HANDLING COMPLEXITY IN A SMALL ENGINEERING BUSINESS

IN TWO VOLUMES

VOLUME 2

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SUBMITTED FOR THE DEGREE OF MASTER OF PHILOSOPHY

THE UNIVERSITY OF ASTON IN BIRMINGHAM

NOVEMBER 1979

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CHAPTER 4

EVALUATION OF POTENTIAL SOLUTIONS TO P & ED'S PROBLEMS

4.1 Introduction

There were two basic lines of approach which could have been taken in seeking out methods to handle the problems of P & ED:-

1. Handle the complexity of the existing situation.
2. Change the situation in order to reduce or simplify the complexity of the problems.

Because P & ED's management could provide no quantitative proof that a change in the situation would not be against the best interests of the Group as a whole - even given that there might be significant advantages for the Division on its own - the Group Directorate was not prepared to even consider any alteration of P & ED's role and operations until the Division had exhausted all possible methods of improving the situation as it existed.

The first part of this section considers the measures which were or might have been taken to handle the complexity under the following headings:-

1. Rationalize the product range - investigate new product areas and reassess involvement in existing areas.
2. Examine and re-appraise the Division's resources - direct labour, staff, machines, material stocks and site.
3. Reform the organizational structure - replace the purely functional structure with a more appropriate "mixed" or "matrix" one and define lines of responsibility more logically.

4. Co-ordinate and integrate the efforts of the various departments - increase formal procedures for information flow in the light of the failure of informal communications.
5. Investigate control systems to govern and monitor shop floor activities
6. Seek re-definition of P & ED's status and role - as a profit centre within the Dunlop Union and as an operating division within Engineering Group.

One further method was added at the prompting of the Group Directorate in the belief that P & ED's problems resulted from a poorly-motivated direct labour force: link performance to remuneration - introduce an incentive payments scheme.

The Division's management had previously found it impossible to reach agreement with trade union representatives on such a scheme and indeed, the suggestion that it might be of value in helping to improve P & ED's performance indicates more than anything else a lack of understanding at Group level of the character of P & ED's business. First, as Robbins notes, selection of the correct criteria for evaluation is absolutely crucial: "Employees alter their behaviour so that they look good according to the criteria on which they are being evaluated, even if it is detrimental to actual job performance or to the organisation itself" (1).

For this type of firm, Radford and Richardson suggest that: "Due to the probable inaccuracy of the allowed times, premium bonus schemes..... rather than incentive schemes in which earnings are directly proportional to effort should be used" (2). Woodward's research also led her to the conclusion that "a financial incentive is not the most appropriate system of payment for unit and small batch production" (3).

In fact, P & ED's management never made any serious attempt to reach agreement on an incentive payment scheme with the workforce: the latter showed no interest in a method of remuneration which could only be interpreted as devaluing the skilled and highly individual type of work in which they were engaged.

4.2 Product Rationalization

Whereas product rationalization could not of itself solve P & ED's problems, it did represent an element in the puzzle which could be considered without pre-supposing any improvements in the other areas. The Division's financial position would be certain to improve if it was able to:-

1. Only take on jobs upon which it could be sure of making a profit, and
2. Enlarge its activities to incorporate new products, or product areas, with good profit potential.

4.2.1 Re-evaluation of the Existing Range of Products Produced

As a result of the 1975 Production Evaluation Report (Chapter 3, Appendix 2) and an examination of the Product Results figures for the years 1970-1975, it appeared to the researcher that these were two areas in which the Division might do well to take a more cautious approach to the acceptance of orders:-

4.2.1.1 Tooling Work for Outside (Non-Dunlop) Customers

Besides being a method of using up spare capacity in P & ED's Coventry machine shop, this type of work represented both a possible growth area for the Division and also a business on which a higher customer contribution might be exacted, because of the absence of transfer-price constraints. However, this was a competitive market, particularly in the difficult economic conditions which prevailed in 1975, and P & ED found that the only contracts which it was regularly able to obtain were either for orders where a particularly high quality product was required

or where the uncertainties and risks involved in production led other firms to quote artificially high price or not to submit quotations at all.

In the five years from 1971-1975, the contribution achieved on this type of business only once exceeded that achieved on internal tooling work and in the last two years the contribution was a bare 9% against an average of 31% for internal tooling (4). In rationalizing the attitude towards outside tooling orders it was decided that, whereas the high quality work should still be accepted, even sought after, the risky "one-off" jobs should be avoided.

4.2.1.2 Special Purpose Machinery Outside of the Rubber Technology Industries for External Customers

Much more disturbing, from the point of view of the Division's growth prospects, was the consistently poor performance of this business group. Over the four years 1972-1975 it averaged only a 14.3% contribution and made up less than 4% of total turnover and 2% of total contribution (5). To a certain extent, this may be justified in terms of the need to accept low contributions as a means of establishing the firm in new technological areas. In this case, however, one would expect the figures to show a gradual improvement over the four-year period, whereas the Product results tables in fact show a marked deterioration in the situation.

P & ED's management saw the uneconomical production of parts by the machine-shop as the major contributing factcr to the poor performance of this product category and sought an answer by allowing an increasing proportion of parts to be sub-contracted at fixed prices to outside suppliers. As the extreme example given in figure 3.11 suggested, however, a major problem was also the poor estimating at the quotation stage on jobs in

areas where the Division had little or no previous production experience.

If specific growth areas in non-rubber technology industries were identified, then suitably experienced sales estimators were essential if planned contributions were to be achieved. The only regular source of work in this product group was the nuclear processing industry and an estimator had been assigned to deal with all work for this customer. The beneficial effect which this had on predicting costs and contributions is demonstrated by the results for this category of business given in the 1976 Product Results table, included in Appendix One, which shows an overall contribution of 34% for the year. The Accounts Department's analysis of sales by customer for this same year notes that over £½ million on 80% of turnover in this category was made up of sales to the nuclear processing industry (6).

4.2.2 Attempts to Establish New Products

The areas in which new products could be sought by P & ED were restricted by a directive that all products manufactured by members of Engineering Group should have a basic "engineering" character. This was part of a common sense Dunlop corporate policy of establishing strategic business areas to prevent "interdivisional overlaps of product lines and markets" (7). A further limitation came from the small budget which P & ED, considering its existing financial problems, could afford to set aside for research and development work.

Rather than seeking to develop its own new products, therefore, the Division looked to expand its product range through obtaining licences and concessions to manufacture items developed by other companies. The restricted capital which was available for new products led management to

turn down the idea of manufacturing "spark eroding" units - a new method of making items requiring extremely high accuracy. The developer was asking effectively that P & ED should produce a number of units to be held in stock, which he might then call off for immediate delivery as and when buyers were found. This involved tying up a large amount of capital in stocks and P & ED took all the risk of a lack of interest on the part of the potential market, especially significant considering the difficult economic conditions at the time.

One industry which was expanding at this time, however, was North Sea Oil. P & ED attempted to benefit from this expansion through agreements reached with two American firms:-

1. A licence was purchased to produce a range of slush pump liners for the European and Middle Eastern markets. For practical purposes, P & ED would be sub-contractors to the Texas firm, who retained responsibility for marketing the product and submitted invoices direct to the customers.
2. A second licence was purchased to produce and sell, in Europe, pipeline servicing equipment consisting of a range of sparkless bevel cutters and a "flange-facer" - to give a fine finish to pipe ends which were to be bolted together rather than welded. As these agreements preceded the start of this project, the chief concern of the researcher was to analyse their performance over the first two years and arrive at conclusions as to the causes of their failure.

4.2.2.1 Expendable Slush Pump Liners

The planned output figure on the 1975 Product Results table shows that the Division was highly optimistic about the potential of this product, but in the event the actual output figures for 1975 and 1976 show that this

YEAR	PLAN (£)						ACTUAL (£)					
	SLUSH PUMP LINERS		PIPELINE SERVICING EQUIPMENT		METRICATION		SLUSH PUMP LINERS		PIPELINE SERVICING EQUIPMENT		METRICATION.	
	OUTPUT	CONTRIB-UTION.	OUTPUT	CONTRIB-UTION	OUTPUT	CONTRIB-UTION	OUTPUT	CONTRIB-UTION.	OUTPUT	CONTRIB-UTION.	OUTPUT	CONTRIB-UTION.
1975	400,500	111,400	136,500	42,300	NO FIGURES		65,643	(7,817)	620	182	NO. FIGURES	
1976	229,352	39,870	38,158	11,448	50,000	14,286	53,247	7,257	31,987	(87,205)	12,642	3,710
TOTAL	629,852	151,270	174,658	53,748	50,000	14,286	118,890	(560)	32,607	(87,023)	12,642	3,710

FIGURE 4.1 : PERFORMANCE OF P.&E.D.'S NEW PRODUCT LINES, 1975-1976.

(NEGATIVE CONTRIBUTIONS ARE IN BRACKETS)

optimism was unjustified. Figure 4.1 shows the results for the new business over two years. Less than 20% of the expected output total was achieved and there was a negative contribution.

Moreover, the figure for 1976 would have been much worse if it had not been for the fact that the product area was terminated and, under the terms of the original agreement, the American firm purchased all remaining liners held in stock by P & ED. This transaction accounted for 80% of actual turnover for 1976.

Briefly, the reasons identified by the researcher for the failure of this product were:-

1. P & ED had no control over the marketing effort.
2. It thus had no research to substantiate its optimistic predictions about the output to be expected.
3. Because of the contribution added by the licensing company, the product was priced higher than it would have been if sold direct by P & ED, and the Division had no control over the final selling price.
4. The liners were "expendable", or needing fairly regular replacement, because of a fragile inner sleeve; however, an improved, longer life sleeve was developed by a competitor, virtually ending the product life cycle of P & ED's liners.
5. It seemed to the researcher that problems might have been encountered anyway in the longer term because of the addition of yet another variety of production, small batch repetitive operation, to the already complex situation noted in Chapter Two. The attempt to move from a situation with "many exceptions" to a more predictable, and thus controllable, one is noted by Perrow to be far from uncommon and far

from generally successful (8).

4.2.2.2 Pipeline Servicing Equipment

A lower output total was planned for these products over the first two years, but actual performance was even worse than on the liners (see figure 4.1). To the time when, at the end of 1976, it was wound up, it had made a loss of over £87,000. My analysis of the poor performance of this business led to basically the same conclusions as for that above: there had been insufficient investigations of how the European market would react to what was certainly an advanced product, technologically, and was one which had, according to the licensing company, shown great potential in the American market.

The investigation revealed, however, that the details were rather different here:-

1. P & ED discovered deficiencies in the design of the products when manufacturing prototypes and undertook the development work required at its own expense.
2. The Division was responsible, in this case, for the marketing side of the project and, as such, had to provide and maintain a demonstration unit to visit prospective customers.
3. Although technologically an advance on torch cutters, the equipment was very much more expensive and there was insufficient proof of specific areas of dissatisfaction with torch cutting.
4. The element of extra safety as a result of the new cutters being "sparklers" had to be offset against the difficulty of using them in adverse conditions.
5. Although the range of standard cutters could cope with pipe diameters from 2" to 60", each single model only had a range of 6", and it was necessary to have a certain amount of clearance around the pipe in order to give the cutter room to operate.

4.2.2.3 Metrication of Machine Tools

This third new product area was never expected to have more than a very short term life-span. The government had decided in 1965, that the United Kingdom should change over to the metric system of measurement, and when the service was launched by P & ED in 1975 it could only have been expected to catch a last minute rush from companies which had made no arrangements to convert their machine tools before the country became substantially metric in 1976.

Output for 1976 (see figure 4.1) was only a quarter of the planned figure and, rather than being a more-or-less full time occupation for one of P & ED's commissioning engineers at times when work elsewhere for these men was scarce, metrication became little more than an inconvenient distraction. It was rarely possible to quote prices for metrication work without an engineer visiting the prospective customer's premises and, although the cost of such a "survey" could be reclaimed from the subject firm, it meant that the engineer was not available for consultations and emergency service work which was part of the after-sales function offered to customers for special-purpose machinery.

Possibly, if the service had been made available shortly after the establishment of Dunlop's own metrication panel in 1969, a useful business group might have built up by the middle '70's. As it was, by 1975, major firms had all made their own metrication arrangements.

4.3 Resource Rationlization

The information upon which management could make decisions upon adjustments to the resources employed by the Division was limited by the lack of accurate information on the machine shop load situation. The huge backlog

on Group tooling orders in the first few months of 1975 (see figure 3.10) would seem to suggest that there was at least sufficient work to keep this area occupied fully, whereas there was so little work in the assembly area that the fitters were put on a 3-day week early in 1975.

In view of the overall deficit for 1974, it was felt that, in line with the rationalization of the kinds of orders accepted by the Division, some reduction in expenses, primarily through labour force reductions, was essential. To prepare the ground for negotiations with the trade unions involved, Divisional Management first instituted an overtime ban and then put the whole of the workforce on a 3-day week.

4.3.1 Direct Labour Force

Unfortunately, the Accounts Department's statistics for this period do not distinguish between the machine shop and assembly shop labour forces. The researcher did find, however, that there were grounds for management's assertion that the Division was overmanned.

Over 1974 as a whole, the cost of time "waiting for work" amounted to £35,700, only 5.6% of total variable factory costs. But of this figure, almost half (£16,700) was accumulated in the last two months of the year. Despite short-time working, waiting time during the first three months of 1975 cost £11,500, 8½% of variable factory costs (9). Negotiations with the trade unions led to a call for volunteers for redundancy. Because of the generous system of redundancy payments which existed, there were more than sufficient volunteers forthcoming. This at least allowed management some choice as to which operatives to let go. I noted an obvious practical disadvantage to the Division, of a voluntary system: that the best machinist and fitters were the ones who most readily applied, since they were the ones

who would have the best chance of finding posts elsewhere. The other group ready to apply were the younger element, who could offer potential employers a long remaining working life without the expense of training and apprenticeship.

The outcome was a reduction in the number of direct staff by 56, to a total of 154,between the end of 1974 and the end of 1975 (10). This was made up of 46 voluntary redundancies at the end of March and the remainder by natural wastage through retirement and early retirement.

4.3.2 Indirect Labour Force

No study had ever been carried out to establish the amount of unproductive time which was occurring in the pre-production departments and the decision appears to have been fairly arbitrary that the staff in these departments should be reduced in proportion with the direct labour force. This appears from the fact that the ratio of operatives to staff only rose from 1.76:1 at the end of 1974 to 1.81:1 at the end of 1975 (11).

The reduction in staff employees of 34 came from the lower clerical levels. With the exception of one foreman from the machine shop and the production controller from the assembly shop, both of whom retired during the year, their duties being assimilated by existing staff, there were no redundancies amongst the management levels. One middle manager described the resulting situation as being one of "all chiefs and no indians", but changes to the functions and responsibilities of various managerial staff, which are dealt with under "structural reforms" in Section 4.4, provided justification for retaining staff needing a lesser degree of direction and supervision from above.

4.3.3 Material Stocks

The Division decided, with Group approval, to transfer its £40,000 worth of raw material stocks to Engineering Group stocks and to obtain materials as required from these stocks or outside suppliers. Even in an inflationary situation, where material prices were increasing quite often sometimes by considerable amounts, it was found to be more expensive to carry material stocks than to purchase quantities as required. The reasoning behind this lies in the unpredictability of material and dimension requirements in this type of business rather than in a quantifiable comparative cost analysis.

4.3.4 Machinery

In view of the reduction in the direct labour force during 1975, it is perhaps surprising to find that there was not a similar reduction of fixed assets in Plant and Machinery. The book value of these assets at the end of 1974 was just under £190,000 and sales and transfers during 1975 amounted to only £3,400. With depreciation for the year of £46,000, this left a total of £140,400 tied up in Plant and Machinery at the end of 1975 (12). However, it was machines which had already been written off - i.e. had no book value - which represented the facilities on the turnin milling and grinding sections which were seriously under-utilised.* Potentially, the increased ratio of machines to machinists raised the scope for mobility of the labour force between machining sections, in line with demand fluctuations, although this obviously relied upon successful resolution of the workload control problem, examined below in section 4.6.

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* Naturally, in itself this does not mean that the machines had no re-sale value, but the researcher's discussions with the Chief Inspector of P & ED, suggested that the age of the equipment rendered breakdowns increasingly likely should they be required for more than occasional usage.

4.3.5 Site

By the end of 1975, P & ED had secured the right to use the floorspace adjacent to its administrative offices (see site plan, figure 1.2) and the area had been cleared in preparation for the re-location of the Division's assembly area and stores during the first months of 1976. The rationalisation was, as I have already pointed out, both far more convenient liaison between the Production Planning Department and the production staff and to ensure closer integration of purchasing activity with stores records.

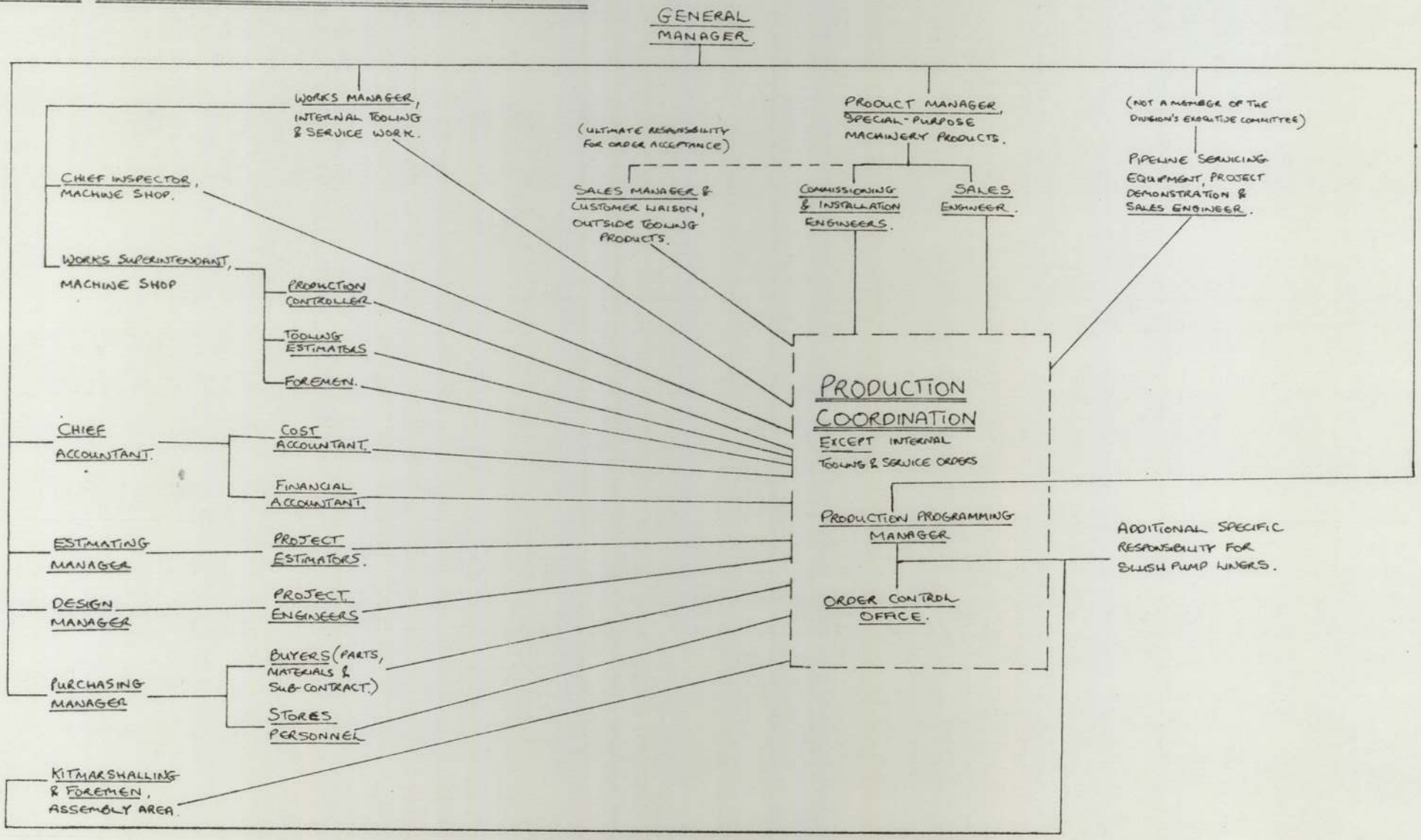
4.4 Reform of Organisational Structure

In line with the accepted differing characteristics of the two basic types of business in which P & ED was involved, outlined in Chapter 2, Section 5, the structure of the Division was altered from the imprecise but basically functional format, described in Chapter 3, Section 4, to a mixed structure more along the lines of that suggested by the researcher and outlined in Chapter 2, Section 7.

Figure 4.2 gives an impression of the new structure as it should ideally have worked. Being a description of an actual business, it would be expected to be more complex than the diagrams in Section 7 of Chapter 2 (figures 2.4 & 2.5). Indeed it has been simplified here in the interests of clarity: it suggests, for example, that inter-departmental communications only took place through the medium of the co-ordination area, whereas this was only true of information which was not specific to two departments alone.

Brief notes are given below in explanation of the structural changes.

FIGURE 4.2 REFORMED ORGANIZATION STRUCTURE OF P.R.E.O., APRIL 1975.



4.4.1 The Administrative Area

On retirement of the Marketing Manager, the Division employed a new senior manager to have responsibility for operations within the special purpose machinery business area. In the main, this still concerned machinery for rubber technology industries, but opportunities to take on work outside of this area were still sought as a means of divisional expansion, and it was this manager's final responsibility to ensure that quotations were made for such work with genuine profit in view.

The less important outside (non-Engineering Group) tooling product group did not justify employment of a product manager at the executive or senior management level and was made the responsibility of a middle manager (previously the Production Administration Manager). The Machinery Product Manager acted mainly in an advisory capacity over this new "Sales Manager", though with the proviso that any large contracts should receive his approval before quotations were issued or orders accepted.

All orders for Group tooling work were now sent direct to the Works Manager, who was ultimately responsible for all activities carried out in the machine shop. Initial responsibility for the development of the pipeline servicing equipment was given to a project engineer, reporting direct to the General Manager. Along with co-ordinating interdepartmental information flow, the Production Programming Manager was given specific responsibility for the slush pump liner production programme.

4.4.2 The Machine Shop

The day-to-day running of the machine shop was the responsibility of the Superintendent. The Production Controller - previously subordinated to the Production Programming Manager - was now also responsible to the

Works Manager. If his status was reduced to that of a subordinate of the Superintendant, in reality this had always been the case because of his lack of power to influence shop floor activities except through this manager. In exchange for accepting the actuality of subordination, he gained a position from which he could draw the attention of a common superior to shop floor shortcomings, faults or plain obstructive actions. He and the Superintendant could now establish common overall objectives for both to strive towards.

It seemed to the researcher, however, that the ability of the Production Controller to influence activities, enhanced by moving within the Works Manager's department, was summarily reduced by the redundancies. From a staff of six progress chasers, a shop-loading clerk and two terminal operators, he retained only one terminal operator and three progress chasers, who were to become "material handlers", or little more than labourers. Providing that this was compensated by a greater emphasis to foremen on their administrative duties, so that they would issue work to machinists as nearly as possible to an order notified to them by the Production Controller, there would be an improved chance of orderly progressing of jobs through the shop and removal of the progress chasers would represent a genuine saving on indirect labour.

An essential part of the role of the progress chasers under the previous system, however, had been not simply to communicate the wishes of the Production Controller to the various sections, but also to supply him with job progress information from which to calculate future operation priorities and potential job completion dates. Unless this information was forthcoming from another source - perhaps a new computer-aided control system - the Production Controller's role would continue to be little above that of a glorified information officer, answering queries from

sales staff of P & ED and procurement staff from other divisions within the Group. The one major change, indeed, would be that he would not now have a staff to whom to delegate the checking up of job progress.

The foremen could now expect close scrutiny of their achievements by the Works Manager. Before the changes, his occasional visits to the shop floor had been narrowly preceded by a sudden rush of activity, particularly from supervisory staff. Now, by reserving for himself a parking space immediately outside the machine shop entrance, he served notice that his visits were to be more frequent and of longer duration.

Moving a section of estimators onto the machine shop floor to deal with internal tooling work was a commonsense method for saving these jobs, the majority of which were small and of short duration, from having to go through the whole of the administrative area's routine procedure. Administrative time was saved and the customer could be offered a reduced throughput time.

The one pecularity which I noted in the new job estimating system concerned machinery parts and outside tooling work which were designated to be manufactured "in-house". Because the Works Manager had effectively been given the task of proving whether or not the machine shop was capable of paying its way and justifying its continued existence, he and the shop floor supervisory staff had to be allowed to reject any estimates for those types of parts or jobs, sent down by the administrative area, which they considered to be too low. What this meant ultimately was that all machinery parts and outside tooling work might end up being estimated twice, which was clearly a waste of manpower. The practice was then adopted for outside tooling jobs of submitting the job immediately to the

machine shop estimators. If their costing of the job gave the required profit on the sale, the work would be left with them. If it did not, their estimates would be used as a basis for negotiations with sub-contractors. Because all the estimators were basically "out of the same stable", there was rarely a major disagreement on operation times between the two areas except in the case of very lengthy operations where the shop floor estimator might take the advice of the actual machinist who was likely to be involved.

4.4.3 The Assembly Area

This was probably the least affected of the three areas of P & ED by the structural reforms, which is appropriate as it was the part in which the fewest problems were identified. As long as the right parts arrived for kitmarshalling by the right times, there were few delays in this area: none, in fact, where tyre-making equipment was concerned, but occasionally some modifications as a result of faults discovered at the commissioning stage on other special-purpose machinery contracts.

The rationalisation of the lines of responsibility in the machine shop made it easier to chase up any parts which did not arrive on schedule for kitmarshalling in the assembly stores. Information on parts purchased from outside suppliers was brought under even closer control following the retirement of the Assembly Area Production Controller and the assumption of his duties by the goods inwards clerk, who received order progress reports direct from the Buying Department.

Subordination to the Production Programming Manager meant that the assembly supervisors were well placed to have access to any information which they required from other departments. Until early 1976 there remained, however, the problem of the actual distance between the project engineers, in the

administrative area and the fitters and electricians. Close liaison was required where problems or modifications arose and it was both inconvenient and inefficient to have a situation where the assembly area was virtually at the opposite end of the site to the design office.

4.5 Co-ordinate & Integrate the Efforts of the Various Departments

4.5.1 Rationalisation of Job Coding Procedure

The Production Planning Manager took action at the end of 1974 to rationalise the job coding and numbering system in order that all work should have a unique numerical identity from the quotation stage, facilitating the matching of serial numbers on the operation computer punched cards directly with job numbers. Whereas it is difficult to justify his assertion, in introducing the changes, that: "It paves the way for the initiation of a far tighter shop floor control and monitoring system"(13), which suggests that it was a major innovation and not a mere rationalisation, it certainly did provide a basis for "automatic collation of shop floor data by business mix category"(14). This allowed the areas of responsibility of the staff responsible for different business areas to be clearly distinguished.

The new system was not without its problems, however. It did, through the maintenance of a single unique number from the enquiry to order acceptance stage, make it possible for me to analyse the ratio of orders returned to quotations issued for each type of business, which might be used as a basis for deciding either where a more active marketing strategy was required or where a more selective approach was justified in the production of detailed quotations. But the various product business codes defined groups such that a vast range of job values were encompassed within each: jobs due for delivery to Dunlop rubber technology equipment customers during March 1975 included one valued at only

£66 for some modifications and one for over £15,000 for a fairly small machine; at the same time, tooling jobs for outside customers included an £11 saw machine tape repair job and a £7,000 contract, made up of a number of articles, but covered by a single job number.

The order value distribution statistics produced in Chapter 3, Appendix 4, confirm that this was true for all job categories which the researcher analysed. The effect of this vast range of values was to devalue the meaning of the statistics showing the return of orders on quotations. It was obviously important not just to have the ratio expressed in terms of absolute numbers, but also to have some idea of returns according to value.

I found that modifications also presented a problem under the new system - one which had also existed under the old coding system. For costing and charging purposes, it was important that all extra work should be separately identified for the Accounts Department. This was done by retaining the unique four digit job number and replacing the 'X' prefix with a 'Z', Unfortunately, the existing computer data collection system sorted first according to the prefix and a manual search was thus necessary in the Accounts Department to ensure that all costs and charges were picked up at the conclusion of a job.

The list issued to show the new codes and the ones which they replaced is included as Table A in Appendix One.

4.5.2 The Job Delivery Schedule

This monthly report was also introduced late in 1974 by the Production Planning Manager and was central to the co-ordination of the efforts of

all administrative departments towards a common goal. Its clarity was assisted by the job coding rationalisation noted above.

The schedule was prepared manually from the job progress file kept within the department. It was not possible, because of inaccuracies noted in Section 3.6, to collate the information required for the schedule from the reports of the data collection program and, in order to give the pre-production departments sufficient prior notice of future work, it was also necessary to include jobs from the point of receipt of an order and thus before they had even been entered on the computer file under the current system.

Any revised or new computer aid program would have been expected to save the management time taken up by the production of this report, but for the present it was produced manually, along with summary sheets specifying the production totals expected for the current month in each business category.

The researcher was involved with several revisions of the format of the report before it was finally settled in July 1975 that it should contain a separate sheet for each week's production within the current operating month and a sheet for each month thereafter for which orders had been received. Internal service jobs could not be scheduled in advance and were therefore not included in the schedule. Internal tooling work was also omitted from the end of April 1975, both because it was now the specific responsibility of the Works Manager, and thus details were not available to the Produ ction Planning Department, and also because the load changed considerably within any given month through the arrival of new jobs, many of which had sufficiently short throughput times to prevent

them ever appearing on a schedule.* An agreed average output figure for Group tooling work was thus entered on the schedule summary sheet and it was left to the Works Manager's staff to decide how this total should be produced in any given month.

One serious reservation which the researcher had about information included in the report, which must also be regarded as a reservation for the reformed organisational structure, concerned the sharp division of responsibilities which it drew between "machine shop jobs" and "assembly shop jobs". At this time, spare capacity in the machine shop was still being filled up with production of machinery parts for the assembly area. However, given a £100 internal tooling job needed to reach the prescribed machine shop target and a small component required to complete a £50,000 machine in the assembly area, there was no incentive for machine shop staff to elect to process the second in preference to the first, even though it was obviously in the best interests of the Division as a whole: they were "responsible" for reaching the output target for Group tooling work, but responsibility for getting the machine out on time lay exclusively with the assembly area staff.

Despite my reservations, however, the "delivery schedule" did act as a central operating document for the division and helped to focus the attentions of all departments upon the common goal in terms of output and to examine the overall performance against plan. The current month's schedule was up-dated as a result of weekly meetings with production

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* On the schedule issued on 28th March 1975 for example, only 7 of 125 jobs of this type had delivery dates beyond the end of April specified.

control staff from the machine shop and assembly area. The Production Planning Department summarized the major jobs which these meetings showed to be at risk for completion on time and issued the list weekly along with progressive totals for the current month's output to-date.

Progress on forward load jobs was checked through formal committee meetings with representatives (effectively the "liaison officers" suggested in Chapter 2, Section 7.3) from each of the pre-production departments, which took place on one afternoon per week. These meetings resulted in the issue of pre-production schedules for all major jobs. Initially, the schedules were arbitrarily worked out by the Production Planning Manager, based on reverse or due date scheduling from the promised delivery date. At the next progress meeting, each department would be required to register any difficulties foreseen in keeping to this schedule and if necessary the plan would be amended.

The realization that the detailed schedule could be used not merely for progress information, but also for analysis of departmental performance, gave an incentive to each department to plan the workload in its own area. It also represented a source from which the Production Planning Manager could construct a master schedule, in the form of a wall-chart, for all the major contracts in which the Division was involved.* My major criticism of the operation of the system was that there was insufficient attention to up-dating this chart to reflect changes or falldown on the schedule for particular jobs.

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* This had the advantage over the previous display board, criticised in Chapter 3, Section 5.2, that departmental involvement was shown by the use of easily adjustable cardboard strips placed into slots on the board.

4.5.3 Analysis of the Paperwork System With Reference to the Needs of all Departments

The researcher's concern that available information was not reaching all the departments by whom it was required appeared justified in view of complaints received from various sources during his survey of the Division's problems.

Various attempts to deal with specific deficiencies in parts of the paperwork system were made during 1975.

1. At the end of April, the Production Planning Manager issued flowcharts and notes covering issues of drawings, parts list and modification information by the Design Department (15).
2. The Sales Manager assisted by the researcher issued procedures for enquiry and order processing at the same date (16).
3. At the beginning of February, alterations were made to some of the details input to the computer file in order that:-
   - Punched card serial numbers should become the same as job numbers.
   - The start week as well as the delivery week for jobs should be held on file.
   - The origin of an item requiring machine shop work (i.e. whether it was a bought out part, raw material or "Free of Charge" issue from the customer), should be identified.
4. I designed a form and outlined a procedure for weekly communication of relevant order progress information from the Buying Department, via the Goods Inwards area, to the Machine Shop Production Controller.

All of these brought about some improvements in the specific areas concerned, but the researcher felt that the whole paperwork system needed reappraising and the General Manager set up a committee, with members drawn from all departments, at the beginning of 1976 to define procedures

for all the paperwork connected with an order. As a result of this committee's advice the researcher produced, in March of the same year, the report and flow charts which are given in Appendix 2.

Although my examination of the procedures resulted in approval from all concerned, no steps were taken by management to institute them. By this time, changes of a much more major nature were occupying their thoughts.

4.5.4 Potential Use of Computerized Sorting & Storage of Information As An Aid to Integration

It should be explained that the reason for the piece-meal approach to the problems of interdepartmental information flow and intra-divisional co-ordination was that short-term solutions to specific problem areas were seen to be most appropriate at a time when the Division was investigating various methods of automated data processing. It was envisaged that any system adopted would probably replace some of the existing paperwork and would certainly make modification of procedures necessary.

Because the principal benefits which were sought from a computer system were initially in terms of control of machine shop operations, the programs considered are dealt with in the next section. My objective in terms of co-ordination and integration was to provide a system which would replace some of the manual expedients, such as the many weekly meetings, thus creating the potential for management to rise from a day-to-day administrative function to "entrepreneurial management" - concerned with creating profit potential for the firm through identifying areas of opportunity, creating and developing products for those areas and introducing them to the market, but also concerned with the opposite policy of divestment (17).

4.6 Investigation of Control Systems to Govern Shop Floor Activities

Before describing the attempts to select or design an electronic data processing system to assist control of the machine shop, it is important to note that the arrival of the new Production Planning Manager and his initiation of monthly delivery schedules and weekly order progress meetings produced a climate where the importance of increased control was recognised. Indeed, the responsibilities of his supervisory level subordinates and the constant scrutiny of their actions and achievements resulted in the tightening of manual controls over shop floor activities.

Even if its function prior to the structural reorganisation was limited to a monitoring role, the production control section in the machine shop represented a check to the total independence of the production staff and the direct workforce. Where before the administrative area of the Division had been solely interested in feedback on job dispatches and some limited experiments in "Work Study" * and had taken interest, through personal interventions by the Works Manager, only in the progress of specific jobs, it was now serving notice that it intended to take a much closer look at the processing of all work through the shop floor area.

The effects, given the lack of any real power of production control staff, were, it seemed to me, mainly psychological. The foremen, realising that management was beginning to pay attention to reports on their sections' performances, took more interest themselves in the instances where machinists seriously overran estimated times. The machinists still very

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* This section was established at the time when negotiations over an incentive payments scheme were taking place and it carried on for some time after the failure of these discussions, without any clear directives as to its duties. It was closed at the end of 1974.

largely retained the choice of which jobs to do, but looked to support their foremen where possible on the matter of performance. I found it impossible to make a quantified measurement to assess whether an actual improvement in performance did take place, because there were no historical figures to compare with 1975 levels. I felt that there was, in any case, considerable reason to doubt that any figures so produced would be genuinely meaningful:

1. The nature of the business meant that one could never compare like with like and this might mean that any change in the level of performance merely reflected more, or less, generous estimating;
2. The computer files, as noted in Chapter 3, Section 6 above, contained a considerable number of inaccuracies, including several dead jobs with time allocations reamining against them; this laid the way open for abuses in bookings by section foremen, either through booking overrun time against such jobs or through "accidentally" mis-booking against the wrong operation number.
3. The machinists, in selection of work, were not concerned so much with improving their performance on individual operations as with the overall balance on their shift's work: where previously job satisfaction might have led them to proceed from one difficult or intricate item to another, now they would be more likely, having overrun on one operation, to select one which was reasonably straightforward in order to spread the inefficiency across the two jobs.

Incidentally, the Production Controller in the machine shop connived at the abuse of bookings by the foremen and machinists by making his computer reports available to them, presumably in the belief that it was in his own interests to keep on good terms with them in order to be able to elicit favours by way of the job processing order and that any improvement

in shop floor performance essentially reflected to his credit as a member of the supervisory staff.

All of this meant that a reform of information collection systems and, if possible, implementation of work flow control systems became an even higher priority.

4.6.1 Potential for the Reform of the Existing Program & Reports

In view of the time and expense involved in changing to a new or different computer program, it is hardly surprising that the researcher's first efforts were directed by management towards attempting to salvage and reconstruct with appropriate modifications the existing aid program, using the Engineering Group Computer Centre.

Reforms or reappraisals were necessary in three areas:

1. Reports
2. Inputs
3. File Maintenance.

In retrospect, this order, which was the order in which my investigation proceeded, may have been poorly advised. It was based upon the notion that only when reports were in an adequate format and were therefore being actually used by the departments for which they were meant, would the departments become concerned to identify faulty inputs and only after this stage would it be possible to discover and eliminate all the inaccuracies on the files. One can now see that it might have been more appropriate to proceed in the opposite direction: eradicate at least the obvious faulty data from the files, thus encouraging greater attention to detail in input procedures and allowing reports to be judged without discrimination on account of the faulty information which they contained. An

important incidental task of the reform was to change the attitude of the Division's staff towards the computer itself; perhaps towards this end it was an acceptable psychological consideration that in the early stages, to avoid apathy to reforms, significant changes to the "bad old system" should be seen to be made.

4.6.1.1 Reappraisal of Divisional Requirements in Terms of Reports

The researcher carried out a survey early in 1975 to identify the requirements in terms of reports from the computer program of each department within P & ED. As a result of this survey, I designed a series of changed reports (reproduced as Appendix 3), and submitted them for the approval of the departmental heads. After minor modifications it was agreed that I should discuss the reports with an analyst at the Group Computer Centre with a view to assessing the extent of the reprogramming which would be necessary to implement them.

In designing the reports, I attempted to distinguish between departmental wants and needs and paid particular attention to producing information in summarized form wherever this was appropriate. Both of these followed the first two of the five warnings given in Ackoff's article (18), and the exercise as a whole was intended to re-educate management, where necessary, in the use of computers: if managers could be given reports in the format most useful to them, there would be an incentive for them to continue re-evaluating their needs and to suggest further changes to meet future contingencies, thus putting them in control of the computer program, rather than seeing it as something that was basically outside their control and unalterable.

The analyst at the Computer Centre had three basic comments to make after

perusing the reports submitted:-

1. The requested formats certainly were possible and all but the scheduling document required fairly simple program alterations; he even saw some potential savings through modifying the reports to allow them to cover more than one function.
2. In relation to the difficulty with the scheduling report, he pointed out that the existing program was merely intended for data collection: it had been devised as a forerunner to a scheduling system, work on which had been cancelled by P & ED in 1972.
3. He felt that the Centre should examine for themselves P & ED's needs and make suggestions, based on previous experience, as regards means to fulfilling these.

In addition, he pointed out that it was basic to any improvements that input procedure should be reformed. This rested squarely with P & ED. The upshot of all this was that the new report formats were, with the agreement of P & ED's management, put on the shelf pending further investigations by the Computer Centre.

4.6.1.2 Input Reforms - Estimating & Technical Department

Whatever improvements it was eventually decided to use, it was essential that these were supported by more attention to the accuracy of inputs, both of estimated times and job details, by the Estimating and Technical Department and of actual times by the shop floor. The researcher felt, however that because the involvement of the Estimating & Technical Department staff with the computer system ended at the stage when the input forms had been filled in, completion of these latter was regarded very much as a chore. The psychological problem of this has been mentioned before: there was no incentive for people who got nothing back from the system to be scrupulously accurate about what they fed into it.

The effects of this were not so much to be found in problems with the original information establishing a job on file - there were set procedures to govern this which the estimators followed scrupulously. Rather it was a lack of interest in inputting amendments which the researcher found to be the source of file inaccuracies traceable to this department.

The problem was not easy to solve:-

1. The obvious thing to do was to arrange for feedback of actual performance against estimates to the Technical Department from which they might alter their estimates and their predictions of job costs for future reference. But, in view of the nature of the business, the chances of such "future reference" ever being required were so limited that the department felt that the feedback would have only academic interest and that time spent examining such reports would be time wasted.
2. Also, the variety of products involved and the major performance variations from one job to the next meant that feedback of average figures over a period of time did not really provide a basis for adjusting all estimates for particular types of operation.
3. What may have been more useful to them, providing they carried a record of old jobs somewhere, was the facility which existed within the program for requesting historical information. This history file had never been used, although P & ED paid a charge for it. On consultation, the estimators rejected the idea: any reference which was required to historical performance figures was readily accessible in the Accounts Department's files.

I considered, therefore, that perhaps the answer to the problem of updating files with amendments should have been established as a clerical

function in another, more directly interested department. The difficulty with this was that the file location of jobs was needed for any amendments and this was contained on the original input forms, which meant that the same department was obviously best placed to deal with amendments.

Ultimately, the problem needed to be covered by setting up a formal procedure between the Production Planning Department and the Estimating Department - the former advising of amendments required and a clerk in the latter being delegated to deal with such requests.

4.6.1.3 Input Reforms - Machine Shop Booking Procedure

The researcher examined the revision of shop floor time-bookings as a necessary prerequisite to any work scheduling system which might be implemented. As a result of this survey, I worked out procedures for an experimental system, to be tried out in the first instance on the turning section. These procedures are given in Appendix 4.

The purpose of the procedure was:-

1. To increase control over work-in-progress on the shop floor;
2. to achieve accurate booking of operations and times;
3. to institute an immediate feedback of information to the files from which schedule adjustments and "exception" reports could be generated.

I considered that the likely problems would be:-

1. Industrial relations - would the unions accept the new procedures?
2. Worker motivation - would reduced job satisfaction result from ending personal selection of job?
3. Machine group identification - were the current groups sufficiently defined?

4. Booking office workload - this would be substantially increased, but how was the increase to be handled: by increased clerical staff, or by tailoring computer programs to take over automatically such things as calculation of total machining time, allowing for work breaks and jobs spreading over more than one shift or even over holiday periods?

Until some fairly definite conclusions were reached concerning likely scheduling systems, senior management decided that this scheme should be left in abeyance.

4.6.1.4 File Maintenance

Over a number of years, as detailed in Chapter 3, Section 6, the amount of faulty data held on the computer file had increased because no specific responsibility had been assigned to any individual or department to monitor it and make corrections. The researcher suggested that what was needed, if it were to be re-established as a genuine data base for the Division's operations, was a complete overhaul of the file to remove not just "dead" jobs, of which there were a considerable number (Chapter 3, Appendix &), but also faulty bookings on live jobs. Only then would future errors begin to stand out and to be traced to their source and only then would input departments develop some respect for the importance of their functions in the system.

What seemed a matter of commonsense, however, struck a problem when the Accounts Department were consulted for their views. The blue terminal card which acted as an authority to the Computer Centre to delete jobs from the current orders file also led to deletion of the job from the "bought ledger file". Since invoices in respect of a job - particularly

a large machine contract - could arrive anything up to two months after completion of the job, the immediate elimination of jobs records was not acceptable to this department as it might prevent the collection of total job costs. With indisputable logic, the Chief Accountant pointed out that in any case, if jobs were finished, no machining time should be left on the file anyway if the shop floor was doing its bookings correctly.

One hoped that this would indeed be the case, subsequent to the reform of inputs, but the present situation concerned the correction of past errors. Whether or not they should have existed was largely irrelevant: they did exist and they needed to be removed. The only alternative to removing whole job records was to go through each job and delete or amend figures in all the various fields. In view of the large number of jobs involved this was a mammoth task.

It was settled that, in the first instance, Accounts should examine the file of "current jobs" and delete all the most glaring faults. Management would then consider delegating a clerk to assist the researcher to produce amendment forms to cover the other discrepancies.

4.6.2 Alternative Control Systems Examined - Aviation Division Scheduling System

While my investigation of potential reforms to the existing system was still going on, other means of tackling the problem were already being examined. I have noted that the Computer Centre wished to make its own examination of P & ED's needs as a basis for deciding what type of system would help to solve the problem of machine shop control.

Some preliminary investigations were carried out by them in the first half

of 1975 and as a result they suggested that P & ED should consider using scheduling programs employed by Aviation Division (19) with some modifications (20).

The advantages of this were:-

1. Low development costs.
2. Fairly rapid implementation of the system would be possible.
3. Fairly easy linking up with the existing data collection system.

The disadvantages identified by the researcher, however were many and of varied importance to different members of P & ED's management:

1. The running costs of such a system would be extremely high and it was envisaged that they would run alongside, not in place of, the existing and already expensive system; the Chief Accountant and the General Manager saw this alone as enough of a problem to justify looking elsewhere.
2. The system had been designed for a batch production situation, not a "one-off" jobbing shop.
3. The simplicity of inputs to the system relied on repetitive production of an albeit large number of discrete parts: P & ED dealt with an ever increasing number of parts with every new job - indeed, because of its own disorganized part numbering system, which had not improved since it was pointed out in the 1969 Management Services Report (21), there wasn't even any guarantee that where the same part was produced at a future date the existing record would be located in the computer file.
4. Examination of the proposed reports made it clear that the modifications required would be more complex than suggested, if they were to be genuinely useful to P & ED's staff.

5. Of eleven reports put forward by the Management Services Department (21) only four were considered at all useful by P & ED's Production Planning Manager, which raised some questions as to whether the problem had been correctly understood or communicated.

Management decided that further investigation, at P & ED's cost, of the potential for adopting part of Aviation Division's scheduling system was not warranted.

4.6.3 Alternative Control Systems - the EBS11 Programs & Mini-Computer

At the beginning of 1975, mini-computers were a new phenomenon in the field of manufacturing scheduling and control. When P & ED first took an interest in this particular project, in fact, detailed publicity material had not been printed. A visit by three members of the Production Planning Department to the premises of the marketing firm resulted in optimistic noises being made about the potential of the unit to cover P & ED's problem.

The leaflet which returned with them made vast claims for the machine as a "colossal step forward in production control"; what no doubt also appealed was the assertion "No knowledge of computers required" (which is one of the dangers noted by Ackoff (23) and the limited training which was apparently needed (24).

In brief, the advantages proven or claimed for the system were as follows:-

1. Easy to instal.
2. Little operator training required.
3. Always available (as opposed to time-sharing on the Group Computer).
4. Capable of rapid adjustment with addition of rush orders to schedule.
5. Provides simulation facilities to examine effects of orders on each other.

6. Can make future planning calculations and recommend resource allocations.
7. "Management will gain control of manufacture".
8. Measurable financial benefits from "reduced investment in work-in-progress" and "increased productivity" - i.e. through maximising effective use of resources (25). (In the actual proposal a saving of £40,000 is suggested for the former of these and £70,000 on account of the latter) (26).
9. Capital cost lower than annual bill to Computer Centre and is a "one-off" cost (27).

There was sufficient here to prompt management to invite P.E. to make a detailed proposal of the costs and implementation procedure for the project. But there were also obvious difficulties and the researcher had a large number of questions which remained unanswered even after the receipt of the detailed proposal:

1. EBS11 was designed for a batch production situation, and one in which there was a defined range of products - although new products could be added. The simplicity of operation of the module seemed based on this, whereas in P & ED, new products were the rule, not the exception
2. The "measurable financial benefits" were actually only potential gains: they rested on the premise that P & ED could find extra work to make use of this potential on a <u>regular basis</u>. But the Division produced to specific customer orders and was thus subject to demand fluctuation. The effect of more efficient resource allocation might be simply to accentuate the peaks and troughs in the 'demand curve' if P & ED were unable to find jobs to fill spare capacity.

3. No specifications - particularly with reference to file sizes - were offered by the producers, which made it virtually impossible for the Computer Centre, who were acting as P & ED's advisers, to assess whether the machine had sufficient capacity for P & ED's purposes.
4. It was made plain that EBS11 would not replace all the functions presently served by the existing program. In particular, it would not serve the requirements of the Accounts Department, although it was noted that extra programs at a cost of £5,000-£10,000 could be produced to cover such of these functions as could be served from information which would be available on EBS11's files. This made the capital cost aspect much less attractive.
5. The proposal did not seem to take sufficient account of the human problem in controlling the machine shop. While this was primarily the internal concern of P & ED, it might have been expected that potential problems would have been commented upon.
6. Substantial procedural improvements were necessary internally if the best use of the system was to be made: by February 1976, when the proposal was received, more major changes concerning the Division's future were already being discussed.
7. A final and very major question was quite simply, would it work? The module was not at the time in use at any single industrial location and the "model factory" situation (28) in which it was tried and tested obviously did not have the complexity of an actual industrial locale. Probably this meant that P & ED, as a prospective guinea pig, was being offered advantageous rates for the system, but could it, given its financial position, afford to take the risk?

Probably the most important factor in the decision not, at this time, to go ahead with the purchase of EBS11 was the possibility of wider changes.

Combined with this was the departure of its great champion within P & ED, the Production Planning (or Programming) Manager, and the absolute refusal of the Computer Centre, on the basis of the information which it had received, to commit itself as to whether the purchase was justified. Without the backing of the latter, it would have been difficult to secure Group approval for the expenditure.

4.6.4 Alternative Control Systems: IBM's "Caposs" Package

The risk involved with the EBS11 system caused the Division to examine the possibility of using the tried and proven "Capacity Planning and Operation Sequencing System" marketed by IBM Data Centre Services.

The advantages were essentially similar:

"CAPOSS provides the vital information which can help you achieve the following:-

- Cut production costs.
- Meet target dates.
- Increase productivity by reducing idle time within work centres.
- Save money invested in work-in-progress by reducing project load time.
- Improve customer confidence because you can make accurate estimates of delivery dates - and keep them!"(29)

But once again, I identified problems with the system:-

1. The package was designed for at least a batch production environment. One of the chief advantages here is the avoidance of the need for repetitive information inputs. P & ED, however, had a standard range of products and, therefore, there would be a continued need for inputs to the files - as with the existing system.

2. There was a good deal in the package, particularly on the requirements planning side, which was not relevant to the P & ED method of operation (30), yet the charging system seemed to be partly based upon what was available as well as on what was actually used.
3. Also, a disadvantage compared with EBS11, the charges for the system would be annual and subject to increases which were largely beyond P & ED's control.
4. Caposs would not entirely replace the existing use of the Group Computer Centre and thus would constitute additional expenditure on aids, whereas the Division was looking to reduce, or at least to keep constant, its costs in this direction.
5. Either there would be a problem of tieing together the information produced by the two discrete sources or linking programs between the two would have to be written. IBM's representatives noted, anyway, that extra and modified programs would be needed to help to handle some of the specific problems associated with the jobbing shop environment.
6. The unpredictability of P & ED's operations meant that the frequency of interrogations of the computer and production of amended reports by it would be high, which naturally meant that running costs would be high.
7. If the computer aid were to be successful, there was once again a pre-requisite that P & ED should "put its own house in order" first; the system could not of itself increase the Division's internal discipline.

A visit to an industrial location where the package was in use and discussions with both that plant's Production Planning Manager and IBM's representative did nothing to allay my suspicion that these problems made the package inappropriate for P & ED and, along with the high early

estimates of the system's cost, led to a decision not to pursue negotiation for the package.

4.6.5 Conclusions About Potential EDP Aid to Machine Shop Control

The foregoing investigations led the researcher to two basic conclusions regarding the use of computer aids in an environment with the characteristics of P & ED's machine shop. These concern:-

1. Inputs, and
2. Costs

4.6.5.1 Inputs

It is an obvious truism to say that one can only get out of a computer system what one puts into it, in terms of programs and specific data. In "one-off" jobbing production the information input is no less complex, to satisfy all the various departments' purposes, than in batch or flow line production. The difference is that whereas a file can be built up to cover a specific product range, in the latter cases a new input is required for every new customer order in the jobbing environment.

It remains unlikely that the department responsible for inputs will be able to get any useful feedback from the system to guide its future policy. In view of the unrepetitive nature of the business, there must be a line to be drawn as to just how much information it is worth recording on the files and decisions will also have to be taken as to what, if anything, is worth retaining on the files at the conclusion of a job.

The only assistance which use of computers will give with regard to inputs is through the incidental imposition of a greater discipline and there will be a parallel need to monitor inputs to ensure, in the absence of

information feedback to the input department, that the discipline of the procedure is maintained.

4.6.5.2 Costs

Jobbing production requires great flexibility from the aid programs which also means high costs. I have already noted what seems to me an impasse: that the need for program sophistication increases with the unpredictability of production, while the amount of capital available for use on such systems is likely to be decreased because unit production firms are generally smaller in terms of annual turnover than batch or mass-production firms.

4.7 Limitations Imposed by the "Petty-Political" Situation

A good deal has already been said, both in the introductory chapter on the project environment and in Chapter 3 on P & ED's problems, concerning the petty-political situation within which resolution of the Division's difficulties was to be sought. The researcher believed that this was indeed, as suggested in Figure 4.3, the central piece affecting the chances of success of all improvements in other areas, for the following reasons:-

1. The very real influence of the superordinate objective of the best interests of the Group.
2. The falseness of P & ED's profit centre status: product rationalisation was limited because some orders could not be refused; the problem of controlling work flow was increased by the presence of "privileged" orders.
3. A Group need for on-site tooling and, more especially, breakdown servicing: resource reappraisal had to take account of fluctuations in these requirements, and the urgency of the latter.

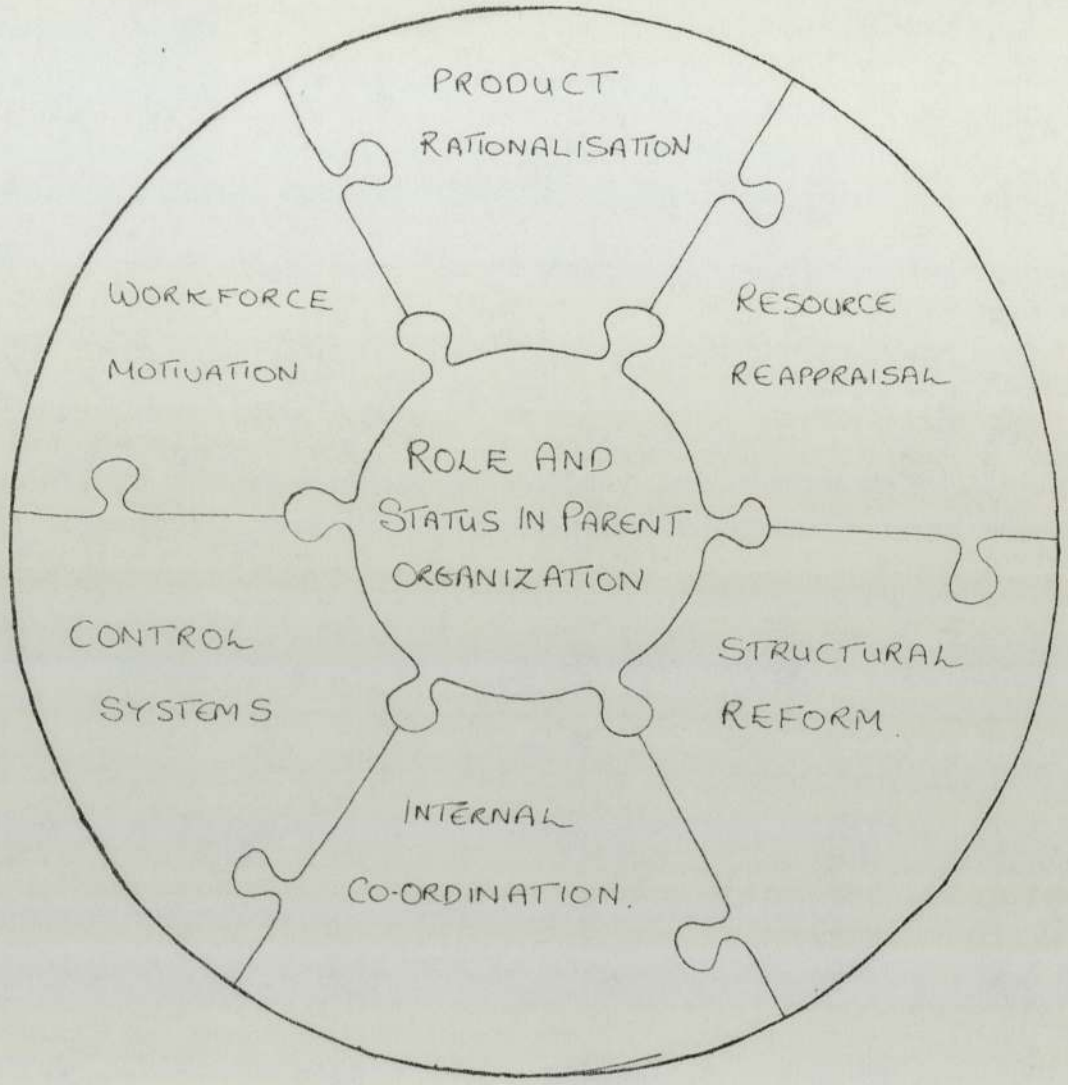


FIGURE 4.3 : HOLISTIC "JIGSAW PUZZLE", SHOWING THE CENTRAL POSITION OF P.& E.D.'S PETTY-POLITICAL SITUATION TO THE REST OF ITS PROBLEMS.

4. A Group climate which did not favour decentralisation of these facilities.
5. The existence of a Group Computer Centre, carried as a fixed overhead, discouraged attempts to examine outside control solutions.
6. Managers of other operating divisions within the Group took advantage of their proximity to P & ED to exercise influence over its operations, particularly the priority sequencing of work.

Against this, the arrival of a new Divisional General Manager in 1974 produced a change in attitude of the Division: management now had an ambition for genuine independence where before, under a Works Manager directly responsible to the Group Director, it had been content with a subsidised subordinate role within the Group.

The basis for the new ambitions was the potential - though not proven in all cases as Section 4.2.1.2 pointed out - profitability of special-purpose machine building as a separate business. Although a large percentage of this business was with other Dunlop divisions (66% in 1974 and 91% in 1975), these divisions were not on the same industrial site and were, therefore, in a position to influence P & ED, but not to actually interfere with its operations. There was also a suggestion in the orders received during 1975 that there might be some move away from the dominance of Dunlop orders: 55% of the £2 million of orders for machinery in that year were from non-Dunlop customers (30).

This added support to P & ED's claim that there was an extensive outside market for its expertise in machine construction. Management claimed, however, that it was unsatisfactorily placed to take full advantage of the potential in this market because of its current position within Engineering

Group. Its basic arguments may be summarised as follows:-

1. The Division's operations were subject to an increased degree of uncertainty and risk on account of its tooling and Group servicing functions;
2. attempts made suggested that it was not possible to find an economic solution to the problem of actually controlling machine shop activities - that the best that could be achieved amounted to adjustments made from feedback on shop floor results;
3. fluctuations in Group service and tooling demands meant that there would continue to be a need to fill up machine shop capacity at times by producing machinery parts internally and yet the privileged position of Group orders and the potential for their demands on the machine shop to alter substantially over short periods of time made them disruptive to the production schedule for kits of parts for the longer-term machinery projects;
4. the machine assembly business did not depend upon the existence of the machine shop: the link between the two was an artificial one as their very different characteristics demonstrated (Chapter 2, Section 5).

The researcher found that senior management's ambition to alter the Division's situation by divesting itself of the machine shop naturally affected their attitude towards attempts to improve the existing situation:

1. On practical grounds, it could be argued that expenditure of time and money on improving the machine shop situation would be wasteful in view of the fact that it was not essential to the business in which the Division's potential for growth rested;
2. but this involved,to some extent, prejudging the issue as to the viability of the machine shop as a profitable entity and I felt that the real reason for management's half-hearted encouragement of

proposed improvements rested in Group politics: any improvement in the situation could be used by the other members of the Group as an argument against any change from the status quo - the blacker the machine shop situation appeared, the less likely it was that P & ED's management would get serious opposition to its divestment proposals.

4.8 Change the Situation so as to Reduce or Simplify the Complexity of the Problems

I identified several possible alternative ways in which changes in the nature of P & ED might reduce the difficulties faced by those seeking to control its operations:-

1. Close down the Division.
2. Return the Division as a whole to cost centre status.
3. Negotiate an increased piecework rate for internal work to take account of lost opportunity cost.
4. Mix the machine shop labour force by introducing lower skilled machinists to handle the high tolerance work.
5. Split the Division internally, making the machine shop an allocated central resource and a cost centre while assessing machine assembly separately as a profit centre operation.
6. Divisionalise the two separate units in recognition of the growth of the machine assembly business.
7. Disperse the tooling operation, by setting up individual units within each user division, and reorganise P & ED as an equipment manufacturer alone.

Some of these alternatives were suggested by P & ED during the period in which it was attempting internal improvements. Various items were rejected as unacceptable either to particular operating divisions or to

Engineering Group as a whole. In these cases, the researcher has limited to a superficial survey the pros and cons of the alternative.

4.8.1 Close Down P & ED

In view of the annual loss being made by the Division, this must obviously be considered a serious alternative. But P & ED's management justified its continued existence on the grounds of the potential, which was felt to be in capital equipment products and in the benefit which it brought to Dunlop as a whole through the internal manufacture of such equipment for Tyre Group, Fluid Seal Division and Belting Division. This alternative was only likely to be considered as a last resort if all else failed to make the Division profitable. It would always leave the problem of how tooling and urgent breakdown servicing work required by Group members should be dealt with.

4.8.2 Revert to Cost Centre

This would be a retrograde step and, in view of P & ED's optimism, albeit unproven, about the growth potential of its capital machinery business, it was not justified. Certainly, it would have allowed centralisation of many of the administrative functions - purchasing, stock-holding and accounting are the most obvious - and thus have reduced the overheads of the unit "per se". The effect, however, would merely be to spread the costs around the user divisions.

Assuming, for example, that P & ED were to continue to build machines for divisions outside Engineering Group, then divisions would have to employ design staff to deal with such work - and it is not hard to envisage that the total number spread over all the user divisions would be higher than the number employed by P & ED.

But perhaps the major problem with this solution would be that of assessing what contribution towards the costs of P & ED's upkeep should be levied against each user. In the days of Engineering Services Unit, the problem was simpler because it only concerned Engineering Group. Now, unless units were separately established by other Groups, a much wider range of Dunlop customers were served. With the piecework charge, customers at least had some notion of what the service was costing them, even if it was necessary to make a year-end contribution to subsidise the continued existence of P & ED.

Ultimately, this alternative was acceptable to neither P & ED, who saw it as unnecessarily drastic action, nor to other members of Dunlop, for whom it offered no certainty of financial savings.

4.8.3 Increase Piecework Rate for Internal Tooling & Service Work

The complaint which P & ED's management voiced about tooling work for Group customers was that because of its privileged position in work queues it had a disruptive affect on the manufacture of machinery parts for the Division's own assembly area. This was felt to restrict the expansion of the machinery-building business as it left P & ED with a poor reputation on the delivery of machines to customers.

If the Division was to operate as a true profit centre, internal tooling and service work prices needed to be raised to reflect this opportunity cost. However, internal customers already complained that the rates charged by P & ED were higher than comparable rates outside for tooling work. They also felt that the rate for servicing work was at the limit that its convenience justified. Suspensions Division, indeed, had already established a small toolroom of its own to handle the more straightforward breakdown service work and had found that there were a number of sub-

contractors who were able to offer an overnight service for such jobs. Because this division was not on the main Holbrook Lane site, its procedure for dealing with this work was a matter of convenience - P & ED was no more or less accessible than a number of other local sub-contractors.

The fluctuating input of work from internal customers caused problems for P & ED in defining the resources of men and machines which it was necessary to maintain and made it impossible to make a straightforward cost analysis decision about whether to make or buy the manufactured parts required for its machines. Once again, the situation turns on the definition of P & ED's role in the larger Group environment. If it was to continue to provide a service to the genuine operating divisions of the Group, but not allowed to charge for such work at what it felt was an economic operating rate, then its performance should not have been judged alongside this in terms of annual profitability.

4.8.4 Mix the Machine Shop Labour Force

The employment of a lower grade of machinists to deal with work which did not require operating to low tolerances would not so much solve the problem of handling manpower resources as double it. Sufficient highly skilled labour would still have to be maintained to cope with fluctuations in demand for this type of work and, in the event of such work being below capacity, there would be an alternative of putting the skilled labour force on lesser skilled work, which might only result in the lesser-skilled machinists being short of work.

Potentially, this solution seemed likely to lead to industrial relations problems over gradings and wage differentials between the two groups and it was discarded as impractical.

4.8.5 Split the Division Internally

The idea that the machine shop part of P & ED should be treated as an allocated central resource, supported by agreed fixed payments from each of the user divisions within Engineering Group, in return for a certain amount of reserved machining capacity was suggested to the other divisions and rejected by them.

In order for it to work satisfactorily for them, they would have needed to be able to predict future tooling requirements and smooth out their demand fluctuations or accepted a situation where they would under-utilise their allowed capacity in one week - perhaps allowing one of the other divisions to exceed their allowance - and make up for it by a higher demand in another week. This was based upon the unproven supposition that periods of heavy demand for machine shop capacity would not coincide between one user division and another.

Other potential problems with this solution existed:

1. Who was to decide upon and pay for any new capital equipment for the machine shop?
2. Who was to decide machine tool and material stocking policy?
3. Who was to have the right of hiring and firing in the machine shop?
4. Who was to be responsible for sorting out industrial relations problems?
5. Who was to decide upon acceptance of work from other Dunlop divisions and how was it to be charged-out?
6. What was to be the policy on accepting outside tooling orders?
7. Would not such a situation discourage interest on the part of P & ED's management in any problems which might occur in the machine shop?

The price of reducing the uncertainty of meeting the expense of the machine shop to P & ED seemed to be the creation of a whole series of

uncertainties for the other divisions of the Group.

4.8.6 Divisionalise the two Separate Units of P & ED

I must confess a bias in dealing with this alternative. Both my research, showing the normally good performance, in terms of contribution, of tooling work for Union customers, and my reading suggested that this was the most logical alternative for the Division. Both Child (32) and Perrow (33) note that research has shown that the usual, or growth, method for dealing with a situation such as that in P & ED, where a new business area shows potential, but does not fit well with traditional production, has been to create the new area as a separate entity or division. But this obviously depends on establishing that the original product base can exist economically, independent of its offspring.

Thus, to separate the machine assembly business offered advantages to it in that it would no longer be tied in its decision as to whether to make or buy its parts by the prevailing machine shop loading situation. It could treat the separate machine shop as one of a number of possible sub-contractors and place work on it according to how it competed in terms of price and delivery. However, to the machine shop, separation from the machine assembly business increased the problem of how to make use of any spare capacity resulting from fluctuations in tooling orders.

The solution to this rested in adopting a more active policy in seeking tooling contracts with outside customers. But again here, the Division was hamstrung by the privileged position of work for internal customers: a sudden input of Group tooling work might cause lengthy delays on outside contracts leading to loss of potential future contracts for the same customers and the establishment in the market of a poor reputation for

consistency in meeting delivery targets. The subsidiary factory at Leicester was much more successful in attracting outside customers and did not have this disadvantage of being a "captive supplier" to a group of privileged internal users.

Given, however, that a new, purely tooling division would not have had to support such a large indirect or clerical staff - the Leicester subsidiary again, provides evidence for this assumption - one wonders whether it might not have proved possible to offer internal customers more advantageous rates, and thus to attract a greater percentage of their tooling work to a local "Union" supplier?

In the event, Group management obviously felt, in discarding this idea, that to divisionalise the two units might more readily lead to a doubling of the problems which they had with P & ED.

4.8.7 Disperse the Tooling Operation

Logically, the next alternative was to reconstitute P & ED around its machine assembly business and disperse the tooling operation amongst the other divisions of the Group. I have listed what I considered to be the pros and cons of this below:

4.8.7.1 Potential Advantages to P & ED

1. Reduction or transference of costs:
   - Direct Labour - only a skeleton staff of machinists or machinist/fitters needed to be maintained to cope with the Division's own special parts and tooling requirements. No night shift would be needed.
   - Staff - A very limited number of staff would be needed for the machine shop.

- Machines - Only a few basic machines needed to be retained; the rest could be transferred or sold with a consequent input of capital.
- Material Stocks - Limited stocks would be needed; material could be bought as and when it was required.
- Site - The smaller machining unit would require less floor space with a consequent saving on the rental charged to P & ED by the Group.

2. Greater certainty in the production cycle:
   - Removal of complex production control problems and of the need for sophisticated control systems.
   - Allows definitive planning of production, which helps reputation in external market and, therefore, ability to compete for contracts.
   - "Make or Buy?" decisions become less complex.
   - Assuming greater use is made of sub-contractors for parts, fixed prices can be established in advance, making it easier to calculate job costs in advance and foresee problems.
   - No privileged customers to complicate priority decisions - this is not entirely true, since Dunlop customers for machinery will still expect some preference; but at least these customers were not on the same industrial site.
3. Reality of 'Profit Centre' Status:-
   - P & ED could take its place alongside the other operating divisions of the Group.
   - Decisions could be taken on the basis of the Division's best interests
   - There would be no interference from staff of other Divisions.

4.8.7.2 Potential Disadvantages for P & ED

1. Reduction of Capacity:
   - Manpower and machinery resources would be more limited.

- The diversity of machinery resources which could be maintained in a smaller unit would be reduced.
- These made it more likely that there would be some reliance on sub-contractors, if only for an increased range of specialist operations.
- There would be a higher ratio of indirect, or staff, employees to direct operatives increasing the overheads to be apportioned against each individual job.

2. Reduction of product range:
   - With a smaller machine shop, the Division was unlikely to be able to continue to handle the small number of lucrative outside tooling orders.
   - There would be over-reliance, therefore, on rubber technology area, making P & ED vulnerable to major innovations.
   - Potential for growth relied upon broadening the product base within the new, narrower parameters of special-purpose machinery and ancillary equipment.
3. Increased responsibilities:
   - As a profit centre, P & ED would be genuinely responsible for its own income and expenses - it could no longer excuse itself on the grounds of the indirect benefits which it brought for other members of the Group.
   - There was less likelihood of help from other divisions in the event of shortage of work: in 1974, for example, other members of Engineering Group had helped P & ED through a period when machinery orders were slack by increasing tooling orders to the Division.
   - An active marketing policy was needed to broaden the product base, where before P & ED had been able to rely on a substantial number of orders passed through by other members of the Dunlop Organisation for rubber technology equipment.

These disadvantages do not seem to add up to anything more than would be expected in any firm which was responsible for shaping its own destiny: they were simply the price of greater independence. It was even possible that the purely tooling subsidiary at Leicester might be able to take over some of the regular work for outside customers. However, this method of solving P & ED's problems by decreasing the complexity of its operations affected not just the Division but also the Group as a whole.

4.8.7.3 Potential Advantages to the Rest of the Group

1. Capacity Planning:
   - Each member division could decide its own needs in terms of men and machines.
   - An objective decision about what to subcontract could be made without thought to any subsidy which would have to be paid at the end of the year.
   - At the same time, there would be an incentive for divisions to ensure that all the available capacity in their own units was taken up.
2. Control over tooling:
   - Divisions could grade the urgency of jobs placed on the tooling unit and could decide with certainty the priority between two jobs competing for the same scarce resource.
   - Capacity would be instantly on call to deal with emergencies.
   - There would be an incentive to forward plan tooling requirements where possible.
3. Financial advantages:
   - Tooling should cost less in absolute terms because the contribution charged by P & ED would be saved.
   - There would be no need to subsidize the continued existence of P & ED.

- In terms of the Group as a whole, another genuine operating division would be added since P & ED, if it were to survive, must be expected to add to Group profits.

4. Motivation of workforce:
   - Should be increased by direct employment in user divisions: genuine interest in well-being of division and machine breakdowns achieve an identifiable significance.
   - Smaller work groups produce personal reliance between various machinists and may even lead to machinists effectively progressing each other.
   - Workers could concentrate on the single criticism of quality.
   - Machinists would not lose identification with finished product.

4.8.7.4 Potential Disadvantages for Other Members of Engineering Group

The researcher felt that there were also serious disadvantages to the rest of the Group and this probably accounted for the fact that there was serious opposition to the promotion of this method by P & ED's management from late 1975:-

1. Costs
   - Each division would incur set up, maintenance and depreciation costs for the machinery required by the new unit.
   - There would also be a continuing cost in respect of site rental for the unit.
   - A direct labour force would have to be taken on to operate the machines.
   - An indirect or administrative staff, however small, would be needed to organize the operations of the unit.
   - Where divisions worked more than one shift, a skeleton night shift would be needed to deal with emergencies.

- o It might be necessary to carry extra material stocks to serve the tooling unit.

2. Reduction of tooling capacity available:
   - o Flexibility to deal with major demand increases would be reduced.
   - o The range of types of machinery which could be justified on grounds of utilisation in the smaller units would be more limited than in the single centralized machine shop.
   - o There would thus be a need to put an increased number of individual operations out to sub-contractors and these latter would also have to be used in times of heavy demand, such as when tooling for new products was required.
   - o During periods of low demand there would be a risk of under-utilization of the tooling unit.
   - o This would mean greater emphasis on attempting to predict future tooling requirements.
3. Workforce attitudes:
   - o The machinists might resent a situation where, because labour mobility would be vital, they were prevented from making full use of particular skills which they had developed.
   - o It would be difficult to establish criteria upon which to judge the performance of individual machinists - in a section where all used the same type of machines, this was much easier.

4.8.7.5 Effects on the Dunlop Union as a Whole

Finally, there existed a very definite advantage as far as the wider Dunlop organization as a whole was concerned, from the setting up of the machine assembly business as an independent unit. Delivery dates given by P & ED would be much more reliable, which would mean that customer divisions could plan receipt in advance for the date that they would have

a site prepared for the machine; could plan its usage into their production schedules; could plan the cash outlay, or more accurately, transfer, for the time at which it most suited them.

Withdrawal of the tooling service at Coventry meant that some divisions would have to go elsewhere for such things as new moulds and special tools, but the Leicester subsidiary would remain a potential supplier for some of these items.

The other major potential effect on the Union as a whole depended upon the balance of the advantages and disadvantages previously noted. If the rest of the corporation benefited less than Engineering Group suffered, then the whole would be adversely effected by the change.

4.8.7.6 Conclusions on Dispersal of the Tooling Operation

This alternative was clearly the one preferred by the Managing Director of P & ED, but it is hardly surprising that the Engineering Group Directorate was only with difficulty convinced that it represented the best solution available. Few of the advantages and disadvantages listed above could be expressed in quantitative terms. Indeed, the balance between the two would only really become clear after the dispersal had taken place and, as the advantages to P & ED seemed to offer a fair certainty that its financial position at least would improve in the short term, the change once made was likely to be difficult to reverse.

CHAPTER 5

RESULTS OF IMPROVEMENTS & OF THE CHANGE IN THE BASIS OF P & ED'S OPERATIONS

As implied in the title, there are two separate areas considered in this section.

1. Improvements brought about by the methods through which an attempt was made (in 1975 and 1976), to handle the complexity of the existing situation.
2. The results of changing the basis of P & ED's operations (in January 1977), and thus reducing the complexity of the situation in terms of the control systems requirements.

It should again be stressed that the comments made in the second section may be coloured by the researcher's view that the alternative selected - dispersing the tooling operation - was less logical and appropriate than divisionalisation of the two separate producing units.

5.1 The Financial Situation 1975 & 1976

The Product Results Summary for 1976 prepared by the Accounts Department of P & ED is given in Appendix 1 to this Chapter. The 1975 Summary was included in Appendix 1, Chapter 4. The researcher's analysis of these figures is offered below.

5.1.1 1975 Figures

The raw statistics show that P & ED's losses were reduced by £210,000 in 1975, but closer scrutiny reveals that this was entirely due to reduced expenses in the form of apportioned overheads (or "constants"), and not

FIGURE 5.1. INCREASING IMPORTANCE OF MACHINERY PRODUCTS AS PERCENTAGE OF ANNUAL FIGURES

YEAR	TOTAL OUTPUT	TOTAL CONTRIBUTION	TYRE MACHINERY NON-DUNLOP (XC)		TYRE MACHINERY DUNLOP (XD)		OTHER MACHINERY NON DUNLOP (XG)		OTHER MACHINERY DUNLOP (XJ)		TOTAL MACHINERY	
			OUTPUT	CONT.	OUTPUT	CONT.	OUTPUT	CONT.	OUTPUT	CONT.	OUTPUT	CONT.
1974	£1,894,974	£460,101	3%	4%	24%	15%	5%	2½%	12%	9½%	43½%	31%
1975	£2007,913	£477,499	10%	16%	22%	22%	5%	½%	8%	8%	45%	46%
1976	£3327725	£888.337	18%	18%	24%	27%	20%	25%	6%	7%	68%	77%

to increased contributions. Perhaps the most ominous thing about the 1975 figures was the failure of output to increase significantly. Part of the reason was the failure of the two new products, which is analysed later.

5.1.2 1976 Figures

Figures for 1976 look much more encouraging. The Division made a pre-reorganization profit of over £70,000 (a £230,000 improvement on the previous year), thanks to a 65% increase in output and an 86% increase in the total contribution. Once again, however, a saving of £70,000 against the expected total for apportioned overheads must be accepted as significant in bringing about the improvement.

Examination of the performance of specific groups reveals the decisive influence which machinery orders had on both the increased output and the increased contribution; as figure 5.1 summarises.

5.1.3 The Influence of the Performance of the New Products on the Total Financial Picture

The failure of the two new product ranges - slush pump liners and pipeline servicing equipment - to contribute in any way to the Division's output has already been dealt with in Section 4.2.2. However, it seems worth emphasising here the very crucial affect which these product groups had on the total figures for 1975 and 1976.

The two tables, given as Figure 5.2, show the actual total results for the two years and a set of projections as to what the figures might have been given that:-

1. the two product groups had not existed.
2. they had performed according to the plan for the year.

FIGURE 5.2. SUMMARY OF THE FINANCIAL EFFECTS OF THE NEW PRODUCTS- SLUSH PUMP LINERS (XN) AND PIPELINE SERVICING EQUIPMENT (XL) - ON THE TOTAL DIVISIONAL RESULTS FOR 1975 AND 1976

TABLE A : 1975

	Actual total results	Total results excluding figures for XN & XL product groups	Projected results if XN & XL groups had performed at planned levels	Projected results if XN & XL groups had performed in line with average achievement of other groups
Turnover (£)	2,007,913	1,941,650	2,483,650	2,348,150
Contribution (£)	477,499	485,134	638,834	586,759
Contribution (%)	24	25	26	25
Net Loss (£)	165,536	149,902	4,201	56,276

TABLE B : 1976

Turnover (£)	3,327,275	3,242,491	3,510,001	3,536,752
Contribution (£)	888,337	968,285	1,019,603	1,056,563
Contribution (%)	27	30	29	30
Net Profit (£)	72,845	152,793	204,111	241,071

Figure 5.3 Effect of New Products on Year End Profit Predictions

ALL FIGURES IN £s	PLANNED FIGURES			PLAN EXCLUDING NEW PRODUCTS			ACTUAL YEAR-END
YEAR	OUTPUT	CONTRIBUTION	PROFIT	OUTPUT	CONTRIBUTION	PROFIT (LOSS)	PROFIT (LOSS)
1975	3,120,000	875,000	23,000	2,583,000	721,300	(130,700)	(165,536)
1976	3,200,706	935,438	91,152	2,933,196	844,120	39,834	72,845*

* 1976 'profit' figure is given at the level prior to adjustments in respect of reorganisation of the Division at year end.

The original figures show a net variation, over the two years, of actual profit below plan of £206,843. If the new products are excluded, however, the variation is reduced to only £1,825 below plan.

3. they had performed at the average rate of achievement against plans of the other product groups.

In all three instances, the totals for the year would have been significantl - in the case of 1976, very substantially - better. Over the two years, these products made a negative contribution to the Division.

There would also have been a significant difference in the predicted year-end results if the two new products had not existed. (see figure 5.3)

The researcher by no means intends to suggest that the new products were the root of all P & ED's financial problems, but only that they made a more significant contribution to them than the other groups over the two year period as a whole. The Division was singularly ill-advised to forecast so large an element of its planned production in products which were unproven or untested and for which there were not guaranteed orders already on the books at the end of the previous year.

5.2 Production Performance Evaluation 1976

The financial statistics tell only a part of the story, albeit an important part, in assessing the results of the charges made in P & ED's organization and method of operation; it is necessary also to take into account any significant changes in production performance. To this end, the researcher made an evaluation along similar lines to that prepared for 1974-75 by the Production Programming Manager. My subsequent report is given as Appendix 2, Chapter 5.

5.2.1 Reservations

Before noting its major findings, there are certain reservations which I

feel in retrospect should be made about the report:

1. Like the 1974-75 report, included as Appendix 2, Chapter 3, the figures upon which it is based were taken from production schedules rather than Accounts Department invoices. Job values thus appear under the month in which the job was completed, rather than as invoices were submitted to customers. While I believe that this gives a more realistic view of production achievements - disregarding as it does any percentage pre-payments or progress payments made by customers - it does result in fairly serious discrepancies between the output figures, given in Table 1 of the report, and the Annual Product Results prepared by the Accounts Department.
2. To emphasise that it was the shapes or "trends" of the graphs and tables with which the report was concerned, 3-month rolling averages were used in most cases. These reduced the possible influence of isolated erratic, or untypical, results in individual months. They helped, for example,to spread the disruptive effect of works holiday weeks. On the other hand, there is always a certain loss of contact with the actual figures when such averages are employed and the validity of any figures abstracted from the graphs must be evaluated in this context.
3. Essentially, the purpose of the report is to compare the situation in 1976 with that identified in the previous report, which covered the period from October 1974 to September 1975. It was not possible to take the comparison any further into the past because of the absence of production schedules for previous periods. However, as has been noted in earlier sections, the period up to July 1975 is probably not typical of the Division's historical situation. Figures for machinery output are abnormally low over this whole period, representing an extended slump in market demand. Some of the conclusions

reached by the report need to be prefaced by this proviso.

4. The report does not include figures for breakdown servicing work for Group customers, hardening work done as a sub-contractor or sub-contract inspection charges.

5.2.2 Major Findings

Despite these reservations, I believe that several significant points are brought out by the report:

1. The Change in the Division's Business Mix

   This may not be as dramatic as it seems in graph 1, but the point is definitely valid that there was a swing away from the original tooling base to output dependent on machinery sales. Tooling output, given the high number of indirect or staff employees, was no longer sufficient to make up the Division's "bread and butter". This role had now been taken over by Rubber Technology Equipment for Corporation, or Union, customers. Tooling - indeed, all machine shop manufacturing - had now become a fairly small sideline. Graphs 2 & 3 show that there continued to be regular output of tooling work for Group customers, but both in percentage and actual terms it no longer held any real importance in determining output performance.

2. The Division's Record on Performance against Schedule

   This took a distinctly different pattern from October 1975 onwards, as Graph 1 again demonstrates. To this point, as the total production scheduled increased and decreased, so output rose and fell. Also, in general, the higher the total scheduled, the greater the amount of the slippage against schedule. From October onwards, however, output increased steadily, seemingly regardless of the total scheduled for production, to a peak in May and June. Thereafter there is a decline in both amount scheduled and the output total, but no return to

the earlier situation where it seemed that no matter what amount of work was scheduled, only 50-67% of it would be produced. As a generalization, it is suggested that the Division copes adequately with schedules up to £225,000 per month and fails by increasing amounts as this figure is exceeded. In fact, as table 4 illustrates, very specific reasons could be identified for many of the major slippages against schedule.

The real reasons for the change in the pattern of performance against schedule were not to be sought in some attempt to find a maximum possible expected output - the nature of the major products meant that wide deviations should be expected between one month and the next because assembly throughput times extended beyond four weeks in some cases. The new pattern actually reflected:-

a) More attention to the accuracy of scheduling on all major jobs: where previously schedules had sometimes been used as instruments through which to put pressure on manufacturing areas by setting targets for them, now they became straight forecasting documents reflecting the latest information available on job progress as transmitted to the Production Planning Manager at weekly meetings.

b) Along with more realistic scheduling of completions on major jobs came the fact that such jobs now made up a much larger percentage of the total schedule; the predictability of Rubber Technology Equipment output (Graph 3 shows that this exceeded 92% for 11 months in 1976) was particularly significant and might be expected in view of the fact that the products concerned were substantially repetitions of previous orders.

While one might claim that an improved performance against schedule over the year as a whole reflects in part the increased organisation

and control over pre-production planning and work-in-progress monitoring, it must be admitted that one of the absolutely key factors was that the Division's most uncontrollable and unpredictable manufacturing unit, the machine shop, was relied upon for a lower percentage of total output during 1976.

3. The Division's Performance Against Original Promise of Delivery

This provides a more acceptable measure of any improvement in production efficiency. P & ED had a poor reputation on delivery to promises on all its products and there can be no doubt that this harmed its ability to compete for work and possibly forced it to accept a lower contribution as the price for securing contracts. Graph 6 of the report shows that there was a substantial improvement on performance to original delivery promises during 1976. In January almost 70% of all work on the production schedule was overdue: by December, only 8% of the schedule was made up of overdue work. This situation resulted in part simply from an increased output level and in part from a more informed and, therefore, more accurate calculation of throughput time for jobs, including time required by the pre-production departments.

5.2.3 Summary

The author believes that the report gives grounds for concluding that there was an improvement in production performance during 1976, though it is impossible to assess how much of this may be attributed to attempts at solutions to its problems outlined in the previous chapter and how much occurred coincidentally through the increase in orders for the more predictable Rubber Technology Equipment. There is nothing here which could be used to support the suggestion that there was any improvement in control over the machine shop area, where it has been suggested that many of the Division's problems lay.

5.3 Results of the Continued Absence of Machine Shop Loading Data

Increased output in the machinery categories perhaps owes something to the improvements in organization which were made in 1975, particularly with regard to the firm's enhanced reputation for being able to keep more accurately to its original delivery promises. This partly resulted from the more scrupulous monitoring by the Production Planning Department, through its monthly schedule and weekly progress meetings, of the machinery parts manufactured in the machine shop, but partly also reflected management approval for a policy of subcontracting the manufacture of an increased proportion of these parts.

Indeed, in the initial period after this policy decision was made, the advantage of being able to secure fixed prices outside, and thus of predicting production costs, led to very few of the parts for new jobs being placed on the shop. I found that it was only in cases where the Buying Department was unable to secure outside prices in line with estimators' allowances that parts would be manufactured "in-house". Since the machine shop was only given these same rejected allowances, its performance was bound to look poor when compared to outside. There remained no system for examining machine shop performance against the lowest actual quotation received for the same job from an outside agency.

Because it seemed that the machine shop was being underloaded as a result of the very extensive use of sub-contractors, management modified its policy and brought a percentage of the machinery parts production back "in-house". I should emphasise that estimates of the shop load at any one time were still not based upon statistical analysis of data, but rather upon the short-term examination of the amount of material on section racks, which at best produced criteria for "educated guesswork".

There was also no genuine system for deciding which parts, under the modified sub-contracting policy, should be made in the machine shop. Selection was made by the estimators on the basis that a certain number of hours of work was needed to "top up" the shop load. The actual number of hours was, at best, the result of the "guesstimates" of the shop floor supervisory staff. No consideration was given to the difficulty of operations and, thus, their suitability for production by highly skilled machinists. The lack of data upon which to base production decisions was obviously a serious shortcoming. It resulted from the Division's inability to find a suitable control system for the shop floor within the limited budget available.

Four short-term experiments carried out by the researcher during the last months of 1975 and the first half of 1976 achieved limited successes in particular problem areas and are worth recounting briefly:-

5.3.1 Reform of Priority Ticket Usage - Grinding Section Experiment

The section progress chaser's files were replaced by a box tray, with a compartment for each different group of grinding machines. Tickets were filed in strict priority sequence by earliest start date. Operators seeking new jobs were to be given the top ticket for the machine group upon which they were working.

In theory, the system was simple and meant that jobs would be processed in the correct order on the section, while accepting that individual operators should not be moved from one machine group - where they could make use of particular skills and experience - to another, albeit within the same section, unless there was no work for their usual machine. In practice, the operators continued to choose their own jobs and during the

period of the experiment, the section as a whole was never sufficiently heavily loaded for this to make a great deal of difference to item completion dates.

5.3.2 Reform of Computer Input Procedure for Service Jobs

To avoid operation entries for service jobs preceding the input of the job details onto the computer file, and thus appearing as unmatched bookings or remaining on file after despatch of the job, I designed and introduced a system whereby batches of "dummy" service jobs were set up on the file with zero time estimates. Bookings were then made by machine section rather than machine group.

As customers were charged on the basis of the actual number of hours it took to process an item, this left the Accounts Department with the required information for invoicing. It also prevented these jobs from affecting the collection of workload data direct from the computer file. The disadvantage was that there was now only a manual file against which the performance of the service-work planner could be checked. But this was only ever necessary in the rare instances where the customer division queried the price which had been charged for a job.

The expedient was successful in reducing the size of the unmatched bookings file and in preventing service-jobs from adding to erroneous data on the central file.

5.3.3 Printer for On Line Interrogation of Computer Files by Machine Shop Production Controller

At the suggestion of the Computer Department, a printer was set up for a trial period on the shop floor in order to give the Production Controller direct access to the latest job progress information on the files.

I felt that the exercise was rather pointless given that the booking clerks always entered information a shift in arrear and that a daily print-out was already received reporting on previous day's time bookings. After an initial period of usage, the Production Controller found it more accurate, and on many occasions actually easier, to locate items and predict job completion dates by a manual check using the progress chasers.

Use of the printer was terminated when the Computer Centre tentatively suggested what maintenance of such an "on-line" facility was likely to cost the Division.

5.3.4 Computerised Production of Load Analysis Data from the Existing Program

Program modifications and a report format were already available in the Computer Centre for the production of a report tabulating and summarising remaining machinery time for all jobs currently on file. The report was divided into work for completion by the end of the current week and thence for successive 4-week periods.

Totals were shown per machine group for each job and a summary showed the totals under each product code. The usefulness of the report was reduced by several factors revealed in the researcher's weekly analysis of its contents:

1. It was based upon a file which was known to contain inaccurate information and, therefore, its results were immediately devalued for practical usage.
2. Analysis of a report produced at the end of June 1976 showed that only 78% of the hours on the computer master file were included in the analysis; the remainder were omitted because the entries in the delivery date columns for them were not classifiable into a definite

load period.

3. The same June 1976 analysis showed that a total of 2,700 out of 11,700 hours included in the report for machine shop work no longer existed.
4. While the grouping into four-week load periods was accurate enough for most of the tooling work, it was totally unrealistic for machinery orders, where the throughput time for machine shop parts would be considerably longer than a month.
5. Delivery dates were not amended in line with changes in the production schedule.

The report could be used to give a general impression of the shop situation and was reasonably accurate in showing the comparative load situation on the different sections. It could also form the basis of a more accurate manual analysis of the load situation. However, it was far removed from an instrument through which the labour resources of the Division's machine shop could be most effectively allocated or future capacity planning approached. Eventually, the researcher suggested that even the minimal extra cost involved was not justified and secured the General Manager's approval to cancel it.

5.4 The Case Against the Machine Shop

Given the failure of my efforts to bring the machine shop under closer control, the element of uncertainty which this area contributed to the Division's operations remained a serious source of instability within P & ED. The predominance of the machine assembly business and the optimism with which management viewed the possible future development of this field combined to make this situation less acceptable. I have already noted that the machine shop was not an essential part of the machinery building production process, and Chapter 2 spelt out the

difficulties of combining two essentially different types of production within one firm. Indeed, with an economic situation in which sub-contractors were clamouring for work and were thus willing to quote prices in some cases which would bring any contribution - however small - to profits, there was evidence to support the view that it was actually uneconomic, at least in the short term, to manufacture machinery parts internally.

P & ED was thus strategically armed to put its case to the Engineering Group Directorate.

1. The continued existence of the machine shop could be justified only in terms of service and tooling work.
2. The problems of controlling its activities meant that its existence had a deleterious effect on the performance of the Division as a whole because, although the profitability of the service work and of the tooling work (given a more selective acceptance of outside contracts) was proven by the annual results, this work no longer formed such an important part of the Division's business. In consideration of the fact that there seemed no prospects for expansion of this product area, the disruptive effect which privileged orders could have on the completion of parts for the machine assembly shop was against the best interests of P & ED's growth.
3. The Division was prevented from establishing itself as a true profit centre which could make a genuine contribution to the parent Corporation by its position as "captive supplier" of the service and tooling requirements of other Divisions in the Group.
4. A situation existed where other Engineering Group divisions were competing with each other for some of the resources in the machine shop. Such competition was against the best interests of the Group.

5. Divisions constantly complained about P & ED's performance in terms of price and delivery. They were also concerned about their lack of control over the order in which their jobs were processed. This suggested that P & ED's machinery manufacture might be having the same effect on Group jobs as they were on it, which again favoured separation of the two distinct areas of operations.

After considerable discussion, the Group accepted P & ED's case in mid-1976 and proceeded with arrangements to disperse the tooling and servicing operation to the individual Engineering Group divisions. P & ED re-established a small machining force to cater for its own special requirements within what had previously been the bench fitting area of the machine shop.

Aviation Division and Wheel Division set up their own servicing units, employing some of the machinists released by P & ED. Suspensions Division already had a small service unit and enlarged this a little by taking on 8 machinists from P & ED. Fixed assets, in the form of machinery, were transferred to the other Divisions as required and a small number which were surplus to needs were sold.

5.5 Changes in the Complexity of the P & ED Situation

The problems to be handled or managed had now altered significantly. As a broad generalisation, there was a movement from a problem of controlling people, in the form of a complex machining labour force, to one of handling things - co-ordinating the arrival from a number of different sources of kits of parts for the construction of machines.

The most important area of concern had moved from production control to

production planning, in line with the characteristics outlined in Chapter 2, Section 4. Indeed, machine shop production control had continued to be the dominant problem beyond the point at which its essential manufacturing role as a jobbing tooling shop had a significant influence on the total output performance of the Division. This was probably the result of fears for the future potential of the machinery business in the light of the low volume of orders in 1974.

By the time the re-organization of the Divison took place, there was a considerable degree of optimism about the possibilities for expansion of this side of the business, an optimism which the researcher was loath to share, given the limited concrete evidence to support management's assumptions about the potential for expansion outside the largely Union-based rubber technology machinery area. In closing the machine shop, divisional management was asserting that it would not in future need to fall back on tooling work to make its output totals respectable in the way that it had relied on Group tooling work in 1974.

My assessment of the potential problems of its new position have been outlined above in Chapter 4. There was an immediate and obvious need to compensate for a reduction in the types of product manufactured - in future all would come under the general heading of machinery and ancillary equipment - by broadening the range of machinery products manufactured and markets served. Production uncertainty and risk had been reduced, and forward planning of manufacture became possible, but the programmes remained dominated by Rubber Technology equipment, particularly for customers within the Union. As such, I felt that the product range was highly susceptible to sudden obsolescence resulting from technological change.

Two distinct stages were essential in planning the future strategy of the Division:

1. Analyse and firm up the prospects for development within the Union market, involving not simply the current range of products, but also the potential for expanding the Division as the source of all equipment required by Union customers.
2. Examine the potential for outside sales of similar equipment and for the development of new product lines, not necessarily having any market within the Union.

Obviously, management had formed its plans preparatory to stating its case for a change in its operations within Engineering Group. Some of the main features and assumptions are outlined below, with the researcher's own observations upon them.

5.5.1 The Union Market

1. Tyre Machinery

While this product area remained, for the present, the basis of P & ED's output, it was seen as unlikely that "Union based tyre plant sales will show any appreciable upturn" (1) over the next 5-year period. My analysis of the historical figures from 1972 supported this prediction. After adjusting even the very high 1977 figure to take account of inflation over the previous 5 years, the real value of output of this type of product had not increased significantly and there was no reason to believe that the high 1977 figure would necessarily be maintained. (In fact, it is difficult to make direct comparisons between the figures because sales to Pirelli customers are treated as non-Union sales in 1972, but as Union sales in 1977).

Forward strategy in this business area consisted of seeking agree-

ments to recognise the virtual monopoly of P & ED as the manufacturer of all unique Union tyre machinery (2). Growth, so far as it was possible, depended upon reaching such agreements with overseas members of the Union. Naturally, depression within the British automotive industry would effect the timing of the replacement of capital machinery in this category, although there was always the chance that the Division might benefit from the acquisition by U.K. Tyre Group of contracts to supply foreign manufacturers with tyres for new cars.

2. Union Influence on Receipt of Outside Orders for Tyre Machinery

Most of the other orders for tyre machinery which were received by P & ED resulted from major contracts secured by Dunlop International Projects Limited, part of which might be assigned to the Division, or from collaboration, particularly with the Pirelli organisation, on projects in eastern Europe. Direct negotiations with customers took place in cases where plant only, and not technology and know-how, was involved. The amount of business of this type fluctuated from year to year, as the Product Results table show.

It was not to be expected that this would ever become a reliable regular element in the Division's output. As noted earlier, the researcher found such sales of equipment rather hard to reconcile with the best interests of the corporation as a whole, since one would obviously expect a functional relationship to exist between sales of tyre-building equipment to outside customers and sales of actual tyres by Dunlop Tyre Groups in the same areas.

3. Non-Tyre Machinery & Ancillary Equipment

With the natural policy of the Corporation to provide for its needs wherever possible from within the Union, this area could be looked

upon as having potential for considerable expansion. P & ED again sought agreements to manufacture under royalty all unique plant and machinery (3). It involved broadening the Division's reputation from mainly a tyre machinery manufacturer to a producer of any special purpose equipment. Internal progress in this respect would probably affect the chances of securing outside contracts for non-rubber technology equipment.

4. Limitations of the Union Market

The point is made in the Strategic Plan that: "it would be unwise to rely on Union patronage to ensure a viable Division, particularly in view of the unpredictable nature of Union business. It is essential, therefore, that the Division should broaden its product, market and customer base as quickly as possible"(4). At its existing level of output, Union business would continue dominant, but if, as was obviously its wish, the Division were to grow, the expansion would result only in the first instance from an increase in internal sales and thereafter would depend upon diversification of products and markets.

5.5.2 The Outside or Competitive Market

This section must, of necessity, be restricted to a general appraisal of the Division's expansion policy. It would obviously be impolitic for the researcher to disclose any details on the specific products and projects through which the Division hoped to expand.

Basic strategy depended upon identifying industrial needs and associated opportunities, particularly in areas where the Division's current expertise had some relevance - it was suggested, for example, that there might be common features between some of the Rubber Technology equipment and machinery for processing plastics and textiles. At the same time, the

Division examined the potential of any new inventions placed before it, with a view to purchasing patents or acquiring production licences. Previous experience of the failure of the slush-pump liners and pipeline servicing equipment led to much more careful analysis of the potential profitability of such products. In the capital equipment market it was the industrial consumer or customer who dictated what should be produced because of an economic environment where the capital available was limited and was cautiously deployed.

The long-term future of P & ED depended upon developments into new fields of industry in order to remove the dangerous dependence on rubber technology equipment and more particularly on tyre machinery. Expansion within the Union was essential in establishing a base, but growth beyond a certain limit rested on establishing substantial profitable non-Union business.

I have noted earlier that closure of the machine shop meant the loss of a small number of lucrative tooling contracts. There was a possibility also that some equipment contracts, requiring high-precision parts manufacture, might also be lost. The prestigious and generally profitable production of equipment for the Nuclear Processing industry had developed from the impressive quality of P & ED's workmanship on early special-purpose tooling orders. The industry insisted on the right of approval of any sub-contractors used, and employing the latter meant that quality passed out of P & ED's absolute control, although unsatisfactory parts could be rejected after internal inspection. It is the author's opinion that the Division might thus prove less attractive to some customers, especially if the design facilities offered can be found elsewhere.

5.6 Resulting Changes in Internal Requirements

The characteristics of the business were simplified by the closure of the tooling operation and would be expected to fall very much in line with the ideas expressed in Section 2.4 of the "model". The dominant element in internal operations was no longer production control but production planning. The latter is meant in the widest possible sense, including product development, pre-production organization and marketing. Further work on the project was concerned with the second of these areas.

5.6.1 The New Status of P & ED

Re-organization at the time of the closure of the machine shop altered P & ED's relationship to the other Engineering Group Divisions. A new "Industrial Products Division" (IPD), was formed and P & ED's General Manager became Director of IPD. A number of small divisions, including P & ED, were grouped together into IPD for business analysis purposes though each remained semi-autonomous. Thus, the new General Manager of P & ED was responsible in the first instance to the Director of IPD, but had the power to set his own objectives. P & ED's performance was judged as a true profit centre within IPD, just as IPD as a whole was judged by its contribution to the Group.

Although it would appear that P & ED's General Manager was now one stage further away from being able to influence Group policy decisions affecting his charge, in reality its interests were better looked after because of the presence of the IPD Director on the Group Executive Committee.

5.6.2 Internal Organization

The rationalisation of the type of product manufactured by P & ED made it logical to return for the present to a functional structuring of

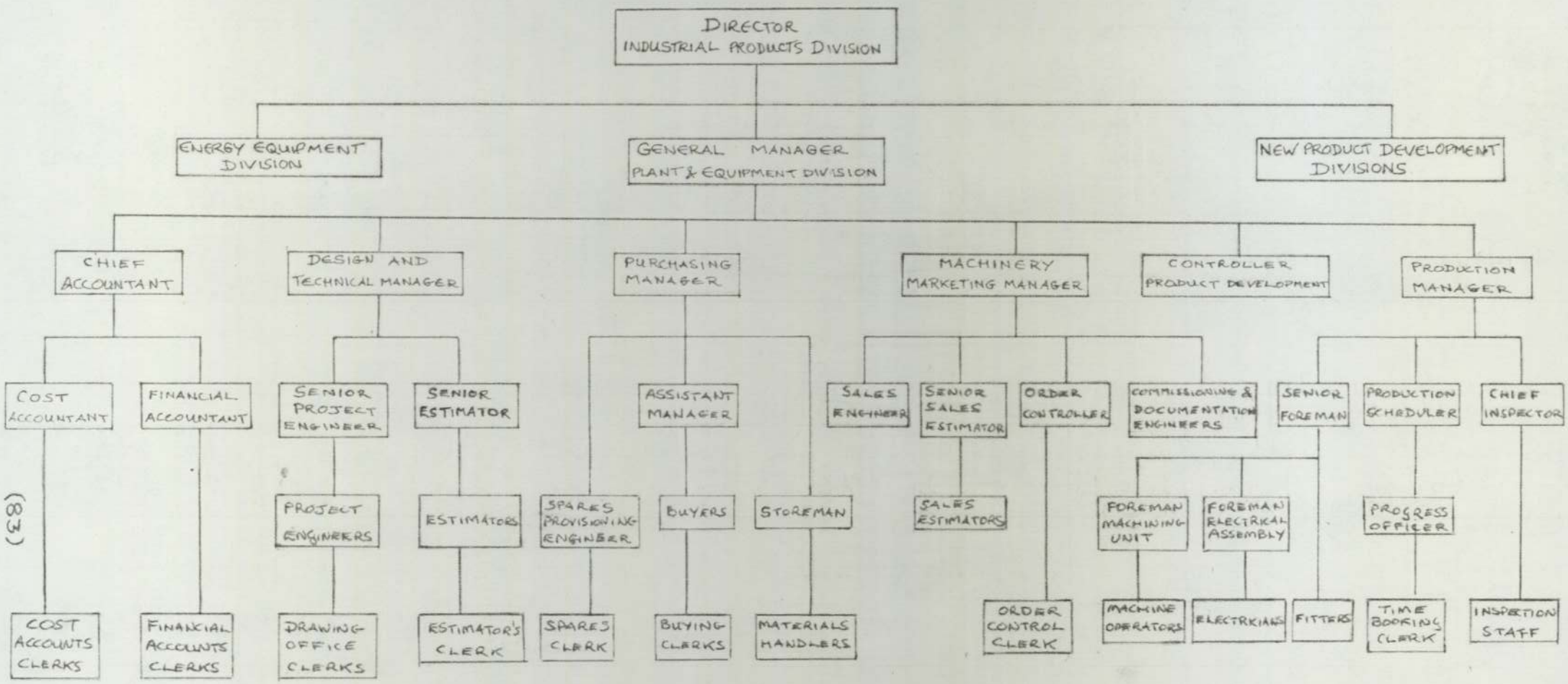


FIGURE 5.4. INTERNAL STRUCTURE OF P&ED FOLLOWING CLOSURE OF THE MACHINE SHOP

internal departments. The reorganized hierarchy is shown in Figure 5.4.

However, it is rather difficult to understand the comment in the strategic plan that despite an estimation that real turnover would double by the end of 1983, "No significant changes are foreseen in divisional organization" (5).

Management themselves had noted that expansion of turnover is most likely to occur through development of new products and outside markets. Whilst it is satisfactory to deal with short-term projects, or the early or launch stage in the life of new products, by setting up teams temporarily seconded from the various departments, permanent staff would be needed during the growth and maturity stages of the product life cycle to ensure the best results.

With the sort of products under consideration here, this part of the life cycle would be expected to extend over a period of years. Any major product or group of products for use in a specific area of industry would require at least the assignment of marketing staff, project engineers and draughtsmen, if not actually its own production facilities. This would suggest to the researcher that, over a period of time, a form of mixed structure might again become more appropriate with assigned staff under project managers covering some areas, and functional departments covering others, in order to utilize available specialist resources most efficiently.

Presumably, the comment in the strategic plan should be taken as a prediction that no one product area would have developed sufficiently by the end of the plan period to justify assignment of separate permanent staff, in which case one would view the predicted doubling of output totals after inflation correction as distinctly optimistic.

The reorganization presented an opportunity for rationalizing the functional grouping of staff and a number of changes were made:-

1. It was recognized that the old Estimating and Technical Department had two quite distinct functions in the new organization - estimating in general terms for quotations (referred to as sales estimating) and detailed estimating following order placement. These activities were essentially linked with different departments and thus the function was split: the sales estimators were seconded to the Machinery Marketing Manager, the detail estimators became integrated with the Design Department.

   I found that the re-arrangement was not without its problems. The first indication of the contribution to be expected on any job came from a comparison of the sales estimators' total figures with similar figures produced by the detail estimators. Where all were within the same department, such comparison could readily be made, though there might be a risk that pressure would be put on detail estimators to "work within" the totals given at the quotation stage. Separation of the two functions meant that neither area necessarily had figures available to make the comparison. However, it did make it possible for an absolutely objective comparison to be made by the Accounts Department, who received figures from both areas. This department could then produce, at the conclusion of a job, figures measuring the performance of sales estimators and the detail estimators against the actual job cost. I found, however, that no such analysis or comparison was taking place on machinery produced during 1977.

2. A member of the senior management team was given specific responsibility for making a preliminary assessment of the potential of any proposed new products. If it was decided to proceed with further

investigations, consultants might be called upon to make an appraisal of the market and, as with special projects taken on in association with Dunlop International Projects Limited, a team would be drawn from the relevant departments to handle development work. My discusions with this manager revealed that he felt himself in an almost impossible position because of the variety of different products which he was asked to assess, many being outside his technical competence.

3. All production now became the province of one senior manager, since it was required that the operations of the retained small machining unit should be totally integrated with the requirements of the assembly shop. However, the two units were still physically separate from each other which in practice tended to mean that the machinery unit foreman enjoyed very much greater freedom of action than had any foreman in the old machine shop.

5.6.3 Identification of Potential EDP Assistance in New Situation

The small machining unit did not justify employment of a computerised shoploading system. It was considered that manual loading, although it might not actually maximise utilization of available resources of men and machines, would be sufficiently accurate. Despite the fact that the unit only produced machinery parts, the author noted that definitive forward loading was still not possible. An unpredictable element in the load was provided by a small number of rush modifications required by the assembly shop, including correction of parts manufactured by sub-contractors which were rejected on internal inspections, but were needed too urgently to be returned for rectification.

Such jobs provided the main justification for retention even of the small

unit, since an exercise carried out by the researcher and representatives of various departments early in 1978 showed that the hourly cost of manufacture internally could definitely match sub-contract prices only on the two large multi-purpose milling and boring machines which had been retained (6). But modification work also meant that adjustments to the production schedule were needed from day to day. This would have increased the running costs of any computer aid program.

Closure of the machine shop also made the existing computerised data collection system redundant. Time sheets for the 16 remaining machinists were manually summarized daily by a clerk for accounting and progress monitoring purposes. Daily bookings by the assembly area fitters and electricians had never been useful or significant, since a man, or a team, would be concerned with the same job for a period of weeks or even months.

The Production Department thus identified no specific areas where EPD seemed to offer potential savings of staff, effort or delay in receiving information.

It was in the pre-production departments that there seemed to be potential, in P & ED's changed business environment, for electronic data processing. The key document throughout these areas after placement of an order was the Parts List. This was compiled by drawing office clerks and the information on it was subsequently re-written, in the form of purchase requisitions, by the estimators and reproduced yet again on Purchasing Department orders.

The Group Computer Centre was invited to examine this procedure and con-

cluded that, besides saving a good deal of clerical effort, use of an EDP system would be expected to cut 1-2 weeks off the existing pre-production processing time. The overall effect would be that the potential capacity of the various departments would be increased without any corresponding need to raise the numbers employed. P & ED's management requested the Computer Centre to analyse the situation and submit a detailed proposal (7). The researcher was delegated the task of providing information required by the computer analyst; acting in a liaison role between him and P & ED; discussing the ideas and suggestions of the analyst from experience of the actual problem situation within the Division.

The proposal was accepted towards the end of 1976 and work advanced to the detailed program specification stage before, in the middle of 1977, work was suspended by P & ED. The problem was that it now appeared that there was considerable doubt as to the validity of the two major premises upon which the usefulness of the system depended.

It was accepted from the outset that, in the case of one-off equipment manufacture, use of the computer would represent very little saving, since completion of computer input forms would involve as much clerical work as the existing system. The system was commissioned, however, because:-

1. P & ED intended to standardize its existing product lines rather than allowing customers absolute freedom to specify special requirements.
2. It was anticipated that the Division would be able to diversify fairly quickly and acquire new standard equipment product lines.

A set range of products could thus be set up on a computer file and parts list called off according to formats suiting each of the user departments. It was accepted that a small percentage of parts were

likely to change from one build of a machine to the next, if only through obsolescence, but it was hoped that this would never make up more than 20% of the total number of parts.

In the light of actual experience during the first half of 1977, both the researcher and management found that neither of the two premises were currently justified: no new product lines were even close to becoming established and customers for the traditional range of equipment resisted P & ED's attempts to introduce greater standardization - as noted before, the industrial consumer was still dominant in dictating the terms of capital equipment purchases. The Division needed the business and was thus forced to concede.

The parts list computerization project was thus set aside for reconsideration at a later stage in the Division's development. If growth did take place as expected, there was a good chance that such a reappraisal might be justified towards the end of the current strategic plan, in 1983, although I note that there is no mention of it in the plan.

The point was made that the work which had been done was by no means wasted, since development could recommence, from the point at which the decision to suspend was taken, at any future date. Unfortunately, a valuable "spin-off" benefit of the system - the rationalization of P & ED's totally chaotic part numbering practice - was also lost with the suspension. Certainly this rationalization would have placed an extra load of work upon the Division's Design and Technical Department, but the bulk of the work was available as a free service from the centralized "Coding Section" maintained at the Union's major works in Birmingham.

The researcher felt that standard identification of parts across the product range would have made it possible, even under a continued manual system, for the Purchasing Department to obtain the maximum discount from suppliers and, more immediately, would have provided a basis for a rationalized organisation of parts locations in the stores. As already explained in Chapter 3, it was perfectly possible with the existing system that a part used on three different machines would have three different numbers assigned to it and that the records would show an "out of stock" situation under the number required for a current build, though there might be stocks under the alternative numbers. This could mean both delay to the machinery building programme and more particularly an unnecessary duplication of stock holding.

5.7 The Results of the New Situation for P & ED over the first 12 Months

5.7.1 The Financial Situation at the end of 1977

For P & ED's management, an absolute justification for the re-organisation of the Division and the closure of the machine shop was provided by the large profit shown at the end of the first year (see Table B, Appendix 1).

My own analysis of the results, however, reveals a rather less conclusively encouraging situation. The profit was achieved, in spite of a decrease in total turnover compared to the previous year, by increasing the overall level of percentage contributions and by reducing "constant expenses", or apportioned overheads, both in absolute terms and as a percentage of turnover. More particularly, it was through the achievement of better than expected contributions from Union customers - 10% up on planned levels for non-tyre machinery and 9% up for tyre machinery - that the major part of the profit was returned.

Union customers, indeed, paid a higher contribution rate than outside

customers and, while such distinctions were not important to P & ED alone, they must naturally be of concern to the Corporation as a whole. I considered it disturbing that sales to outside customers not only failed to achieve the planned contribution rate, but also reached only 20% of the anticipated turnover level and made up only 7½% of the Division's total (Coventry) turnover for the year.

More than ever, P & ED was reliant upon Union business and especially tyre machinery, whereas it had been stressed ever since the reorganization that the future prospects of the Division depended on expanding its share of the outside market. The only terms by which the figures are satisfactory are found by emphasising the importance at the birth of the new organization of maximising the extent of Union business as the necessary base to future expansion. Even so, one would have been looking for at least a maintenance of previous levels on outside sales. The actual turnover - even without taking account of inflation - was the second lowest in the seven years over which the machinery sales to outside customers had been made, only the figure for the exceptionally bad year of 1974 being lower.

5.7.2 Internal Organization & Control Systems

The Division's reputation was enhanced in the market by completion of 98% of all deliveries to customers in accordance with the original schedule. Only one complaint was received and investigation showed that the fault lay with the customer's own installation and maintenance engineers, who had failed to level up the site for a machine correctly.

This would seem to suggest that all was well co-ordinated internally, but in reality the source of the good performance was in the fact that

the Division was working well below its estimated turnover capacity. The researcher found that problems with internal co-ordination remained.

1. There was no check upon the performance against estimates of the machining unit and it was thus difficult to assess whether it was being loaded correctly or not.
2. The paperwork system for parts made internally remained based upon the requirements of the old computer system (now scrapped): forms contained a good deal of redundant information and several were still produced which were not used at all.
3. Partly because of the above situation, the decision to make or buy a particular part was still being made by the estimators, based on information from the Production Department on the capacity available in the machining unit; the policy was to place a certain amount of work internally, rather than a selected group of particularly low tolerance parts.
4. Following on from this, the Purchasing Manager, who was supposed to take the "make or buy" decision, based upon subcontractors' operations, was pre-empted: parts for internal manufacture would only make an appearance in his department in order that material might be ordered for them, yet his department would still designate other parts for shop floor manufacture if outside quotations for them were unacceptable.
5. The procedure by which estimators did not prepare a costed parts list as they went along, but rather left the estimator's clerk to gather the figures from requisitions and internal manufacturing forms at a later stage, was not only wasteful of time and effort but also meant that the "costed parts list" was delayed in reaching the Accounts Department.
6. The Accounts Department was thus prevented from performing a valuable service in providing a beginning of job assessment, comparing quoted

costs from the sales estimators and detailed cost estimates.

7. There was no formal system of feedback to either the sales estimators or the detail estimators on the actual performance against their figures of both the internal machining unit and the external sub-contractors used; such feedback might surely have been valuable in making more accurate future estimates.
8. As a result of the former policy of apportioning all constant expenses equally across the total turnover of the Division, the Accounts Department was unable to offer an accurate variable factory cost (VFC), for work done by the machining unit; yet the VFC was obviously vital to the Purchasing Manager's decision as to whether parts should be manufactured internally or sub-contracted.
9. Such calculations as were made by the researcher, in association with the Accounts Department, on this question suggested that insufficient investigation had taken place as to which machinery should be retained in the new unit and which sold off or transferred: calculations were not totally conclusive, but it seemed reasonably certain that work on the large multi-purpose milling and boring machines competed favourably with sub-contract costs, whereas small turning and milling operations were more expensive internally.

Many of the above points are minor when taken in isolation, but taken together they added up to an organizational problem which I felt could be a major stumbling block to the growth and development of the Division. Just as it was important to expand the Division in external, market and product terms, so also it was vital that its internal co-ordination should be tuned up and capable of efficiently handling the expansion programme.

On the positive side, I found that the reorganization did produce advantages

for P & ED. The strictly financial ones have already been covered previously, but the following should also be mentioned:-

1. The improvement in the Division's delivery record has already been noted and this obviously enhanced its reputation and made it better able to compete in the market.
2. Establishment of the sales estimating group meant that answers to customers enquiries were always produced within 7-10 days of receipt of the enquiry.
3. Use of sub-contractors to supply machinery parts made costs more predictable and an evaluation of probable job performance could be made at a fairly early stage.
4. Lack of complication of machine-shop priorities made for rapid fault rectification and the delivery to schedule of kits of manufactured parts to the assembly area.
5. Simplification of the range of product types gave all areas of the Division a unity of purpose.

5.8 The Effects of the Changes on the Rest of the Union over the First 12 Months

The most obvious advantage to the Union as a whole of P & ED's reorganisation and reorientation was that it was performing as a genuine profit centre, making a contribution towards Union profits, rather than being a drain on Union funds. Its former existence, however, had been justified by its indirect contribution as a source of tooling and equipment for other members of the Union and particularly for Engineering Group. I carried out an investigation to determine the more detailed effects of the closure of the machine shop on the rest of the Union.

5.8.1 The Effects on Other Members of Engineering Group

As suggested in Chapter 4, Sections 8.7.3 & 8.7.4, the main question here

concerned the success of the arrangements made by the other divisions for handling their servicing and tooling requirements. The investigation proceeded through interviews with senior management personnel in each division (8). The list of questions given in Appendix 3 formed the basis of these interviews and my findings are presented below.

1. Problems with Financial Comparisons

An immediate difficulty in making the above assessment was that no strict financial comparison could be made. The Works Manager of Wheel Division, for example, conceded that a great deal more had been spent on tooling during 1977 than in 1976, but pointed out that this included tooling up for two new types of wheel which his Division had secured contracts to produce.

Suspensions Division's Accountant believed that having their own toolroom had made things a little cheaper, but immediately added reservations: although the hourly rate for work was lower "in-house", there was a fair chance that outside contractors might have competed through taking a shorter time over jobs. On service work, jobs that used to be carried out very quickly or overnight by sub-contractors were now actually taking longer to be processed in the toolroom unit. The Division was attempting through the reorganization to process not only work which had been sent to the P & ED machine-shop before, but also part at least of the work previously sent outside.

Aviation Division's Production Engineering Manager noted that, although the new unit was cheaper than the P & ED machine shop, it was still generally a little cheaper to use sub-contractors. However, overall less work was now placed outside, the difference between the prices being more than adequately compensated by the greater control over

and convenience of doing work internally.

The ultimate aim in all Divisions was self-sufficiency in tooling and servicing requirements, but they were all wary of setting manning levels too high in the first instance , recalling the problem of spare toolmaking capacity which P & ED had had to deal with.

2. Setting Up the New Units

Each of the other Divisions had a site available for a toolroom in reasonable proximity to its main factory. Machinery to be used could be transferred from P & ED and the machining labour force was also available for transfer. This meant that the initial capital cost of setting up a toolroom operation was limited. It relied on the Divisions being able to predict more or less what machining capacities would be needed in a year, specifically by each one of them, whereas the larger central P & ED machine shop had been able to deal in terms of the gross requirements across the Group as a whole.

To counter a degree of uncertainty over requirements, Wheel Division, for example, took over 32 machines from P & ED, but only 26 machinists. Mobility of labour between machining sections was so important that the Works Manager insisted that it should be written into the men's job descriptions. Aviation Division was better placed in this respect: the Production Engineering Manager was able to predict from the start what the requirements of his Division would be and did not need to maintain many extra machines to allow for variations in the workload, over and above the ones that his 16 machinists and fitters would normally be employed on.

The administrative system for tooling and servicing was obviously more complex: before, it had been a straightforward procurement system enquiry out to potential supplier(s), quotation received from them and order placed where price and delivery conditions were best. Now, an increased number of staff employers were needed to plan jobs and to ensure that anything needed for jobs was available. Experienced planners, once again, could be re-employed from those considered surplus to P & ED's new requirements.

Wheel Division's Works Manager noted that the age of some of the machinery taken over from P & ED posed a fairly immediate problem in terms of laying aside capital for replacement equipment. Difficulties had been encountered during the first year on the maintenance of some of the machines and additional requirements had been identified; for example, two pressing machines had been ordered from Plant and Equipment Division and a new jib boring machine was needed because of the obsolescence of the one transferred.

3. Effect of Lower Capacity Flexibility

The smaller individual tooling units meant that there was a reduced maximum tooling capacity available to any of the individual Divisions. This could have caused problems in dealing with sudden increases in demand for tooling. A case in point was the tooling required for the two new Wheel Division contracts, mentioned above. The Works Manager noted that a good deal of this work had had to be placed on outside sub-contractors, but asserted that not all of it could have been handled by the old central P & ED toolroom anyway. He also stated that Wheel Division had established good relations with a small group of sub-contractors which meant that delivery by a stated date

did not pose a problem. On the other hand, he was adamant, in answer to another question, that sub-contractors could not match the internal unit on the price of tools. It would thus appear that there was some financial disadvantage to his Division in having to place a greater amount of work, in respect of sudden increases in demand through new contracts, on outside suppliers.

Decreased flexibility in the other sense, that of having a smaller range of machining operations available, did not pose much of a problem for Wheel Division, since the tools required did not tend to require specialised machining. The one exception was die sinking. Copying of dies had been possible in the P & ED machine shop, but was now sent outside. The Works Manager considered that the Division would probably find it necessary to purchase a die sinking machine for its tooling unit in order to get over this problem.

Aviation Division, on the other hand, experienced no problems with capacity flexibility. Their policy was to fill the new unit with work first and send any surplus to sub-contractors. It was difficult to say what effect substantial new projects might have: it might prove possible to predict tooling requirements in advance and thus produce these in the internal unit over a period of time.

Aviation Division was the part of the Group which had required most usage of the specialised machines in the P & ED machine shop, but here too no greater problems were found than had existed before. Only such specialised operations as had always been placed outside needed to be sub-contracted. It had been thought at the time of the

reorganization that Aviation Division had sufficient work to occupy specialised units full-time and thus they had been transferred from P & ED.

4. Availability of Suitable Grade of Work

In all cases, enough (and more) work was available to employ the new units full-time without the need to resort to using "fill-up" jobs. No downtime was recorded through a shortage of work. All the Divisions proceeded on a policy of filling the known capacity of their individual units first and subcontracting any variable surplus above this capacity. There was a definite advantage here of closer knowledge of the potential capacity available in the individual machining units. Both Aviation Division and Suspensions Division had found it possible to reduce the amount of work placed outside and there were special reasons why this had increased in Wheel Division.

5. Control Over Order of Production

Each Division stressed the advantage of direct control over tooling and servicing resources as against the previous situation where they might be in unhealthy competition with each other for scarce resources on the machine shop. As a result, Wheel & Aviation Divisions noted that there was now a faster service on repairs and breakdowns, though Suspensions Division found that these took rather longer, not because of the unavailability of the P & ED machine shop, but rather because of the move away from using sub-contractors who could offer an over-night turn round.

Delivery of tools was more in line with the requirements with the new units. Wheel Division's Works Manager made the point that, although

on occasions they were still late, it was no worse than before and the significant thing was that not only did he now know what was late and how late it would be, but also he was in a position to choose which jobs to be late on, in line with the urgency of his various tooling needs.

6. Workforce Motivation

In all cases, closer involvement with the Division served was felt to have increased the interest of the workforce in their tasks. Smaller groups of workers had logically produced a greater interdependence between individuals both on quality and on the timing of operations. All workers were able to have some sense of identity with the finished product. Aviation Division's Production Engineering Manager noted that the machinists now understood the purpose of what they were doing, whereas in P & ED's machine shop they had been to a large extent abstracted or divorced from the ultimate usage to which replacement parts or tools were to be put.

7. Other Comments

Wheel Division had found that there was a problem with steel stocking decisions as a result of the closure, at the same time as the P & ED machine shop, of the central steel stores. In their normal production cycle, a limited range of steels and dimensions were required and separate arrangements had to be made to provide for the different and far greater range needed for toolmaking operations.

Aviation Division did not encounter this problem because it already used a wide range of steels in its production cycle and maintained extensive stocks from which toolmaking requirements could be met.

8. Overall Conclusions About Effect on Group of Closure of P & ED Machine Shop

Both P & ED and all the other Divisions in the Group found the new situation of dispersed tooling and servicing facilities, if not totally satisfactory (as in the case of Wheel Division), certainly a marked improvement upon the previous situation. The major advantages were to be found in unquantifiable factors: increased control over service and tooling activities; ability to alter the internal priority of tooling jobs; genuine knowledge about progress on jobs and expected completion dates; closer identification of workforce with the purpose of their activities.

In financial terms, transference of plant and staff from the old machine shop had kept the capital cost of setting up the new units to a minimum. With full utilization of labour resources, the new units were proving less expensive per item produced, though it was difficult after a single year to assess what effect on this balance maintenance expenses and budgeting for capital outlay on replacement plant might have.

But essentially, the important thing was that senior management in all Divisions were pleased with the results of the dispersal: both Wheel Division's Works Manager and Aviation Division's Production Engineering Manager stated that this was an area of operation which they had been wanting to take over for sometime and the former noted that there was a good chance that his unit would be expanding in the near future. Wheel Division had already taken over one of the lucrative tooling contracts for an outside customer which had previously been handled by P & ED and were showing a good return on the work: good enough indeed to justify putting some of their own tooling work outside in order to accommodate it!

As regards manpower, 95 operatives and 9 staff had been released by P & ED at the end of 1976 and of these 51 machinists and 7 staff had been taken on by other Divisions. This reduction in manpower helps to account for the rather different picture painted by lower supervisory staff transferred to the other Divisions in various informal conversations with the researcher during 1977. One material handler noted that there was so much work in the unit to which he had transferred that the whole place was "in chaos". Another ex-progress-chaser stated that his unit couldn't even cope satisfactorily with its own machine-tool "regrinds", and a third that machinists were now working a great deal of overtime in an attempt to keep up with demands.

All of these comments must be put in their true perspective, in that these men were comparing the current situation with one in which there had been extensive underutilization of resources. Maximisation of capacity loading might thus seem like overloading and the recurrent need for overtime is, after all, one of the characteristic features of jobbing production (noted in Chapter 2, Section 3.2.3).

In general, it appeared from this survey that my own fears about the potential consequences for the Group of a dispersal of the tooling and servicing facilities were largely unfounded, but in view of the extensive amount of work which continued to flow out to sub-contractors, I retained the reservation that the establishment of a new independent central tooling unit or division might have answered the needs of the Group better, with an additional saving in the number of managerial staff required to operate it.

5.8.2 The Effects on Other Members of the Union

Closure of the Coventry machine shop of P & ED potentially affected other, non-Engineering Group, members of the Union in two ways:-

1. As the reorganized Division was now concentrated solely around machinery manufacture, other members of the Union should benefit from a better service on such requirements: this was reflected in the improved delivery performance. It could also be expected, as a future development, that P & ED would become an internal supplier for a wider range of equipment, which would reduce the outside expenditure of the corporation: this depended on the success achieved in reaching agreements with other Union divisions to manufacture their unique machinery.
2. The tooling service, including manufacture of jigs, fixtures and moulds, was now withdrawn by P & ED, Coventry and it might prove difficult to find alternative sources for such precision work without accepting a significant price increase. However, a tooling service continued to be available at P & ED's Leicester subsidiary and the Product Results table for 1977 (Appendix 1, Table B), shows that 58% of Leicester's turnover concerned business for Dunlop customers as against a planned 22% of a slightly lower turnover. Evidently, some customers, at least, found Leicester an acceptable alternative.

Complaints about P & ED s inability to deliver on schedule, particularly in the case of moulds, had already caused the Union's sports goods manufacturers to examine alternative sources of supply.

The most interesting feature of the Leicester product results figures, however, is that there was actually an increase in the amount of tooling

work done by P & ED as a whole for Union customers. This must largely be attributed to the more active sales policy pursued by the Leicester subsidiary, which was obviously concerned to justify its continued existence in the light of closure of the similar operation at Coventry.

5.9 Summary of Conclusions on the Reorientation & Reorganization of P & ED

Both the other operating divisions of Engineering Group and the rest of the Unions benefited from the dispersal of the Coventry machine shop operations of P & ED. Neither area identified any substantial disadvantages to themselves of the new situation. Thus, if the optimism of P & ED's senior management about the future of the Division as a special-purpose equipment manufacturer was justified, the decision was advantageous to all concerned.

I have made some personal reservations above, regarding P & ED's future, partly in terms of unresolved problems with the internal organization of the Division and partly because difficulties had been experienced in finding suitable products through which to expand the range manufactured. Essentially, both of these are more concerned with the Division's growth potential than with doubts about its continued existence. The latter seemed to be provided for by business with Union customers.

The only danger in this latter respect was presented by P & ED's dependence on tyre manufacturing equipment. Any major technological innovation in this field, or in transportation in general, would remove the basic ingredient in the Division's output. But then it would also shake the foundations of the Union as a whole.

HANDLING COMPLEXITY IN A SMALL ENGINEERING BUSINESS

APPENDICES

CHAPTER I APPENDICES

1. PLANT & EQUIPMENT DIVISION PRODUCT RESULTS, ANNUAL SUMMARY TABLES 1970-1974.

2. LISTING OF P & ED MACHINE GROUPS, SHOWING MACHINES PER GROUP AND TOTALS PER SECTION.

CHAPTER 1. APPENDIX 1

PLANT AND EQUIPMENT DIVISION PRODUCT RESULTS

ANNUAL SUMMARY TABLES 1970 - 1974

TABLE A	1970
TABLE B	1971
TABLE C	1972
TABLE D	1973
TABLE E	1974

The tables have been reproduced as issued by the P & ED Accounts Department, despite the fact that not all code numbers or product group descriptions remain consistent from year to year. The key given below should reduce any difficulties.

DESCRIPTION OF TYPE OF PRODUCT	CODE NUMBERS USED IN TABLES				
	1970	1971	1972	1973	1974
General Tooling for Engineering Group Customers	800	800	800	800	800
Service and Repair Work for Engineering Group Customers	802 803 804	803	803	803	803
Tooling for Union Customers, Outside Engineering Group	-	806	806	806	806
General Tooling for Outside (Non-Union) Customers	-	807	807	807	807
Tyre making Machinery and Ancillary Equipment - Union Customers	801	801	801	801	80I
Other Special Purpose Equipment - Union Customers	801	801	809	809	809
Tyre making Machinery and Ancillary Equipment - Non-Union Customers	801	802	802	802	802
Other Special Purpose Equipment - Non-Union Customers	801	802	810	810	8I0
Spares Sales	-	804	804	804	804
Sub-Contract Hardening Service	805	805	805	805	805
Installation and Commissioning Service	807 808	808	807 871	871	87I

DESCRIPTION OF TYPE OF PRODUCT	CODE NUMBERS USED IN TABLES				
	1970	1971	1972	1973	1974
Design Sales	-	-	872	872	872
Expendable Slush Pump Liners	-	-	-	-	840
Pipeline Servicing Equipment	-	-	-	-	-
Bought-out Parts Inspection	809	-	-	-	-

PLANT AND EQUIPMENT DIVISION, PRODUCT RESULTS

TABLE A : JANUARY/DECEMBER 1970

Code	Product Description	Plan			Actual		
		Turnover £	Contribution £	%	Turnover £	Contribution £	%
800	New Jigs & Fixtures - Coventry	720,000	247,551	34.4	386,068	96,900	25.1
801	Special Purpose Machinery	1,456,000	430,428	29.6	1,074,445	126,852	11.8
802	Modifications	26,000	10,627	40.9	15,020	6,937	46.2
803	Repairs and Overhauls	164,000	79,320	48.4	184,730	75,249	40.7
804	Reconditioning	-	-	-	52,645	15,827	30.1
805	Hardening	40,000	6,376	15.9	89,858	25,662	28.6
807	Fitters on Loan	30,000	4,307	14.4	25,363	6,877	27.1
808	Installation Work	-	-	-	-	-	-
809	Bought Out Parts - Inspection	-	-	-	-	-	-
	Factored Goods	-	-	-	52,859	12,080	22.9
Leicester - Mould Making		257,000	86,000	33.5	120,839	13,124	10.9
Ramsgate - Stat Products		185,000	67,945	36.7	191,360	43.110	22.5
	- Misc. Products	156,000	62,290	39.9	49,285	14,338	29.1
		3,034,000	994,884	32.8	2,242,472	436,956	19.5
Less: Constants							
Management		579,000			674,305		
Fixed		152,000			127,058		
Selling and Administration		18,000			17,422		
			749,000			818,785	
Operating Margin			246,000			- 381,829	
Capital Investment Grants			8,000			6,000	
Net Profit before Interest			254,000			(375,829)	

PLANT AND EQUIPMENT DIVISION, PRODUCT RESULTS

TABLE B : JANUARY - DECEMBER 1971

CODE	PRODUCT DESCRIPTION	PLAN TURNOVER £	PLAN CONTRIBUTION £	PLAN %	ACTUAL TURNOVER £	ACTUAL CONTRIBUTION £	ACTUAL %
800	Tooling & General - Engineering Group	400,000	109,000	28	327,706	92,301	28
801	Special Purpose Machinery - Dunlop	1,032,000	193,000	19	680,946	107,222	16
802	Special Purpose Machinery - Non Dunlop	462,000	158,000	34	569,010	174,445	31
803	Modifications & Repairs	232,000	93,000	40	137,510	66,342	48
804	Spares	-	-	-	82,404	38,987	47
805	Hardening	88,000	44,000	50	63,730	30,564	48
806	Tooling & General - Other Dunlop Customers	190,000	62,000	33	153,354	47,866	31
807	Tooling & General - Outside Customers	76,000	23,000	30	99,340	17,866	18
808	Fitters on Loan	24,000	4,000	17	36,409	9,333	26
	Leicester	-	-	-	-	-	-
	Ramsgate	250,000	84,000	34	34,006	520	-
		2,754,000	770,000	28	2,184,415	584,406	27
	Less Constants						
	Management	625,000			525,867		
	Fixed	178,000			180,136		
	Selling and Administration	19,000			11,043		
	Constants to stock adj	34,000			11,455		
			856,000			728,501	
	Operating Margin		- 86,000			- 144,095	
	Capital Investment Grants		6,000			5,300	
	Net Profit before Interest and Tax (Net loss in brackets)		(80,000)			(138,795)	

PLANT AND EQUIPMENT DIVISION, PRODUCT RESULTS

TABLE C : JANUARY/DECEMBER 1972

CODE	PRODUCT DESCRIPTION	PLAN TURNOVER £	PLAN CONTRIBUTION £	PLAN %	ACTUAL TURNOVER £	ACTUAL CONTRIBUTION £	ACTUAL %
801	Tyre making Machinery - Dunlop	632,000	130,000	21	605,041	170,048	28
802	Tyre making Machinery - non Dunlop	299,000	89,000	30	244,677	89,301	36
809	Non Tyre Machinery - Dunlop	418,000	87,000	21	153,501	39,099	25
810	Non Tyre Machinery - non Dunlop	226,000	69,000	30	25,077	6,136	24
804	Spares	53,000	27,000	51	57,072	28,042	49
800	Tooling and General - Engineering Group	525,000	152,000	29	397,545	105,150	27
806	Tooling and General - Other Dunlop Customers	210,000	59,000	28	116,669	28,414	24
807	Tooling and General - Outside Customers	210,000	50,000	24	137,463	33,600	24
803	Modifications & Repairs	158,000	60,000	38	127,624	50,548	40
805	Hardening	74,000	37,000	50	62,602	32,278	52
808	Fitters on Loan	40,000	9,000	23	29,175	7,254	24
871	Installation & Commissioning	5,000	2,000	31	15,454	3,821	24
872	Design Sales	20,000	6,000	30	9,272	2,742	29
		2670000	777,000	27	1981,172	596,433	30
	Less Constants:						
	Constant Expenses in Stock Adj				9,910		
	Management	581,000			485,514		
	Fixed	170,000			141,271		
	Selling & Administration	14,000	765,000		12,042	649,737	
	Operating Margin		12,000			-52,304	
	Capital Investment Grants		3,000			8,691	
	Royalties Received					26,194	
	Net Profit before Interest and Tax (Net loss in brackets)		15,000			(17,419)	

PLANT AND EQUIPMENT DIVISION, PRODUCT RESULTS

TABLE D : JANUARY/DECEMBER 1973

CODE	PRODUCT DESCRIPTION	PLAN TURNOVER £	PLAN CONTRIBUTION £	PLAN %	ACTUAL TURNOVER £	ACTUAL CONTRIBUTION £	ACTUAL %
801	Tyre Making Machinery - Dunlop & Pirelli	838,000	218,000	26	773,392	200,526	26
802	Tyre Making Machinery - Non D/P	395,000	150,000	38	208,459	92,520	44
809	Non Tyre Machinery - Dunlop & Pirelli	346,000	75,000	22	524,155	128,867	25
810	Non Tyre Machinery - Non D/P	108,000	24,000	22	90,265	24,116	27
804	Spares	58,000	28,000	48	66,733	29,278	44
800	Tooling & General - Engineering Group	405,000	108,000	27	341,442	69,579	20
806	Tooling & General - Other Customers	145,000	35,000	24	173,775	37,954	22
807	Tooling & General - Outside Customers	178,000	44,000	25	108,495	27,473	25
803	Modifications & Repairs	135,000	53,000	40	145,275	55,642	38
805	Hardening	68,000	35,000	52	62,261	34,023	55
871	Installation & Commissioning	15,000	5,000	33	11,669	3,524	30
872	Design Sales	20,000	7,000	35	18,412	6,520	35
		2,711,000	782,000	29	2,524,333	710,042	28
Less Constants							
Constant Expenses in Stock Adj					10,025		
Management		559,000			543,338		
Fixed		167,000			153,621		
Selling & Administration		15,000			11,665		
			741,000			718,649	
Operating Margin			41,000			- 8,607	
Capital Investment Grants			5,000			5,143	
Royalties Received			15,000			26,554	
Net Profit before Interest and Tax			61,000			23,090	

TABLE E : JANUARY/DECEMBER 1974

CODE	PRODUCT DESCRIPTION	PLAN TURNOVER £	PLAN CONTRIBUTION £	PLAN %	ACTUAL TURNOVER £	ACTUAL CONTRIBUTION £	ACTUAL %
801	Tyre Making Machinery - Dunlop & Pirelli (XD)	560,000	129,000	23	457,333	69,195	15
802	Tyre Making Machinery - Non D/P (XC)	250,000	94,000	38	59,326	19,128	32
809	Non Tyre Machinery - Dunlop & Pirelli (XJ)	430,000	101,000	23	220,865	43,790	20
810	Non Tyre Machinery - Non D/P (XG)	150,000	37,000	26	88,111	11,478	13
804	Spares (XK)	80,000	33,000	43	67,907	27,744	41
800	Tooling & General - Engineering Group (ASWR)	300,000	62,000	20	499,239	169,984	34
806	Tooling & General - Other Customers (XF)	140,000	29,000	23	133,870	32,101	24
807	Tooling & General - Outside Customers (XT)	150,000	37,000	24	134,878	12,221	9
803	Modifications & Repairs (XB)	130,000	50,000	38	159,218	55,219	35
805	Hardening (XH)	70,000	36,000	51	49,124	17,262	35
871	Installation & Commissioning (XU)	10,000	4,000	30	9,089	2,727	30
872	Design Sales (XO)	20,000	7,000	35	16,914	5,585	35
		2,290,000	619,000	27	1894,974	466,434	25
	Less Constants					(6,333)	
	Constant Expenses in Stock Adj				(4,741)	460,101	
	Management	531,000			667,852		
	Fixed	148,000			143,825		
	Selling & Administration	38,000			42,707		
			717,000			849,643	
	Operating Margin		(98,000)			(389,542)	
	Capital Investment Grants		5,000			5,143	
	Royalties Received		30,000			7,718	
	Net Profit before Interest and Tax (Net loss in brackets)		(63,000)			(376,681)	

LISTING OF P & ED MACHINE GROUPS, SHOWING MACHINES PER GROUP AND TOTALS PER SECTION

OPERATION GROUP	SUB GROUP	COMPUTER CODE	ADDITIONAL INFORMATION	DESCRIPTION	NUMBER OF MACHINES (5)	SECTION	NUMBER OF MACHINES PER SECTION
1	A	TU	2"	Turning	19	Turning	42 machines
	B	TU	2"-B"	Turning			
	C	TU	8"-16"	Turning			
2		TU	16"+	Turning	10		
3		CT		Copy Turning	7		
4		PL		Planing	1		
5		SH		Shaping	5		
6		SL		Slotting	3	Milling	46 machines
7	A	VM	Large	Vertical Mill	6		
	B	VM	Rotary	Vertical Mill	1		
	C	VM	Small	Vertical Mill	7		
	D	HM		Horiz Mill	1		
	E	UM		Universal Mill	11		
	F	VM		Boko	3		
8		RD		Radial Drill (*)	1		
9		RD	NC	Rad. Drill NC	1		
10	A	VM	HPE	N.C. Vert Mill	1		
	B	VM	KT	N.C. Vert Mill	1		
11		JB	NC	Jig Bore NC	2		
12	A	HB	Large	Horiz Borer	1		
	B	HB	MED	Horiz Borer	1		
	C	HB	Small	Horiz Borer	1		
13		VB		Vertical Borer	5		
14	A	JB	Large	Jig Borer	2	Grinding	49 Machines
	B	JB	MED	Jig Borer	2		
	C	JB	Small	Jig Borer	3		
15		UG	Large	Univ. Grind	7		
16		UG	Small	Univ. Grind	9		
17		SG		Surface Grind	13		
18		TG		Tub Grind	1		
19		RG		Rotary Grind	5		
20		SE		Spark Erode	1	Bench Grinding	
21		OG		Optical Grind	2		
22		CG		Cutter Grind	4		
23		JG		Jig Grind	1		

OPERATION GROUP	SUB GROUP	COMPUTER CODE	ADDITIONAL INFORMATION	DESCRIPTION	NUMBER OF MACHINES (5)	SECTION	NUMBER OF MACHINES PER SECTION
24		BE		Bench	-	} Bench	
25		FT		Fitting	-		
26		MA		Machine Assy		Mech Assembly	
27		EA		Electrical Assy		Elect Assembly	
70		HT		Heat Treatment		Heat Treatment	
80		IN		Inspection		Quality	

(5) N.B. Figures in this column are extracted from the 1973 publicity phamphlet "Engineering Services by Dunlop P & ED" (A complete list, by individual machines of the Coventry facilities is given on pages 4 - 8).

(*) There were also facilities for drilling operations in the Bench section.

CHAPTER 2 APPENDIX

I. COMPLEXITY OF THE "MAKE OR BUY" DECISION:
A SIMPLIFIED EXAMPLE.

CHAPTER 2. APPENDIX 1

COMPLEXITY OF THE "MAKE OR BUY" DECISION: A SIMPLIFIED EXAMPLE

Given: A firm has two manufacturing units: A machine shop and an assembly area. Each is under a "product manager" whose primary objective is to maximise the profitability of his unit. Their superordinate objective is to maximise the profit made by the firm as a whole.

Part "x", requiring £30 worth of material to be machined for 10 hours is needed by the assembly area.

Should the firm make or buy this part?

Quotation of outside supplier:-

Material	£30	
10% handling charge	£ 3	
		£33
Labour @ £4 per hour	£40	
20% contribution	£ 8	
		£48
		£81
Plus 8% V.A.T.		£ 6.48
TOTAL PRICE		£87.48

Quotation of internal machine shop:				MANUFACTURING COST
Material	£30			£30
10% hand ~~hig~~ fee	£ 3			
		£33		
Variable factory cost @ £5 per hour	£50			£50
20% contribution	£10			
		£60		
TOTAL PRICE		£93	TOTAL COST	£80

Therefore:-

1. Apparent saving by using outside supplier: £5-52 or more than 6%
   However in terms of the total organisation, manufacture outside is actually costing: £7-48 or over 9% more

2. Supposing that the 10 labour hours will be booked as downtime if the job goes outside, the cost of outside production to the organisation as a whole should be increased by another £50, making a total of £137-48 - nearly 72% more!

The foregoing example is a very simple illustration of the fact that what would be best for the assembly area product group manager, in terms of his primary objective, could be against the superordinate objective of the firm's profitability. Taking the figures one step further: Suppose a particular machine assembly is made from 1,000 such parts and sells for £100,000. Buying from an outside sub-contractor a net gain would be shown for the machinery product group of £12,520. Supposing that sufficient machine shop capacity was available to handle all 1,000 parts, the net loss to the jobbing machine group would be £50,000, making a net loss for the organisation as a whole of £37,480. In house manufacture would have given the machinery product group a smaller gain of £7,000, but there would also have been a gain by the jobbing

machining group of £13,000, and thus a total profit to the organisation of £20,000.

Just as there are dangers of over-separating the two production units, so also are there dangers in too much interdependence. Awareness of the above dangers could lead to the decision that the 10,000 parts above will always be made "in house". If, however, there is outside work which could be taken on to fill the 10,000 hours capacity in the machine shop - perhaps at a higher, 30% contribution - then there will be a lost opportunity cost to the machine shop of £5,000 in producing the parts needed by the assembly area, and the organisation as a whole will be substantially worse off, having a £20,000 profit instead of a potential £27,520 profit, even without any profit for the handling of materials.

This example has been lengthy and is grossly over-simplified in, for example, that it assumes that contribution equals net gain, and that the machining operations will always be performed in the time estimated. It does demonstrate, however, the need for integration between the two production units in order that decisions can be made on the basis of optimising the benefits to the organisation as a whole, provided that the information necessary for making the decision is available. It shows also how important it is for the Estimating, Purchasing and Production Departments to work together in order that "make or buy" decisions should be in the best interests of the business as a whole.

CHAPTER 3 APPENDICES

I. ATTEMPT TO ESTABLISH THE CAPACITY OF P & ED's TWO PRODUCING UNITS AT COVENTRY, AND EVALUATION BASED ON THIS, OF THE ACTUAL RESULTS ACHIEVED BY THE DIVISION IN 1974.

2. PRODUCTION PERFORMANCE EVALUATION REPORT, 1974-5.

3. TABLES SHOWING THE ANNUAL RESULTS FOR EACH OF P & ED's TYPES OF PRODUCT FROM 1970-1975.

4. ANALYSIS OF QUOTATIONS AND ORDERS DURING 1975.

5. ANALYSIS OF 2000 CONSECUTIVE BUYING ORDERS ACCORDING TO THE BUSINESS GROUP OF THE JOB WITH WHICH THEY WERE ASSOCIATED.

6. MANUAL PROCEDURES FOR PROJECT EG03.

7. ANALYSIS OF COMPUTER REPORTS EG03 01 (WORK IN PROGRESS) & EG03 05 (ORDERS NOT STARTED) DATED 5/9/75.

8. COMPUTER REPORTS: LIST & SELECTED EXTRACTS.

CHAPTER 3. APPENDIX 1

ATTEMPT TO ESTABLISH THE CAPACITY OF P & ED's TWO PRODUCING UNITS AT COVENTRY, AND EVALUATION, BASED ON THIS, OF THE ACTUAL RESULTS ACHIEVED BY THE DIVISION IN 1974

Theoretical analysis of the annual output capacity of P & ED based on the labour force as it stood at the end of January, 1975*

a. MACHINE SHOP

Given the following facts:-

1. Labour force - 120 machinists and fitters on day shifts. 19 machinists on night shifts.
2. Labour cost - £2-65 per hour.
3. Working week for machinists was 40 hours.
4. Working year for machinists was 47 weeks.

And the following assumptions:-

1. Material content = 20% by value of labour cost on all tooling jobs.
2. An overall contribution amounting to 25% of selling price.
3. Total labour force mobility.

The total potential output of the machine shop was:-

$(139 \times 2.65 \times 40 \times 47) \times \frac{120}{100} \times \frac{100}{75}$ = £1,107,997 (say £1,108,000)

---

* Figures taken from Production Programming Department records.

b. ASSEMBLY AREA

Given the following facts:-

1. Labour force - 15 mechanical fitters.
2. Working week for fitters was 40 hours.
3. Working year for fitters was 47 weeks.
4. A T.10 machine required 380 hours of mechanical assembly and sold at £26,000.
5. A G.R. system required 1,400 hours of mechanical assembly and sold at £80,000.
6. On average, contribution was 30% of selling price.
7. There were no limitations, in terms of the site available for the assembly of machines.

And the following assumptions:-

1. Half of the total labour hours in a year were spent building G.R. systems and the other half building T.10 machines.
2. The number of fitters available remained constant throughout the working year.

The total potential output of the assembly area was:-

$\frac{(15 \times 40 \times 47)}{2} \div 380 = \frac{28,200}{760} = 37$ (to the nearest whole number below)

x £26,000

plus

$\frac{(15 \times 40 \times 47)}{2} \div 1400 = \frac{28,200}{2,800} = 10$ (to the nearest whole number below)

x £80,000

= £962,000 + £800,000 = £1,762,000

c. The total potential capacity of the Division was therefore:-

£1,108,000 + £1,762,000 = £2,870,000

d. Important Variable - Mobility between the two Manufacturing Units:-

In actual fact the assembly shop mechanical fitting labour force was not limited to the 15 men employed there at 31st January, 1975. They could be immediately reinforced from the pool of 24 "bench" fitters employed in the machine shop. The effect of such a movement would be as follows:-

1. On the potential output total

For each man/year of work done by a fitter in the assembly shop instead of in the bench fitting area:-

$$1{,}108{,}000 \times \frac{138}{139} = £1{,}100{,}029 \text{ plus } 1762000 \times \frac{16}{15} = £1{,}879.466$$

$$= £2{,}979{,}495$$

This represents an increase of £109,495.

2. On the contribution received

For each man/year of work done by a fitter in the assembly shop instead of the bench fitting area:-

$$\text{Contribution foregone} = \frac{1{,}108{,}000}{139} \times \frac{25}{100} = £1{,}993 \text{ (say £2,000)}$$

$$\text{Contribution gained} = \frac{1{,}762{,}000}{15} \times \frac{30}{100} = £35{,}240$$

e. Contribution per indirect employee

Clearly, given the existing manpower of the Division, it was in the best interests to employ as many fitters as possible on machine assembly in order to maximise the

total contribution, if orders were available.

However, this is not to say that the machine assembly business, "per se", was more profitable than the tooling business. It was pointed out in section 1.4.2.4 that the ratio of operatives to staff employees at Coventry was very much lower than would normally be expected in a tooling business. Comparison was drawn with the Leicester subsidiary factory, where the ratio was 7:1 as against Coventry's 1.76:1. The conclusion must be that the number of staff employees was higher at Coventry because of the requirements of the machine assembly business.

A calculation is shown below for the actual contribution received per indirect employee from each type of business. It is based upon the labour force totals at the end of 1974, as given in figure 1.8: That is, 210 operatives and 119 staff employees. The direct labour force is taken to have been the same as given in the Production Programming Department record for 31st January, 1975: That is, 139 machinists and fitters in the machine shop, and 15 mechanical fitters in the assembly area. Four electrical fitters were required for every five mechanical fitters, though the Division only actually employed 6 electricians as at 31st January, 1975.*

---

* Calculated on the basis of Electrical assembly times of 360 hours for a T.10 and 920 hours for a G.R. system. P & ED made use of contract electrical labour as needed to boost a permanent force of 6 electricians.

The following assumptions are made in the absence of actual figures:-

1. All "operatives" not specifically identified as machinists or fitters were "indirect" workers, giving a total of 175 indirect workers.

2. The ratio of direct to indirect for the tooling operation may be reasonably estimated at one half of the operative: Staff ratio for the Leicester subsidiary - i.e. 3.5:1.

∴ 3. The ratio of direct to indirect for the machine assembly operation was:-

$$15 + 12 - 27 : 175 - \frac{(139 \times 2)}{(7)} = 1:5$$

∴ 4. Contribution per indirect employee for each type of business was as follows:-

a. Tooling: £2,000 x 3.5 = £7,000

b. Machine Assembly: $\frac{£1,762,000}{27} \times \frac{30}{100} \times \frac{1}{} = £3,916$

Under these circumstances it would appear that it is in fact the tooling operation which is more profitable, given that the average cost of an indirect employee is the same in both cases.

However, it must be stated that indirect labour force maintained was capable of supporting a far larger direct machine assembly labour force. If, for example 15 fitters were transferred from the machine shop to the assembly area, the figures given would change considerably:-

a. Tooling (assuming that the size and allocation of the indirect labour force remains constant):-

Labour force ratio becomes:-

$$1 : \frac{124 \times 7}{139 \times 2} = 1 \text{ indirect} : 3.1222 \text{ direct}$$

Contribution per indirect employee is .'. reduced to £2,000 x 3.122 = £6,244

b. Machinery

Labour force ratio became:-

30 (mechanical) + 24 (electrical) = 54 :

$$175 - \frac{(139 \times 2)}{(7)} = 1 \text{ direct} : 2.5 \text{ indirect}$$

The number of mechanical fitters, and also, therefore, the potential output total, have been doubled. Contribution per indirect employee is .'. increased to

$$\frac{£1762000 \times 2}{54} \times \frac{30}{100} \times \frac{2}{} = £7831$$

Machinery has now become more profitable than tooling - indeed this would have been true even if the extra mechanical fitters had been taken on as extra employees, rather than transferred from the machine shop.

f. Conclusions

This final example explains management's eagerness to expand the machine assembly business, if necessary, at the expense of the tooling operation. It also reinforces the case for an accurate, rather than "across the board"

apportioning of fixed overheads, or "constants". Only then could the real profitability of the two types of business be monitored. Also, in order to judge up to what maximum output from the assembly area might be expanded before it became necessary to take on extra indirect employees, an evaluation of the optimum ratio of direct to indirect employees was required. While estimates of this might be arrived at by analysing the production programme for a given machine, the variety of the machinery product range involved would make such an estimate meaningless. For example, an order for six identical machines would obviously not require the same amount of work in the design and estimating areas as orders for six separate machines would, and an order for a machine which had previously been made would not require as long as one which was a new development. Indeed, the greater the standardisation of the product range, the higher the capacity of the pre-production departments, which accounts for management's investigation of potential new product lines, rather than accepting the role of manufacturer of prototypes or single, unique purpose, special equipment.

Application of Results of Theoretical Analysis of P & ED's Capacity to (a) Planned Production Levels for 1974, and (b) Actual Production Levels for 1974

(a) 1974 Product Results Plan

1. Tooling: Output was scheduled for four different product categories as follows:-

XB	£130,000 of which 38% is contribution	49,400
ASWR	£300,000 of which 20% is contribution	60,000
XF	£140,000 of which 23% is contribution	32,200
XT	£150,000 of which 24% is contribution	36,000
TOTAL	£720,000	177,600

(Average contribution 24.

Assuming theoretical statistic that 139 men produce £1,108,000 of which 25% is contribution, they would be expected to produce $1108000 \times \frac{75}{100} \times \frac{100}{75.33}$ at the planned average rate: = £1103,146 (say £1103,000)

Manpower required for planned output would thus be $\frac{720}{1103} \times 139 = 91$ to the nearest man above.

2. Machinery: Output was scheduled for four different product categories as follows:-

XC	£250,000	of which 38% is contribution	95,000
XD	£560,000	of which 23% is contribution	128,000
XG	£150,000	of which 26% is contribution	39,000
XS	£430,000	of which 23% is contribution	98,900
TOTAL	£1390,000		361,700 (Average contribution 26%

Assuming theoretical statistic that 15 fitters produce £1762,000 of which 30% is contribution, they would be expected to produce: $1762,000 \times \frac{70}{100} \times \frac{100}{74} =$ £1667,567 (say £1667,500) at the planned rate. Manpower required for planned output would then be $\frac{13900}{16675} \times 15 = 13$ to the nearest mechanical fitter above and almost exactly 10 electrical fitters to support the mechanics involved.

3. Other planned output for 1974 totalled £780,000, of which only the £80,000 in respect of spares sales in any way called upon the above labour resources. This work was typical of neither of the above, since the labour required was a lower proportion than on tooling work, and the material content varied from job to job but was lower on average than for machine assembly work. For the purpose of this analysis it will be assumed that spares jobs provided sufficient work in a year for three men in the machine shop.

4. Overall, therefore, there was sufficient work planned

for 94 men in the machine shop, and 23 men in the assembly area. Given that the two machines upon which the theoretical figures were worked out were examples where a better than average performance would be expected, it is not unrealistic to assume that a more varied work load in the assembly area would require the talents of the two extra mechanical fitters located there. The surplus of 45 machinists and fitters in the machine shop, were presumably retained to produce the parts required by the assembly area. It would seem, therefore, that it was anticipated that $\frac{1}{3}$ of the work carried out by the machine shop in 1974 would consist of machinery parts.

(b) 1974 Actual Product Results

1. Tooling: Actual results for the four product categories were as follows:-

XB	£159,218	of which 35% was contribution =	£ 55,726
ASWR	£499,239	of which 34% was contribution =	£169,741
XF	£133,870	of which 24% was contribution =	£ 32,129
XT	£134,878	of which 9% was contribution =	£ 12,139
TOTAL	£927,205		£269,735

Average contribution 29.1%

Assuming, again that 139 men can produce £1,108,000 of which 25% is contribution, they would be expected to produce $1108000 \times \frac{75}{100} \times \frac{100}{70.9}$ = £1,172,073 at the actual contribution rate. Manpower required for the

actual output should then have been $\frac{927205}{1172073} \times 139 = 110$

to the nearest man above.

2. Machinery: Actual results for the four product categories were as follows:-

XC	£ 59,326	of which 32% was contribution =	£ 18,984
XD	£457,333	of which 15% was contribution =	£ 68,600
XG	£ 88,111	of which 13% was contribution =	£ 11,454
XJ	£220,865	of which 20% was contribution =	£ 44,173
TOTAL	£825,635		£143,211

Average contribution 17.35%

Assuming that 15 fitters can produce £1,762,000, of which 30% is contribution, they would be expected to produce $1762000 \times \frac{70}{100} \times \frac{100}{82.65} = £1,492,317$ at the actual contribution rate. Manpower required for the actual output should thus have been $\frac{825,635}{1,492,317} \times 15 = 9$ to the nearest mechanical fitter above and $\frac{825,635}{1,492,317} \times 12 = 7$ to the nearest electrical fitter above.

3. Contribution per indirect employee

The calculation is based upon the following facts:-

1. Total contributions on tooling sales were £269,735
2. Total contributions on machinery sales were £143,211

And the following assumptions:-

1. The total number of direct employees was the same as that recorded for 31st January, 1975

(i.e. 115 machinists and 45 fitters).

2. Any surplus mechanical fitters in the assembly area were moved to the machine shop, Accepting the manpower requirements worked out above, this meant that there would be 9 mechanical and 6 electrical fitters (the latter could not be moved, even if there was a shortage of work) in the assembly area, and a total of 145 direct employees in the machine shop.

3. Any labour in the machine shop which was surplus to the requirements of tooling work was employed in producing parts, at cost value, for the assembly area.

4. All employees not specifically identified as "direct" were indirect, and the average sixe of the labour force is taken to equal the actual labour force as at the end of December, 1974:- i.e. 210 operatives and 119 staff.

5. The ratio of direct to indirect employees for the machine shop was 3:1. (If anything, considering the ratio of operatives to staff at the Leicester subsidiary, this estimate will be on the low side).

∴ 6. The ratio of direct to indirect employees for the assembly shop was:-

$$1:\frac{1}{16} \times \left(175 - \frac{145}{3}\right) = 1:7.92$$

Contribution per indirect employee was thus:-

a. Machine Shop

$$\frac{269,735}{145} \times 3 = £5581$$

b. Assembly Area

$\frac{143,211}{16 \times 7.92}$ = £1130

c. Assembly area, eliminating possible machine shop responsibility for low contribution achievement

It was suggested by management that the poor average contribution achieved on machinery sales largely resulted from poor machine shop performance on parts supply. However, even if the planned contribution level of 26% had been achieved, the figure for (b) above would only have been:-

$825635 - 143211 \times \frac{126}{74}$ = £239,771 contribution,

$\frac{239771}{16 \times 7.92}$ = £1,892 contribution per indirect employee.

d. Contribution per indirect employee needed in order to cover fixed costs

The actual total of fixed costs for 1974 was £850,000. Assuming, again, that all employees who were not machinists or fitters were indirect employees, the total number of these was 175. The contribution per indirect employee needed to cover fixed costs was then £4857.

e. Conclusion

It is suggested, therefore, that tooling work was paying its way in 1974, but that machinery output was not, and that the loss recorded for that year should be put

down to a failure to secure sufficient orders for special purpose machinery. The reservation in making this statement is that it is based upon a large number of assumptions which may not be absolutely accurate. The most central of these to the argument is the ratio of direct to indirect employees for the machine shop tooling operations, but it is felt that, if anything, the 3:1 ratio given is more than adequate.

CHAPTER 3 : APPENDIX 2

PRODUCTION PERFORMANCE EVALUATION REPORT 1974-74 *

Issued by Production Programming Manager, P & ED, 14/11/75.

P & ED PRODUCTION PERFORMANCE EVALUATION

D.A. Air

P.A. Darby

P. Griffin

K. Pearson

J.B. Turner

R.E. Underhill

M. Hewitt

E. Williams

J.B. Turner

14/11/75

* The appendices originally issued with this report, and containing the statistics upon which all graphs and tables were based have been omitted as not relevant to its usage in this thesis.

INTRODUCTION

Over the past 6-12 months there have been considerable changes in both the business emphasis in terms of major business mix and in the organisation of the Division. Management is now considering and implementing further changes in organisation and methods with the primary aim of increasing productivity and control of productivity through increased efficiency in all areas.

It is important, therefore that management obtains the best insight into how the Division has performed in recent months. This report is derived from data issued by my Department - the monthly Production Schedule and the weekly output reports. It is therefore confined to orders, schedules and output.

Most of the data is presented in the form of 3 months rolling averages to facilitate the evaluation of production control and business mix change over a relatively long period.

1. Major Performance Trends 1975

Table 1 illustrates the output levels by major business (Group Tooling, Outside Tooling and Machinery) for the period October 1974 to October 1975 on a 3 months rolling average basis. Also included is the total monthly schedule i.e. anticipated output for the three major businesses. The major points that this graph shows are :

a) The major change in business mix during the period
b) The considerable and consistent fall down on schedule
c) The high rate of output increase since May.

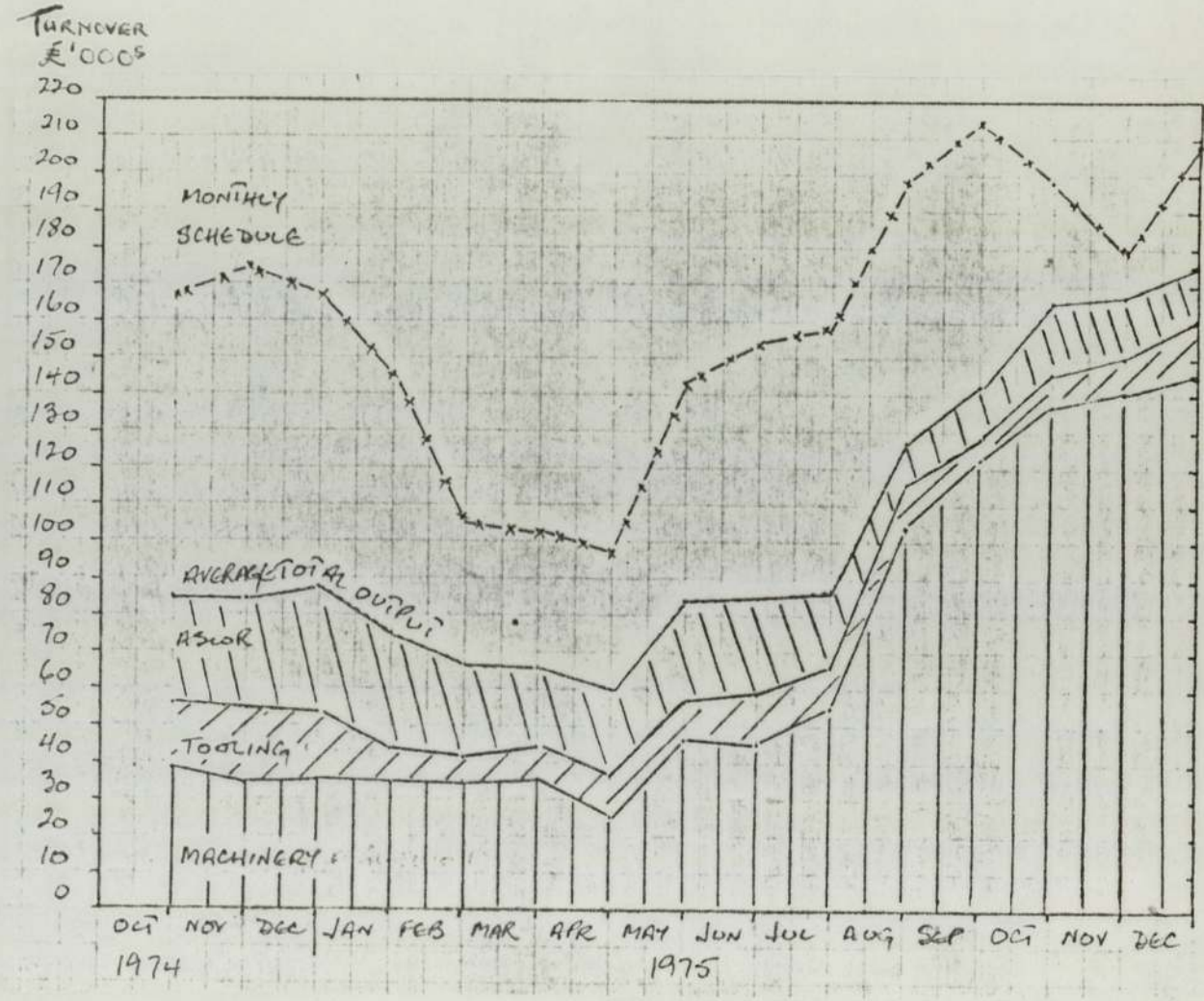
1.1. The change in business mix

The following table shows the business make-up at regular intervals during the last 12 months, and the total output level.

	Dec. '74	March '75	June	Sept.
ASWR	40%	33%	30%	10%
Tooling	19%	13%	16%	4%
Machinery	41%	54%	54%	86%
Total(£)	88,137	65,313	84,475	142,019

Table 2 : Business Mix Change - 3 months rolling average production

Table I. P & ED Delivery Schedule & Actual Production Analysis - 3 month rolling average.



During the last quarter of 1974, ASWR output averaged over £35,000 per month, dropping to an average of £14,000 in the third quarter of 1975 due to the decline in orders. Actual output, however, is currently running at over £20,000, well in excess of forecast.

During the last quarter of 1974, the outside tooling output was at a relatively ligh level - £17,000 per month, but consistently falling well below schedule. Average monthly output has declined since that period and is now averaging about £8,500 per month - a level still well below monthly schedule.

The machinery business output was at a low monthly level until May 1975, averaging about £35,000 monthly. In the last quarter of 1974 this level was well below schedule. The inability of both outside tooling and machinery businesses to achieve even 50% of schedule during the last quarter of 1974 accounts for the schedule/actual discrepancy in that period.

The figures underlying Tables 1 and 2 are in Appendix A.

1.2. Scheduling and forecast reliability

Variations in short term forecasts and performance against schedule are primary indicators of management control. During the past six months, scheduling and production control have been reorganised into two centres - the Machine Shop and the Assembly Shop. Analysis and evaluation of production performance is therefore done on this dual basis.

The following table illustrates the actual variations in forecasts over a four-week period prior to the issue of schedule, e.g. the forecast for August at the beginning of July and at the end of July.

	Machine Shop	Assembly Shop
June	+695%	+14%
July	+91%	+25%
August	+357%	+16%
September	+126%	+30%
October	+574%	-90%

Table 3 : Variation in 4-week forecasts

ASWR is excluded since the forecast period is never more than four weeks.

Apart from the Assembly Shop forecast for October which is analysed further on, all short term forecast adjustments show major increases. The major and primary reason is job slippage. The secondary and minor factor is the introduction of new short orders. This large and unreliable variation in short term forecasting is therefore controllable to a large degree, the root cause being the setting of monthly schedules and the estimation of monthly output by management. The continuing existence of this situation implies that either management is unable to evaluate and control within a four-week horizon or that the business is being managed on a dual standard - an official and an unofficial schedule or monthly output objective.

The figures underlying Table 3 are in Appendix B.

1.3. Performance against schedule

The following table illustrates performance against schedule by the Assembly and Machine Shops on a 3 month rolling average basis over the last six months. ASWR work is also included. The figures underlying Table 4 are in Appendix C.

% Actual Against Schedule

	May	June	July	August	Sept.	Oct.
Assembly Shop	56%	54%	59%	73%	73%	86%
M/S Shop(Pedwork*)	48%	45%	44%	47%	43%	58%
M/S Shop ASWR	115%	88%	87%	68%	123%	159%
Total	61%	58%	65%	62%	66%	82%

Total of the Above (£)

Schedule	209887	185231	159010	206369	215110	200184
Actual	127467	107754	86886	128731	141903	165378
Slippage	82418	77477	72124	77638	73207	34806

* Excludes Spares

Table 4 : Performance against Schedule - 3 month rolling average

The table 4 data indicated that on average the Division slips about £75,000 each month on a scheduled turnover of about £200,000 for those businesses under consideration - an average fall down of about 37%. October is an anomaly in that two major jobs were brought forward - Starglich and part of the BNFC Sample Units (KA104). The overall trend has been slightly upward in percentage terms and more significantly upward in real terms.

The Assembly Shop has increased average output from about 55% to 75% of schedule, i.e. from about £45,000 in May to an average of over £100,000 in Sept./Oct. The main impetus for this was the sale of three GR Systems in August and September and the lower forecast in October.

The P&ED work in the Machine Shop (mostly outside tooling and some machinery, e.g.Automoulds) has achieved about 47% throughout the period on a declining schedule of output, i.e. from about £48,000 actual in May to an average of about £30,000 in Sept./Oct. Monthly scheduled turnover has dropped from about £100,000 to £50,000 over the same period. A major factor in the first part of the review period was machinery, i.e. Bronx and Automoulds.

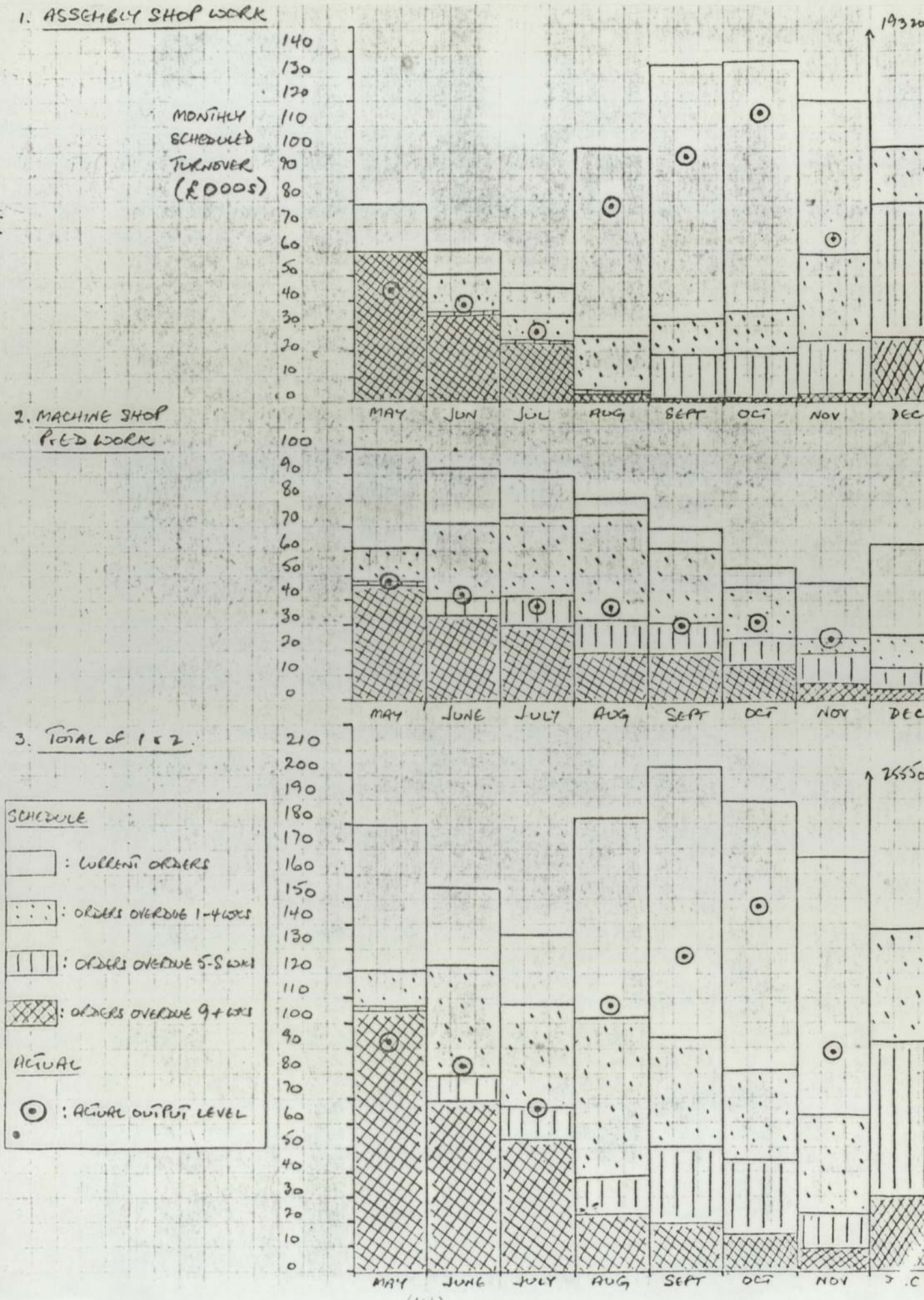
The Group Tooling work (ASWR) declined rapidly during the first part of the review period. Actual output has been close to schedule except in the Sept./Oct. period when schedule has remained low and actual output has been at a level of 200% of schedule. This latter trend would suggest that Group requirements are being underestimated on a short-term basis, or that some other business factor has changed.

1.4. Performance against original delivery promise

Table 5 illustrates an analysis of the monthly scheduled orders by original delivery promise category, on a 3 months rolling average basis ; average output levels are also shown. The data underlying Table 5 is in Appendix D.

Taking Table 5 in conjunction with Table 1, it can quickly be seen that the large delivery fall down at the beginning of the year in machinery and outside tooling placed the Division in a lag situation which has taken at least six months to catch up on, e.g. in July 39% of the

TABLE 5 Output Schedule Analysis - 3 month rolling average



combined schedule for outside tooling and machinery was on average at least nine weeks overdue and only 20% was originally scheduled for that month. By October the average monthly schedule contained 57% of current deliveries.

The Assembly Shop was able to work off a large proportion of its overdue orders during the May-July period which was a period of light new order load. The major improvement during the August-Sept. period in terms of both new orders and delivery of orders was primarily due to the despatch of three GR Systems built largely from items in stock. The Assembly Shop is beginning to have difficulty however, in maintaining delivery promises. The downturn in schedule expansion rate indicated in October-November reflects an actual reduction of the October schedule from a level of £178,600 forecast in September to an actual schedule of £17,500. (This is the -90% referred to in Table 3). This reflected the problems of obtaining parts for certain major orders, particularly the four T10 machines.

The Machine Shop outside tooling and machinery work schedules have consisted of at least 80% late deliveries since May. The relatively low level of output has not enabled the Machine Shop to reduce this proportional figure and forecasts have been continuously over-optimistic.

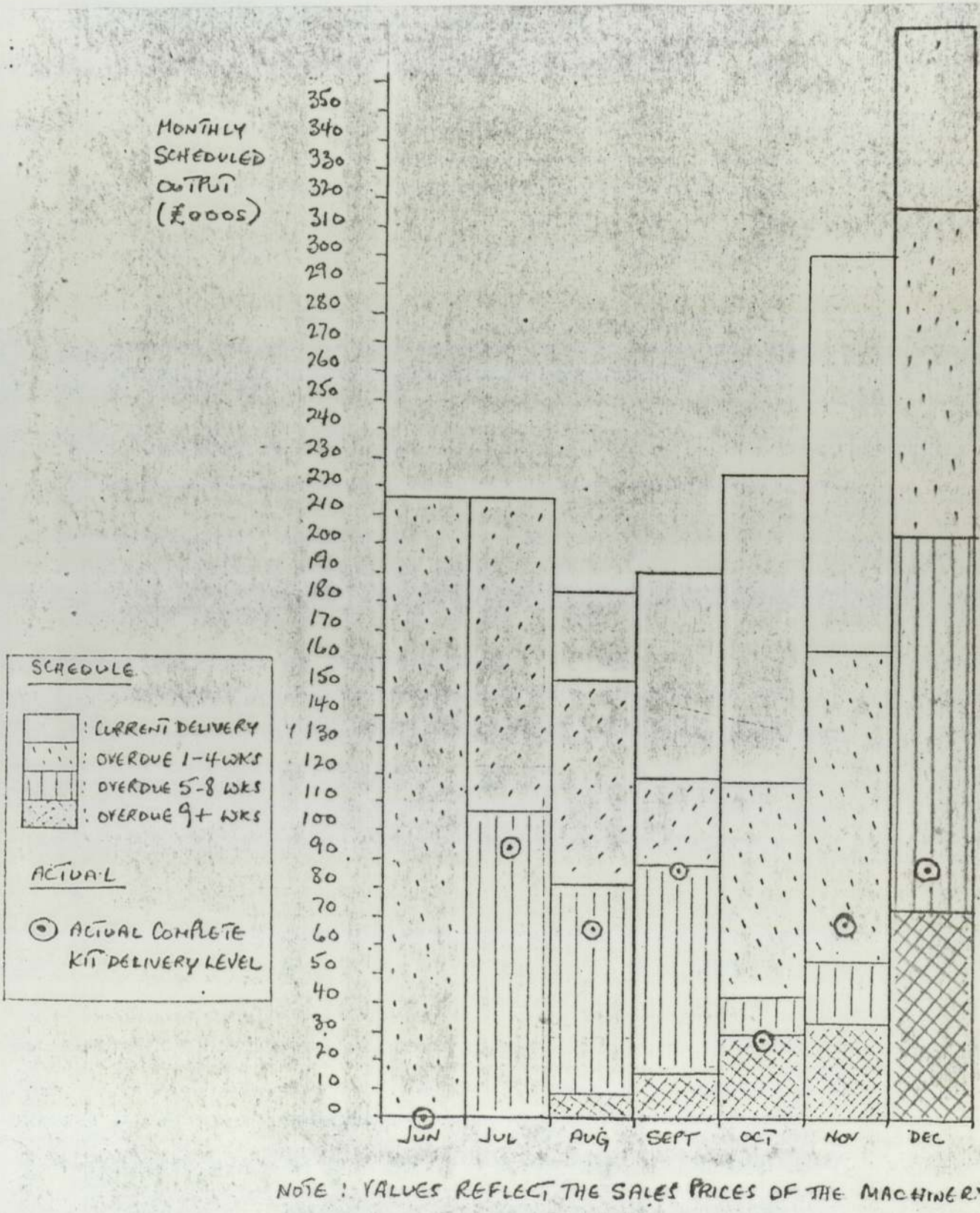
1.5. Machine Shop Parts Service to the Assembly Shop

A major factor affecting Assembly Shop productivity is the timely supply of parts from the Machine Shop. With the reduction of outside tooling work and ASWR requirements, the Machine Shop has required and received a substantial volume of parts business from P&ED. The complete delivery deadlines for these kits of parts is shown in the monthly Delivery Schedule.

Table 6 shows the P&ED parts delivery schedule for the Machine Shop in terms of the value of the assembled machine prices to the Division. The figures are again on a 3 month rolling average basis in order to evaluate the performance and schedule trends. The figures underlying Table 6 are in Appendix E.

TABLE 6 Delivery Schedule Analysis - 3 month rolling average

Machine Shop - P & ED Machinery Parts



NOTE : VALUES REFLECT THE SALES PRICES OF THE MACHINERY

The data in Table 6 indicates that the value of Machine Shop parts kits to P&ED has risen from £216,000 in time to a current average level of about £300,000 per month. The overdue content of the schedule has dropped from 100% to an average of about 60% during the review period. Delivery performance against schedule currently averages 13%, i.e. a potential turnover slippage to the Division of £306,000 on an average monthly basis at this time.

2. Major Findings

The major findings arising from this evaluation are as follows :

- ASWR output declined rapidly during the year from an average of £35,000 per month to a current average of £14,000.
- Outside tooling output declined slowly through the year from a monthly average of £17,000 to a current average of £8,500.
- The Machine Shop's traditional tooling business output has fallen by 57% over the year, from a monthly average of £52,000 to a current avergae of £22,500.
- The Assembly Shop output averaged about £35,000 per month until May. Since then average monthly output has increased rapidly to an average £138,500, an increase of 296% over six months.
- Short term forecasts of output over more than four weeks are totally unreliable and also unpredictable. Machine Shop forecasts for outside tooling output vary from as little as +91% to +695%. Assembly Shop forecasts vary from -90% to +30%. This is symptomatic of the Division management's inability to schedule, i.e. forecast output on less than a four week basis.
- The ability of management to forecast monthly output, i.e. a four-week schedule, is reflected in the May-September performance for the Machine and Assembly Shops. During that period, Machine Shop ASWR work declined from 115% of schedule to 68% and then rose to a level of 123%. Machine Shop P&ED work declined from 48% to 43%. Assembly Shop work rose from 56% to 73%. In October an additional £71,000 was brought forward, bringing actual possible output to £132,000 or 188% of schedule.
- On a Divisional basis the scheduled output indicator is unreliable but the average slippage trend is predictable to some extent. Average monthly output has increased from 52% to about 64% over the past twelve months, a rate increase of 23%. This increase is attributable to the Assembly Shop output in the August-September period.

- During the first six months of the year the Division was producing at an average 60% of schedule but was able to work off its old backlog by July due to a light new order load. The Division was also able to meet its August and September major order deliveries.By October, however, the scheduled delivery forecast was rapidly reduced due to potential machinery parts shortages.
- With the decline of its traditional Group, and outside tooling businesses, the Machine Shop has requested and received a major portion of the parts manufacture for P&ED machinery orders. Machine Shop output of complete parts kits currently averages £29,000 per month in P&ED machinery price terms, or 13% of schedule.

3. Conclusions

- Practical estimating or scheduling over a period of more than four weeks is not possible under the present system of management control.
- Current four-week scheduling is generally overstated by an average of 36% on a Divisional basis. Actual monthly estimates are more erratic, however. In September, for example, ASWR was underestimated by 102%, machine tooling was overestimated by 60% and Assembly Shop output was overestimated by 45%. Monthly scheduling is therefore of questionable value except as a general indicator for longer term business evaluation.
- The Division is currently producing machinery and tools at an average annual rate of £1.6 million on a scheduled rate of £2.4 million. The data indicates that on at least a short term basis the Division can produce at a peak average rate of about £2.0 million annual equivalent. Using the current methods of control one can therefore expect a normal annual average of £1.6 million with an upper limit of about £1.8 million.
- The level of support provided by the Machine Shop for timely machinery completion is totally inadequate under the present management control system. This failure reflects on the efficiency of all other departments supporting business productivity.

4. Recommendations

- The Division has three major needs at this time if it is to operate at all effectively. These are :

1. A clear understanding by management of the business priorities and a precise indication of any priority change.
2. A clear understanding by management of the relevance of scheduling and the responsibility undertaken in commitment to schedules.
3. A business control system.

Unless management is well aware of the ground rules of the business, i.e. the priorities as well as the disciplines of the job, i.e. the responsibilities as well as authorities, there will not be any effective implementation of a proper control system. The first priority, therefore, is to satisfy the needs outlined in 1 and 2.

An effective business control system can take many forms. It will essentially consist of three major elements, however, these being a scheduling system, a progressing system controlling Design, E & T, Buying and Stores, and a Production system controlling manufacture and assembly. These elements must be integrated so that the entire business can be scheduled, actioned and monitored.

Providing it is done logically there is no reason why these three control elements cannot be devised and implemented separately, but total effective control will only be achieved when integration takes place.

CHAPTER 3 : APPENDIX 3

TABLES SHOWING THE ANNUAL RESULTS FOR EACH OF P&ED'S TYPE OF PRODUCT FROM 1970 TO 1975

PERFORMANCE FIGURES FOR THE MANUFACTURE OF TOOLING (X-ASWR) AND SERVICE WORK (XB) FOR ENGINEERING GROUP CUSTOMERS (1970 - 1975)

TABLE 1A PLAN

Year	Turnover (£'s) 000's			Contribution %			Percentage of Total Turnover			Percentage of total contributions		
	XB	X^{aswr}	Total	XB	X^{aswr}	Total	XB	X^{aswr}	Total	XB	X^{aswr}	Total
1970	190	720	910	47½	34.4	37.1	6	23.7	30	9	25	34
1971	232	400	632	40	28	32	8½	14.5	23	12	14	26
1972	158	525	683	38	29	31	5½	18.3	24	8	19.5	27.5
1973	135	405	540	40	27	29.8	5	15	20	7	14	21
1974	130	300	430	38	20	25.4	5½	13	18.5	8	10	18
1975	140.6	361.9	502.5	29	23	24.7	4½	11.6	16	4.6	9.4	14
5 year* total	795.6	1991.9	2787.5	37.2	25.7	29	5.8	14.5	20.2	7.7	13.4	21.1

TABLE 1B ACTUAL

Year	Turnover (£'s)			Contributions %			Percentage of total turnover			Percentage of total contributio		
	XB	X^{aswr}	Total	XB	X^{aswr}	Total	XB	X^{aswr}	Total	XB	X^{aswr}	Total
1970	199750	386068	585818	41	25	30.6	11	17	38	22	22	44
1971	137510	327706	465216	48	28	34.1	6	15	21	11	16	27
1972	127624	397545	525169	40	27	29.6	6	20	26	8½	17.6	26
1973	145275	341442	486717	38	20	25.7	6	13.5	19½	8	9.8	18
1974	159218	499239	658457	35	34	34.2	8½	26.3	35	12	36.4	48.4
1975	160527	252675	413202	40	26	31.4	8	12.6	20½	13.4	13.5	27
5yr* total	730154	1818607	2548761	40	27.6	31.2	6.9	17.2	24	10.3	17.7	28

* 1971-75

PERFORMANCE FIGURES FOR THE MANUFACTURE OF TOOLING FOR CUSTOMERS

OUTSIDE ENGINEERING GROUP (1970-75

(Other Dunlop = XF code ; Outside customers = XT code

TABLE 2A PLAN

Year	Turnover (£'s) 000's			Contribution %			Percentage of Total Turnover			Percentage of total contributions		
	XF	XT	Total	XF	XT	Total	XF	XT	Total	XF	XT	Total
1970*	413	-	413	36	-	36	13.6	-	13.6	14.9	-	14.9
1971	190	76	266	33	30	32	6.9	2.8	9.7	8	3	11
1972	210	210	420	28	24	26	7.3	7.3	14.6	7.6	6.5	14
1973	145	178	323	24	25	24.5	5.3	6.6	11.9	4.5	5.6	10.1
1974	140	150	290	23	24	23.5	6.1	6.5	12.6	4.7	6	10.7
1975	169.1	318	487.1	24	20	21.4	5.4	10.2	15.6	4.6	7.4	12
5 year+ total	854.1	932	1786.1	26.4	23.5	24.9	6,2	6.8	13	5.9	5.7	11.6

TABLE 2B ACTUAL

Year	Turnover (£'s)			Contributions %			Percentage of total turnover			Percentage of total contribut		
	XF	XT	Total	XF	XT	Total	XF	XT	Total	XF	XT	Total
1970	170,124	-	170,124	16	-	16	7.6	-	7.6	6.3	-	6.3
1971	153,354	99,340	252,694	31	18	26	7	4.5	11.6	8.2	3.1	11.2
1972	116,669	137,463	254,132	24	24	24.4	5.9	6.9	12.8	4.8	5.6	10.4
1973	173,775	108,495	282,270	22	25	23.2	6.8	4.3	11.2	5.3	3.9	9.2
1974	133,870	134,878	268,748	24	9	16.5	7.1	7.1	14.2	6.9	2.7	9.6
1975	128,999	265,785	394,784	37	9	18.1	6.4	13.2	19.6	9.9	5.2	15.1
5yr total	706,667	745,961	1,452,628	27.4	15.6	21.3	6.7	7	13.7	6.8	4.1	10.9

* 1970 figures for XF code are made up of mould-making at Leicester and miscellaneous products at Ramsgate which are not directly comparable with subsequent years.

\+ The five year total and averages are taken over the period 1971-5

PERFORMANCE FIGURES FOR THE MANUFACTURE OF **MACHINERY AND ANCILLARY**

EQUIPMENT FOR RUBBER TECHNOLOGY INDUSTRIES (1970-1975)

(XC = Non-Dunlop customers ; XD = Dunlop & Pirelli Customers)

TABLE 3A PLAN

(Fig. 3.28)

Year	Turnover (£'s) 000's			Contribution %			Percentage of Total Turnover			Percentage of total contributions		
	XC	XD	Total	XC	XD	Total	XC	XD	Total	XC	XD	Total
1970 [1]			1,456			29.6			48			43
1971 [2]	462	1,032	1,494	34	19	23.5	16.8	37.5	54.2	20.5	25.1	45.6
1972	299	632	931	30	21	23.5	10.4	22	32.4	11.5	16.7	28.2
1973	395	838	1,233	38	26	29.8	14.6	30.9	45.5	19.2	27.9	47.1
1974	250	560	810	38	23	27.5	10.9	24.5	35.4	15.2	20.8	63
1975	183.1	473.2	656.3	32	31	31.4	5.9	15.2	21	6.6	16.9	23.6
5 year total	1,589.1	3,535	5,124.3	34.5	23.1	26.7	11,6	25.7	37.3	14.4	21.4	35.8

TABLE 3B ACTUAL

Year	Turnover (£'s)			Contributions %			Percentage of total turnover			Percentage of total contribut		
	XC	XD	Total	XC	XD	Total	XC	XD	Total	XC	XD	Total
1970 [1]			1,074,445			11.8			48			29
1971 [2]	569,010	680,946	1,249,956	31	16	22.5	26	31.2	57.2	29.8	18.3	48.2
1972	244,677		605,041	36	28	30.5	12.4	30.6	42.9	15	28.5	43.5
1973	208,457	773,392	981,849	44	26	29.8	8.3	30.6	38.9	13	28.2	41.3
1974	59,326	457,333	516,659	32	15	17.1	3.1	24.1	27.3	4.2	15	19.2
1975	201,047	438,644	639,691	39	24	28.6	10	21.8	31.9	16.3	21.9	38.3
5yr total	1,282,517	2,955,356	4,237,873	35.4	22.1	26.1	12.1	27.9	40	16	23	30.1

1. 1970 figure was not broken down into machine types by Accounts Dept. Annual Report. It has been assumed that a majority would have been of "tyre machinery".

2. Similarly because 1971 figure distinguished only "Dunlop and Non-Dunlop" it has been assumed that machinery involved was largely for Rubber Technology Industries.

EQUIPMENT, NON-RUBBER TECHNOLOGY INDUSTRIES (1970-1975) (Fig. 3.32)

(XJ = Dunlop customers ; XG = Outside customers)

TABLE 4A PLAN

Year	Turnover (£'s) 000's			Contribution %			Percentage of Total Turnover			Percentage of total contributions		
	XG	XJ	Total	XG	XJ	Total	XG	XJ	Total	XG	XJ	Total
1970 [1]	-	-	-	-	-	-	-	-	-	-	-	-
1971 [2]	-	-	-	-	-	-	-	-	-	-	-	-
1972	226	418	644	30	21	24.2	7.9	14.6	22.4	8.9	11.2	20.1
1973	108	346	454	22	22	21.8	4	12.8	16.7	3.1	9.6	12.7
1974	150	430	580	26	23	23.8	6.6	18.8	25.3	6	16.3	22.3
1975	481.8	235.6	717.4	29	27	28.6	15.4	7.6	23	16.2	7.3	23.5
5 year total	965.8	1429.6	2395.4	28.1	22.9	25	8.8	13	21.8	8.9	10.7	19.6

TABLE 4B ACTUAL

Year	Turnover (£'s)			Contributions %			Percentage of total turnover			Percentage of total contributi		
	XG	XJ	Total	XG	XJ	Total	XG	XJ	Total	XG	XJ	Total
1970	-	-	-	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-
1972	25077	153,501	178,578	24	25	25.3	1.3	7.7	9	1	6.6	7.6
1973	90265	524,155	614,420	27	25	24.9	3.6	20.8	24.3	3.4	18.1	21.5
1974	88,111	220865	308,976	13	20	17.9	4.6	11.7	16.3	2.5	9.5	12
1975	105,902	161,357	267,259	2	23	14.6	5.3	8	13.3	0.5	7.7	8.2
5yr total	309,355	1,059,878	1,369,233	14.3	23.4	21.4	3.7	12.6	16.3	2	11.1	13

1. 1970 report groups all machinery together (figs. in Fig 3.28)

2. 1971 report does not distinguish between Rubber Technology and other machinery (figs. in Fig 3.28)

CHAPTER 3 : APPENDIX 4 TABLE I

ANALYSIS OF QUOTATIONS AND ORDERS DURING 1975

	Number of quotations issued	Number of orders received	Total value of orders received (£'s)	Average value of orders received (£'s)	Highest order value (£'s)	Lowest order value (£'s)
Dunlop Tooling (code XF) Excluding Engineering Group	83	39	54,360	1,394	8,544	41
Outside Tooling (code XT)	133	62	125,425	2,033	65,017	12
Total Tooling Excluding Engineering Group	222	101	179,785	1,780	65,017	12
Rubber Technology Machinery Dunlop & Pirelli customers (code XD)	152	36	492,704	13,686	81,726	61
Rubber Technology Machinery Outside customer (code XC)	48	10	867,441	86,744	475,392	108
Rubber Technology Machinery All customers	200	46	1,360,145	29,568	475,392	61
Other Special-purpose Mach. Dunlop & Pirelli customers (code XJ)	70	30	476,950	15,898	172,725	34
Other Special-purpose Mach. Outside customers (code XG)	44	23	338,633	14,723	67,360	211
Other Special-purpose Mach. All customers	114	53	815,583	15,388	172,725	34
Total figures for all Non-Engineering Group Work	530	200	2,355,513	11,778	475,392	12
Servicing Work for Group customers (code XB) *	-	4,620	160,527	35	-	-
Tooling Work for Group customers (code ASWR) *	-	750	252,675	337	5,600	12
Total Engineering Group Work Handled during 1975 *	-	5,370	413,202	77	-	-

* Because of different methods adopted within the Division for processing Group orders during 1975, these figures are not directly comparable with those above. Number of orders shown is the number of jobs actually manufactured during the year, and likewise total value of orders shown is the total actual receipts of the Division from these customers during the year.

APPENDIX 4 : TABLE 2 : DISTRIBUTION OF VALUES FOR NON-ENGINEERING GROUP ORDERS - 1975

Value of orders (£'s) / Type of work	0-100	101-1000	1001-10000	10001
Dunlop Tooling (code XF) Excluding Engineering Group	6	23	10	0
Outside Tooling (code XT) +	20	24	17	1
Total Tooling Excluding Engineering Group	26	47	27	1
Rubber Technology Machinery Dunlop & Pirelli customers(codeXD)	4	11	7	14
Rubber Technology Machinery Outside customers (code XC)	0	2	3	5
Other Special-purpose Machinery Dunlop & Pirelli customers(codeXJ)	5	10	11	4
Other Special-purpose Machinery Outside customers (code XG) x	0	12	3	8
Total Machinery orders All customers	9	35	24	31
Total Internal orders All Business Types (XF,XD,XJ)	15	44	28	18
Total External orders All Business Types (XT,XC,XG)	20	38	23	14
Total orders Excluding Engineering Group	35	82	51	32*

* Total includes 5 orders over £100,000 value

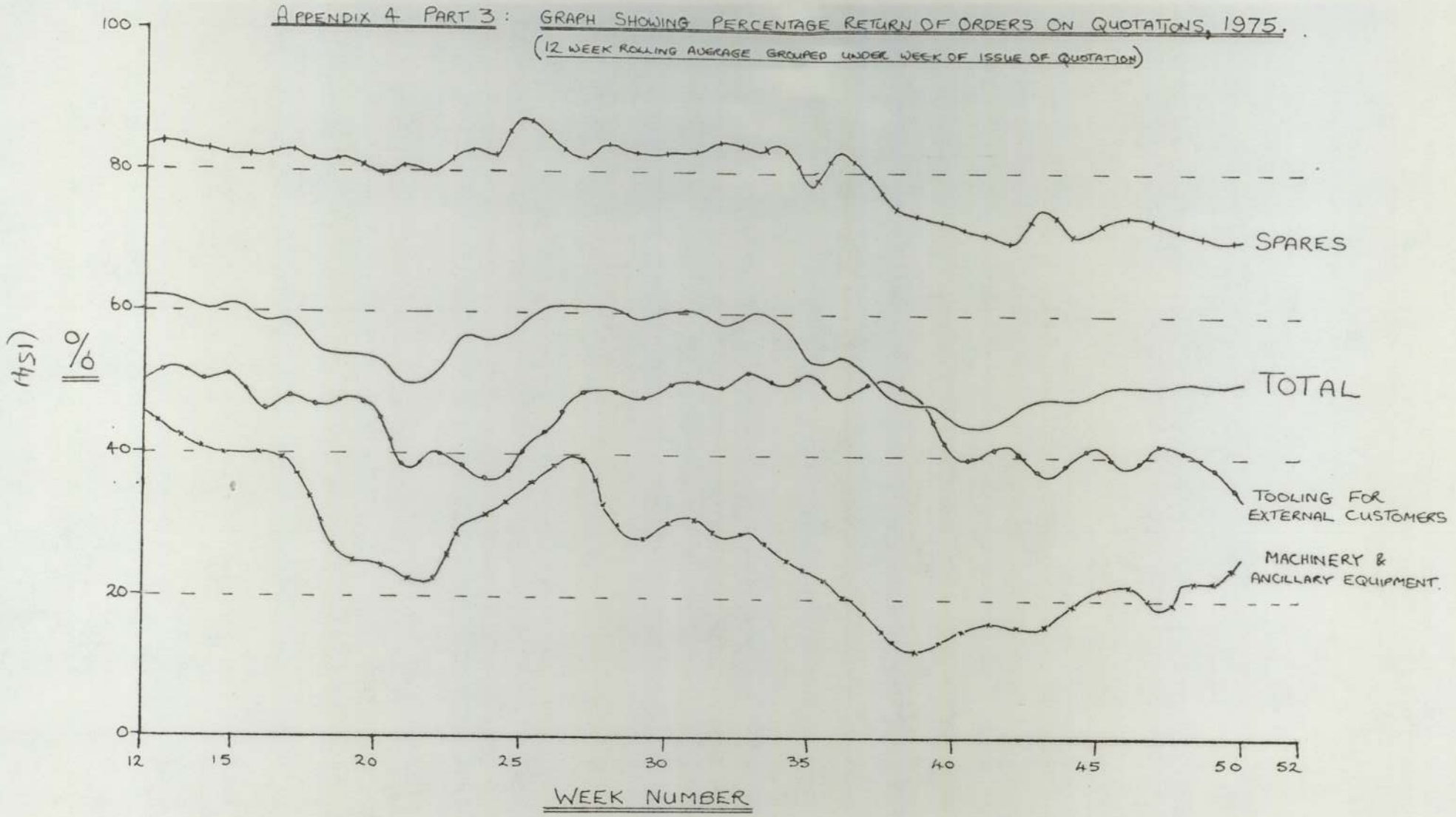
x All XG orders came from 2 customers : 17 orders, total value £335,607 from the nuclear processing industry, including 7 orders on a single contract worth over £300,000. 6 orders ,total value £3,026 from the steel industry for extra work on a contract agreed during the previous year.

\+ An analysis of the six most regular customers in this category is given below.

Customer	1	2	3	4	5	6
Number of orders	12	11	5	5	4	4
Total value of orders (£'s)	18,054	609	73,525	3,837	12,123	459
Average value of orders(£'s)	1,504	55	14,705	767	3,031	115

APPENDIX 4 PART 3: GRAPH SHOWING PERCENTAGE RETURN OF ORDERS ON QUOTATIONS, 1975.

(12 WEEK ROLLING AVERAGE GROUPED UNDER WEEK OF ISSUE OF QUOTATION)



CHAPTER 3 : APPENDIX 5 : ANALYSIS OF 2,000 CONSECUTIVE BUYING ORDERS ACCORDING TO THE BUSINESS GROUP OF THE JOB WITH WHICH THEY WERE ASSOCIATED (Dec.24th1974 -May.23rd1975)

Type of product			Product Business Code	Number of orders	Percentage of total orders	Percentage of groupings of products
	Rubber Technology Industries	Non-Dunlop customers	XC	290	14.5	Machinery 51.25
		Dunlop customers	XD	373	18.65	
	Other Industries	Non-Dunlop customers	XG	201	10.05	
		Dunlop customers	XJ	161	8.05	
	Engineering Group Customers	Aviation Division	XA	96	4.8	Group Tooling 12.05
		Suspensions Division	XS	22	1.1	
		Wheel Division	XW	96	4.8	
		Redditch Mouldings Div.	XR	27	1.35	
	Other Dunlop customers		XF	33	1.65	Outside Tooling 3.8
	Outside customers		XT	43	2.15	
Spares for Machinery	Spares	Connected with Spares Sales	XK	27	1.35	Spares 6.9
		Orders to replenish stocks in spares store	SP	111	5.55	
Engineering Expertise and fitting	Metrication of Machine Tools		XM	8	0.4	
Small Repeat Assemblies	Expendable Pump Lines		XN	43	2.15	
Machinery or new products	Machinery provisioning or prototype development		XP	73	3.65	
(Stock)	No specific job identified on order (stock, maintenance, photos)			291	14.55	
Orders cancelled				92	4.6	
Missing order records or job category uncertain				13	0.65	
TOTAL SAMPLE SIZE				2,000	100.00	

CHAPTER 3 APPENDIX 6 : MANUAL PROCEDURES FOR PROJECT EGO3

DUNLOP LIMITED

ENGINEERING GROUP

1 PROCEDURE FOR RAISING JOB MASTERS FOR COMPUTER INPUT

2 PROCEDURE FOR AMENDING INFORMATION HELD ON THE COMPUTER FILE

PLANT AND EQUIPMENT DIVISION

Distribution List

1 Mr M R Gale
2 Mr D R Marshall
3 Mr A L McKillop
4 Mr J F Weaver
5 Mr E Williams (3)

Copy No. 1
Ref. MRG/DB

MSF 128.

CONTENTS

1 Introduction

In order that shop supervision, progress section, accounting departments etc. can keep up to date with what is happening on the shop floor, the ICL 1904E computer situated in the Computer Centre is being used to monitor activities within the machining and assembly areas.

Each job raised by Planning/Estimating Department on Job Masters is input to the computer.

The Computer Centre copy of the Job Master has two distinct functions to perform

1. Punched cards are raised from it. These cards are read by the computer and the job details stored on the computer file.

2. From the cards raised in 1 above, a different type of card is raised - "terminal cards". These cards are not read by the computer but are sent out to three IBM teleprocessing terminals. They are read by these terminals when time is spent on the operations on the shop floor. The terminals are linked indirectly to the computer such that all time spent on machining/assembly operations is eventually mated up with its appropriate planning data stored as a result of 1 above.

Because of these functions the Job Master must conform to certain standards for computer input and the following narrative details the requirements.

2 Procedure for getting Job Master data on to the computer file

For each job issued a Job Master set must be raised. A Job Master set consists of a top copy (Computer Centre copy), a sheet of one-time carbon, a banda master copy, and a sheet of spirit duplicating paper.

Due to the requirements of computer input, certain rules must be applied and the required method of completing each field of information is detailed below.

2.1 Job Number This must be of the general format:

A	A	A	N	N	N	N	/	N	N	N	A

Where A = any le
A to Z

N = any number
0 to 9

for example	D	A				2	9					
or	D	A				2	9	/			1	B
or	D	A				3	2	/		1	1	E
or	D	A			3	6	5	/				B
or	D	A				8	4	/	1	1	0	

This must be written on the Job Master from left to right with no spaces. No more than one letter or number can be put in each box.

Fill any spaces in the Job No. box with a horizontal line.

Do not start the Job No. with a hyphen or a space.

For example the above Job Nos. are written:-

D	A	2	9								
D	A	2	9	/	1	B					
D	A	3	2	/	1	1	E				
D	A	3	6	5	/	B					
D	A	8	4	/	1	1	0				

The following examples illustrate some recent incorrect job number entries.

ALT9/DA350) Put the ALT No. on its own in the Job No. field.
DA172/ALT6) The original Job No. may be quoted in the 'Description' box or in the spare box underneath it if necessary.

DA310/DA350) Only one Job No. is permissible. If work is
ALT10/ALT11) required to be done on two job numbers then two Job Masters must be raised in order that costs can be accurately allocated.

DA365A) DA365B) DA365C) etc. — These should be DA365/A, DA365/B, DA365/C etc.

MA309 ADD. — Only the basic Job No. (i.e. MA309) should be shown in the Job No. field. The fact that this is additional work may be explained in the Description box or the spare box underneath it.

MA482-3 — This should be MA482/3 unless it is meant to signify MA482 and MA483 in which case the second example above applies.

2.2 Drawing No.

Any combination of letters, numbers, or spaces may be used up to a maximum of 12.

2.3 Quantity

This field can only contain the numbers 0 to 9 and must be written to the right of the box. Note that in all cases the quantity must be 1 or greater, i.e. not zero or blank.

For example.

1 is written [ ][ ][1] not [1][ ][ ] or [ ][1][ ] .....etc.

10 is written [ ][1][0] not [1][0][ ] .....etc.

100 is written [1][0][0] not [1][0][0][ ] .....etc.

2.4 Charge Code

This must contain one letter followed by up to four numbers, e.g. [S][0][1][ ]
[S][0][2][ ]....etc.

2.5 Requested Delivery

This field is split into six boxes: 2 for day, 2 for month and 2 for year.

for example: REQ. DELIVERY REQ. DELIVERY

1st February 1972 is [0][1][0][2][7][2] i.e. not [1][2][7][2][ ][ ]

1st November 1972 is [0][1][1][1][7][2]

23rd December 1972 is [2][3][1][2][7][2]

Note that when an urgent order is received the date of the order receipt should be put in this 'Requested Delivery' box, i.e. not the letters ASAP.

2.6 Item

This must be alphabetic, i.e. A to Z and must be written as follows, e.g.

ITEM		
-	A	-
-	B	-
-	A	B
-	A	Z
-	Z	Z

or

or

or

The following points should be noted.

1 Ignore the lefthand column, except to put in a hyphen.

2 Where there is only one letter, put it in the middle column and fill in the righthand column with a hyphen.

3 If three letters are essential then use all three columns.

2.7 Part Number

Any combination of letters, numbers, spaces may be used up to a maximum of 15.

2.8 Quantity

As for item 3.

2.9 Serial No.

This will be added by the banda machine operator, (but see item 1.2 'Repair/Quick turn-round jobs' and item 1.3 'Ad-Ops').

2.10 Operation Number

Only the last two columns of this block may be used and these must be numeric (allowing up to 99 operations per item). The first column must be filled with a dash.

For example:

	OP. NO.		
Operation 1 is ——	-	0	1
Operation 2 is ——	-	0	2
Operation 10 is ——	-	1	0
Operation 99 is ——	-	9	9

Note: Fill in first column with a hyphen

2.11 Operation

This field must be alphabetic, i.e. A to Z only. The first two columns must be used for all normal operations and the third column reserved specifically for the letter N to denote a numerical control operation.

Suggested codes are as follows:

Operation

Surface Grind	S	G	
Jig boring	J	B	
Inspection	I	N	
Benchwork	B	E	
Assembly	A	S	
Turning	T	U	
N/C turning	T	U	N
Milling	M	I	
N/C milling	M	I	N
Commissioning or	C	O	
	C	M	

etc.

2.12 M/C Group

Only the last two columns are to be used and these must be written as follows

	...M/C GRP	
M/C Group 1 is written as	0	1
M/C Group 10 is written as	1	0
M/C Group 23 is written as	2	3

Any operations which will not have time booked on them by the shop floor must be left blank in this field (for example: heat treatment, inspection). Any operation which will have time booked on it must contain a machine group.

2.13 Wk No.

Leave blank.

2.14 Estimated Hours

Four boxes are available for hours and two for minutes and these must be completed as shown in the examples below

	ESTIMATED HOURS					
¼ hour becomes					1	5
7½ hours becomes				7	3	0
27½ hours becomes			2	7	3	0
100 hours becomes		1	0	0	0	0

Note that where there are no minutes the minutes columns must be filled in with zeros to avoid confusion on the banda copies raised from this paperwork.

2.15 The fields described in items 2.1-2.14 are the only ones that are stored on the computer. All other fields on the document are free from restrictions. The following points, however, should be observed:

Where an item contains more than five operations the additional operations should just be continued down on the appropriate 03 lines on the Job Master. The intermediate 02 line containing details of the item, drawing no., etc. should be filled in to provide the appropriate shop documentation but the printed numbers 02 at the beginning of that line must be deleted to avoid punching duplicate 02 cards.

Similarly, where the job requires more than one sheet of Job Masters the following points should be observed.

All sheets must show the Job No. in order to aid recognition if the sheets are separated.

The second and subsequent sheets should have the printed numbers 01 at the beginning of the top line crossed out. This is so that when the sheets are received for punching only one card with the job information on it is raised.

Completed job master sets should be sent to the banda machine operator for addition of serial numbers and reproduction of the shop documentation.

Note that when the serial numbers are added there should only be one serial number per item, but that serial number must be quoted more than once where an item has more than five ops. (i.e. each yellow route card must have a serial number on it, but where there is more than one route card for an item, then the serial no. will be the same on all the route cards for that item).

After the serial numbers have been added to each item the Computer Centre copy of the Job Master should be split off and passed to the Computer Centre. These copies must be bundled together with a document showing the number of forms sent to the Computer Centre and must be received by the Computer Centre by 9.30 a.m. each day.

Once the Computer Centre copy has been split off, the banda master is used to produce the shop documentation.

3 Repair/Quick turn-round jobs ('CR' jobs)

Where a job comes directly onto the shop floor from one of the divisions the Job Master is raised on the shop and sent to Planning for production of the shop documentation (Route label, Progress Card etc.).

The normal rules for raising the Job Master apply.

4 Inspection Rejections

When as a result of inspection rejections the planners raise a new Job Master, the following points should be observed.

The Job No. quoted on the Job Master must be the original Job No i.e. the current practice of quoting Job No./Reject Note No. must cease. The Reject Note No. may be quoted in the 'Description' box on the Job Master. If more work is required to be done on an existing operation then the existing route card should be used.

5 Amendments to the Computer File

When it is required to alter information stored on the computer from the Job Master then the following details apply.

Just as there are three types of punched card raised from the Job Master (01 = job, 02 = item, 03 = operation) so there are three amendment forms available.

COMPUTER RECORD AMENDMENT SHEET NO. 1
COMPUTER RECORD AMENDMENT SHEET NO. 2
COMPUTER RECORD AMENDMENT SHEET NO. 3

Number 1 amends job information (drg. no., qty., charge code, delivery date).

Number 2 amends item information (part no., item qty.)

Number 3 amends operation information (op. type, machine group, estimated time).

Note that it is not possible to alter job number, item, op. number.

The three amendment forms are shown in appendices 2, 3, 4. It can be seen that the following information is mandatory:-

On form No. 1 - Job number.
On form No. 2 - Job number; Item.
On form No. 3 - Job number- Item- operation number.

It is also necessary that this information matches exactly with that written on the original Job Master so that the computer is able to locate the correct record within its filing system.

On the right hand side of these amendment forms, only fill in those fields which require amendment. Note that whatever is written there will overwrite what is already on the computer. For example, where an estimated time is required to be amended from 1 hour to 10 hours, fill in 10 hours on the appropriate amendment form (i.e. not the difference of 9 hours).

6 Appendices

1 Job Master

2 Computer Record Amendment Sheet No.1

3 Computer Record Amendment Sheet No.2

4 Computer Record Amendment Sheet No.3

5 Sample Operative Timesheet.

PLANT AND EQUIPMENT DIVISION
JOB MASTER (COMPUTER CENTRE COPY)

01 JOB NUMBER RB187 — DRAWING NO. CM10087 — QUANTITY 1 — CUSTOMER WHEEL

DESCRIPTION: DIE RING — REQUESTED DELIVERY 06/11/70 — CUSTOMER REF. RTD/374/051/3/29

NFH — ORDER RECEIVED 10/09/70 — PROMISE WEEK 45

02 ITEM -A- PART NUMBER 1/CM10087 — QUANTITY 1 — SERIAL NO. 57392 — SUPPLIER — DELIVERY PROMI

DESCRIPTION — MATL. & SIZE

	OP. NO.	OPERATION	M/C GRP.	WK. NO.	ESTIMATED HOURS	DESCRIPTION OF OPERATION
03	01	VB	13		500	ROUGH TURN FOR NORMALISE
03	02	IN				INSPECT
	03	HT				NORMALISE
03	04	VB				FINISH TURN
03	05	IN				

X ITEM -A- PART NUMBER 1/CM10087 — QUANTITY 1 — SERIAL NO. 57392 — SUPPLIER — DELIVERY PROMI

DESCRIPTION — MATL. & SIZE

	OP. NO.	OPERATION	M/C GRP.	WK. NO.	ESTIMATED HOURS	DESCRIPTION OF OPERATION
03	06	HT				
03	07	VG	16		230	GRIND 26·75" DIA
03	08	BE	24		100	PRESS WITH DETAIL 2
03						
03						

02 ITEM -B- PART NUMBER 2/CM10087 — QUANTITY 1 — SERIAL NO. 57393 — SUPPLIER — DELIVERY FROM

DESCRIPTION — MATL. & SIZE

	OP. NO	OPERATION	M/C GRP.	WK. NO	ESTIMATED HOURS	DESCRIPTION OF OPERATION
03	01	VB	13		500	ROUGH TURN
03	02	IN				
03	03	HT				
03	04	RDN	09		300	DRILL & C/BORE 6 HOLES
03						

02 ITEM -C- PART NUMBER 3/CM10087 — QUANTITY — SERIAL NO. 57394 — SUPPLIER — DELIVERY FROM

DESCRIPTION — MATL. & SIZE

	OP. NO.	OPERATION	M/C GRP.	WK. NO	ESTIMATED HOURS	DESCRIPTION OF OPERATION
03	01	OG	16		100	GRIND
03	02	IN	18		100	CLEAN UP FACES
03	03	BE	24		230	PRESS
03	04	HT				
03						

DUNLOP ENGINEERING GROUP
PLANT & EQUIPMENT DIVISION

APPENDIX

COMPUTER RECORD AMENDMENT SHEET No. 1

THIS FORM AMENDS JOB DATA

LINE	DATA TYPE 1 2	JOB NUMBER 3 4 5 6 7 8 9 10 11 12 13 14	DRAWING NUMBER 15 16 17 18 19 20 21 22 23 24 25 26	QUANTITY 27 28 29 30	CHARGE CODE 31 32 33 34 35	REQ DE 36 37
1	05					
2	05					
3	05					
4	05					
5	05					
6	05					
7	05					
8	05					
9	05					
10	05					
11	05					
12	05					
13	05					
14	05					
15	05					
16	05					
17	05					
18	05					
19	05					
20	05					
21	05					
22	05					
23	05					
24	05					
25	05					
26	05					
27	05					
28	05					
29	05					
30	05					

THIS FIELD IS USED TO LOCATE THE APPROPRIATE COMPUTER RECORD AND MUST BE PRESENT. IT MUST MATCH EXACTLY WITH THOSE ON THE ORIGINAL JOB MASTER

THESE FIELDS ARE THE ONES THAT CAN BE AMEN
WRITE THE NEW VALUES REQUIRED INTO THE APPROP
FIELDS.
FILL IN ONLY THOSE FIELDS WHICH REQUIRE AMEND

PERSON AUTHORISING AMENDMENT..... DATE.....

DUNLOP ENGINEERING GROUP
PLANT & EQUIPMENT DIVISION

COMPUTER RECORD AMENDMENT SHEET No. 2

THIS FORM AMENDS ITEM DATA

LINE	DATA TYPE	JOB NUMBER													ITEM			PART NUMBER																QUANTITY			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	0	6																																		
2	0	6																																		
3	0	6																																		
4	0	6																																		
5	0	6																																		
6	0	6																																		
7	0	6																																		
8	0	6																																		
	0	6																																		
10	0	6																																		
11	0	6																																		
12	0	6																																		
13	0	6																																		
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26	0	6																																		
27	0	6																																		
28	0	6																																		
29	0	6																																		
30	0	6																																		

THESE FIELDS ARE USED TO LOCATE THE APPROPRIATE COMPUTER RECORD AND MUST BE PRESENT
NOTE THAT THEY MUST MATCH EXACTLY WITH THOSE ON THE ORIGINAL JOB MASTER

THESE FIELDS ARE THE ONES THAT CAN BE AMENDED.
WRITE THE NEW VALUES REQUIRED INTO THE APPROPRIATE FIELDS.
FILL IN ONLY THOSE FIELDS WHICH REQUIRE AMENDMENT.

PERSON AUTHORISING AMENDMENT ..... : DATE .....

MS

DUNLOP ENGINEERING GROUP
PLANT & EQUIPMENT DIVISION

COMPUTER RECORD AMENDMENT SHEET No. 3

THIS FORM AMENDS OPERATION DATA

LINE	DATA TYPE 1	DATA TYPE 2	JOB NUMBER 3 4 5 6 7 8 9 10 11 12 13 14	ITEM 15 16 17	OP. No. 18 19 20	OP. TYPE 21 22 23	MACHINE GROUP 24 25 26	ESTIMATED TIME HRS. 27 28 29 30	MIN. 31 32
1	0	7							
2	0	7							
3	0	7							
4	0	7							
5	0	7							
6	0	7							
7	0	7							
8	0	7							
9	0	7							
10	0	7							
11	0	7							
12	0	7							
13	0	7							
14	0	7							
15	0	7							
16	0	7							
17	0	7							
18	0	7							
19	0	7							
20	0	7							
21	0	7							
22	0	7							
23	0	7							
24	0	7							
25	0	7							
26	0	7							
27	0	7							
28	0	7							
29	0	7							
30	0	7							

THESE FIELDS ARE USED TO LOCATE THE APPROPRIATE COMPUTER RECORD AND MUST BE PRESENT.
NOTE THAT THEY MUST MATCH EXACTLY WITH THOSE ON THE ORIGINAL JOB MASTER

THESE FIELDS ARE THE ONES THAT CAN BE AMENDED
WRITE THE NEW VALUES REQUIRED INTO THE APPROPRIATE FIELDS.
FILL IN ONLY THOSE FIELDS WHICH REQUIRE AMENDMENT

PERSON AUTHORISING AMENDMENT ..... DATE .....

(171)

DAY: 9 | MONTH: 11 | DAY: Mon. Tues. Wed. (X) Thurs. Fri. Sat. Sun. | M/C NUMBER: | CHECK NUMBER: 36009 | NAME: M CONNORS | SECTION: TURN | SHIFT: DAY'S

ESD Job Number	ESD Part No.	Op No.	Qty.	Time Taken	Detail No.	Drawing No.	Description	In Op	Finish	Ad Op
XD0924	ZA	1	2	1-45		3-15749	CARRIER		X	

DUNLOP ESD TIME SHEET

STANDARD HOURS

Total Working Time

F.231

CHAPTER 3 : APPENDIX 7

ANALYSIS OF COMPUTER REPORTS EGO3 01 (WORK IN PROGRESS) AND EGO3 05 (ORDERS NOT STARTED) Dated 5/9/75

A/. Completed or "Dead" Jobs on File

	EGO3 01	EGO3 05
Total number of jobs on file	519	148
Number definitely identified as "Dead"	260	76
Maximum number of live jobs on file	259	72

B/. Performance Against Estimates (EGO3 01)

	Hours
Estimated time for all operations on file	45,172
Actual time booked to date *	49,593
Balance	-4,421
Total of estimated times for remaining work	14,876

* This figure does not include bookings which could not be matched against entries held on the file.

∴ To date, 49,593 hours taken on jobs for which the estimated total was only 30,296. Assuming that there were no jobs which remained incomplete despite already having exceeded estimates (an assumption bound to be invalid, as illustrated in "C" below), the performance was 61%.

C/. Error in Manual Calculation of Remaining Work Load

By the Production Planning Department's method :

(Total of remaining work) $14,876 \times \frac{49,593}{30,296} = 24,351$ hours of work remaining

The problem is that this makes the unwarranted assumption that all operations where the estimated time has already been equalled or exceeded are completed operations. For example, if a 10 hour operation has been in progress for exactly 10 hours, no remaining time will be allowed for it, whereas if one proceeded from the original estimate it would have been expected to take

$10 \times \frac{49,593}{30,296} = 16.4$ hours, i.e. a further 6.4 hours needs to be allowed.

∴ What we must actually conclude on performance (in "B") is that it was BELOW 61%.

To illustrate the point using the figure given :
Suppose for example, that just 1% of the estimated hours booked against are in the situation of having had exactly the allowed time used up with unfinished operations.

The estimated remaining time should then be :

$$14{,}876 \quad X \quad \frac{49{,}593 - 303}{30{,}296 - 303} \quad = \quad 24{,}447 \quad +$$

$$303 \quad X \quad \frac{49{,}593 - 303}{30{,}296 - 303} \quad - \quad 303 \quad = \quad 195$$

$$\text{Total remaining time} \quad = \quad 24{,}642$$

This is 291 hours more than given by the initial calculation.

The inaccuracy is likely to be very much greater than this because all unfinished operations with any time booked against them will receive an insufficient "inefficiency" allowance.

The only way to compute the likely remaining work load more accurately would be through establishing the actual shop floor programme on completed operations alone. Given inaccuracies in the report, detailed in the text, manual calculation of this figure was considered to hold little benefit.

CHAPTER 3 APPENDIX 8 : COMPUTER REPORTS.

TABLE A : PLANT & EQUIPMENT DIVISION: OUTPUT DISTRIBUTION - COMPUTER REPORTS.

PART B : EXTRACT FROM WORK IN PROGRESS REPORT, EG03 01.

PART C : EXTRACT FROM ORDERS NOT STARTED REPORT, EG03 05.

PART D : EXTRACT FROM JOB NOS. WITH POTENTIAL OVERSPEND REPORT, EG03 16

PART E : EXTRACT FROM INCENTIVE PAYMENT SCHEME: OPERATOR'S TIME ANALYSIS REPORT, EG03 22.

TABLE A PLANT & EQUIPMENT DIVISION : OUTPUT DISTRIBUTION - COMPUTER REPORTS

O = original
c = Xerox copy

Distribution :
1. Accounts Dept.
2. Machine Shop Super/Prod. Controller
3. Foreman Assembly Area
4. Terminal Ops. 5. Prod.Planning Dept

Report no.	No. of Xerox copies	Distribution	Frequency	Report Title
EGO3 01	3	O 1 C 2,3,5	Weekly	Work in progress
EGO3 02	1	O 1 C 2	Weekly	Unmatched time bookings
EGO3 03	1	O 1 2	Daily	Operations exceeding estimate for machine groups 1-26
EGO3 04	1	O 1 C 2	Daily	Previous day's despatches
EGO3 05	1	O 1 C 2/5	Weekly	Orders not started
EGO3 06	None	O 1 C	Daily	Labour hours on jobs despatched
EGO3 07	None	O 4 C	-	List of amendments input showing old and new field values
EGO3 08	None	O 4 C	-	List of deletions input
EGO3 09	None	O 4 C	Daily	Unmatched planning data
EGO3 10	1	O 4 C 4	Daily	Jobs despatched - serial cards to be destroyed
EGO3 11	None	O 4 C	Daily	Incorrect planning data
EGO3 12	None	O 2 C	Daily	Previous day's time bookings - Clock Number order
EGO3 13	2	O 1 C 2	Daily	Previous day's time bookings - Job Number order
EGO3 14	None	O 1 C	Daily	Unmatched blue terminal cards
EGO3 15	None	O 1 C	Monthly	Monthly CW and TM totals
EGO3 16	1	O 1 C 1	Weekly	Job Nos. with potential overspend
EGO3 17	1	O 4 C 4	On Request	List of Job and Serial Numbers
EGO3 18	None	O 4 C	RARE	List of errors input, types 5, 6, 7, 8, 9, 10
EGO3 19	None	O 4 C	Daily	Incorrect booking data
EGO3 20	None	O 1 C	Annually	Stocktaling report
EGO3 21	None	O 2 C	Weekly & Monthly	Incentive Payment Scheme Finished Operations
EGO3 22	1	O 2 C 1*	Weekly & Monthly	Incentive Payment Scheme Operator's Time Analysis

* Monthly only.

EG0301 PLANT & EQUIPMENT DIVISION: WORK IN PROGRESS

DATE: 5 DEC 75 PAGE: 2
TIME:20/42/16

JOB NUMBER	DELIVERY DATE	ITEM	PART NUMBER	QTY.	OP. NO.	OP. TYPE	M/C GRP.	TIME ACTUAL	TIME ESTIMATE	BALANCE	LAST OPERATOR	DATE FINISHED
CRR9178	14.11.74	A	DH3655	6	01	TU	1		5.30	5.30		
					02	IN	80		0.00			
					03	HT	70		0.00			
					04	EG	16		2.30	2.30		
					05	IN	80		0.00			
		B	DH3657	6	01	TU	1		8.30	8.30		
					02	HT	70		0.00			
					03	TU	1		3.00	3.00		
					04	IN	80		0.00			
					05	HT	70		0.00			
					06	UG	16	5.00	4.00	-1.00	36013	12.12.74
					07	JB	14	14.00	8.00	-6.00	36331	15.12.74
					08	IN	80		0.00			
		C	DH3656	6	01	TU	1		8.30	8.30		
					02	HT	70		0.00			
					03	TU	1		3.00	3.00		
					04	IN	80		0.00			
					05	HT	70		0.00			
					06	UG	16	4.00	4.00		36013	11.12.74
					07	JB	14	12.00	8.00	-4.00	36331	16.12.74
					08	IN	80		0.00			
		D	DH3654	6	01	TU	1		7.00	7.00		
					02	ML	7		6.00	6.00		
					03	BE	24		3.00	3.00		
					04	IN	80		0.00			
		E	DH13108	6	01	TU	2	24.00	8.00	-16.00	36056	
					02	BE	24		1.30	1.30		
					01	TU	2	36.00	24.00	-12.00	36001	
					02	HT	70		0.00			
					03	TU	2	48.45	24.00	-24.45	36043	
					04	SC	60		0.00			
					05	ML	7	40.00	48.00	8.00	36036	
					06	EG	16	24.00	48.00	24.00	36048	
					07	ML	7	26.30	12.00	-14.30	36310	
					08	BE	24	2.45	2.00	-0.45	36062	18.05.75
					09	IN	80		0.00			
4TH TOTAL IS REMAINING WORK AND EQUALS SUM OF +VE BALANCES FOR UNFINISHED OPS.					JOB TOTALS			237.00	238.30	1.30	80.30	

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EG0305 PLANT & EQUIPMENT DIVISION: ORDERS NOT STARTED

DATE:12 SEP 75 PAGE: 13
TIME:19/46/36

DELIVERY DATE	JOB NUMBER	ITEM	PART NUMBER	QTY.	OP. NO.	OP. TYPE	M/C GRP.	ESTIMATED HRS.MIN	
12.16.75	DB 0914/008	A	2 10771	10	01	HT	70	0.00	
					02	IN	80	0.00	
					03	SC	60	0.00	
					04	IN	80	0.00	
			TOTAL ESTIMATED TIME FOR THIS JOB:".....						0.00
31.12.74	GA 0333	A	4 301 3154 3 0	1	01	IN	80	0.00	
		B	4 301 3121 4 0	1	01	MA	26	0.30	
					02	IN	80	0.00	
		C	4 301 3122 4 0	1	01	MA	26	0.30	
					02	IN	80	0.00	
			TOTAL ESTIMATED TIME FOR THIS JOB:".....						1.00
			M/C GROUP 026		1.00				
4.12.74	KA 0106/003	A	2H180900	2	01	BE	24	16.00	
					02	IN	80	0.00	
			TOTAL ESTIMATED TIME FOR THIS JOB:".....						16.00
			M/C GROUP 024		16.00				
37.38.75	PP 1107	A	37/ESD11099/9	2	01	FI	50	0.00	
					02	ML	7	9.15	
					03	BE	24	2.30	
					04	IN	80	0.00	
		B	38/ESD11099/9	2	01	FI	50	0.00	
					02	ML	7	10.00	
					03	BE	24	3.00	
					04	IN	80	0.00	
			TOTAL ESTIMATED TIME FOR THIS JOB:".....						24.45
			M/C GROUP 007		19.15				
			M/C GROUP 024		5.30				

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EG03I6 PLANT & EQUIPMENT DIVISION: JOB NUMBERS WITH POTENTIAL OVERSPEND

DATE: 9 JUN 75 PAGE: 1
TIME:00/07/08

NOTE: THE CRITERIA FOR INCLUSION OF JOBS ON THIS REPORT ARE BASED ON POTENTIAL OVERSPEND VALUES AS FOLLOWS:-

OVERSPEND = 20 HOURS OR MORE ;-ALL CASES REPORTED

OVERSPEND < 20 HOURS BUT = OR > 20 HOURS ;-REPORTED ONLY WHERE OVERSPEND PERCENT. = 20% OR MORE

OVERSPEND < 20 HOURS ;-NO CASES REPORTED

VALUES ARE CALCULATED AS FOLLOWS: BALANCE (D) = C-B
REMAINING WORK (E) = SUM OF +VE BALANCES ON UNFINISHED OPERATIONS
LIKELY OVERSPEND (F) = D-E
OVERSPEND % (G) = F÷C X100%

JOB NUMBER	ACTUAL TIME TO DATE (B)	ESTIMATED TIME (C)	BALANCE (D)	REMAINING WORK (E)	LIKELY OVERSPEND (F)	LIKELY OVERSPEND %
DB 0485/003	2199	1260	-938	26	964	77 %
DB 0186	2413	1622	-790	149	940	58 %
DB 0735	1856	1272	-584	283	867	68 %
XA 0106	1162	476	-685	5	691	145 %
DB 0485/006	1650	1808	157	790	632	35 %
KA 0104/007	1503	1048	-455	170	625	60 %
DB 0856	794	206	-588	0	588	285 %
DB 0857	1366	1080	-286	258	546	51 %
DB 0825/007	1085	626	-459	61	520	83 %
XF 0507/001	451	0	-451	0	451	**** %
DB 0852	1071	810	-261	145	406	50 %
DB 0485/001	1624	1356	-268	123	391	29 %
XJ 8213	1114	835	-278	111	390	47 %
DB 0485/008	1266	1340	73	458	384	29 %
DB 0858	830	697	-133	247	380	55 %
DB 0859	790	508	-282	49	332	65 %
DB 0825/006	589	351	-237	21	258	74 %
DB 0902/000	536	295	-241	9	251	85 %
XU 8103	561	459	-102	146	248	54 %
KA 0110/001	713	494	-219	22	241	49 %
ME 0149	592	361	-231	3	234	65 %
DB 0825/001	618	426	-192	37	229	54 %
KA 0104/000	474	403	-71	155	227	56 %
KA 0104/012	330	147	-182	29	212	144 %
XA 8166	567	471	-96	116	212	45 %

PART E : EXTRACT FROM INCENTIVE PAYMENT SCHEME: OPERATOR'S TIME ANALYSIS REPORT, EG03 22.

EG03E2 PLANT & EQUIPMENT DIVISION; SECTION PERFORMANCE FOR W/E 04/04/75 DATE:04/04/75 PAGE: 1

NOTE:TIMES ARE HRS AND DECIMAL HRS	1LATHES	2MILLING	3GRINDING	4BENCH	5ASSEMBLY	6FLEXIBLES	TOTALS
A.TOTAL HOURS BOOKED (B+C+F)	525.00	546.25	203.75	201.75	2.00	33.00	1511.75
B.TIME BOOKED ON FINISHED OPS	485.50	494.75	167.00	134.00			1281.25
C.TIME BOOKED ON OPS NOT ON FILE / NO ESTIMATE	15.50	20.00	89.75	24.00			129.25
D.FACTORED TIME ON FINISHED OPS	282.04	295.09	123.32	69.55			770.00
E.STANDARD UNMEASURED (0.900C)	13.95	18.00	62.78	21.60			116.33
F.TIME BOOKED ON NON PRODUCTIVE WORK - CW	24.00	31.50	-33.00	43.75	2.00	33.00	101.25
G.DAILY OTHER ALLOWANCES (0.04A)	21.00	21.85	8.15	8.07	0.08	1.32	60.47
H.TIME BOOKED AD-OP ON FINISHED OPS	1.00	2.00	1.00	7.50			11.50
I.TIME BOOKED REJECT ON FINISHED OPS							
J.OPERATOR PERFORMANCE D/B X 100%	58.09%	59.64%	73.84%	51.90%			60.10%
K.DEPT.PERFORMANCE (D+E)/A X 100%	56.38%	57.32%	91.34%	45.18%			58.63%
L.PAY PERFORMANCE (D+E+G-0.800F)/A X 100%	64.04%	65.93%	82.36%	66.53%	84.00%	84.00%	67.97%
M.LOST TIME F/A X 100%	4.57%	5.77%	-16.20%	21.69%	100.00%	100.00%	6.70%
N.EXCESS TIME (H+I)/A X 100%	0.19%	0.37%	0.49%	3.72%			0.76%
O.UNMEASURED WORK C/A X 100%	2.95%	3.66%	34.23%	11.90%			8.55%
P.TIME BOOKED ON UNFINISHED OPS	180.75	334.25	157.75	158.25	90.00	15.00	956.00
Q.TIME BOOKED AFTER JOB DESPATCH			4.50	1.00			5.50
TOTAL TIME SHEET HOURS	470.25	569.50	346.00	317.75	92.00	48.00	1443.50
TIME BOOKED ON CW NOS							
CW 100							
CW 101 UNION BUSINESS							
CW 102 APPRENTICES IN TRAINING		4.00					4.00
CW 103 SUPERVISORY DUTIES					2.00		2.00
CW 104 TRAINING APPRENTICES	4.50	3.50	2.00	3.00			13.00
CW 105 WAITING FOR WORK			4.00			21.50	25.50
CW 106 WAITING FOR STORES				2.75			2.75
CW 107 WAITING FOR/USING TRANSPORT	1.25	5.75		3.25			10.25
CW 108 WAITING FOR INSPECTION		0.50					0.50
CW 109 EXCESS CONTINGENCY ALLOWANCE	7.50	6.50	3.50	8.25			25.75
CW 110 WAITING FOR DRAWING OFFICE		0.50		7.25			7.75
CW 111 WAITING FOR ESTIMATING/TECHNICAL			1.50	1.00			2.50
CW 112 WAITING FOR PRODUCTION CONTROL	0.50						0.50
CW 113 WAITING FOR TOOLS/PARTS (CONSUMABLE)	1.50	2.00		2.50			6.00
CW 114 WAITING FOR TOOLS(JIGS/FIXTURES)	1.50						1.50
CW 115 M/C BREAKDOWN (MECHANICAL	4.75		0.50				5.25
CW 116 M/C BREAKDOWN (ELECTRICAL)	0.75	3.00	-47.50				-43.75
CW 117 ATTENDING SURGERY/HOSPITAL		1.25					1.25
CW 118 REMOVING EXCESS MATERIAL	1.75	4.50	3.00	15.75			25.00
CW 119 INDIRECT WORK FOR ELECTRICIANS						11.50	11.50

(081) (180)

CHAPTER 4 APPENDICES

I. THE NEW JOB CODE SYSTEM & PRODUCT RESULTS SUMMARY, 1975.

2. INTER-DEPARTMENTAL PAPERWORK SYSTEM.

3. REVISED COMPUTER REPORT FORMATS.

4. PROGRAMME FOR SCHEDULING EXPERIMENT ON TURNING SECTION.

CHAPTER 4 : APPENDIX 1 : TABLE A

The New Job Code System, showing the profusion of old codes. Dated 19/11/74

Old Product Code	Description	Old Customer Code	New Prod. Business Code	New Customer Code
800	Tooling and general	None	ASWR(1)	
	- Aviation	VH,VMR		XA
	- Suspensions	SA		XS
	- Wheel	RE,RMR		XW
	- Redditch	TA		XR
801	Tyre Machinery - D/P	DB	XD	None
802	" " - non-D/P	DB	XG	None
803	Group Service Work	CR	XB	None
804	Spares			
	- Customer Orders	SR	XE	None
	- Made-in	GA	Not appl.	XK
805	Hardening		XH	None
806	Tooling & General - D/P	DB	XF	None
807	Tooling & General - Non-D/P	DB,KA	XT	None
809	Non-Tyre Machinery - D/P	DB,RE,VH SA,TA	XJ	None
810	" " " - Non-D/P	DB,KA	XG	None
840	Pump Expendables	DB	XN	None
	Spares Requisitions	SP1400	Not appl.	SP0099
Other Works				
	Jobs for P&ED Coventry	DB	XP	
	Jobs for P&ED Leicester	DB	XV	
	Modifications and Re-Work (2)	ALT	ZX(Design Dept.) ZY(Design Dept.) ZY(Production Control	

NOTES (1) Not to be used except for business analysis.

(2) Note that this does not include Group Service Work (XB).

TABLE B : JANUARY/DECEMBER 1975

CODE	PRODUCT DESCRIPTION	PLAN TURNOVER £	PLAN CONTRIBUTION £	PLAN %	ACTUAL TURNOVER £	ACTUAL CONTRIBUTION £	ACTUAL %
801	Tyre Making Machinery - Dunlop & Pirelli (XD)	473,200	148,100	31	438,644	104,700	24
802	Tyre Making Machinery - Non D/P (XC)	183,100	58,000	32	201,047	78,009	39
809	Non Tyre Machinery - Dunlop & Pirelli (XJ)	235,600	63,900	27	161,357	36,655	23
810	Non Tyre Machinery - Non D/P (XG)	481,800	141,600	29	105,902	2,405	2
804	Spares (XK)	66,200	26,500	40	88,715	36,185	41
800	Tooling & General - Engineering Group (ASWR)	361,900	82,600	23	252,675	64,609	26
806	Tooling & General - Other Customers (XF)	169,100	40,100	24	128,999	47,392	37
807	Tooling & General - Outside Customers (XT)	318,000	64,700	20	265,785	24,997	9
	Weighpads (XB)	76,300	22,300	29			
803	Modifications & Repairs	140,600	40,200	29	160,527	63,928	40
805	Hardening (XH)	57,200	26,800	47	81,870	33,834	41
	Pump expendables (XN)	400,500	111,400	28	65,643	(7,817)	(12)
871	Installation & Commissioning	10,000	3,000	30	24,692	7,315	30
	Pipe line servicing equ.	136,500	42,300	31	620	182	29
872	Design Sales	10,000	3,500	35	31,437	11,003	35
		3120,000	875,000	28	2007,913	477,499	(25898)*
	Less Constants					(4,393)	
	Constant Expenses in Stock Adj					443,455	*Stock adj.
	Management	635,000				166,865	
	Fixed	159,000					
	Selling & Administration	63,000			52,748	658,675	
			857,000			(181,176)	
	Operating Margin		18,000			5,143	
	Capital Investment Grants		5,000			10,497	
	Royalties Received						
	Net Profit before Interest and Tax (Net loss in brackets)		23,000			(165,536)	

CHAPTER 4 : APPENDIX 2

INTERDEPARTMENTAL PAPERWORK SYSTEM

Some brief explanatory notes on the flow charts.

1. PARTS LISTS

Basic movement : Design file the master and issue two copies to Est. & Tech. Est. & Tech, use one copy to make a start on producing works cards for items which are to be made-in, and forward the other copy immediately to the Assembly Shop stores.

Stores : (i) check to see which of the required parts are in stock
(ii) book these parts out of stock against the job
(iii) endorse, on the parts list, the bin locations of parts in stock
(iv) return the marked up parts list to Est. & Tech.

Est. & Tech. collate the information on the two copies of the parts list, and prepare Requisitions for all items to be bought-out, or made sub-contract complete.

Detailed costing of the job is entered on the parts list. One master copy of the marked up Parts list is now filled for reference.

One Xerox copy of the parts list is made and forwarded to Production Control, Assembly Shop, to become part of the total KIT for the job.

The second master copy is sent from Ets. & Tech. to Inspection.

2. DETAIL DRAWINGS

Basic movement : Design hold the originals and send three copies to Est. & Tech. who forward two copies to Drawing Stores, Machine Shop. The third copy is held in Est. & Tech. until needed by Inspection, Assembly Shop, for checking parts.

Sub-contract operations : Drawings for items having sub-contract ops. are sent with the item to Group Buying Dept. from the Machine Shop, Drawing Stores.

Assembly Area : Detail drawings will only be needed here when there is a problem with a job. A set is available for reference in Inspection, and extra copies, where needed, should be obtained direct from Design.

Sub-contract Complete : Because it is rare for ALL the details on any one detail drawing sheet to be sub-contracted, it is unsatisfactory to try to divert sheets from sets 3 and 4 (see flow chart) to the sub-contractor. The Buying Dept. should thus find out from the sub-contractor how many copies of the drawings are required, and request this number direct from the Design Dept.

3. BUILD SPECIFICATIONS

Basic movement : Design retain two copies : one in the Drawing Office file and one in the Project Engineer's job file. Design forward three copies to Est. & Tech. Est. & Tech file one copy for job planning, forward one copy to Production Control, Assembly Shop to be placed with the KIT for the job, and send one copy to Inspection, Assembly Shop, to monitor the build.

Job Kit : To form a complete KIT, the Build Specification needs to include : (i) specification of any types of oilt to be used in the machine or any part of it

(ii) an authorisation for painting, as and when the Superintendent deems it expedient.

4. ASSEMBLY DRAWINGS

Basic movement : Two copies issued by Design to Est. & Tech. Forwarded to Assembly Shop (Production Control) to become part of KIT, prior to scheduled start of job build.

5. D.O.I. PROCEDURE

Basic movement : Four copies from Design to Est. & Tech. and one copy from Design to the Assembly Shop stores. Est. & Tech. forward one copy to Production Control Dept. of whichever shop any modification work will be carried out (note that if a D.O.I. involves placing new outside orders, Est. & Tech. will forward the necessary Requisition to Buying and a copy of the D.O.I. must go the Assembly Shop Production Controller, who will amend his shortage list as necessary). Est. & Tech. forward one copy, with estimated cost to Accounts, one copy to Inspection Dept. (who inform stores of any necessary amendments to stocks), and note change of detail in question. One copy is retained by Est. & Tech. from which to raise any necssary modification work.

Liability : Design Dept. will assess whether the modification is customer or P&ED liability. Order Control must be contacted in the case of Customer Liability to gain a sanction to cover the cost of the modification BEFORE any paperwork for the modification is produced. In the case of P&ED Liability, Est. & Tech. will assess which particular internal liability code should be used for the modification.

6. SHORTAGE LIST

Basic movement : Production Control, Assembly Shop, produces two sorts of shortage list, a) for Bought-Out parts and b) for Made-In parts. One copy of each list is passed to the Assembly Shop superintendent. One copy of the Bought-Out list is passed to Buying Dept. One copy of

the Made-In list is passed to Production Control, Machine Shop.

Flow of information : Vital that information on delays anticipated in making good these shortages be passed immediately to Production Control, Assembly Shop, in order that start of Build may be postponed if necessary.

7. REQUISITION AND ORDER

Premise : "The raising of requisitions is the business of Est. & Tech. Dept. only. The one exception to this is that stores may raise requisitions to replenish stock items."

Basic movement : Est. & Tech. send one copy of the Requisition to Buying, who place an order for the item. Copies of the order are sent to Accounts, Goods Inwards and Production Control, Assembly Shop. The present duplication of order files held at Buying, Goods Inwards and Production Control, Assembly Shop, would seem to be unavoidable at present.

8. WORKS ACTION REQUEST NOTE

Basic movement and purpose : To formalise and record information from Est. & Tech. to Design concerning a supplier's withdrawal of particular ordered parts, and any supplier-recommended replacements. To act as an official request to modify drawings, parts lists etc., to signify acceptance of the replacement part.

Result : On confirmation from Design that the replacement is acceptable, Est. & Tech. will authorise an "Alteration to Order" by Buying. Distribution of copies of the Alteration to Order is as for the original order.

9. GOODS INWARDS NOTES

Basic movement : Goods Inwards receive an advice note from the supplier and produce four copies of the G.I. note. Copies are sent to Accounts, to Buying (who book the articles in against the order on their progress file, and book them off the job shortage list, where one has been issued) and to Production Control,Assembly Shop (who book the order in against the job file and up-date the shortage list). Goods Inwards retain one copy as a record and also up-date the stores records for the item.

10. INTERNAL REJECTIONS

Premise : Foremen, or leaders of sections, where errors are made leading to rejection of parts made internally, are responsible for correcting that error, and producing the correct part for assembly.

Basic movement : Inspection produce two copies of the rejection note and send one to Production Control, Machine Shop, and one, together with the rejected part (size permitting) to the foreman of the section which is deemed to be responsible for the rejection. The Assembly Shop superintendent is notified in order that he may assess the implications of the shortage to his Build programme. Should the shortage affect the delivery of the finished machine, he should inform the Sales Manager who will contact the customer. All rejects which are returned to the Machine Shop should be entered on the shortage list for the job and should be accompanied by the appropriate paperwork when returned to the Assembly Shop.

11. REJECTS RETURNED TO OUTSIDE SUPPLIERS

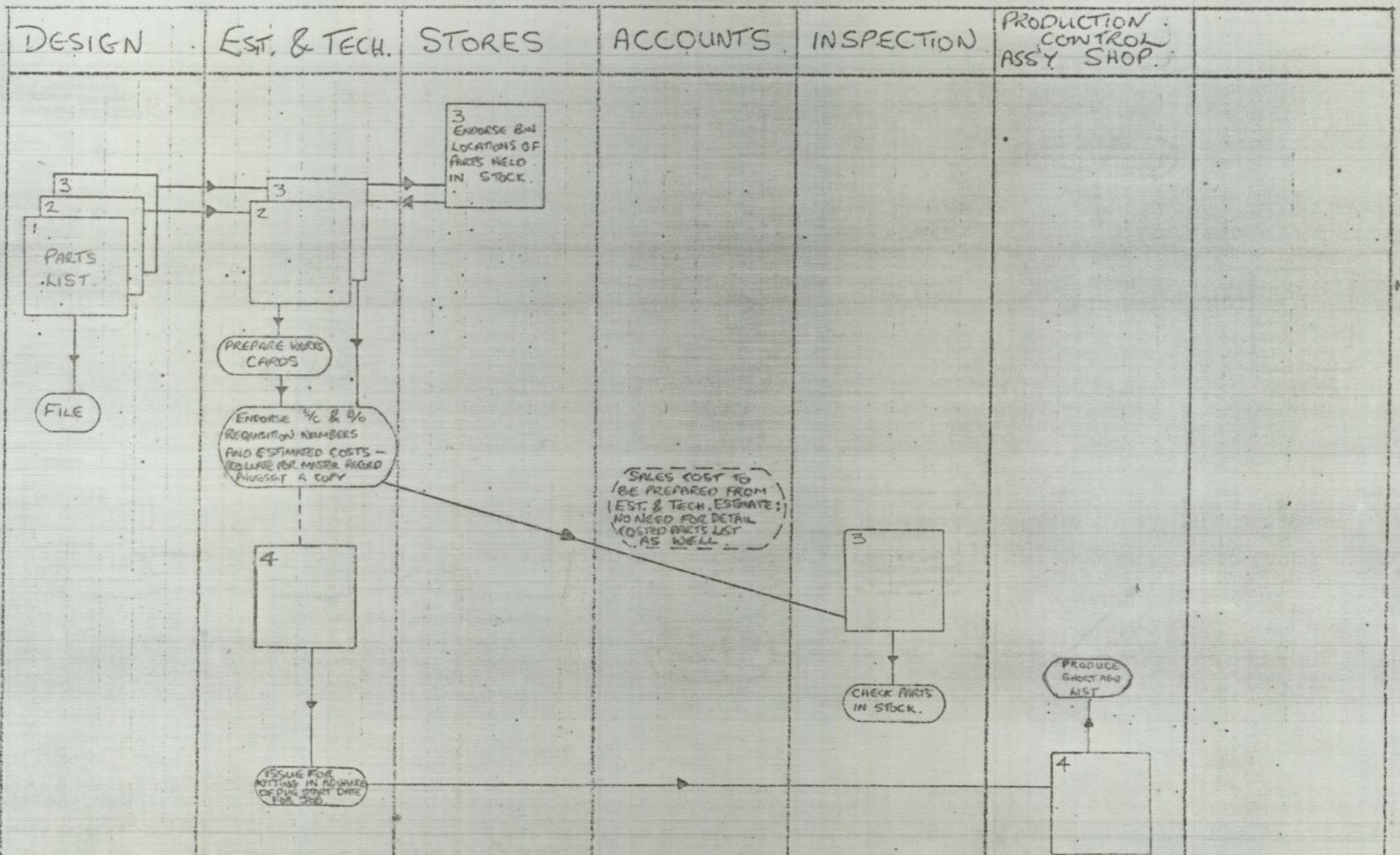
Basic movement : Inspection send copy of Rejection Note to Buying who Xerox a copy for their file and raise a Rejects Debit Note. Copies of the Rejects Debit Note are sent to : Production Control, Assembly Shop who note the item as a shortage against the job in question ; Accounts, who raise a Debit Note, send a copy to the suppliers, note the cost of the re-work against the job in question and debit the supplier's account ; Inspection with the original Rejection Note, to be returned with the part to the supplier.

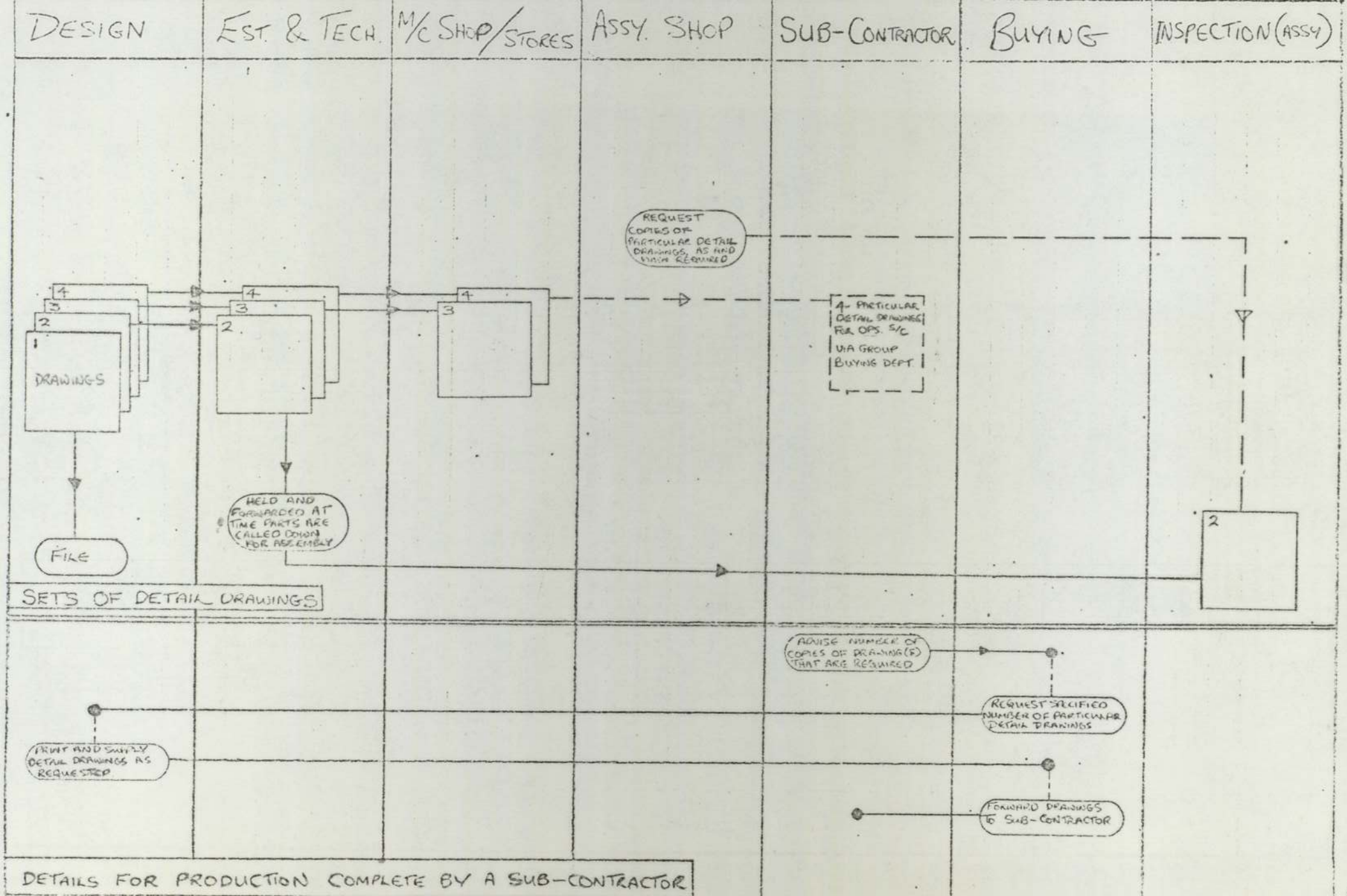
12. REJECTS ON OUTSIDE SUPPLIERS, RECTIFIED INTERNALLY

Premise : In certain cases it may be advisable, to avoid delaying machine build, or where faults are relatively minor, to rectify rejected Bought-Out, or Sub-contracted parts within P&ED. This will require alteration of the above procedure.

Basic movement : Inspection, in consultation with Assembly Shop superintendent, suggested on Rejection Note that rectification be done internally. The Rejection Note is sent to Buying as before, but contact is also made with Est. & Tech. who estimate the time and cost of the rectification work. Est. & Tech. pass on their estimate to Buying who contact the supplier to obtain a sanction for the deduction of the cost of re-work from the credit due to the supplier. Authority may only then be given to Est. & Tech. to produce papwerwork for the rectification. Buying will raise a rejects debit and send copies, as before, to Production Control, Assembly Shop, and Accounts, but in this case the supplier's copy will be sent direct from Buying.

M.R. Brough
March 1976


DESIGN
EST. & TECH.
STORES
ACCOUNTS
INSPECTION
PRODUCTION CONTROL ASS'Y SHOP.
3
2
1
PARTS LIST
FILE
3
2
3
ENDORSE BIN LOCATIONS OF PARTS HELD IN STOCK.
PREPARE WORKS CARDS
ENDORSE S/C & B/O REQUISITION NUMBERS AND ESTIMATED COSTS — RETAIN FOR MASTER RECORD PHOTOSTAT A COPY
4
ISSUE FOR KITTING IN ADVANCE OF DUE START DATE FOR JOB
SALES COST TO BE PREPARED FROM EST. & TECH. ESTIMATE; NO NEED FOR DETAIL COSTED PARTS LIST AS WELL
3
CHECK PARTS IN STOCK.
PRODUCE GHOST ASS'Y LIST
4
(881)
FLOW CHART :— PARTS LISTS
1

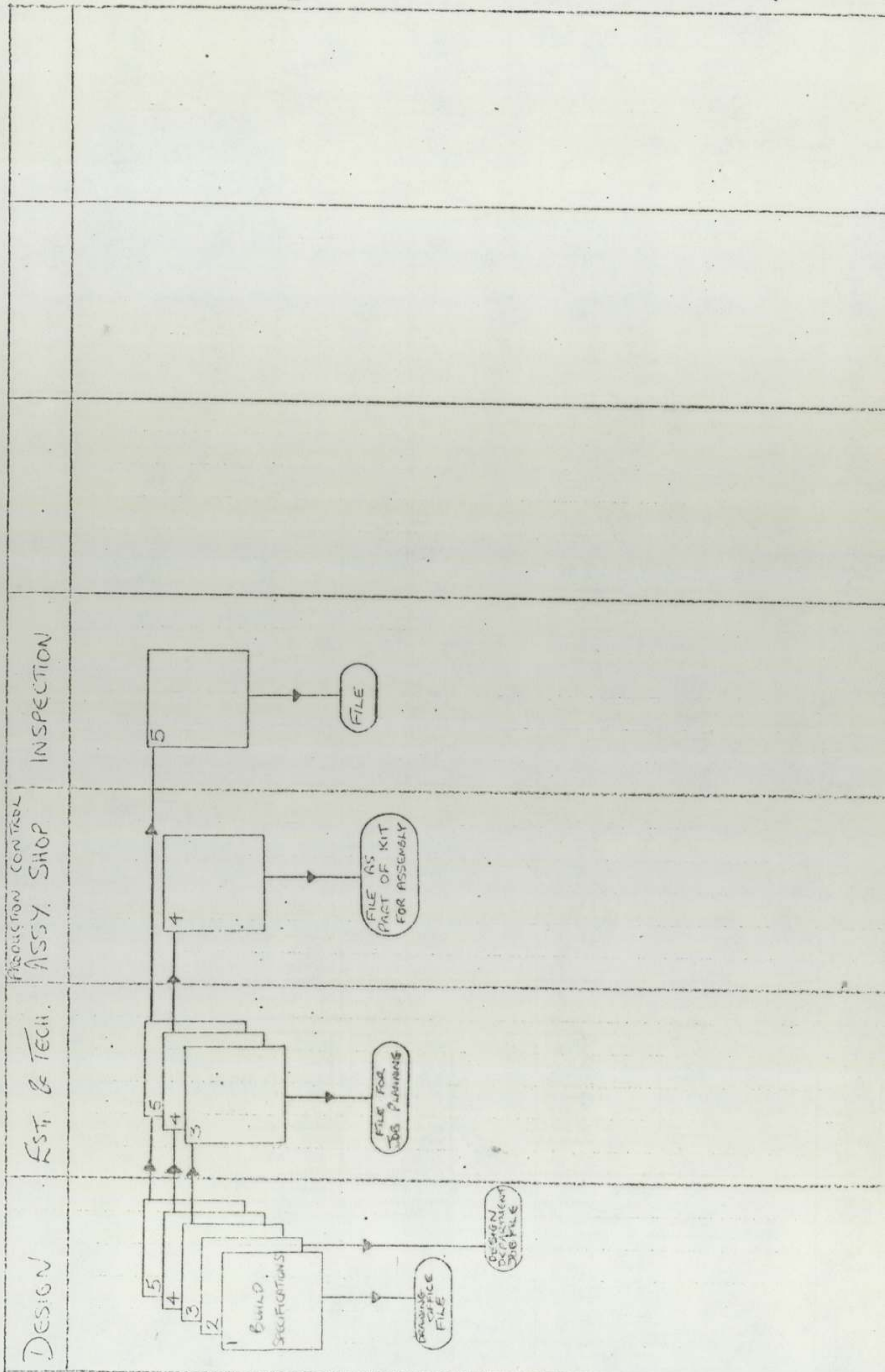


(681)

FLOW CHART - DETAIL DRAWINGS.

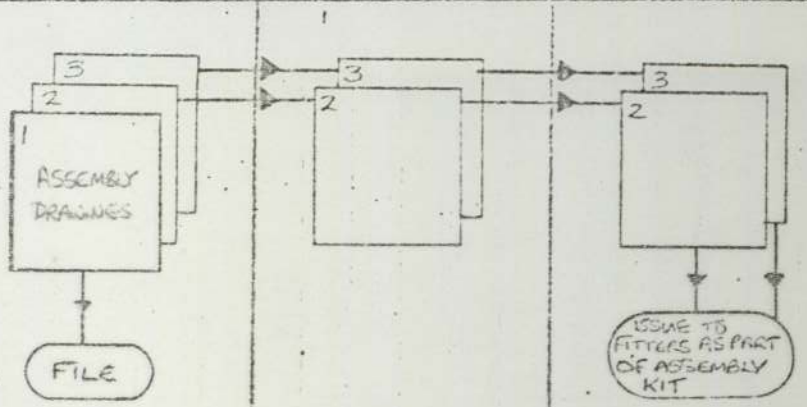
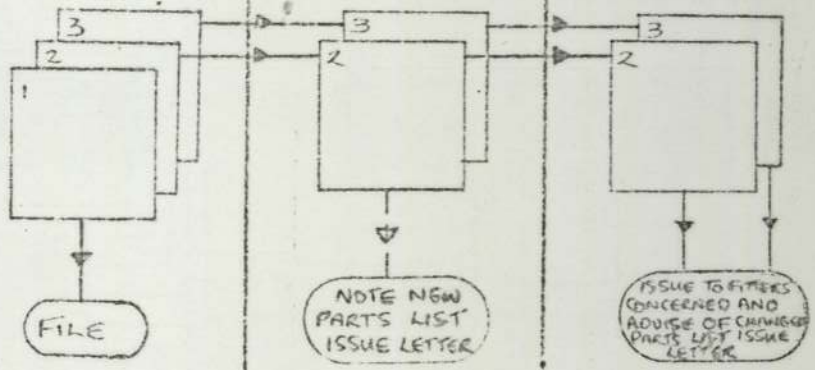
2

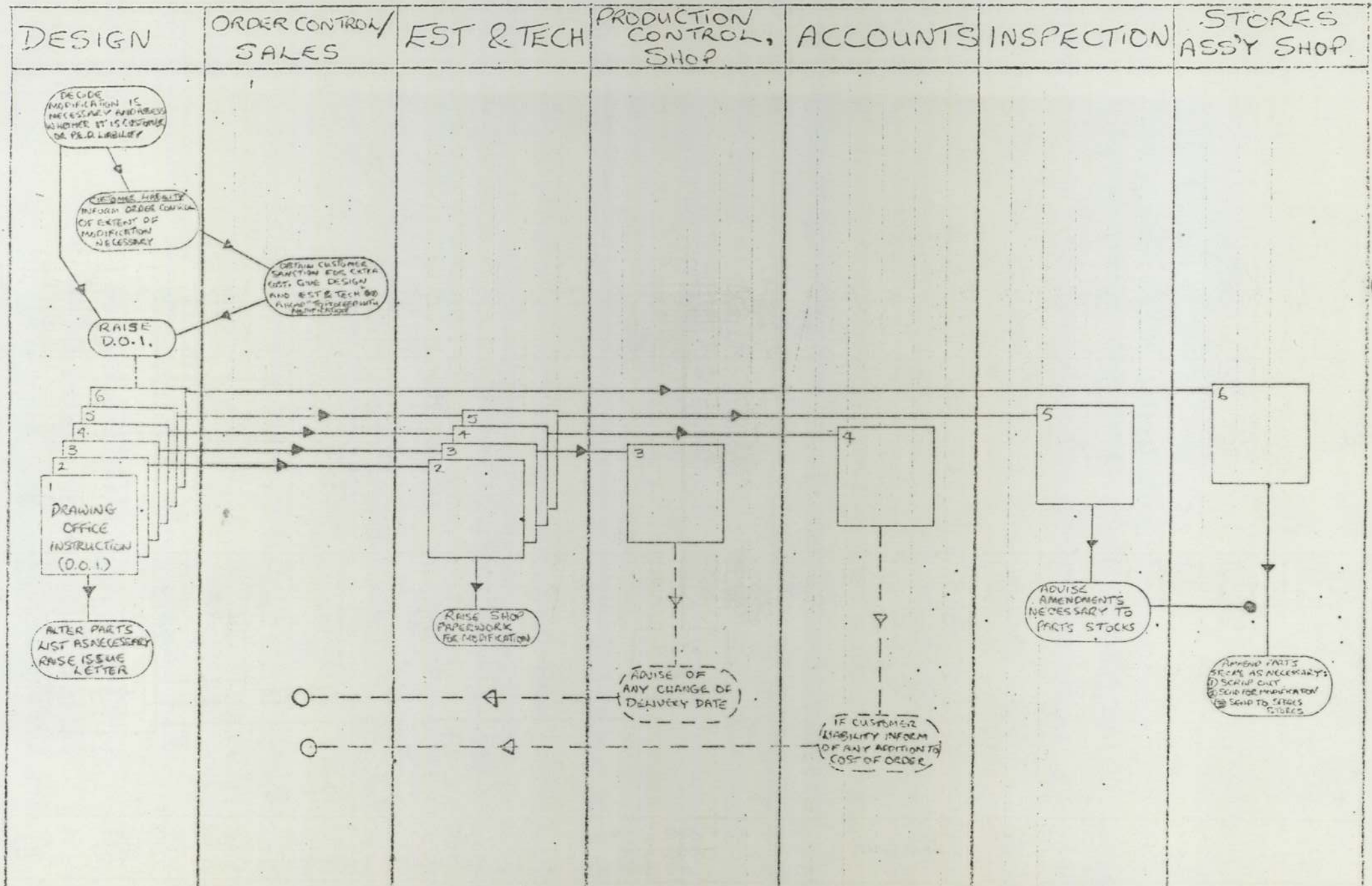
FLOW CHART 3 :— BUILD SPECIFICATIONS



FLOW CHART — ASSEMBLY DRGS

(161)

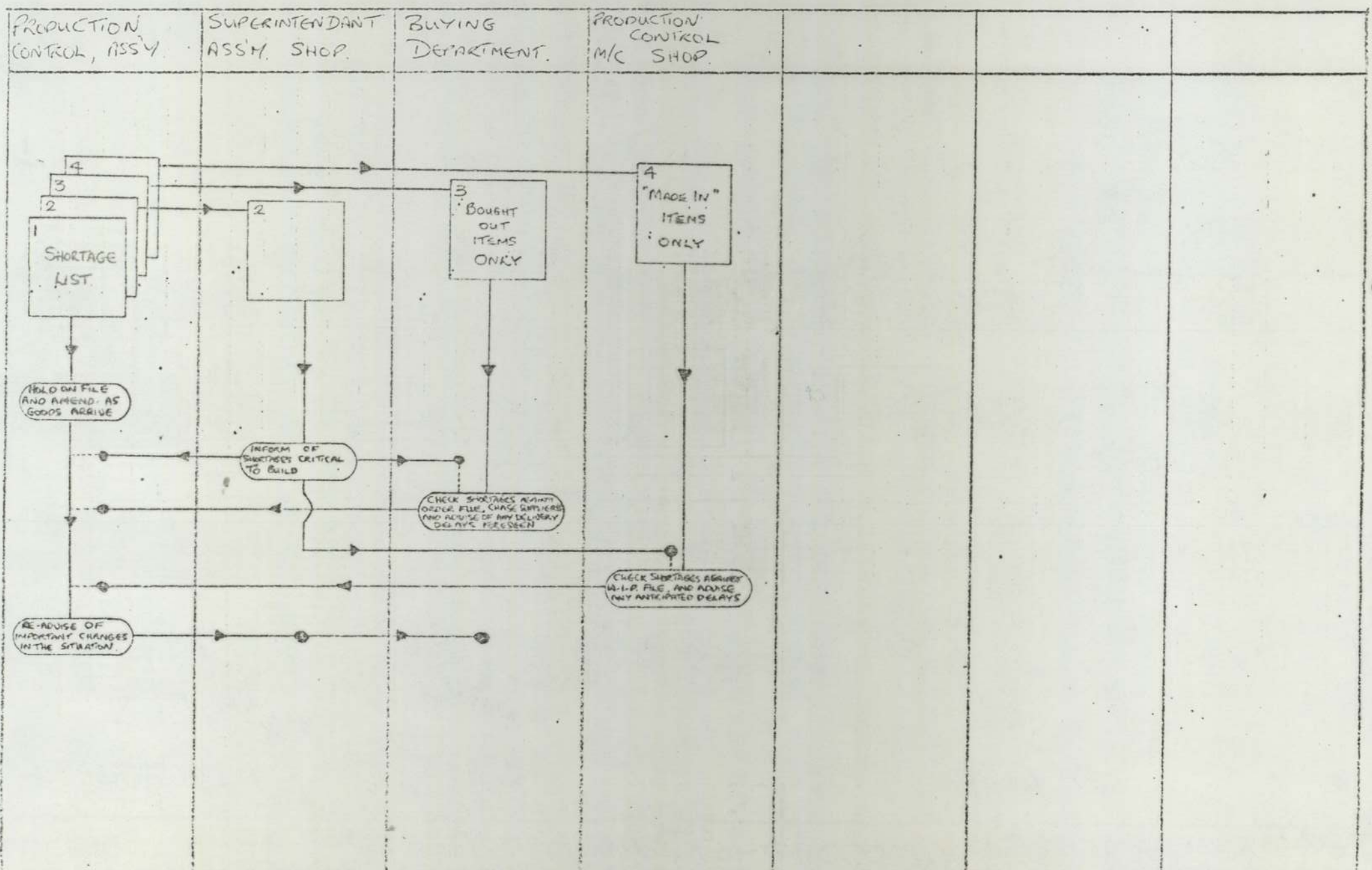
DESIGN	EST & TECH.	PRODUCTION CONTROL, ASS'Y.				
						
ORIGINAL ISSUE						
						
MODIFICATION ISSUE						



FLOW CHART re D.O.I. PROCEDURE.

5

(19)

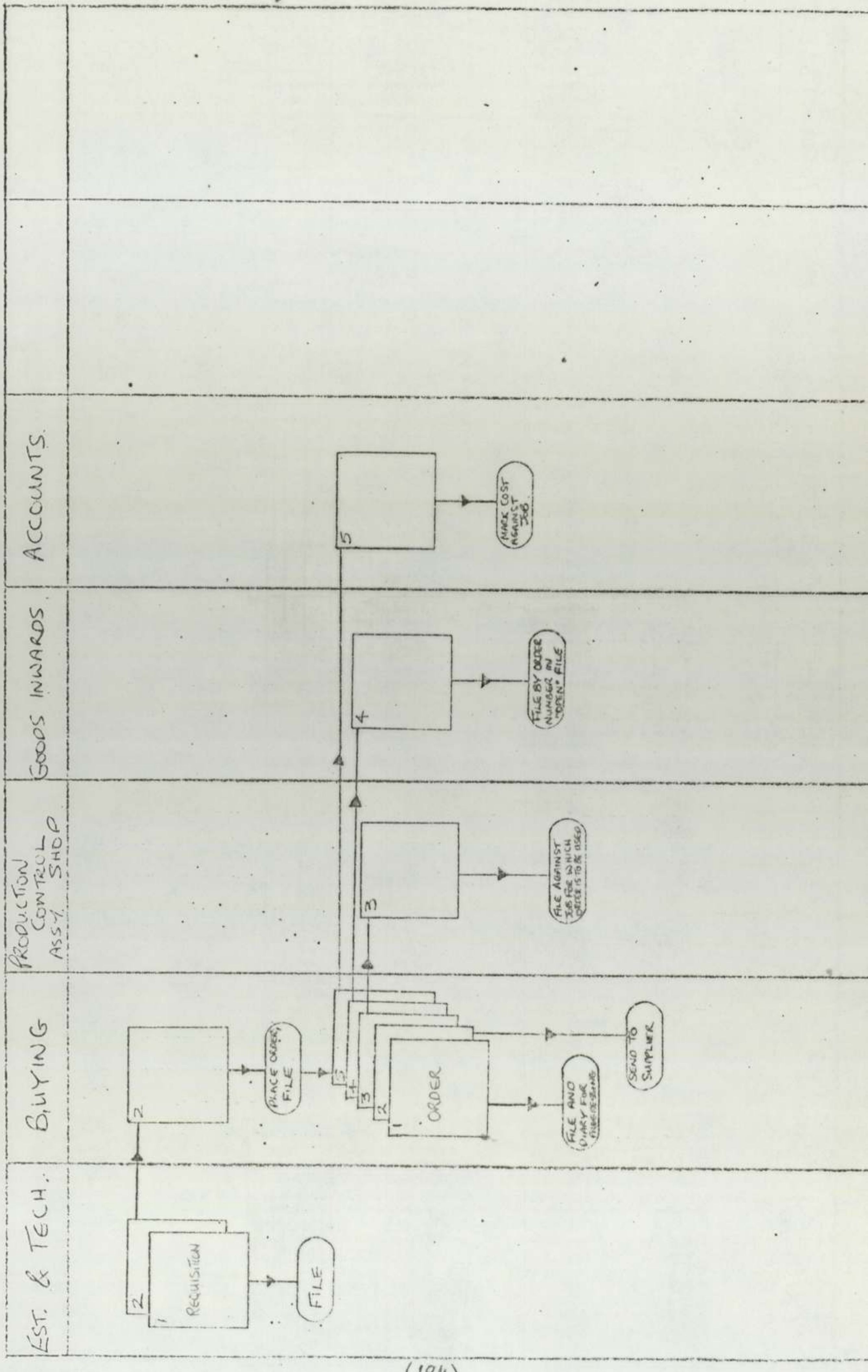


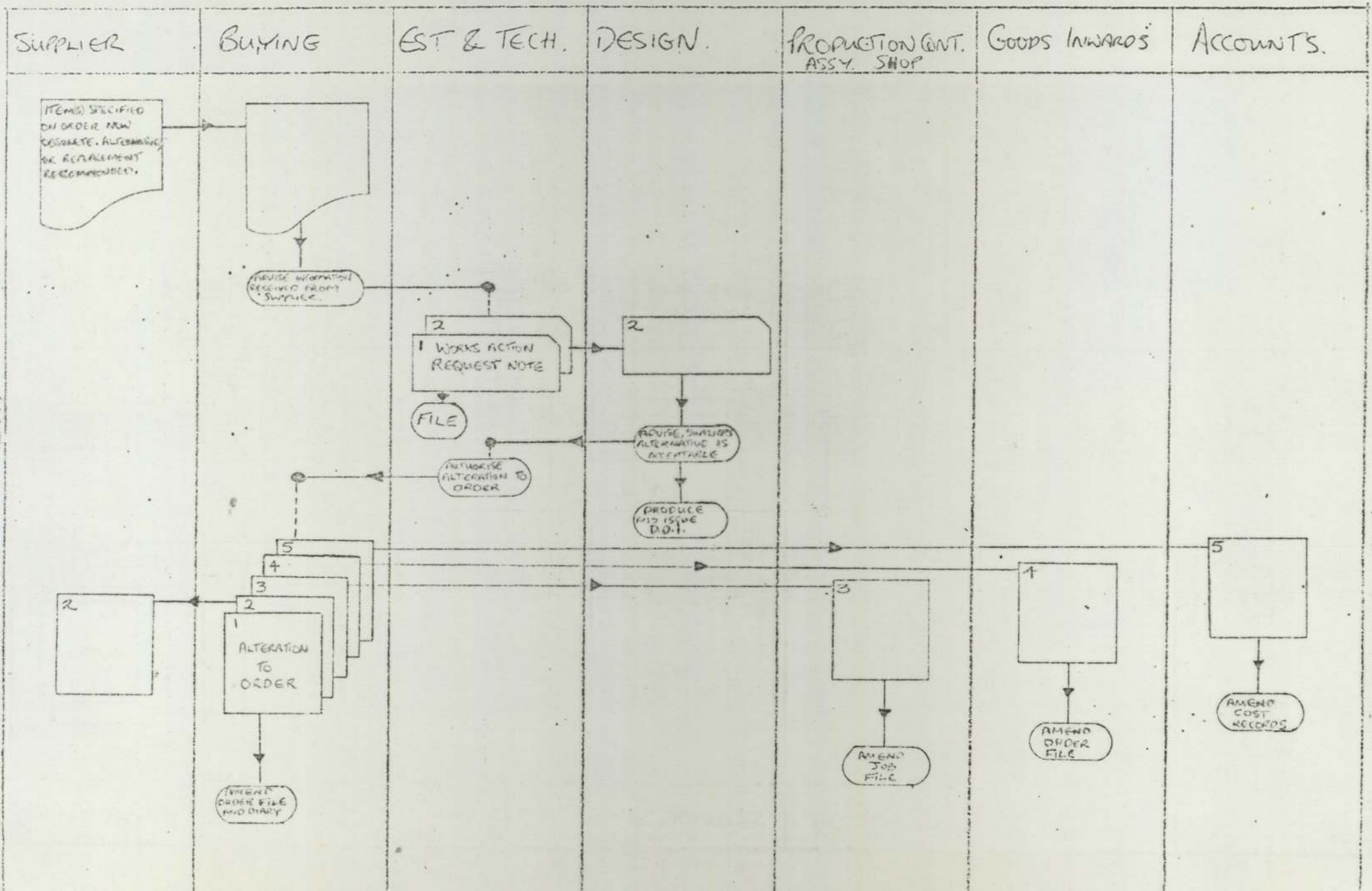
FLOW CHART :— SHORTAGE LIST.
6

(193)

FLOW CHART :— REQUISITION AND ORDER

7



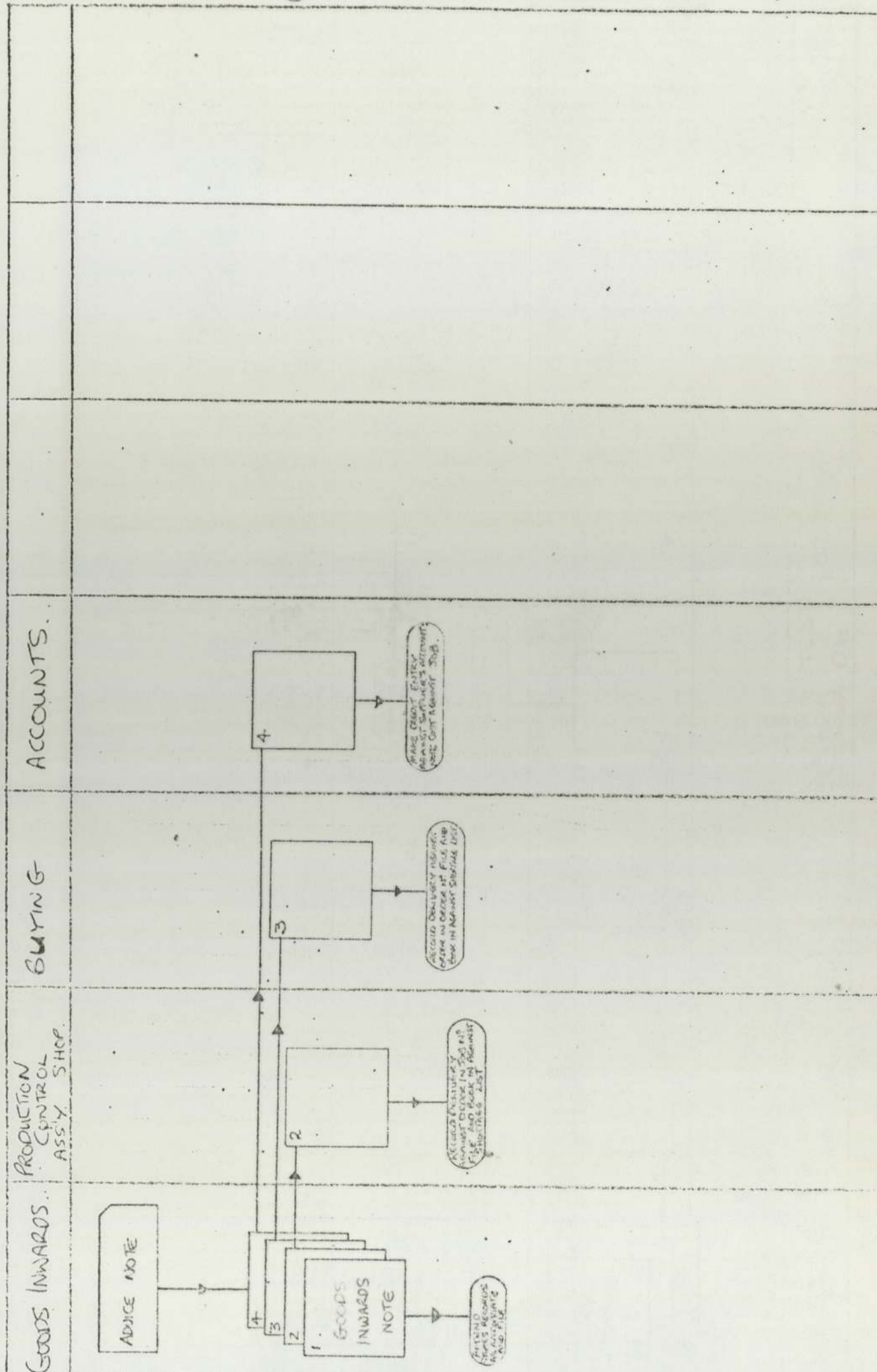


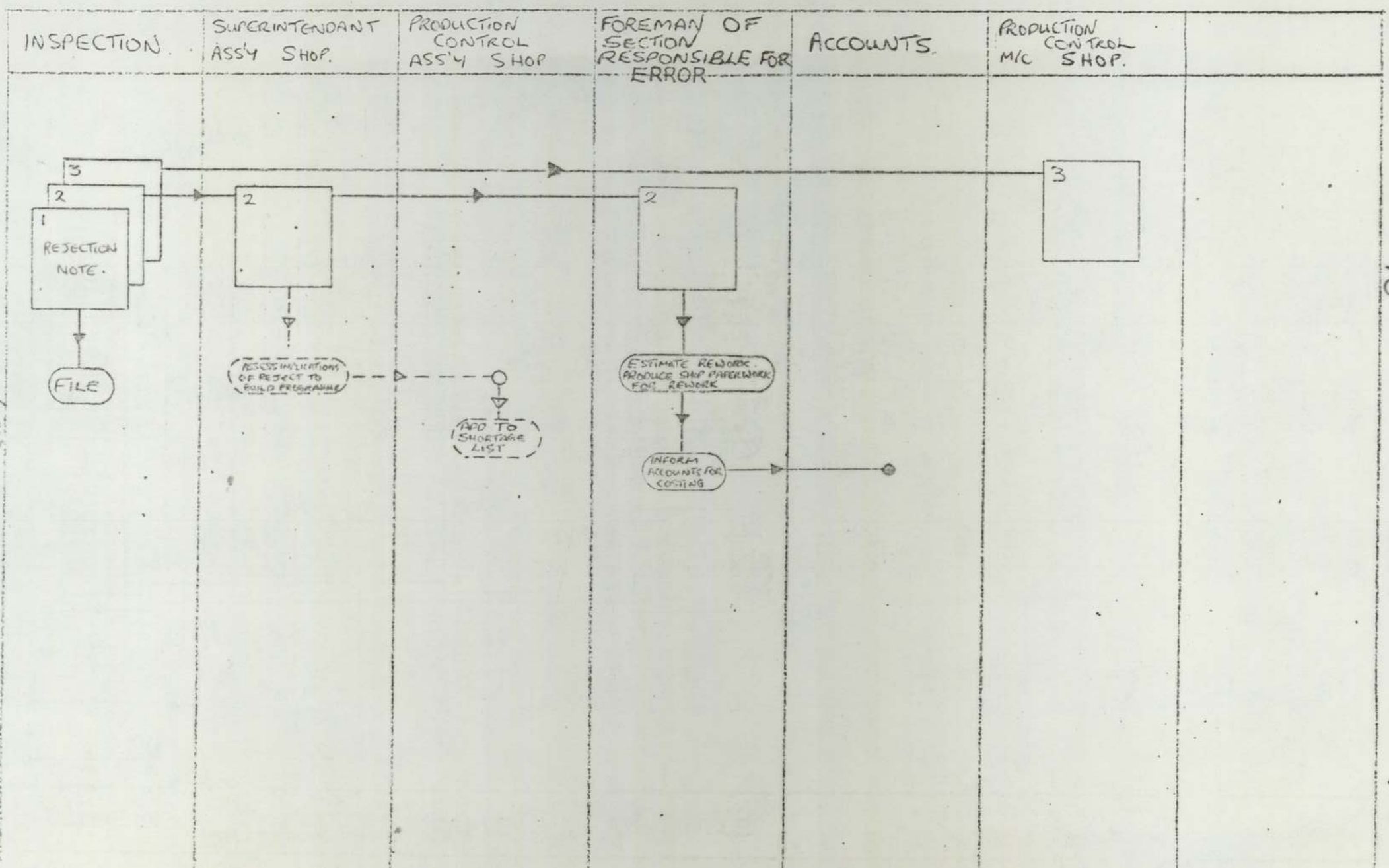
FLOW CHART :— WORKS ACTION REQUEST NOTE AND ALTERATION TO ORDER.

(193)

FLOW CHART :— GOODS INWARDS NOTE

9



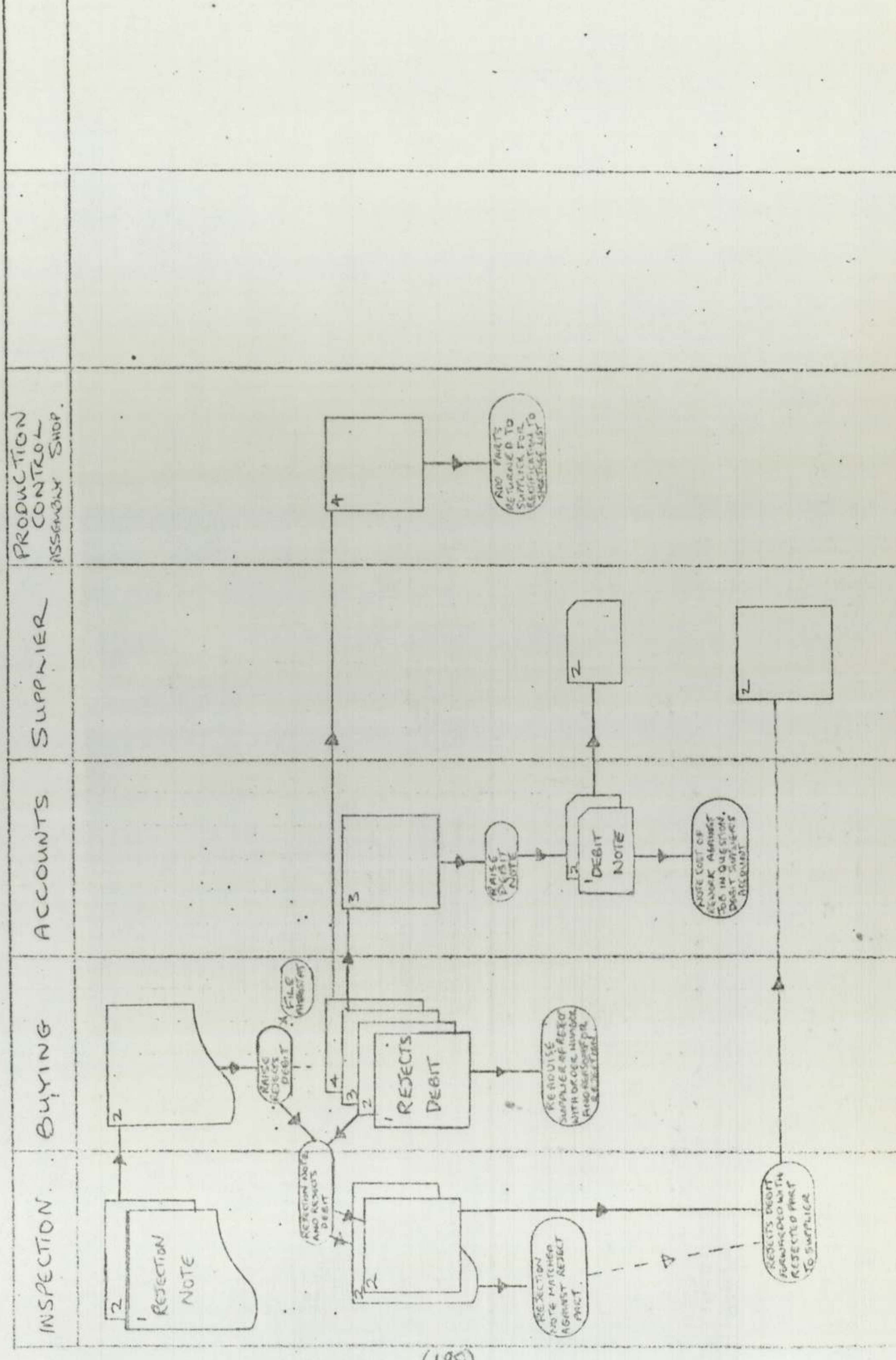


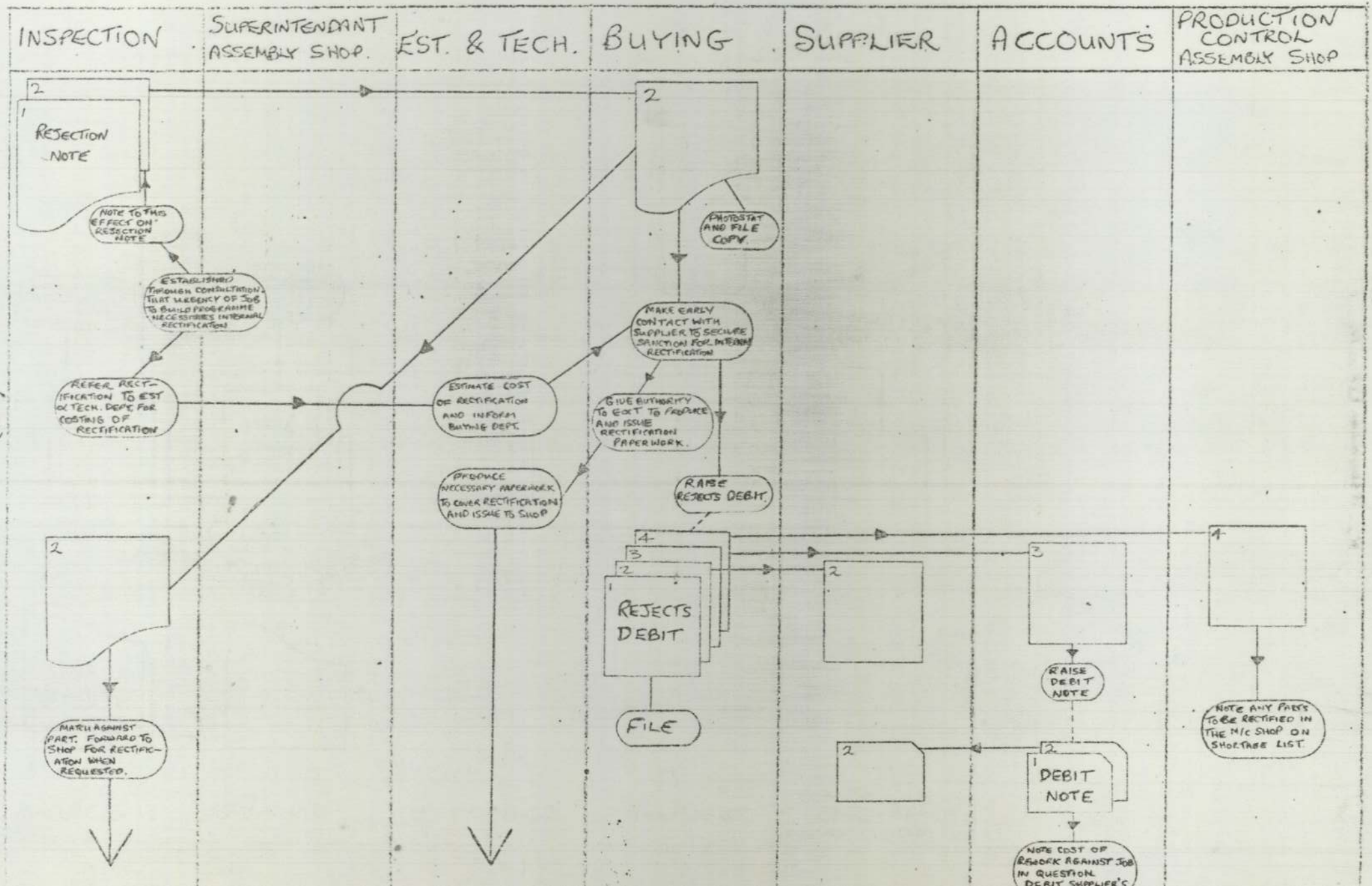
FLOW CHART :— INTERNAL REJECTS.

10

(197)

FLOW CHART :--- REJECTS RETURNED TO OUTSIDE SUPPLIERS FOR RECTIFICATION





(69)

12

FLOW CHART :— REJECTS AGAINST OUTSIDE SUPPLIERS, RECTIFIED INTERNALLY

CHAPTER 4 : APPENDIX 3

REVISED COMPUTER REPORT FORMATS

Production and Production Planning Department Requirements

Two basic functions to be served by computer information :

A - Planning

B - Scheduling

A. Planning - The following print-outs required weekly.

1. Current load - showing by start date work scheduled to be in progress and jobs due to start during the coming week :

(wk.start)

Week 09 Job No.	Item	Machine Groups 20	21	22	23	24	25	26	27	30	40	50	60	70	80
XY 0369/001	A	1				3				Q1			Q1		Q2
	AA	10			2	Q5								Q1	Q1
	E					4					Q1		Q1		Q2
XY 0370	A	1			2	3									Q1
XY 0370/001	F					1									Q1
XZ 0111/006	A				1	2							Q1		Q1
XZ 0112	N		2			1						Q1			Q2
XZ 0401	P			3		1.5						Q1			Q2

* Nominal times used for non-machining operations to highlight areas such as material sources - steel stores ; free issue ; bought-out - sub-contract, heat treatment and inspection, where delays may be critical.

(The above figure shows the sort of lay-out which we would like the print-out to appear in.)

2. Forward load - Summary of jobs for which the due start week has not yet been reached.

(wk.start)

Week 26 Job No.	Machine Groups 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
XX 0345	12		6			5				2		Q5	15				7							22	
XZ 0361	28	12			14		56			9		Q5	12		2	1	3			6			15	66	
XZ 0362	36	7	1	Q5	1	6	71		9	90		11			15									74	

3. Customer Code Summary - showing the total load for one month for each machine group and broken up simply into customer codes.

Customer codes	Machine Groups 21	22	23	24	25	26	27	30	40	50	60	70	80
XC	62	24	104	1061	0	1104	210	5.3	2.7	0.4	17.5	4.9	28.2
XD	12	14	71	1001	0	963	171	4.6	5.6	0.1	12.9	19.1	39.7

4. Efficiency analysis - Variations from standard extimated time for all jobs completed during the previous week, according to the machine groups on which work has been done.

Job No.	M/C * group	Actual	Time Estimated	Difference	%
XZ 0123/001	01	4.0	3.5	0.5	14
	07	10.0	7.5	2.5	33
	17	4.5	5	-0.5	10
	24	9	9	0 0	0
Totals		27.5	25.0	2.5	10

* M/C groups : Only groups 1 to 27 to be shown on this print-out.

A possible fifth report for Production Control use depends on estimated cost :

5. Job Progress Analysis - With reference to particular jobs, the history of work done each week from the initial due start date - Is steady progress being made ?

Job No. XX1111	St/Fin Wk	09 - 15

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Tot.time Est./MC. Group	110		2				80		15				30		16
Time booked in wk 09	10														
10	40						5								
11	10														

B. Scheduling - Print-Out Required Daily

Shift load Shop load for two-day shifts, updated at the end of each day shift *, with facility to change priority sequence. To be divided up into machine groups and show the hors per item of a job scheduled for completion by shift end.

* N.B. Foremen of each section to estimate, towards shift end, time outstanding on all work in progress on his section. This information to be dialled into the computer to become first ops for next shift.

Machine Group 02

Job No.	Item	Hours	Last M/C group	Date completed
XX 0101/001	A	2.5	30	4/4/75
XZ 0222	H	3.5	07	8/5/75
XX 0101/003	C	6.2	70	26/4/75
ZZ 0102	E	8	80	16/4/75
Machine Group	60			
XX 0101/002	A	0.2	80	12/5/75
XZ 0222	C	0.2	80	12/5/75
XX 0102	G	0.2	80	12/5/75

The computer print-out will be split up amongst the foremen according to their several responsibilities. The same print-out will also highlight :

a) Items ready to go out to sub-contractors (Group 60)

b) Items in inspection (Group 80)

c) Items scheduled for 1st M/C op (last M/C group will be 30, 40, or 50)

d) Items due to change from one M/C group to another

e) Items completed (under Group 90-BIN)

ACCOUNTS REQUIREMENTS

1. Ref. EG03 01 & 02. Both of these reports give an unnecessary depth of detail. Actual requirements would be met by :

Job No.	Actual time	Estimate	Balance	Work Remaining	Unmatched Bookings
1001 XZ	114.00	161.00	47.00	40.50	4.50
1002 XZ	12.00	10.00	-2.00	1.00	0.00
1003 PP	201.5	161.00	-40.50	22.50	12.50
1003 XZ	174.5	161.00	-13.50	52.00	7.50
1003 ZX	161.75	251.00	89.25	87.00	10.50
Column 1	2	3	4	5	6

Alterations required

For cost accountant column 1 would be better if it could be listed in strict numerical order, the prefix becoming a suffix in effect, if not in fact. He would then be able to see the total job put together, instead of having to sort through different areas of the present print-out. Column 6 would be an addition to the present totals shown on EG03 01, and represents that part of the information shown on EG03 02 which is useful to Accounts. Columns 4 and 5 not required by Accounts - can save EG03 20 if they are blanked out.

2. EG03 04
06
13
14
15 (May be some duplication with 22)

All these reports are still required by Accounts and the present format is regarded as satisfactory.

3. Ref. EG03 16 Potential Overspend

Print-out that could be useful with some alterations in presentation format.

	Job No.	Actual to Date	Estimated Time	Balance	Likely remaining work	Likely Overspend	Likely Overspend %
	XZ 0011	2199	1260	-938	26xX		
	XZ 0012	2413	1622	-790	149xX[1]		
	XZ 0100	1856	1272	-584	283xX[2]		
	XZ 0102	1162	476	-685	5xX[3]		
	XZ 0110	1650	1808	157	790xX[4]		
	XZ 0110/001	1503	1048	-455	170xX[5]		
Column	1	2	3	4	5	6	7

Alterations required

(i) That the report be presented in Job No. order (change Col. 1 format)

(ii) Estimated time should be magnified to allow for efficiency of only 70% (as it is when job is costed) - Ref. Col. 3.

(iii) Likely Remaining times - this "times" is not a useful indication of a likely conix of events unless the actual figure for ops outstanding is magnified by the actual performance on that part of the job which has been done.

(iv) Likely overspend figures may now have some genuine meaning.

4. Ref. EG03 22 Efficiency

3-page summary, as at present required, but meat of report can be dispensed with if the computer can simply kick out once monthly the total times for work carried out a) on the Machine Shop

b) in the assembly area

to facilitate charging out to respective persons. Facilities for obtaining this information aleardy exist on EG03 12. Totals required are of : b) 37000 series clock numbers (assembly area)

a) all other clock numbers (Machine Shop)

Net effect of new requirements on existing computer reports

Report No	Contents	Present dist.*	Effect of new requirements
1	Work in progress	1,2,3,6	Change of format
2	Unmatched time bookings	1,2	Change format (totals only)scrap copy
3	Ops exceeding estimate	1,2	Covered by new scheduling report
4	Previous day's despatches	1,2	Retain but scrap copy 2
5	Orders not started	1,3	New format-scrap copy 1-add copy to 2
6	Labour hrs on jobs despatched	1	Retain
7	Amendments input	5	Input facility still required
8	Deletions input	5	" " " "
9	Unmatched planning data	5	" " " "
10	Jobs despatched serial cards to be destroyed	4,4	Not needed with new booking system
11	Incorrect planning data	5	Error report - retain
12	Previous days bookings - clock no. order	2	Same information in different form
13	Prev. day's bookings - job no. order	1,2,6	covered by new requirements
14	Unmatched Blue terminal cards	1	Error report - retain
15	Monthly CW and TM totals	1	Retain
16	Jobs	1,1	New format required
17	List of job & serial nos.	4,4	Scrap: redundant in new job code syste
18	Input errors	4	Error reports - retain
19	Incorrect booking data	4	" " "
20	Stocktaking report	1	Retain
21	Incentive payment scheme - finished ops	2	Scrap
22	Incentive payment scheme - operator's time analysis	1,2	Scrap copy 2;useful to 1 if inputs reformed

* Key to distribution

1. Accounts
2. Machine Shop Production Control
3. Sales Manager
4. Booking Clerk
5. Estimator M/C Shop
6. Superintendent M/C Shop

PROGRAMME FOR SCHEDULING EXPERIMENT ON TURNING SECTION

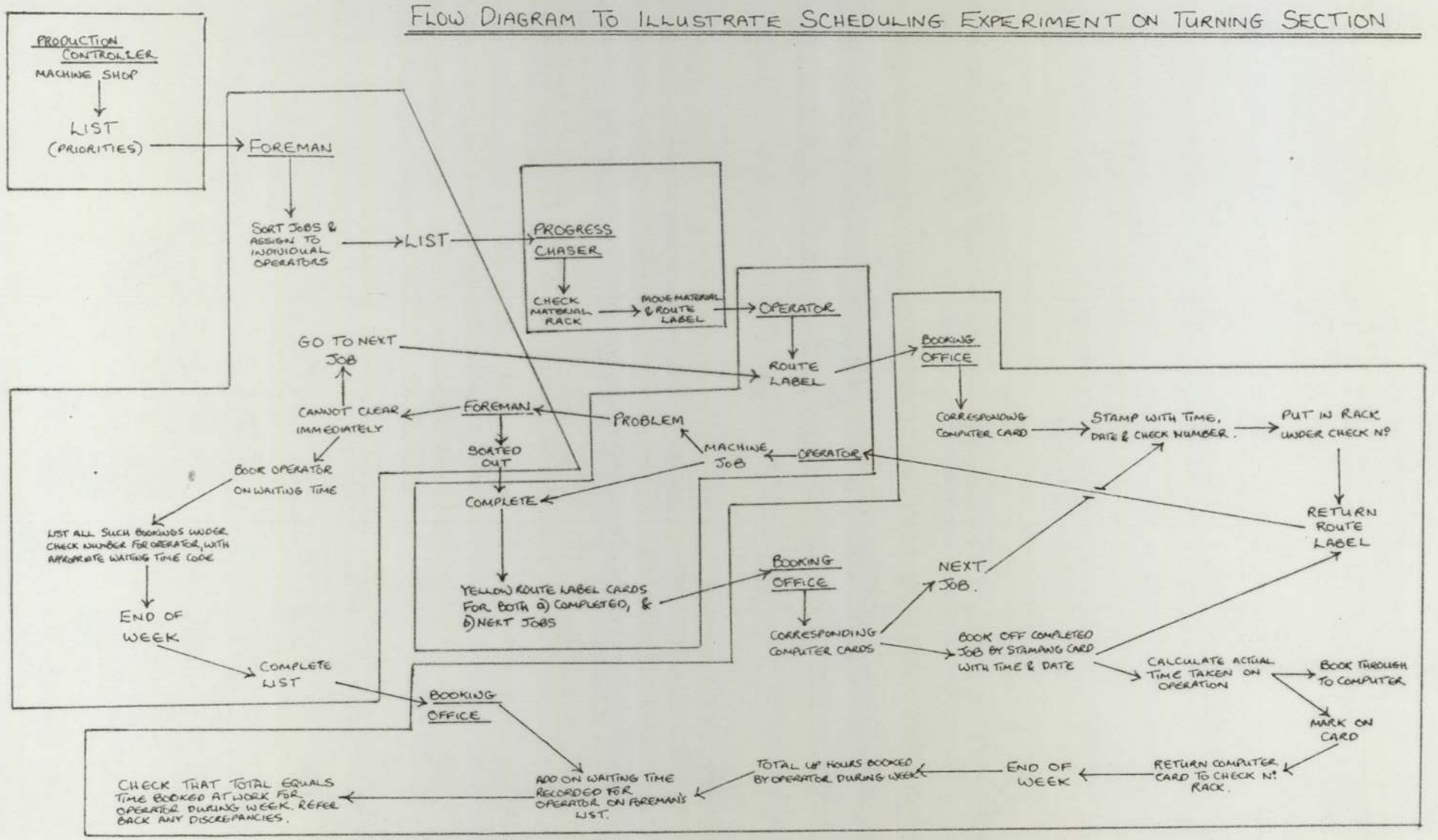
1. Production Controller, Machine Shop, to inform Foremen, turning section, of priority sequence of jobs during coming week.
2. Based on this information, Foremen to assign jobs from the rack at the end of the section, to particular operatives.
3. All time sheets to the end of previous day shift to be booked through to the computer.
4. At the start of scheduling by use of computer cards, all operatives - whether starting on new jobs or continuing jobs unfinished at the end of the previous shift - to take the yellow route label for their job to the booking office.
5. Booking Clerk to match up route label with computer card for the operation to be performed, and mark onto the computer card the time at which the operation was started. The computer card is then to be placed in a check number rack under the operative's check number. The route label is returned to the operative.
6. Operative proceeds with machining as before. If, for some reason, he is unable to complete his operation on the job (reject/scrap/ drawing problems/machine breakdown, etc.) he is to see his foreman and explain the difficulty. The foreman may then assign a different job to him, or tell him to wait until such time as the problem is sorted out. In the latter case, the foreman will make a waiting-time entry against the appropriate code on a waiting-time list for the week which he will hand in to the Booking Clerk at the end of the week for booking through to the computer. EITHER WAY it is essential that, where problems do occur, the yellow route label is taken immediately to the Booking Office where the clerk will book the operative off the job.
7. Foremen to inform progress chaser of next jobs for operatives expected to finish shortly.
8. Progress chaser to take next jobs from rack at end of section and place them with route labels by operative's machine.
9. On completion of every operation, operative to take route label for finished job and label for next job, to Booking Office.
10. Booking Clerk to match route label for finished operation with computer card in check number rack under operative's check number, and mark card with time at which the operation was finished, noting also the date of completion if it should be different from the start date.

11. Booking Clerk to match "new job" route label with computer card and mark computer card with time and date that operation was started. Computer card placed in rack under operative's check number. Route label returned to operative.

12. Booking Clerk to take "finished operations" computer cards from operators' racks and book time taken through terminal to computer. If date of start and date of finish are not the same, Booking Clerk to book only time when operative was at work. Appropriate adjustments may also be necessary on account of breaks during normal working hours. Computer card to be marked with actual time spent on operation - sub-totals are required in cases where more than one operative has worked on an operation - and placed in a "finished operation" rack under the operative's check number. Where more than one operative has worked on a single operation, it will be necessary to add dummy cards to the "finished operations" rack to show the operatives' extra hours.

13. At end of week, all computer cards for finished operations to be withdrawn from finished operations rack. Total number of hours booked on operations by each operative during the week to be added up. All computer cards in "in progress" check number rack to be sub-totalled for position as at week-end. These hours to be booked through to computer and added to hours booked on finished operations by operative.. When added to "waiting time" shown for operatives on foremen's lists, this should total to the operatives' hours for the week. Booking Clerk to draw Machine Shop Controller's attention to any discepancies which occur between the total hours booked down to an operative, and that operative's hours at work for that week.

FLOW DIAGRAM TO ILLUSTRATE SCHEDULING EXPERIMENT ON TURNING SECTION



CHAPTER 5 APPENDICES

1. P & ED PRODUCT RESULTS SUMMARIES, 1976 & 1977.
2. PRODUCTION PERFORMANCE EVALUATION REPORT 1976.

CHAPTER 5 : APPENDIX 1 PRODUCT RESULTS

TABLE A : JAN - DEC 1976

Product description	Plan Turnover	Plan Gross Contribution		Actual Turnover	Actual Gross Contribution	
Tooling :	£	£	%	£	£	%
Engineering Group	151,091	43,315	29	226,302	55,635	25
Mods & Reps	112,418	44,967	40	162,340	69,277	43
Other Dunlop Cos.	48,164	13,764	29	90,012	26,511	29
Outside customers	350,623	64,986	18	255,042	62,802	25
Hardening	93,633	40,827	44	45,489	8,684	19
	755,929	207,859	27	779,185	222,909	29
Tyre Machinery :						
Dunlop	701,365	204,009	29	794,902	238,785	30
Non-Dunlop	964,733	310,952	32	610,651	160,339	26
Non-Tyre Machinery:						
Dunlop	54,000	16,201	30	213,389	62,780	29
Non-Dunlop	264,200	77,793	29	654,080	220,746	34
	1,984,298	608,955	31	2,273,022	682,750	30
Pump Expendables	229,352	39,870	17	53,247	7,257	14
Pipe-line Servicing Equip.	38,158	11,448	30	31,987	(87,205)	
	267,510	51,318	19	75,234	(79,948)	18
Spares	86,793	34,717	40	130,317	43,780	34
Sub-Contr. Inspection	15,176	6,003	39	9,740	3,798	39
Metrication	50,000	14,286	29	12,642	3,710	29
Design	36,000	10,800	30	20,805	6,243	30
Installation & Commissioning	5,000	1,500	30	16,780	5,095	30
	192,969	67,306	35	190,284	62,626	33
TOTAL ENGINEERING PRODUCTS	3,200,706	935,438	29	3,327,725	888,337	27
Less: Constant Expenses						
Management	608,522					
Fixed	188,764					
Selling	67,000					
	864,286			794,511		
Constant Expenses in Stock adjustment	(15,000)	849,286		26,413		
Operating Margin		86,152			67,413	
Investment Grants		5,000			5,413	
Royalties					289	
NET PROFIT		91,152			72,845	
Redundancy costs					85,119	
Reorganisation					46,542	
Profit on sale of assets					74,156	
NET PROFIT					15,340	

PLANT AND EQUIPMENT DIVISION

FINAL

PRODUCT RESULTS

TABLE B JAN/DECEMBER 1977

	Turnover		Gross Contribution			
	Actual	Variation	Actual		Variation	
LEICESTER	£	£	£	%	£	
Dunlop Customers	241,303	161,118	100,402	42	76,346	1
Outside Customers	172,131	(115,414)	65,329	38	(29,502)	
Contribution on Coventry Jobs	-		11,643	-	(10,277)	
	413,434	45,704	177,374	40	36,567	
Constant Expenses						
Management			(73,898)		(5,053)	
Fixed Expenses			(25,364)		168	
			(99,262)		(4,885)	
Constant Expenses Adj.			655		655	
Profit on sale of Fixed Assets/Raw Material			6,673		6,673	
P.B.I.T.Leicester			85,440		39,010	
COVENTRY						
Tyre Machinery Dunlop/Pirelli	1,372,674	490,239	556,546	41	278.521	
" " Non Dunlop/Pirelli	49,229	(689,183)	17,307	35	(243,068)	-
Non Tyre Machinery Dunlop/Pirelli	786,811	226,735	292,019	37	142,147	1
" " " Non Dunlop/Pirelli	136,397	(43,168)	43,596	32	(21,313)	(
Spares	135,367	35,367	47,482	35	7,482	(
Design	4,050	(19,950)	1,216	30	(5,984)	-
Installation & Commissioning	12,908	908	4,167	32	567	
Miscellaneous	29,295	15,295	15,079	51	10,879	2
Contribution Leicester Jobs	-	-	3,867	-	25,787	-
Inventitex			(23,583)	-	(23,583)	-
	2,526,731	16,243	957,696	38	171,435	
Constant Expenses						
Management;			(510,841)		(1,032)	
Fixed Expenses			(76,698)		10,141	
			(587,539)		9,109	
Constant Expenses Adj.			22,091		(2,162)	
Miscellaneous Income			5,538		395	
Inventitex Agreement			(35,000)		(35,000)	
P.B.I.T.Coventry.			362,786		143,777	
Contingencies						
Write back 1976 Provision	4,975	4,975	4,975		4,975	
Service Contingency			(40,000)		(40,000)	
P.B.I.T.Coventry			327,761		108,752	
Total Division	2,945,140	66,922	413,201		147,762	
Adjustments re Energy T/O	-	(250,000)	-		(87,499)	
" " " Constants	-		-		116,665	
	2,945,140	(183,078)	413,201		176,928	

CHAPTER 5 - APPENDIX 2

PLANT & EQUIPMENT DIVISION

PRODUCTION PERFORMANCE EVALUATION - 1976

Preface: All the tables and graphs in this report are based upon PRODUCTION statistics, not FINANCIAL statistics. As such, it is the shape of the graphs with which we are mainly concerned, and where figures are quoted, it is for the purpose of drawing attention to points of interest within those shapes. Similarly, tables have been made out in percentages, because it is the proportions which matter, not the figures themselves. For this reason, the statistics, upon which the graphs and tables are based, have not been included, although they are available if required.

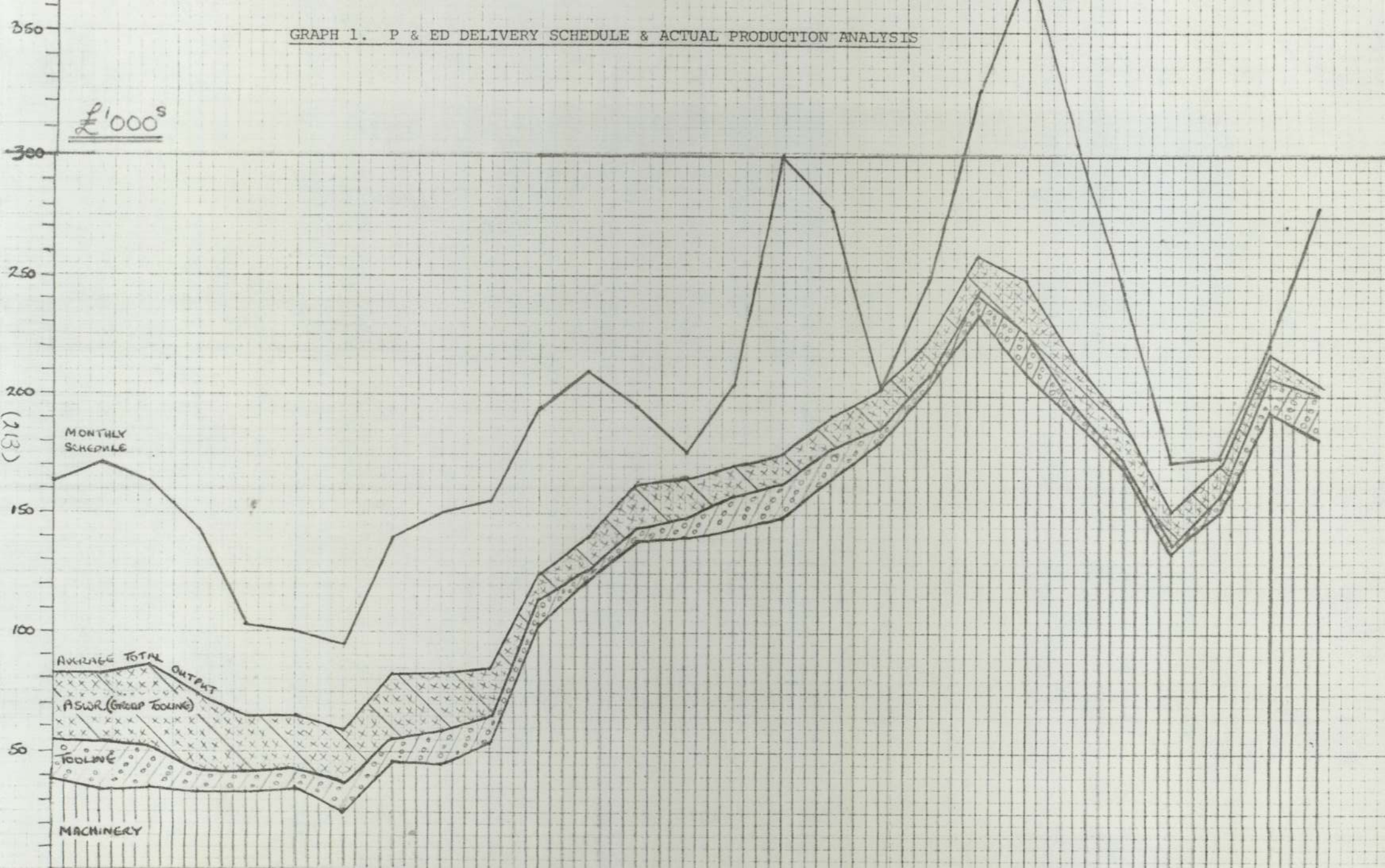
M.R. BROUGH

1. Major change in business mix

Graph 1 goes back to October 1974, to show the complete change of emphasis within the Division, from a tooling business which made machines as a "sideline", to a machine assembly business. Graph 2 and Table 1 demonstrate how insignificant tooling business has been as a percentage of P. & E.D. Coventry, total output, during 1976.

Table 2 shows the monthly breakdown of the Division's output during 1976. The historical figures, covering the period during which the change of emphasis took place, are given in Section 1.1 of the 1975 Report, which is reprinted as an Appendix.

GRAPH 1. P & ED DELIVERY SCHEDULE & ACTUAL PRODUCTION ANALYSIS



THE PERCENTAGE CONTRIBUTION TO OUTPUT OF THE DIFFERENT BUSINESS TYPES - 1976

(BASED ON A 3 MONTH ROLLING AVERAGE)

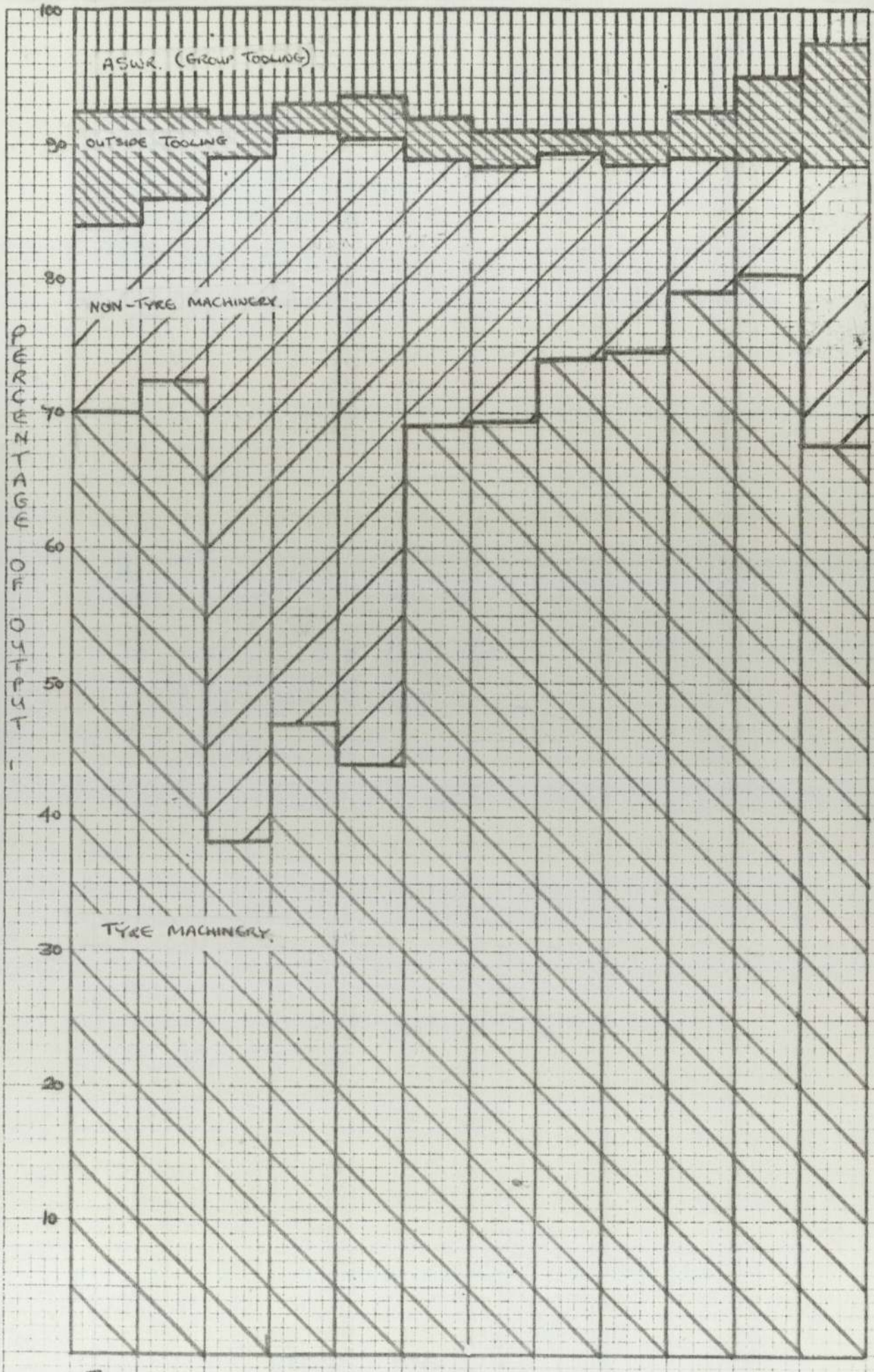


Table 1: Output Breakdown 1976. (based on monthly actuals)

BUSINESS TYPE	% OF TOTAL	AMOUNT (£)
TYRE MACHINERY	50.8	1,501,355
NON-TYRE MACHINERY	21.9	647,040
P. & E.D. LEICESTER	10.9	321,878
ENGINEERING GROUP TOOLING (ASWR)	5.6	165,157
OUTSIDE TOOLING	3.6	107,064
SPARES	3.6	106,881
HARRISBURG LINERS	1.8	53,327
PORTATOOL	0.9	24,073
METRICATION	0.5	14,453
COMMISSIONING	0.4	10,825
ENERGY EQUIPMENT	---	1,870
DESIGN SALES	---	777
TOTAL OUTPUT	100%	2,954,700

Table 2: Monthly Business Make-Up by % of Output (based on 3 month rolling average)

MONTH / BUSINESS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TYRE MACHINERY	70	72.3	38.3	46.8	44	69.2	69.5	73.7	74.3	78.9	80.6	67.7
NON-TYRE MACHINERY	14	13.6	50.6	44	46.5	19.7	19	15.6	14	10.3	8.5	21
TOTAL MACHINERY	84	86	89	91	90	89	88.5	89	88	89	89	89
OUTSIDE TOOLING	8.5	6.5	2.8	2.3	3.3	3.1	2.7	1.5	2.7	3.5	5.9	9
GROUP TOOLING (ASWR)	7.4	7.5	8.3	7	6.3	8	8.8	9.1	9	7.4	5	2.3

1.1/ Effect on output and schedule

This change in direction, of the Division, led to an upsurge in the monthly output in the Summer of 1975. This pattern continued through to the middle of 1976 as a result of increased machinery output, and has only decreased since as a result of a lower scheduled load.

Even with the smoothing effect of a 3 month rolling average, the line showing the monthly schedule totals remains erratic. With the dominant role of machinery in the output one would expect such a schedule line. The machines involved are of high capital value, and take longer than 4 weeks to assemble, in many cases. One month's labour will thus be reflected as a different month's output. Perhaps the output total does not follow a similar pattern because the schedule, in the peak areas, exceeds the Division's capacity. No study has yet been undertaken to ascertain the actual capacity of the pre=production departments, or of the assembly shop, on an ongoing basis. Such calculations are made only at times of heavy loading. Graph 3 supports the thesis that the division copes adequately with schedules up to £225,000, and, in general, fails by increasing amounts as the schedule exceeds this figure. There are, however, specific reasons for failure to meet monthly schedules, and these will be considered in an analysis of slippage (section 2.1).

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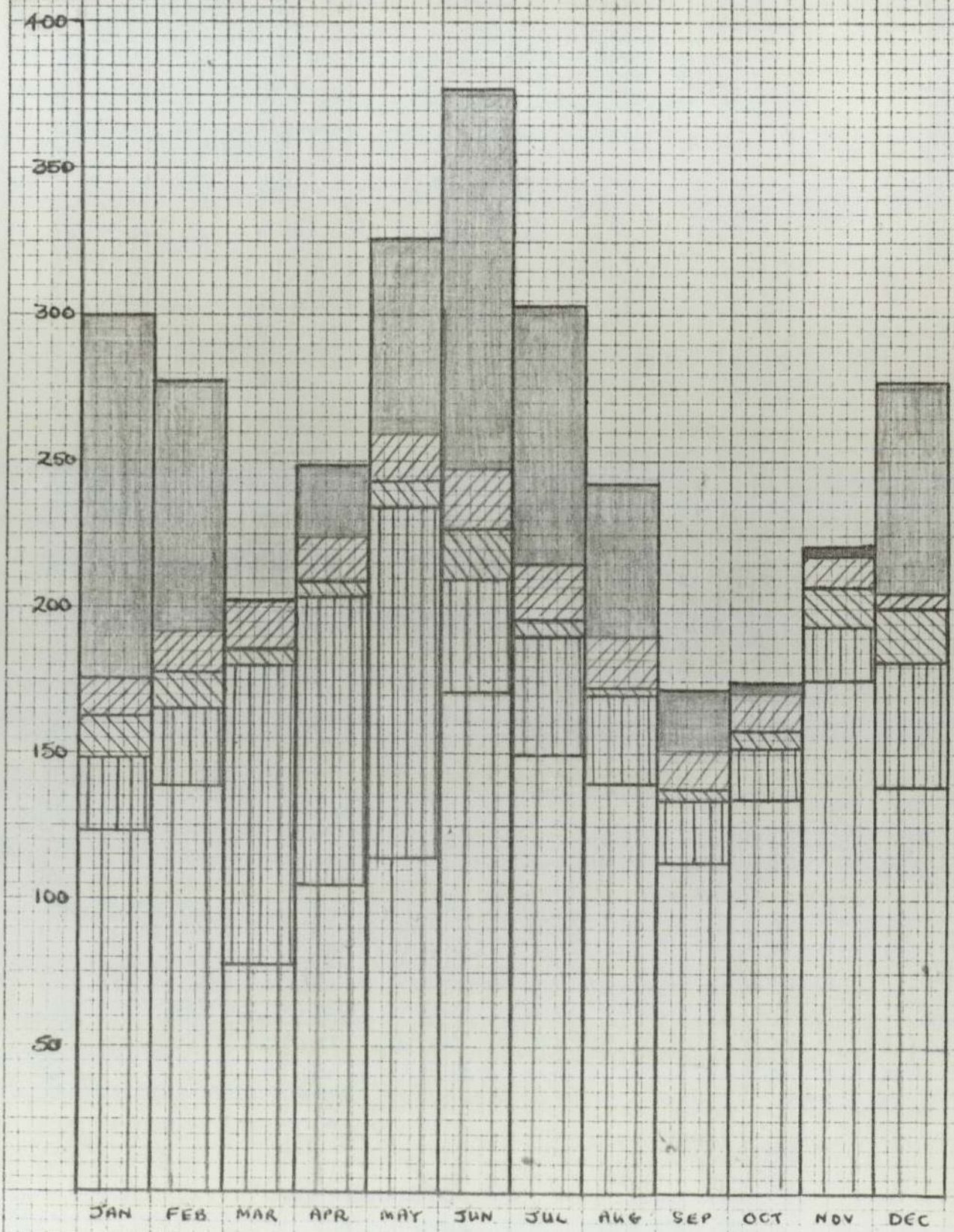
GRAPH 3 P&ED PRODUCTION ANALYSIS BY BUSINESS GROUP 1976

BASED ON A 3 MONTH ROLLING AVERAGE.



2. Performance against schedule

Graph 4 shown the output of the various business types as a percentage of schedule. Group Tooling work (ASWR) was artificially estimated at £3000 per week, declining to £1000 per week towards the end of the year, as the business was wound up, and output figures have always exceeded this estimate in 1976. The percentage of jobs which had less than a four week duration made it impractical to attempt more realistic output forecasting, particularly as the amounts involved were small. The ASWR business has thus been omitted from the graph.

The predictable area of the Division's output is Tyre Machinery, which shows 11 months in excess of 92% of schedule. On other machinery, performance is highly erratic, with 6 months below 50%, and 3 months over 100%. Tooling is totally unpredictable, and performance is particularly bad in months where the Division in concerned to meet a heavy schedule in other areas. Table 3 emphasises the poor performance in the Outside Tooling area.

TABLE 3: Total Slippage as a percentage of schedule - 3 months rolling average

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MACHINERY	39	29	0	8	16	34	26	19	9	0	0	28
OUTSIDE TOOLING	0	17	36	64	67	78	82	87	72	48	26	2
TOTAL	36	28	0	11½	20	38	33	26	15	3	2	26

CUMULATIVE TOTAL SCHEDULED: 2910217 AVERAGE SLIPPAGE PER MONTH: 22¼%

CUMULATIVE TOTAL SLIPPAGE : 647447

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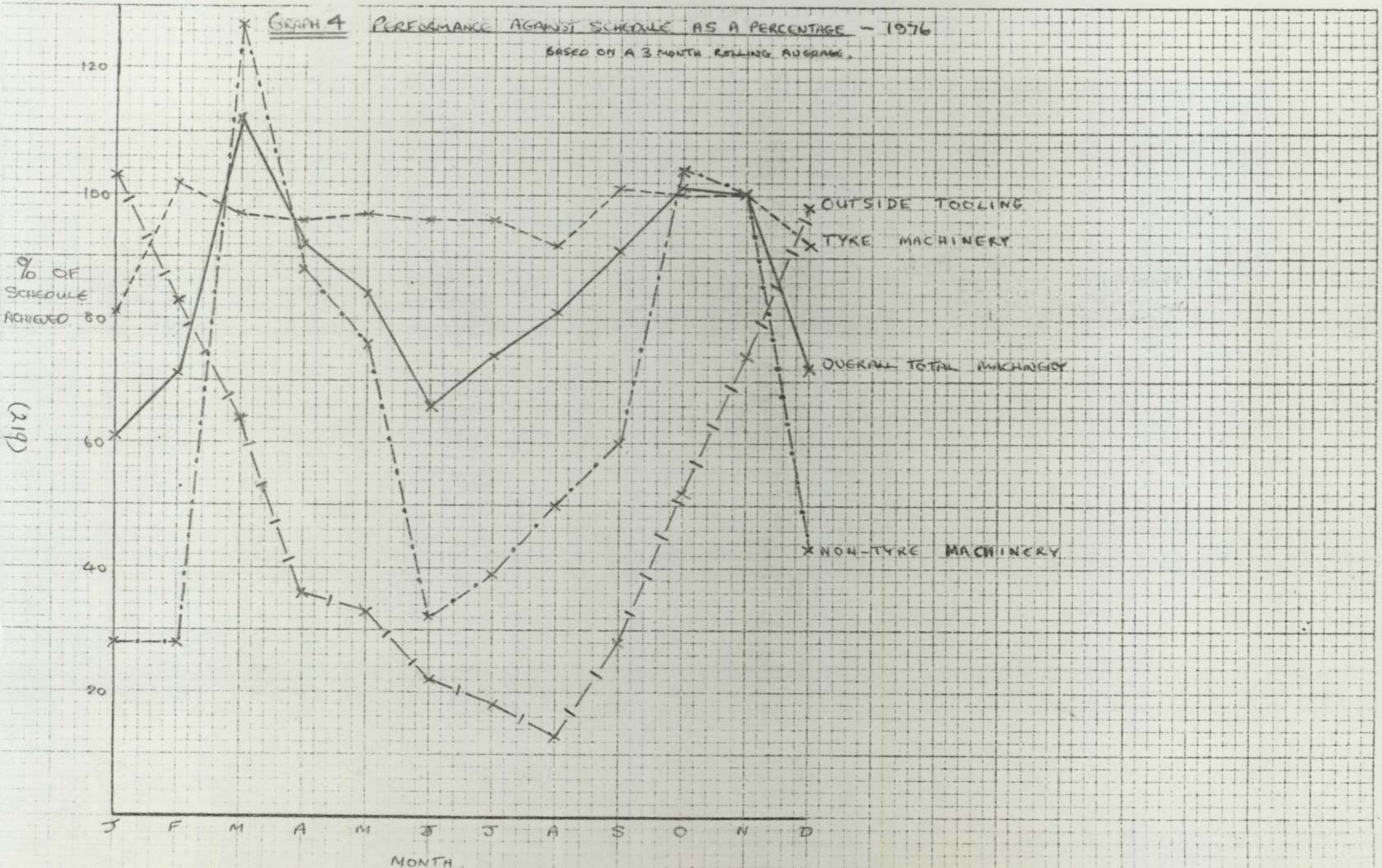
GRAPH 4 PERFORMANCE AGAINST SCHEDULE AS A PERCENTAGE – 1976

BASED ON A 3 MONTH ROLLING AVERAGE.



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2.1/ Slippage Analysis

Graph 5 shows, both as percentages, and as actual amounts, the extensive part of each month's slippage which falls into the Non-Tyre Machinery category.

Moving to more specific details of the slippage, Table 4 lists the major jobs which have adversely affected the performance in particular months. The Automoulds affected figures for 4 months, and it is fair to say that some part of this resulted from modifications required by the customer. Failure on the Spring Collet assemblies was totally the result of the customer's failure to inform P. & E.D. on delivery of F.O.C. springs.

Table 4. Particular Jobs which have influenced performance figures

April:-	Non-Tyre machinery slippage	Automoulds (XJ1141)	£172,000	
May:-	" " "	Automoulds (Part)	£ 98,000	
June:-	" " "	Automoulds (XJ1142)	£ 39,000	
	Tooling "	Spring Collets (XT1393)	£ 14,400	
July:-	Non-Tyre Machinery "	Automoulds (XJ1142) and Mods.	£ 41,000	
		Seal Test M/c (XJ1752)	£ 6,000	
	Tooling "	Spring Collets (XT1393)	£ 14,400	
August:-	Tyre Machinery "	RB3 Machine (XD0550)	£ 18,500	*
December:-	Non-Tyre Machinery "	Starglide (XJ0263 & XJ0264)	£173,000	**
		Motivated Bridge (XG1202)	£ 22,000	
	Tyre Machinery "	Uniformity M/c (XD0259)	£ 24,000	

* The RB3 machine was completed on schedule, but despatch was delayed pending the arrival of an official order from the customer.

** A pre-payment of this amount was anticipated on the conveyors during December. It was subsequently put back one month.

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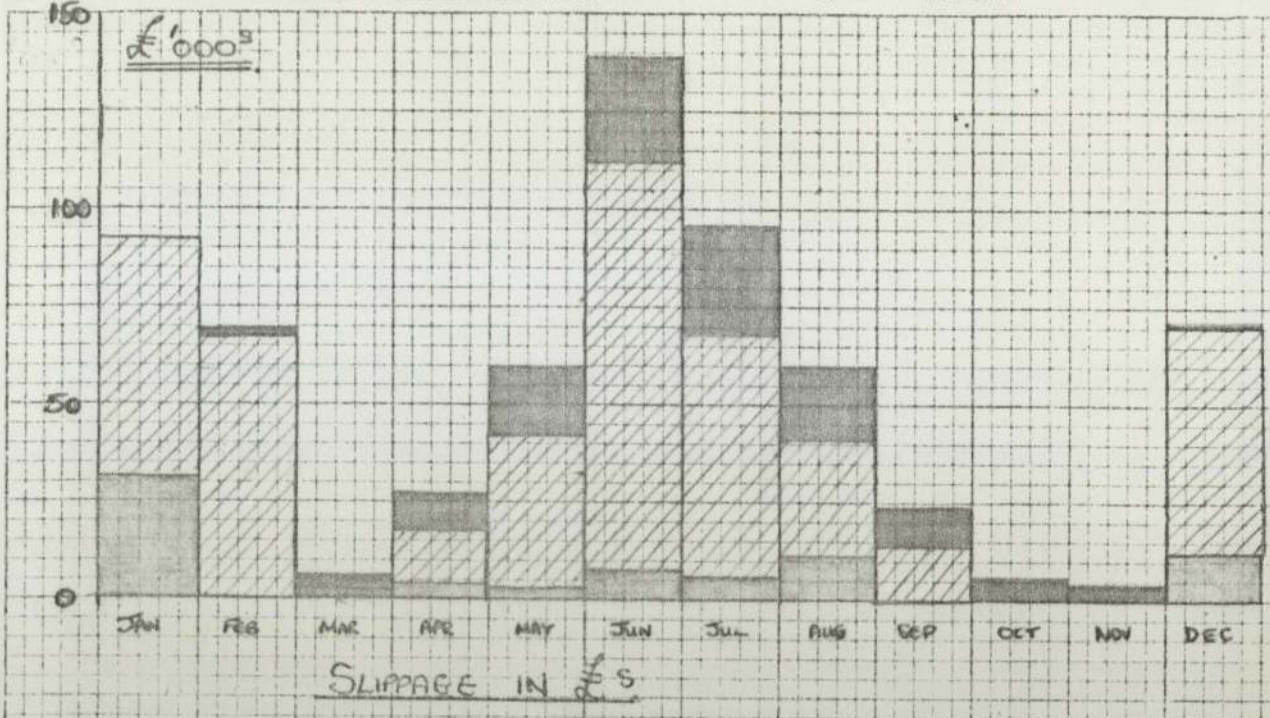
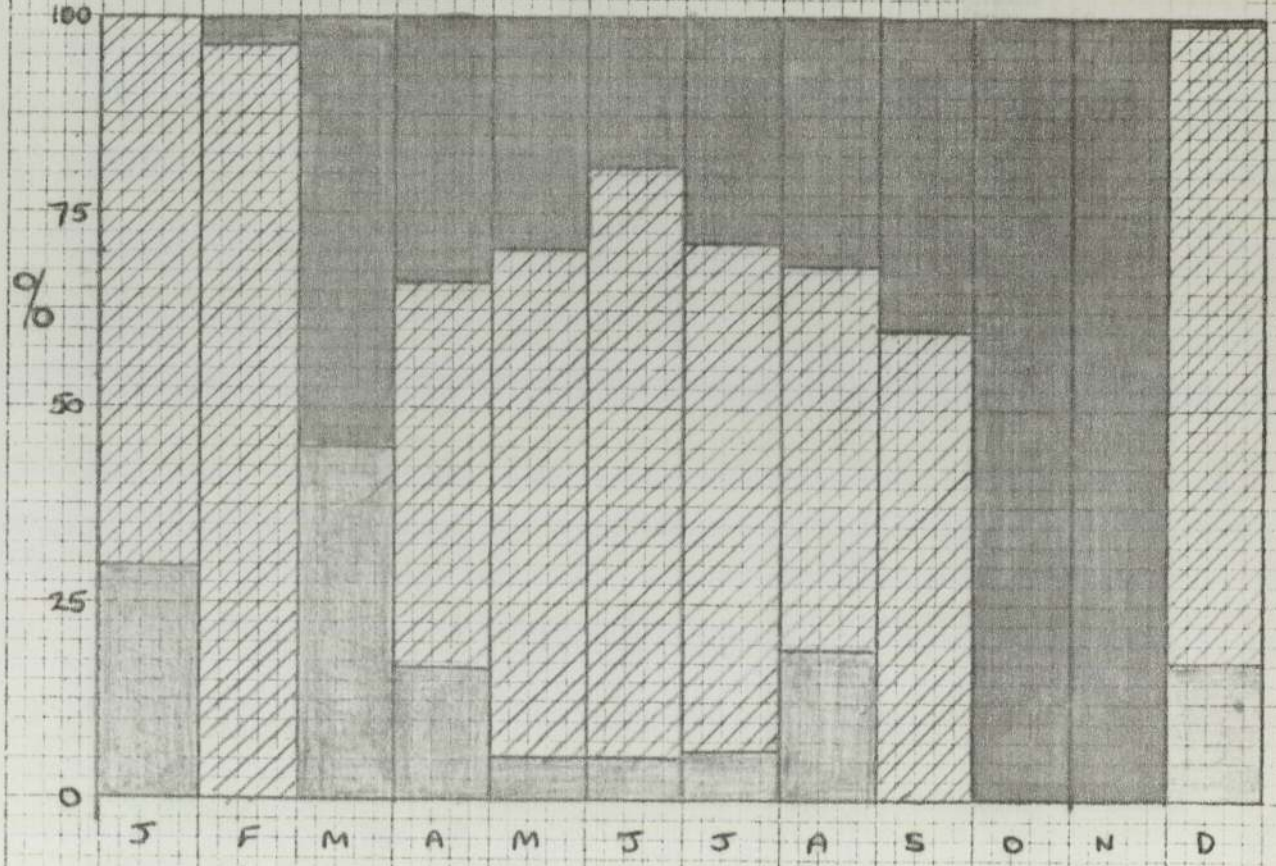


SLIPPAGE IN £s



PERCENTAGE OF SLIPPAGE FALLING IN DIFFERENT BUSINESS AREAS

KEY

TOOLING

NON-TYRE MACHINERY

TYRE MACHINERY

THERE WAS NO SLIPPAGE AGAINST SCHEDULE FOR ASNR WORK DURING 1976

GRAPH 5

SLIPPAGE ANALYSIS BY BUSINESS TYPE – 1976

BASED ON A 3 MONTH ROLLING AVERAGE

3. Performance against original promise of delivery

Graph 6 shows that there has been a significant improvement in performance to original delivery promise in 1976. The backlog carried over from December 1975 was almost £190,000, ⅔ of the total output scheduled for January 1976. By April the figure was down to £65000 (28% of schedule) thanks to a high monthly output. The slight rise in May, June and July reflects the exceptionally heavy schedule in these months, and concerns items slipping one month at most. Figures from September to the end of the year are particularly satisfactory (in December only 8% of the schedule was overdue). The predictability of Tyre Machinery, and the high percentage of the schedule which this accounted for from August to November (see Table 5) is largely responsible for this improvement.

Table 5: Business make-up by % of schedule - 3 months rolling average

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
TYRE MACHINERY	31.4	63.7	40.5	37.8	34.8	68.5	46.7	64.7	85.4	83.5	75	18.6
NON-TYRE MACHINERY	58.1	23.1	46.4	52.7	50.4	18.9	34.8	26.5	1.2	1.9	16.2	72.2
TOTAL MACHINERY	89.5	86.8	86.9	90.5	85.2	87.4	81.5	91.2	84.6	85.4	91.2	90.8
TOTAL TOOLING	10.5	13.2	13.1	9.5	14.8	12.6	18.5	8.8	15.4	14.6	8.8	9.2
TOTAL SCHEDULE in £ THOUSANDS	300	259	180	249	316	378	303	243	172	174	220	277

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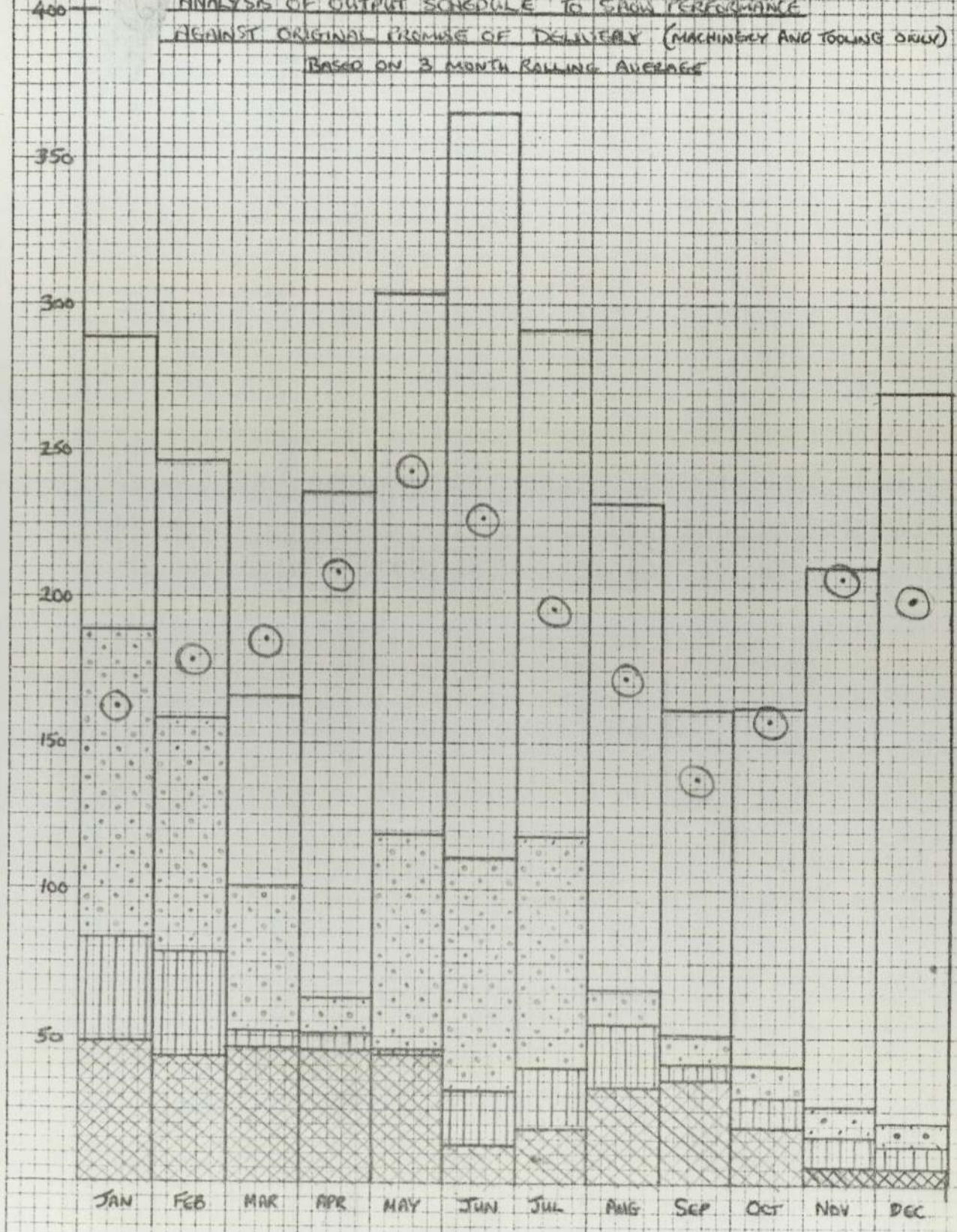
GRAPH 6

£'000's

ANALYSIS OF OUTPUT SCHEDULE TO SHOW PERFORMANCE AGAINST ORIGINAL PROMISE OF DELIVERY (MACHINERY AND TOOLING ONLY)
BASED ON 3 MONTH ROLLING AVERAGES



KEY :

- CURRENT WORK
- 1-4 WEEKS OVERDUE
- 5-8 WEEKS OVERDUE
- OVER 9 WEEKS OVERDUE

BREAK DOWN OF ALL JOBS SCHEDULED COMPARED TO ORIGINAL DELIVERY PROMISE

- ACTUAL OUTPUT LEVEL

3.1 Variation in 4 week forecasts

Table 6 demonstrates the improvement which this has also brought about in forecasting, although the improvement in the communication of pre-production information between departments has also played no small part in this. The table compares the amount predicted for a month at the beginning of the previous month, with the amount ultimately scheduled for that month's production. One would expect the Tooling figures to be erratic, as job durations are often less than 4 weeks, and thus new jobs should have a boosting effect on the amount forecast in advance. The negative figures for August and November havebeen caused by the rescheduling of the Spring Collet assemblies.

Table 6 Variation in 4 week forecasts 1976 - 3 month rolling average

MONTH	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MACHINERY	-53	-47	-6	79	5	144	-9	14	-6	3	-4
OUTSIDE TOOLING	115	195	40	83	88	33	-58	133	151	-17	+ INF.

FOR EXAMPLE: February figure shows % difference between what was predicted at start of January for February output, and what was eventually scheduled at the start of February for that month.

4/ Conclusions.

- More careful planning and monitoring of schedules for Non-Tyre machinery production seems advisable
- Present knowledge of capacity is sufficient to deal with current business load. But perhaps we should use this period to gain greater knowledge of the Division's potential, in order to assess our ability to cope with any large contract which we might win.
- Programme progress meetings have succeeded in producing a more accurate schedule, and forward load prediction.
- The Division remains heavily reliant on a demand for Tyre-building machines, and is thus highly vulnerable to any technological improvements in this field.

APPENDIX

As an appendix, J.B. Turner's 1975 Production Evaluation Report has been reprinted, * giving additional historical information. The figures given in his original report as appendices have been omitted, but are available if required.

The following table lists his 1975 tables, and shows their equivalents in the 1976 report.

	JBT	MRB
P.E.D. Delivery schedule and actual production analysis:	Table 1	Graph 1
Business mix change:	Table 2	Table 2
Variation in 4 week forecasts:	Table 3	Table 6
Performance against schedule:	Table 4	Graph 4
Output schedule analysis:	Table 5	Graph 6
Machine shop - P.E.D.Machinery parts:	Table 6	No equiv.

* The 1975 Production Evaluation Report appears as Appendix 2 to Chapter 5.

CHAPTER 5 APPENDIX 3

QUESTIONS PUT TO MANAGERS OF DISPERSED TOOLING UNITS

I. Is there a straight financial comparison available between toolimg during I976 & I977? Have tooling operations cost more or less? Is a comparison of the figures meaningful or are there special circumstances to be taken into account?

2. Does the Unit compete, in terms of price, with alternative sub-contractors?

3. Has the availability of a smaller tooling facility led to any problems with:
   a) Capacity flexibility to deal with sudden fluctuations in demand for toolmaking work (e.g. new projects or contracts)
   b) Machining variety - has it been necessary to send outside more pieces for specific specialised machining operations, previously carried out in the P & ED machine shop?

4. Has the staff of the smaller tooling unit been totally employed in work of a suitable grade? (Has it been necessary to use other jobs to fill up capacity? or alternatively, has 'downtime' been recorded due to unavailability of work?)

5. What effect has the smaller unit had on any of the following:
   a) Turn-round on service work?
   b) Manufacture of tools in line with requirements?
   c) Flexibility of tooling work queue priorities, in line with alterations in the urgency of tools?

6. Any significant changes in workforce motivation? (resulting perhaps from: closer involvement with division being served; smaller work groups bringing greater inter-dependence between personnel; identification with a finished product, rather than just a finished operation).

7. Any other comments about effect on division of the closure of the central tooling and service facility?

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