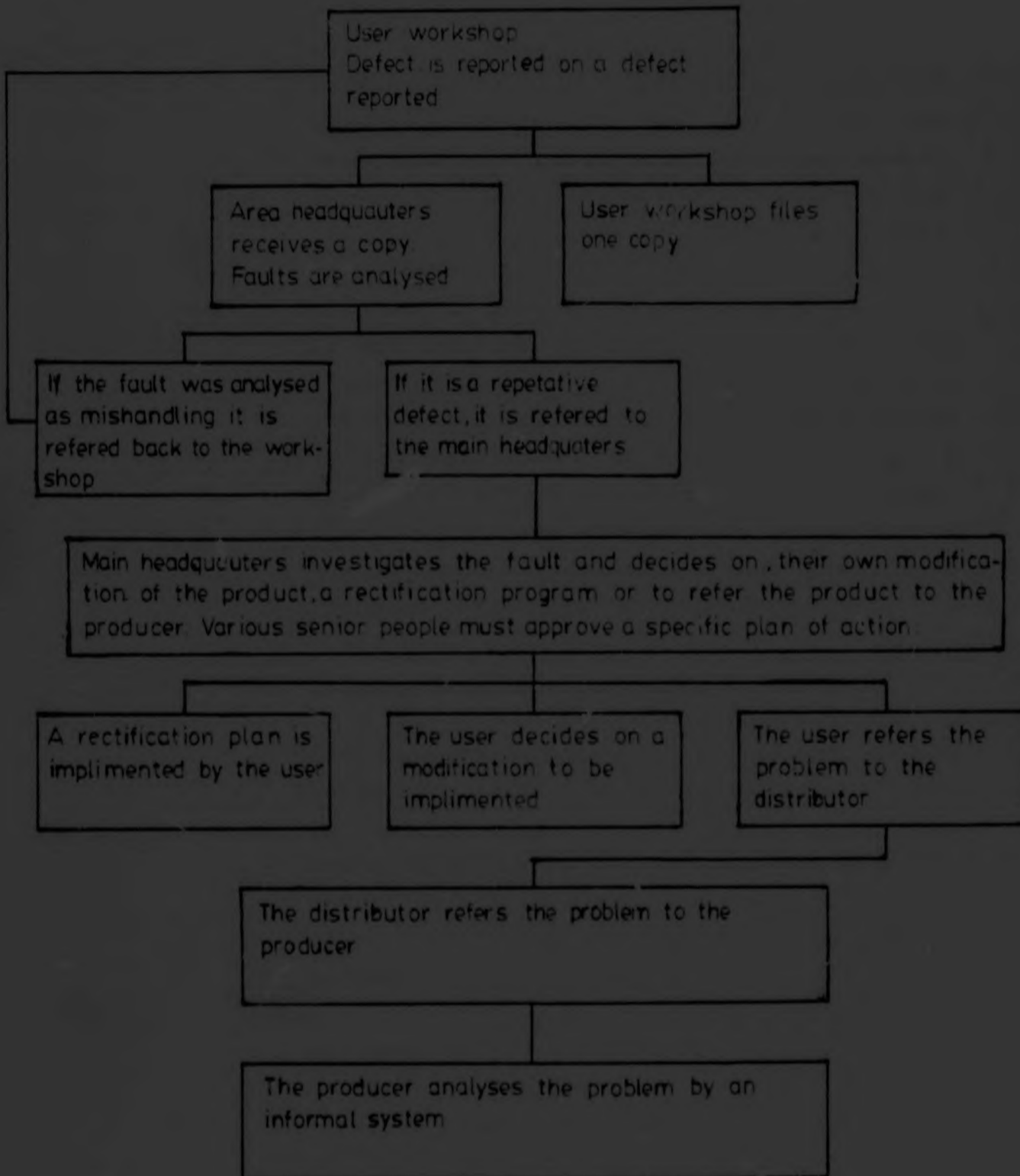


Fig. 7. BLOCK DIAGRAM OF THE EXISTING FEEDBACK SYSTEM IN THE USER ORGANISATION

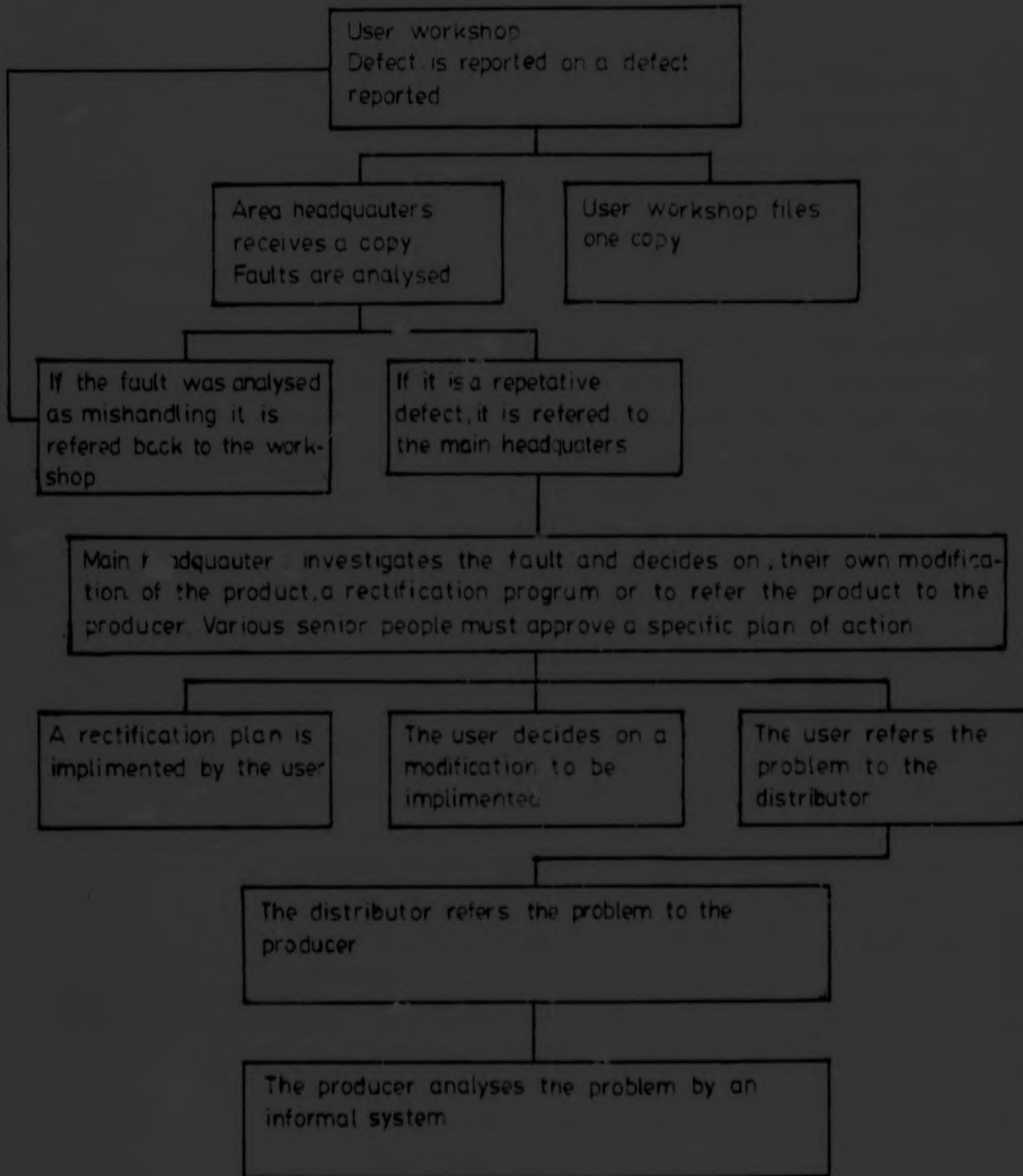


Fig. 7. BLOCK DIAGRAM OF THE EXISTING FEEDBACK SYSTEM IN THE USER ORGANISATION

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





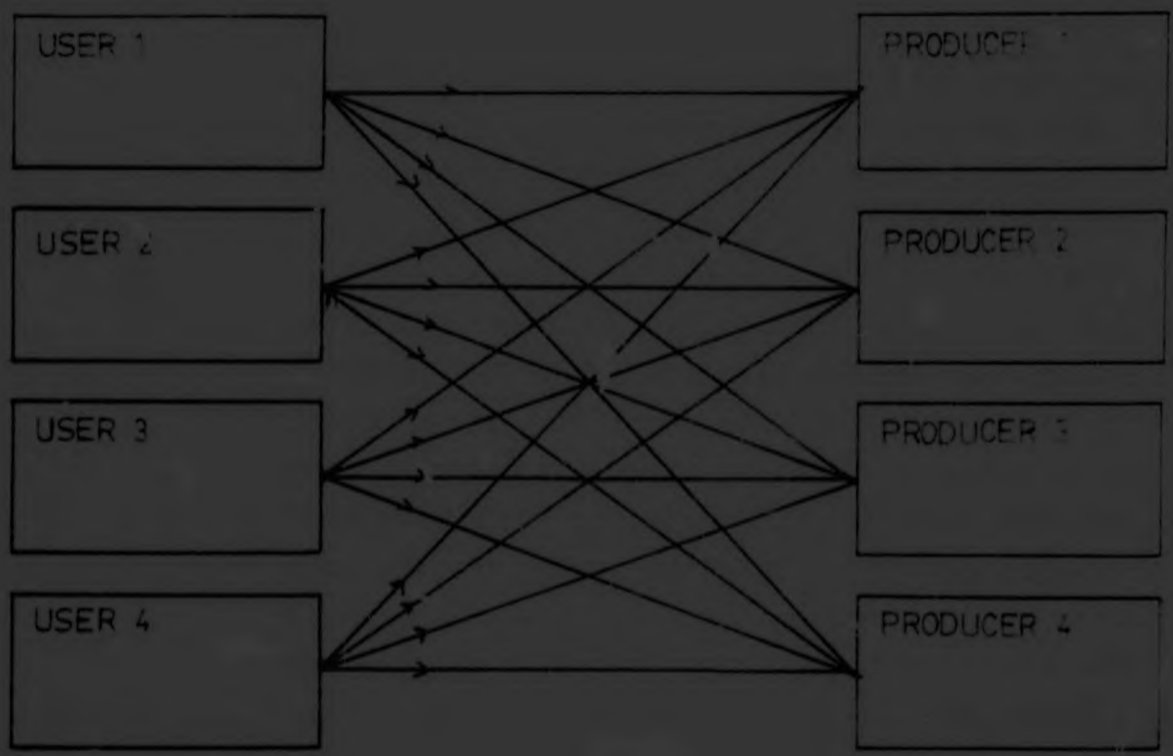


Fig. 8. BLOCK DIAGRAM OF THE COMMUNICATION CHANNELS WHEN EACH PRODUCER COLLECTS DATA FROM EACH USER

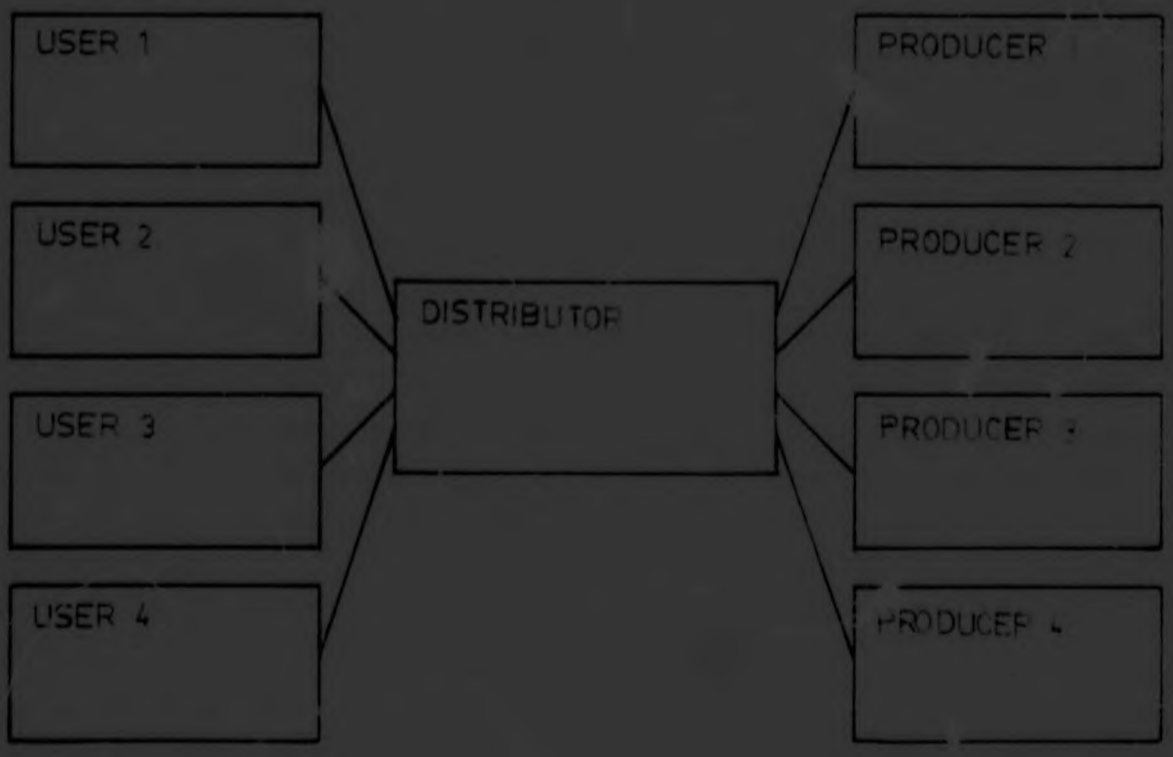


Fig. 9. BLOCK DIAGRAM OF THE COMMUNICATION CHANNELS WHEN THE DATA COLLECTION BY THE PRODUCER FROM THE USER IS CENTRALISED BY THE DISTRIBUTOR























## 6. DEVELOPMENT OF THE FINAL SOLUTION

The final solution Fig. 13 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.



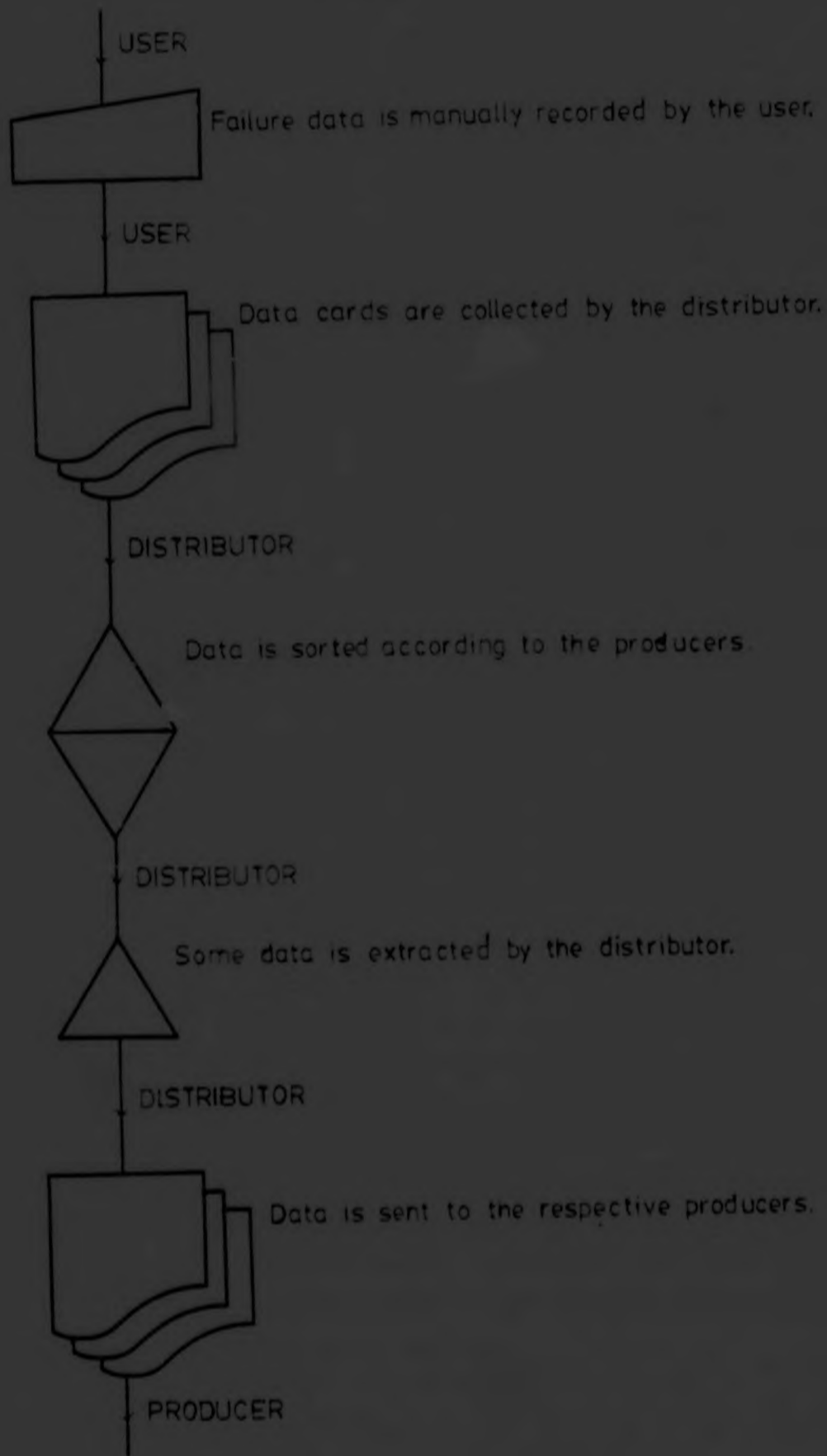


Fig. 14. FLOW DIAGRAM OF THE DATA CAPTURE SUB-SYSTEM.





CONTROL CHART OR TYPE OF REPORT	DEPARTMENTS WHO RECEIVE REPORTS					FREQUENCY
	ENGINE	PROGRAMMES	QUALITY	PROC.	MAN	
1. Control charts						
a) Control in dividuwl parts						
i Average $\bar{X}$ and range R			X			Weekly
ii Average $\bar{X}$ and standard deviation G			X			Weekly
iii Individual $\bar{X}$			X			Weekly
iv Cumulative FOLDERS			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			Weekly
5. Ranges		X	X			Weekly
6. Tabulations by defect type	X	X	X	X	X	Monthly
7. Defect matrices	X	X	X			2 Weekly
8. Failure patterns (failure ratios time; 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.

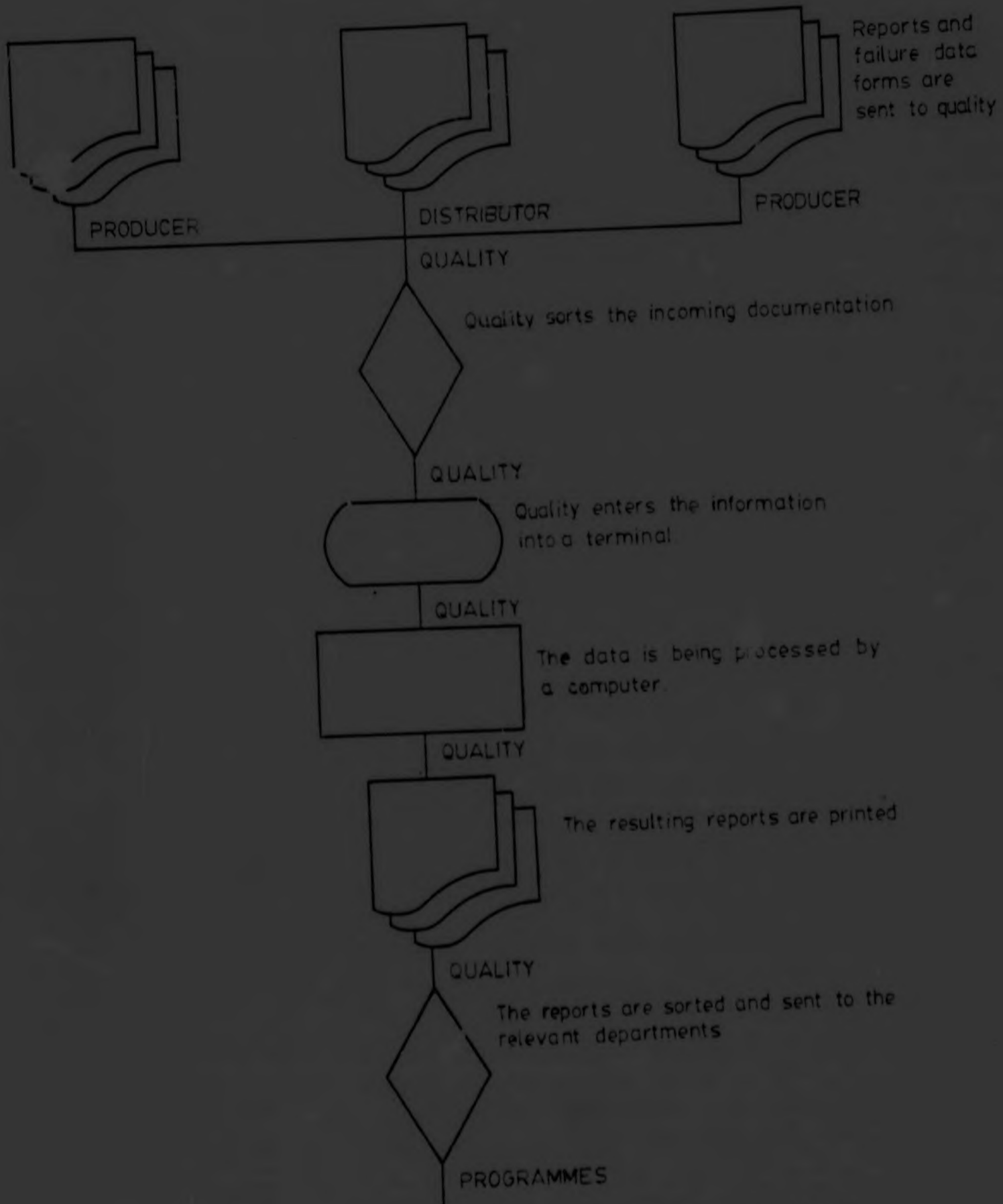


Fig. 15. FLOW DIAGRAM OF THE DATA ANALYSIS-SUB SYSTEM





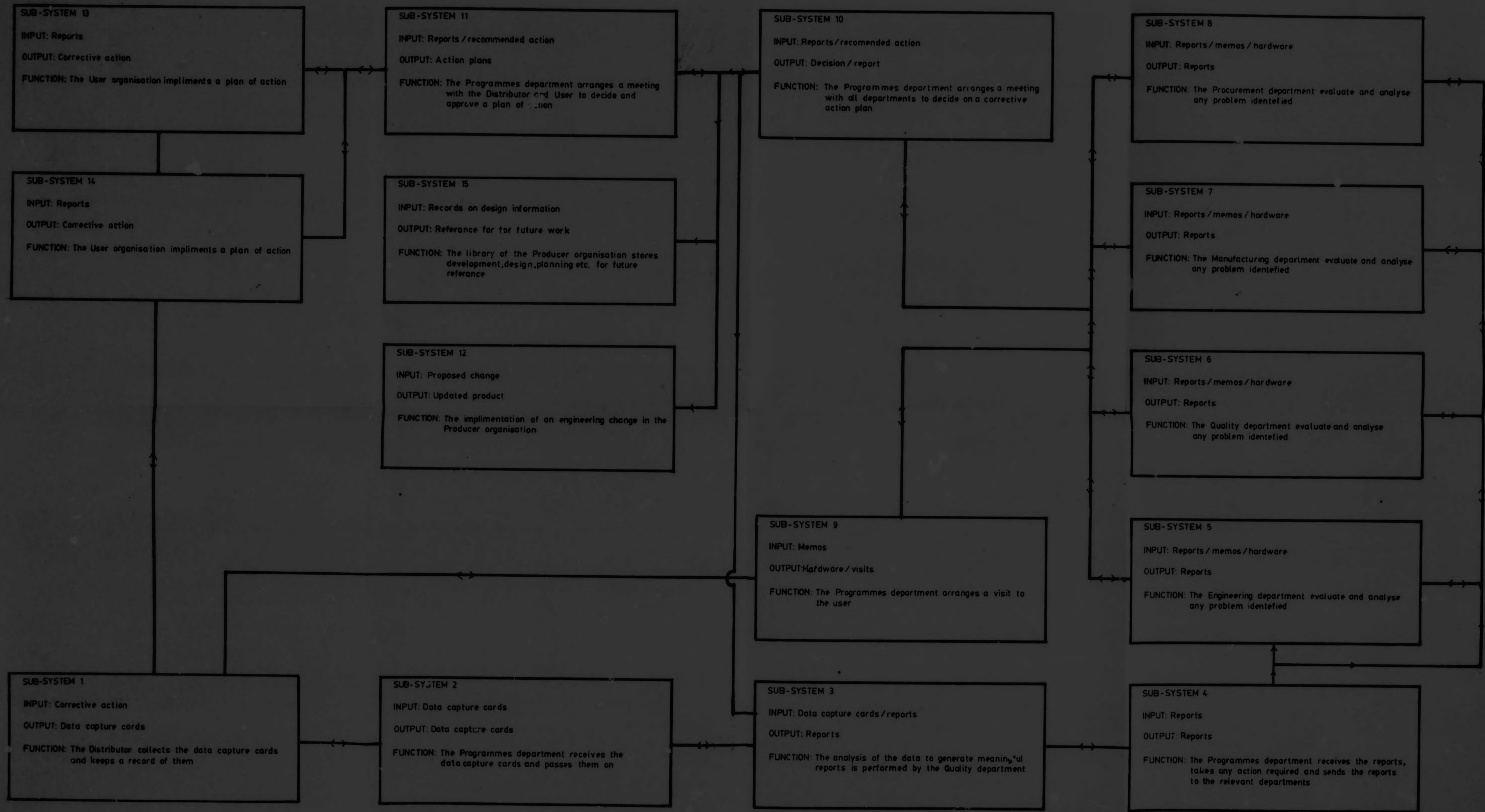
month and pass a copy of them to Quality. Quality will have to work according to their procedures.

- 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.







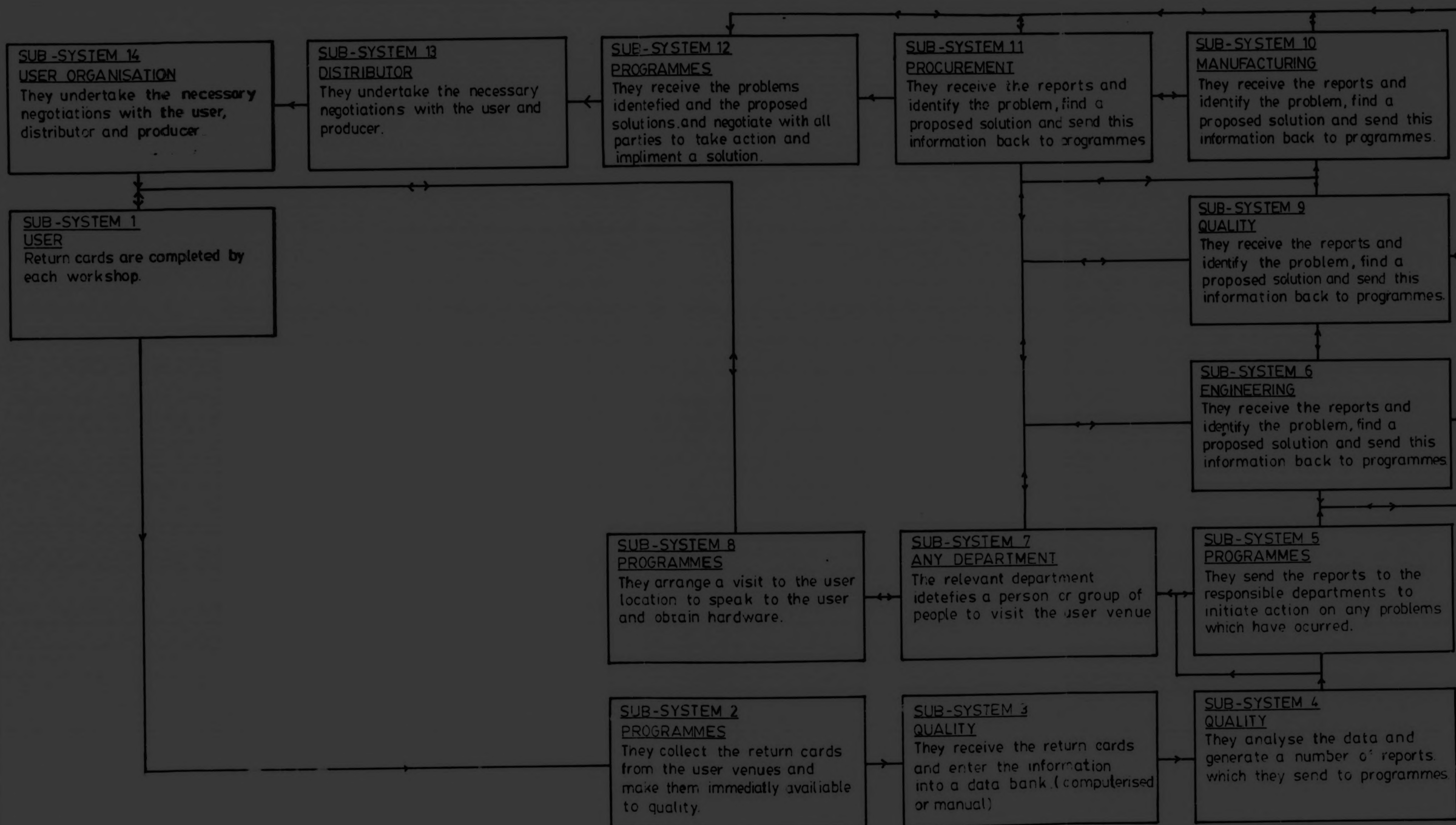


Fig. 11. BLOCK DIAGRAM OF THE PROPOSED SYSTEM 11

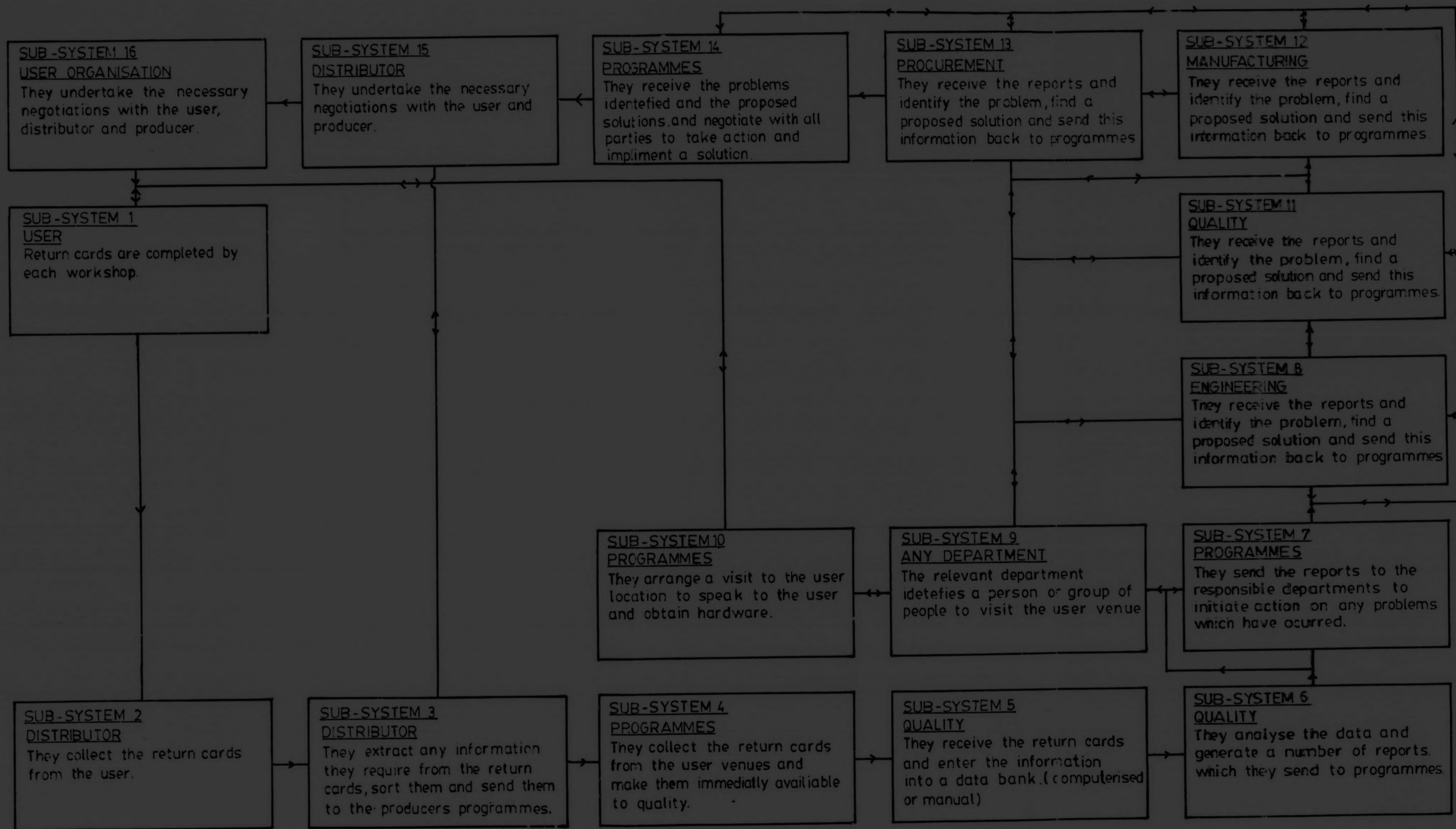


Fig. 10. BLOCK DIAGRAM OF PROPOSED SYSTEM I

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 system
3.	Producer I Procurement Department	Yes	To trace material faults for their origin and to trace faulty externally procured parts. 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







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 outputs 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.



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.





- 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 physiological, security, social, ego and self actualisation in descending 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 identified as: To obtain accurate and reliable











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 computers. To select the media to be used the media characteristics of these four were compared in Table 4.

<u>Characteristic</u>	<u>Telex</u>	<u>Telephone</u>
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

<u>Characertistic</u>	<u>Computer</u>	<u>Card</u>
Hardware cost	Very high	Low
Storage required	High	Low
Reliability	Less 100 %	Less 100 %
Transprtability	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





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)

















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



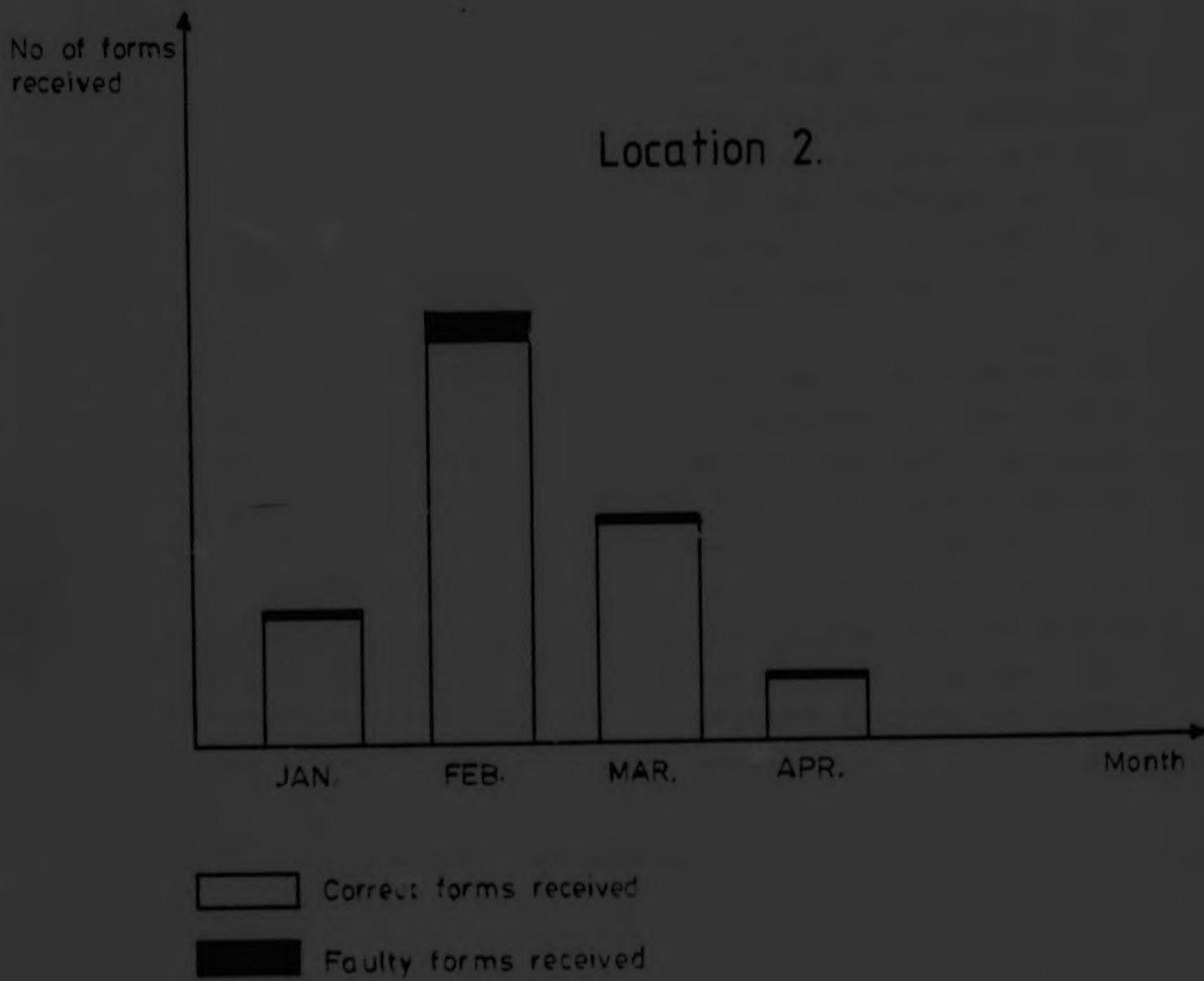


Fig. 17. Bar chart to identify the correct and faulty data return cards received per month per location



6.3.4.1 A control chart of number of defectives

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

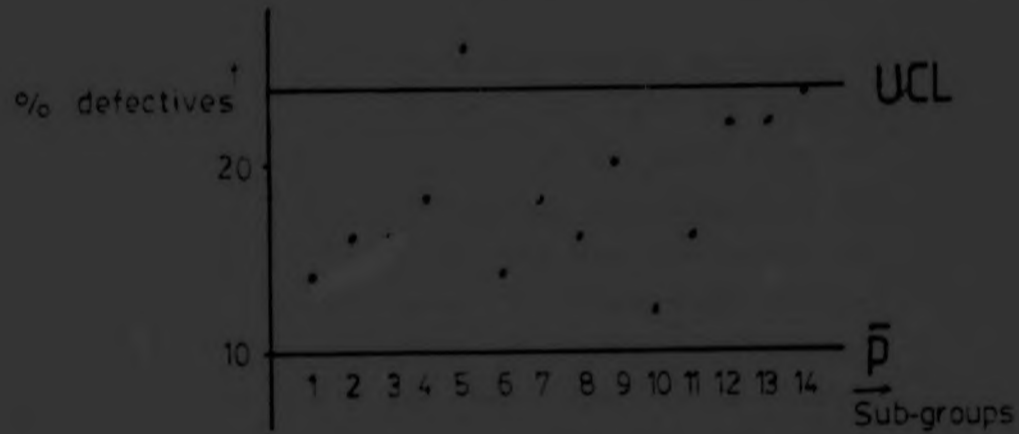


Fig. 18. A CONTROL CHART FOR THE % DEFECTIVES

$n$  - number of products at the "User" venue  
 $p$  - percentage of failures of the product per week

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

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

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

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

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.

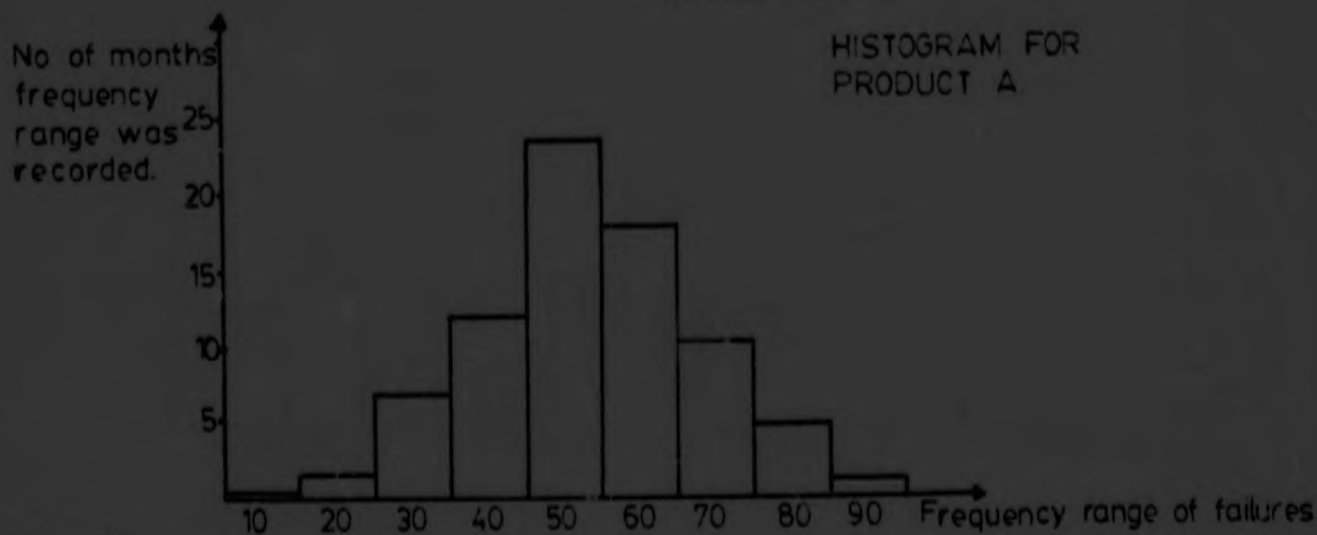


Fig. 19. BAR GRAPH OF NO OF MONTHS FREQUENCY RANGE WAS RECORDED VS. FREQUENCY RANGE OF FAILURES PER PRODUCT

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.

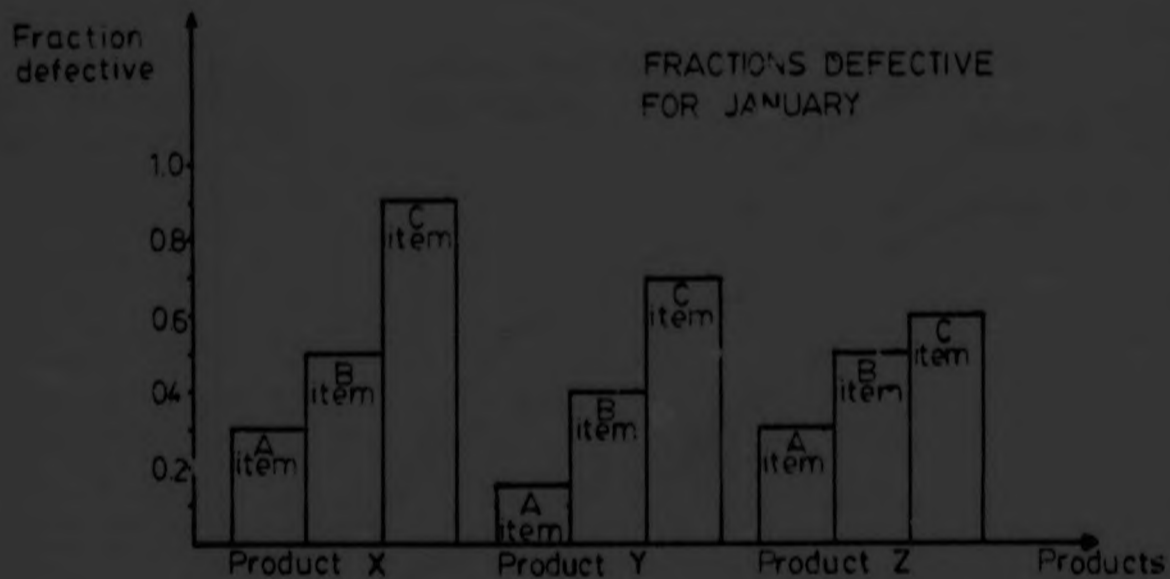


Fig. 20. A BAR GRAPH OF THE FRACTION OF PARTS DEFECTIVE PER PRODUCT PER MONTH.

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).

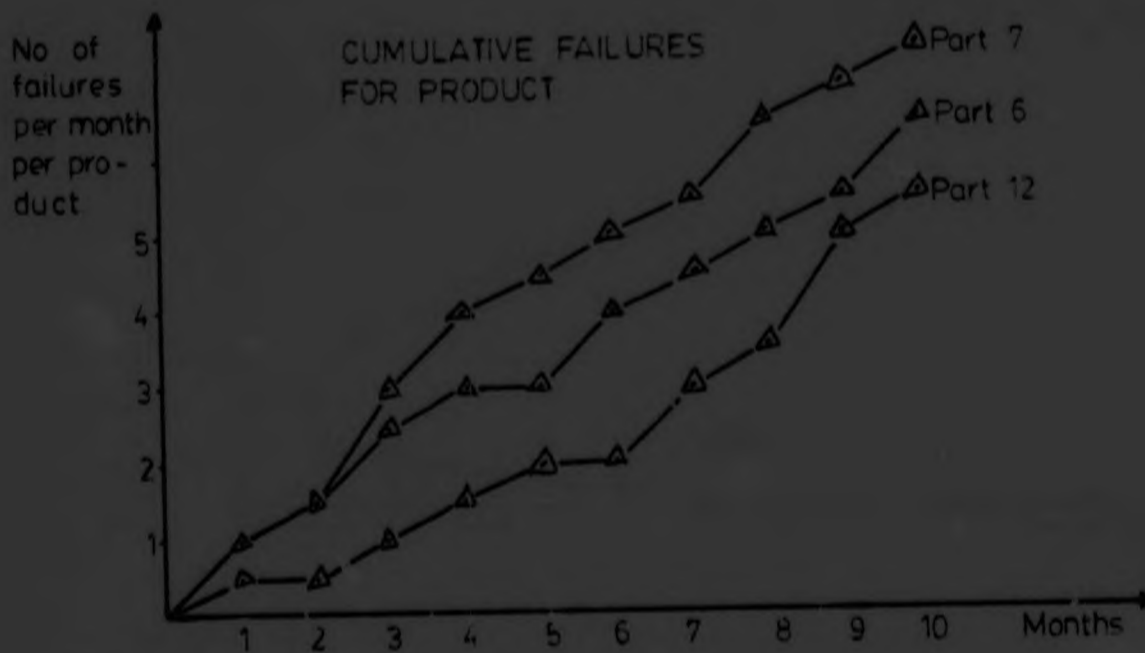


Fig. 21. A GRAPH OF CUMULATIVE FAILURES PER PART PER PRODUCT PLOTTED AGAINST TIME.

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).

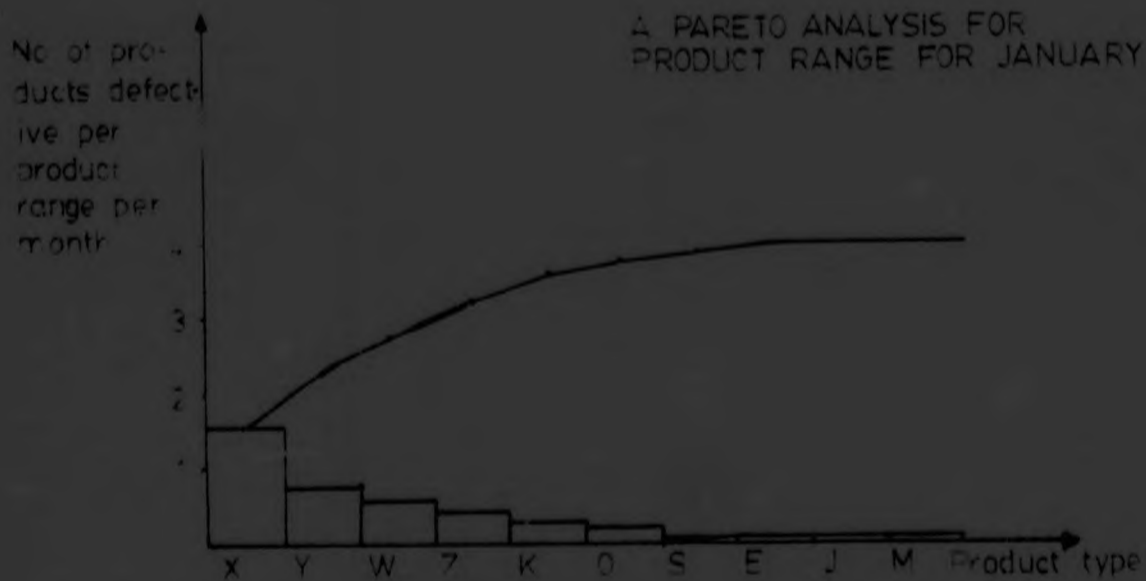
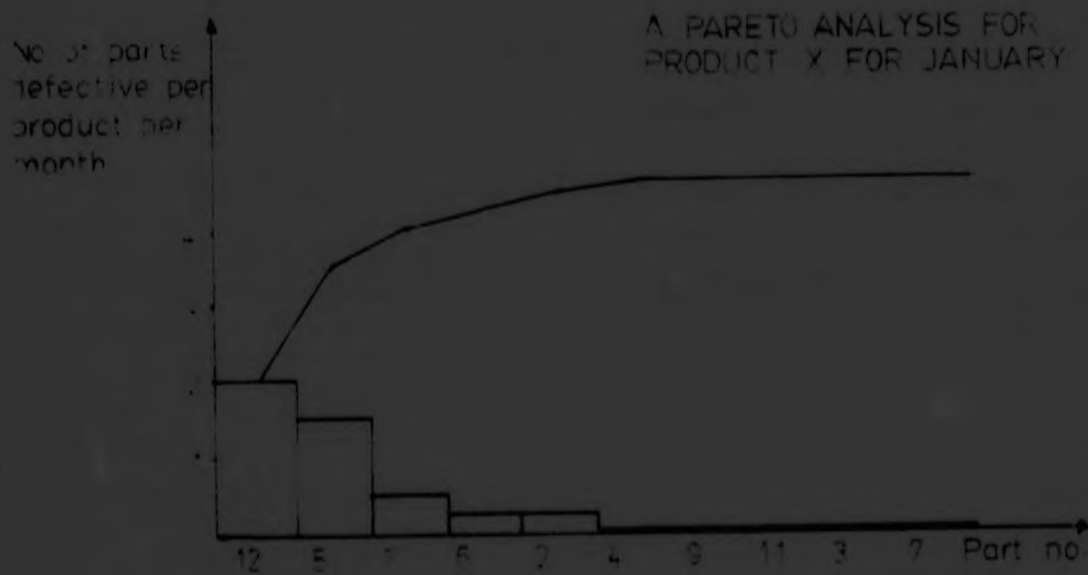


Fig. 22. A PARETO ANALYSIS OF PARTS PER PRODUCT AND THE COMPLETE PRODUCT RANGE.

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).

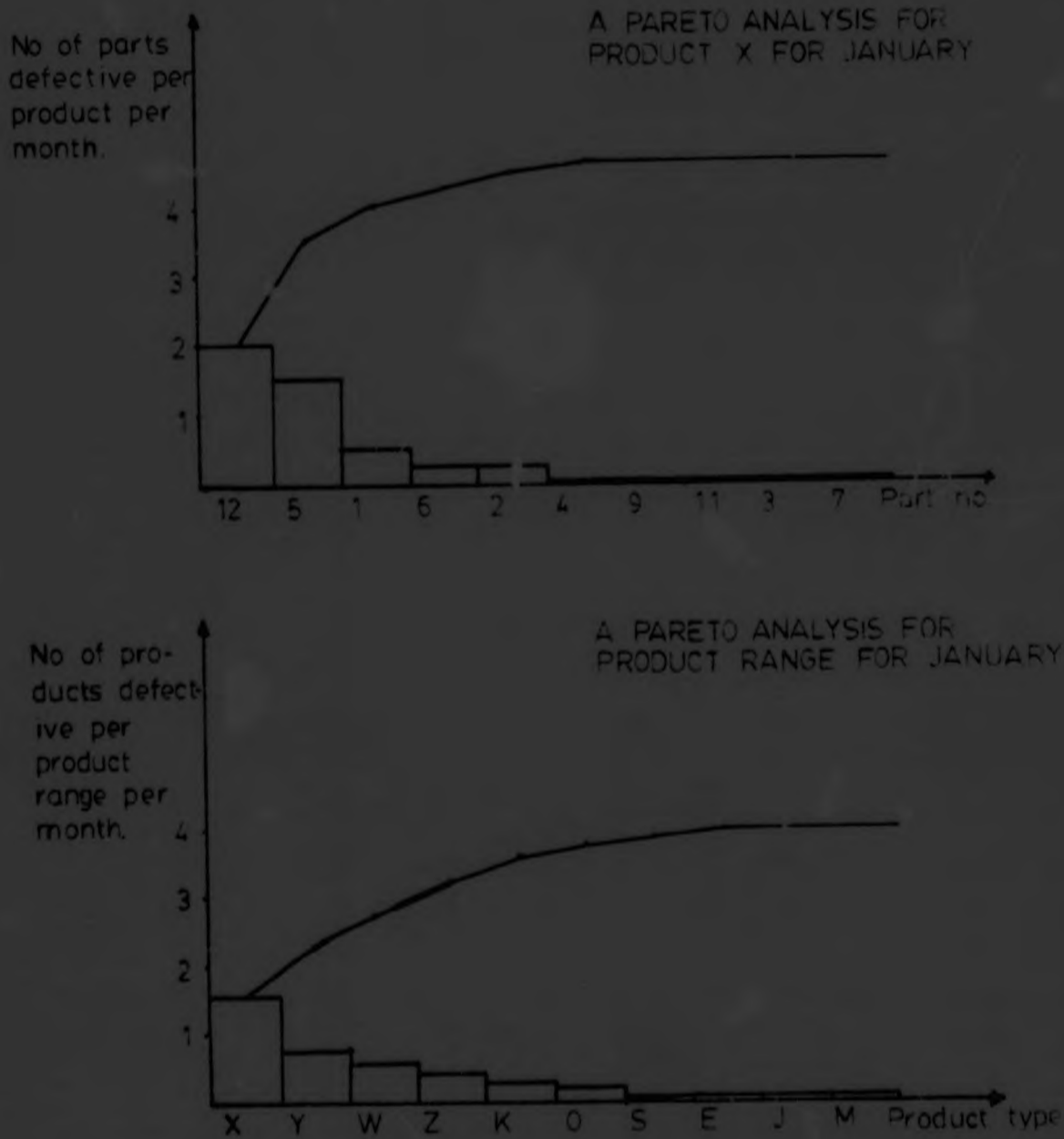


Fig. 22. A PARETO ANALYSIS OF PARTS PER PRODUCT AND THE COMPLETE PRODUCT RANGE.

6.3.4.7 Field Failure versus factory reject

This report 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.

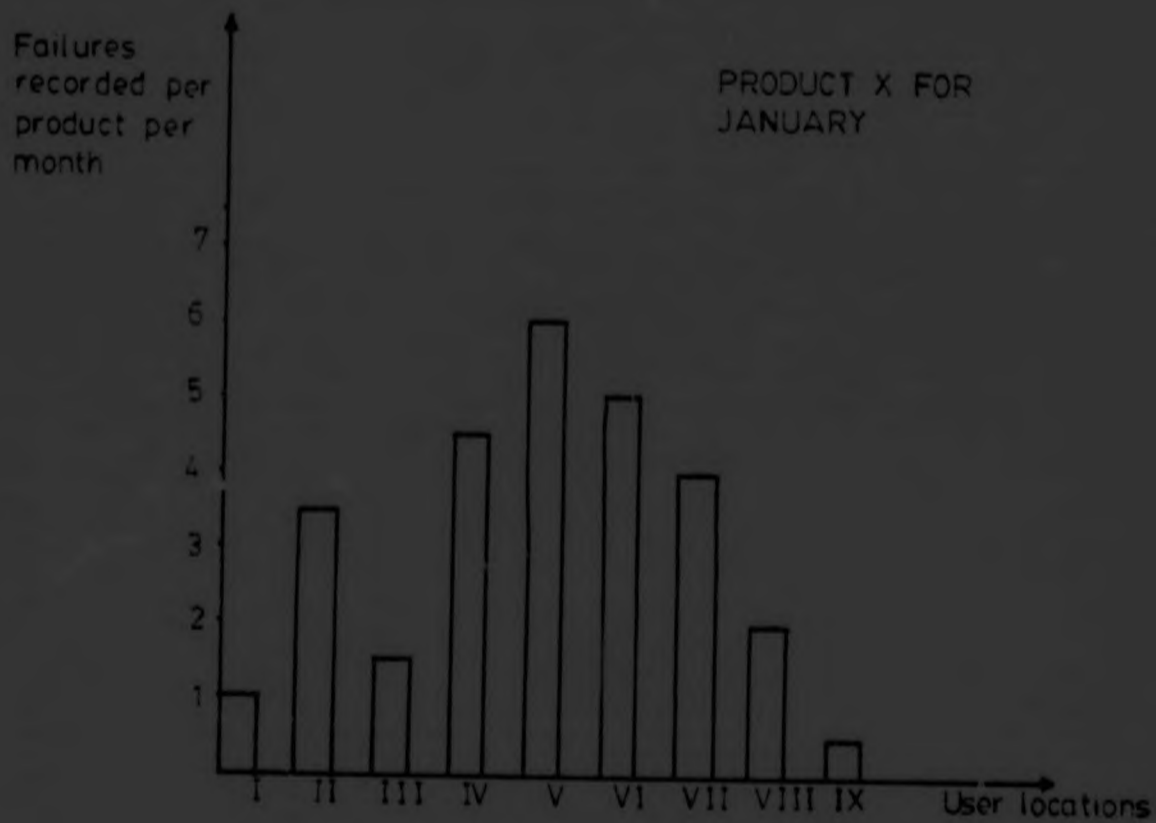


Fig. 23. A BAR GRAPH OF FAILURES PER PRODUCT VS. USER VENUE.



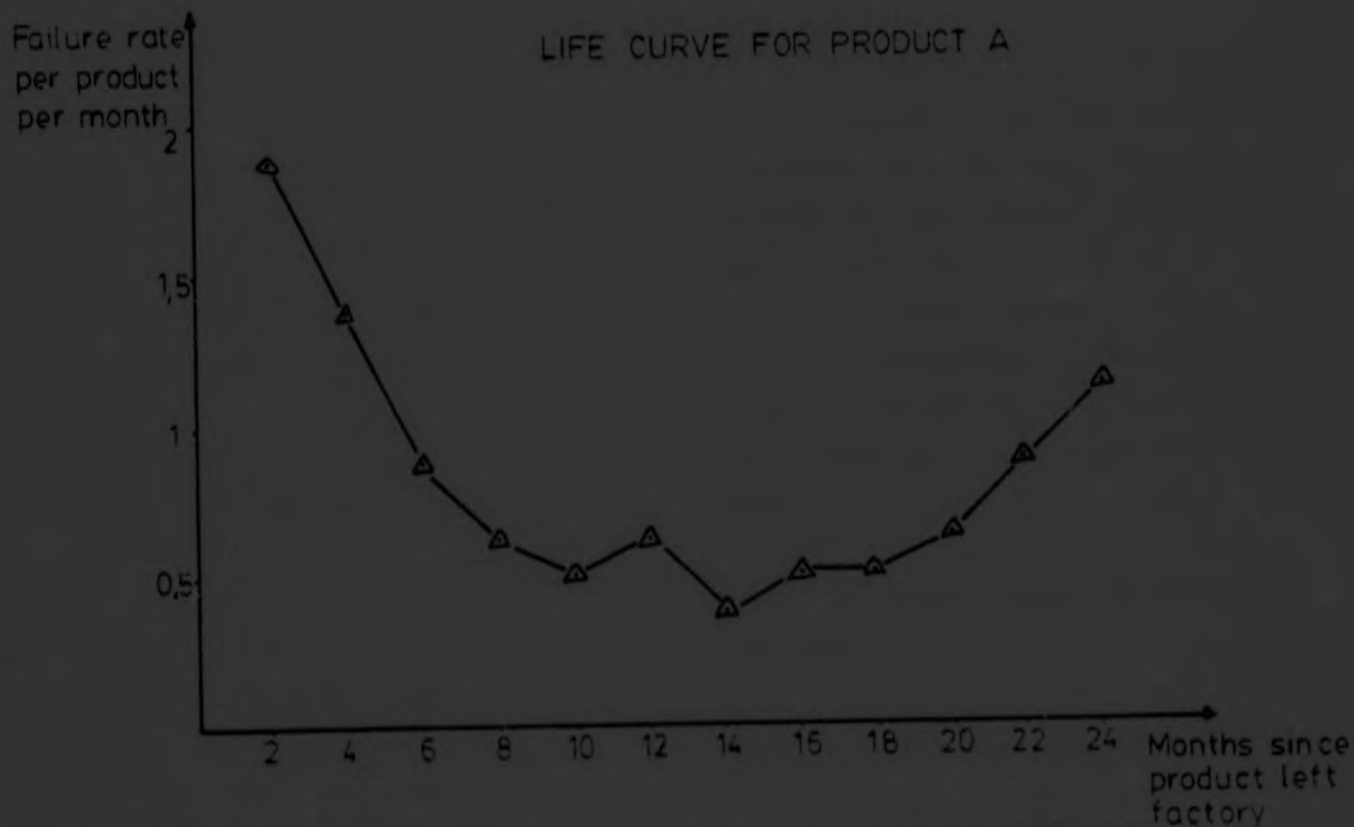


Fig. 24. A LIFE CURVE OF PRODUCT FAILURE RATE VS TIME FOR EACH PRODUCT

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	2	8
		4	10
		5	12
			6
		13	
		15	
Y	6	7	9
	.	:	:

Table 5. TABLE OF PARTS IN EACH PRODUCT

6.3.4.12 Reliability

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

MTBF = Mean time before failure

MTTR = Mean time to repair

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

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

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

t = Time

$\lambda$  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 repetitive failures occur.

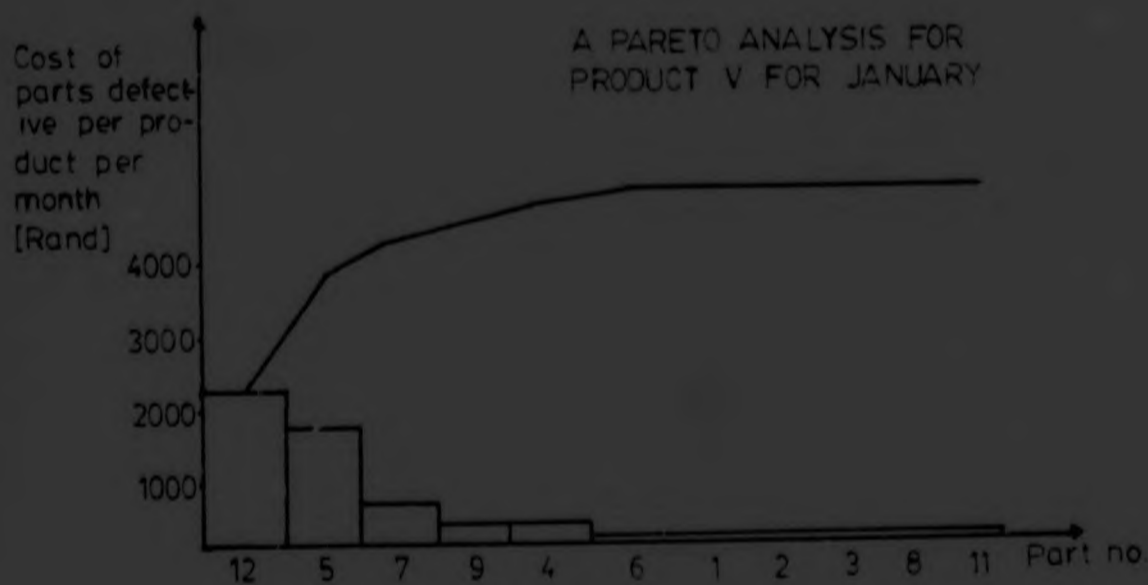
6.3.4.13 Cost analysis

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.



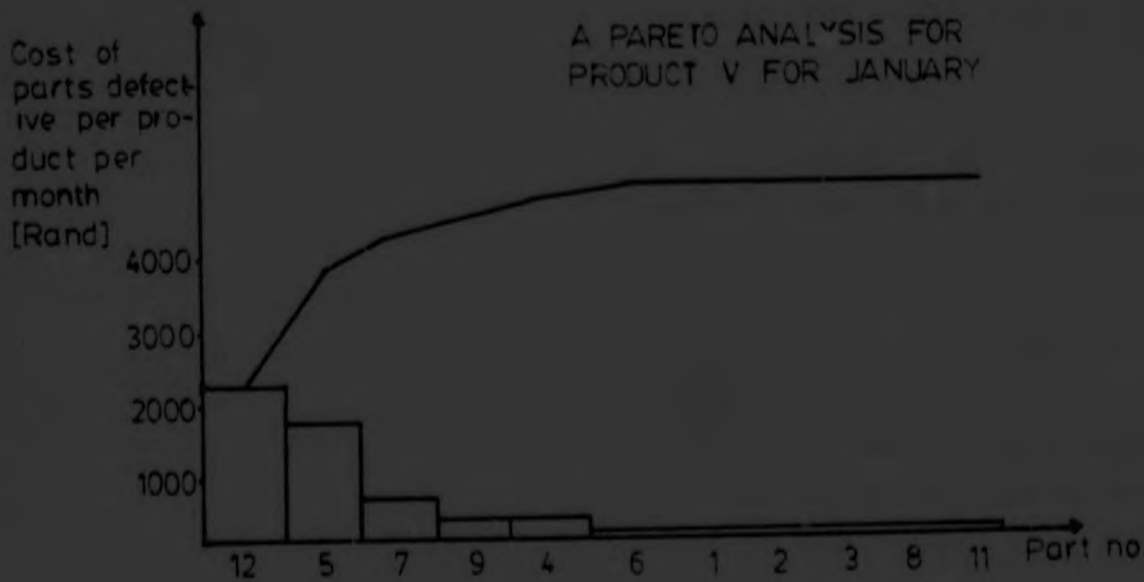
6.3.4.13 Cost analysis

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.



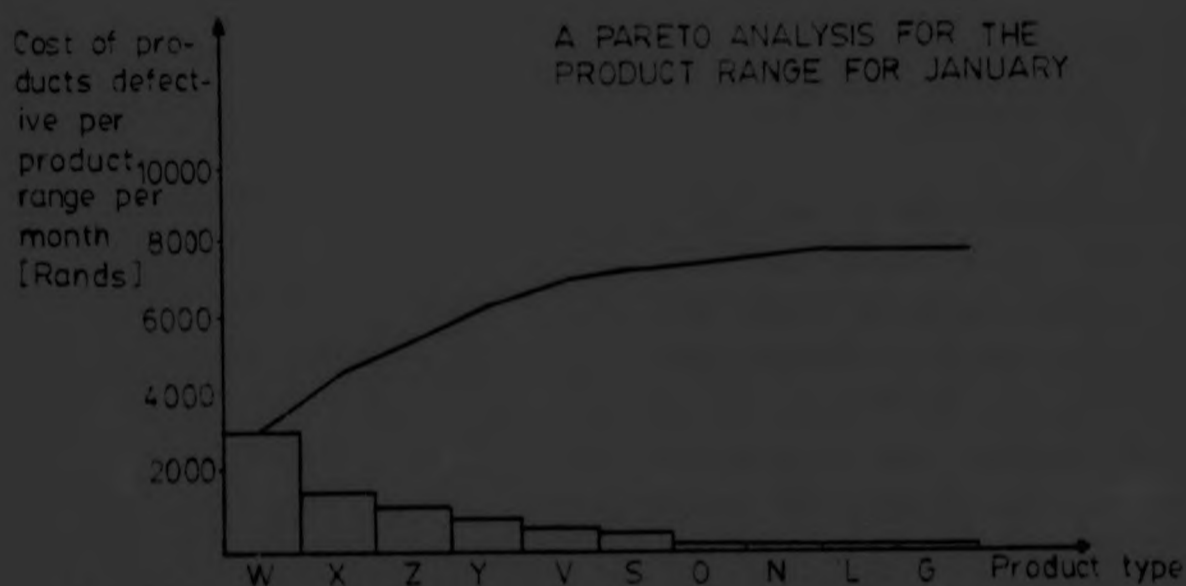


Fig. 25. A PARETO ANALYSIS OF THE COST OF PARTS PER PRODUCT AND THE COST OF PRODUCTS PER PRODUCT RANGE

#### 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:

$N_i$  = 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

$$N = \frac{N_{ij}}{j \times 1000}$$

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.

<u>PRODUCT</u>	<u>PART NO.</u>	<u>USAGE</u> (per month per product-N)	
A	16	27	
	27	10	
	3	5	
	1	3	
	6	2	
	7	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



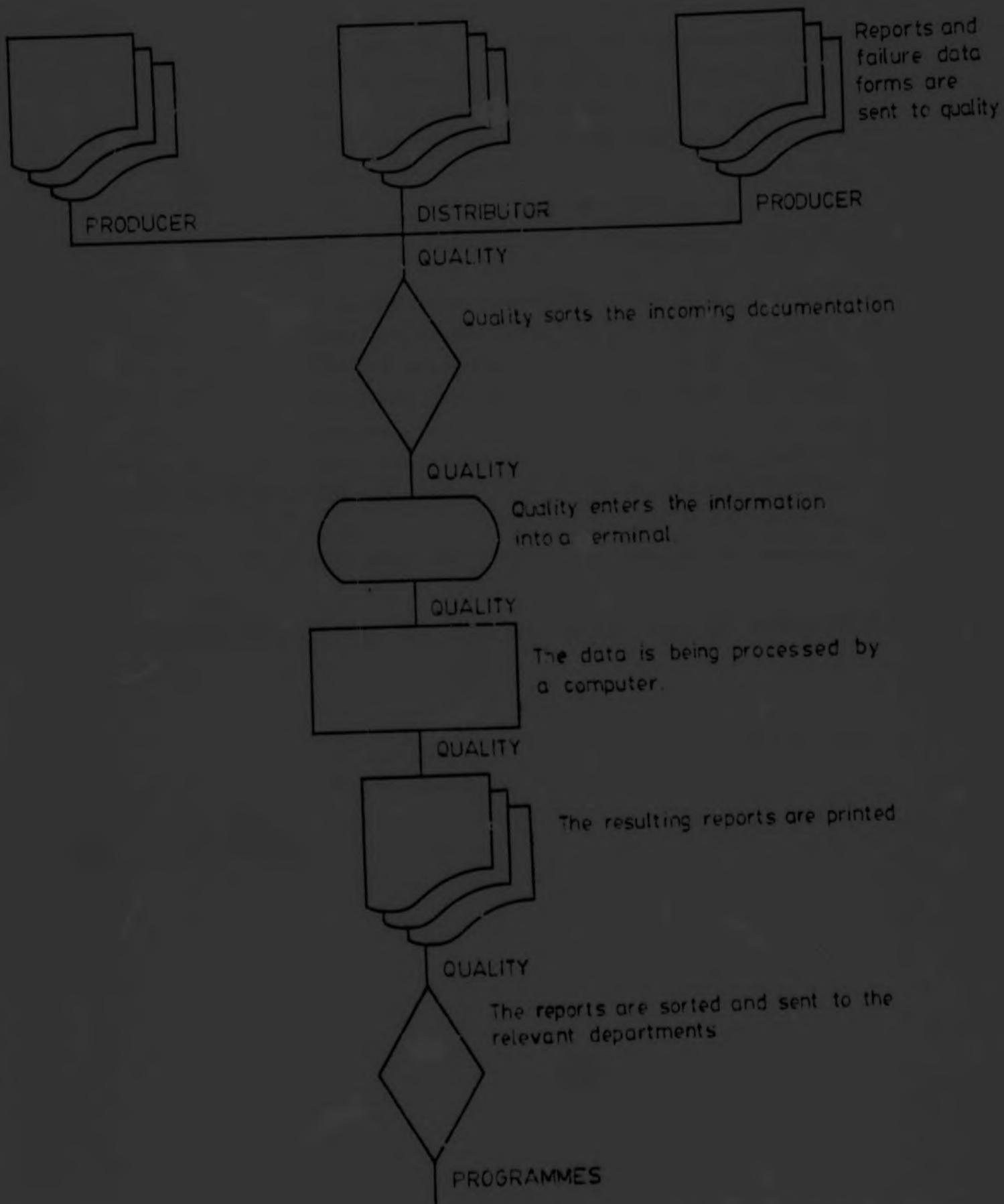


Fig. 15. FLOW DIAGRAM OF THE DATA ANALYSIS-SUB SYSTEM





```
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,PRCDNC,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,PRCDNC:
19 S1,DATE:
20 T3,PAR,80,SPACE A1,CCUNT:
21 T2,PRCDNC,90,CCUNT:
22 END:
EC=
```

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	MONTH	PART NO	NO OF FAILURES	TOTAL
April	1	2	<u>19</u>	June	1	1	<u>36</u>
	2	5			3	9	
	3	2			7	3	
	4	2			9	2	
	5	1			10	2	
	7	2			11	5	
	11	1			13	1	
	10	2			15	1	
	21	2			16	1	
May	1	2	<u>21</u>	July	1	8	<u>49</u>
	2	3			2	1	
	3	4			3	18	
	6	3			7	4	
	7	1			10	3	
	8	1			11	2	
	11	2			12	4	
	12	1			13	2	
	16	1			16	2	
	17	1			18	2	
	22	1			19	2	
26	1	25	1				

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 =  $2/4 = 0.50$

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

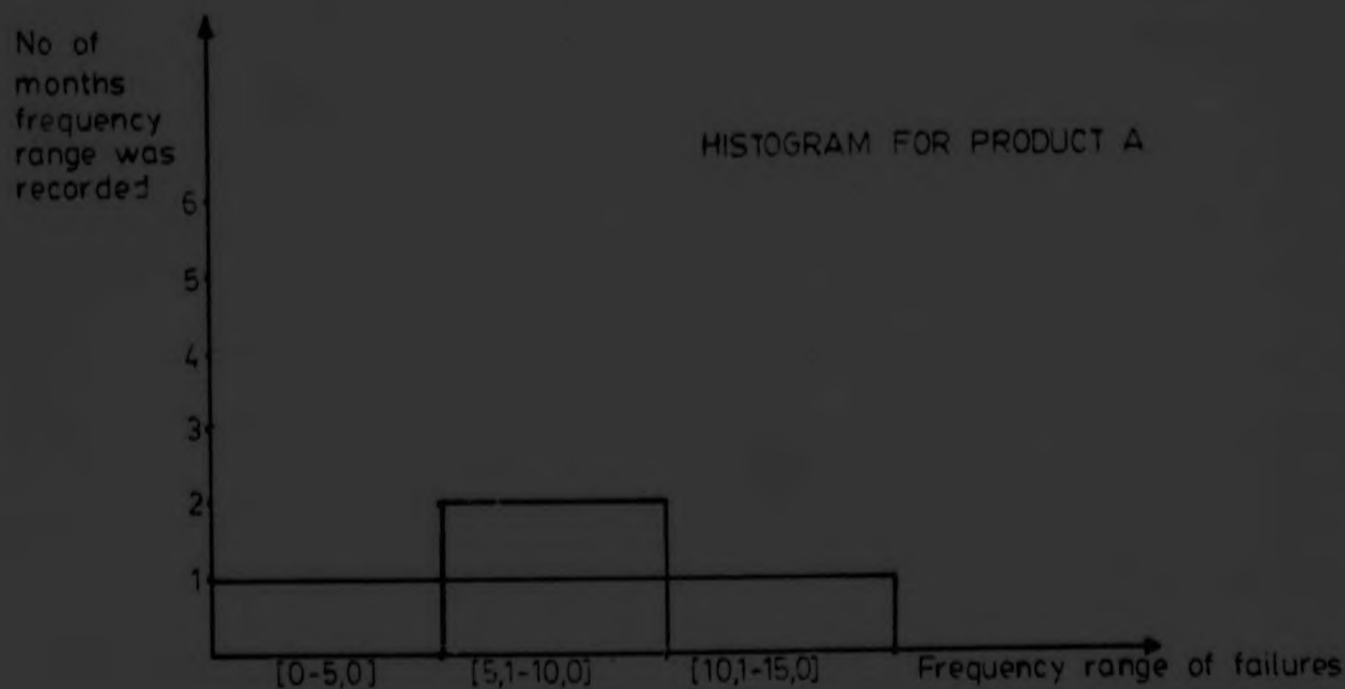
Similarly for part 3 of product A:

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 available (i.e. only 4 months from which no real distribution can be identified) but they were plotted as shown in Fig. 26.



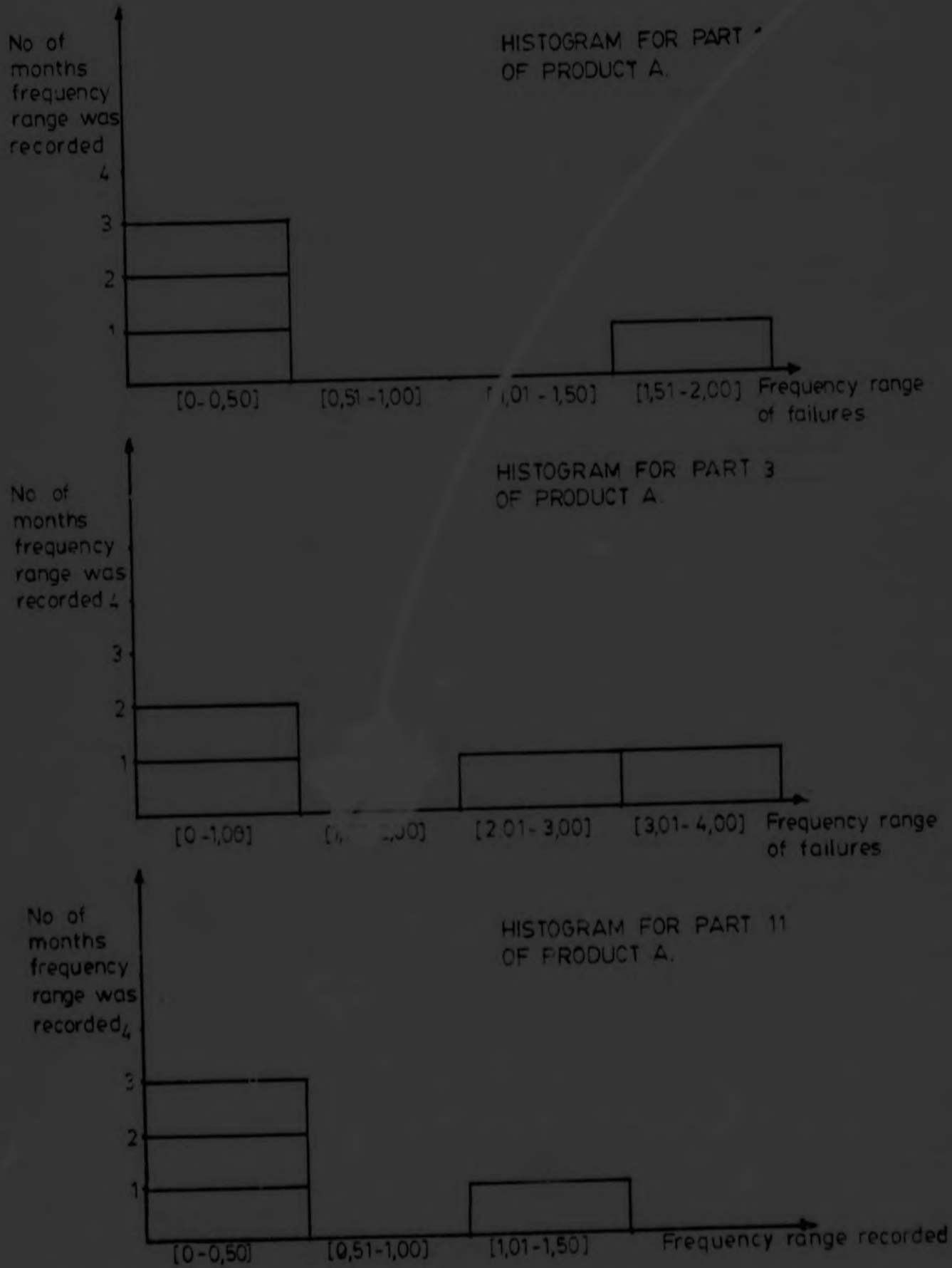


FIG. 26. BAR GRAPHS OF NUMBER OF MONTHS FREQUENCY RANGE WAS RECORDED VERSUS FREQUENCY RANGE OF FAILURES PER PART AND PRODUCT.

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 summarised 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 divided 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.

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 summarised 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.	1	2	7	11	16
MONTH	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 divided 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.

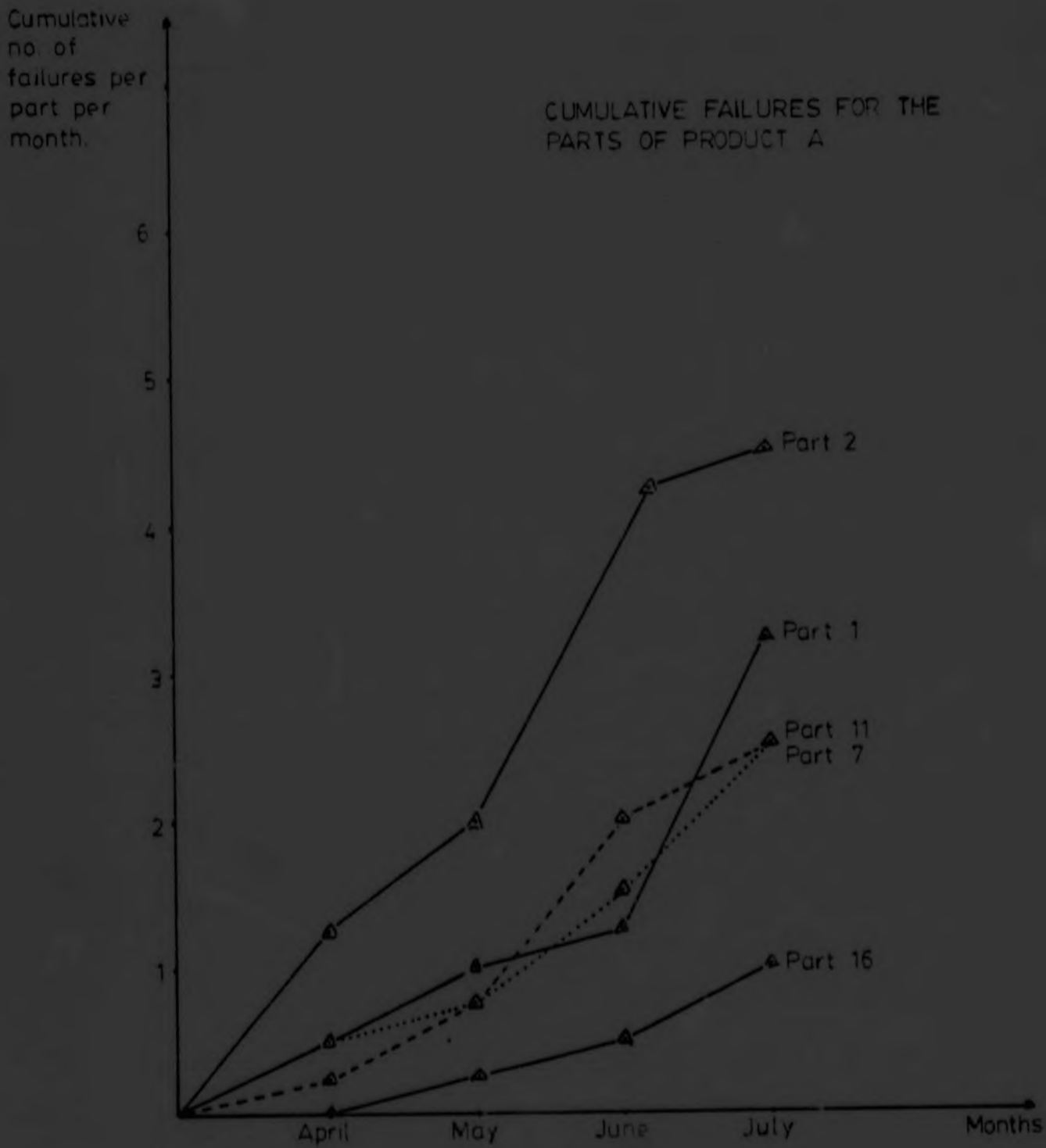


Fig. 27. A GRAPH OF CUMULATIVE NO. OF FAILURES PER PART PER MONTH VS. TIME.



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	$\frac{1}{4 \times 4} = 0.06$

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.

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

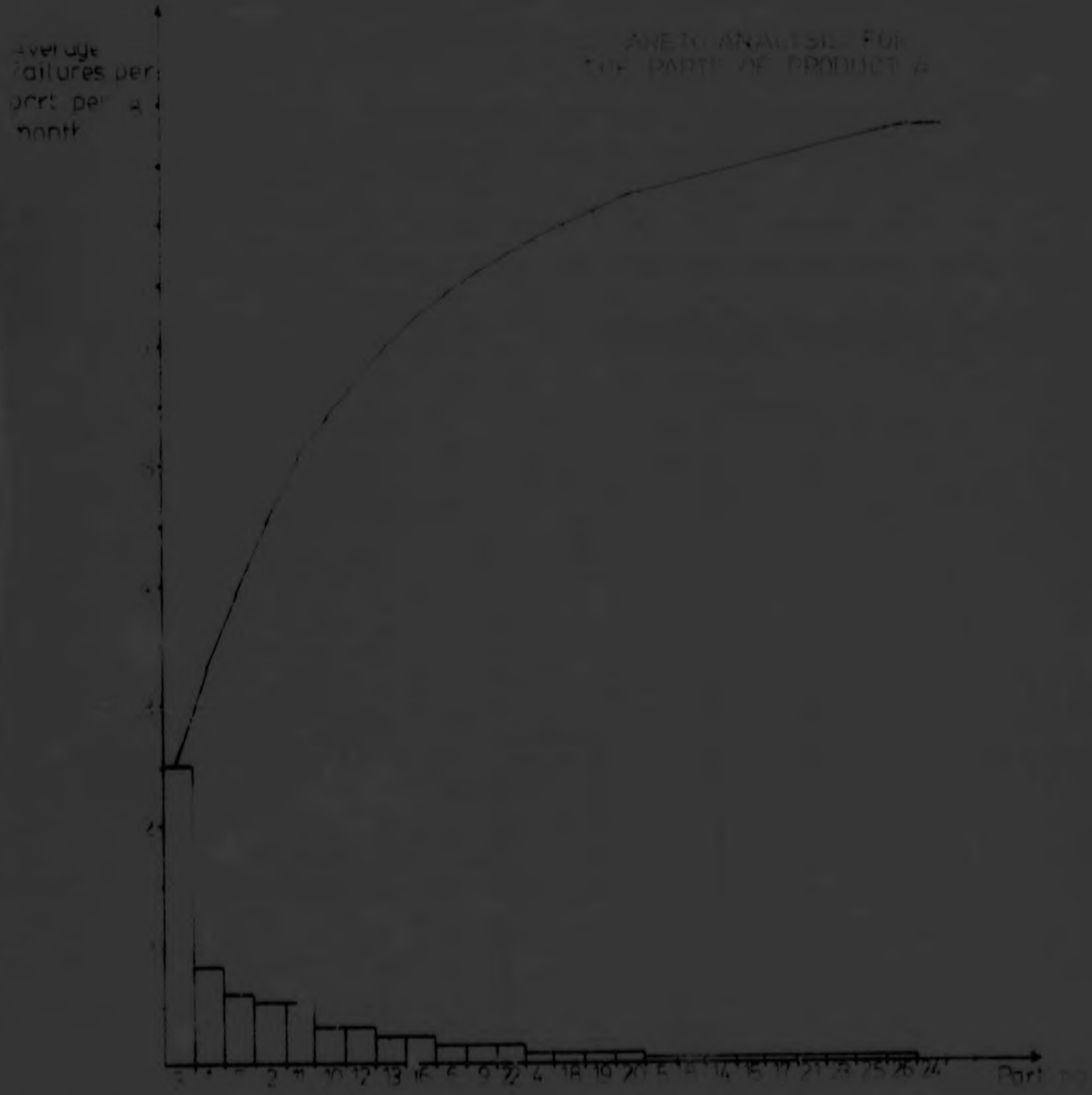


Fig. 28. PARETO ANALYSIS OF THE PARTS PER PRODUCT

#### 7.4 FAILURES PER USER VENUE

From APPENDIX X the PART TOTAL of failures (TR) was added and the operational failures 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.

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

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

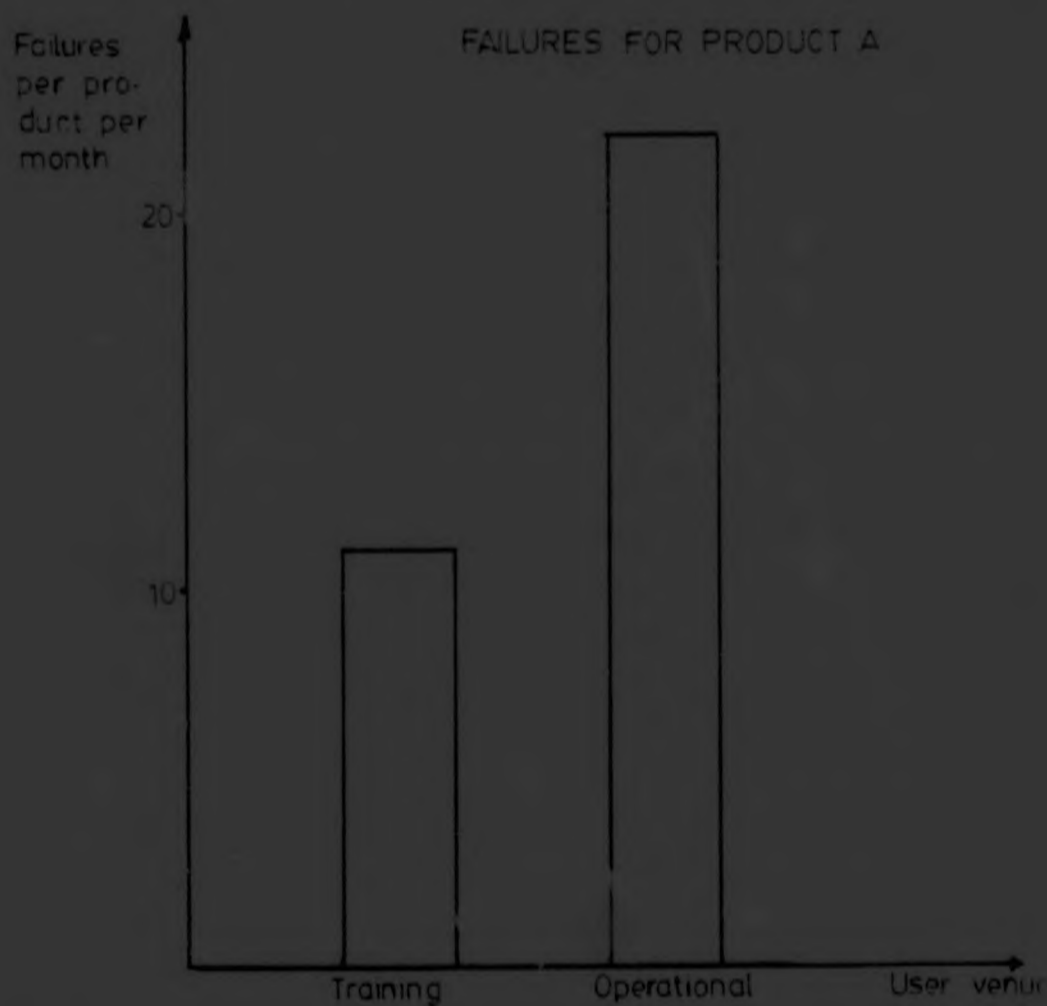


Fig. 29. A BAR GRAPH OF FAILURES PER PRODUCT PER MONTH VS. USER VENUE.

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	TOTAL 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

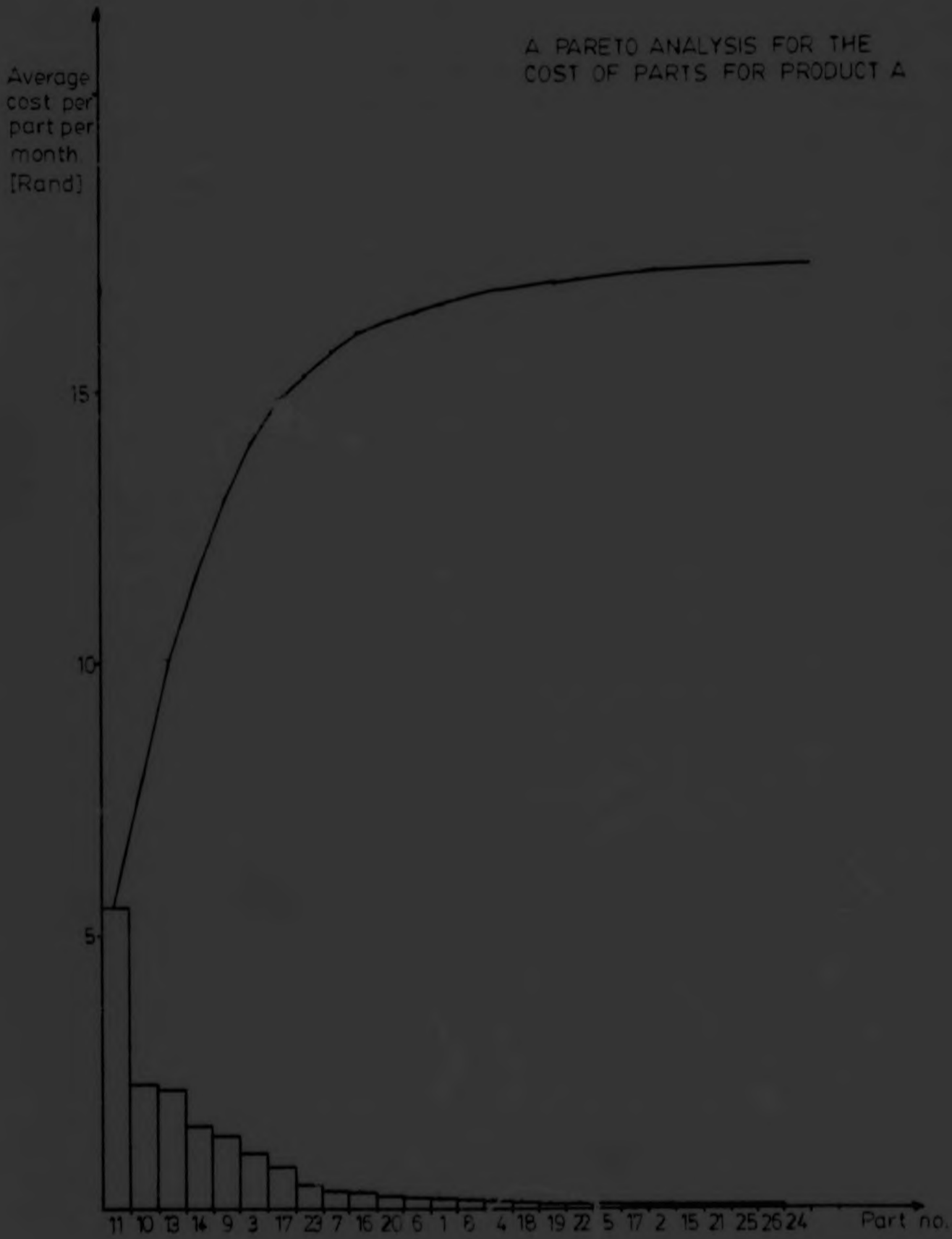


Fig. 30. A PARETO ANALYSIS OF COST OF PARTS PER PRODUCT.







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.

Questionnaire

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 available 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.

Questionnaire

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 im-  
portant?  
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

Questionnaire

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 available 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.

Questionnaire

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 available which can be used by such a system?  
None of this kind
8. Comments:  
None

Questionnaire

1. Name:

2. Organisation:

Producer 1 (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 available 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.

Questionnaire

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 improve it.
5. What reports and information would be required by you?  
A report of Mean Time Between Failures, would be the most important, but it is not believed that this can be achieved. Defect/Environment 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 this 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.

Questionnaire

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 attempts 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 available 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.

Questionnaire

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 available 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.

Questionnaire

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, replacements 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 available 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.

Questionnaire

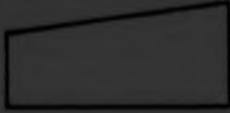
1. Name:  
IC
2. Organisation:  
Producer 1 (Programs)
3. Is there a need for a data feedback system?  
Yes
4. What is the reason for the decision made in 3?  
If there are more systems it will be easier to identify existing problems
5. What reports and information would be required by you?  
What deficiencies exist, where requirements are exceeded and technical data.
6. Is the time that information is received important?  
As soon as possible
7. What data/information is available which can be used by such a system?  
A system of defect reporting
8. Comments:  
All systems should work via "Programs" department.

APPENDIX II

Symbols used in the flow charts.



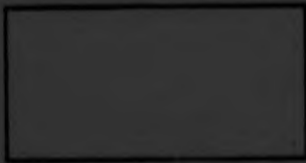
DOCUMENTATION



MANUAL INPUT



SORTING



PROCESS



EXTRACT INFORMATION



ENTER INFORMATION INTO TERMINAL





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 meant 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<sup>9</sup>: 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 their 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.







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 addressed 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 12: 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 23: 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



"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

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

Link 78: 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 85: These are the findings of "After Sales Service" which are sent to Quality.

Link 81: 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 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 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.

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.

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 labeled 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.

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 1)

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

Link 4,5: This is on. / a dummy link.

Sub-system 5

(same as sub-system 3 in system 1)

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

Link 7,8: This is only 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 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 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 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.

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  $\bar{R}$

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 Need not be known	Each item measured. Inspection more sophisticated. Higher inspection and clerical cost Must be known (normal usually assumed)
Distribution of individual measurements		
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\*

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

Plan	Sample size
Single-sampling attributes . . . . .	125
Variables:	
$\sigma$ known . . . . .	19
$\sigma$ unknown ( $s$ ) . . . . .	50
$\sigma$ 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.

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 ( $s$ )	$T_U = \frac{U - \bar{X}}{s}$ $T_L = \frac{\bar{X} - L}{s}$	$Q_U = \frac{U - \bar{X}}{s}$ $Q_L = \frac{\bar{X} - L}{s}$
	Section C ( $R$ )	$T_U = \frac{U - \bar{X}}{R}$ $T_L = \frac{\bar{X} - L}{R}$	$Q_U = \frac{(U - \bar{X})c}{R}$ $Q_L = \frac{(\bar{X} - L)c}{R}$
	Section D ( $\sigma$ )	$T_U = \frac{U - \bar{X}}{\sigma}$ $T_L = \frac{\bar{X} - L}{\sigma}$	$Q_U = \frac{(U - \bar{X})v}{\sigma}$ $Q_L = \frac{(\bar{X} - L)v}{\sigma}$
Estimation			Enter table with $n$ and $Q_U$ or $Q_L$ to get $p_U$ or $p_L$
Action	Single specification	Accept if $T_U \geq k$ or $T_L \geq k$	Accept if $p_U \leq M$ or $p_L \leq M$
	Double specification	Accept if† $T_U \geq k, T_L \geq k$ and $s < \text{MSD}$ or $R < \text{MAR}$	Accept if $p_U + p_L \leq M$

$c$  = 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  
PRCDNO=1  
PRODES=A  
PARTREP=01  
AGE =NE  
FAIL =BR  
FORM =001

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

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

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

AGE =NE  
FAIL =FU  
FORM =004

DATE =83/04/26  
PART =02  
DESC =NUT  
ENV =TR  
PRCDNO=1  
PRODES=A  
PARTREP=02  
AGE =US  
FAIL =BR  
FORM =005

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

DATE =83/05/03  
PART =06  
DESC =CHAIN  
ENV =TR  
PRCDNO=1  
PRODES=A  
PARTREP=  
AGE =US  
FAIL =BR  
FORM =007

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

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

ENV =TR  
PRCDNO=1  
PRODES=A  
PARTREP=07  
AGE =LS  
FAIL =BR  
FORM =003

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

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

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

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

DATE =83/06/25  
PART =03  
DESC =BOLT  
ENV =CP  
PRCDNO=1  
PRODES=A  
PARTREP=03

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

AGE =US  
FAIL =BR  
FORM =013

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

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

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

DATE =83/06/29  
PART =01  
DESC =PIN

ENV =CP  
PRCDNC=1  
PRODES=A  
PARTREP=01  
AGE =US  
FAIL =BR  
FORM =018

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

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

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

AGE =US	ENV =OP
FAIL =BR	PRCDNO=3
FORM =079	PRODES=A
	PARTREP=23
DATE =83/06/28	AGE =US
PART =03	FAIL =BR
DESC =BOLT	FORM =083
ENV =OP	
PRCDNO=3	DATE =83/06/29
PRODES=A	PART =03
PARTREP=03	DESC =BOLT
AGE =US	ENV =OP
FAIL =BR	PRCDNO=3
FORM =080	PRODES=A
	PARTREP=03
DATE =83/06/28	AGE =US
PART =03	FAIL =BR
DESC =BOLT	FORM =084
ENV =CP	
PRCDNO=3	DATE =83/06/29
PRODES=A	PART =03
PARTREP=03	DESC =BOLT
AGE =US	ENV =OP
FAIL =BR	PRCDNO=3
FORM =081	PRODES=A
	PARTREP=03
DATE =83/06/28	AGE =US
PART =10	FAIL =BR
DESC =CONTROLS	FORM =085
ENV =CP	
PRCDNO=3	DATE =83/06/29
PRODES=A	PART =16
PARTREP=10	DESC =CABLE
AGE =US	ENV =CP
FAIL =BR	PRCDNO=3
FORM =082	PRODES=A
	PARTREP=16
DATE =83/06/29	AGE =US
PART =23	FAIL =BR
DESC =HEATING	FORM =086

DATE =83/06/30  
PART =07  
DESC =PIPE  
ENV =OP  
PRCDNC=3  
PRODES=A  
PARTREP=C7  
AGE =US  
FAIL =BR  
FORM =C98

DATE =83/06/30  
PART =03  
DESC =BOLT  
ENV =CP  
PRCDNO=3  
PRODES=A  
PARTREP=C3  
AGE =US  
FAIL =BR  
FORM =C89

DATE =83/07/01  
PART =01  
DESC =PIN  
ENV =CP  
PRCDNO=3  
PRODES=A  
PARTREP=01  
AGE =US  
FAIL =BR  
FORM =09C

DATE =83/07/01  
PART =11  
DESC =WHEEL  
ENV =CP  
PRCDNO=3  
PRODES=A  
PARTREP=11

AGE =US  
FAIL =BR  
FORM =091

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

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

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

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



AGE =US  
FAIL =BR  
FORM =103

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

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

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

DATE =83/07/10  
PART =01  
DESC =PIN

ENV =OP  
PRCDNC=3  
PRODES=A  
PARTREP=01  
AGE =US  
FAIL =BR  
FORM =107

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

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

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

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

AGE =NE  
FAIL =BR  
FORM =114

DATE =83/04/26  
PART =20  
DESC =DCCR  
ENV =TR  
PRCDNO=4  
PRODES=A  
PARTREP=20  
AGE =NE  
FAIL =FU  
FORM =115

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

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

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

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

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

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

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

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

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

DATE =83/05/03  
PART =25  
DESC =SEALS  
ENV =TR  
PRCDNO=4  
PRODES=A  
PARTREP=25  
AGE =US  
FAIL =BR  
FORM =121

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

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

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

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

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

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

DATE = 83/07/04  
PART = 10  
DESC = CONTROLS  
ENV = OP  
PRCDNO=1  
PRODES=A  
PARTREP=10

AGE = US  
FAIL = BR  
FORM = 024

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

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

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

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

ENV =CP  
PRCDNO=1  
PRODES=A  
PARTREP=03  
AGE =US  
FAIL =BR  
FORM =028

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

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

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

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

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

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

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

AGE =US  
FAIL =BR  
FORM =034

DATE =83/06/27  
PART =03  
DESC =BOLT  
ENV =OP  
PRCDNO=2  
PRODES=A  
PARTREP=03  
AGE =US  
FAIL =BR  
FORM =036

DATE =83/06/28  
PART =14  
DESC =EXHAUST  
ENV =OP  
PRCDNO=1  
PRODES=A  
PARTREP=14  
AGE =US  
FAIL =BR  
FORM =037

DATE =83/06/28  
PART =11  
DESC =WHEEL  
ENV =OP  
PRCDNO=2  
PRODES=A  
PARTREP=11  
AGE =US  
FAIL =BR  
FORM =038

DATE =83/06/28  
PART =01  
DESC =BOLT

ENV =OP  
PRCDNO=2  
PRODES=A  
PARTREP=02  
AGE =US  
FAIL =BR  
FORM =039

DATE =83/06/29  
PART =07  
DESC =PIPE  
ENV =OP  
PRCDNO=2  
PRODES=A  
PARTREP=07  
AGE =US  
FAIL =BR  
FORM =040

DATE =83/06/29  
PART =03  
DESC =BOLT  
ENV =OP  
PRCDNO=2  
PRODES=A  
PARTREP=03  
AGE =US  
FAIL =BR  
FORM =041

DATE =83/06/30  
PART =13  
DESC =CAM  
ENV =OP  
PRCDNO=2  
PRODES=A  
PARTREP=13  
AGE =US  
FAIL =BR  
FORM =042

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

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

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

DATE =83/07/05  
PART =03  
DESC =BOLT  
ENV =CP  
PRCDNO=2  
PRODES=A  
PARTREP=03

AGE =US  
FAIL =BR  
FORM =046

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

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

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

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







DATE = 83/04/26  
PART = 11  
DESC = WHEEL  
ENV = TR  
PRCOND=3  
PRODES=A  
PARTREP=  
AGE = US  
FAIL = BR  
FORM = 065

DATE = 83/04/26  
PART = 03  
DESC = BOLT  
ENV = TR  
PRCOND=3  
PRODES=A  
PARTREP=  
AGE = US  
FAIL = BR  
FORM = 066

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

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

AGE = US  
FAIL = BR  
FORM = 068

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

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

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

DATE = 83/05/04  
PART = 06  
DESC = CHAIN  
AGE = US  
FAIL = BR  
FORM = 072



APPENDIX VIII

A sort of the part's failed in order of part numbers per product.

PART PRODUCT NO.	DATE	ENV	FAIL DESC.	FCRY NO.	PROD. AGE	FAILURE
01	83/04/20	TR	PIA	001	A	BP
01	83/05/06	TR	PIA	011	A	BR
01	83/06/29	GP	PIA	018	A	BR
01	83/07/07	GP	PIA	025	A	BR
PRODUCT TOTAL 4						
01	83/04/20	TR	PIA	069	A	BR
01	83/07/04	OP	PIA	044	A	BR
01	83/07/13	OP	PIA	060	A	BR
PRODUCT TOTAL 3						
01	83/07/01	GP	PIA	090	A	BR
01	83/07/06	OP	PIA	054	A	BP
01	83/07/09	OP	PIA	105	A	BR
01	83/07/10	OP	PIA	107	A	3R
01	83/07/10	GP	PIA	108	A	BR
PRODUCT TOTAL 5						
01	83/05/03	TR	PIA	127	A	BR
PRODUCT TOTAL 1						
PART TOTAL 13						

PART PRODUCT NO.	DATE	ENV	PART DESC.	FCRY NO.	PROD. AGE	FAILURE
02	83/04/20	TR	NUT	002	A	FU
02	83/04/20	TR	NUT	029	A	BR
02	83/04/26	TR	NUT	005	A	BR
02	83/05/03	TR	NUT	009	A	BR
PRODUCT TOTAL 4						
02	83/04/26	TR	NUT	032	A	BR
02	83/05/03	TR	NUT	031	A	BR
PRODUCT TOTAL 2						
02	83/05/06	TR	NUT	075	A	BR
PRODUCT TOTAL 1						
02	83/04/21	TR	NUT	113	A	BR
02	83/09/29	TR	NUT	117	A	BR
PRODUCT TOTAL 2						
PART TOTAL 9						



UNIT	PRODUCT NO.	WHET REP	DATE	ENV	PART DESC.	FCRY NO.	PROD AGE	FAILURE	PRODUCT TOTAL
03	3	03	83/07/13	OP	BOLT	111	A	PR	17
03	4	03	83/05/03	TR	BOLT	118	A	BR	
03	4	03	83/05/03	TR	BOLT	119	A	BR	
									2
									40

(FBKPI)

FAILURE DATA

UNIT	PRODUCT NO.	WHET REP	DATE	ENV	PART DESC.	FCRY NO.	PROD AGE	FAILURE	PRODUCT TOTAL
07	1	07	83/05/03	TR	PIPE	008	A	BR	
07	1	07	83/06/29	TR	PIPE	019	A	BR	
07	2	07	83/06/29	OP	PIPE	040	A	BR	2
07	2	07	83/07/09	OP	PIPE	053	A	BR	
07	2	07	83/07/13	OP	PIPE	056	A	PR	
07	2	07	83/07/13	OP	PIPE	057	A	BR	
07	3	07	83/04/28	TR	PIPE	069	A	BR	4
07	3	07	83/06/30	OP	PIPE	080	A	BR	
07	3	07	83/07/07	OP	PIPE	101	A	BR	
07	4	07	83/04/26	TR	PIPE	114	A	BR	3
									1
									10

(FBKPI)

FAILURE DATA

UNIT	PRODUCT NO.	WHET REP	DATE	ENV	PART DESC.	FCRY NO.	PROD AGE	FAILURE	PRODUCT TOTAL
10	1	10	83/06/28	OP	CONTROLS	017	A	BR	
10	1	10	83/07/04	OP	CONTROLS	024	A	PR	
10	2	10	83/07/05	OP	CONTROLS	049	A	BR	2
10	3	10	83/06/28	OP	CONTROLS	082	A	BR	1
10	3	10	83/07/10	OP	CONTROLS	109	A	BR	
									2
									5

(FBPPI)

FAILURE DATA

Part	PRODUCT NO.	Part REP	DATE	ENV	Part DESC.	FORM NO.	Prod AGE DESC	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	09	83/04/26	TR	WHEEL	065	A US	BR
11	3	11	83/05/03	TR	WHEEL	070	A US	BR
11	3	09	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 AGE DESC	FAILURE
12	2	12	83/07/06	OP	AXEL	050	A US	BR
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.

FAILURE DATA										(FB01)	
PART	PRODUCT	Part	DATE	ENV	Part	DESC.	FCR	AGE	FAILURE		
NO.	NO.	REP			NO.		NO.	DESC			
01	1	01	83/04/20	TR	PIA		001	HE	BR		PRODUCT TOTAL
01	2	01	83/04/20	TP	PIA		064	NE	BP		PRODUCT TOTAL
											Per Part TOTAL
02	1	02	83/04/20	TR	NUT		002	NE	FU		PRODUCT TOTAL
02	1	02	83/04/20	TR	NUT		029	NE	BR		PRODUCT TOTAL
02	4	02	83/04/21	TR	NUT		113	HE	BR		PRODUCT TOTAL
03	1	00	83/04/26	TR	BOLT		003	NE	BR		PRODUCT TOTAL
											Per Part TOTAL
04	1	00	83/04/26	TR	LEVFR		004	NE	FU		PRODUCT TOTAL
04	2	04	83/04/20	TR	LEVER		030	NE	BR		PRODUCT TOTAL
											Per Part TOTAL
07	4	07	83/04/25	TR	PIPE		114	NE	BR		PRODUCT TOTAL
20	4	20	83/04/26	TR	JOOR		115	NE	FU		PRODUCT TOTAL
											Per Part TOTAL
21	4	21	83/04/25	TP	LIGHT		116	NE	BR		PRODUCT TOTAL
											Per Part TOTAL

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APPENDIX 12

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

PROD	PRODUCT MP.	Part REF	DATE	ENV	Part DESC.	FLYR NO.	VEED DESC	AGE	FAILURE	(FBRP)
01	1	01	83/04/20	TR	PIN	001	A	GF	BR	PRODUCT TOTAL
01	2	01	83/04/20	TR	PIN	064	A	NE	BR	PRODUCT TOTAL
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	4	02	83/04/21	TR	NUT	113	A	DE	BR	PRODUCT TOTAL
03	1	00	83/04/26	TR	BOLT	003	A	NE	BR	PRODUCT TOTAL
04	1	00	83/04/26	TR	LFVFR	004	A	NE	FU	
04	2	04	83/04/20	TR	LEVER	030	A	NE	BR	PRODUCT TOTAL
07	4	07	83/04/26	TR	PIPE	114	A	NE	BR	PRODUCT TOTAL
20	4	20	83/04/26	TR	JOCP	115	A	NE	FU	PRODUCT TOTAL
21	4	21	83/04/26	TR	LIGHT	116	A	BR	BR	PRODUCT TOTAL

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(FBRPI)

FAILURE DATA

PART NO.	PRODUCT NO.	Part REF	DATE	ENV	Part DESC.	FBRP NO.	PCOD DESC	AGE	FAILURE	
G1	1	01	83/05/06	TR	PIN	011	A	US	BR	
G1	1	01	83/06/29	OP	PIN	013	A	US	BR	
G1	1	01	83/07/07	OP	PIN	025	A	US	BR	
										PRODUCT TOTAL 3
G1	2	01	83/07/04	OP	PIN	044	A	US	BR	
G1	2	01	83/07/13	OP	PIN	060	A	US	BR	
										PRODUCT TOTAL 2
G1	3	01	83/07/01	OP	PIN	090	A	US	BR	
G1	3	01	83/07/06	OP	PIN	094	A	US	BR	
G1	3	01	83/07/07	OP	PIN	105	A	US	BR	
G1	3	01	83/07/10	OP	PIN	107	A	US	BR	
G1	3	01	83/07/10	OP	PIN	108	A	US	BR	
										PRODUCT TOTAL 5
G1	4	01	83/05/03	TR	PIN	122	A	US	BR	
										PRODUCT TOTAL 1
										PART TOTAL 11
G2	1	02	83/04/26	TR	NUT	005	A	US	BR	
G2	1	02	83/05/03	TR	NUT	009	A	US	BR	
										PRODUCT TOTAL 2
G2	2	02	83/04/26	TR	NUT	032	A	US	BR	
G2	2	02	83/05/03	TR	NUT	033	A	US	BR	
										PRODUCT TOTAL 2
G2	3	02	83/05/06	TR	NUT	075	A	US	BR	
										PRODUCT TOTAL 1
G2	4	02	83/09/29	TR	NUT	117	A	US	BR	
										PRODUCT TOTAL 1
										PART TOTAL 6
G3	1	03	83/06/25	OP	BOLT	014	A	US	BR	
G3	1	03	83/06/25	OP	BOLT	014	A	US	BR	
G3	1	03	83/06/25	OP	BOLT	013	A	US	BR	
G3	1	03	83/06/25	OP	BOLT	013	A	US	BR	
G3	1	03	83/06/29	OP	BOLT	016	A	US	BR	
G3	1	03	83/06/29	OP	BOLT	020	A	US	BR	
G3	1	03	83/07/04	OP	BOLT	023	A	US	BR	
G3	1	03	83/07/07	OP	BOLT	026	A	US	BR	
G3	1	05	83/07/10	OP	BOLT	024	A	US	BR	
G3	1	03	83/07/10	OP	BOLT	027	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	83/06/28	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	C46	A	US	BR		
03	2	03	83/07/06	OP	BOLT	049	A	US	BR		
03	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	03	83/04/26	TR	BOLT	066	A	US	BR		
03	1	03	83/05/04	TR	BOLT	C71	A	US	BR		

(FBRP1)

FAILURE DATA

PIV	PRODUCT NO.	PROJ RFP	DATE	ENV	PICT DESC.	FORM NO.	PROD DESC	AGE	FAILURE
03	3	03	83/06/20	TR	BOLT	075	A	US	BR
03	3	03	83/06/24	OP	BOLT	077	A	US	9P
03	3	03	83/06/28	UP	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	086	A	US	BR
03	3	03	83/06/30	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	UP	BOLT	102	A	US	BR
03	3	03	83/07/09	UP	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
03	4	03	83/05/03	TR	BOLT	118	A	US	BR
03	4	03	83/05/03	TR	BOLT	119	A	US	BR
05	1	05	83/04/27	TR	CAP	006	A	US	FU
06	1	06	83/05/03	TR	CHAIR	007	A	US	BR
06	1	06	83/05/03	TR	CHAIR	010	A	US	BR
06	3	06	83/05/04	TR	CHAIR	072	A	US	BR
07	1	07	83/05/03	TR	PIPE	008	A	US	BR
07	1	07	83/06/29	TR	PIPE	019	A	US	BR
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	UP	PIPE	057	A	US	BR
PRODUCT TOTAL 17									
PRODUCT TOTAL 2									
PART TOTAL 39									
PRODUCT TOTAL 1									
PART TOTAL 1									
PRODUCT TOTAL 2									
PRODUCT TOTAL 1									
PART TOTAL 3									
PRODUCT TOTAL 2									



C7	3	07	83/04/28	TR	PIPE	069	A	US	RR	PRODUCT TOTAL	4
07	3	07	93/06/30	OP	PIPE	088	A	US	RR		
07	3	07	83/07/07	OP	PIPE	101	A	US	BR		
										PRODUCT TOTAL	3
										Part TOTAL	9
08	1	08	93/05/25	UP	CYLINDER	012	A	US	3K		
										PRODUCT TOTAL	1
09	1	09	83/06/25	UP	DRIVE	015	A	US	FU		
										Part TOTAL	1
09	3	09	93/06/27	OP	DRIVE	078	A	US	BR		
										PRODUCT TOTAL	1

(FRP1)

FAILURE DATA

UNIT	PRODUCT NO.	QTY REP	DATE	ENV	PART	DESC.	FCRM NO.	PRDP DESC	AGE	FAILURE	PRODUCT TOTAL	PART TOTAL
09	3	0	83/06/28	OP	DRIVE		079	A	US	BR	2	3
10	1	10	83/06/28	OP	CONTROLS		017	A	US	BR	2	
10	1	10	83/07/04	OP	CONTROLS		024	A	US	BR	2	
10	2	10	83/07/05	OP	CONTROLS		042	A	US	BR	1	
10	3	10	83/06/28	OP	CONTROLS		082	A	US	BR	2	
10	3	10	83/07/10	OP	CONTROLS		109	A	US	PR	2	5
11	1	11	83/06/31	OP	WHEEL		022	A	US	BR	2	
11	1	11	83/06/83	OP	WHEEL		021	A	US	BR	2	
11	2	11	83/04/26	TR	WHEEL		031	A	US	BR	3	
11	2	11	83/05/28	OP	WHEEL		038	A	US	BR	2	
11	2	11	83/07/12	OP	WHEEL		059	A	US	BR	3	
11	3	11	83/04/26	TR	WHEEL		065	A	US	BR	4	
11	3	11	83/05/03	TR	WHEEL		070	A	US	BR	9	
11	3	11	83/05/04	TR	WHEEL		074	A	US	BR	1	
11	3	11	83/07/01	OP	WHEEL		091	A	US	BR	3	
12	2	12	83/07/06	OP	AXEL		050	A	US	BR	1	
12	3	12	83/07/06	OP	AXEL		097	A	US	BR	3	
12	3	12	83/07/07	OP	AXEL		103	A	US	BR	1	
12	3	12	83/07/09	OP	AXEL		103	A	US	BR	3	
12	3	12	83/05/03	TR	AXEL		120	A	US	BR	1	
13	2	13	83/06/23	OP	CAM		035	A	US	BR	1	5

13	2	13	83/C6/30	OP	CAM	042	A	US	BR	PRODUCT TOTAL 3
13	2	13	83/C7/09	OP	CAM	055	A	US	BR	
13	3	13	83/C7/13	OP	CAM	112	A	US	BR	
14	2	14	83/C6/21	UP	EXHAUST	037	A	US	BR	PRODUCT TOTAL 1 PART TOTAL 4
15	2	88	83/C6/30	UP	SUPPORT	043	A	US	BR	
										PRODUCT TOTAL 1 PART TOTAL 1
										PRODUCT TOTAL 1 PART TOTAL 1



25	3	25	03/07/11	UP	SLEEVE	110	A	US	FU	PRODUCT TOTAL	1
										PART TOTAL	1
26	4	26	42/05/03	TP	SEALS	121	A	US	BR	PRODUCT TOTAL	1
										PART TOTAL	1

APPENDIX A

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

(FBP11)

FAILURE DATA

Prod. No.	PRODUCT NO.	Part REP	DATE	ENV	Part	DESC.	FCRP NO.	PROD. DESC.	AGE	FAILURE	
01	1	01	83/04/20	TR	PIN		001	A	NE	BR	PRODUCT TOTAL
01	1	01	83/05/06	TR	PIN		011	A	US	BP	
01	2	01	83/04/20	TR	PIN		065	A	NE	BR	PRODUCT TOTAL
01	4	01	83/05/03	TR	PIN		122	A	US	BP	PRODUCT TOTAL
07	1	02	83/04/20	TR	NUT		029	A	NE	BR	PRODUCT TOTAL
02	1	02	83/04/20	TR	NUT		002	A	NE	FU	
02	1	02	83/04/26	TR	NUT		005	A	US	BR	PRODUCT TOTAL
02	1	02	83/05/03	TR	NUT		009	A	US	BR	
02	2	02	83/04/26	TR	NUT		032	A	US	BR	PRODUCT TOTAL
02	2	02	83/05/03	TR	NUT		033	A	US	BR	
02	3	02	83/05/06	TR	NUT		075	A	US	BR	PRODUCT TOTAL
02	4	02	83/04/21	TR	NUT		113	A	NE	BR	PRODUCT TOTAL
02	4	02	83/03/29	TR	NUT		117	A	US	BR	
03	1	00	83/04/26	TR	BOLT		003	A	NE	BK	PRODUCT TOTAL
03	2	03	83/05/06	TR	BOLT		034	A	US	BR	PRODUCT TOTAL
03	3	03	83/04/26	TR	BOLT		066	A	US	BR	PRODUCT TOTAL
03	3	03	83/05/04	TR	BOLT		071	A	US	BR	
03	3	03	83/06/20	TR	BOLT		076	A	US	BR	PRODUCT TOTAL
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
04	1	00	83/04/26	TR	LEVER		004	A	NE	FU	PRODUCT TOTAL

C4	2	04	83/04/20	TR	LEVER	030	A	NE	9R	PRODUCT TOTAL PART TOTAL	1 2
05	1	06	83/04/21	TR	LAP	006	A	US	FU	PRODUCT TOTAL PART TOTAL	1 1
06	1	06	83/05/03	TR	CHAIN	007	A	US	BR	PRODUCT TOTAL PART TOTAL	2 1
06	1	06	83/05/03	TR	CHAIN	010	A	US	BR		
06	3	06	83/05/04	TR	CHAIN	072	A	US	3R	PRODUCT TOTAL PART TOTAL	2 3

(FORPI)

FAILURE DATA

UNIT	PRODUCT NO.	PROT REP	DATE	ENV	PROT	DESC.	FCRM NO.	PROD DESC	AGE	FAILURE	
07	1	07	83/05/03	TR	PIPE		008	A	US	BR	2
07	1	07	83/06/29	TR	PIPE		019	A	US	BR	
											PRODUCT TOTAL
07	3	07	83/04/28	TR	PIPE		069	A	US	BR	1
07	4	07	83/04/26	TR	PIPE		114	A	NE	BR	1
											PRODUCT TOTAL
											PART TOTAL
11	2	11	83/04/26	TP	WHEEL		031	A	US	BR	1
11	3	00	83/04/26	TR	WHEEL		065	A	US	BR	
11	3	11	83/05/03	TR	WHEEL		070	A	US	BR	
11	3	00	83/05/04	TR	WHEEL		074	A	US	BR	
											PRODUCT TOTAL
											PART TOTAL
12	4	12	83/05/03	TR	AXEL		120	A	US	BR	1
16	4	16	83/05/06	TR	CABLE		124	A	US	BR	1
											PRODUCT TOTAL
											PART TOTAL
17	4	17	83/05/06	TR	INLET		123	A	US	BR	1
20	3	00	83/04/28	TR	DOOR		067	A	US	BR	1
20	4	20	83/04/26	TR	DOOR		115	A	NE	FU	1
											PRODUCT TOTAL
											PART TOTAL
21	3	00	83/04/28	TR	LIGHT		063	A	US	BR	1
21	4	21	83/04/26	TP	LIGHT		116	A	NE	BR	1
											PRODUCT TOTAL



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