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BUSINESS CHARTS

ALSO BY T. G. ROSE

HIGHER CONTROL IN MANAGEMENT

A MANUAL FOR COMPANY DIRECTORS,
SECRETARIES, AND ACCOUNTANTS

By T. G. ROSE, M.I.Mech.E., M.I.P.E.,
F.I.I.A. With a Foreword by A. H. POLLEN,
*formerly Director of Birmingham Small Arms
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BUSINESS CHARTS

A CLEAR EXPLANATION OF THE
VARIOUS TYPES OF CHARTS USED IN BUSINESS,
AND OF THE PRINCIPLES GOVERNING THE CORRECT
PRESENTATION OF FACTS BY GRAPHICAL METHODS.

BY

T. G. ROSE, M.I.Mech.E. .

TECHNICAL CONSULTANT

LATE WORKS MANAGER, LEYLAND MOTORS LTD.

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WITH A FOREWORD

BY

SIR FRANCIS W. GOODENOUGH, C.B.E.

THIRD EDITION



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FOREWORD

BY

SIR FRANCIS W. GOODENOUGH, C.B.E.

THE conditions under which business is carried on to-day are very different from what they were a generation ago. Competition for the neutral markets of the world is for ever becoming more keen; the struggle for trade brings with it a constant necessity for reducing costs and increasing turnover, until the responsible head of a modern business finds it extremely difficult, indeed almost impossible, to keep a clear picture in his mind of all the facts and tendencies which influence his undertakings and need his personal consideration.

The executive chief of a concern, whether large or small, is only too well aware of the labour involved in the careful analysis of the multitudinous statistics laid before him. But when those statistics have been turned into "graphs," not only is the work vastly simplified, but a picture is obtained of the conditions governing the state of affairs at the moment which no columns or tables of figures can ever hope to convey.

In this small book on Business Charts the author has endeavoured to set out in a simple and straightforward fashion the best methods of presenting facts in a graphical manner. Those who have not so far had any experience of this method will find this book a useful introduction to the subject, and may feel confident that if they start on the lines indicated they will be laying

satisfactory foundations for more advanced work as their interest in the subject grows.

The problems that surround British trade are perhaps more complex than those which have to be faced by any other nation; anything, therefore, that can help us to solve these problems more effectively, in however small a degree, is worthy of earnest consideration.

PREFACE

TO THE THIRD EDITION

SINCE the first edition of this small handbook on *Business Charts* was published suggestions have, from time to time, been made to the author that it might with advantage be considerably enlarged. As its sole reason for existence was the intention to provide a simple and elementary handbook for those who desire to obtain information on sound methods of charting in business, it seemed to the author that any attempt to extend and complicate it would lessen such value as it may possess. There are many admirable volumes on advanced graphics to be obtained, and reference to these will be found in the bibliography at the end of this handbook.

In response to several requests a short section has been included describing the making of a Gantt chart, and a number of other minor alterations have been made in order to bring the book up to date. A search amongst publishers' lists revealed only one or two necessary additions to the bibliography, though the opportunity has been taken to add a short section mentioning certain books which are illustrated entirely by charts, and are in themselves excellent examples of the practical use of graphics.

T. G. ROSE.

36 GREAT SMITH STREET,
WESTMINSTER, S.W.1.
March, 1936

P R E F A C E

THIS little book is the outcome of a series of nine articles on Business Statistics which were published between 27th September and 23rd November, 1929, in *The Times Trade and Engineering Supplement*. So much interest was taken in these at the time that it was clear that a need existed for some simple explanation of the principles upon which is based the use of graphical methods in recording business facts.

To reprint the articles as they were originally written would scarcely have met the case, as owing to the exigencies of space a large number of important examples and recommendations had to be omitted. The whole series has, therefore, been almost entirely rewritten from end to end, and the author hopes that the matter that has been added will assist those whose attention was originally attracted by the articles in question to develop the subject a little more fully.

It is desired to make clear at the outset that this elementary handbook does not endeavour in any way to vie with the large textbooks at present existing, such as those of Brinton, Karsten, Haskell, Smith, and the other experts whose names are given in the bibliography of the subject at the end of this volume. There must be very little relating to graphical methods of presenting facts which has not been exhaustively covered in one or other of these books. They are mostly, however, expensive, and so wide in application that they are apt to frighten anyone who has previously had little or no dealings with graphical methods. One or two pamphlets of an elementary nature certainly do exist, but these are all too short to give an adequate survey of the subject.

It appears, therefore, that there is an opening for a book of an inexpensive nature covering that portion of

graphical methods for presenting statistics which is needed by the student or the business man who is more or less a newcomer to charts and their uses. This little handbook is intended to fill this gap, and has been written as much as possible from the point of view of the minimum requirements of the business man and not to meet the advanced ideas of the expert.

As the first practical book on business graphics of British origin, it may be criticized as a poor reply to the extensive treatises on the subject that have been produced in America since Mr. Brinton first published his work in 1910. It is, however, the outcome of some twenty years of practical experience in engineering management, during which the author has come to realize so keenly the advantages to be attained by a reasonable use of charts and graphs that he has been tempted to try to help others to follow the same path. Those who use this book in making a start on the subject are strongly advised to purchase at a later date one or more of the advanced textbooks mentioned, and so to continue their studies. There is a vast amount of most interesting matter in connection with the subject which has been of necessity passed over here in silence. The reader will find nothing relating to Schlink charts, ogives, Lorenz curves, polar, isometric, trilinear, or nomographic charts, zones, bands or blocks—or any of the advanced forms of graphics which make the subject so alarming to the non-mathematical business man; yet all these forms of charts have their uses, and all can be adapted for the clearer understanding of business problems. Nor is there any discussion here of weighted averages, medians, modes, and other statistical terms, or of any facts concerning statistical sources. The objective in view has been to take from the vast field of matter available only such items as are primarily necessary to a beginner in business graphics, and it is asked, therefore, that the work may be judged from that standpoint alone.

The author desires to record his grateful acknowledgment to the manager of the *Times Trade and Engineering Supplement* for permission to use the nine articles on Business Statistics as the basis for this book; also for permission to use the illustrations which appeared with those articles. He would like also to record at the same time his appreciation of the interest in the subject shown by the Editor of the *Supplement*, but for whose suggestion and encouragement the articles in question—and therefore this present book—would never have been written.

T. G. ROSE.

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BUSINESS CHARTS

CHAPTER I

BUSINESS STATISTICS—THE VALUE OF GRAPHICS

It is a notable indication of the general tendency to-day towards better business methods that the reluctance to use charts in dealing with facts and figures is beginning to die away. Hitherto there has been among business men a feeling that diagrams on squared paper are useful only to statisticians, and that to the ordinary reader they are more apt to confuse the issue than to make things clear. In fact, the business man in the past has looked upon a chart much as he would have looked at the wine list if the vintages had been expressed by their chemical formulæ instead of by their well-known names.

When the reason for this curious antipathy is analysed, it is not difficult to see that it arises from several causes. First, the ordinary man has never had any schooling in graphical methods of presenting facts, since such methods scarcely existed in his youth. He has got along very well without them up to the present, and he has yet to learn that any advantage can accrue to him from their use. He has a firm conviction that there is something abstruse and mathematical about them, and being no mathematician himself, and possessing also the practical man's mild contempt for the sciences, he extends that mild contempt to the use of charts in business.

Secondly, there is no doubt that the well-meant but mistaken efforts of assistants in submitting totally unsuitable diagrams must take some portion of the blame in the matter. These badly made charts are responsible in a sense for a double amount of harm, since the chief who is trying to use them can dimly see more facts than

he would have been able to see from his columns of statistics; yet, because the charts laid before him do not make those facts clear, he cannot properly grasp what he can dimly see, and so condemns the graphical method as useless.

One more reason for this unpopularity may perhaps be added, and that is when a chart is properly made, and therefore instructive, it forces the reader to think. Most people object strongly to thinking—or at least to thinking hard. They are quite prepared to do a quick calculation on the back of an envelope, quote a price and take an order, but to sit down to a set of interlocked business charts and think hard and collectedly as to what lessons can be gleaned from the whole series of results is a task that calls for will-power and concentration, and, therefore, will never be popular.

However, the fact that graphical methods are becoming much more frequently employed in trade returns and commonplace statistics tends to popularize their use. Every month brings fresh converts, and the average man is beginning to appreciate the primary importance to himself of knowing what is happening in his business, and the fact that it is much easier to do this by means of two lines than by means of two columns of figures. All management is based on comparison, and since the administrator can make certain which way he is going only by comparing what is happening at the moment with what happened in the past, or what he then had hoped would happen in the future, it is obvious that he must look about to find the simplest and most effective means of setting out this information in the clearest manner. The variations of a series of individual results in a single column of statistics may be grasped if the column be studied carefully and at length; with the greatest concentration two columns of figures may be compared. But three columns become extremely difficult, and more than three impossible. Since, therefore, as has

already been said, the main basis of management lies in comparison, it follows that the graphical method presents an enormous advantage over the statistical when matters connected with business are under review.

A monthly return, an annual dividend, a daily rubber quotation may be of immediate interest to the buyer or the seller as a fact upon which an investment can be made or a contract placed; but whether it is wise to place that contract at that particular figure can be ascertained only by a comparison of the quotation in question with previous quotations, and this brings the matter back immediately to the problem of the trend of affairs.

The barograph is a simple but very effective example of the case in point. The ordinary barometer tells us the weather. But we all know what the weather is at the moment; what we desire to find out is what the weather is going to be, and for this purpose barometers are provided with a movable pointer which can be set every day and the variation of the mercury column thereby marked. Even with this addition, however, only two results are shewn—the present, and the past at the time at which the pointer was set. The barograph, on the other hand, draws a curve showing the rise and fall of the pressure hour by hour. The single line on the squared paper informs the observer how the glass has been rising or falling, and so indicates what the weather is likely to be within the next few hours. In other words, by reading the past we forecast what is going to take place in the future. So in business by using the facts of the past to draw lines upon squared paper, it is possible to obtain an idea how matters are likely to go in the period to come.

In the chapters that follow an attempt has been made to give a clear explanation of the various types of charts used in business. Only the simplest examples have been taken, as the reader will soon begin to develop the subject for himself once he has made a start.

CHAPTER II

ILLUSTRATION CHARTS

THE various classes into which the different types of charts can be divided are shown in Fig. 1. The calculation

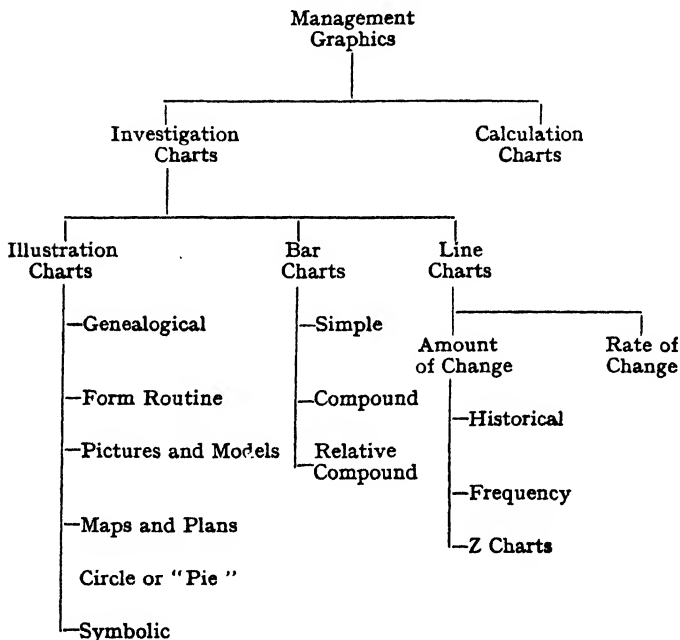


FIG. 1

Note the combined vertical and horizontal spread, which avoids excessive width, and at the same time permits a clear idea of the categories to be instantly obtained. Compare with Fig. 2.

charts can be dismissed without more ado. They comprise different types of mathematical diagrams used for calculating purposes, and their study does not enter into the field of elementary business graphics. The class known as "investigation charts" can be divided up into

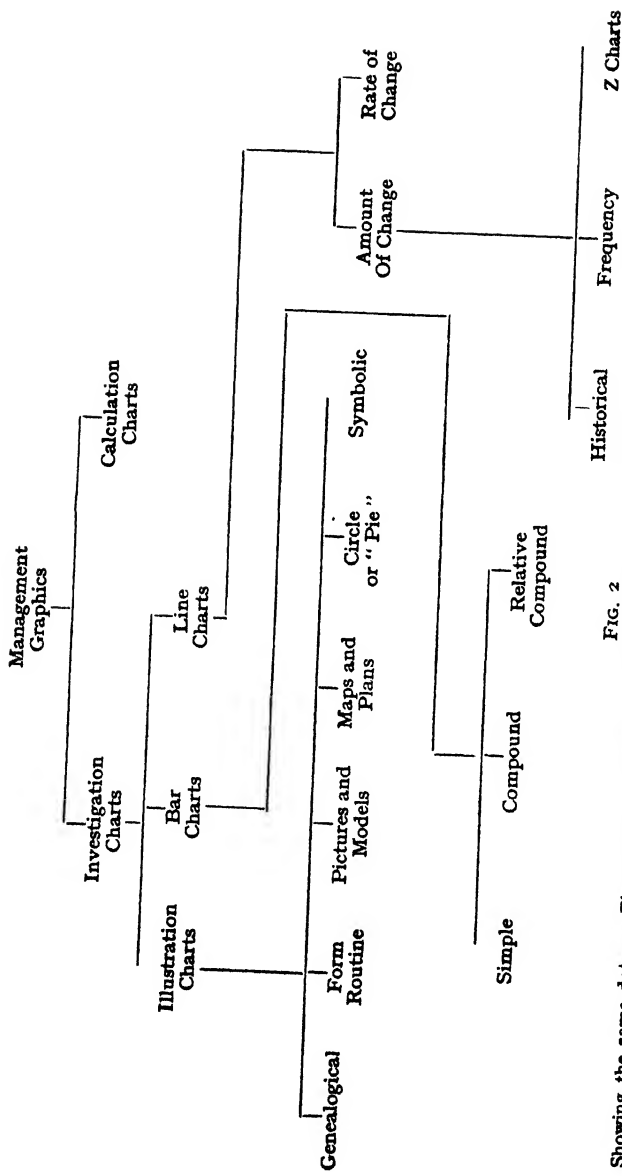


FIG. 2

Showing the same data as Fig. 1, but laid out with horizontal spread only. The eye is confused by the lines leading from one sub-division to the next, and the problem of paper width forces a distorted arrangement which leaves the complete picture vague. The above lay-out is intentionally made as bad as possible, but it is not uncommon to meet in actual use examples quite as faulty. Compare with Fig. 1.

illustration, bar, and line charts. The two latter are the ones with which we shall chiefly have to deal, but it may be as well to describe briefly a number of the better-known types of illustration charts in order that the reader may obtain a comprehensive idea of the whole field covered by the various graphical methods of presenting facts.

1. Genealogical Charts.

Fig. 1 is itself a genealogical chart, and this class of diagram is almost too well-known to require description. It should be noted, however, that Fig. 1. is composed partially with horizontal spread and partially with vertical spread. The trouble with most of these genealogical charts is to get them clearly on to a piece of paper of a reasonable size if the ramifications are extensive. Every effort should be made to keep the whole thing as compact as possible, and connecting lines which go round corners and link one out-of-the-way item with another on an altogether different part of the diagram, should be avoided (see Fig. 2). It will be found that the method illustrated, of spreading both horizontally and vertically, will give the most easily understood results.

It is not unusual to see the items on these genealogical charts placed inside squares or circles—or “berries” as they are sometimes called—with simple diagrams. This tends to neatness, but is apt to look clumsy when the chart is of any size.

2. Form Routine Charts.

When investigating routine in an organization, it is first necessary to obtain a concise idea of what printed forms are actually in use and how they are sent from one individual or department to another. The very human wish to have instructions on paper, so that a record can be kept of them, is at the bottom of this desire for printed

forms which exists in every organization. But as the organization grows, unfortunately the printed forms multiply as well, and few managers as a rule realize what a complicated net-work of paper flows steadily to and fro behind their backs.

Where it is desired to hold an investigation of an existing department, or perhaps of the organization as a whole, it is usual for the whole of these forms to be traced from their source to their filing point, and for this purpose it is best to make out a Form Routine Chart, in which every printed form in use has its share clearly shown upon the diagram. In this manner duplication or unnecessary red tape can be easily detected, and such a diagram also forms an invaluable reference if arguments arise as to the exact use and itinerary of any given form.

Where the wall of an office or some similar blank space is available, it is a good plan to take the actual forms themselves and pin them to the wall, connecting them with chalk lines—in different colours if necessary—so that the whole movement of the paper work in the department under review can be clearly seen. It is astonishing what an amount of time and paper can be cut out once the system has been put under the limelight in this fashion.

A word of warning may perhaps be added. When endeavouring to obtain a full idea of the form routine in any department or works, it will be found that the patience of Job and the quiet persistence of a K.C. will be necessary if more than half of the existing routine is to be dug out from its hole-and-corner existence. It will always be found that the main printed forms which circulate are accompanied by a healthy collection of subsidiary pieces of paper of no particular pedigree passing between the various officials, and that really important information is being conveyed on these surreptitious "chits," whilst the main printed forms are chiefly used

by the Time-keeping, Costing, or the Progress Departments.

3. Pictures and Models.

Every reader will be familiar with these so-called diagrams where a small man shows the population of London in 1800 and a large man the population of London in 1900; or perhaps a series of drawings of locomotives of different sizes, which purport to show the quantity in use each year over a period of time. As the actual figures involved are usually available, quoted underneath these pictures, the best that can be said for them is that they draw the attention of the reader to the fact that the figures have increased. They are perhaps suitable for the entirely uneducated, and are usually to be found in magazines, or popular summaries of simple statistics, because they look more like an illustration than a bar or line would do. Dr. Otto Neurath has, however, recently adopted the small picture of this nature for his graphical demonstrations of sociological facts. He avoids the normal disadvantage of this method by using the picture as a unit and showing change in the figures demonstrated by means of increasing or decreasing the number of units shown. For instance, one small soldier would be taken to represent a unit of 10,000, and where a standing army has increased from 30,000 to 100,000 the figures would be demonstrated first by a row of three little soldiers and then by a row of ten. It will be seen that in effect he uses the pictures like a bar chart, and he has produced some admirable work on these lines. It is, however, a method which is scarcely suitable for business purposes.

Models are of different kinds. Where they merely consist of actual reproductions of the type of picture just mentioned they are of little value. Not infrequently they are to be met with at exhibitions, and when in the form of columns or repetitions of the same items (for

instance, piles of the same coin, each pile of a different height) they form an effectual means of drawing the observer's attention to the facts demonstrated, and are really three-dimension bar-charts. Where three dimensions are involved, they certainly do form a practical method of illustrating the facts under review and have the same value as Dr. Neurath's picture charts.

It will be remembered that not long ago a large scale map of Europe was exhibited in London, having each country surrounded by little walls, these walls varying in height in accordance with the tariffs of the respective countries. This was an excellent example of a really useful model chart, as the bird's-eye view of the walled-in nations gave an immediate impression of which country imposed the highest tariffs, and the extraordinary obstacles at present existing to the free interchange of trade.

On the whole, however, models do not come within the scope of practical graphics, owing to the length of time and the expense required for their construction.

4. Maps and Plans.

Maps form the basis for a very considerable amount of charting work in connection with selling organizations. In almost every case where two or three agents handle the goods of a firm a map will be found in the Sales Manager's office showing the different agents' territories clearly marked. In some cases these maps are used to show many other items, and there is on the market to-day a considerable choice of pins, flags and other signs which can be used to denote various facts in connection with the sales organization. It would occupy far too much space to attempt to give here any detailed description of map technique, which has been worked up to a high degree of excellence. Those whose duties call for close touch with assistants, representatives or agents who work over areas of country, would do well to study

the sections to be found in the larger textbooks on graphics on what can be done with maps.

The word "plan" is generally used to denote small scale drawings of works or shop lay-outs. These can be of the greatest assistance, and every works should possess at least one lay-out of the site as a whole, drawn to such a scale as will permit it to be reproduced on a foolscap sheet with filing margin; this plan should show all buildings, roads, party-walls and doors, so that a bird's-eye view can be obtained of the opportunities for movement throughout the whole of the works' property. In addition, there should be a subsidiary range of such plans for all the shops, out-buildings, etc., that go to make up the works' estate shown on the first plan, also foolscap size, and all of sufficiently large scale to show each machine and fixture in place. Once these are available, a considerable amount of valuable work may be done in reducing transport expenses, shortening the passage of work, and generally easing the means of communication throughout the organization. It is quite impossible to walk among machines and in and out of shops and buildings and obtain an accurate idea of the traffic which passes between the various points, and why it goes that way rather than another. Once the small scale plans are available, the absurdity of making a detour through another shop, merely because there does not happen to be a door through a party wall, at once becomes apparent, and in studying these small plans, improvements and economies almost force themselves upon the manager's attention. They may be used in office organizations just as much as in the shops, and many an office manager would be surprised if he were presented with a fully laid out plan of the organization of his office, accompanied by a suggested revision showing how much time and energy would be saved if some slight re-arrangement was made of individuals or sections.

It will perhaps be thought that to include in an

elementary textbook on business graphics the above remarks on pictures and models, maps and plans, a departure has been made from the true subject-matter under review. On the other hand, a chart is a graphical or pictorial method of presenting facts, and the facts that require investigation and revision in business and in management are not always statistical facts. A brief description of the more useful forms of graphical presentation of such facts may therefore be included with advantage.

CHAPTER III

ILLUSTRATION CHARTS (CONTINUED) CIRCLE OR PIE-CHARTS

A TYPE of diagram that is popular in certain quarters is the circle or pie-chart. This, as its name denotes, consists of a circle which is cut up into segments in order to demonstrate the component make-up of the figures represented. These segments are often shaded or coloured.

If it were not for the fact that these pie-charts provide an elementary method of demonstrating simple facts to people who are not used to reading charts, it would be better to ignore them altogether. Their use is beset with disadvantages of all kinds, and the mere fact that they appear to be simple often leads to their being used—and even advocated for use—under totally wrong conditions. Lest, therefore, the beginner in business graphics should fall into these pitfalls, it may be as well to spend a little time on these circle charts, if only to demonstrate the reasons why they should be relegated to the scrap-heap.

To begin with, in the vast majority of cases the graphical method of presenting statistics is used in order to compare those statistics. To take a very simple example, the following table gives the tonnage of fish landed in England and Wales during 1926—

	Tons
Cod	135,218
Herring	180,659
Other	309,330
Total	<u>625,207</u>

Let us suppose that it is desired to demonstrate these figures graphically to a meeting, and it is decided to use a pie-chart for the purpose. The first objection immediately arises that the figures themselves are easy enough to

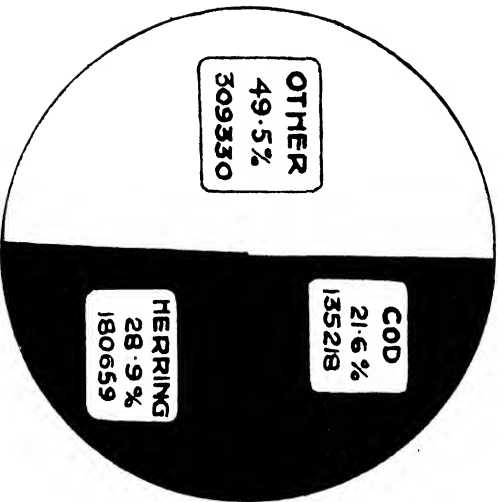


FIG. 3. TONNAGE OF FISH LANDED IN ENGLAND AND WALES, 1926

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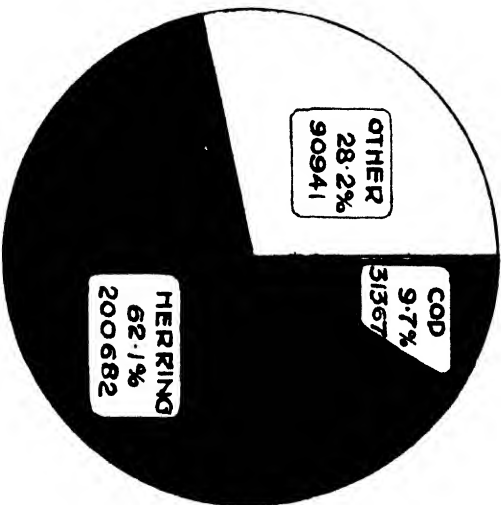


FIG. 4. TONNAGE OF FISH LANDED IN SCOTLAND, 1926

grasp without any picture, which is quite true. However, if for some reason it is desired to show the percentage make-up of this total, Fig. 3 would be a pie-chart showing the statistics concerned.

Let us now suppose that it is desired to compare the tonnage landed in Scotland with the tonnage landed in England and Wales; the following table is then added to the first—

	Tons
Cod	31,367
Herring	200,682
Other	90,941
	<hr/>
Total	<u>322,990</u>

and Fig. 4 then demonstrates the percentage make-up of the Scotch tonnage.

These two pie-charts side by side demonstrate clearly the fact that the herring tonnage represents 62.1 per cent of the Scotch landings and 28.9 per cent of the landings for England and Wales.

Now at this point we have got to decide what the demonstrator is trying to prove to his audience. If he merely wishes to show that the Scotch herrings represent more than twice the share of the total output that they represent in the English section, he will have achieved his object. But it is very seldom that so simple a demonstration is required. Almost invariably the next question of the audience would be: "Yes, but since the tonnage landed for England and Wales is nearly twice the tonnage landed for Scotland, how does the actual tonnage of herrings compare between the two countries?", and reference to the tables would show that in spite of the fact that herrings represent 62.1 per cent for Scotland and 28.9 per cent for England and Wales, the actual tonnage landed by the former is only 11 per cent more than the latter.

In other words, the comparison begins to get muddled at once, owing to the fact that the two pie-charts represent

percentage make-ups only, and do not in any way picture the *amount* of the total involved.

At this point the novice who was responsible for making

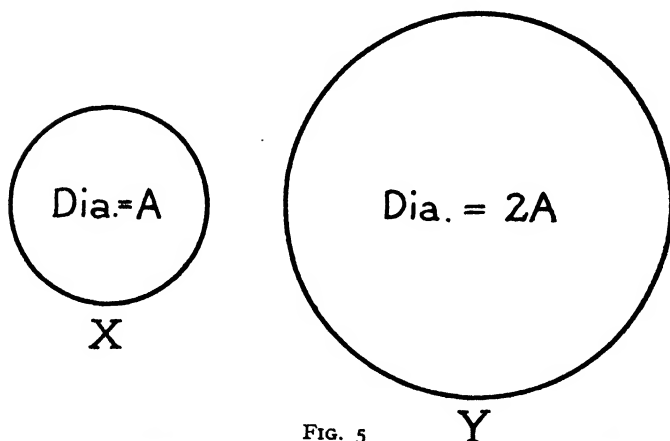


FIG. 5

Here a 100 per cent increase has been represented by a 100 per cent increase in diameter of the circle; this doubles the circumference, but quadruples the area. Hence a totally false impression to the eye.

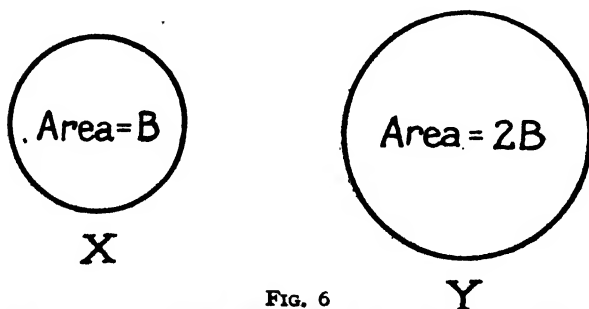


FIG. 6

Here a 100 per cent increase has been represented by a 100 per cent increase in the area of the circle. But the eye is not used to comparing areas, and no observer would be prepared to say that the larger circle is exactly twice the size of the smaller, it just "looks bigger." Hence all value in the demonstration is lost.

these demonstrations would probably endeavour to work out mathematically two circles which would be comparable in diameter or area, in the ratio of 625,207 to

322,990. No doubt he would be successful, but when he came to make his charts he would find that the resulting pies gave a totally false impression as to the relative size of the two figures involved.

Figs. 5 and 6 will perhaps show this more clearly. In Fig. 5 circle *Y* has been drawn with twice the diameter of circle *X*, and in Fig. 6 circle *Y* has been drawn with twice the area of circle *X*. In the first case it will be seen that the circle *Y*, having double the diameter, looks 3 or 4 times as big as circle *X*; which in fact it is, since doubling the diameter doubles the circumference and quadruples the area. On the other hand, where in Fig. 6 circle *Y* has been drawn with twice the area of circle *X*, very few readers would be so bold as to say that it looks just double the latter.

Here, therefore, is the most important of the many reasons why pie-charts should be abolished altogether from business graphics. Almost the whole of management being based upon comparison, a form of chart that does not permit of true comparison is obviously a waste of time.

Amongst the other reasons, minor but still valid, is the difficulty of labelling the segments. A chart must convey its message to the eye instantaneously, and must not require careful investigation before the reader can discover what it is all about. If we suppose that the chart clerk has drawn his two circles having an area based upon the ratio of 625,207 to 322,990, he then has to label the segments with both the percentage and the tonnage figures. In the simple example given only three segments are used, and there is, therefore, room for labels of sufficient size. On the other hand, it frequently occurs that some of the percentages concerned are very small, and, therefore, either the segments can hardly be coloured owing to the size of the label, or else there is no room for the label at all. The labels must, therefore, be recorded outside the pie itself, and this would probably lead to

all the labels being put outside the pie with arrows pointing at the segments concerned. The eye is then compelled to wander from the segment to the label, and over on to the other chart to find the same coloured segment, and again look for the label, so that the whole affair becomes so complicated that more harm than good is done. Add to this the fact that the two circles will not look as if one were nearly double the size of the other, and therefore no true idea of the two total landings would be gained.

Fig. 7 shows the best way of demonstrating graphically the figures that have been given. The eye can take in at a glance a comparison of the two totals and the actual figures of the classes of fish for the two sections. The figures are there at the top of the column, and, for instance, the close resemblance of the two figures for herring can be immediately seen, whilst the eye takes in at the same time the relation of the blue herring column to the green total column. On the right are the percentage bars, with the figures set out above so that a direct comparison of the percentages can be made without the eye having to wander from one chart to another. In other words, Fig. 7 provides all the information that can be asked for in a clear and comparable form.

The utmost that can be said for the pie-chart is that it can be used at meetings, drawn on a large scale, to demonstrate to people who are totally ignorant of graphics *the make-up of a total*, provided that that make-up does not consist of more than three or four sections, none of which is less than about 10 per cent. Pie-charts must, however, under no circumstances ever be used for comparison, and they must not be used if the make-up of the total contains a large number of sections.

It will be seen, therefore, that the wisest thing to do with the pie-chart is to abandon its use altogether; there is nothing demonstrated by the pie-chart which cannot be shown far better and in a far simpler and clearer fashion

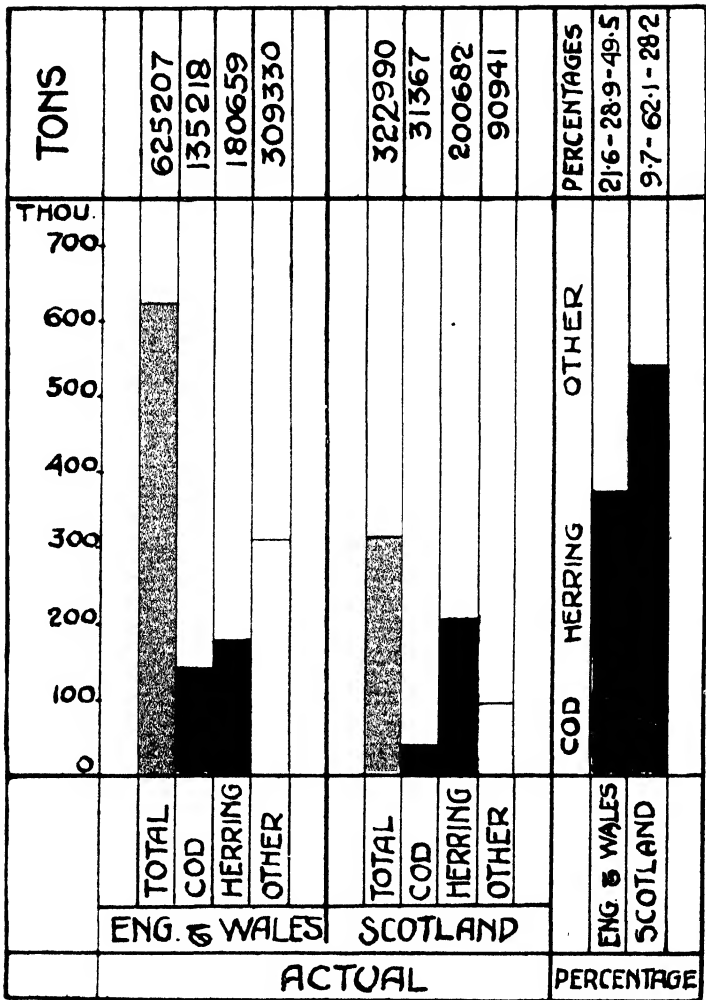


FIG. 7. BAR CHART

by the bar chart. Even to the uninitiated the bar is easy to read, since it is not mathematical in any way, and it will be found that when drawn on a large scale for the purpose of demonstrating straightforward figures and facts, the bar chart will invariably meet all requirements.

CHAPTER IV

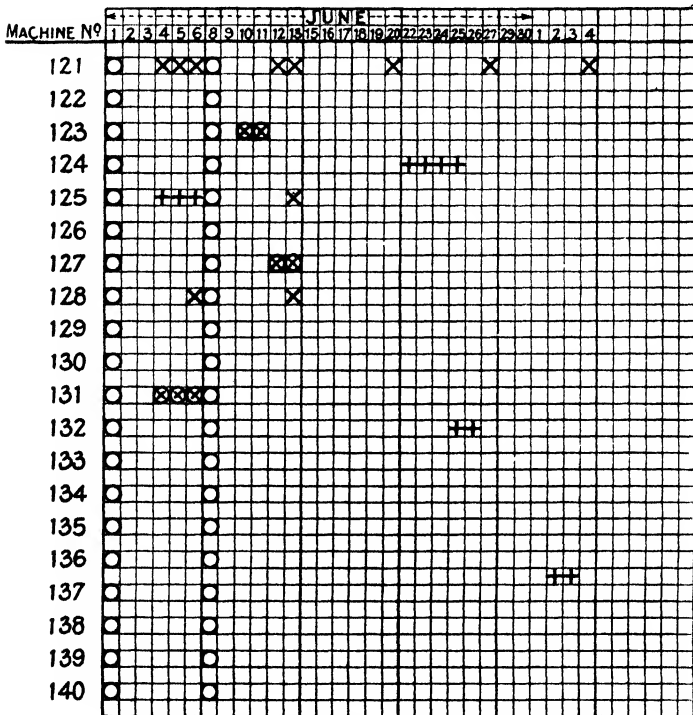
ILLUSTRATION CHARTS (CONTINUED) SYMBOLIC CHARTS

SYMBOLIC charts denote certain graphical methods of recording facts in which symbols are used to represent certain recurring events or items. They are, perhaps, more generally used in production or works management than in business graphics, but they ought to be much more used than they are at present in connection with such matters as accounts payable or receivable, bills, insurances falling due, hire purchase records, etc., etc.

Fig. 8 shows a portion of a page in a Machine Idle Time Book in a works. Here it will be seen that the various reasons owing to which machines have stood idle are denoted by symbols; and the insertion of one of these symbols where a machine has been stopped enables the works manager to see at a glance why this productive time was lost. Such symbolic charts can be equally well used for many office purposes, and when the symbols are entered in different coloured chalks, such charts will be found to be of considerable practical use in the daily survey of working results.

The chief drawback to these symbolic diagrams lies in the fact that they are usually kept up by enthusiastic assistants, who are very difficult to restrain once their interest in this symbolic method has been awakened. Symbol after symbol is added until the page becomes so full that it is quite impossible for a reader to gain any immediate idea of the state of affairs. Those who use these symbolic charts should invariably lay down some limit which is not to be over-stepped in the matter of entering symbols, otherwise they will find that after a chart has been running for some months it will have become so bewildering to look at that they will be tempted

to throw the whole thing up in disgust. It is an important principle never to allow charts to run away with you. They must be kept strictly under control, or else one day



- O - Breakdown of Power.
- +
- ⊗ - Machine under Repair.
- ⊗ - Waiting for Work.
- X - No Operator

FIG. 8. MACHINE IDLE TIME CHART

the author of the system will make the unpleasant discovery that his charts have become so complicated that the labour of keeping them up is far greater than the advantage which he gains from studying them.

A symbolic chart which was developed by the author

and which proved itself of exceptional value under difficult circumstances is shown in Fig. 9. The problem was to balance an output consisting of machines assembled from a large number of different units each composed of a more or less large number of parts. It was necessary to arrange a control such that completed machines could always be assembled in any combination of units that might be called for, and that in spite of calls for spare parts there should never be a shortage either in the Rough Stores or the Finished Part Stores.

The number of items involved ran into several thousands, and the number of shortages reported by the Stores day by day was considerable. Moreover, it was frequently found that all the parts except two or three for a certain unit would be ready for assembly, but the whole machine was delayed because those parts were not ready. Those who have had experience of production will know that this is an extremely common state of affairs in works where job or batch production is carried on, and the production manager who can solve the problem of always having adequate supplies of every unit and part in stock to meet sales demands in a batch production works has very little left to learn about his job.

In the instance under discussion, the situation was reviewed and the parts that went to make up each unit were written out on a large grid on a double-elephant sheet of drawing paper. This grid was divided horizontally into 100 squares and vertically into 80, and every item that went to make up each unit was written out on these sheets. Some units required as many as five or six sheets to complete the list. Parts common to all units, such as bolts, nuts, washers, split pins, etc., were standardized and given special sheets to themselves.

Once the production manager was certain that every schedule was correct, the procedure was as follows—

- (1) Having decided how many sets were represented by one horizontal square, the outstanding contracts for the

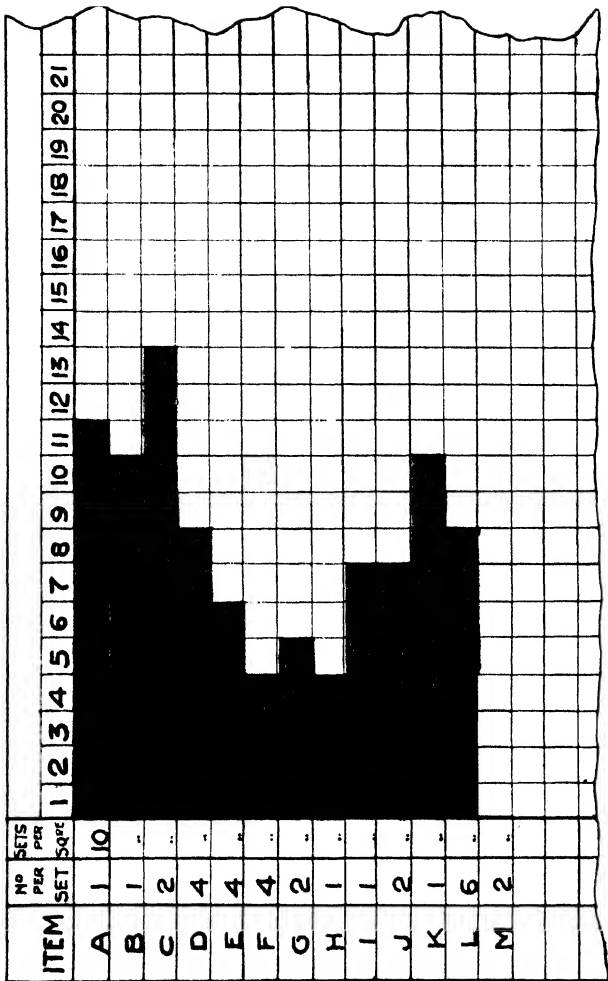


FIG. 9. BALANCING CONTROL CHART

KEY

- Item A. 60 sets still to come in.
20 sets Rough Stores.
20 sets Machine Shops.
10 sets Finished Stores.
- Item C. Nil sets still to come in.
30 sets Rough Stores.
30 sets Machine Shops.
Nil Finished Stores.
- Item H. No movement (probably obsolete).
90 sets still to come in.
50 sets Rough Stores.
Nil Machine Shops.
Nil Finished Stores.

material to make the parts were marked off in yellow chalk without reference to dates.

(2) The Advice Note indicating that the material had been dispatched was handed to the Production Department which then marked up as many squares in red (on top of the yellow) as were represented by the quantities on the Advice Note, and the plain red portion on the diagram, therefore, showed what rough material had arrived in stores.

(3) When a batch was issued to the shops for manufacture the Production Department, on receipt of their copy of the Issue Note, would then mark off with one diagonal stroke as many squares as were represented by the material issued.

(4) In due course a batch would be received in the Finished Part Stores, and the Stores Received Note was the authority for the Production Department to mark off the quantity received by putting a second diagonal stroke across the first for the number stated on the Stores Received Note, an X then representing finished parts in stores.

(5) In due course these parts would be issued to the Assembly Shops in order that the units might be built, and the Production Department would receive a copy of the Parts Issued Note and so "black out" from the finished stock the quantity issued.

From the illustration it can be seen that under these conditions the exact position could be ascertained for every part of every unit under manufacture. A single glance at the chart enabled the production manager to see—

(1) What contracts were still outstanding, and therefore to what extent he was safe for future supplies.

(2) The amount of rough stock in stores waiting to be issued to the shops.

(3) The quantity in the shops under manufacture.

(4) Finished stock in stores, ready for issue for spare parts or unit building.

In a few minutes each sheet could be reviewed, and so a complete control obtained of the position as a whole. So effective did this system prove that in a very short time the various units were levelled up, and the shortages reduced to an absolute minimum.

It should be noted that the "black-out" line which

advances steadily from the left-hand edge of the chart acts as a moving datum line. When this black line reaches the right-hand side of the chart, it is obvious that the line will either have to be begun again lower down or a fresh chart made out. The scales, however, can be so arranged that new charts would only be required about every six months. In actual practice it was found that it was sufficient to review each unit every fortnight, and some sixty or seventy charts of eighty items each were handled without difficulty by one girl.

The above example shows a simple application of a symbolic chart, in which two symbols only are employed—the single and double diagonal—combined with three colours.

There is another well-known form of chart which is a combination of the symbolic and the bar chart. This was developed by H. L. Gantt during his early management work, and has subsequently become widely known under his name.

“In the Gantt chart a division of space represents both an amount of time and an amount of work to be done in that time. Lines drawn horizontally through that space show the relation of the amount of work actually done in that time to the amount scheduled. This is the feature which distinguishes the Gantt chart from all other charts. Equal divisions of space on a single horizontal line represent at the same time—

1. Equal divisions of time.
2. Varying amounts of work scheduled.
3. Varying amounts of work done.

Thus it shows the relation of time spent to work done. Furthermore, since *knowledge of what has happened and when it happened causes action*, the past projects itself into the future, and records charted in this way become dynamic. A single example may make this method clear.

A week's work is planned as follows—

Monday.	.	.	.	.	100
Tuesday	.	.	.	.	125
Wednesday	.	.	.	.	150
Thursday	.	.	.	.	150
Friday	.	.	.	.	150

A sheet is ruled with equal spaces representing days (Fig. 10), and the amount of work planned is shown by

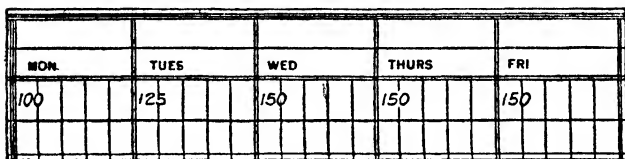


FIG. 10. GANTT CHART SHOWING THE DAILY SCHEDULE

figures on the left side of the day's space. So far the chart shows the schedule and its relation to time.

The work actually done through the week was—

Monday.	.	.	.	.	75
Tuesday	.	.	.	.	100
Wednesday	.	.	.	.	150
Thursday	.	.	.	.	180
Friday	.	.	.	.	75

This is charted as shown in Fig. 11.

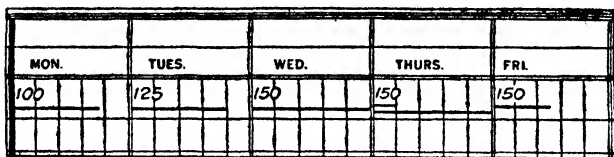


FIG. 11. GANTT CHART SHOWING THE WORK ACTUALLY ACCOMPLISHED

Lines are drawn through the daily spaces to show a comparison between the schedule and the actual accomplishment. On Monday the space represents 100; only 75 were done, so a light line is drawn through 75 per cent of the space. On Tuesday 125 were planned;

100 were done; a line is therefore drawn through 80 per cent of the space. On Wednesday 150 were to be done and 150 were done, so the line is drawn through the entire space. On Thursday 150 were scheduled and 180 were done, i.e. 120 per cent of the schedule; a line is therefore drawn all the way across the space to represent 100 per cent and an additional line through 20 per cent of the space. On Friday 150 were planned, but only 75 were done; a line is accordingly drawn through 50 per cent of the space. The chart now gives

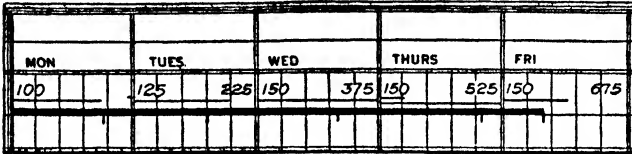


FIG. 12. GANTT CHART SHOWING THE CUMULATIVE SCHEDULE AND THE CUMULATIVE WORK DONE

a comparison day by day of the amount of work done and the amount scheduled and the relation of both schedule and accomplishment to time.

It is, however, desirable to know how the whole week's work compares with the schedule and so the figures representing the *cumulative schedule* are entered on the right of the daily space (Fig. 12). At the end of the day on Friday, for instance, the total amount to be done up to that time was 675. A heavy line is therefore drawn to show a comparison between the *cumulative work done* and the *cumulative schedule*. On Monday the heavy line is the same length as the light line. Of the 100 done on Tuesday, 25 have to go to make up the shortage for Monday. The remaining 75 are applied on Tuesday's schedule and the heavy line is drawn through 60 per cent of the Tuesday space. Of the 150 done on Wednesday, 50 are needed to meet the schedule to Tuesday night and the remaining 100 are applied on Wednesday's schedule

of 150, the line being drawn through 66 per cent of the space. Of the 180 done on Thursday, 50 are used to meet the schedule to Wednesday night and the line representing the remaining 130 is drawn through 87 per cent of the day's space. Of the 75 done on Friday, 20 go to meet the schedule to Thursday night, leaving 55 to be applied to Friday. The cumulative line, therefore, shows us that on Friday night the work is two-thirds of a day behind the schedule.

This chart (Fig. 12) shows the relation of the schedule to time, the work done each day in relation both to time and the schedule, and finally the cumulative work done and its relation to time and the schedule."¹

The above is a simple description of the principles upon which Gantt charts are built up. They have been developed to a considerable degree of complexity, but space will not permit here of reference to their various uses, or to the different methods by which they are made to convey information.

It should be borne in mind, in making up Gantt charts, that they serve a specific purpose in a more or less limited field, and those who use them should avoid any attempt to force them into covering ground for which they are not suitable.

¹ The quotation is from "The Gantt Chart," by Wallace Clark (Pitman), and the author desires to express his acknowledgment for permission to use the extract.

CHAPTER V

SOME GENERAL RULES FOR GRAPHICS

BEFORE beginning to deal with the Bar and Line Charts with which business graphics are chiefly concerned, it may be as well to consider some simple recommendations for the proper making out of these charts. Shortly after the war the American Society of Mechanical Engineers extended invitations to a number of Associations to form a Joint Committee¹ on Standards for Graphic Presentation, and seventeen members formed a Committee, with Mr. Willard C. Brinton as chairman, in order to study "the methods used in different fields of endeavour for presenting statistical and quantitative data in graphic form." The result of their deliberations was a preliminary report embodying seventeen recommendations, and in the interests of standardization these should certainly be reproduced here.

The author ventures to comment on each recommendation, as some of them are so condensed as to need a certain amount of explanation to a beginner.

1. The general arrangement of a diagram should proceed from left to right.

This may appear elementary, but it is curious that

¹ Some time ago this Joint Committee was discharged, and in December, 1926, a new Sectional Committee was organized under the procedure of the American Standards Association with the American Society of Mechanical Engineers as sole sponsor. This Committee has subdivided the subject into six parts, as follows—

- No. 1. Plan and Scope.
- „ 2. Terminology.
- „ 3. Time Series Charts.
- „ 4. Non-Time Series Charts.
- „ 5. Survey of Current Practice.
- „ 6. Engineering and Scientific Graphs.

The final draft of the report on Part 3 (Time Series Charts) is now being prepared for publication (March, 1936).

The author is indebted to Mr. C. B. Le Page of the A.S.M.E. for the above information.

inexperienced people are often tempted to draw charts vertically. The eye is used to reading from left to right and consequently by invariably keeping all charts in the same manner the eye is trained to take in quickly the effect of the diagrams from a similar point of view.

2. Where possible represent quantities by linear magnitudes, as areas or volumes are more likely to be misinterpreted.

The above suggestion bears out the remarks that have already been made with regard to pie-charts. It would have been, perhaps, more satisfactory if a definite recommendation had been made that quantities should never be represented by areas or volumes. The principle is unsound even when applied to percentage block charts.

3. For a curve the vertical scale whenever practical should be so selected that the zero line will appear on the diagram.

Whilst this is certainly important as a general rule, cases very often occur in which the items to be compared do not vary to a large extent, and if a scale were chosen which would permit the zero line to be shown on the field, the variations would be so small in scale that they would not be visible. In such cases it is obvious that the whole of the chart field available should be devoted to the variations in order that these may be as clear as possible; but it should be remembered that the omission of the zero line may be very misleading in its optical effect. It is the optical effect which decides whether the zero may be omitted or not. With bar charts the zero should *never* be omitted. Reference will be made to this point in dealing with these latter charts.

4. If the zero line of the vertical scale will not normally appear on the curve diagram, the zero line should be shown by the use of a break in the diagram.

The above suggestion is certainly an effective way

of drawing the reader's attention to the fact that the scale has been broken. If, however, ordinary commercial squared paper is in use, the horizontal break in the diagram must be drawn in artificially, and this has the effect of two added curves. Where the chart has been made on a specially drawn grid, this break is easy to arrange. Under ordinary circumstances, however, it is probably better to omit the zero altogether if it can be done without introducing an optical error; or else to draw a whole chart on such a scale that the zero can be included.

In a great number of cases there is no real reason why the curve should *start* from zero, and if the points are plotted as they should be in the middle of the time period, zero is, correctly speaking, in the middle of an imaginary time period to the left of the vertical axis. It is better, therefore, in business graphics not to attempt to join the point representing the first recorded result to the zero point, unless a useful purpose is served by so doing.

5. The zero lines of the scale for a curve should be sharply distinguished from the other co-ordinate lines.

This is particularly true in the case of divergence charts, where the zero line is in the middle of the chart field. Normally the zero lines are at the bottom and at the left-hand side of the charting paper, and no great advantage is obtained by emphasizing these lines unless it is intended to have photostat copies made of the charts in question. In this case the heavy black zero lines will come up white in the photostat, and they are then of great assistance in obtaining register when two photostat charts are compared one above the other over a source of light.

As a general rule, however, the use of heavy lines at the bottom and left-hand side of the ordinary quarto charting paper is not to be advocated, as it imparts a clumsy appearance to the chart.

6. **For curves having a scale representing percentages, it is usually desirable to emphasize in some distinctive way the 100 per cent line or every line used as a basis of comparison.**

This suggestion follows from the previous one, since the 100 per cent line is in a sense a zero line especially in cases where percentages above and below 100 are recorded.

7. **When the scale of a diagram refers to dates and the period represented is not a complete unit, it is better not to emphasize the first and last co-ordinates since such a diagram does not represent a beginning or end of time.**

This suggestion is presumably intended to apply to cases where a portion of a large chart is extracted and reproduced in order to demonstrate certain definite facts. In such cases the first and last co-ordinates are really intermediate co-ordinates and, therefore, should be left as they are in the original diagram and not be emphasized in such a manner as to appear that they form a new chart.

8. **When curves are drawn on logarithmic co-ordinates the limiting lines of the diagram should each be at some power of ten on the logarithmic scale.**

This suggestion will be referred to in the chapter on "Rate of Change Charts."

9. **It is advisable not to show any more co-ordinate lines than are necessary to guide the eye in reading the diagram.**

Presumably this suggestion is more intended to guide those who make their own grids for various purposes. Where the usual standard charting paper is used the suggestion has no practical effect.

10. **The curve lines of a diagram should be sharply distinguished from the ruling.**

THIS IS IMPORTANT. It is extremely common to see the curve presented as a thin coloured line scarcely to be distinguished from the squared-paper lines themselves.

This practice is a throw-back to the use of curves for mathematical purposes, where the result of an equation is obtained by projecting a point on the curve back to the base line. Obviously, if the curve were thick and heavy, an accurate point of projection could not be obtained. In the charts under discussion, however, there is no question of projecting points back to the base line; a chart line is wanted that strikes one the moment one looks at it, and it is, therefore, made bold and thick. If the actual figures involved are required, they are read from the horizontal column at the top of the chart, and if the thickness of the chart line happens to be equal to a thousand or two of the scale it is of no consequence.

II. In curves representing a series of observations, it is advisable whenever possible to indicate clearly on the diagram all the points representing the separate observations.

This suggestion must be accepted or not, according to the type of chart under consideration. Where, for instance, a long moving annual total occurs, or a complex line chart showing, say, a series of prices recorded over a long period, the indication of the actual points which have been taken to make the curve breaks up the slopes too much and serves no useful purpose. On the other hand, a short curve, covering, say, seven or eight monthly results arranged cumulatively, certainly looks better if each monthly result is indicated by a small circle or spot in the line. This is particularly true where standard Z-chart paper is in use, and the monthly observations are therefore about half an inch apart. Again, where an approximation curve is drawn through a large number of observations (and cases of this frequently occur) where results are irregular and yet an effort has to be made to draw some definite conclusion from them, it is as well to mark clearly all the individual observations or results, and in this manner a field is obtained of varying density through

which the approximation curve can be drawn. These are sometimes known as "gun-shot" curves.

12. The horizontal scale for curves should usually read from left to right and the vertical scale from bottom to top.

For practical charting purposes this suggestion might have been worded "must always" instead of "should usually."

13. Figures for the scale of a diagram should be placed at the left and at the bottom or along the respective axes.

To this might be added that when using standard quarto charting paper horizontally, i.e. with the right side acting as the bottom, it is frequently a good thing to repeat the left-hand scale at the right-hand side of the grid. Although the figures themselves will always be entered on the chart, it frequently assists the eye if the vertical scale is available for quick reading. When, therefore, the curve is approaching the right-hand side of the paper, it is a great help to be able to glance to the right of the scale, instead of following the point back to the left-hand edge.

14. It is often desired to include in the diagram the numerical data or formulae represented.

The author submits that it should be taken as an invariable rule that: *Whenever a chart is made, the figures from which it is made must be clearly shown upon the chart itself.* The chart is merely an illustration of the figures, not a pretty picture drawn from the figures. As a general rule the scale can be so adjusted that sufficient space for these figures to be written or typed is left along the top edge, and in this manner the reader has his column of statistics, as well as the chart showing the trend of the statistics. The omission of these figures is one of the commonest errors in charting, and one that causes the most trouble to the reader, who is then thrown back on the scale. The figures also

should always be large and clear; the absurd little figures which delight the heart of the professional chart clerk, because he thinks they look so neat, should be avoided. Charts are made for use and not for ornament.

In the majority of cases it is necessary to put in these figures vertically. At first sight this appears to offer a difficulty as regards easy reading, but it will be found that in a very short time the eye becomes accustomed to reading vertical figures just as easily as those written in the usual horizontal manner. Occasions arise where the figures can be written horizontally without difficulty, and wherever possible this should be adopted, since anything that makes for the quick and easy reading of a chart should always be encouraged.

It has been the author's experience that insistence on the figures always being entered on the charts themselves causes at first some demur amongst those who are not used to this method of working, on account of the space required. This is, however, only a matter of scale, and in a number of instances standard charting paper is available in which space is specially allocated to the figures. The reader, if he is in any doubt as to whether the figures themselves are necessary for the proper use of a chart or not, should make out two charts with similar results, one having the figures entered and the other blank or "blind" as it is called. He will then have little difficulty in realizing the advantage of having the figures themselves available for immediate reference.

15. If numerical data are not included in the diagram, it is desirable to give the data in tabular form accompanying the diagram.

The above suggestion comes under the same heading as No. 14, and no further comment is, therefore, necessary.

16. All lettering and all figures on a diagram should

be so placed as to be easily read from the base as the bottom or from the right-hand edge of the diagram as the bottom.

This suggestion embodies sound practice, and appears to call for no comment.

17. The title of a diagram should be made as clear and complete as possible. Sub-titles or descriptions should be added if necessary to ensure clearness.

This suggestion is worthy of careful attention. How often has one not heard the remark "What on earth is all this about, anyway?" made by some bewildered business man with a collection of tangled lines in front of him headed "Total Output," "Total Sales," or some such general title? Bear in mind that your chart must be so self-explanatory that a complete stranger can take it up and immediately understand what it represents. Titles should explain exactly what is under review and what the desired result is.

In making a chart one should not be afraid of inserting comments concerning events which have governed the results. These comments can be, and often are better, in pencil, and here again too many comments are better than too few. Statistics, whether in columns or pictured as lines, are at the best dangerous things, and it is always useful to make comments on the ups and downs of your chart; perhaps reference can be made to other charts, or to abnormal happenings which have occurred during the time period; in fact, any changes in circumstances which have had a bearing on the fluctuations of the results charted.

Since the whole purpose of these charts is to reveal as much information as possible, there is no reason why this information should be omitted merely because the pencil notes will make the chart look untidy. All statistics are influenced by circumstances, and it is a good thing to transfer as many of these as possible to the chart in the form of comments.

In addition to the above suggestions the author submits the following as also worthy of consideration.

1. When dealing with time and another variable, always lay out the time period horizontally and the other variable vertically.

This is a rule which should be strictly kept, and once a standard size of paper has been adopted an effort should be made always to keep the time periods (week, month, or year) the same horizontal distance apart, so that any two charts of the same vertical scale may be compared by placing one over the other against the light.

2. Be careful in the choice of the scale.

The scale to which the chart is drawn will often make or mar the usefulness of the chart itself.

Violent fluctuations should be avoided as much as possible, and the scale should be such as will make clear to the eye the changes that have occurred, without accentuating those changes to such a degree that the eye cannot take them in. A few experiments in drawing a chart to different scales will soon show the extent to which scale variations can alter the impression made by the chart. Remember the effect which you wish the chart to produce, and choose the scale which will give that effect in the clearest manner.

The subject of the choice of scales is almost complex enough to deserve a chapter to itself. Space, however, will not permit of this, and the reader can only be recommended to experiment personally in order to find out how the distortion of scales distorts the impression that he gains from the curve. There is a great deal of the personal element in the reading of charts, and since a chart is an illustration of facts and happenings, it must be drawn in such a manner that these facts or happenings are clearly demonstrated. If, for instance, it is desired to show the change in temperature of a fever patient, a large scale chart is used, since the temperature is not likely to vary more than

a few degrees, and therefore the open scale flashes to the eye the rise or fall from normal; but, if the same scale of units was used to represent the patient's weight before and after the illness, it is probable that the drop would appear altogether too startling.

It will be found when the reader comes to build up his system of business charts that in certain instances it is more important to flash to the eye the fact that some item has begun to fall than to make this fall directly comparable to another through the use of the same scale.

It may be taken as an all-round recommendation that the chart scales should be so adjusted that the results are clear without being "jumpy." Trends should always be arranged so as to be gradual—the individual results being recorded in such a manner that the maximum fluctuation is confined within reasonable limits.

3. Whenever possible, indicate by a coloured or dotted line on the chart the course that the recorded results ought to take.

This recommendation comes very close to the "setting of a quota," which belongs more to questions of management than the technique of making charts. At the same time no chart which records results that can be controlled by the business man interested is really complete unless it bears some ideal line against which the reader can compare the periodical results that he is entering up on the growing chart. The quota or "desired" line should, therefore, be added whenever possible, and it will be found that once the practice of adding quotas has taken root, the whole science of graphical management control begins to grow almost at once. Are you considering your monthly sales results? Draw upon the chart field the monthly results for the previous year, and you will find that as your current line grows month by month, the fact that it is above

or below last year's results has a most stimulating effect upon the whole outlook. In fact, it forms an immediate appeal to that sporting instinct which has been always the root of so much remarkable effort.

4. Do not put more than two or at most three curves on one sheet of paper, unless each curve is in a separate portion of the chart field and does not interfere with the other curves.

One of the commonest and most annoying mistakes made in charting is the attempt to get a large number of curves upon one sheet of paper because the facts from which the curves are made happen to relate to each other. The effect of a number of lines criss-crossing each other becomes bewildering, and the eye is quite unable to obtain that immediate impression which is the primary object of all good charts. Occasionally, of course—as in multiple control charts—the results can be so arranged that the lines do not interfere with each other; in this case it is an advantage to have all the curves on the same sheet, as direct reference can then be made to the relative rise and fall at the same date. If, however, the curves are not separated it is better to make several charts, repeating where necessary the same curve on a different sheet for comparative purposes. Curves representing facts which have no relation to each other should never be shown on the same sheet.

5. Make all your charts on standard octavo, quarto, or foolscap.

Handiness is one of the most important qualities of a chart. Squared paper was originally produced for the use of mathematicians and draughtsmen who desired to solve problems which were easier to handle when dealt with graphically, and the use of printed squared paper, in large sheets or rolls, saved a considerable amount of time in drawing up such graphs. As squared paper came into use for business charts, this

paper, being the only one available, had to be used. It was, therefore, at one time the practice to make up these business charts on large-size sheets, which were then kept in a portfolio.

But the portfolio proved a very unhandy method of keeping the charts, and was in fact an actual hindrance to their use. It would not fit into any ordinary desk drawer, and, when stood upon end, soon caused the charts to become crumpled at the edges. To open the portfolio a complete clearance of the desk top was usually necessary, and the result was that only too often the portfolio remained untouched, save by the chart clerk, month after month.

When, however, the growing popularity of graphical methods in America caused a demand for chart paper of various sorts, there were soon found enterprising firms who were prepared to supply what was wanted. In this way a large range of chart papers of different designs came into being, printed on pocket-book, quarto, or foolscap size. Several firms in England are to-day supplying these papers, and there is, therefore, no difficulty in obtaining convenient paper already punched for loose-leaf binders.

Where a large number of charts requires periodical examination it is often convenient to make them out on standard 6 in. by 4 in. cards with suitable grids. Special cards for this purpose are now obtainable, and they have the advantage of occupying little space and at the same time being quite effective as far as the demonstration of rising and falling curves is concerned. When not in use they can be kept in the standard filing cabinet, brought out periodically, and made up, and then pinned to a board with the charts representing interlocking facts arranged in close proximity to each other.

In this manner a quick view can be obtained of any facts which are liable to influence each other.

The pocket-book size paper should not be used for standard charts, but may be of great assistance for supplying information for the private use of members of the staff. The best size to use for a standard range of charts is quarto, punched with three holes for a standard ring binder, care being taken to choose a binder in which the rings are of a generous size. Small rings will be found to tear through the paper very quickly, and if the edge of every chart has to be backed the binder is soon over-full.

For reports, or diagrams covering a number of years, foolscap should be used.

6. If there is any chart in the set which is not looked at at least once a month, tear it up or transfer it to a file for reference.

In no circumstances should "dead" charts be allowed to remain among those in current use. The book should contain nothing that does not come under weekly or monthly review. But frequently it is of assistance to make some chart which will be in use only for a few weeks; once done with, however, it should be put away for reference, and not kept with the current set.

In a small textbook of this nature it is difficult to include all the suggestions and recommendations which rise to one's mind in connection with the making of charts for business purposes. The reader will find that experience is the best teacher, and that the eye soon accustoms itself to what looks best, either for large "wall" charts or quarto size for general control use. The most important things to aim at or avoid have been given in this chapter, and by taking these recommendations to heart the beginner in business graphics will find he is starting on the right lines.

CHAPTER VI

THE BAR CHART

WE come now to a class of charts which is constantly in use for business purposes, and which possesses a number of special advantages, viz., the bar chart. This type of diagram has one great advantage over the line charts, which will be dealt with later, in that it has no connection with mathematics. Hence it is apt to be accepted more readily by those who are not accustomed to diagrams and therefore think that a line laid out on squared paper must of necessity have something complicated and magical about it. The most suspicious mind cannot be puzzled by a row of bars standing beside each other, and as long as these bar charts are not complicated by ingenious methods into Chinese puzzles, they can be of great assistance to us.

It is not proposed to deal here with the more unusual and freak forms of bar charts to which reference will be found in the larger textbooks on graphics. It is not to be expected that so simple a matter as a line of bars standing beside each other on a common base would be allowed to go on for long unmolested by the experts. We shall, however, only deal here with the simple and useful forms known as "Simple," "Compound," and "Relative" Bar Charts.

Fig. 10 shows an elementary example of a simple bar chart. The scale is set out on the left, the time periods along the bottom, and the figures involved will be seen set out above the bars. A glance at this chart shows that the total sales rose rapidly from January to March, fell off again to June, and, after a rise in July, fell steadily throughout the remaining five months of the year. This chart expresses clearly one simple fact, i.e. the total sales recorded for each month of the year 1928; and in

addition to this fact a dotted line has been drawn across the chart at the point marking £11,765, which was the average monthly result for the previous year. From this can be deduced a second simple fact, i.e. that five months of 1928 were above the average of 1927, and seven months were below.

It is obvious that a great many more facts could be demanded. How do the individual months compare

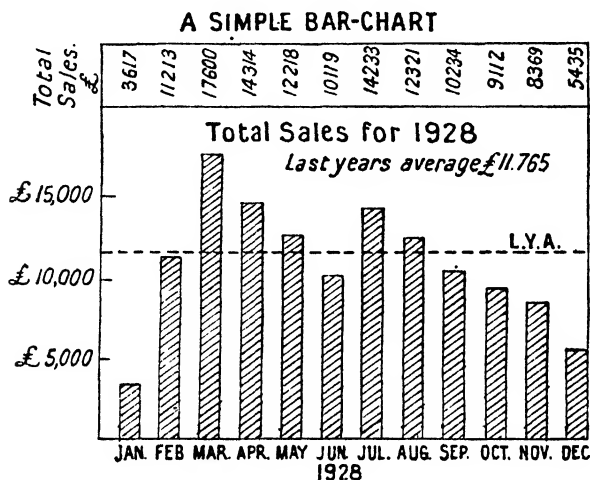


FIG. 13

between the two years? How do the cumulative results, mounting up month by month, compare for the two years? Was the total at the end of 1927 greater or less than the total for 1928? Were the seasonal fluctuations the same in both years? None of these questions, it will be noticed, are answered by this bar chart, for the simple reason that bar charts are not intended to answer such questions. If the reader is anxious to know so much he must refer to the line charts, which are dealt with later, and not expect a simple bar chart to do work for which it is not designed. It is important to appreciate this point, as one frequently hears a comment such as "Yes,

that is very interesting; but it does not say what the total result for the year is—so what good is it?" If such a question can be raised at all it is evident that the information should never have been put forward in the form of a bar chart. Bar charts should be used to illustrate simple facts, where each item recorded is complete in

A COMPOUND BAR-CHART.

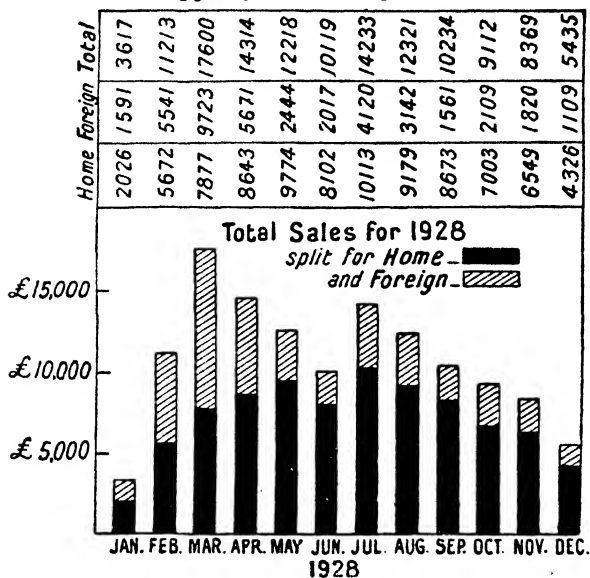


FIG. 14. (COMPARE WITH FIG. 13)

itself. For instance, bar charts are eminently suitable for recording stocks held, population figures over a period of years, or classified quantities which have no relation to each other. In the example shown it is surmised that for some reason it was desired to demonstrate the total sales results according to months—on purpose, possibly, to establish a periodic fluctuation. Four or five years set one above the other in this manner would show at a glance whether the rises in March and July were repeated in other years, and based on this information the

manufacturing department could prepare their seasonal production programme.

Fig. 13 standing by itself would naturally be open to criticism as supplying only a partial picture of the sales result for the year. It could only be justified by having been required for a special investigation of some nature.

A bar chart is called "Compound" when each bar has been split up into a number of components, which have then to be distinguished from each other by shading or colouring. This is where the bar chart presents a distinct advantage over the line chart, since the bar chart

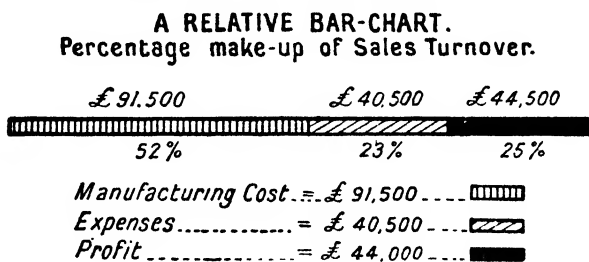
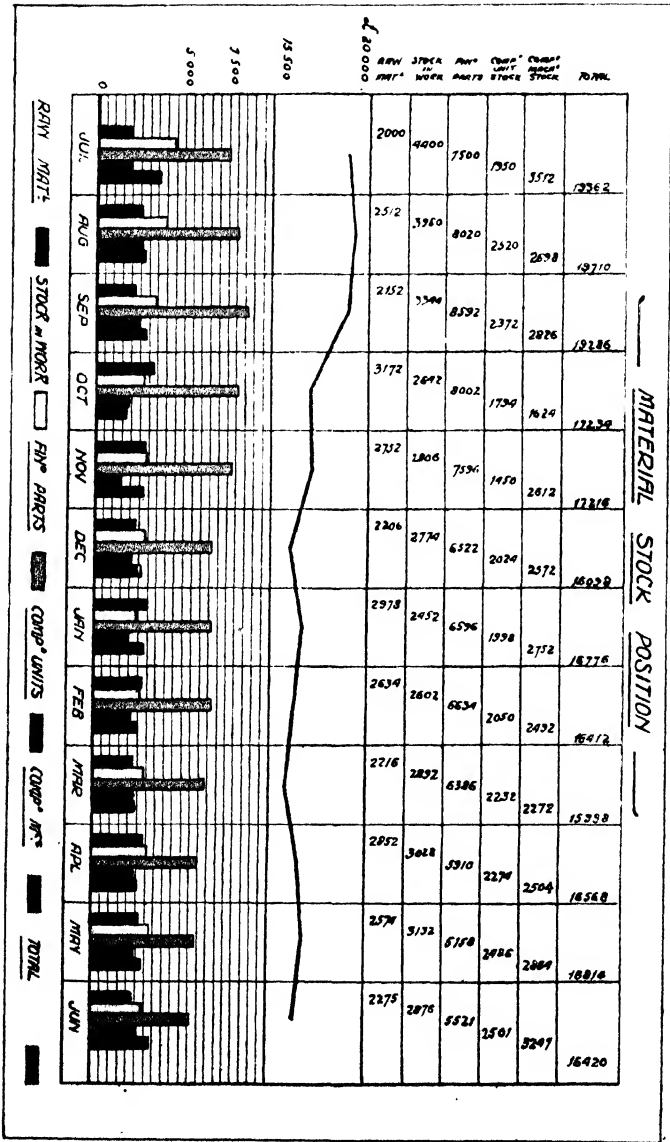


FIG. 15

can be split up into a number of convenient sections shown in different colours, and yet the full height of the bar still draws the eye to the effect of the total. In this manner the eye can take in the expansion and contraction of the various shaded or coloured sections, and at the same time easily compares the monthly results as a whole by the heights of the various bars. Fig. 14 shows a compound bar chart of this type.

The bar also forms a handy method of expressing percentages, and when used in this manner is known as a "relative" bar chart. If it is desired to illustrate the make-up of one total, the bar should be horizontal and of a good size, each section being coloured or shaded in a distinguishing manner as shown in Fig. 15. The percentages should be written in below each section and the actual figures above. These last points should never be

FIG. 16. MONTHLY RETURN OF MATERIAL STOCK POSITION



overlooked, as otherwise the chart is "blind." If possible the figures should be written horizontally so as to be read easily at a glance, but where the sections involved are small it may be necessary to write them vertically; this should, however, be avoided if possible.

Where percentages are compared on a monthly basis (as, for instance, in Sales \pounds Charts) the time variable is introduced and, therefore, the percentage bar should be vertical. They will naturally all be the same height and the percentages should be written in at the top of the chart in the usual manner. Such charts are usually best coloured, and it is a simple matter to compare the varying size of the sections by running the eye across the chart.

There is another type of chart in which the bar can be useful. Take a monthly return of six items which are dependent on each other; for instance, in a works the stock total will be made up of raw material, material in process, finished parts, finished units, completed machines, and goods packed for delivery. The total of these items should be the total stock value at the works, and the manager will desire to ensure that a certain figure is not exceeded. As one increases another will decrease—as the quantity of completed machines becomes larger the value of the finished parts in stores will become less, until replenished from the machine shops, which again will draw their own further supplies from the raw material stores. In this manner the various items will see-saw, and here a series of six bars drawn alongside each other to the varying heights represented by the values involved will enable the manager to keep a careful watch on how each section is behaving. In this case the six bars standing alongside each other are undoubtedly more effective than six lines vertically superimposed; for if the lines are drawn from the zero base they will criss-cross to such an extent that they will not be legible, and if each is drawn upon the back of the previous one the movable base lines

prevent the slope of the line above having any significance whatever. Fig. 16 shows a bar chart of this type, and it will be seen that it is quite easy to concentrate the attention on the individual colours, in order to watch the rise and fall of each section.

There is one point in connection with these bar charts

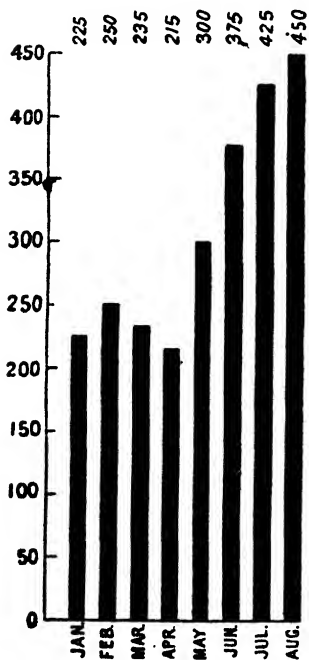


FIG. 17. A CORRECTLY DRAWN BAR CHART

that should be borne in mind, and that is that the zero should always be shown. Occasionally one comes across bar charts drawn to a somewhat exaggerated vertical scale,

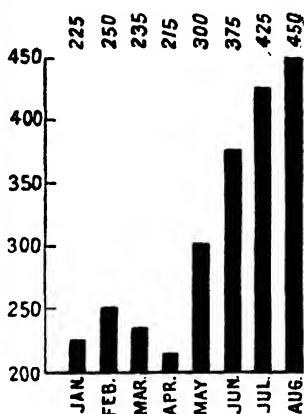


FIG. 18. A MISLEADING BAR CHART

and this tempts the unwary to omit that lower section of the bars which is common to all. But in doing, this a totally false impression is given, as will be seen at once from Figs. 17 and 18. The August figure is an increase of 100 per cent over January, and in Fig. 17 is correctly set out, the bar for January being half the height of that for August. In Fig. 18, however, though the figures are the same, the bar for August is ten times as high

as the bar for January, thus conveying an altogether untrue idea of the relative magnitudes.

Remember, therefore, that in bar charts all bars should *invariably* start from zero.

As in all charts, the choice of scale for bar charts must be carefully made. The bars should be adjusted to the size of chart field in such a manner that they are neither too small nor too large, and a little practice soon educates the eye to estimate the correct proportions. Except in the multiple bar charts just described, spaces should always be left between each bar, not only to emphasize the fact that each is a fresh result, but so as to permit the comparison of the one bar chart with another over a source of light. The bars being more or less opaque, it is not as easy to place the charts one directly above the other in register as it is with line charts, since it will be found that the different heights of the bars on the front chart and the back chart become confusing to the eye. If, however, one chart be set half a space to one side, the heights on the front and the back charts can be readily noted. On the whole, however, it will be found that the direct comparison of bar charts is unsatisfactory, and where such comparison is likely to be needed line charts should be used.

If neatly drawn these bar charts are very decorative and seldom fail to find favour amongst those to whom they are submitted. It is an undoubted fact that they are easier to read than a line chart, and the fact mentioned above, that there is no mathematical association with them, is in their favour. They have their limitations, and it is a great mistake to endeavour to force them to do more than their duty; but provided the right principles are observed and these limitations clearly understood, they will be found of great service for presenting simple facts in a clear and striking manner.

Before leaving the subject of bar charts it may be as well to describe what are known as "mechanical bar

charts." These can be very simply and cheaply made out of red and white silk ribbon, say $\frac{3}{8}$ " wide. The two colours are cut square and joined neatly with seccotine; a suitable board is taken and the top and bottom edges rounded off and well smoothed; the tape is then passed over the board, top and bottom, in equal portions of red and white, and tied fairly tightly at the back. In this manner an endless band is formed, half red, half white, kept taut by the elasticity of the material itself.

A sheet of paper is then suitably ruled with horizontal lines, slipped *beneath* the tapes, and pinned to the surface of the board; this forms the scale. The title of the chart is written on a long, narrow strip of paper, and pinned right across the top of the board, *above* the tapes; another strip, also pinned *above* the tapes, extends across the board at the bottom. This latter strip is divided into sections, one to each tape, and in these sections is entered the description of the item represented by the tape. As many tapes as desired can be put on the same board, each one being provided with guides top and bottom so as to prevent it working out of place as it is pulled up and down. These guides can be formed by small brads with rounded heads, tapped into the wood on either side of the ribbon.

With all items set at zero all the tapes will show white, the red portion being covered by the lower strip. As the items rise, the tapes are pulled round (from behind) and the red shows above the lower strip, the joint being raised to the correct point on the scale. The red then shows up vividly as a vertical bar, the white ribbon scarcely showing against the white paper background. In this way the tape for each item is set every day, and a permanent bar chart is obtained where it is never necessary to rub anything out.

These "tape-charts" are simple to make, very decorative, and most effective in use. Once made, they can

be used for any purpose, as the scales, title, section-headings etc., being only pinned on, can be altered at any time, leaving the actual tapes untouched.

Multiple boards can be made, with different coloured tapes one above another, giving different phases of the same item, provided a slot be left between each part of the board so that the tape can pass round. The slot is covered by the title sheet, so that the appearance is that of a solid board.

CHAPTER VII

LINE CHARTS

It is customary to divide line charts into two categories: those showing amount of change and those showing rate of change. The former is the better-known class, and almost everyone nowadays is familiar with the type of diagram in which a number of points are plotted and then joined by a line. Such a line, rising or falling, shows the amount of change from week to week or from month to month.

This particular method of illustrating facts graphically is susceptible to a vast number of variations. In the usual form the scales are laid out at the bottom and the left-hand side of the paper, leaving the whole of the chart-field free for the diagram. Where the horizontal scale deals with time and the vertical with some other factor, such charts are called "historical." The only really satisfactory way of demonstrating the uses of these charts is to give a number of examples and explain each in turn; unfortunately, this cannot be done here owing to lack of space. Descriptions in words would merely prove tedious and confusing, but if the reader follows out the suggestions set out in Chapter V, he has only to plot his information and draw the connecting line to get an historical chart of the statistics under review.

It might be as well to point out that if results covering a period are being plotted, the point should be placed in the middle of the space allowed horizontally for that period. Not infrequently charts will be found with the months or years written in between the vertical rulings, and the points plotted on the rulings themselves—generally to the right, owing to the fact that the scale occupies the first vertical line. This procedure is apt to be misleading, as by the time the curve has reached the middle of the

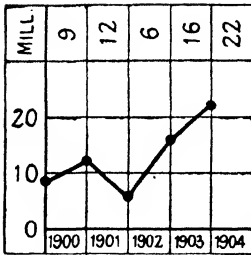


FIG. 19 a

YEARS BETWEEN THE RULINGS; POINTS TO LEFT. WRONG

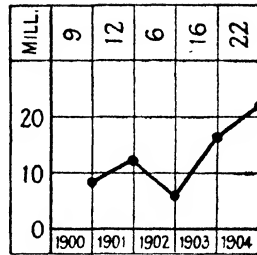


FIG. 19 b

YEARS BETWEEN THE RULINGS; POINTS TO RIGHT. WRONG

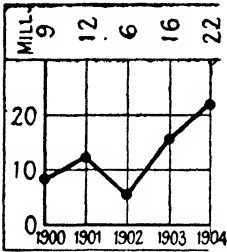


FIG. 19 c

THE USUAL AMERICAN METHOD, WITH YEARS BELOW THE RULINGS
SOMETIMES INCONVENIENT OWING TO THE FIRST PLOTTED POINT LYING ON THE SCALE.

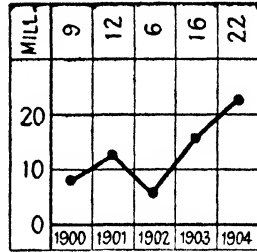


FIG. 19 d

THE MOST EFFECTIVE METHOD; YEARS BETWEEN THE RULINGS, AND POINTS PLOTTED IN THE CENTRE OF EACH TIME-SPACE

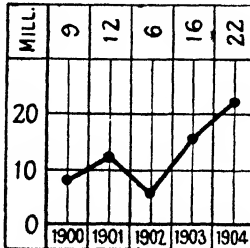


FIG. 19 e

THIS SHOWS FIG. 19 d WITH THE INVISIBLE CENTRE-LINES DRAWN IN

chart-field the reader, seeing a point on a vertical line between two months, is uncertain to which it belongs.

Examination of Figs. 19 *a*, *b*, *c*, *d* and *e* will make this point clear. It will be seen that *c* and *d* are really identical, the difference being that in *c* the divisions between the years are invisible, and in *d* the centre-lines of the years are invisible. In 19 *e* we see 16 *d* with the centre-lines drawn in, and this is the theoretically perfect form for use in historical line charts. When using commercial chart-paper it is almost always possible to choose a horizontal time scale such that both time-divisions and centre-lines are available.

The disadvantage of 19 *c* is that all historical charts record results over a period of time, and a period is better represented by a space than by a line. Even though we may be thinking of the recorded result of a month's sales, we think of it as a sum obtained between the first and the last day of the month—i.e. over a time period. It is therefore, more natural to show that time period as a space, with the result plotted in the centre of the space—since we cannot plot it to the right of the space (where it properly belongs, having been achieved by the conclusion of the time period) owing to the reasons already stated.

The reader will find that the majority of existing textbooks, being of American origin, use the style shown in Fig. 19 *c* in plotting historical charts. If the first result was plotted on the first vertical to the right of the scale axis, the result would in effect be style 19 *e*, with invisible time-divisions. But the usual American practice appears to be to plot the first result on the scale axis itself, and this effectually prevents the "time period" impression, which the author submits is too important in business graphics to be thus overlooked. Moreover, style 19 *c* makes it more difficult to write in the figures at the top of the chart, where they must always be shown.

It may be objected that if accuracy is to be obtained it is necessary to draw in the centre-lines in style 19 *e*. But

in actual practice—and this book is intended for practical use—the eye can estimate the centre of the space without difficulty, even if the chart-paper used does not supply a centre-line ready drawn in.

Frequency Charts.

On many occasions it is desired to compare the relation of two variables at a given point of time. For instance, a diagram (Fig. 20) showing the number of times the

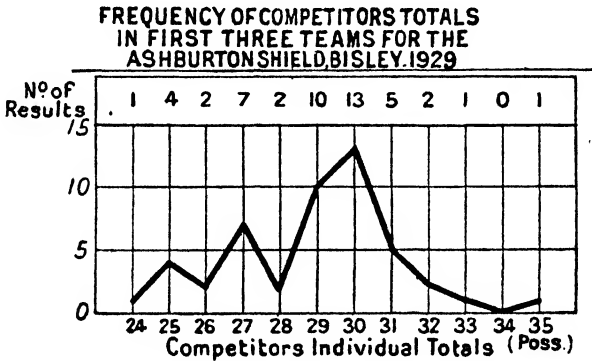


FIG. 20. A FREQUENCY CHART

various scores up to the possible occurred in the results obtained by the first three public school teams competing in the Ashburton Shield at Bisley is a “frequency chart,” and shows that 30 was the most frequent score, occurring 13 times. In this case the “given point of time” is the duration of the competition.

It can be seen that charts of this nature can be of great help in obtaining a clear impression of, say, the relative popularity of the different models that go to make up a sales range, or the amount of sickness prevalent amongst workmen of different ages, or, indeed, the relation to each other of any two items. And as so much in business depends on the relation of two ranges of statistics at a given moment of time, the frequency chart can be of great assistance.

Divergence Charts.

When it is desired to show the profit or loss made over a series of years, or the rise or fall of a stock above or below a minimum, or, in fact, to plot any information where the divergence of the results from a normal is under consideration, the base line of the diagram is best drawn across the middle of the chart-paper, instead of the bottom. The vertical scales are then laid out above and below this central base line, working upwards and downwards so that the variation of the results appears as a wavy line crossing and recrossing the base, or as a series of bars above and below the line. In this manner the attention is immediately drawn to the fact that the results have been better or worse than normal; the eye estimates the amount below against the amount above and so gains an immediate impression of the net result. It is often a good plan to run a "cumulative value" line on the upper half of the chart, so that the variations can be judged in terms of the cumulative results (Fig. 21).

Such charts are known as "divergence charts," and with astute use they can be made a great help towards keeping a tight hold on the trend of affairs. For, if the first step is to set a "quota" to be aimed at, the second is clearly to measure the divergence from it.

For further information on charts of this nature the reader is advised to study the more advanced textbooks, since they invariably give a very large number of examples, and by examining these examples the best idea can be obtained of the methods by which various classes of statistics can be turned into graphical form. When all is said and done, they are all variations of the line and bar, and whilst the study of illustrations has a great educative value, it would be impossible to attempt to provide them in a small textbook of this nature.

Moreover a definite danger arises, and that is that since the simplest charts are really the most valuable

ones, the study too early of advanced practice sometimes leads to ambitious and unsatisfactory attempts on the part of the beginner. To an expert analyst, accustomed to seeking for key facts in a combination of graphical presentations, the more complex forms of chart present no difficulty. It is, however, an undoubted fact that

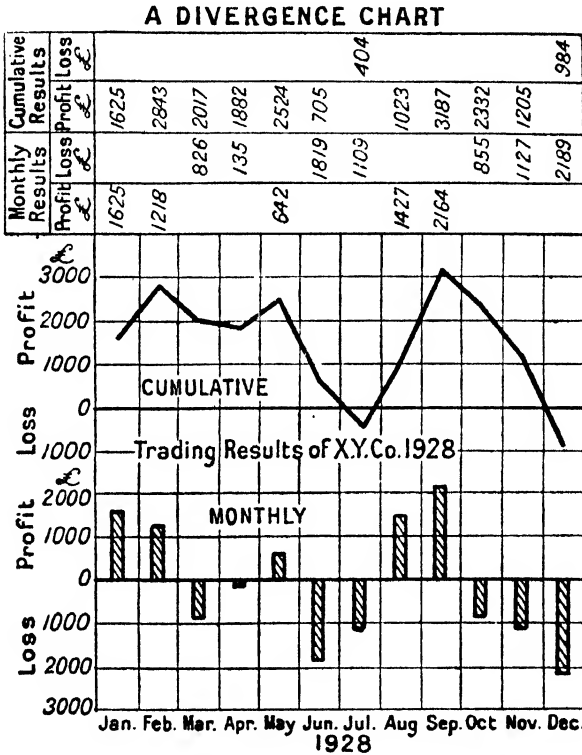


FIG. 21

they do bewilder and depress those who are not accustomed to their use, and therefore the author prefers to omit them altogether and so endeavour to keep within the capacity of the student for whom this book is intended.

CHAPTER VIII

LINE CHARTS (CONTINUED): A PRACTICAL EXAMPLE

PERHAPS the best method of explaining how line charts are used in business will be to take a definite example. Let us suppose that the X.Y.Z. Company was taken over in July 1928 by a rival concern, a new board being formed. The newly appointed managing director desires to investigate the past results of the company from different angles, and to lay out a policy which will enable sales to be extended and profits increased.

Investigation shows that the X.Y.Z. Company deals in four main selling lines, which we will call Departments *A*, *B*, *C* and *D* respectively. The company when taken over was considered to be in a good position, and so far as the old management was aware matters were proceeding smoothly.

The new managing director has heard some of his friends speak of the advantages to be obtained by graphical representation of business facts. He is not himself an expert in graphical control, and he therefore desires to proceed cautiously and work up his charts step by step, thus not only forming his own opinion as to the best method of demonstrating what he wishes to find out, but also teaching the staff of the X.Y.Z. Company, which has so far not had much to do with graphical methods.

The first item investigated will naturally be the sales results as far back as these can be ascertained. Two full trading years of departmental sales results are available, and these are tabulated. Fig. 22 shows these results. A consideration of the figures leaves the impression that Department *A* shows but small variations, Department *B* has risen steadily from £23,712 to £34,412, Department *C* has kept fairly steady with a slight fall, and Department *D* shows altogether irregular figures, from which little or nothing can be gleaned by casual inspection.

Our managing director calls then for a line chart representing these figures. The clerk appointed to make out the new charts, who has been getting what information he can from textbooks so as to do his best at his novel job, therefore looks the figures over, and seeing that *A*, *B*, and *C* do not clash in any way, decides that they can

MONTHLY SALES TURNOVER. X.Y.Z. CO.

		Dept. A.	Dept. B.	Dept. C.	Dept. D.
1926	J	8,212	23,712	49,611	20,769
	A	9,116	24,620	48,482	25,480
	S	9,483	25,892	47,712	17,219
	O	11,013	27,712	47,481	29,568
	N	11,552	28,216	45,810	30,489
1927	D	11,485	28,517	46,010	36,510
	J	12,007	28,780	45,109	20,497
	F	10,615	29,187	44,185	13,612
	M	9,312	28,687	44,671	10,333
	A	8,003	28,011	44,285	18,861
	M	8,195	28,198	45,012	27,682
	J	8,016	28,816	46,009	29,480
	1928	J	8,611	29,820	46,002	24,386
A		8,987	30,863	45,108	28,327
S		9,310	31,437	45,493	18,002
O		9,662	33,313	45,016	30,789
N		9,811	34,490	44,107	31,015
D		10,808	34,367	44,003	36,272
J		11,009	34,298	44,207	20,115
F		10,516	34,785	43,896	12,501
M		10,085	35,397	44,371	9,162
A		9,890	34,289	44,011	17,867
M		10,001	34,246	43,252	26,688
J		9,882	34,412	42,887	28,678

FIG. 22

safely be put on the same piece of paper. Department *D*, which fluctuates to a considerable extent, had better be drawn out on a sheet by itself. This is then carried out and Figs. 23 and 24 are the result.

The managing director ponders over these four lines, and without much difficulty can draw the following conclusions.

1. The goods made by Department *A* are evidently subject to a sale which is in some degree a seasonal one, i.e. the sales are higher in the winter months and less in the summer. The peak for the winter season 1927-28 is however less than the peak for the same period 1926-27. This might indicate that the demand is becoming steady rather than seasonal, but the fact that the results for the winter 1927-28 were worse than those for the previous year should call for some explanation from the sales manager in charge of that department.

2. The sales for Department *B* show a steady increase since April 1927, and from the end of that year have kept almost constant. The rise during the autumn of 1927 is no doubt a matter for congratulation, but that seven months should have elapsed with very little further increase must have some reason at the back of it that ought to be known by the sales manager of Department *B*.

3. Department *C* has shown a steady fall from the start of the figures available. A very slight recovery during the summer of 1927 has been followed by a steady fall ever since, and here it is evident that a strict investigation will be needed as to the causes of this fall: whether the sales policy requires adjustment, or whether it would be wiser to drop this line of goods altogether.

4. Department *D* is evidently seasonal to some extent as well, and obviously represents a department manufacturing comparatively small numbers of expensive items. Where a turnover is numerically large and the articles concerned are low-priced, the fluctuations in monthly sales value will probably be comparatively small as in the case of the three departments already mentioned. Where, however, the turnover is numerically small and the prices high, the monthly sales value is liable to fluctuate to a considerable extent.

Department *D* is evidently a case of this nature, since the monthly sales vary between £9,162 and £36,510. In this case, the managing director is a little puzzled as to

MONTHLY SALES TURNOVER, X.Y.Z. G.

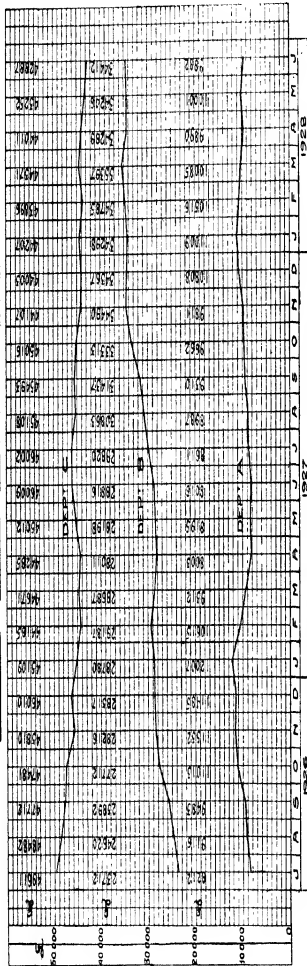


FIG. 23

MONTHLY SALES TURNOVER, X.Y.Z. G.

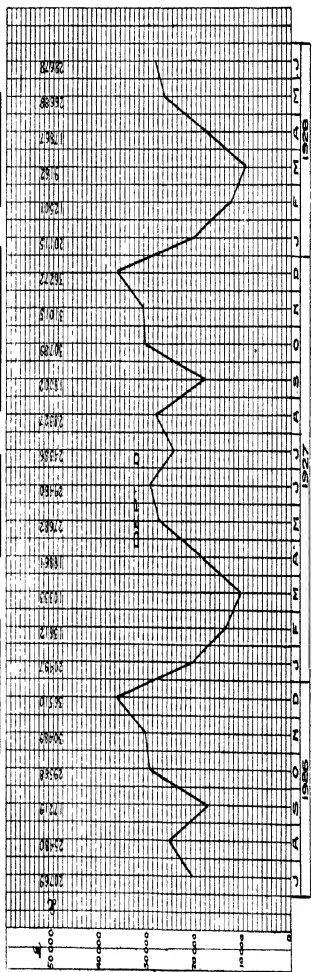


FIG. 24

what deduction he is to draw from the line chart showing Department *D*'s results. The general impression he obtains is that, although the results show a remarkably regular periodicity, the sales are on the whole falling off—this impression being due to the fact that the big drop in March 1928 is lower than the drop in March 1927, and this gives an indication of decrease. He refers this chart back to the chart clerk for further investigation, and from his study of the other three comes to the conclusion that the sales results of the company are by no means healthy, a fact which he would never have noticed from the four columns of figures in Fig. 22.

None of the four departments appears to show improving results. Department *B* is stationary, and *A*, *C*, and *D* are apparently falling off. The net result, therefore, of his first graphical study is to call a special meeting of his sales managers to discuss the whole position, placing before them these curves and asking them for their suggestions and proposals.

Had he laid before the sales managers the table of figures shown in Fig. 22, it would undoubtedly have left them cold. As it is, however, three of the four charts show clearly what is happening, and that something must be done if the prosperity of the firm is to increase.

Meanwhile, the chart clerk has retired with Department *D*'s results in order to try to get some clearer picture for his chief as to how matters are going. What he wishes to show is the trend of affairs. That is to say, it is necessary for him to smooth out the peaks and valleys. He refers to his textbook on graphics for help in his problem, and finds that there are a number of ways of showing trends, and that the best of these, and the one which should be used wherever possible in business statistics, is the moving annual total.

The vast majority of business statistics are taken annually. Profits, turnover, output, and so forth, are all summarized in the annual statements as the result of

twelve months' work. Hence the result which is most easily recognized and upon which most faith is placed in business circles is the result obtained at the end of a financial year of twelve months. Now companies frequently vary as to the concluding date of their financial year. Some work to the 30th June, some to the 31st December, others again to the 30th September, and there appears to be no fixed rule as to when this date should be. If, therefore, this imaginary year ends on 30th June, there is no reason why it should not end just as well on 31st July, or 31st August; and if the results are known for the financial year ending 30th June, it is simple to obtain a financial year ending on 31st July, by adding the results for the month of July to the 12 months ending 30th June, and then subtracting the results obtained for the previous July. By so doing we are left with 12 months as before, or in other words a financial year that has ended on 31st July; another financial year ending 31st August is obtained by adding the new August results and subtracting the old ones, and so we go on, always producing a twelve-monthly result as the months pass. Obviously when we have done this twelve times we shall have got back to our original date of 30th June again; all the old months will have been subtracted and we shall have been left with the twelve months which represent the new financial year just completed.

This principle is known as working with a moving annual total, and it is one of the most valuable facts in connection with business graphics. It is most common to hear a dogmatic statement that certain facts can only be obtained as the result of twelve months' trading, and yet if such results can be obtained at all for the twelve months' trading, they can obviously be obtained—given modern accountancy methods and machinery—each month, and so by adding the new and subtracting the old the permanent twelve-monthly period can be carried on.

Our chart clerk, therefore, works out his M.A.T. for Department *D* as follows—

CALCULATIONS FOR MOVING ANNUAL TOTAL FIGURES
Department *D*

1926-27 Monthly Results			1927-28 Monthly Results		
£			£		
1926	J . .	20,769	1927	J . .	24,386
	A . .	25,480		A . .	28,327
	S . .	17,219		S . .	18,002
	O . .	29,568		O . .	30,789
	N . .	30,489		N . .	31,015
	D . .	36,510		D . .	36,272
1927	J . .	20,497	1928	J . .	20,115
	F . .	13,612		F . .	12,501
	M . .	10,333		M . .	9,162
	A . .	18,881		A . .	17,867
	M . .	27,682		M . .	26,688
	J . .	29,480		J . .	28,678

Subtract July, 1926 $\frac{280,520^*}{20,769}$ = Total for 12 months ending 30th June, 1927.

Add July, 1927 . $\frac{259,751}{24,386}$

Subtract Aug., 1926 $\frac{284,137^*}{25,480}$ = Total for 12 months ending 31st July, 1927.

Add Aug., 1927 . $\frac{258,657}{28,327}$

Subtract Sept., 1926 $\frac{286,984^*}{17,219}$ = Total for 12 months ending 31st August, 1927.

Add Sept., 1927 . $\frac{269,765}{18,002}$

Subtract Oct., 1926 $\frac{287,767^*}{29,568}$ = Total for 12 months ending 30th September, 1927.

Add Oct., 1927 . $\frac{258,199}{30,789}$

Subtract Nov., 1926 $\frac{288,988^*}{30,489}$ = Total for 12 months ending 31st October, 1927.

Add Nov. 1927 . $\frac{258,499}{31,015}$

Subtract Dec., 1926 $\frac{289,514^*}{36,510}$ = Total for 12 months ending 30th November, 1927.

Add Dec., 1927 .	253,004	
	<u>36,272</u>	
Subtract Jan., 1927	289,276*	= Total for 12 months ending
	<u>20,497</u>	31st December, 1927.
Add Jan., 1928 .	268,779	
	<u>20,115</u>	
Subtract Feb., 1927	288,894*	= Total for 12 months ending
	<u>13,612</u>	31st January, 1928.
Add Feb., 1928 .	275,282	
	<u>12,501</u>	
Subtract Mar., 1927	287,783*	= Total for 12 months ending
	<u>10,333</u>	29th February, 1928.
Add Mar., 1928 .	277,450	
	<u>9,162</u>	
Subtract April, 1927	286,612*	= Total for 12 months ending
	<u>18,881</u>	31st March, 1928.
Add April, 1928 .	267,731	
	<u>17,867</u>	
Subtract May, 1927	285,598*	= Total for 12 months ending
	<u>27,682</u>	30th April, 1928.
Add May, 1928 .	257,916	
	<u>26,688</u>	
Subtract June, 1927	284,604*	= Total for 12 months ending
	<u>29,480</u>	31st May, 1928.
Add June, 1928 .	255,124	
	<u>28,678</u>	
	283,802*	= Total for 12 months ending
		30th June, 1928.

This is the final figure for the new financial year.
Hence we can now compare, on the old system—

Sales Turnover, Financial year 1926-27	=	280,520
" " " " " " " " " " " "	=	283,802
An increase of		3,282

Under the old system the 1927-28 "year's turnover" would only have been known at the end of June. Working on the "moving annual total" system the trend of the

“year’s turnover” is known at the end of every month, as shown by the figures marked with an asterisk (*).

It will be seen that the first twelve months’ results gave him his M.A.T. and the remaining 12 months will give him 12 points from which he can obtain his trend. It is then immediately apparent that the trend of the sales for Department *D* has been falling off since November 1927. From June 1927 to November 1927 the trend was steadily improving; but December showed the first step on the

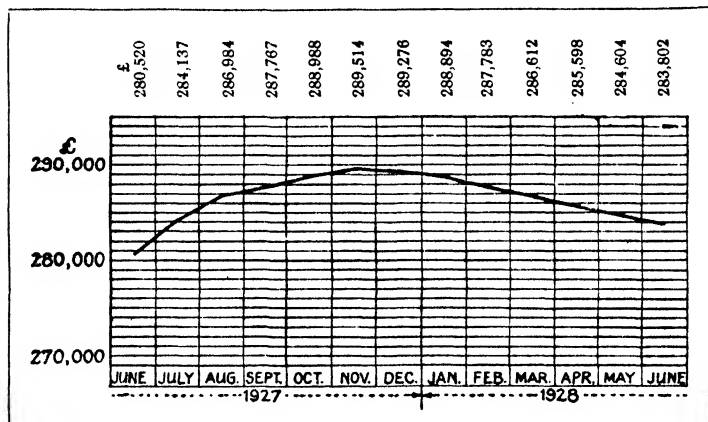


FIG. 25

downward grade, and since then there has been no sign of recovery (Fig. 25).

This result is placed before the managing director and serves him as an example of how a trend worked out as a M.A.T. is the only way to obtain a true idea of what is happening when results are erratic. He realizes, when he has grasped the principle upon which the M.A.T. rests, that he could have seen whether the trend was upwards or downwards by comparing each monthly result with the same month of the previous year. This is, however, a very slow and clumsy method when compared with a single glance at the M.A.T. line which shows the trend immediately.

Struck by the impression which he has gained from the trend line for section *D*, the managing director calls for a series of trend lines for *A*, *B*, and *C*. He knows that his annual turnover at 30th June 1928 amounted to £1,282,254, made up as follows—

Dept. <i>A</i>	£
Dept. <i>B</i>	117,009
Dept. <i>C</i>	330,348
Dept. <i>D</i>	554,377
	<hr/>
Total	280,520
	<hr/>
	£1,282,254
	<hr/>

Taking into consideration the fixed charges of the company, the overheads, the manufacturing expenses and the profits which he desires to make for the year's trading, he concludes without difficulty that he will have to raise the turnover of the company to £1,750,000 if he is going to fulfil his programme. He, therefore, has a series of conferences with his departmental sales managers, and after more or less strenuous discussion decides—and obtains the agreement of the sales managers to his decision—that the departmental turnovers to be aimed at for the coming year are to be as follows—

Dept. <i>A</i>	£
Dept. <i>B</i>	150,000
Dept. <i>C</i>	500,000
Dept. <i>D</i>	750,000
	<hr/>
Total	350,000
	<hr/>
	£1,750,000
	<hr/>

In other words, he has budgeted his sales turnover, and set a quota for each department to work to.

Much has been written on the subject of budgeting, and as it is a topic upon which a good deal of mental ingenuity may be expended, there is a danger of its assuming a degree of complication which may defeat its own object. To budget expenditure and output for

every department, for every section, and almost for every individual, is certainly a high ideal; but when carried to great lengths the budget principle is apt to become so onerous a burden that it does more harm than good.

On the other hand, the setting of a quota for a sales department or for a works output, in the first instance as an annual figure which is then split into a monthly allocation, is both simple and salutary. It forms a "bogey" against which the whole company can play. The salesmen know the quota that they have to get, and have a definite goal at which to aim. The works know the output that has been laid down for them to obtain, and are given to understand that if they fall down on their side the sales structure will go to the ground as well. It may be possible to sub-divide the sales quota into area quotas or representative quotas; it may be possible to sub-divide the works quota into departmental quotas; but in every case common sense must prevail over red tape. A set quota is useless unless it is treated seriously as a result that *must* be obtained or else a full report and explanation given to the managing director as to why it was not obtained; quotas that are treated as vague goals or unattainable counsels of perfection are worse than useless, since they bring the whole principle of defined aims into disrepute.

The managing director of the X.Y.Z. Company, therefore, calls for five new charts for the coming year (one for each department and one for the total) covering the financial period July 1928 to June 1929, upon which can be marked off month by month the results obtained, so that he can see precisely whether he is reaching or falling away from the quota he has set. For this purpose a line is drawn from zero at the beginning of the year to the quota figure at the end of the twelve months; to give him continuity in his ideas the last month of the previous year is shown on the same chart and the moving annual

total figure is marked upon this as a starting point for the new twelve-months' period.

Being instructed to do this, the chart clerk naturally discovers that he will have to use two scales upon the chart. He wishes to show the monthly results in a clear but not exaggerated fashion, and at the same time he must show the fluctuations of the M.A.T. line, which represents a figure somewhere in the neighbourhood of twelve times the monthly results. Past results will give him a rough idea of what this should be, and since the worst penalty that will befall him is that he will have to make out a new chart if his M.A.T. line runs into the figures, he starts it boldly in the upper third of the chart field.

For reasons of space, and to avoid confusion in the mind of the reader, we will in future deal only with one chart, that for the total sales. The departmental results will, of course, be recorded and analysed in the same manner, but will not be shown here.

Fig. 26 represents, therefore, the chart for the total sales results at the beginning of the 1928-29 financial period. The quota has been set at £1,750,000 and broken lines drawn in for the cumulative and trend lines. All the managing director has to do, month by month, is to enter the results obtained, and the divergence of the lines so obtained from the quota will show him clearly how his affairs are going.

In this manner he records the efforts of his staff, and as the months pass it is evident that these efforts are not sufficient to obtain the result that he is aiming at. At the end of December, when half the year has gone by, the position is as shown in Fig. 27.

The results are improving, certainly—the trend is a steady upward movement—but the progress is so slow that his turnover for the year looks like being nearer £1,450,000 than £1,750,000. Now the managing director realizes that this £300,000 shortage will be enough to

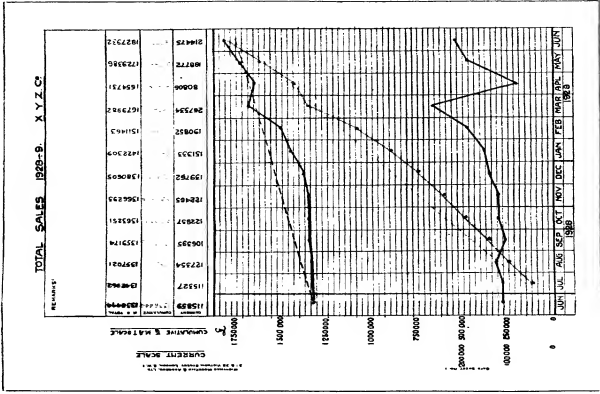


Fig. 28

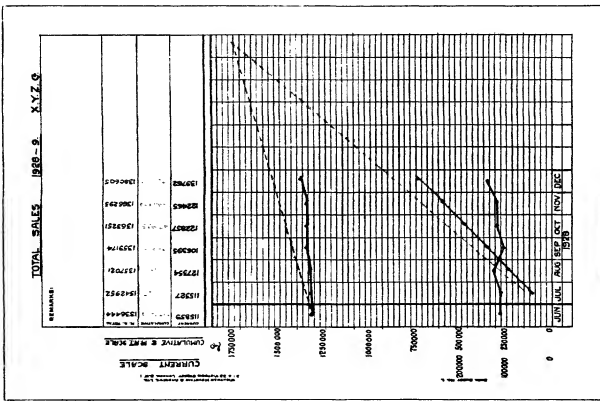


Fig. 27

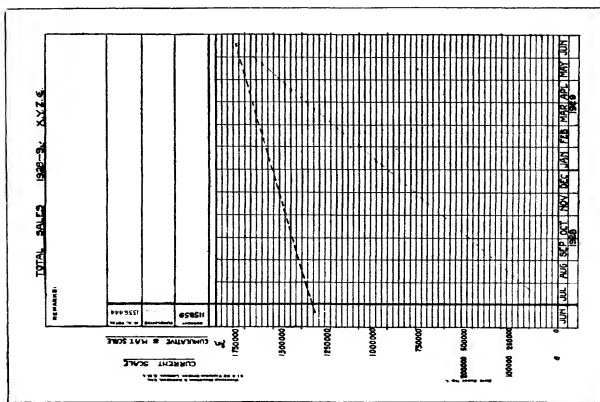


Fig. 26

wreck his plans, and must be avoided at all costs. He sums up the position, therefore, as follows—

Quota required by December, 1929	=	£ 875,000
Actual result obtained	=	734,160
Deficit		<u>£140,840</u>

If he is to reach his £1,750,000 by the end of the year, the sales will have to tackle their normal quota for the next six months, *plus* this deficit; in other words—

Revised sales quota for Jan./June, 1929

Original monthly quota	. . . =	£ 146,000
Share of deficit	. . . =	23,500
Total	. . . . .	<u>£169,500</u>
Say		<u>£170,000</u>

In other words, the sales will have to average £170,000 per month for the rest of the year (instead of £146,000 which was their original task) if the managing director is to get his desired turnover.

Obviously a full and energetic sales conference is required to discuss the situation. The managing director calls in all his responsible staff, a thorough analysis of the position is made, policies and prices revised, the true facts of the situation made clear to all concerned—and the sales staff scatter again, fully armed to begin the fight afresh with a clear policy, definite selling facts, and each man with his quota that he is out to get.

The managing director's confidence is not misplaced. Fig. 28 shows how he was backed up by his staff, and how, after a grim fight through March, April, and May, with the whole team pulling well together, the quota was final achieved.

CHAPTER IX

THE Z-CHART

THE type of chart which has just been described and which is illustrated by Fig. 28 is one of the best known and most useful types of business diagram. It is called a Z-chart, owing to the fact that the three lines of which it is composed, when correctly spaced on the chart field, form a rough Z. These three lines are, it will be remembered—

1. The current results for the month.
2. The cumulative results month by month.
3. The moving annual total.

In view of the great importance of this particular type of chart it may be as well to add a few remarks regarding its composition and use—

1. It will be noted that 13 results are charted instead of 12; the last month of the previous year should always be included in order to provide continuity. If the chart started in January and finished in December, a gap would be found between the years when two or three years' results were placed side by side. Moreover, the trends for the current and M.A.T. lines would not be shown between December and January.

2. The choice of the two scales is of considerable importance and will depend upon the amount of fluctuation expected in the current line. In Fig. 29 it will be seen that the cumulative and M.A.T. scale is twice the current scale, though it should be noted that in the example the M.A.T. line has been started dangerously high. Had the trend begun to move upwards instead of downwards in May 1928, the M.A.T. line would have been off the chart field very quickly, and although it is a simple matter to add with paste and scissors an additional area of chart field, putting the figures below the curve

line, the cumulative with a red line, and the M.A.T. with a blue line. If the figures are typed in the columns at the top they will be all black, the titles having a distinguishing coloured line drawn beneath them. (If carbon backing is used to darken the figures when typed in, care should be taken to see that the chart below in the book is not dirtied by the carbon figures rubbing against it.) Objection is sometimes raised to the fact that coloured lines in charts will not reproduce, and therefore such charts lose their advantages when blue-printed or photostated. This is quite true, but all three lines will come out white if blue-printed or photostated, and can, therefore, be coloured with a very small amount of trouble; and if reproduced by a process in which they come out black, a coloured line can be laid above them with a crayon. A comparison between Fig. 29 and Fig. 28 will show how greatly the balance of interest and appreciation lies with a chart where coloured lines are used to denote different results, and as no more trouble is involved in making up charts in colours than in black, the reader would be well advised to make a practice of using colours.

The psychological effect of a brightly coloured chart, whether bar or line, is very much greater than that of one drawn out entirely in black. And as in business graphics everything possible should be done to arouse and sustain the interest of the reader in the charts and the lessons that can be gained from them, it would, in the writer's opinion, be a very great mistake to adhere to black only, merely because it would be slightly cheaper in the very unlikely event of two or three hundred copies being required.

There are one or two points which can be noted from careful consideration of Fig. 29. It will be remembered that the M.A.T. shows us the trend of the results over a period of twelve months, and therefore is primarily dependent upon the relations between the results for a month

this year with the corresponding month last year. Without the M.A.T. line our managing director would have "patted himself on the back" because his foreign shipments for June were higher than they had been for the three previous months. He would have noticed the fall in May and probably imagined that the excellent result for June had righted the position.

But since he has his M.A.T. as well as his current results he observes with alarm that although the May results have dropped off a couple of thousand pounds and are the worst so far for the year, his M.A.T. for May has shown a fall of £3,409, and therefore the fall is really £3,409 and not £2,094 as it appears to be from the current monthly result. June, which looks so satisfactory because it brings the current line back to nearly the highest point of the year, is really a catastrophe; the M.A.T. has dropped another £7,603—in other words, June, 1927, must have been an exceptionally good month. Consequently June, 1928, which looks satisfactory, is really a relative failure.

The latter half of the year, which appears from the current line to be a steady recovery from the worst point in July, is shown by the M.A.T. to be a continuation of the falling trend until the final result in December, and the net result at the end of the year is that the foreign shipments, instead of having a turnover of £104,271 for the twelve months, have been reduced to £82,266.

A little time spent in studying this example will be well repaid by the sense of security which is gained from the understanding and use of these Z-charts. It will be found that if lines are drawn through the August and September results for the cumulative and M.A.T. lines, they will very nearly meet at the spot where the year's results finally finish; in other words, when the September result was available the estimate of "where the two curves will meet" would have been almost correct. This practice of producing the unfinished curves each

month when the results are entered, in order to see where they appear to be going to meet, is one that can be of great assistance in stimulating effort or in obtaining accurate forecasts. After all, what we ask our business charts to do is to give a clear indication of the trend of affairs. Half the battle is to use the charts so as to see what is going to happen in the future, quite as much as what has happened in the past. And the Z-chart lends itself, as much as any other, to studies of this nature.

It should always be remembered that the M.A.T. line represents a trend; that is, a difference. It gives no indication of the actual result for the week or month—M.A.T.'s can be worked by 52 weeks just as easily as by 12 months. Imagine two years having precisely similar monthly results; the M.A.T. line would be absolutely level, no matter how much the individual results fluctuated. Such fluctuations will, of course, be visible in the current line at the bottom of the chart, and this fact should be borne in mind when seasonal trades are being investigated.

The M.A.T. line may, in fact, be looked upon somewhat in the light of a perpetual inventory of turnover. At the end of each month the managing director can say: "At the moment we are doing business at the rate of so much per annum." It is naturally left to his experience and discretion as to how he uses this information. If the business is subject to seasonal fluctuations it is obvious that at certain periods in the year an increase or reduction in trade must be expected, notwithstanding the fact that the M.A.T. line remains level; but—and here again lies one of the great advantages of these Z-charts—by laying the chart for the current year upon the chart for the previous year, and holding them together against the light, the reader can immediately see whether the turnover in the current period is greater or less than it was at the same time in the previous year from the position of the two lines.

The moving annual total is probably much the most successful manner of comparing business statistics which fluctuate over the period of the financial year. Where, therefore, it is desired to compare the trend of two or three items which, though continuously going on, are periodic in their function, it will be found useful to plot the moving annual totals of the items under discussion one beneath the other, and so compare their movement, the current and cumulative lines being omitted.

Experience will show that the Z-chart loses in value where the monthly fluctuations are very marked. If, for instance, heavy machinery is sold at irregular intervals, and the monthly figure of sales, therefore, varies from zero to several thousands—the price of one machine—and back again to zero, the Z-chart assumes a distorted shape, which makes it difficult to grasp. But in this it only follows the characteristics of all business charts, which invariably have their limitations. In such a case the graphical method must take another form, depending upon the circumstances.

A word may perhaps be included about the “moving annual averages” often met with in statistical work. Where the trend is desired of a range of results extending over many years—the price of wheat, the agricultural labourer’s wage—the moving annual total is obviously useless. Hence, in such cases the practice is to take an average over, say, five years at the start; then, by adding the next year and subtracting the first year, and again dividing by five, and proceeding in this manner up to the end of the period under review, a “moving annual average” is obtained for the whole series. In this way fluctuations are smoothed out and the trend shown. But such a chart is seldom needed in business, nor are results often available sufficiently far back to enable the series to be worked out. It is possible to conceive an old-established wine merchant, with records going back for many years, making a diagram to show the trend of sales of

port or sherry, and so demonstrating how the popularity of these wines has changed. From such a chart a far-seeing man could probably obtain a good idea of how to commit himself for future supplies. But "moving annual average" trend diagrams belong more to the category of research charts than to the current collection of business charts, with which we are dealing here.

CHAPTER X

RATE OF CHANGE CHARTS

FREQUENTLY in business it is more important to know the *rate at which* something is changing than the *amount* it has changed.

Everything that has been dealt with so far in this book has referred to the amount of change that has taken place between one period of time and another. But when a comparison is required between two sets of data, one dealing with large quantities and the other with small, it would be obviously misleading to draw on ordinary squared paper two curves showing the amount of change in each set. Equal amounts of change would show equal slopes in the lines joining the points plotted, but the same amount added to or deducted from both a large and a small item might mean a very different *rate of change* in the two.

The following figures give a simple example of this.

	Jan.	Feb.	Mar.	Apl.	May	June
Sales. . .	£ 2,900	£ 3,140	£ 3,220	£ 3,080	£ 3,425	£ 3,410
Expenses . .	200	440	520	380	725	710

Plotting these results on ordinary squared paper would give us the chart shown in Fig. 30, from which the inexperienced reader would deduce that the expenses were increasing or decreasing in exact proportion to the sales.

Let us now analyse these figures a little more—

Sales—

Month	Amount	Amount of Change Movement		Rate of Change Performance for Month
		Up	Down	
Jan. .	£ 2,900	—	—	
Feb. .	3,140	240	—	Started at £2,900, rose to £3,140, equivalent to 8.3% rise.
Mar. .	3,220	80	—	Started at £3,140, rose to £3,220, equivalent to 2.5% rise.
Apl. .	3,080	—	140	Started at £3,220, fell to £3,080, equivalent to 4.3% fall.
May .	3,425	345	—	Started at £3,080, rose to £3,425, equivalent to 11.2% rise.
June .	3,410	—	15	Started at £3,425, fell to £3,410, equivalent to .4% fall.

Expenses—

Month	Amount	Amount of Change Movement		Rate of Change Performance for Month
		Up	Down	
Jan. .	£ 200	—	—	
Feb. .	440	240	—	Started at £200, rose to £440, equivalent to 120% rise.
Mar. .	520	80	—	Started at £440, rose to £520, equivalent to 18% rise.
Apl. .	380	—	140	Started at £520, fell to £380, equivalent to 27% fall.
May .	725	345	—	Started at £380, rose to £725, equivalent to 91% rise.
June .	710	—	15	Started at £725, fell to £710, equivalent to 2.1% fall.

If we now tabulate the performance for the month in percentage increase or decrease we find that the position is somewhat startling.

	Feb.	Mar.	April	May	June
Sales . .	8.3% rise	2.5% rise	4.3% fall	11.2% rise	.4% fall
Expenses .	120% ..	18% ..	27% ..	91% ..	2.1% ..

Few general managers would be pleased to find a rise of 8.3 per cent in their sales turnover accompanied by

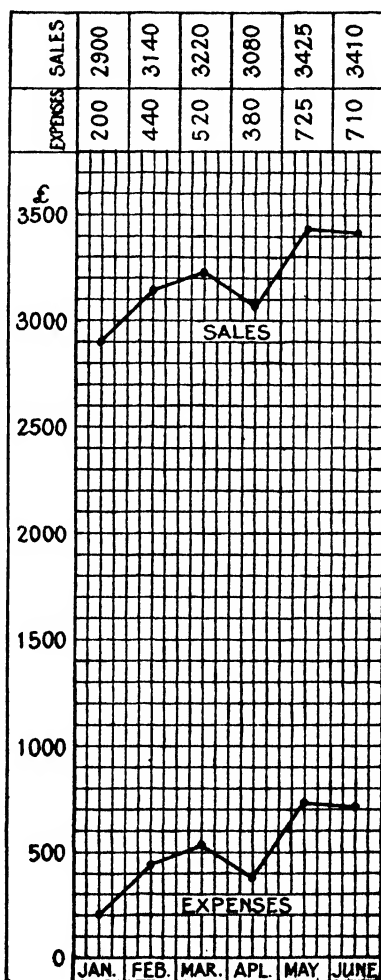


FIG. 30

a rise of 120 per cent in their expenses, and when the position is stated in this manner on a percentage basis

it is evident that a chart such as Fig. 27 might be most misleading.

In other words, we are now comparing *percentage rates of change* instead of actual results.

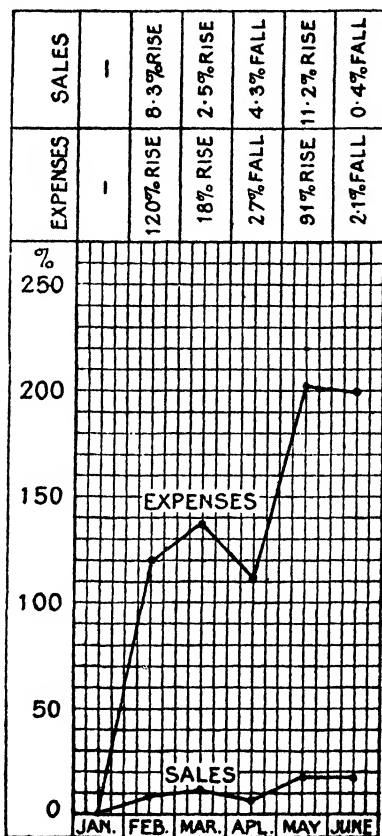


FIG. 31

Plotting these percentages on ordinary squared paper, we obtain Fig. 31, very different from Fig. 30, and in this chart it will be seen that the *amounts* have now disappeared altogether, their place being taken by the *percentage rates of change* from month to month.

But to get this ratio chart a number of calculations were necessary, and to avoid these we take advantage of the fact that commercial chart paper can now be easily obtained so divided that equal spaces represent equal percentage changes. This is known (rather unfortunately, perhaps) as "semi-logarithmic" or "semi-log." paper, owing to the fact that the vertical scale is laid out "logarithmically," and the horizontal scale in equal divisions for the time-period basis.

It is not easy to explain in non-mathematical language why the "logarithmic" scale corresponds with the ratio scale, although the two are really the same thing. On a piece of semi-log. paper it will be found that the distances from, say, 2 to 4, 3 to 6, $3\frac{1}{2}$ to 7, $4\frac{1}{4}$ to $8\frac{1}{2}$ are all equal, since all the ratios are 100 per cent increases. If, therefore, we plot our actual figures for sales and expenses on this semi-log. paper, we obtain Fig. 32—and this will be found to correspond with the percentage chart shown in Fig. 31 as far as the slopes of the curves are concerned.

Hence we obtain this very important fact in business graphics—that if the figures under review are plotted on semi-log. paper, the slopes of the lines represent the ratios of increase or decrease, no matter where they may lie on the chart field. Consequently the relative *rate of change* of the two sets of figures can be directly compared by comparing the slopes of the lines.

And this gives us what we set out to find at the beginning of this chapter—a method of comparing accurately the rate of change of two sets of data, one dealing with large quantities and the other with small.

This "semi-log." paper is made with one, two, or more "cycles" in the vertical scale. These are known as "single-deck," "double-deck," "three-deck," etc. It is called "*semi-logarithmic*" because paper exists with logarithmic scales both horizontally and vertically: this, however, is seldom used for business graphics. If a piece of

BUSINESS CHARTS

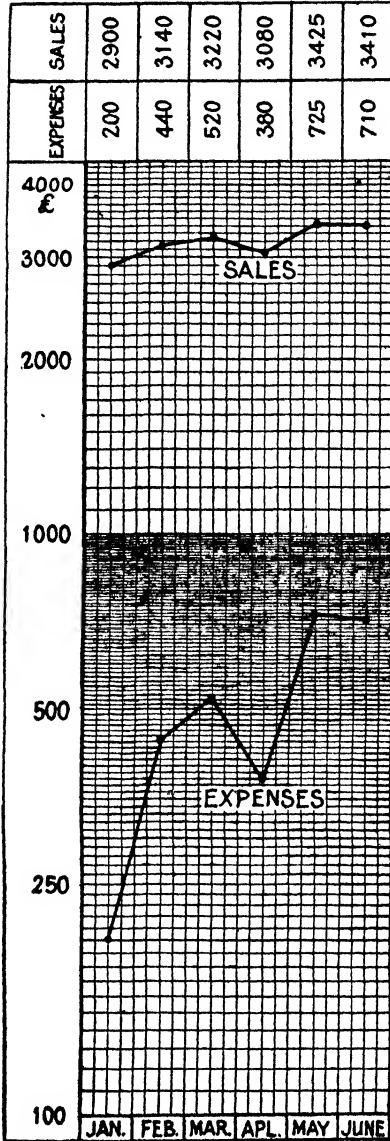


FIG. 32

this paper be studied it will be seen that the bottom figure on the left in the logarithmic scale is 1, and the scale goes up to 9 and then reverts to 1 again. There is no zero, and in making out the vertical scale for the variable (the horizontal equal rulings being always kept for the time periods) a power of 10 should always be used. In single-deck paper, for instance, the scale might begin at 1 and go up to 10, or at 100 and go up to 1,000. If this range is not sufficient, double-deck paper must be used, and the scale might then go from 10 to 100 on the first deck and from 100 on again on the second deck to 1,000. A simple trial will show that if five-deck paper (which is on the market) be used, the bottom figure can be 10, and the top of the fifth deck will then give 1,000,000.

Here is a remarkable property, therefore, possessed only by this semi-logarithmic paper—that the rate of change of two ranges of figures, one from 10 to 100 and the other from 100,000 to 1,000,000, can be accurately compared on a quarto sheet of paper, without any distortion, and with the absolute certainty that if one curve is rising with a sharper slope than the other it is out of step and growing faster than the other.

The reader will have seen by the example previously given how the ordinary "amount of change" charts are apt to be very misleading at times. A fifty per cent increase in amount at the top of the ordinary arithmetic paper gives to the eye an impression of faster growth than a fifty per cent increase at the bottom of the paper, owing to the sharper angle of the curve. Yet the "rate of change" is identical, in each case fifty per cent. A very simple example will demonstrate this fact: an increase of 20 to 30 is a 50 per cent rise, and so is an increase from 60 to 90, yet the eye is apt to judge from the slope of the two curves that the latter is "going up" much more quickly than the former—an entirely false conclusion. Plot the same result on semi-logarithmic paper, and it will be seen that the two lines are parallel

since their rate of change is the same. Fig. 33 illustrates this.

Once this prerogative of semi-logarithmic paper has been taken on trust it will be seen how valuable it may be. For instance, where machines of any kind are sold there usually follows a subsequent sale of replacement parts for those machines, and most categories of machinery builders can establish some kind of ratio between the value of the machines and such parts sold. Both

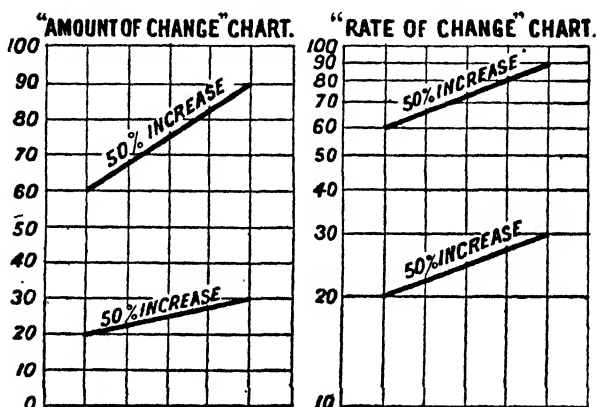


FIG. 33

should normally increase at a proportionate rate—though not, of course, by the same amounts. Hence an "amount of change" chart, showing the two sales figures on ordinary squared paper, might easily be misleading, for the sales of the machines would be at the top of the chart in the high values, and sales of the parts at the bottom as a comparatively small figure. On a semi-logarithmic chart the correct relation of one to the other would be accurately shown.

Whilst the semi-logarithmic charts are a very valuable section of business graphics, they must not be used without attention being drawn on the chart itself to the fact that they are the "rate of change" and not "amount of

change" charts. Being less common than the ordinary arithmetical charts, the eye of the reader becomes accustomed to judge increases or decreases from the "amount of change" point of view. If, therefore, a "rate of change" chart be interpolated amongst the ordinary ones, the reader may not be sufficiently experienced to appreciate without warning that he must for the moment revise his sense of values. A moment's thought will show that as the amount becomes larger towards the top of the logarithmic deck, the slope of the curve will become less, since, as we have seen, an increase from £800,000 to £900,000 will show the same angle of rise as an increase from £800 to £900. In multiple charts used for control purposes this point must be carefully borne in mind, since where 4 or 5 sections are arithmetic and one logarithmic, the eye will naturally tend to judge the logarithmic rise in the same manner as the arithmetic rise.

This semi-logarithmic paper is especially useful in conditions where it is desired to show the growth of an item from a very small figure to a very large one. For instance, an item which increases from 10 to 1,000,000 in an erratic fashion over a period of 10 years, would be difficult to show clearly on a single sheet of arithmetic paper, owing to the fact that the large maximum figure would demand a very small scale to keep the complete range on the paper. But with semi-logarithmic paper a single five-deck quarto sheet would give us what we want, and would moreover show the smaller quantities clearly.

Moving annual totals, again, in which it is only desired to watch the upward or downward trend, can very conveniently be shown on semi-logarithmic paper. In this manner, if multi-deck paper be used, all the various moving annual totals, whether large or small, can be shown on one sheet and this, in graphical control work, is often of very great value. Moreover, under these circumstances semi-logarithmic paper gives the additional advantage that the slopes of the trend will be directly proportional

to the increase or decrease—although this advantage will probably be cancelled out by the fact that the trends, being moving annual totals, will fluctuate so slightly that definite angular comparison from one to the other may be difficult.

In some textbooks it is recommended that the scales should be adjusted up and down when comparing a number of items of widely different value, so that the whole of the items under review can be brought as close together as possible on a single deck of paper. It is certainly an advantage to have the curves which need comparison as close together as possible, but the writer does not believe in the principle of multiplying scales, and so bringing the larger item below the smaller one. It is true that what is really under review is the rate of change of the two items, and, therefore, it is of little consequence which curve is above and which is below, but the first principle of a good chart is that it shall give to the eye an immediate picture that conveys the desired information, and to reverse the position of the curves is merely a trap to catch the unwary. For, having noticed that the upper curve was rising faster than the lower one, he would suddenly discover that the lower curve was really the larger item—which he would naturally expect to be the upper one.

The difficulty can be got over by drawing the curves on different sheets of paper, using one as a background, and cutting out with scissors or razor-knife the portion of the chart-field containing the other curves. Then, after carefully registering it by the vertical grid-edge, each curve can be pasted neatly below the other as close together as possible. It is unlikely that the comparison would require to be so accurate that the infinitesimal error caused by crooked pasting or cockling of the paper would give trouble. In this manner the curves can be kept in their correct value positions, and at the same time large spaces of empty chart be avoided.

As there is no zero on semi-logarithmic paper, a difficulty sometimes arises where an item that is being charted falls to zero, or perhaps becomes a minus quantity. For instance, the relation between sales turnover and profit is being charted, and the profit, as the sales turnover drops, eventually turns into a loss. How can this be shown on semi-logarithmic paper?

One method is to paste an *inverted* sheet of similar paper below the original, with identical scale. The chart line will then break at a certain point and restart on the inverted sheet below where the loss reaches the first scale amount. Obviously, there will be a zone between the last figure on the positive sheet scale and the first figure on the negative sheet scale in which no chart-line will appear, but if it is desired to watch the relation between sales turnover and loss this blank zone will probably not be important.

Another method is to start a curve upwards again on the positive sheet, in, say, red, so as to distinguish the loss figures from the profit figures. This has the disadvantage of reversing the slopes of the lines and so causes the loss of a valuable source of comparison.

Some users prefer to omit altogether the loss line, merely entering the figure on the chart. The profit line is shown falling away until it goes off the chart altogether, reappearing again as soon as better results are obtained.

In conclusion, it may be said that the best teacher with regard to "rate of change" semi-logarithmic charts is experience. By making such charts, and using them, their advantages and disadvantages will soon become obvious, and the eye soon learns to take up the fresh point of view when the logarithmic vertical ruling is recognized.

CHAPTER XI

MULTIPLE CONTROL CHARTS

IN practical business graphics the multiple control chart has an important place. It is true that the management problems connected with them are often complicated, but the actual construction of them is simple enough, and they are so useful that they deserve a place even in an elementary treatise of this nature.

In the control of the activities of a works or a company as a whole there are invariably a number of factors—often of a widely different nature—which, owing to their reaction one upon another, cause the results obtained from the concern to fluctuate. Sales, stocks, production, number of employees, business indexes, bank returns, weather reports, crop forecasts—all have their separate influence upon the results obtained at the end of the financial year, and the more they can be correlated and watched the closer will be the management control.

Statistics concerning these facts are always available, and those responsible for the management of the concern usually endeavour to work from the statistics only. But the attempt to compare many columns of figures becomes so wearisome and barren that it will be found a very much simpler matter to lay out these statistics in the form of simple line charts. In this manner the variations of the results relative to each other can be easily seen.

But to lay out ten or fifteen line charts on the same sheet of paper simply results in inextricable confusion, and entirely defeats its own object; taking one chart per sheet, we have ten or fifteen sheets, and in the multiplicity of paper we lose the connection between the items. The best way, therefore, to obtain clarity and at the same time a close connection between the items

involved, is to make up one large chart, split into as many sections as may be found necessary.

For this purpose it is advisable to take a good-sized sheet of drawing-paper (double-elephant if possible), and lay out the frame-work of the control chart with drawing-board and T-square. Having decided the number of items necessary to obtain a full control, the space available on the paper must be allocated to these items in sections, each section having not more than two—possibly, under certain circumstances, three—lines in it. Then the range of each item must be carefully examined and sufficient space left to allow for the rise and fall of the line to be clearly visible—since it is with the *fact* of rise or fall that we are primarily concerned in control charts.

The chart field is then divided horizontally for the time intervals, as desired. Fig. 34 shows a Works Control Chart divided for two financial years, but the spacing can be designed for weeks, months, or years, just as it may be found necessary. This completes the construction of the chart, and after all the scales have been clearly marked in the result can be entered up as the time-periods pass, and the effect of the variations upon each other will be clearly seen.

If a record of the chart is needed for monthly reports to the board, or any other purpose, reduced copies can be made by the photostat process; or the large master-chart itself can be mounted and used as a wall-chart.

In connection with the multiple control charts there are a few points which are worth keeping in mind.

It is as well not to strain the scales so as to try to keep sections the same, except in the case of sections worked on the percentage basis. In these the 100 per cent height should be the same; with the others the scale for each section should be chosen so that a normal fluctuation gives a normal effect to the eye.

This is not an easy matter to describe in words; it

will be found that there is a certain amount of fluctuation in the lines, which impresses the eye with the importance of the change. In order, therefore, to gain the correct impression from the control chart care must be taken to choose the scale in such a manner that important fluctuations, even if small numerically, give a striking effect, whilst an unimportant fluctuation, even if large numerically, leaves the eye unimpressed.

Remember, above all things, that in these multiple control charts we are not attempting to give a definite graphical record of the fluctuation of one item so much as to form a picture which represents the simultaneous effects of the combined influence of all the items on the chart on each other. Each section shown on the main control chart will naturally have been transferred from a single chart which forms part of the whole charting system of the management, and therefore if any section of the main chart is under itemized scrutiny, it would be the single chart for that item which would be called for, and not the section on the main control chart. It is seldom possible to work from a zero base in these multiple control charts, and therefore a scrutiny of one item by itself might well be misleading.

It is therefore most important to remember that a multiple chart must be studied as a whole, and not in sections.

CHAPTER XII

SOME GENERAL RECOMMENDATIONS

THOSE readers who may have been aroused by this little book to take some interest in the use of simple graphs for business purposes will probably look for some practical advice as to how a definite start should be made in the matter. To give this advice, however, is by no means an easy thing for anyone not cognizant of the facts surrounding the business of the reader in question.

But no expert knowledge of graphics is needed to make a start, and common sense and experience will soon develop the work on useful lines. The simplest way at first is to sit down and make a note of what points in connection with the business under review are those which seem to call for the most frequent consideration and which are at the moment regularly recorded; among these should be included items which, though simple in themselves, are of vital importance to the business—monthly turnover, sales, production, stock fluctuations, market prices, etc.

Once these points have been jotted down at random it is best to sort them out into various distinct categories, so that the system will grow on certain well-defined lines, which will be of considerable assistance later on, when the number of charts in use has been increased. A decision should be made on the size of the paper which is going to be used, and a stout loose-leaf ring binder be bought to fit the sheets, which can be obtained ready punched; guards with title-slips should be inserted, so as to divide the various categories of charts; and when the first half-dozen charts have been produced by the assistant who has been allocated to the work they can be filed under their respective headings, and the start

will have been made. It is as well to choose an assistant of an inquiring and an intelligent nature, one who can be trained to take a real interest in the charts and what they show, as he—or she—can be of considerable use in the future in suggesting combinations of results which may be of the greatest value. The dull type of copyist, merely concerned with neatness and the production of a pretty picture, should be taken off the work.

If the charts are going to be handled often, a stout class of chart paper should be chosen. Colour for lines and bars is best applied by crayons: coloured inks are difficult to handle and inconvenient in many ways. If blue-prints are to be taken from the charts it is sometimes the custom of the chart clerk to back the chart with reversed carbon paper when typing the figures in; where this is done care should be taken to see that the carbon on the back of the chart does not smudge the chart next to it in the book.

Colours should be used freely; they are a great help in making the picture clear and striking. It is usually safer to draw out the chart first in pencil, as it is a very easy matter to plot a point in the wrong place, especially if the time-periods are rather wide.

There are many special chart papers on the market now. Foolscap, quarto, and octavo can all be obtained, arithmetic, semi-logarithmic, double-logarithmic, isometric, polar, and other special rulings; also papers ruled for days, months, and years, and the special Z-chart paper. Before starting a chart system it is always as well to get into touch with a good firm supplying chart paper and obtain a full range of samples. The chart clerk will then have an idea of what materials are available for his work. The common squared paper sold in rolls and large sheets should be avoided.

Mistakes will be made at the start. Wrong scales will be chosen, wrong combinations of records will be made, and items will be charted which will prove to be of little

interest. These, however, will only show up all the more the value of the remainder. If the suggestions set out in Chapter V of this book are followed, it will be soon found that the system is easy to extend, and creates a record which is far easier to grasp than the columns of statistics from which the charts are made.

It should never be forgotten that these are business charts and not statistical diagrams. The trained statistician is apt to treat the figures with which he is dealing as so much material which must be set out in order, certainly as clearly as possible, but more with reference to mathematical correctness than to immediate effect upon the reader. As a well-known writer on such matters has said, all statistics must be treated with the greatest suspicion and closely analysed for their veracity before they can be accepted. In the case of business statistics, however, it is unlikely that any misleading diagrams will be found in the managing director's set of charts, since the figures which they illustrate are mostly simple and clear in their bearing upon the business. They can, of course, be made as complicated as desired, but so much good can be done with such simple material and in so plain a manner that the bugbear of statistical mathematics need never arise. To take the facts that the accountant and the secretary provide and then picture them graphically is surely a task which need not alarm anyone, and once a trial has been made of this method of analysing the past, realizing the present, and visualizing the future, the reader will find that the enhanced vision which he has thereby obtained has repaid him many times over for the little trouble that he may have given himself in trying to understand the principles upon which graphical methods rest.

One last point, which should be superfluous, but which perhaps ought to be mentioned. Having started to chart your business results, remember that you must allocate some time to the study of the facts that they

demonstrate. It is not so much that the reader must puzzle over the chart itself—that should never be necessary if the chart is properly made. But the secrets of combining charts into a higher control only surrender themselves to thought and study; therefore, let some time be set aside each week at least for uninterrupted investigation in some quiet office where concentration is possible, where the door can be locked and the mind encouraged to range over the facts that are set out so clearly, making new combinations, suggesting fresh fields of research, or different factors that may have some influence hitherto unsuspected. Like all work that needs hard thinking, it is not easy, however clear the charts themselves may be; but once the habit has been formed it will be found that control of the whole course of the business, with its aims, shortcomings, prospects, and failures, becomes simpler and simpler until the directing mind begins to feel that sense of security that only comes when the path can be seen in the future clear to the goal.

Let it not be forgotten that such charts are an insurance as well as an investment. Sometimes, when a long range of results have been recorded week by week or month by month without anything unusual being shown, there is a tendency to feel that the making up of such charts has been a waste of time. But since the whole object of graphical control is to keep a clear vision of what is occurring, if the charts show that all is well and there are no backslidings to report, they are surely accomplishing their main purpose.

In conclusion, the writer would urge that the simple science of business graphics should above all be kept practical. It is better to have ten tattered grubby charts pinned to the wall than a beautiful morocco volume with a hundred works of art that are never looked at except by the clerk who makes them up. Charting is an insidious affair; one leads to another, and so to a third, until the enthusiast flounders in bewilderment in a sea of squared

paper, having, like Frankenstein, created a monster that he can no longer control.

Once again—above all, be practical. Keep your charts for use—ask yourself “Is it going to be of any real use?” every time you are tempted to make up a fresh chart; give it a chance to make good, certainly, but destroy it—or file it—at once if it proves to be only an academic subtlety. If you keep strictly to this rule, you will realize before a year is out that amongst all the complications of modern commerce there is no better aid to far-sighted and prudent management than business graphics.

BIBLIOGRAPHY

THE following is a list of the majority of books and pamphlets on graphics at present existing, together with a brief descriptive notice of each. Books on statistics and statistical methods are not dealt with.

(a) *Works of a general nature on Graphics.*

1. ARKIN, H. and COTTON, R. C. *Graphs, How to Make and Use them.* Harper's, New York and London, 1936. 6½ in. by 9½ in., 224 pp., 141 illustrations. Price 9s.

Deals with a wide range of different types of chart. All examples are "blind." More for statistical than business use.

2. BRINTON, WILLARD C. *Graphic Methods for Presenting Facts.* New York, The Engineering Magazine Co. (one of the "Industrial Management Library" series). 7 in. by 10 in., 380 pp., 257 illustrations. Price \$6.

Mr. Brinton's book was one of the earliest textbooks on charts for advertising and business purposes. It has recently been revised and brought up to date, and still forms a valuable work of reference on business graphics under wide conditions.

3. HASKELL, ALLAN C. *How to Make and Use Graphic Charts.* Codex Book Co., Inc., 461 Eighth Avenue, New York. 6 in. by 9 in., 539 pp., 514 illustrations. Price \$5.

More mathematical than most, but an exhaustive treatise on all forms of graphics. Most chapters conclude with a bibliography of articles on the subjects dealt with, all concerning practical business conditions. Not to be recommended to the beginner.

4. KARSTEN, KARL G. *Charts and Graphs.* Prentice-Hall, Inc., New York (London, Pitman). 6 in. by 9 in., 734 pp., 498 illustrations. Price \$6.

An advanced textbook, well arranged and presented in simple and colloquial language. Possibly the most thorough of all the general books known to the writer, though not to be recommended to the beginner.

5. *Manual of Charting* (Business School Series). Prentice-Hall, Inc., New York (London, Pitman). 6 in. by 9 in., 106 pp., 33 illustrations. Price 6s.

"This book . . . is designed to help the inexperienced to such an understanding of graphics as will enable them to continue the study intelligently."

The information given regarding statistical sources must be used with caution in Europe. All chart examples are "blind." Problems are set at the end of the chapter, but no solutions given.

6. MARSHALL, WILLIAM C. *Graphical Methods for Schools, Colleges, Statisticians, Engineers, and Executives*. McGraw-Hill Book Co., 6 Bouverie Street, London, E.C.4. 6 in. by 9 in., 250 pp., 220 illustrations. Price 15s.

Written with the intention of filling the gap between Prof. Peddle's mathematical treatise and W. C. Brinton's business graphic study. It inclines, however, to the mathematical side, especially from an engineering and technical viewpoint. The uses of graphs in business are little developed.

7. PEDDLE, JOHN B. *Construction of Graphical Charts*. McGraw-Hill Book Co., Inc., 6 Bouverie St., London, E.C.4. 6 in. by 9 in., 158 pp., 79 illustrations. Price 10s.

Purely mathematical; deals with calculating charts and the solution of equations by graphical methods.

8. PORTER, DAVID B. "Charts," Section 3 of *Management's Handbook*, edited by L. P. Alford. Published by The Ronald Press Co., N.Y. The Handbook is 4½ in. by 7¼ in., 1607 pp. Price 30s.

The section devoted to charts comprises 99 pages with 82 illustrations, and forms a very excellent and concise summary of the subject. Apart from the chart section the handbook contains a vast amount of information invaluable to those concerned with management problems.

9. RIGGLEMAN, JOHN R. *Graphic Methods for Presenting Business Statistics*. McGraw-Hill Book Co., Inc., 6 Bouverie Street, London, E.C.4. 6 in. by 9 in., 230 pp., 253 illustrations. Price 12s. 6d.

The author claims to bring out points hidden in, or omitted from, other books on the subject. A very thorough description of chart material, drawing instruments, and methods of drafting and lettering is included, and the various types of charts are described with examples. The book is the outcome of the author's lectures on the subject at the Harvard School of Business Administration and the University of California.

10. SECRIST, HORACE. *Statistics in Business: Their Analysis, Charting and Use*. McGraw-Hill Book Co., Inc., 6 Bouverie Street, London, E.C.4. 5½ in. by 8 in., 130 pp., 30 illustrations. Price 8s. 9d.

Like No. 4, describes all the sources of vital statistics in the U.S.A. Analyses these into categories which are as applicable to Europe as to America.

Illustrates the different types of chart and discusses advantages and disadvantages in the customary manner.

NOTE.—The Codex Book Co. (461 Eighth Avenue, New York) publishes a 104 pp. booklet with 124 illustrations, advertising their chart papers and special books. The booklet is very well got up, and is valuable as a reference for the various types of chart paper now on the market.

The Educational Exhibition Co., 26 Custom House Street, Providence, R.I., also publish a 56 pp. booklet, with about 120 illustrations, advertising chart papers, frames, tape-boards, etc., etc. The illustrations are mostly in colour, and the booklet is useful for reference and example.

Both the above are commercial catalogues, but are certainly worthy of inclusion in any library of works on graphics.

(b) *Works specially devoted to Business Graphics.*

11. ACLAND, L. H. D. *Charts and their Use in Purchasing.* A paper read before the British Industrial Purchasing Officers' Association. Oct., 1932. 8½ in. by 11 in., 46 pp., 38 illustrations.

A survey of the different types of chart, and how they can be of use to the buyer of a concern.

12. DE LEEUW, A. L. *How's Business.* Codex Book Co., Inc., 461 Eighth Avenue, New York. 5 in. by 8 in., 220 pp., 70 illustrations. Price \$3 (1928).

Describes a system of graphical control for an imaginary factory, thus enabling the reader to model a complete set of control charts on the examples given. A very interesting work, and useful for developing higher control.

13. GILMAN, STEPHEN. *Graphic Charts for the Business Man.* La Salle Extension University, Chicago. 6 in. by 9 in., 62 pp., 58 illustrations. Price 75c.

An inexpensive pamphlet, based on a series of lectures. Simple, and suitable for interesting business men with no previous experience of graphics.

14. HASKELL, ALLAN C. *Graphic Charts in Business.* Codex Book Co., Inc., 461 Eighth Avenue, New York. 5 in. by 8 in., 451 pp., 306 illustrations, some in colour. Price \$4 (1928).

A concise and well-written general book devoted to the business end of graphics. Will be found of constant assistance for reference in higher control charting work.

15. SAVAGE, WINFIELD A. *Graphic Analysis for Executives.*

Codex Book Co., Inc., 461 Eighth Avenue, New York. 5 in. by 8 in., 164 pp., 57 illustrations, some in colour. Price \$3 (1926).

The purpose of this book is to present to business executives a definite set of facts for the application of the new methods of graphic analysis to the problems involved in the management of a business.

A very useful handbook on graphical control work, applied to all phases of a commercial undertaking. The examples are mostly "blind," unfortunately, but apart from this the subject is treated in a very practical manner.

16. SMITH, WILLIAM HENRY. *Graphic Statistics in Management*. McGraw-Hill Book Co., Inc., 6 Bouverie Street, London, E.C. 4. 6 in. by 9 in., 360 pp., 242 illustrations. Price \$4.

Another good book, dealing with the general use of graphics in business. Largely devoted to American statistical resources and their use, and hence of less value in Europe except for references and examples.

(c) *Works relating to special forms of Charts.*

17. BIVINS, PERCY A. *The Ratio Chart in Business*. Codex Book Co., Inc., 461 Eighth Avenue, New York. 5 in. by 8 in., 200 pp., 57 illustrations. Price \$3.

Devoted entirely to "rate-of-change" charts drawn on semi-logarithmic paper. Shows many uses to which such charts may be put, and the advantages of "rate-of-change" charts in business.

18. CLARK, WALLACE. *The Gantt Chart*. Pitman. 5½ in. by 8½ in., 146 pp., 45 illustrations. Price 7s. 6d.

A detailed description of Gantt charts, with many examples of how they can be used.

19. FISHER, PROFESSOR IRVING. *The Ratio Chart for Plotting Statistics*. Yale University, 1917. Reprinted by the Educational Exhibition Co., Providence, R.I. Pamphlet No. 807. 6 in by 9 in., 24 pp., 18 illustrations. Price 25c.

Probably the clearest explanation yet offered of the theory at the back of the "rate-of-change" charts. Also contains a bibliography relating to this method of presenting statistics.

(d) *Books in which Charts are largely used.*

Much may be learned in practical charting work from the following books—

20. DENT, A. H. G. *Management Planning and Control*. Gee & Co., 6 Kirby Street, E.C.1., 1935. 6 in. by 8½ in., 332 pp., 25 illustrations. Price 10s. 6d.

A treatise on the latest methods of management planning, illustrated by charts of many different types.

21. KNOEPEL, C. E. *Profit Engineering*. McGraw-Hill Book Co., New York and London, 1933. 6½ in. by 9 in., 326 pp., 42 illustrations. Price \$3.

An interesting book on achieving profits in an industrial undertaking, with explanations of the special charts upon which the work can be built.

22. PERSONS, W. M., FOSTER, W. T., and HETTINGER, A. J. *The Problem of Business Forecasting*. Pitman. 5½ in. by 8½ in., 317 pp., 55 illustrations. Price 16s.

The papers presented at the eighty-fifth Annual Meeting of the A.S.A., 1933. Many different types of chart are used in the illustrations.

23. WALLACE, W. *Business Forecasting*. Pitman, 1928. 5½ in. by 8½ in., 123 pp., 12 illustrations. Price 7s. 6d.

Another work on forecasting, illustrated by some interesting charts.

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