# The Use of Pegasus Autocode in Some Experimental Business Applications of Computers

*By* H. W. Gearing

**This paper, based on a talk given at The Brunel College of Technology (Acton, London, W.3) on 26 October 1960, describes some applications of the Pegasus Autocode to a market-research survey, experimental sales forecasts, and quality-control statistics, at a time when a suitable business or statistical autocode compiler was not yet available. The significant features of these applications were the relatively short time taken by program development and the tabulation of results, which helped to demonstrate the potential advantages of a computer in business.**

## Introduction

In the early stages of preparing for an electronic computer, we attended programming courses on several machines and we took the viewpoint that a decision as to which machine would best suit our work should be based on running models of jobs on different equipment. We therefore set out to program models of three jobs, but found that it took many months to develop a model to the stage when a demonstration could be attempted. In fact, only two models were completely programmed on one machine in a period of 18 months: they related to production allocation and sales analysis.

The Pegasus Autocode was introduced for mathematical and statistical work in the autumn of 1958 (Clark and Felton, 1959; Ferranti, 1958). In the Ferranti publication, the authors drew attention to its value in early attempts at new work, particularly where several alternatives have to be explored. They claimed that this simplified method of coding could be learned in a few hours. It does not include any facilities for £ s. d. working, so it would need to be supplemented by a part of the program written in machine orders if, for example, we were to use it for a trial payroll, or any other jobs where rounded £'s or decimals were not applicable. This may soon be modified.

In the Metal Box Company, despite these limitations, we have made good use of Autocode in three types of work, when asked to explore the possible application of a computer to them. I will deal with the most recent example first.

## A Market-Survey Application

One range of our products is the Worcester Ware tray, which is available at local retail hardware stores. At the end of May 1960 we were told that a survey of household tray usage was being made for the Company by a market research agency. The forms were already out and we were requested to analyse them on our punched-card equipment. The forms had been pre-coded by the agency in a manner suitable for recording in punched cards, if they could be analysed on a counter-sorter. There were 17 general questions for each housewife; the trays available in each home were then examined and 10 observations of each tray were recorded, regarding shape, size, method of acquisition, approximate cost (if purchased), place where kept, place where used, application and frequency of use. The general questions included the recording of 3 preferences for 15 new designs of Worcester Ware tray, and comments on these designs, including whether the housewife would be likely to purchase them if they became available locally.

Even if the forms had been re-coded, there would have been difficulty in getting all the information into one card per interview, and our punched-card section was busy with year-end work and staff holidays were approaching. It was therefore decided, as an experiment, to analyse the results of this survey using a Pegasus computer, after recording the answers to the questionnaires on our punched-tape editing equipment.

It was also decided, in order to shorten the computer program, to re-code the answers to the questionnaires using (within the tray detail part) numbers which could conveniently be used directly within the computer as modifiers, i.e. numbers ranging from 0 upwards and excluding any alphabetical codes. The coded answers were recorded on new forms designed by Computer Division. When, later in July, it was decided to add a further sample, the forms used at the households already had our computer codes on them.

An autocode program was written which summarized the answers in a detail table, or matrix, containing 1,460 cells. This matrix contained the full degree of detail required in the report tables. (Arrangements were made to punch out this table after 350 and 700 questionnaires had been processed, as a precaution against machine failure, and again at the end of the 990.) Tests of this program showed that interviews resulting in no-trays could be processed in autocode in $5\frac{1}{2}$ seconds, but that this time was extended to 27 seconds where there were 6 trays. It was estimated that the whole of the 990 schedules could be processed in a little over 4 hours, using autocode; but in the event this time was not necessary.

Immediately the autocode program had been written, and after it had been fully tested, we began to write a program in Pegasus machine-code to process the detailed answers and form a similar summary table. This program included tests of the compatability of the data and included checks that the code in each position was within the permitted range. The writing and development of this machine program took about ten days and



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was greatly facilitated by the existence of the autocode program, which had already been tested.

The full machine-code program processed each questionnaire in 3–6 seconds, including tape input and testing. The entry of the first 990 questionnaires produced 15 rejects (warning printed as interview number on the teleprinter), and these were examined and re-punched on a separate tape. A summary tape was punched out in a similar sequence to that which would have been produced by the autocode, including all autocode conventions for output. Subsequently, in July, a further 149 households were added, and a print-out of part of the summary tape is given in Table 1.

This summary tape is to be likened to a series of punched summary cards, produced for our conventional sales analyses, before any major tabulations are prepared.

*Printing of finished Tables on the Computer*

An autocode program was written to assemble the results in 17 tables with appropriate vertical and cross-additions and percentages where required. This autocode program is controlled by 22 variable parameters, covering such items as number of rows and columns, where percentages are required, and the beginning and ending locations of the data (ex summary tape) in the store. This autocode program produced the finished tables within 80 minutes of computer time.

When using this latter program, all the data from the summary tape was first entered into the computer in floating-point form, before the program started to run. The variable parameters tape was entered on tape reader 1 and the headings tape on tape reader 0. The headings tape had been punched from table skeletons laid out on 1/10 inch-square graph paper to indicate the precise number of spaces to be punched after each heading. Preparation of this headings tape for the 17 tables (one of which extends over 3 pages and has over 100 rows), occupied approximately 4 hours of tape punching time, and a few errors in it were subsequently corrected by skilful patching with scissors and Sellotape. An example of one final table, which happens to be a frequency distribution, is given in Table 2.

This experience has demonstrated that existing autocode facilities on Pegasus can be applied to market research work. A simple machine-code program for assembling the data and editing the forms rapidly can be written in a few days, and autocode facilities are then available to print out the finished tables, including any re-arrangements or re-grouping that may be necessary.

We were asked to undertake this work on Friday, 20 May 1960, and arrangements for the re-coding of the questionnaires were put in hand on Wednesday the 25th. The first questionnaires were received at Baker Street on 30 May and were re-coded during the period ending 15 June. Punching of the paper tapes was carried out between 10 and 17 June and the first tables were produced on 22 June. One of the two programmers concerned sat for (and passed) a section of a professional

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WORCESTER WARE SURVEY MAY 1960 MB 4003

| | | |
|---|---|---|
| +10 +6 +17 +53 +121 +520 +72 +88 | | |
| +252 +5 +22 +140 +25 +45 +119 +0 | | |
| +7 +32 +12 +31 +163 +7 +8 +37 | | |
| +2 +2 +10 +1 +2 +7 +0 +1 | | |
| +5 +1 +0 +1 +0 +2 +4 +0 | | |
| +0 +2 +0 +1 +0 +3 +0 +6 | | |
| +45 +68 +143 +0 +0 +2 +4 +5 | | |
| +64 +11 +12 +25 +8 +0 +3 +0 | | |
| +1 +4 +0 +0 +2 +0 +0 +1 | | |
| +1 +1 +2 +0 +1 +0 +10 +6 | | |
| +17 | +2 +15 +135 +18 +60 +336 +36 | MATRIX for TABLE2 |
| +55 +193 +36 +44 +88 +22 +24 +24 | | |
| +11 +8 +10 +7 +8 +3 +3 +1 | | |
| +0 | +77 +113 +434 +93 +65 +68 +131 | |
| +201 +408 +41 +35 +73 +42 +50 +117 | | |
| +21 +29 +50 +33 +49 +122 +47 +17 | | |
| +47 +11 +13 +18 +7 +10 +37 +17 | | |
| +13 +83 +6 +14 +35 +34 +64 +155 | | |
| +131 +188 +398 +91 +101 +213 +4 +7 | | |
| +15 +12 +15 +22 • • • • • | | |

**Table 1**

**Matrix produced by Market-Survey Program**

TABLE 2
HOUSEHOLDS
TRAYS PER HOUSEHOLD BY SOCIAL CLASS

| NUMBER OF TRAYS | - NUMBER OF HOUSEHOLDS - AB | C | DE | ALL | •/• |
|---|---|---|---|---|---|
| NONE | 2 | 15 | 135 | 152 | 13·3 |
| 1 TRAY | 18 | 60 | 336 | 414 | 36·3 |
| 2 TRAYS | 36 | 55 | 193 | 284 | 24·9 |
| 3 TRAYS | 36 | 44 | 88 | 168 | 14·7 |
| 4 TRAYS | 22 | 24 | 24 | 70 | 6·1 |
| 5 TRAYS | 11 | 8 | 10 | 29 | 2·5 |
| 6 TRAYS | 7 | 8 | 3 | 18 | 1·6 |
| OVER 6 | 3 | 1 | 0 | 4 | 0·4 |
| TOTAL | 135 | 215 | 789 | 1139 | 100·0 |

**Table 2**

**Example of finished Table produced by Autocode Program**

examination in the middle of this work! The summary tape prepared on 22 June was merged with the new data on 3 August to produce the 17 final tables, of which an example is given.

*Market Research and Survey Work elsewhere*

Since this work was done, a general program for the analysis of surveys, written for the Elliott 401 computer at Rothamsted, has been described by Dr. Yates and Mr. Simpson (1960; 1961). Their program, which is more general as to format of data, scaling, and deriving of variates than ours, is also in two parts, the first dealing with input of data, computation and assembly of tables, and the second part dealing with the derivation of the final tables from the first part. The independence



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between the two programs economizes in storage space, leaving more room for the actual tables, and the authors review other devices for increasing the number of tables available.

Leeds University was also engaged in writing a special autocode language for statistical data processing "Autostat" (Douglas and Mitchell, 1960). Our table-output program involves considerable printing and the gain from a fully-coded program here would probably be less: we shall explore it if the need arises for many survey reports and if we have time; our immediate requirements are adequately covered by the autocode program.

Similar work has also been done on an Elliott 803 (Cook, 1960) and Leo (Gosden, 1960).

**Experimental Sales Forecasts**

In the autumn of 1959, one of our groups had asked for help in planning material requirements. As a result of the work done on this, five autocode programs have been written, two of which are now in regular quarterly use.

One of these has also been used for experimental sales forecasting for one of our customers. It deals with each product separately, as follows:

*Data*

(1) Up to 72 accounting-period sales = 4 quarters per year or 12 months per year or 13 four-week periods per year.

(2) Up to 120 periods of working days to cover sales data period above, and forecast period. (For ice cream and foods, calendar days may be preferred to working days.)

*Output*

(1) Two forecasts with actuals over a recent period (e.g. 6 months) to show how it would have worked if used on recent figures.

(2) Two or three forecasts from current data forward.

(3) Confidence intervals given on one of these.

(4) Slope of trend lines and seasonal factors are also printed.

*Method*

(1) Calculate Moving Annual Total (M.A.T.), and adjust to constant working days.

(2) Fit up to 5 linear trend lines to different periods, two ending at an earlier date (e.g. 6 months ago) and three ending currently, e.g. 2, 4, $5\frac{1}{2}$ years.

(3) Calculate seasonal factors = average ratio of monthly output per working day to output per working day of trend.

(4) Calculate standard deviation of these seasonal factors to provide confidence interval.

(5) The projection is a combination of trend and seasonal pattern, adjusted for working days.

*Note:*

(1) Variable parameters permit reduction of output: these and working days data are assembled on forms.

(2) Another program is now available which fits an exponential curve to the trend by fitting a linear curve to the logarithms of the M.A.T.s.

*Time:*

6–7 minutes per product, reduced if output reduced.

An example of a forecast for one product is given in Table 3.

Another program makes two alternative sales forecasts and calculates the material provisions required for delivery in a month to close each month with an adequate stock level, covering for a variable period of future demand.

Thus we have developed three final programs, two of the five having been superseded by the later versions. We shall continue experimenting with them. This work has been carried out part-time by two people and would not have been possible in a short time without autocode. One of these programs has been translated into machine code to incorporate the Pegasus Library floating-point routines. This has resulted in a reduction of one-third in running time on Pegasus for the program which we are using most frequently in our experiments. The program of which results are shown in Table 3 was also run experimentally on Mercury by Mr. A. Gibbons (Gibbons, 1961): the running time was about one-quarter of that on Pegasus, due to the large amount of output, although the effective Mercury calculating speed is twenty-five times faster than Pegasus under autocode.

In March 1961, on a 1,000-word Sirius computer at the Ferranti London Computer Centre, the Table 3 program of 370 autocode instructions was converted automatically into a Sirius program containing 1,409 orders, preceded by 74 control and library parameters, using the Sirius autocode compiler developed by Mr. J. F. Davison (Ferranti, 1960). Four orders were added to the tape manually, to amend the printing and index parameters. The conversion was accomplished in about ten minutes. The Sirius program was then tested on a 4,000-word Sirius computer, calculating a four-year forecast from six past years' data: the calculation was completed in 3 minutes 10 seconds per product, compared with $7\frac{1}{4}$ minutes on Pegasus in autocode, part of the increased speed accruing from the faster output punch and the single level store. Whilst these speeds may appear pedestrian to the advanced scientific programmer now, and to the business user in a few years' time, it will be appreciated that a similar calculation by a clerk on a desk machine would have taken 10 to 15 *hours* per product, and could not therefore normally be attempted for individual products.



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HEADING FOR ONE PRODUCT — SEE OUTPUT NOTES IN TEXT

153456 = Y ← TOTAL 12 months to JUN '60

| MONTH | A | C | σC | |
|---|---|---|---|---|
| +1 | 0.8621 | 0.8385 | 0.12544 | PERIOD A = 5 YEARS, C = 5½ YEARS — SEASONAL FACTORS — See Method notes (3), (4). |
| +2 | 0.8354 | 0.8144 | 0.10950 | |
| +3 | 0.9939 | 1.0072 | 0.26141 | |
| +4 | 1.3552 | 1.4318 | 0.21867 | |
| +5 | 1.5075 | 1.5011 | 0.19255 | |
| +6 | 1.5035 | 1.4932 | 0.28606 | |
| +7 | 1.1949 | 1.1890 | 0.10670 | |
| +8 | 0.9102 | 0.9055 | 0.13535 | |
| +9 | 0.6429 | 0.6387 | 0.15344 | |
| +10 | 0.6660 | 0.6622 | 0.22077 | |
| +11 | 0.7470 | 0.7422 | 0.14875 | |
| +12 | 0.7814 | 0.7762 | 0.16889 | |

| DATE | A | B | | Y=mt+c TREND | (4) |
|---|---|---|---|---|---|
| 0.0 | 320.9 | 516.1 | ← m | | |
| 12.59 | 144688 | 151116 | ← year data | | |
| 1.60 | 10324 | 10790 | 8858 | 1486 | (1) |
| 2.60 | 10026 | 10490 | 8771 | 1315 | |
| 3.60 | 13094 | 13717 | 14638 | 3779 | |
| 3.60 | 33445 | 34997 | 32267 ACTUAL | | |
| 4.60 | 14782 | 15503 | 20310 | 1397 | |
| 5.60 | 19081 | 20035 | 19319 | 2782 | |
| 6.60 | 18205 | 19137 | 18116 | 3796 | |
| 6.60 | 52067 | 54675 | 57745 ACTUAL | CONF. INT | |

| DATE | C | D | E | Y=mt+c TREND | (4) |
|---|---|---|---|---|---|
| 0.0 | 366.7 | 709.9 | 533.5m | | |
| 6.60 | 148578 | 155334 | 153395 y | | |
| | | | | (3) | |
| 7.60 | 14623 | 15304 | 15105 | 1312 | (2) |
| 8.60 | 11696 | 12266 | 12093 | 1748 | |
| 9.60 | 8270 | 8691 | 8559 | 1987 | |
| 9.60 | 34588 | 36261 | 35757 | | |
| 10.60 | ~~8204~~ | 8640 | 8500 | 2735 | |
| 11.60 | 9058 | 10192 | 10016 | 1936 | |
| 12.60 | 9204 | 9733 | 9555 | 2003 | |
| 12.60 | 27067 | 28564 | 28071 | ↑ CONFIDENCE | |
| 1960 | 61655 | 64825 | 63828 | INTERVAL ↓ | |
| 1.61 | 10964 | 11617 | 11393 | 1640 | |
| 2.61 | 9704 | 10303 | 10094 | 1305 | |
| 3.61 | 13233 | 14077 | 13777 | 3435 | |
| 3.61 | 33902 | 35997 | 35264 | | |
| 4.61 | 16286 | 17359 | 16972 | 2487 | |
| 5.61 | 19818 | 21165 | 20672 | 2542 | |
| 6.61 | 19762 | 21146 | 20633 | 3786 | |
| 6.61 | 55866 | 59670 | 58277 | | |
| 9.61 | 35223 | 37821 | 36838 | | |
| 12.61 | 27788 | 30020 | 29148 | | |
| 1961 | 152778 | 163509 | 159526 | | |

TREND PERIODS:
A – 5 YEARS } to 31. DEC. '59.
B – 12 YEARS }
C – 5½ YEARS } to 30. JUN. '60.
D – 4 YEARS }
E – 2 YEARS }

METHOD NOTES (2).

**Table 3**

**Output from an Experimental Sales-forecasting Program**

*(Occasional rounding differences in totals are due to the floating-point arithmetic of Autocode.)*

The methods used in this experimental sales analysis differ from those used by Muir and others (Muir, 1958). They have been applied merely as an attempt to analyse past series for trend and seasonal elements, as a service to those who are responsible for making forecasts, as suggested in an earlier paper (Gearing, 1958).

I must emphasize that we do not claim to be "doing sales forecasting by computer": we provide the forecasters with two or three alternative projections of linear trends and seasonal patterns, and these are available for interpretation alongside any evidence they may have of future intentions of customers, for example if some were changing the size of their pack or launching a new pack.

## Quality Control Work

Our first job on quality control was in 1958–59, when we undertook an analysis of variance in connection with a productive operation being carried out by one group of machines in the chain between the sheet tinplate and the finished can. Three factors were involved and an Autocode program was written. Within a few weeks, however, we succeeded in developing a full machine program with variable parameters which is now available in the Pegasus interchange scheme. It covers analysis of variance with three factors varied at equal increments.

In 1960 we were asked to assist in the analysis of data on the variability of some raw material which had been collected from sampled consignments over two years. Several different characteristics of the material had been measured. An autocode program was written to analyse each characteristic separately, printing sample means, ranges, standard deviations, and compiling frequency distributions of means and standard deviations. A hierarchic analysis of variance was also given at the end of each characteristic. We were asked to undertake this work on 29 March and the calculations were substantially completed on 12 April. Further calculations and a correlation between two characteristics were made on 3 June and 5 October 1960.

Here, I would like to stress that although the program was written in Autocode, which is normally advocated for one-off jobs, the program is again a general one. The progress of the calculations is controlled by ten parameters and the print routine by seven more. Thus one program served for the analysis of all the different characteristics, including some that involved preliminary arithmetic on pairs of observations. The correlation program was written separately but took only two hours to write, using pairs of existing data tapes fed in on the two tape readers simultaneously. What foresight the designers of Pegasus had to give it two tape readers!

## Conclusion

Our main programming effort is now directed to the data processing jobs which we shall undertake on our



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Orion computer early in 1963. We have been able, meanwhile, to give immediate service to three other divisions of the Company, and to demonstrate that in the field of business statistical methods, the computer is able to render a service which is a major advance over what was previously available from punched-card and other mechanical equipment. We expect that our main applications will be accelerated by using "Nebula," and our confidence here is based on our experience with Autocode.

**Acknowledgements**

This work would not have been possible in limited time without the work that Ferranti had put into the development of their Autocode for Pegasus. We are also indebted to them, to the Northampton College of Advanced Technology, and to the British Iron and Steel Research Association for the facilities which these organizations have placed at our disposal, for the hiring of a Pegasus computer for our work, and help in the development of our first programs.

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# Data Transmission—Problems and Prospects

*by* P. A. Long and E. H. Truslove

**This article summarizes the factors to be taken into account and facilities currently available for the transmission of digital data over Post Office Lines. It mentions some of the problems of using land lines and discusses the role of the Post Office in this field.**

**Introduction**

The 1950s will have some claim to be remembered as the decade in which the electronic computer began to come into its own. It already seems apparent that the present decade may become equally well known for the consolidation of past efforts and for the introduction of new techniques and more powerful computing systems. Not so widely appreciated is the interest that was arising in the late 1950s in the possibilities of transmitting digital data over land lines, and there are now some indications that this interest will lead to the introduction of new systems and facilities for the purpose.

**The part of the Post Office**

As the provider of rented transmission lines in the United Kingdom, the Post Office has an important part to play. Its policies and capabilities are likely to influence the techniques and facilities that become available and these, in turn, may affect the computing art. It is quite clear from the attention being paid to the subject that the Post Office appreciates that ADP users will have special needs and is anxious to co-operate in the development of new facilities.

A problem facing the Post Office is that it is difficult to forecast the types of transmission service that will be of greatest use in the growing ADP field—it is much easier to obtain a critical assessment of existing services. However, a start was made to solve this problem by the issue of an informative booklet (G.P.O., 1958), followed by personal contact and discussion with computer manufacturers and potential customers, in an attempt to establish what service or services might be needed to meet the general need.

Recently, a further step has been taken by the issue of a Questionnaire about data transmission, to a considerable number of users and potential users of ADP machinery.

**Background to the use of Lines**

Cost will undoubtedly be a major consideration in the choice of transmission facilities for ADP. It is therefore to be expected that data will be transmitted mainly over standard, and consequently the least expensive, types of circuit in the national network. This network was established primarily for handling telephone and



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