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PROJECT IN THE ISLAMIC
REPUBLIC OF PAKISTAN

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# Final Report: General Automotive Manufacturing

Prepared for Pakistan Automobile Corporation

by the

United Nations Industrial Development Organization

acting as Executing Agency

for

United Nations Development Programme

Based on the work of S.E. Mansour

Expert in "Automotive Manufacturing

United Nations Industrial Development Organization

Vienna

Karachi, Sept. 23 1986

Report on 3 Month Mission

To

Pakistan Automobile Corporation

September, 1986

## I, Objectives

1. Study and suggest plans for integrating the existing deletion programme of the PACO units in order to optimise results.

2. Advise the vendors on product development, work lay out and ways of improving manufacturing capability in order to improve quality and achieve cost reduction.

3. Study and propose methods for introducing advanced manufacturing technology for Automotive Parts within the country.

4. Advise vendors on advanced manufacturing methods for specialized vehicle components.

5. Advise vendors on manufacturing processes of electrical components like alternators, starters, ignition coil, cable harness ... etc.

## II. FINDINGS AND CONCLUSIONS.

1. Study suggest plans for integrating the existing deletion Programme of the PACO Units in order to optimise results.

The existing deletion programme was planned by licensor, and agreed by PACO in 6 stages, six years, starting 1983. Attempts are now being made to achieve this, regardless of insufficient manufacturing facilities and technical capability available at Vendors. In Suzuki Cars about 29% deletion achieved as against 45% target plan. There was no programme to set up the new facilities for deletion of components. An alternative programme was prepared by me (Attachment IA, IB, IC, ID) with three manufacturing stages, starting with the simplest parts within facilities available at local vendors, and the more sophisticated parts, which should be manufactured in house by PACO units and large industrial units. Lack of documents delivered by licensor (Suzuki) will seriously affect any deletion programme. Even th· quality and quantity to be locally produced will be enormously affected as well.

List of necessary documents was prepared and delivered to PACO (Attachment 2).

2. Advise vendors on product development, work lay out, and improvement of manufacturing methods in order to improve quality and achieve cost reduction.

A wide range of visits for 25 factories (Attachment 3A,3B,3C) in Karachi & Lahore was made by me, accompanied with Dr. Qureshi, VDTC engineer. The best company in respect of quality and manufacturing technology was Allwin Engg. (Karachi) who makes mainly pistons for trucks buses and tractors engines. The factory is working on 3 shift basis, and no more capacity exist for

Suzuki piston engines.

"Naya Daur" Karachi, a PACO Unit nave sufficient manufacturing facilities in Press shop but only 30% capacity is utilised. Product quality of tne machine shop for production of components can be considered as 60% due to quality of machine tools.

"Millat Tractor Ltd". Lahore producing 40% of M.F. tractor "in-house" with 35% utilised capacity, but quality is not more than 60%.

Other local vendors can be considered as just started taking off in manufacturing Automotive parts after many years of producing other parts where quality is not necessary. Machine tools available at those vendors are conventional with very low quality. Jigs, Fixtures & dies are 100% of their own design due to missing documents from OEM. 60% of the product do not reach the quality required. On the other hand man power is creative and active but due to lack of knowledge with principals of manufacturing methods and lack of technical documents they are unable to get successful results.

An individual report is prepared for each factory visited by me, with necessary advise, and recommendations for solving manufacturing problems. Second visits were made to local vendors (14) with full explanation of reports.

3. Study & propose methods for introducing advanced manufacturing technology machining of engines and components.

Systems applied in automotive industries are as follows :-

1. Functional production work shops.
2. Line production work shop.
3. Group technology work shops.
4. Transfer lines with automatic machines.
5. Robbots.

PACO is planning to produce 20,000 car/year. This can be considered as limited production, even after extension of doubling the capacity upto 40,000/year is also limited. Providing the amount of production lays between 20,000 and 40,000 system 1,2,3 could be considered. Considering one type of production (Suzuki) and efficient utilisation of machines,system 1,2 could be applied.

4. Advise vendors on advanced manufacturing methods for specialised venicle components.

The existing facilities and technical capability at vendors will never allow them to produce specialised venicle components such as carburattors, propeller shafts, roller bearisngs, drive chain, electronic pannel equipments, and other similar components.
This issue has been discussed with G.M. (VDTC). It was agreed that the items which can not be produced must constitute the proposed 20% of components which will not be deleted.

5. Advise vendors on manufacturing processes of electrical components like alternators, starters, ignition coil, cable harness etc.

Manufacturing Alternators & Starters consists mainly of electric components & few mechanical components. I was able to advise on the mechanical aspects, but due to the problems out lined in the proceeding 4 objectives, the programme did not allow me to deal with this issue. Only one factory visited who produce wire harness for tractors. The plastic coating process was improved by modifying the extrusion die for better quality of wire harness.

## III. RECOMMENDATIONS.

1. study and suggest plans for integrating the existing deletion programme of the manufacturing units in order to optimise results.

I strongly recommend that PACO should take quick action to get the necessary technical documents (Attachment 2) for Suzuki product. In case the documents are not supplied from licensor, PACO will face a tremendous great task which can never be achieved by existing capabilities. In this case an international consulting office could be approached for the preparation of required documents.

80% deletion of Suzuki's could be achieved in 3 years only if all technical documentation will be available before establishing factories for producing the sophisticated components/sub assemblies which do not exist presently. Moreover sophisticated dies, tooling have to be imported.

Following in house production shops are recommended:-

- Miscellaneous production shop at PMTF can be utilised by adding one more shift for the production of sophisticated miscellenous parts.
- Press shop for sophisticated pressed parts at Naya Daur Factory can be utilised, by adding one more shift.
- New engine shop for engine sophisticated parts manufacturing, could be established at PMTF.
- New gear box shop for the production of gear box components could be established at PMTF premises.
- Pistons, piston rings and piston pins should be produced at Allwin Engg.

- Leaf springs at Suleman Engineering Factory,Lahore

  Other simple miscellaneous components to be manufactured at vendors who possess good facilites.

In order to optimise the results, guidance and assistance of VDTC would be essential for vendorization of components, their initial development and final inspection/testing.

2. Advise vendors on product development, work layout and improvement of manufacturing methods.

After visiting 25 factories (Attachment 3A,3B,3C) individual reports with necessary recommendations of improving their manufacturing processes and solving their technical problems were prepared. 14 vendors were revisited for explaining the reports. VDTC should follow-up my recommendations mentioned in each report. So far VDTC will provide engineering services and technical assistance particularly to small vendors, the VDTC should have the highly experienced staff to acnieve this task successfully. I recommend recruiting 8 engineers with at least 5 years experience in manufacturing workshops. Training programme with recommended institutions (Attachment 4A,4B,4C,4D).

I have been asked to help in upgrading the 6 ton Bedford truck with 113 HP engines, to 12 ton payload, same engine components with super charger, to reach 150 HP (Attachment 5A,5B,5C) explains my views.

3. Study and propose methods for introducing advanced manufacturing technology machining of engines and components.

In view of the production 20,000 car/year, and future extension upto 40,000 car/year, this can be considered as limited production in car industry. For this limited size of production, the most relevent manufacturing technology is that recommended

for the particular shops mentioned in item 1 (recommendation). This will allow also in case of changing car model, same machines will be used and tooling will be changed only.

4. Advise vendors on advanced manufacturing methods for sophisticated vehicle components.

In order to produce these specialised items to an adequate standard of quality, would require considerable capital investment in modern production facilities, which is not considered justifiable due to small production volume. Therefore, it is recommended that those items should not be deleted in the short term. It comprises 20%.

5. Advise vendors on manufacturing processes of electrical components like alternators, starter, ignition coil, cable harness, etc.

The above mentioned components comprises of mostly the electrical parts. The visits to the vendors who have capabilities of producing these components could not be made due to short of time. The assistance was however, provided to cable Harness manufacturer. A feasibility study could be carried out for establishing an in house production shop for electric components (startors, alternators) for all automotive products in Pakistan.

## IV DISCUSSION AND DETAILS

1. The existing deletion programme does not comply with the technical capabilities and manufacturing facilities at vendors. Moreover, plans were not made for setting up required facilities for the development of components. After making number of visits (25 factories) accompanied by Dr.Qureshi (VDTC) and studying their capability as well as problems, I prepared a plan which could be implemented successfully, but following actions would be necessary :-

i) Delivery of technical documents for all components of vehicle from licensor SMC Japan Attachment 2.

ii) Simultaneous development of facilities (Machines, dies and tooling).

If documents are not provided, the development and deletion would not be possible in stipulated time.

Alternatively some international consulting offices should be approached for the preparation of technical documents. But it would be very costly (estimation $ 2,000,000) and will also take long time (2 years min). Consulting offices recommended as under:-

i) ITAP Torino ITALY

ii) ATON Consulting Office
Awkaf New Building B.2. Flat 5,
Hadaiek El Koba Cairo, EGYPT

iii) Scandia-Consult Stockholm SWEDEN

iv) Mackee Kearnee U.S.A.

(Complete address of above mentioned offices can be obtaifned from their Embassies).

Set up of new facilities for inhouse production is necessary, for

sophisticated parts,as the facilities do not exist presently at small vendors. It will need an integral set up of departments, such as planning, procurement, production control design, quality control and stores. Moreover, the sophisticated components need high manufacturing technology, high capital investment with low rate of return and high skill for maintaining the quality. This will not attract the small vendors at private sector. Therefore PACO/PSMC should concentrate for putting these facilities in following units for achieving the deletion target and optimise results.

- Miscellaneous production shop (existing at PMTF) can be utilised by adding one shift more, for producing sophisticated miscellaneous components such as (steering arms, steering gears, worms, tie rods, driving shafts,crown and pinion and similar components).
- Press shop existing at NDML can be utilised by adding one more shift for producing sophisticated pressed components, such as (floor pannels, doors,roof,engine hood, mudguards and similar components.

Following new production shops should be established :-

- Engine shop at PMTF premises for sophisticated engine components such as (crank shfat, conrod, cylinder block, cylinder head, axle housing) and similar parts.
- Gear box shop at PMTF premises for producing complete gear box.

Multiple facilities available at PMTF such as CNC machines, machine shop,heat treatment shop, tool shop and technical

departments (Planning deptt., Design deptt., Quality Control deptt., Production Control deptt., and Laboratories), could be gainfully utilised.

Facilities available at NDML such as, press shop, tool shop, heat treatment shop can be utilised as well.

This will save capital investment, reduce over heads and cost of the production.

- Pistons, Piston rings, and Piston pins should be produced at Allwin Engineering.The factory is working on three shift basis,Suzuki Pistons should be produced at the extension they already started.
- Leaf Sprirgs could be produced at Suleman Engineering factory Lahore. Facilities available at the factory allows producing that particular part.
- Other miscellaneous simple parts could be produced at local vendors having adequate facilities.
- "Millat Tractors Ltd". Lahore manufacturing M.F. Tractors 13000/year reached 70% deletion." National Motors Ltd". manufacturing Bedford trucks and buses 2000/year reached 65% deletion. Both units are controlled by PACO.

2. Vendors visited (25) can be classified to three main categories:-

   A. Vendors with sufficient manufacturing facilities, high technical capability and producing components with required quality. Those vendors does not need much help, but need close coordination with PACO to implement the deletion programme, by utilising their facilities.

Allwin Engineering Industries &

Alsons Engg. Ltd are good examples for this grade.

B. Vendors with sufficient technical and manufacturing facilities e.g P.M.T.F. and NDML. Those factories could be upgraded by supplying the necessary sophisticated tooling materials and additional machines. Adding one shift more could be beneficial to be utilised as in house production shops.

C. Small vendors with limited facilities and low technical capability need more attention to be developed. Soft loans could be helpful for mutual benefit to up-grade manufacturing facilities. Technical assistance from VDTC is of great importance for their technical development.

Registration of vendors (grade C) should be made at VDTC, who will keep records of all facilites and work load with them. Further order of components could be given after assesing their capabilities and capacities of vendors by VDTC.

During development phase of manufacturing components technical assistance should be provided to those vendors by VDTC. The first off sample and pilot lot should be checked by VDTC from the following aspects :-

a) Material, Physical, mechanical & Chemical aspects.

b) Geometring according to drawings.

c) Heat treatment properties.

d) Vioration, fatigue or specific tests, if any.

e) Fittment test, if any.

Feed back report on functional test on vehicles should be provided by PSMC before giving final clearance for mass production. In order to maintain healthy composition and less dependance, minimum two vendors should be engaged for one part. As soon as part has been awarded to a vendor, policy should not allow any changes or modifications of drawing within 5 years, so that the vendor will not loose the capital invested in manufacturing toolings required for that part before modification occured.

The staff member of VDTC should be highly experienced in manufacturing technology, so that they will be able to achieve their task towards the small vendors and provide them with necessary engineering services and technical assistance. I strongly recommend recruiting the technical staff and start training. Attachment( 5A, 5B, 5C, 5D, 5E) includes the necessary training programme and recommended institutions.

3. Due to the limited production of 20,000 cars a year (Phase I) & considering the existing facilities of factories visited, I strongly recommend the following shops to be newly established:

i) Engine shop (line production) at PMTF Karachi.

ii) Gearbox shop (Functional Production shop) at PMTF., Karachi.

Both factories should be planned on one shift basis. The unexpected delays in production plan to be substituted by extended shift/over time.

In case of doubling the capacity upto 40,000 cars/year(Phase II), a 2nd shift basis could be considered, with a room for extended shift/over time to substitute the unexpected delays as well.

Upgrading following workshop is essential :-

i) NDML Karachi could be utilised as press shop by adding one shift more to the existing one. The factory already started developing some sophisticated parts (doors, roofs) but with very low rate.

ii) PMTF Karachi - The existing machine shop produces machine tools under licence from Orlikon, and gear boxes for Bedford rtuck buses. The work shop have 70% free capacity due to market drop in selling Bedford trucks as well as machine tools.This free capacity could be utilised for producing the sophisticated components such as, steering arms, steering gears, worms, driving shafts, torsion bars and similar components. No additional shifts is required for 1st phase (20,000 car/year). In case of regaining market for Bedford Truck and machine tools, the factory can work on 2 shift basis for phase-I, and 3 shifts for Phase-II.

Feasibility study could be prepared by technical departments available at PMTF and NDML with the coordination of PACO technical staff.

The above mentioned suggedstions will enormously reduce capital investment as well as overheads. This will lead to reduce production costs.

4. The highly sophisticated parts, such as carburrators, electronic components, hydraulic systems are not recommended to be produced for the time being. This needs high capital investment, which should be covered by high mass production. In addition, the adequate quality required could not be reached by existing facilities. Such components could constitute the 20% which will not be deleted.

5. Only one factory visited out of the (25) producing the wire harness for tractors. The problem faced was that the copper wire was not at center of plastic coat.

A report with drawings for modifying the extrusion die was handed over to the factory. Processing of the die was explained as well. This principal can be applied to other cable manufacturers.

In my view it is recommended to establish an in house production shop for electrical components manufacture to provide all automotive industries in Pakistan with these components.

During my visits to Vendors, I felt they need information about tne principles of Jigs & Fixture design, as well as some conceptions for solving problems.

A seminar was conducted by me with two sessions on the following topics :-

i) Design of Jigs and fixture and their economic aspects.

ii) Quality Control circuits for solving technical problems.

Lectures attached (appendix 6,7).

Attachment IA.

## DELETION PROGRAMME

Stage-I — Assembly C.K.D. Body Welding, Tyres, Rims, Batteries Upholstry, seats, Tool Kit, Wire harness and simple pressed parts.

These parts already deleted, and being supplied by local vendors. Parts already deleted, comprising about 9%.

Stage-II — Fuel tanks, fly wheel, steering wheels, simple pressed parts (brake assembly, brake plate, brake shoe, hydraulic brake cylinder). These parts are under development.

Seats, brake pedals, and other similar unsophisticated components are deleted and being supplied by local vendor, it constitute about 20%. Total deletion is about 29%.

Stage-III — New Engine shop at PNTF premises Karachi.

Line production for :-

Cylinder blocks, crank shaft, engine cover con. rods, cylinder heads and other sophisticated parts.

Engine assembly line & engine tests at same premises.

New Gear Box Shop at PNTF premises Karachi.

For all gear box components.

Press Shop upgrading existing press shop NDM Karachi.

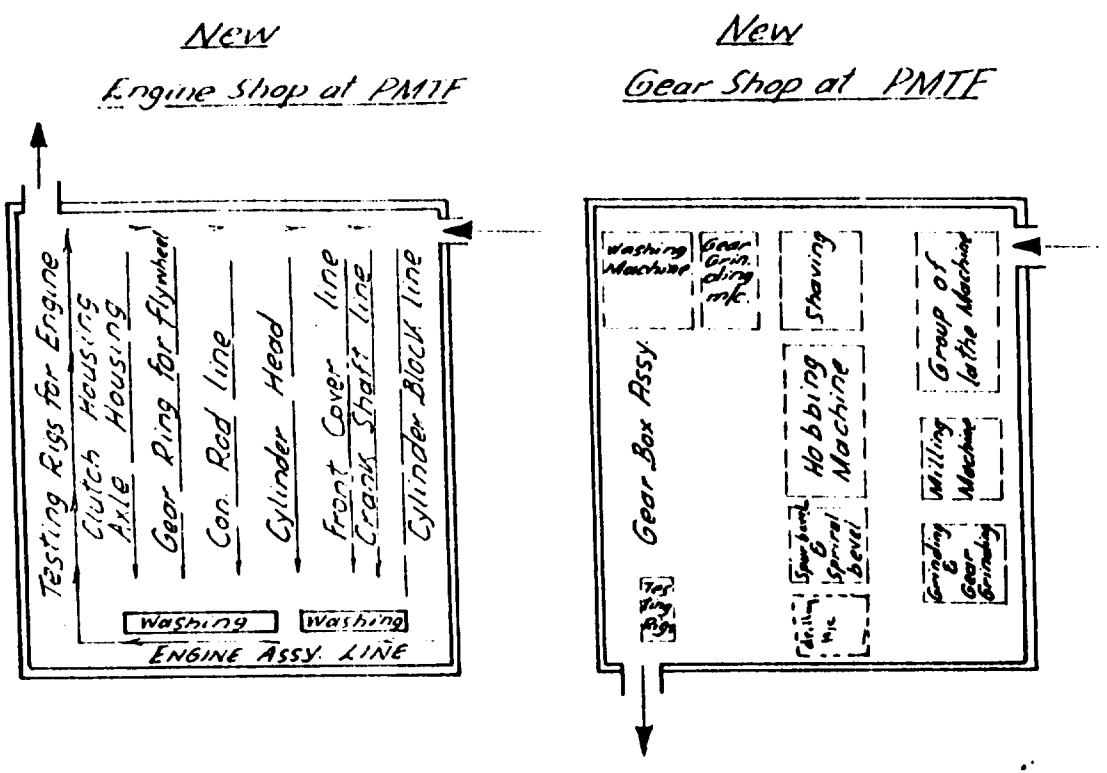
For the production of sophisticated pressed parts:

Body roof, floor panel, doors, roof, engine hoods, rear deck, mudguards and other similar components.

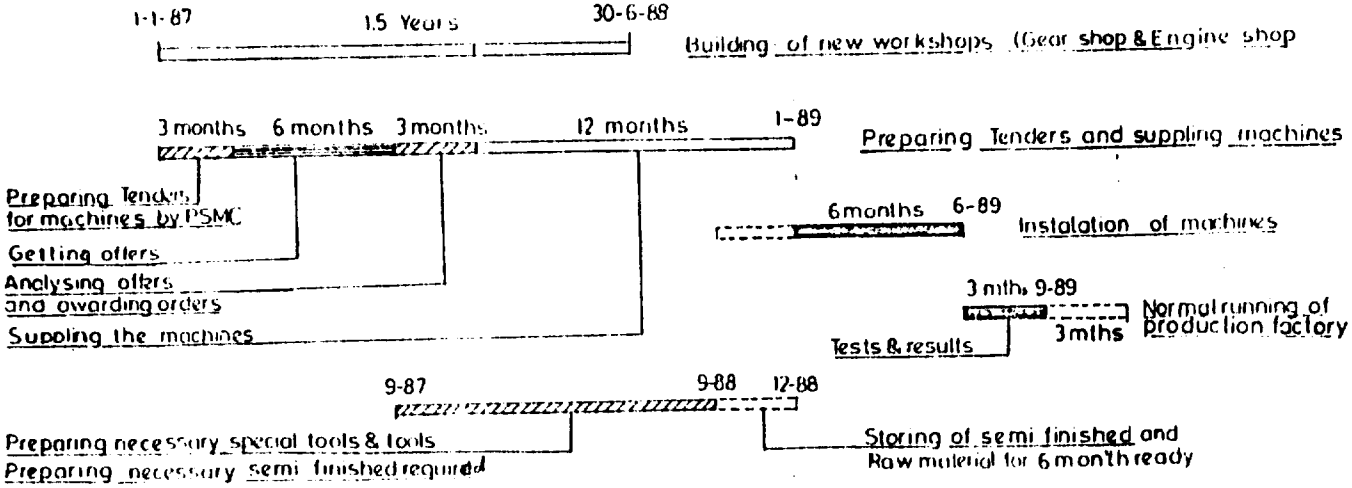
Miscellaneous Shop upgrading existing shop at PNTF Karachi.

For production of :

Steering arms, steering worm . worm wheels and other similar components.

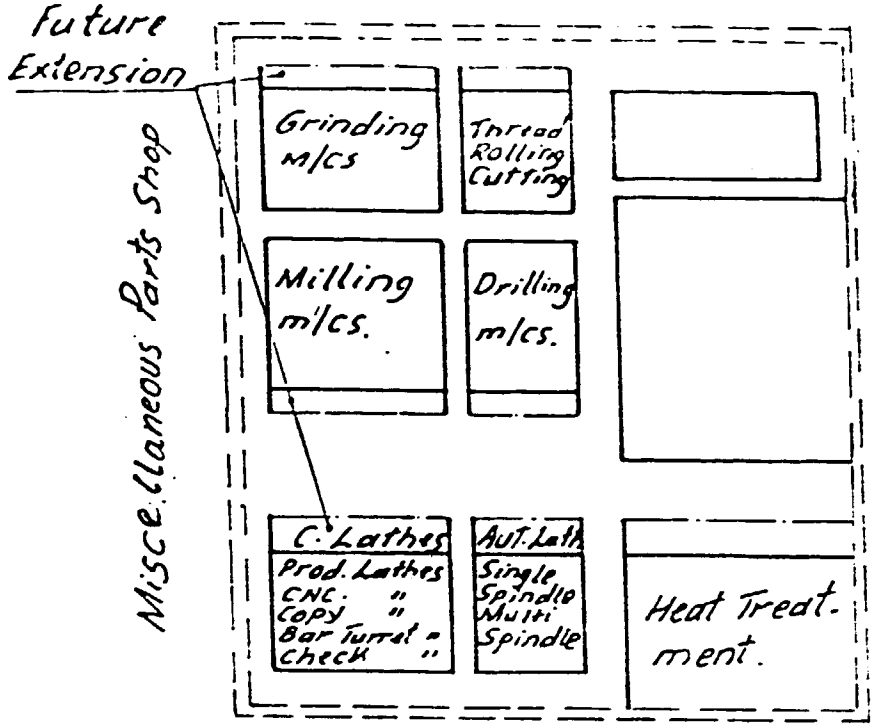



PLAN FOR ESTABLISHING THE ENGINE SHOP & GEAR SHOP

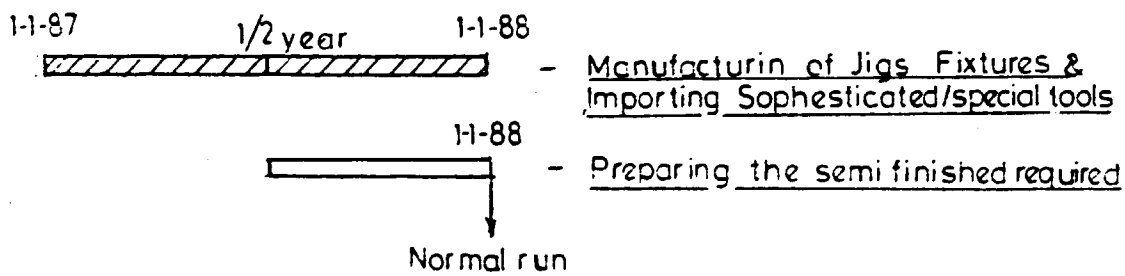


# Existing

# Machine Shop at PMTF

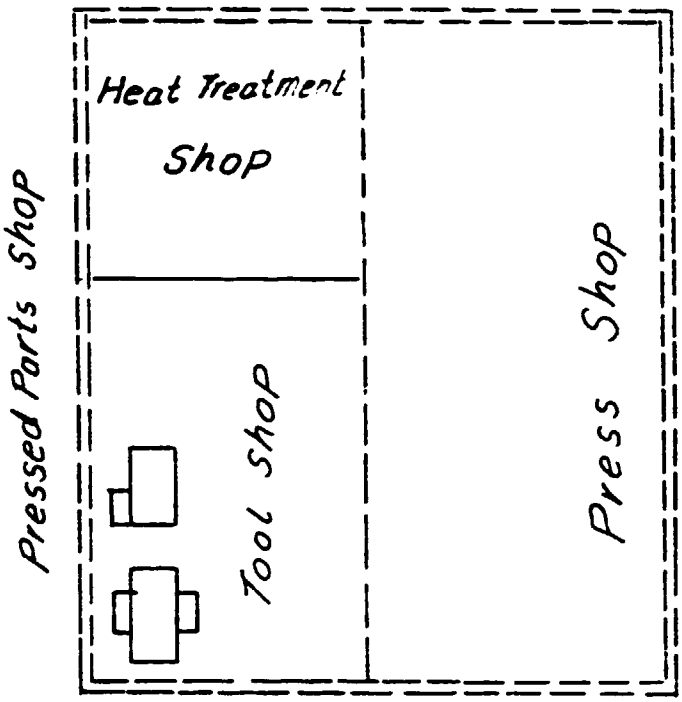



**PLAN FOR UPGRADING MISCELLANEOUS PARTS SHOP EXISTING AT PMTF**

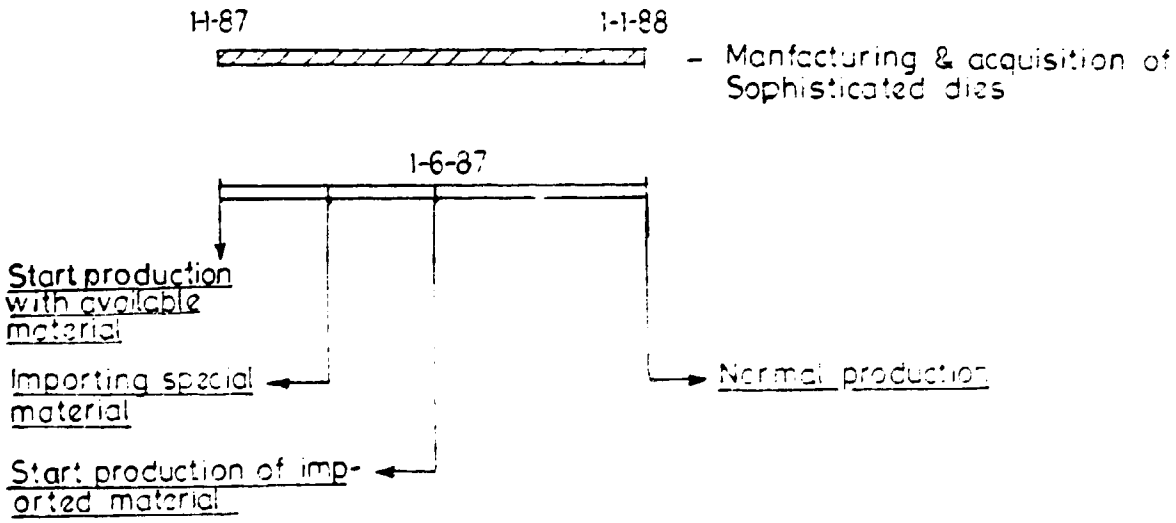



- **The above mentioned plan could be completed by 1988 by which the factories will start normal running. An allowance of 6 months is given for unexpected delays.**
- **The above mentioned plans are subjected to delivery of documents from Suzuki (Attachment 1).**

# Existing
# Press & Tool shop at NDML




## PLAN FOR UPGRADING THE EXISTING PRESS SHOP AT NDML



ESSENTIAL TECHNICAL DOCUMENTS NEEDED FOR MANUFACTURING

The essential technical documents needed for manufacturing comprises on the following:-

1. CONSTRUCTION DOCUMENTS

- CKD PARTS LIST WITH PRICES
- Drawings for components & sub-assemblies
- Drawings of semi-finished parts

  . Forgings
  . Castings
  . Pattern & Cores
  . Blank size & development drawings
  . etc. etc.

- Material Specifications:

  . Physical properties
  . Chemical propertis
  . Surface treatment procedure
  . Heat treatment process

2. TECHNOLOGY DOCUMENTS:

- Process sheets
- Operation sheets
- Machine list with specifications
- Material Handling equipment
- Loading of Machine, Economic batch size
- List & Drgs., cutting tools, special tools (Jig, fixture and dies)
- Working drawing for each component and sub-assemblies for Jigs, Fixtures & Dies

3. QUALITY CONTROL DOCUMENT:

- Inspection Standards for each component & sub-assemblies
- Check list during process & final inspection for components and sub-assemblies
- Drawings of gauges, inspection fixtures & test rigs alongwith testing procedures

Factories visited

1. AGTL Site Office Karachi.
2. NDML
3. Ghafco Industries
4. Sky Ways
5. Alsons Industries
6. Pervez Engg Industries
7. PSMC
8. Shaheen Engg. Works
9. Mack Trucks Ltd.
10. Tariq Engg. Works
11. Oceanic Industries
12. Baluchistan Foundry
13. Hussain Engg. Works
14. NDML Foundry
15. Precission Engg. Co.
16. Pervaiz Mechanical & Engg. Works (Ferozpurwala)
17. GEMCO
18. Baluchistan Wheels Ltd.
19. PMTF
20. Alwin Engg.
21. PSMC Lahore Office
22. Suleman & Co. Lahore
23. MTL Lahore
24. Machinecraft Lahore
25. M.A. Industries Lahore

(Contd.....P/2)

Jobs Completed:

1. Process sheet for machining of Brake Drums and Clamping device so as to meet the concentricity and tolerances - Suzuki, Baluchistan Foundry, Oceanic Industry, Naya Daur Motors, Precision Engineering.

2. Suggesting the machining operation in spacer ring so as to avoid shifting in hols - Naya Daur.

3. Machining Process for Hydraulic lift cylinder of MF tractor so as to eliminate variation in wall thickness - Precision Engineering.

4. Designing the jig for milling the thread in Racket for seat mechanisum for Suzuki Car. - Pervaiz Engineering, Ansari Noorsons.

5. Suggestions for making alteration and utilisation of existing paint booth at Mack Trucks.

6. Suggestions for making the rivet head for screw jacks.

7. Suggestions for improving the machining process for levelling box and link rocker - Baluchistan Foundry.

8. Suggestions for improving the machining operation of Hub at Naya Daur Motors Ltd.

9. Designing of fixture for Hard Board Trims - Pervaiz Engineering.

10. Lay out sketch for paint booth for small components - Pervaiz Engineering.

11. Improvement in design of roof dies of Suzuki - Tariq Engineering.

12. Designing of fixture for reducing the Brake Pedal pipe of motorcycle - Tariq Edngineering.

13. Suggestions for improvement of screw jack components - Shaheen Engineering.

14. Welding and inspection fixture design of Sash of Suzuki Car - Pervaiz Engineering.

(Contd.....P/3)

15. Layout of fixture for spot welding of silencer cap for a tractor - Pervaiz Industry.

16. Designing of extension dies for p.v.c. coating on cable 0 GAFCO Industries.

17. Suggesting clamping device for oil sump machining on transfer line which will reduce setting time - Millat Tractors Ltd., Lahore.

18. Suggesting for improving drilling oil level hole in the sump through a guided bush so as to improve quality of machining - Millat Tractors Ltd., Lahore.

19. Improvement in machining process in hydraulic lift cover, MF Tractor for the boss hole - Machine Craft, Lahore.

20. Drilling and reaming operation in bearing caps in one fixture at one location instead of two which reduce variation. - Machinecraft Lahore.

21. Improving drilling operation in rail by adjustment in guide bush which reduce vibration - Machinecraft Lahore.

22. Rotating device for induction hardening of Gear shift rails so as to get uniform harness - Machinecraft , Lahore.

23. Advice for reducing the warpage in a clutch friction plate - Suleman & Co. Lahore.

24. Device for slotting in Gear shift cover which ensure consistency in quality - Suleman & Co. Lahore.

25. Inspection fixture was suggested for Suzuki fuel tank flatness & machining process for drain lock, as advised to make a fixture for fillment test - M.A. Industry Lahore.

Recommended Training Programme

for

VDTC Staff Personnel in Manufacturing.

| S.No. | Field of Training | No.of Pers. | Duration for each person. months | Place of Training. |
|---|---|---|---|---|
| 1. | Processing | 2 | 6 ) | Automotive Manu- |
| 2. | Tool Design | 2 | 6 ) | facturing with |
| 3. | Tool Manufacturing | 2 | 6 ) | limited Production. |
| 4. | Heat Treatment. | 2 | 6 ) | |

I. <u>Processing:</u>

No.of candidates: 2

Qualifications : min. B.E. (Bachelor Engineering)*

Experience : min. 5 years after graduation in the field of manufacturing.

Period of training: 6 months.

Course of training:

- Preparation of process sheets for Automotive components, jigs, fixtures and dies' components. (6 weeks).
- Improving methods of processing and cutting condition to comply with existing facilities (10 weeks)
- Time study. ..... (1 week)
- Tool selecting and improve cutting conditions to achieve required quality of production. (3 weeks)
- Geometrical testing of components, cutting tools and special tools(jigs,fixtures, Dies) (3 weeks)
- Selection of machine tools and recommending proper specifications. ..... (1 week)

* similar to BSc.

Contd....2

Attachment ...

II. Tools Design. (jigs,fixtures & dies)

No.of candidates: 2

Qualification : min. B.E.Degree.

Experience : min. 5 years in the field of Tool design.

Period of Training: 6 months.

Field of Training : Design principles of Dies,jigs and Fixtures. (2 weeks)

- Component design for jigs,fixtures and dies. (8 weeks)
- Properties of material and material specifications. .... (4 weeks)
- Assembling & testing of special tools and producing the prototype. (2 weeks)
- Inspection of (jigs,fix.& dies), using different instruments and calibration of measuring equipments. ... (2 weeks)
- Repairing of dies, jigs & fix.(3 weeks)
- General knowledge of heat treatment. (3 weeks).

III. Tool Production:

No.of candidates: 2

Qualification : min. B.E.Mechanical Engg..

Experience : min.5 years after ~~production~~ graduation at manufacturing field.

Duration of Training. : 6 months.

Field of Training : 

- Principles of design jigs,fixtures & dies components. (2 weeks)
- Preparing process sheets for jigs,fix. and dies, compnt. (8 weeks)
- Optimising cutting conditions w.e.t. feeds, speeds depth of cut...etc. to get the required geometry of parts & maximum quantity of production. ... (3 weeks)
- Improving & modifying jigs,fix.& dies.
- Maintenance & repair of jigs, fix. & dies. (4 weeks)
- General knowledge of material spec.(2 weeks)
- General knowledge of testing and using measuring instruments. (2 weeks)
- General knowledge of heat treatment. (3 weeks)

contd...3

IV. Heat Treatment.

No.of candidates: 2

Qualification : min. B.E.Mechanical Engg.

Experience : 5 years in manufacturing units.

Duration of Training : 6 months (min.)

Field of Training :

- Metalergical Lab.
  Hardness testing, Microstructure testing, Spectrography... etc. (4 weeks).
- Material Dept., material specifications, material replacements, deciding and improving of heat treatment processes. .... (12 weeks)
- Heat Treatment Shops. ... (8 weeks)
  - Salt baths for case hardening operation,gas carborizing operation.
  - Nitriding and other heat treatment operations,quenching,tempering.
  - Induction hardening, annealing, normalizing operation.
  - Use of different types of furnaces for particular heat treatment operation.

S.E. Mansour

S.E. MANSOUR
UNIDO - Consultant

m/q

Recommended Institutions for Training.

I Processing, Tool design & Tool production

1- Industrija Motora Rakoviska I.M.R.
Patrijarha Dimitrja 7-31
1090 Belgrad
Yougoslavia

2- Nasr Automotive Co.
c/o Chairman Engineering Industries Organization
26, Adly St. 6th Floor
Cairo, Egypt.

3- The following Institute could be contacted who can recommend the relevant Institutions for training in U.K.
Institute of Mechanical Engineers
Birmingham Walk,
West Minister
London U.K.

II Heat Treatment :-

1- Metalergy High Institute
Tebbin, Helwan,
Cairo, EGYPT.

2- Nasr Automotive Co.
c/o Chairman Engineering Industries Organization
26, Adly St. 6th floor,
Cairo EGYPT.

3- Industria Motora Rakoviska I.M.R.
Patrijarha Dimitrija 7-31
1090 Belgrad
Yougoslavia.

S E [illegible]
31.8.86

Subject:- Upgrading of Bedford trucks 6 tons.

Upgrading of Bedford trucks 6 tons pay load with Engine. 113 HP, to a higher capacity with engine 150 HP will be followed by many changes of components for the frame chassis, suspensions and transmission system. After checking the Engine performance (mainly torque and r.p.m.) and truck performance for different types of locally, assembled trucks, it is impossible to get use of Bedford Engine 150 HP to be mounted on these trucks. Even for gear box and transmission systems can not be replaced. Redesign for frame chassis, suspensions and all transmission system is required.

From my experience at our factory the change from 8 ton truck to 12 ton truck was achieved with the following economic aspects :-

1. Minimise changing of components as much as possible, if redesign calculations proved safety of part for new loads, such as :
   some side-members of frame chassis, axle housing, covers, spring bracket, fuel tanks, Air compressed tanks etc...
   This will lead to getting use of whole documents and tools ... necessary for manufacturing.

2. Improving existing components without changing of geometrical shape, by changing material or heat treatment operation to increase strength of part due to increased payload. Such as rear axle shafts front axle (changing the king.pin hole dia.)... etc.

3. Improving of existing components for pressed parts by adding reinforcements whenever possible such as main longitudinal members and some side member of the frame.

The following procedure was achieved in our factory

1. Complete data of old truck 8 tons was available.

.....

2. A complete team of designers Engineers of of 10 years experience min. with their assistances, most of them were trained at Licensor's Factory "Magirus Deuts" Germany. One Mechanical design consultant from Cairo University contributed for 6 months. The whole design work took almost 16 months.

3. A proto type shop - belongs to the design department was producing individual parts and assembling at the same time. Due to shortage of facilities at prototype shops some parts are produced in the tool room shop. Components from castings and forgings were obtained from vendors.

4. After testing the finished parts at the laboratory and proved successful results the drawings were sent to :

   a. Material requisition department to plan for material delivery 9 months before the first start of production. This will give chance fr for forging factory, casting factory alominu. casting factory and local market to prepare the necessary dies or any tools required.

   b. Process and tool department to prepare the necessary process sheets, tools, measuring tools .... etc. and all requirements necessary for production. Those documents were prepared for both inhouse manufacturing and at Vendors factories.

5. The prototype truck was subjected to severe road test according to standards. Some modifications were added and production may start on September 1986.

My advise is that before starting up grading of the Bedford truck, the following essential items should be prepared :-

1. Complete data of Engine performance 150 HP should be obtained from Bedford (England).

.....

Attachment 5C

2. Drawings documents of old frame, chassis, suspensions and transmission system should be available at design office (VDTC).

3. A complete staff of Mechanical design engineers highly trained at Automotive Design field should be available.

4. Mechanical test, material test laboratory are available and Metrology Lab as well.

5. prototype machine shop for manufacturing the new mechanical system with :

   1. Centerlathe centre distance 1500 mm.
      height of Center 200 mm.
   2. Universal Milling m/c Table Size 1500x 600
   3. Radial drill Cap 40 mm.
   4. Universal cylindrical grinding m/c max dia 40 mm.
   5. power Hak Saw
   6. Welding (arc welding & Oxy-Asteline welding)

The above mentioned machines (with tentative dimensions) are the most important at prototype shop.

For sheet metal parts; can be manufactured manually at local market.

I also advise to start immediately training the design Engineers on "Automotive Design Industries" and I recommend "Nasr Automotive Factory" in Egypt could be selected for this training course. If this is decided, matter can be taken with the Chairman of Engineering Industries at Egypt. Design Engineers for (VDTC) should be recruited as soon as possible so that they can carry on upgrading design jobs in future.

Best Regards.

S. G. M

S. G. MANSOUR
UNIDO Consultant.
July 20, 1986.

2.

APPENDIX VI

VENDOR DEVELOPMENT & TRAINING CELL

(PAKISTAN AUTOMOBILE CORPORATION LTD)

# PRINCIPLES OF FIXTURES & JIGS DESIGN & ECONOMIC ASPECTS

BY S.E. MANSOUR
UNIDO CONSULTANT
AUTOMOTIVE MANUFACTURING

Fixtures & jigs are special attachments or devices used in production to obtain quick setting of work piece for the cutting operation, consistant with dimensional accuracy in the parts to be machined.

Functionally, a fixture or a jig performs the duties of:-

1. Supporting the work piece by means of properly and acurately placed bearing surfaces.

2. Locating the work piece in alignment with cutter by pre-arranged locating points.

3. Holding the work piece firmly against the cutting load by means of positive stops and clamps.

4. Providing gaging or setting surfaces to locate the cutters with respect to the fixture or jig & work piece.

Fixtures & Jigs Elements:

To satisfactorily perform these functions, fixtures & jigs are provided with certain essential elements. These elements may vary in shape and arrangement as required accodrding to the nature of work piece, but are identical in duties which they perform. These elements are:-

- **Rest Blocks or plates:**

  The rest blocks or plates provide bearing areas or surface for supporting the work piece.

- **Clamps:**

  To securely hold the work-piece in the fixture or jig, clamps are provided opposite the bearing areas.

- **Locating points:**

  Locating points accurately locate work piece in the fixture or jig and establish the location of the surface to be machined with respect to the setting surface.

- **Gaging or Setting Surface:**

  The gaging or setting surface which is usually provided in fixture for setting the cutters in proper relationship with the fixture and work piece.

- **Fixture Body:**

  Jigs & fixtures body is the main frame on which the various elements are mounted. The base of the fixture & jig has a machined surface which is provided with slots for the bolts which clamp it to the machine table. These slots are spread aprt a distance equal to the spacing of the machine table T slots.

## Types of jigs & Fixtures:

- Temporary fixtures or jigs may be used sometimes. Special jigs or fixtures are disfavoured because of the limited number of parts to be produced. It is often a practice to build up a temporary jig or fixture on the table of the machine, which can be considered as the base of a jig or fixture. In this case the work piece is supported on top of the table and home made clamps and locators are utilized.

- **Special Jigs & Fixtures:**

When the shape and size of parts, as well as the production rate are such as to require designing a special fixture to fit the conditions of the job, the fixture or jig should be made as simple as possible. Special fixtures and Jigs may be:-

a. Hand clamped in which the work piece being held with simple clamps, hand tightening by turning a nut or a cam lever.

b. Power calmped; which have clamps actuated by hydraulic, pneumatic or electrical means.

c. Automatic fixtures, jigs are particularly those in which loading and unloading, aswell as clamping and unclamping are arranged to function in conjunction with the cycle of operation of the machine. Most probably the loading will be done by hand while the rest of the cycle is automatic.

d. Center-type-fixtures are those fixtures in which the work piece is located between centers.

e. V blocks fixtures or jigs permit locating the workpiece on the outer cylindrical surface on V shaped blocks.

f. Rotary fixtures, jigs are those fixtures in which the work piece is around an axis or its own axis while cutting.

g. Indexing fixtures and jigs permit positioning the work piece for repetitive cutting or drilling.

h. Progressive type jigs or fixtures are those in which the work piece can be located in different positions for performing different cuts or drilling in a given operation cycle.

i. Built-in fixtures or jigs are built as integral part of the machining.

j. Universal fixtures & jigs are types which can be adapted by means of removing locations, rest blocks etc. to hold and locate similar parts of different sizes.

**Economic Aspects:**

Generally, jig or fixture, like any other piece of equipment should be profitable; that is, it should pay for itself from the savings derived from its use. The economic aspect of the use of the fixture can be considered on the following basis:-

1. The production per year necessary to pay out of saving for a jig or fixture of given essential cost.

2. The max. allowable cost of fixture or jig to "break even" for a given savings in operating cost per piece and specific number of parts produced during the year.

3. The number of years it will take to pay out savings relative to saving in operation time per piece and amount of production/year.

4. The net savings from the use of a jig fixture of a given cost, for an estimated saving in operating cost per piece at a given out part.

Example 1 - Number of pieces of the fixture or jig in "Order to Break Even" on cost of jig or fixture.

The number of pieces N, which must be processed in a year to "Break Even" on a proposed fixture or jig costing C Rupees can be obtained by the following simplified formula:-

$$N = \frac{C\left(i + u + t + \frac{1}{a}\right) + Si}{S\,(I + L)}$$ **Formula 1**

N = Number of pieces produced per year.

C = Cost of jig or fixture in Rupees.

S = Difference between an amortized and scrap value of old fixture or jig.

i = Yearly interest on capital invested expressed in decimal number.

u = Yearly percentage of cost for up keep, expressed in decimal number.

t = Yearly percentage of taxes, insurance ... etc. expressed in decimals.

a = Years required for amortizing the cost of the fixture.

S = Savings in direct operating cost per piece in Rupees.

L = Percentage burden expressed in decimal number.

If the selected values of i, u, t, and a, are assumed as constant for a given period of time, their combined value may be represented by a fixed factor:-

The formula can be simplified as follows:-

$$N = \frac{CF + Si}{(i+L)s}$$ **Formula 2.**

Assuming the following values:

C = 6000 Rupees, i = 0.06 u = 0.44 t = 0.1

a = 2 years hence f = 0.06 + 0.04 + 0.10 + ½ = 0.70

s = 6 Rup. S = 1500 Rup.

From formula 2 it follows that:

$$N = \frac{6000 \times .7 + 1500 \times .06}{1.5 \times .6}$$

$$= 3860 \approx 4000 \text{ Pieces}$$

Example 2. Allowable Fixture or jig cost to "Break Even".

The max. allowable cost of a fixture to be paid for out of savings can be calculated by solving Formula 2.

$$C = \frac{1.5Ns - Si}{f}$$

Assuming the same values as used in example 1 but changing the number N of parts to be processed to 5000.

$$C = \frac{1.5 (5000 \times .6) - 1500 \times .6}{.7}$$

$$= 6300 \text{ Rup.} - 6500 \text{ Rup.}$$

In order to Break Even in this case the cost of the jig or fixture should not exceed 6500 Rup.

Example 3. Number of years Required to "Break Even" on Fixture or jig Cost.

The number of years "a" required to pay for a proposed jig, fixture costing C Rupees, when producing parts at a yearly rate N, may be obtained from the following formula:-

$$a = \frac{C}{1.5NX - Si - C (i + u + t)}$$

If C = 6000 Rs. and N = 8000 pieces and the order values are the same as example 1 then

$$a = \frac{6000}{1.5 \times 8000 \times .6 - 1500 \times .6 - 6000(.06 + .04 + .1)}$$

$$= \frac{6000}{7200 - 90 - 1200} = \frac{600}{5910}$$

$$= 1.02 - 1 \text{ Year.}$$

## Principle of Fixtures & Jigs Design:

Some of the general principles to be observed in jigs & fixture design, are the following:-

1. The main frame of the fixture or jig should be made of simple but strong section in order to minimise deflection and clamping strains when clamping on machine or clamping the work piece.

2. Jigs & Fixtures should be designed so that the work piece can be located in the correct position.

3. Ease of locating and removing the work piece should be carefully considered in designing jigs & fixture.

4. Fixtures & jigs should be safe to operate.

5. Fixtures & Jigs should be designed with a view to reduce operator fatigue to a minimum, for this purpose power operated jigs & fixtures are used.

6. Whenever possible a jig or fixture should be designed it can be used to perform as many machining operations as possible on the part being machined.

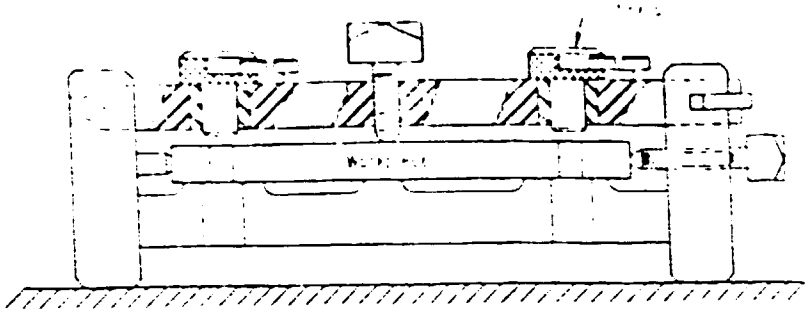
7. Easy disposal of chip and coolant should be provided to the jigs & fixtures.

8. Simple fixture and jigs design is preferable, as it lowers the initial and operating cost.

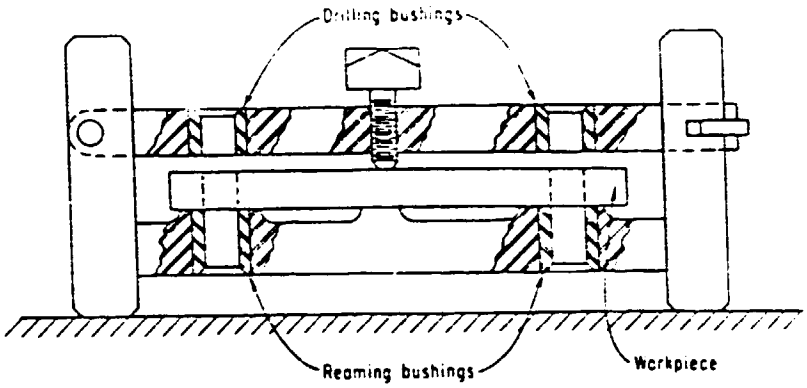
9. Locating & clampings point should be well selected so that the part will not be deformed against clamping forces.

10. Jigs & fixtures should be made so that they can be used interchangeably on various machine tools.

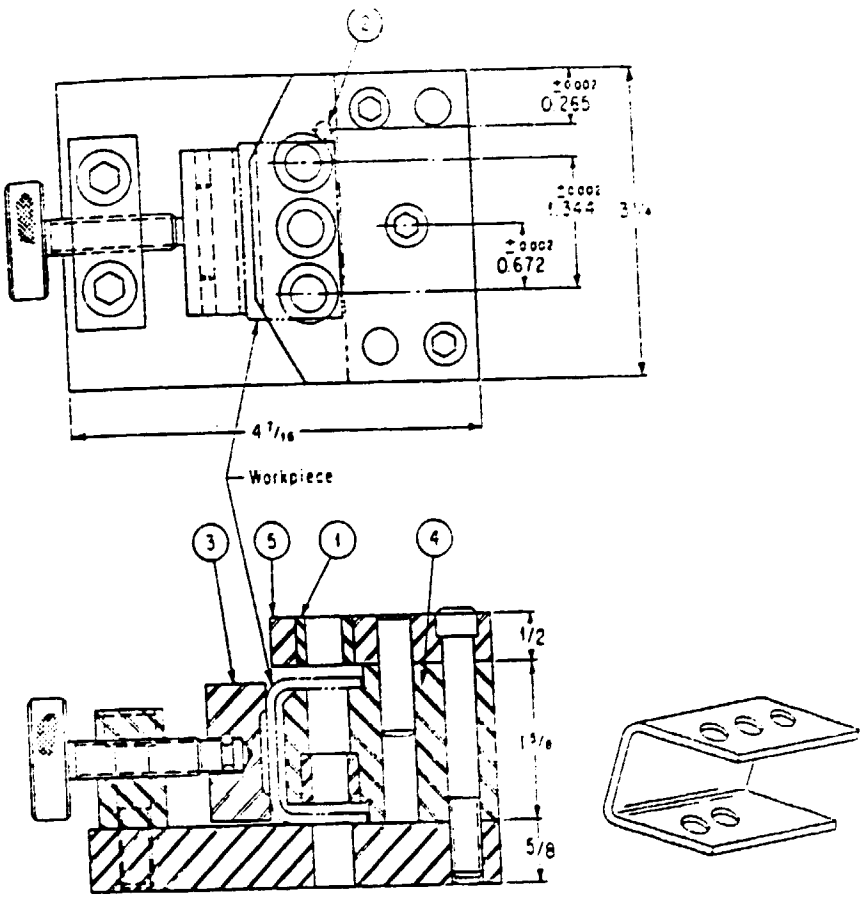
11. As a general principle, in order to have the work piece in stable contact with rest blocks or supporting points and without straining or deforming the part, it is necessary to have three points or areas of support so arranged that the center of gravity of work piece located in the triangle resulting from the three support points.



Tumble jig with renewable slip bushings (*H. J. Gerber, ASTME member-at-large*)




Redesign of the jig of Fig. 4-25. (*H. J. Gerber, ASTME member-at-large*)




Jig for drilling a channel. (*Barth Corp*)

## DRILL JIG TYPES

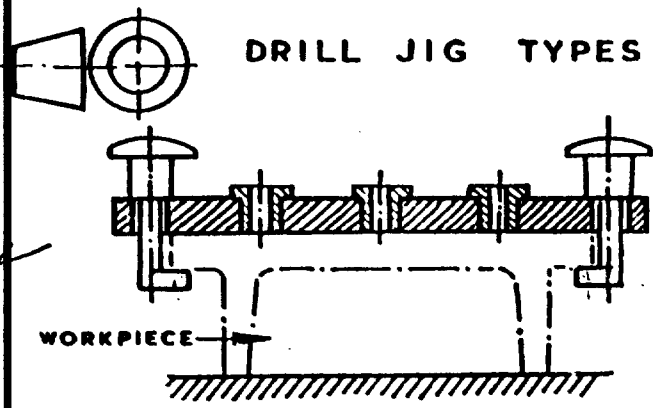
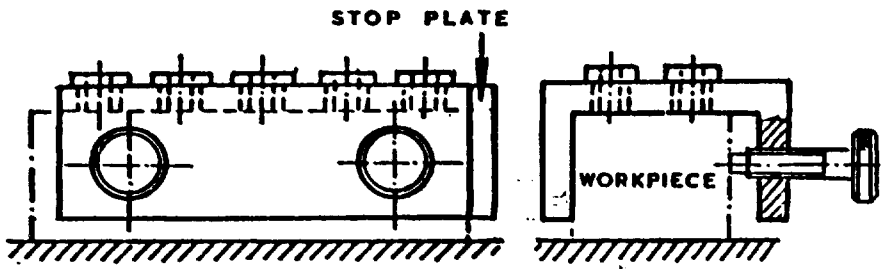
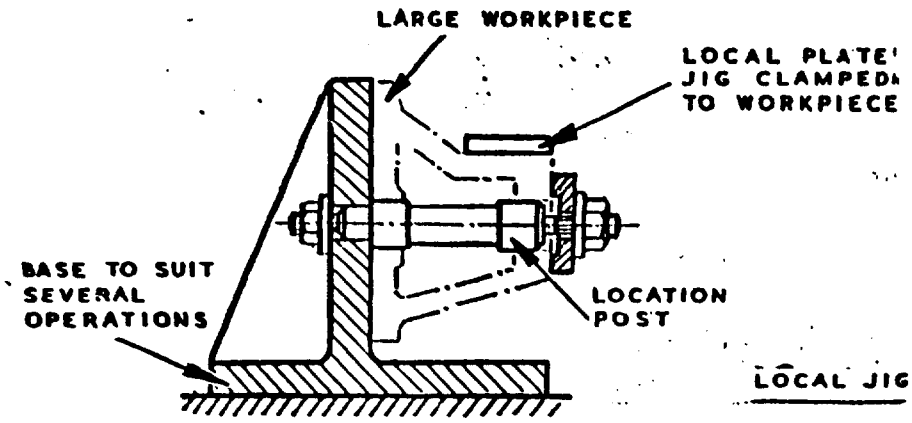



PLATE JIG

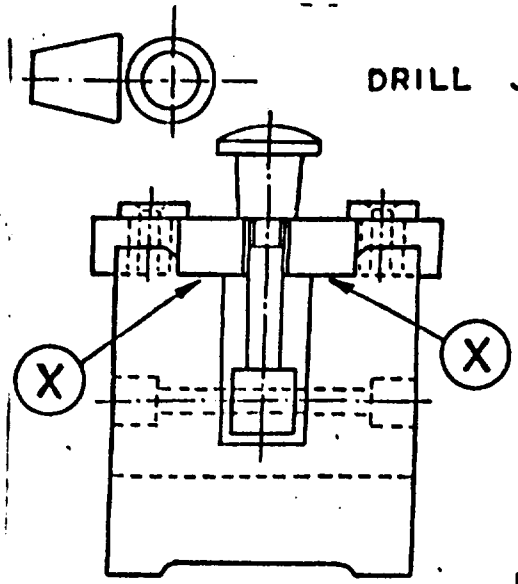


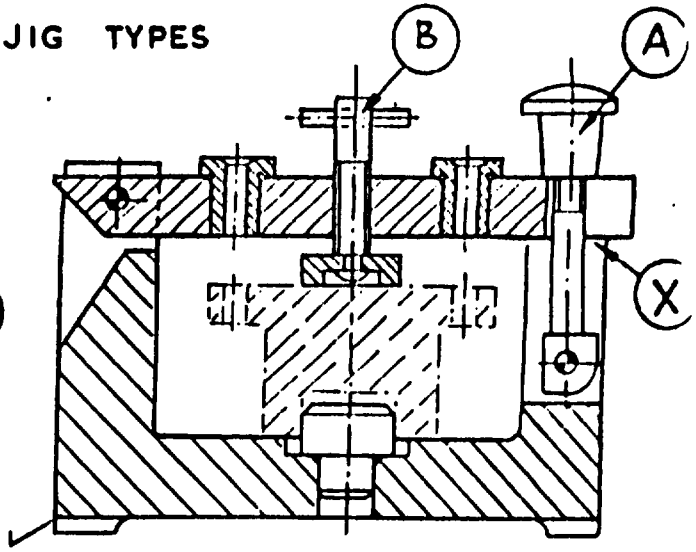

CHANNEL JIG

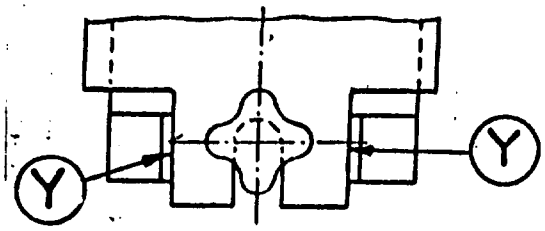



LOCAL JIG

## DRILL JIG TYPES



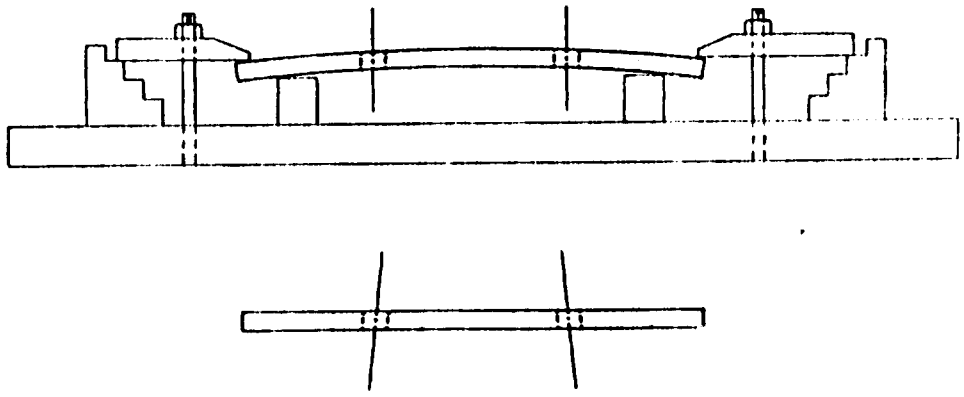




LATCH IS THE DRILL PLATE & MUST BE LOCATED (AT 'X' & 'Y'), AND CLAMPED BY NUT 'A'.

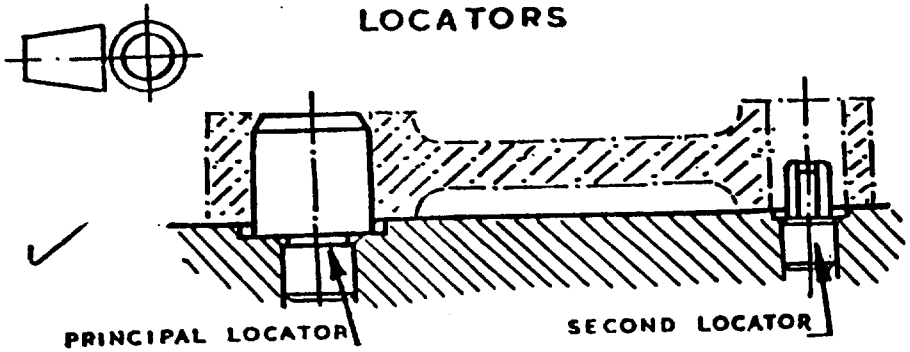
WORKPIECE IS CLAMPED BY SCREW 'B'

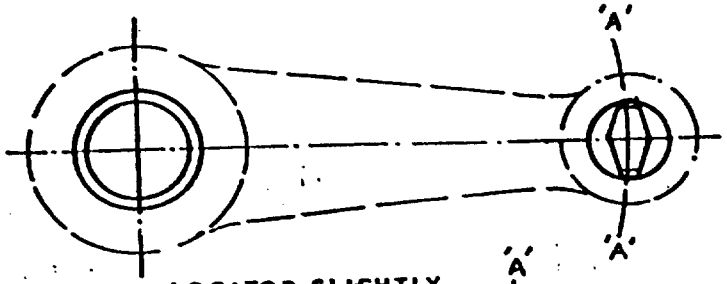
LATCH JIG



Nonparallel holes as the result of clamping over unsupported surfaces.

# LOCATORS

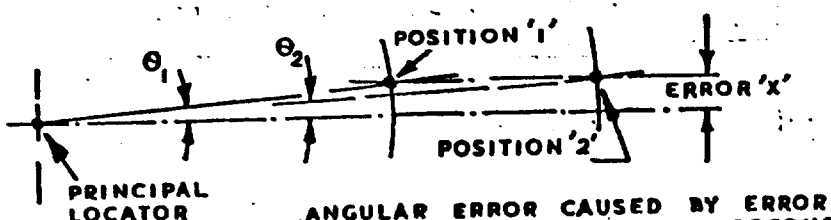



**CYLINDRICAL LOCATORS IN COMBINATION**

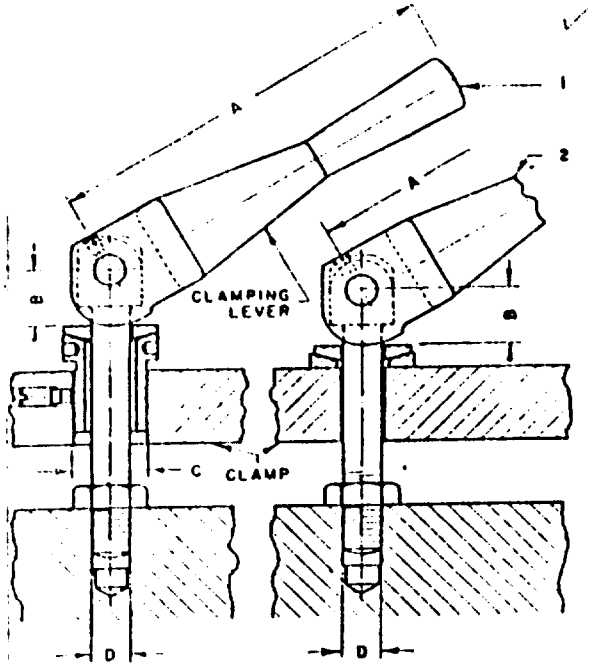
LOCATOR SLIGHTLY SMALLER THAN LOCATION HOLE

SECOND LOCATOR MUST BE SHAPED AS SHOWN SO THAT IT WILL ONLY INFLUENCE WORKPIECE ALONG 'A-A'



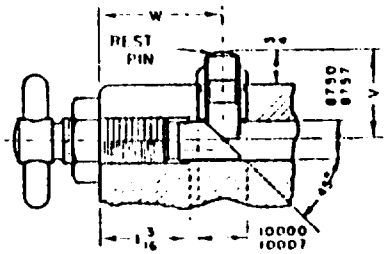

ANGULAR ERROR CAUSED BY ERROR 'x' IN THE POSITION OF THE SECOND LOCATOR, IS INVERSELY PROPORTIONAL TO THE DISTANCE BETWEEN THE TWO LOCATORS

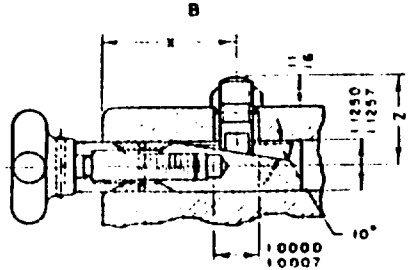


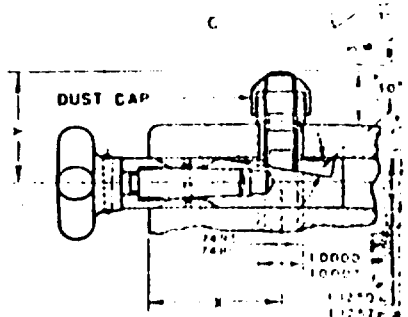



| A | B | C | D |
|---|---|---|---|
| 7 3/8 | 1 1/8 | 1 1/2 - 16 N F | 3/4 |
| 9 1/4 | 1 3/8 | 2 - 16 N F | 1 |

Standard designs of cam lever clamps.

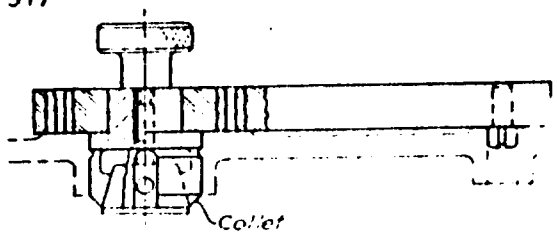


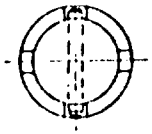




| | | | | | | |
|---|---|---|---|---|---|---|
| N | 3 | 3½ | 4 | 4½ | 5 | 5½ |
| Y | 2½ | 3 | 3½ | 4 | 4½ | 5 |
| Z | 2 | 2½ | 3 | 3½ | 4 | 4½ |
| V | 2 | 2½ | 3 | 3½ | 4 | 4½ |
| W | 2¾ | 3¼ | 3¾ | 4¼ | 4¾ | 5¼ |

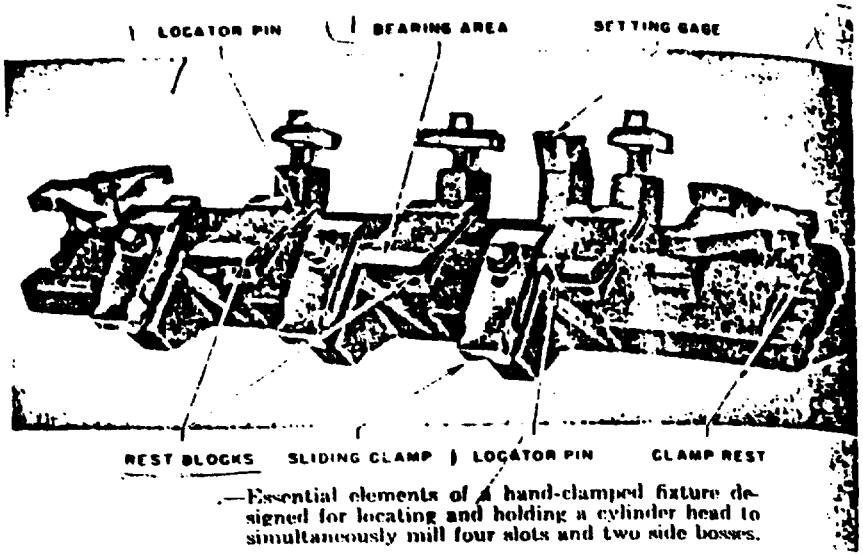
017



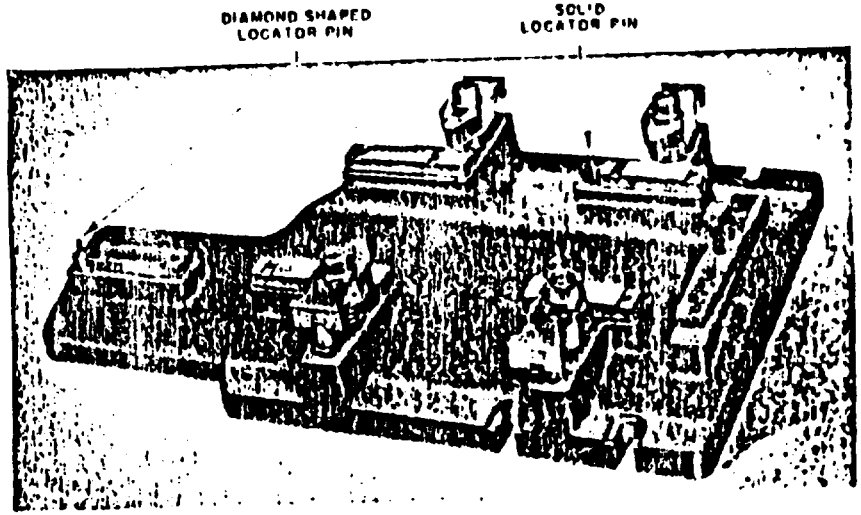



The bushing plate locates additional holes in relation to the holes already drilled.

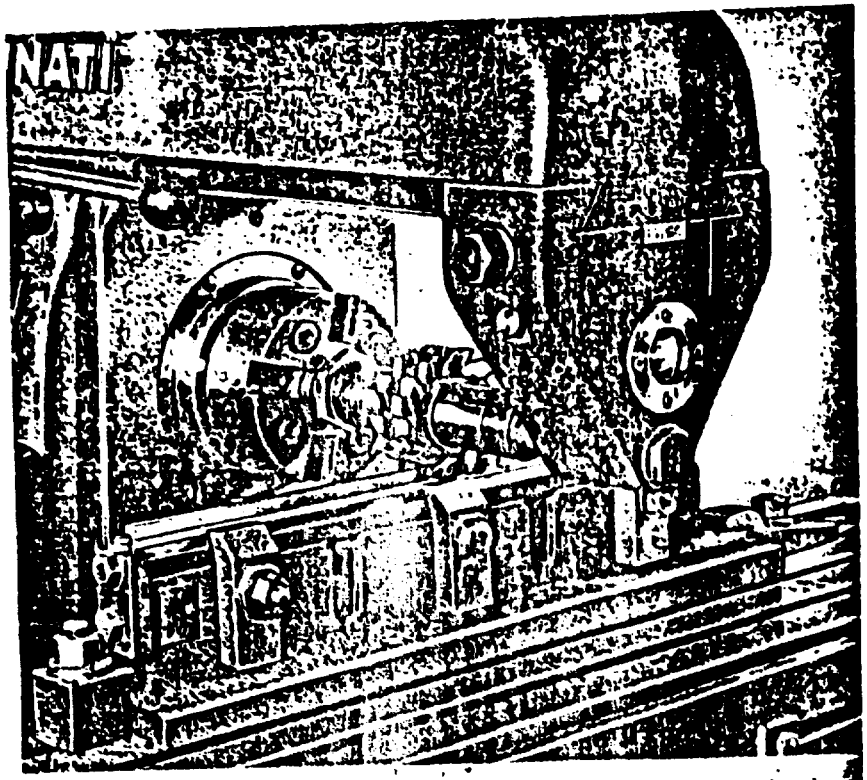
Bushing Plate (Removable)



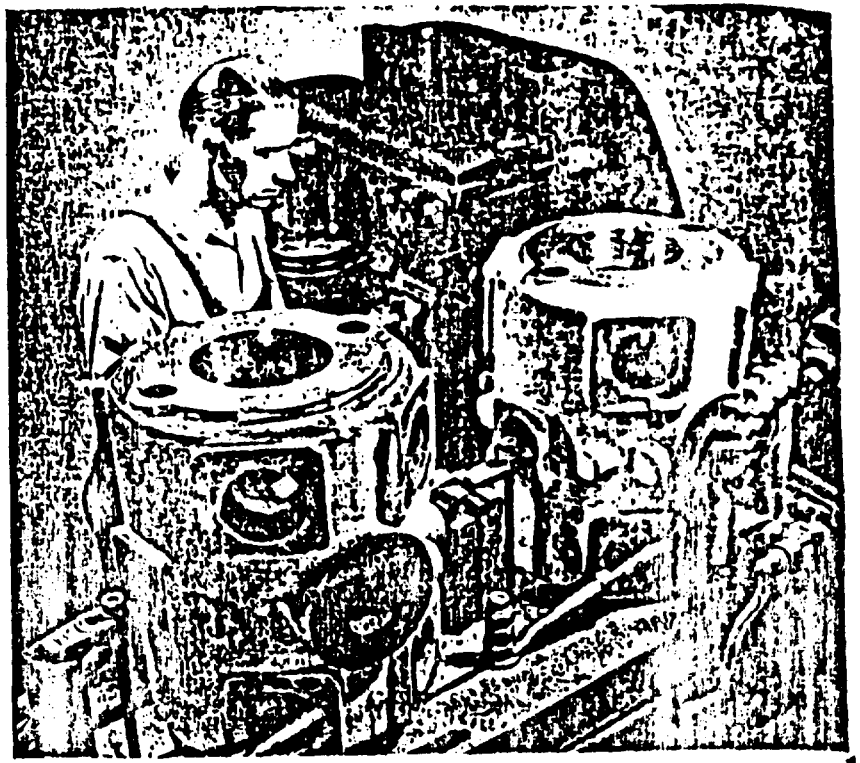

—Essential elements of a hand-clamped fixture designed for locating and holding a cylinder head to simultaneously mill four slots and two side bosses.



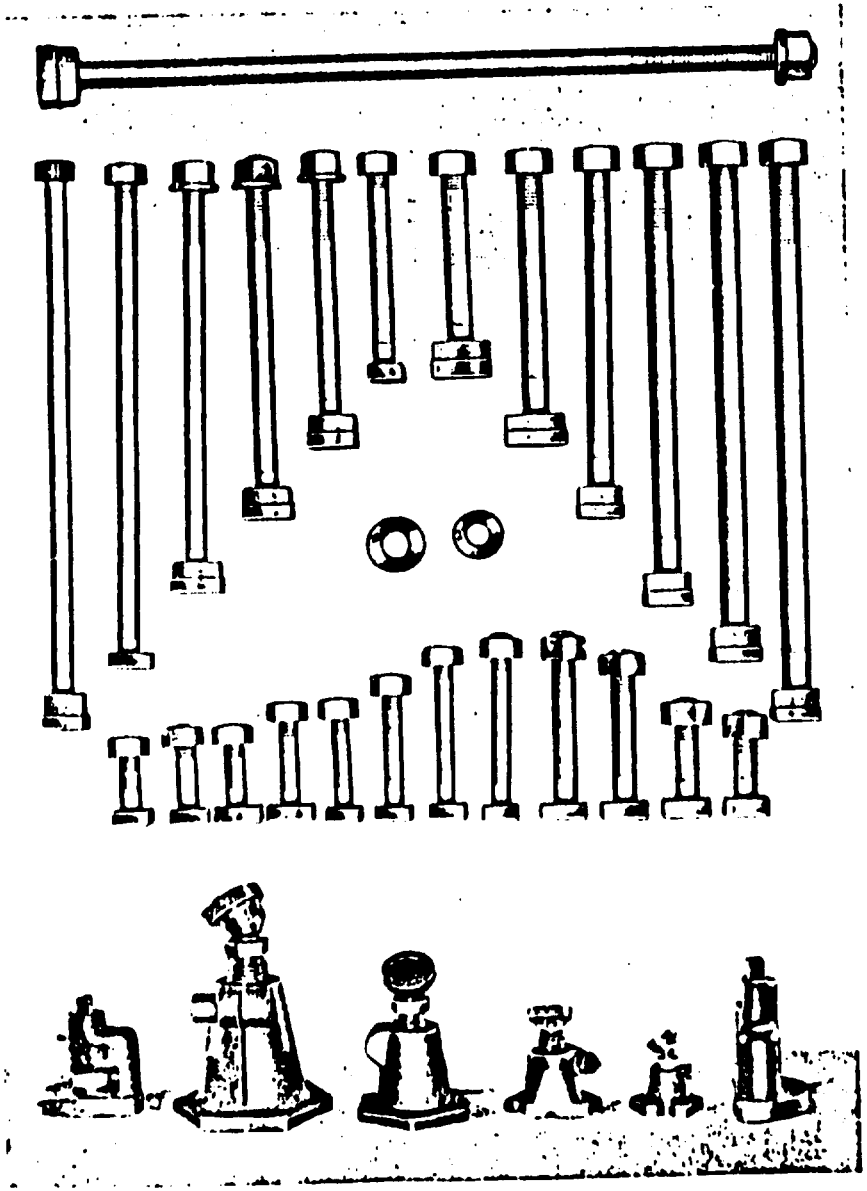

—Hand-operated, block-type fixture for holding a cylinder block, showing fixed locating pins placed diagonally with respect to rest blocks.



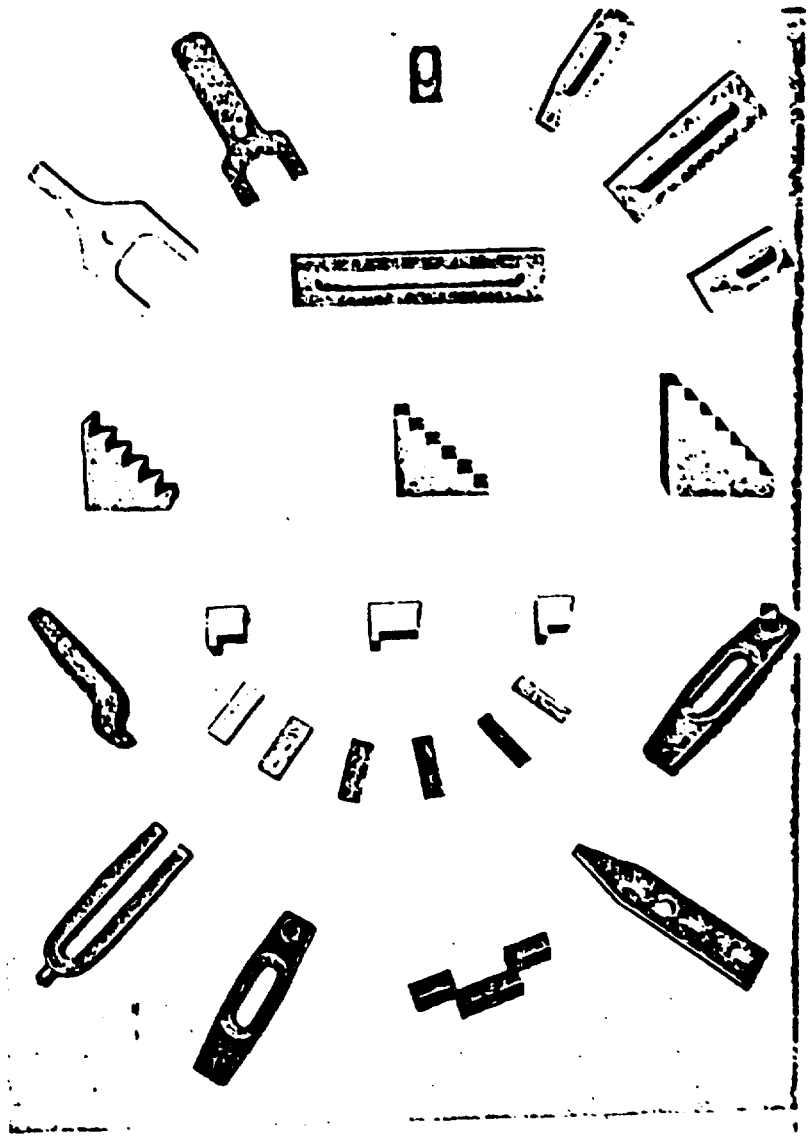
Clamping a fixture on the machine table by means of end



—Set-up made on a manufacturing milling machine by improvised clamping and locating means from commercial or "home-made" units.



Samples of *T-slot bolts and jacks* for temporary set-ups on milling machines.



— Samples of *step blocks, parallel blocks and various types of clamps* for temporary set-ups on milling machines.

APPENDIX VII

VENDOR DEVELOPMENT & TRAINING CELL
(PAKISTAN AUTOMOBILE CORPORATION LTD)

# QUALITY-CONTROL-CIRCUIT

BY S.E. MANSOUR
UNIDO Consultant
Automotive Manufacturing

The quality control circuit is a procedure for problem solving. A problem is defined in the terms used in QC circuit as follows:-

**"A problem is a desirable result of a job"**

The solution of a problem is to improve the poor result to a reasonable level. The causes of the problem are investigated from viewpoint of facts, a cause and effect relationship is analyzed precisely. Decisions based on imagination or check theory are strictly avoided. Counter measures for the problem are devised and implemented to prevent the causal factors from recurring. The procedure is a kind of story in the activities of quality control and this is why people call it the Q.C. circuit.

A problem is solved according to the following steps:-

| | | |
|---|---|---|
| I) | Problem: | Indication of the problem (What is the problem) |
| II) | Observation: | Recognition of the features of the Problem. |
| III) | Analysis: | Finding out the main causes. |
| IV) | Action: | Action to eliminate causes. |
| V) | Check: | Conformation of its effectiveness of the action. |
| VI) | Standard-ization: | Permanent elimination of the causes. |
| VII) | Future Planning | |

If the above mentioned steps are clarified and implemented in this order, the improvement activities will be logically consistent and steadily accumulated. This procedure seems some times to be round about for solving problems, but in the long run it is the shortest and more over the shortest route.

**How to proceed:the Quality Control Circuit:**

I) Problem:

Define the problem clearly.

Activities:

1) Show that the problem being handled is of much greater importance than any other problem.

2) Show what the background of the problem is and what its cause has been so far.

3) Express in concrete terms only the undesirable results of the poor performance. Demonstrate what it has in performance in the present situation and how it will be after improvement.

4) Set up a team and a target, and subteam if necessary.

5) Nominate a person to take charge of the task officially and the team, if any.

6) Make a schedule for the improvement.

Notes: a) The circumstances of the problem should be clearly identified.

b) Give reasons for the importance of solving the problems and what advantages will be gained.

c) it would be unlogic to try to describe causal factors and provide remedial action while the problem is at explanation stage, but later, on the analysis stage. Only the results of the problem are expressed.

d) State the deadline for reaching the solution of the problem.

**II. Observations:**

Investigate the specific features of the problem from a wide range of different viewpoint.

**Activities:**

1. Investigate four points (Time, place, type) to discover the features of the problem.

2. Thus investigate from many different points of view to discover variation in the result.

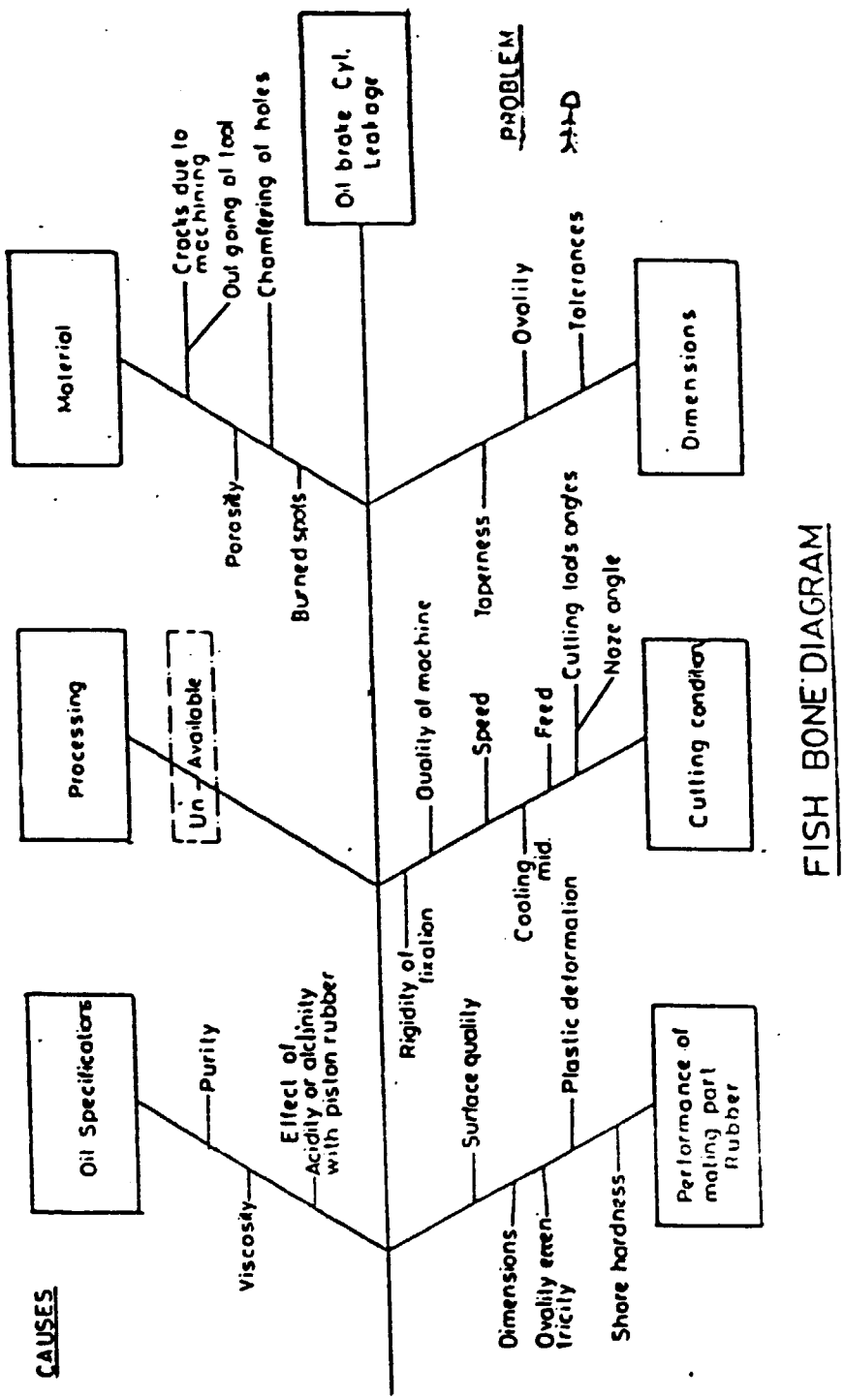
3. Go to the site and collect necessary information, if necessary.

**Notes:** Investigate the problem from diff. point of view and gain a full understanding of all its features. Be very careful, do not touch on the causes for the occurance of the problem. Skilled criminal investigation and private detectives always thoroughly investigate the site of the crime before they do anything there and gradually tighten the nose around the suspect.

## III. Analysis:

Find out what the main causes are.

1. Write down the cause and effect diagram as follows:




FISH BONE DIAGRAM

2. The diagram contains all elements related to problem, so as to collect all knowledge concerning the causes.

3. Use the information obtained in the observation step and delete any elements which are clearly not relevant.

4. Derive the main causes from the candidates.

5. Integrate all the information investigated and decide which are the main causes.

6. If possible, intentionally reproduce the problem.

**Notes:**

This step is devided into two parts, the first being setting up the causes and the second varifying causes. The reason of that is to determine scientifically the causes. The cause of the problem is determined through discussion among those who are concerned with solving the problem.

The statistical procedure should be as follows:-

1. To step up causes, a cause and effect diagram (Fish bone diagram) is a useful tool. The diagram must contain the elements which will ultimately be identified as the main causes.

   a) The expression of the effect in the diagram must be as concrete as possible, since it is expressed in abstract terms, the number of elements in the diagram will become tremendously large. Thus the more concrete the expression of characteristics the more effective the diagram.

First draw up a cause and effect diagram that has enough elements including all the opinion of those involved in solving the problem.

b) Investigate all the possible causes that would not be effective, so at this point we have to reduce the number based on the data. The information examined in the observation step will be very useful for this. Elements that do not correspond to the variation of results are removed from chart. If various dispersed results have been examined in the observation step, we can remove many of the possible causes from the diagram. After elements which cannot be causes have been removed in this way, we take another cause and effect diagram, using the remaining elements. The smaller this diagram (No. of elements), the better.

c) All elements in the revised diagram do not have the same probability of causing the defect. The elements should be ranked according to their possibilities on the basis of the informations collected from observation step.

2. We must avoid making decision on main causes through "votes". Determining the cause by voting is a democratic method, but there is no guarantee of its scientific correctness.

3. The main cause is one or several elements which have the greatest influence on the results. Remedial actions should be taken against factors of major causes and not against those who have minor effect.

**IV. Action:**

Take action to eliminate the cause.

**Activities:**

1. A strict distinction must be made between action taken to (immediate remedy) and action taken to eliminate causal factors (preventing recurrence).

2. Make sure that the action will not create other problems (side effects). If they do, adopt other actions or select remedies for the side effects.

3. Select a number of different proposals for action, examine the advantage and disadvantage of each and select those which the people agree to.

**Note:**

1) There are two types of action. One for handling quick results, while the other to prevent the factor causing the result from occuring again. For example if we produce a defective produt, we will repair it. Even if we succeed in repairing, but this will not prevent the defect from occuring in the future. The ideal way of solving is to prevent from happening again by adopting remedies to eliminate the cause of the problem.

2) Actions often cause other problems, similar to medicines which cure the desease but cause side effects. To prevent the side effects, the action has to be thoroughly evaluated and judged from a wide range of various points as possible. If side effects have to arise, consider another action or a remedy to the side-effects.

3) An important practical point in selecting actions is whether or not the active cooperation of all those involved can be secured. The action must be that every one agrees to. If there are many counter measures, the advantage and disadvantage of each measure should be examined from every point of view of the people involved. In the final decision, if there are several possible solutions that satisfy economical and

technical conditions equally well, it is better to select one on democratic basis.

**V. Check:**

Make sure the problem is prevented.

**Activities:**

1. In the same formal (tables, graphs, charts) compare the results both before and after action.

2. If there are any other effects, good or bad, list them.

**Notes:**

1. In the check step, we ask "to what extent the recurrance has been prevented?" In the check step, a comparison of the situations before and after actions is carried out to determine to what degree the undesirable results have been reduced. The formal (tables, graphs, charts) have been used before and after action must be the same.

2. When the results of the action is not as satisfactory as expected, make sure that all planned actions have been implemented precisely according to the decision. If the undesirable results continue to occur after action have been taken, it is necessary to go back to the observation step and start again.

**VI. Standardization:**

Eliminate the cause of the problem permanently.

**Activities:**

1. The five W's and one H : who, when, where, what, why and how for the improved job must be clearly identified and used as standard.

2. Necessary preparations in regard to the standard should be carried out correctly.

3. Education and training should be implemented.

4. A system of responsibility must be set up.

**Notes:**

1. Remedial actions must be standardized to prevent the problem from occuring permanently. There are two main reasons . The first is that without standards, the actions taken to solve the problem will gradually revert to the old ways and lead to the occurance of the problem. The second is that without clear standards, the problem is likely to occur when new people become involved into work.

   Standards must be apart of the thoughts and habits of the workers. Education and training are needed to provide them with the knowledge and technology to implement the standards.

**VII. Future Planning:**

Review the problem-solving procedure and plans for future problems.

**Activities:**

1. Think about what has gone well and bad in the previous activity.

2. Sum up the problems remaining.

**Notes:**

1. Some reflecting thinking should be given to the personnel who attended the problem solving. This will aid in upgrading the quality of subsequent improvement activities.

2. A problem is almost never perfectly solved and the ideal solution almost never exists. It is not good to aim for perfection and to continue the same activity on the same team for too long. When the original time (fixed) before was reached, it is better to de-eliminate the activity even if the target is not reached. In this case a 2nd team can be selected. Programming the problems and estimating time is necessary for repeating the same procedure.