XEROX

BUSINESS SYSTEMS

Systems Development Division

June 13, 1978

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From: Dave Smith / SD at Palo Alto

Subject: Graphical bar chart examples

This is a reference note intended to provide some information that may be of interest to us as we develop Star 2 and beyond.

Attached are some examples from Bill Bowman's book *Graphic Communication* that deal with bar charts. They suggest the great deal of richness that exists in the bar chart domain alone. As we have found throughout Star, each domain has more depth than is first apparent. We haven't really addressed this richness in the Star data-driven symbols yet, but it is something we should be aware of as we consider Star 2.

The point here is not "this is what we are going to do in Star" but rather "here are some of the ways that people use bar charts to express information." Some of the ways, such as *"comparative"* and *"compound"*, our current bar chart maker can handle. Some, such as *"divided"*, it clearly should be extended to handle eventually. Some, such as *"interrupted"* and *"composite"*, it may never handle.

COMPARATIVE

DIVIDED

EMPHASIZED

COMPOUND

VARIABLE

CHARACTERIZED

STANDARD

SPLIT

INTERRUPTED

PERIODICAL

COMPOSITE

CUMULATIVE

RELATED
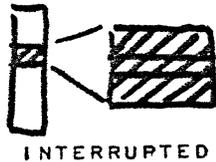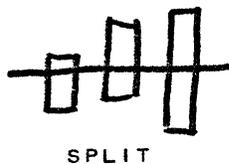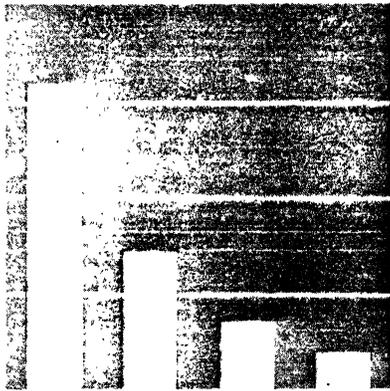
Quantity concerns the amount of a subject in terms of a fixed scale of measure. In the graphic figure, quantity can be shown in *comparative* relation to other quantities, through the extension of abstract parallel bar forms. The height of each *bar* form is measured in terms of a common scale, and corresponds to the quantity of the subject. The bars themselves can show *divided* quantities, or differentiated groups of quantities in a *compound* arrangement. A specific quantity can be *emphasized* or shown as a *variable* amount. Quantities can also be shown in terms of a *standard* amount, or visually *characterized* in relation to the subjects they represent. Bar elements can be organized on a *split* scale, to show opposing quantities, or be represented as *periodical* in relation to time. Bar elements can be *interrupted* to show a detailed enlargement of a quantity, or to omit an unnecessary bar segment. Bar elements can be scaled in width as well as height, to show amounts which are a *composite* of two quantitative factors. Quantities can also be shown as *cumulative,* or as *related* in their progression. The following figure models represent design solutions to specific problems in these areas.

COMPARATIVE quantity shows the amount of a subject in direct visual relation to other subject amounts, through the use of extended bar forms whose heights correspond to subject quantities. This type of figure is often termed a "bar" chart. The bars are measured in terms of a common scale, which is generally represented as a subordinate frame of reference.

FIGURE 1. A simple representation of four amounts, shown in close proximity to facilitate comparison (see page 42).
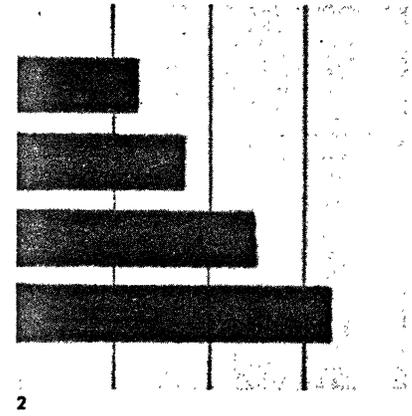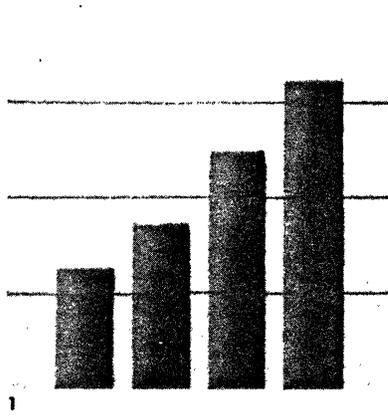
FIGURE 2. A horizontal version of the bars of figure 1, to enable efficient placement of lengthy word identifications whose horizontality would be difficult to associate with vertical bars.
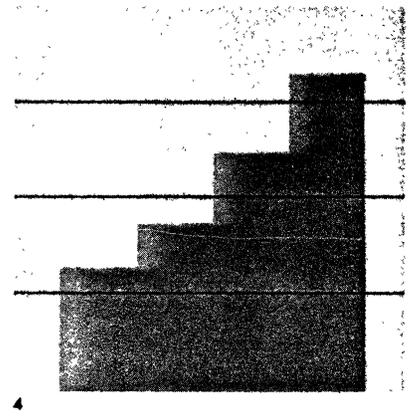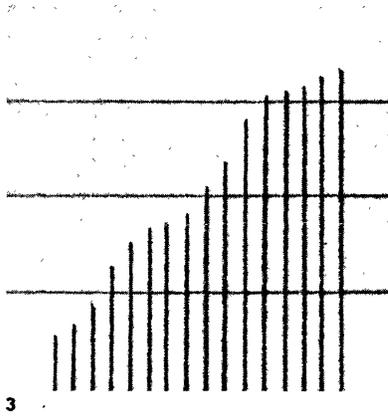
FIGURE 3. A series of many comparative amounts represented in linear form to emphasize continuity rather than separation.

FIGURE 4. Four amounts shown connected to indicate the progressive quantification of a single subject identity.
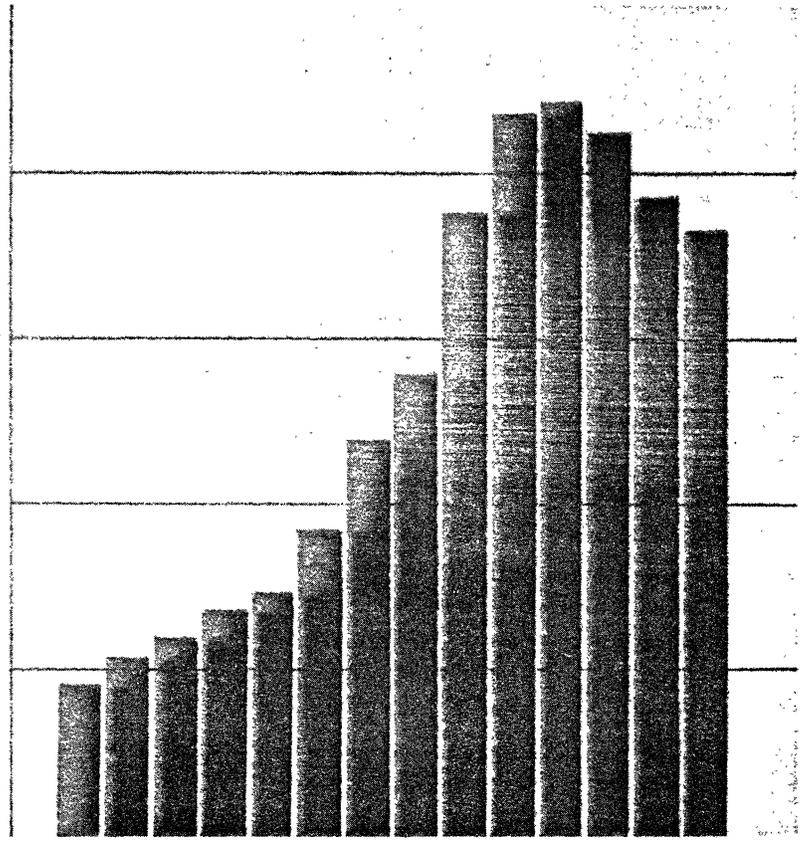
FIGURE 5. A more complex example of related amounts associated with a single subject, but finely divided to individualize each amount.
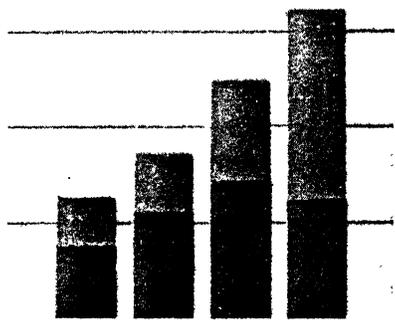
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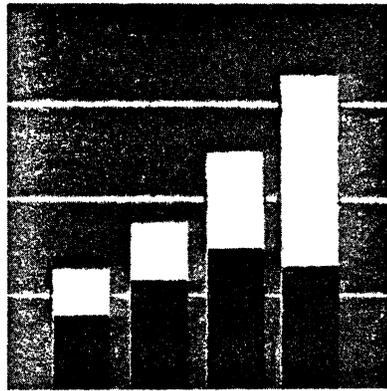
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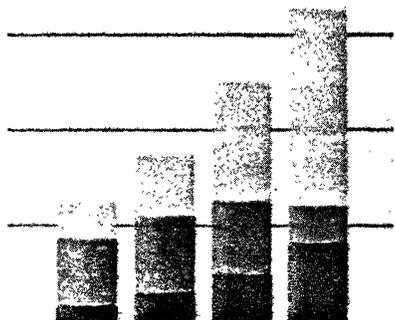
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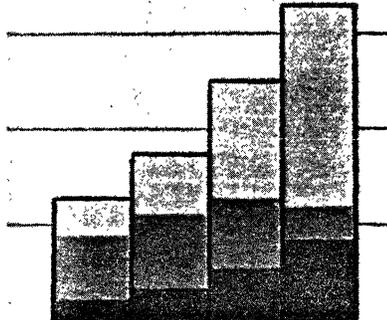
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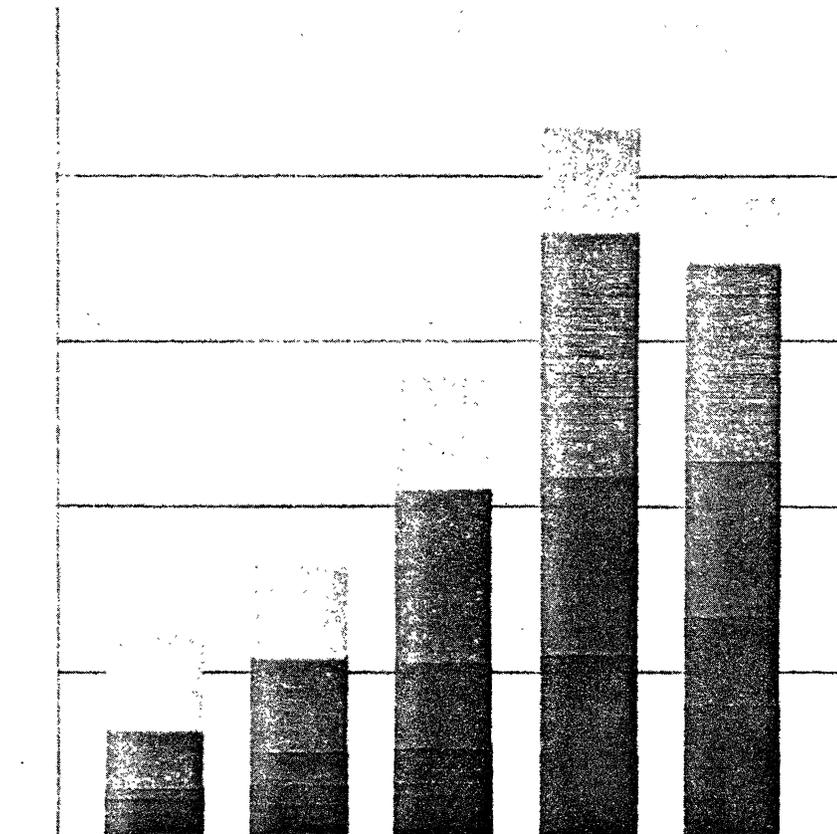
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DIVIDED quantity shows a subject amount whose representative bar is split into two or more component segments that indicate fractional amounts of the whole. In each bar, the segment amounts are additive. As forms, the divided amounts require visual differentiation usually achieved through varying shade values.

FIGURE 1. A simple divided quantity using black and gray for element differentiation.

FIGURE 2. A reversal of the gray and white pattern of figure 1, to maximize differentiation (as black and white) between component elements of each bar.

FIGURE 3. A triple division of amounts using two gray values and black.

FIGURE 4. A triple division of progressive amounts in which a black outline is used to separate each amount.

FIGURE 5. Multiple division of progressive amounts using shade value differentiation. For more than this number of divisions, shade value differences become difficult to distinguish, and other means for differentiation should be sought (see page 153).

COMPOUND quantity shows two or more progressions of subject amounts concurrently. Each bar group represents two or more distinct quantities which are comparative rather than additive. In practice, they can represent different occasions of measure of a single subject's quantity.

FIGURE 1. A series of compound quantities superimposed and differentiated by outline and solid shade.
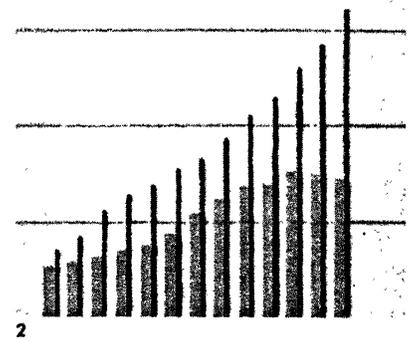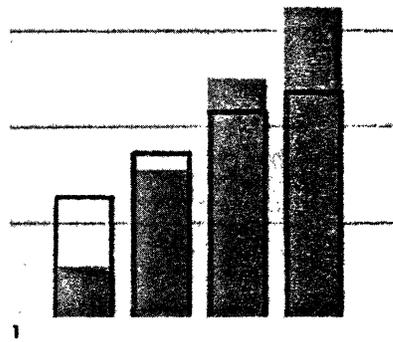
FIGURE 2. A large series of compound quantities shown as narrow bars to emphasize group continuity rather than individual identity.
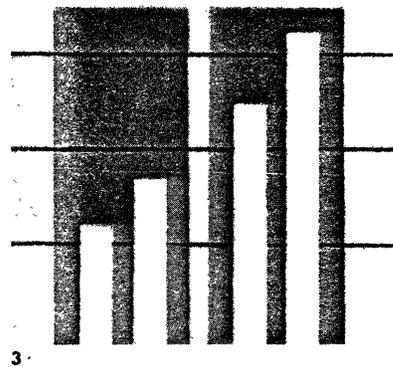
FIGURE 3. Compound quantities shown through parallel arrangement in which each pair represents two occasions of measure of a subject less related than in figure 1.
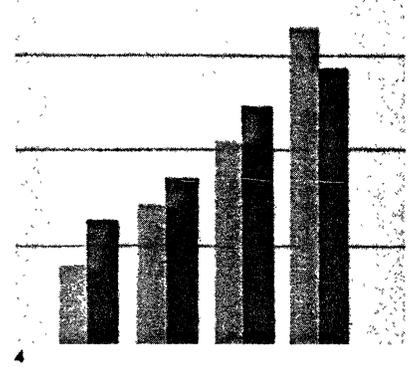
FIGURE 4. Compound pairs of amounts in which each pair is measured in terms of the same two occasions.

FIGURE 5. A quadruple compound in which each successive subject is measured in terms of four standard occasions.

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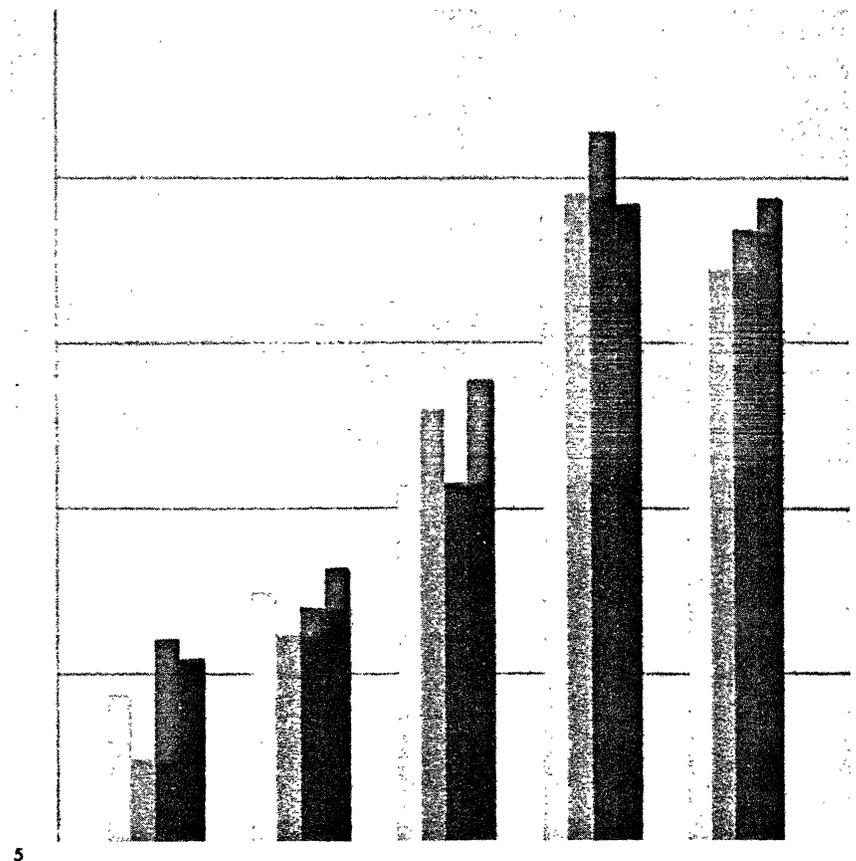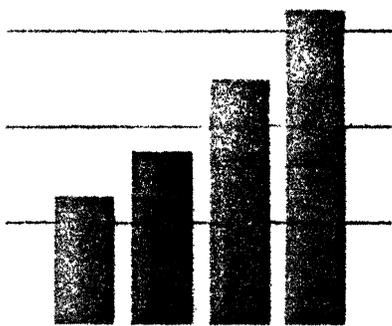
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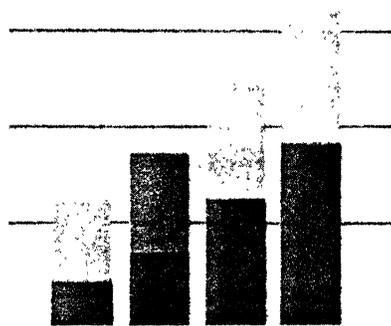
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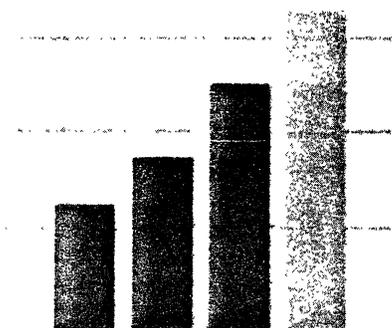
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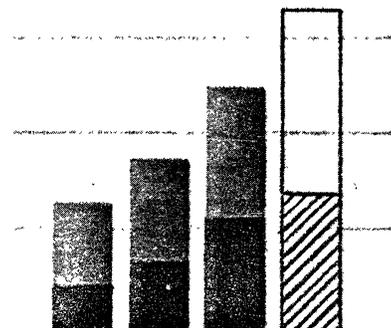
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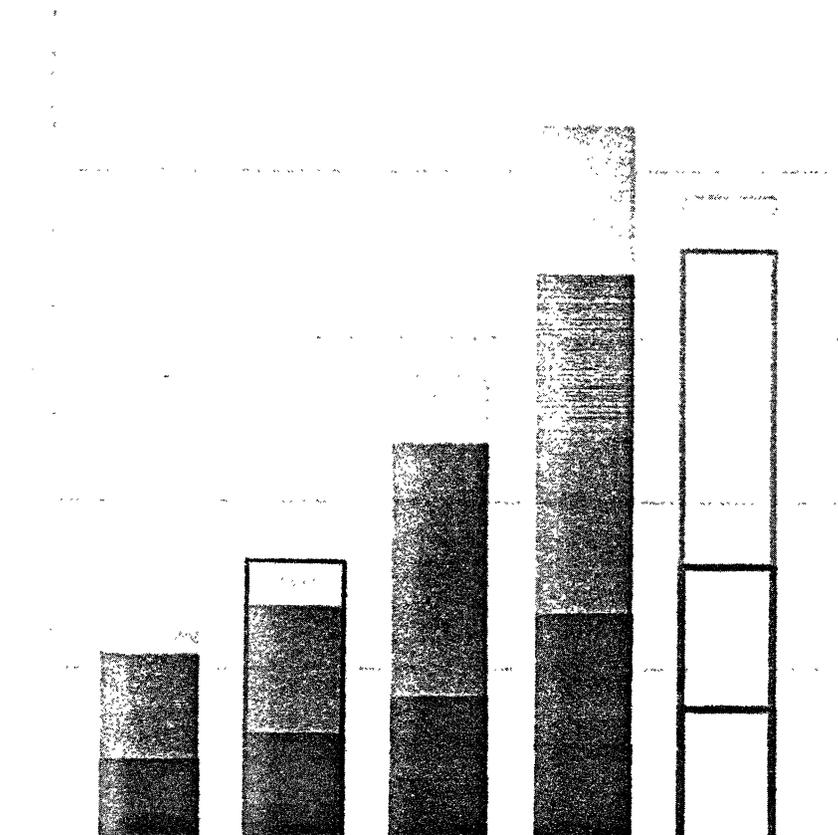
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EMPHASIZED quantity shows the particular importance of one amount in relation to neighboring amounts. If all but one of the quantities are visually emphasized, that one becomes correspondingly subordinate in character, and can indicate indefinite meanings such as estimated or projected quantity.

FIGURE 1. The emphasis of one quantity in a series, through darker value.

FIGURE 2. The emphasis of a divided quantity in a series, through a relative darkening of the values of both quantity components.

FIGURE 3. The subordination of the last quantity in a series to suggest probable quantity, by emphasizing the first three quantities.

FIGURE 4. The subordination of the last quantity in a series by giving it a weaker line form, to indicate a planned or projected quantity.

FIGURE 5. A complex series of divided quantities in which the second amount is emphasized by a reinforcing outline, and the last amount is subordinated by outline alone.

VARIABLE quantity shows a general- ized amount whose exact numerical measurement is not determined. The amount represented can vary from a minimum to a maximum, indicate a possible median, suggest a probable quantity with a possible range of er- ror, or simply fade out visually in di- rect relation to its decreasing prob- ability.

FIGURE 1. A series of quantities which show maximum and mini- mum limits and also indi- cate decreasing probability through form disintegra- tion.

FIGURE 2. A series of estimated quan- tities showing also a prob- able range of variation with fixed limits.

FIGURE 3. A series of probable quan- tities and a suggestion of possible variation upward.

FIGURE 4. A series of quantities whose range of variation is used to make an angular cut which suggests the degree of vari- ability.

FIGURE 5. A series of quantities, each with a defined maximum limit of variability, but an undefined lower limit which is shown by graduated shad- ing.

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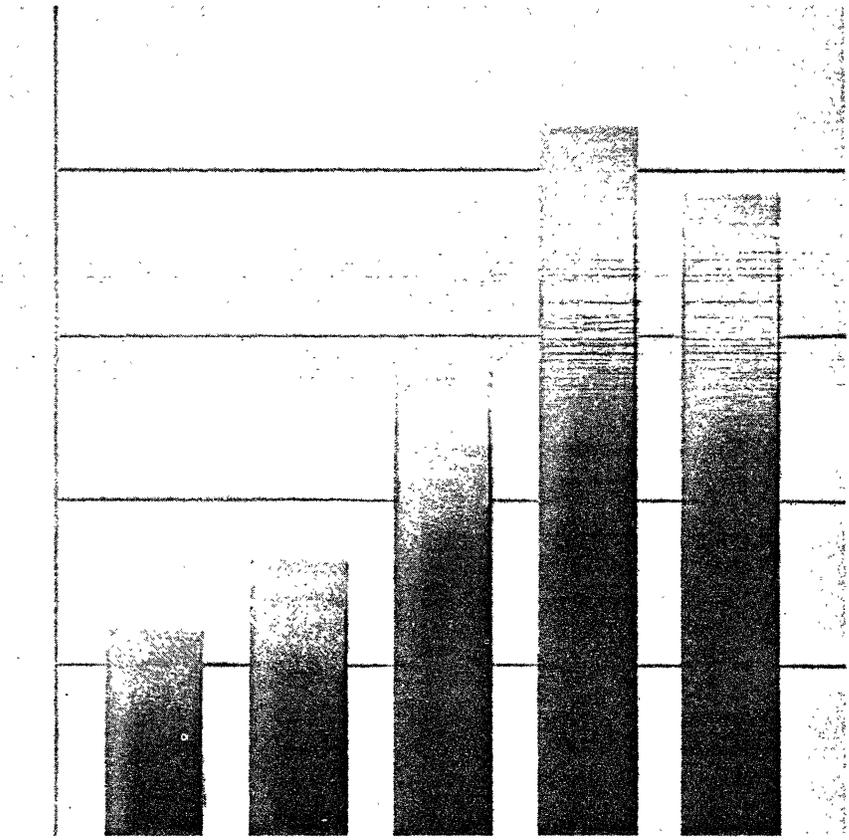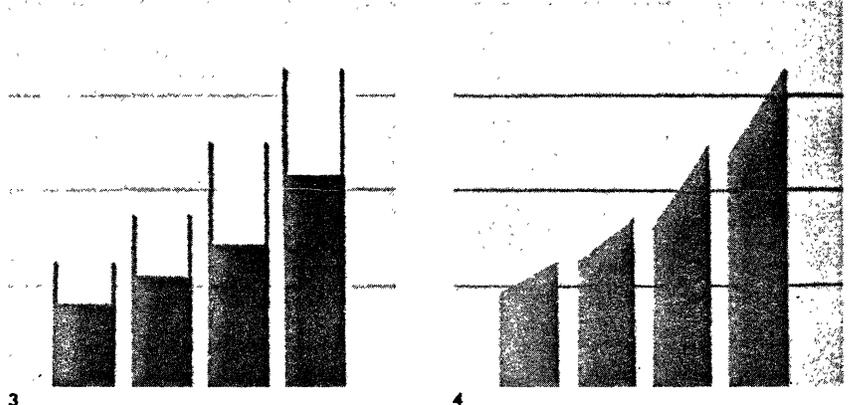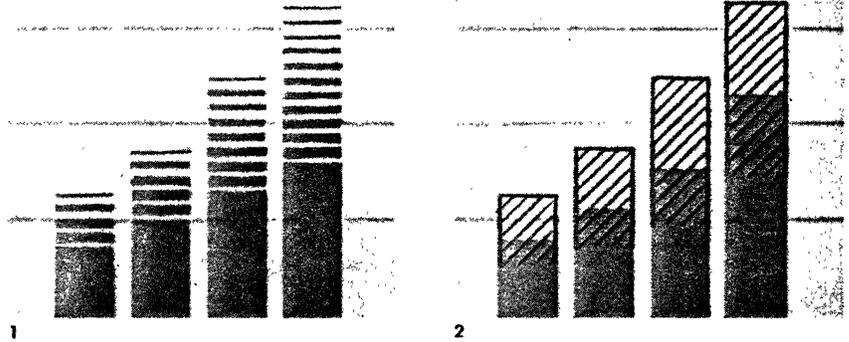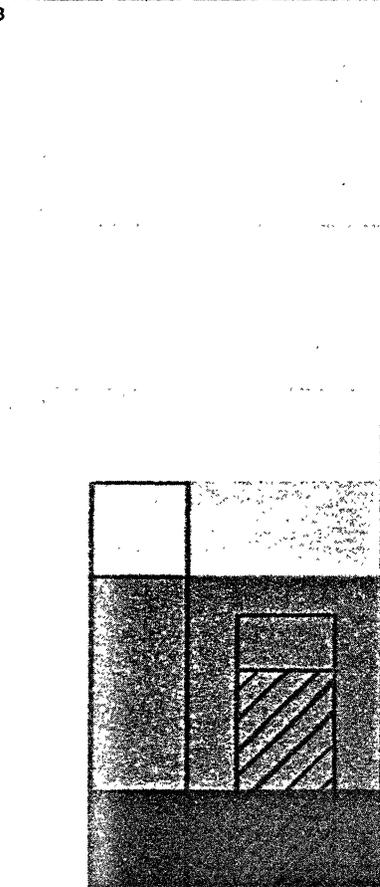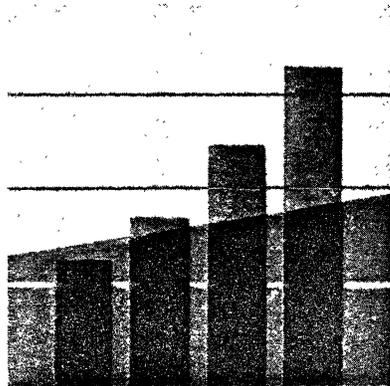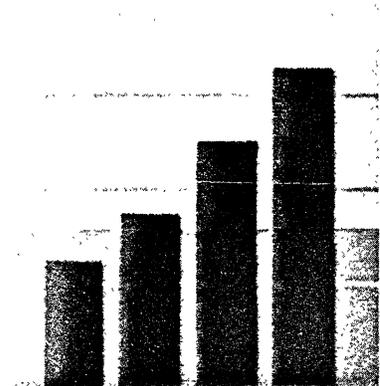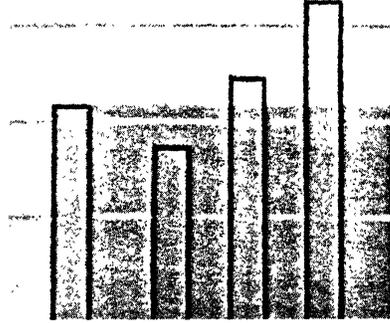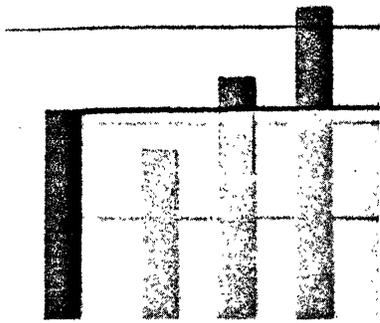
STANDARD quantity shows a series of different amounts in terms of one fixed amount, which serves as a basic criterion for the evaluation of the others. This means that any bar quantity which does not equal the standard quantity is seen as either excessive or deficient, since it varies from the ordinate standard line projected by the fixed amount.

FIGURE 1. A standard quantity, as black, in relation to three gray quantities which are darkened for emphasis when they exceed the standard line.

FIGURE 2. A standard quantity emphasized by a shaded area in relation to subordinated outline bars.

FIGURE 3. A standard quantity shown without a standard bar as a subordinate frame of reference for emphatic black quantities.

FIGURE 4. An increasing standard quantity which acts to emphasize (as black) the segments of the bar quantities which it includes.

FIGURE 5. A complex version of figure 2 showing divided quantities (line) as well as a corresponding divided standard (gray).

CHARACTERIZED quantity shows differentiated bar identity through differentiated structure, shade value, and texture. Frequently, form characteristics require assigned meanings to act as temporary conventional symbols. At other times, associative features serve to identify the subject meanings.

FIGURE 1. Differentiated shade character designating individual bar identities which decrease in visual importance as they increase in quantity.
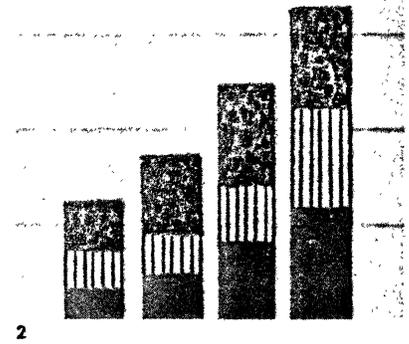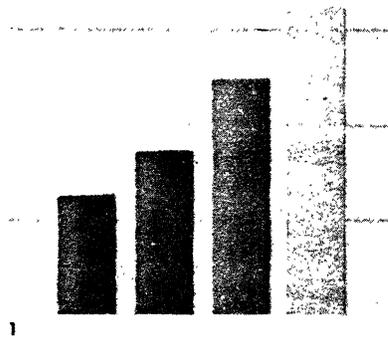
FIGURE 2. Characterized bar divisions, using shade, line, and texture to maximize identity differentiation at the expense of the visual unity of the whole.
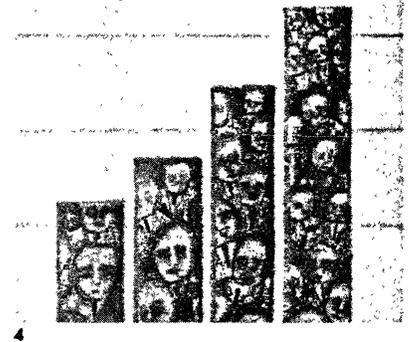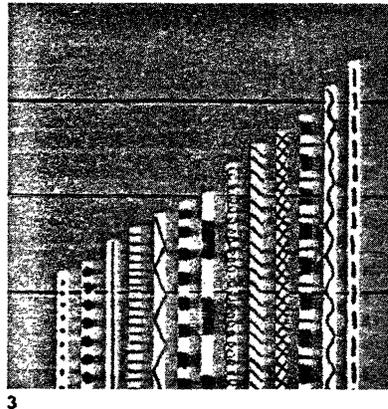
FIGURE 3. Dramatic characterization of closely related bar quantities which act as individual linear symbols.

FIGURE 4. Characterization of quantities as a whole through subject association.

FIGURE 5. Symbolic characterization of quantified substances through texture, using shade value to identify divided amounts within each bar.

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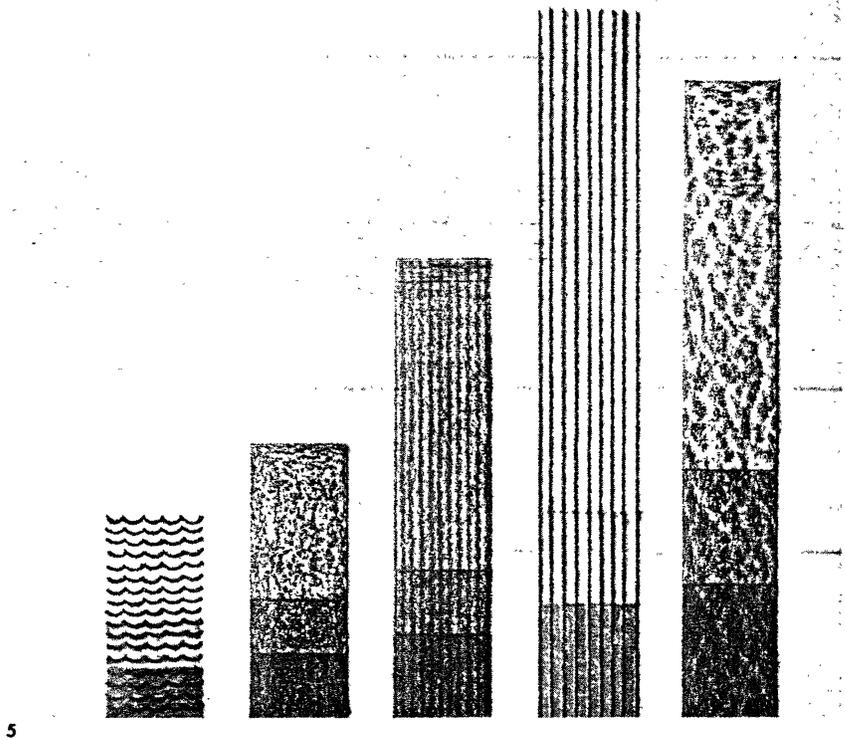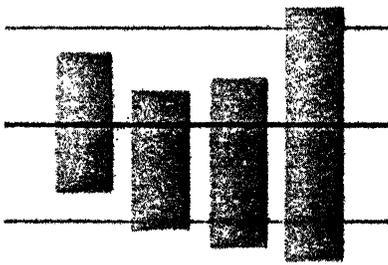
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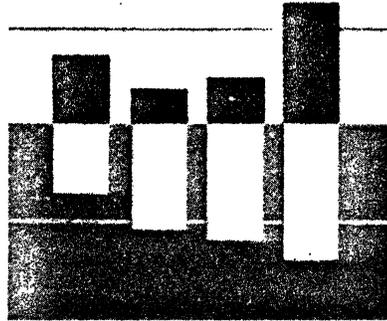
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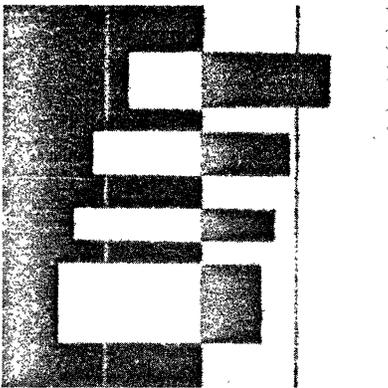
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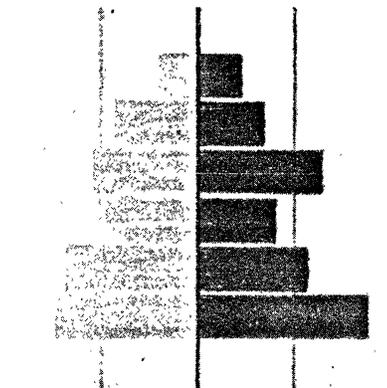
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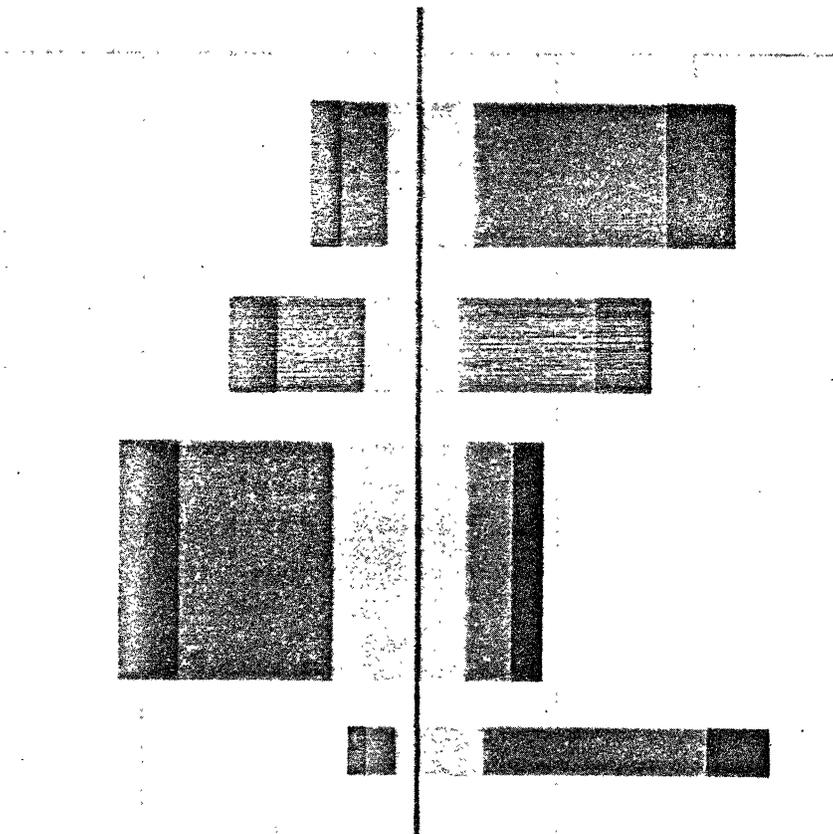
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SPLIT quantity shows an amount in relation to a dividing line which separates the whole amount into two areas of quantitative measure. The two areas are mutually complimentary, and they serve to create a divided quantity in which each amount is measured on an individual scale that begins on the dividing line and proceeds outward in both directions. Split quantity can show positive and negative conditions, or other dual measures of a subject.

FIGURE 1. Simple split quantity in which subject unity is maintained as continuous gray bar form.

FIGURE 2. Split quantity in which positive and negative aspects are differentiated as black and white.

FIGURE 3. Split percentages of related wholes quantified in width and shown on a vertical dividing line to permit interior, horizontal bar identification.

FIGURE 4. Dual aspects of a split quantity in which individual bars are shown to be closely related in subject meaning.

FIGURE 5. A complex example of split quantity in which each of the dual aspects is subdivided into fractional amounts of a fixed whole, and quantified specifically in terms of bar width.

PERIODICAL quantity shows the amount or extent of a subject element relative to a measured continuum, such as time, in which the element is represented as a quantitative span within that continuum. A related grouping of periodical bar elements can create a sequential pattern which shows the measured phasing of a subject.

FIGURE 1. A simple pattern of periodical phases in which each element begins at the termination of the preceding element.

FIGURE 2. A pattern of periods, each with a subordinate subdivision which acts as an overlapping period. Increasing shade value indicates phase progression.

FIGURE 3. An overlapping periodical pattern shown in terms of specific phase areas (gray values).

FIGURE 4. Periodical quantities shown in terms of beginning (shade) and terminating (outline/shade) measurements.

FIGURE 5. A complex periodical pattern showing differentiated (outline/shade) phases and tapered elements to indicate gradual beginning and termination.

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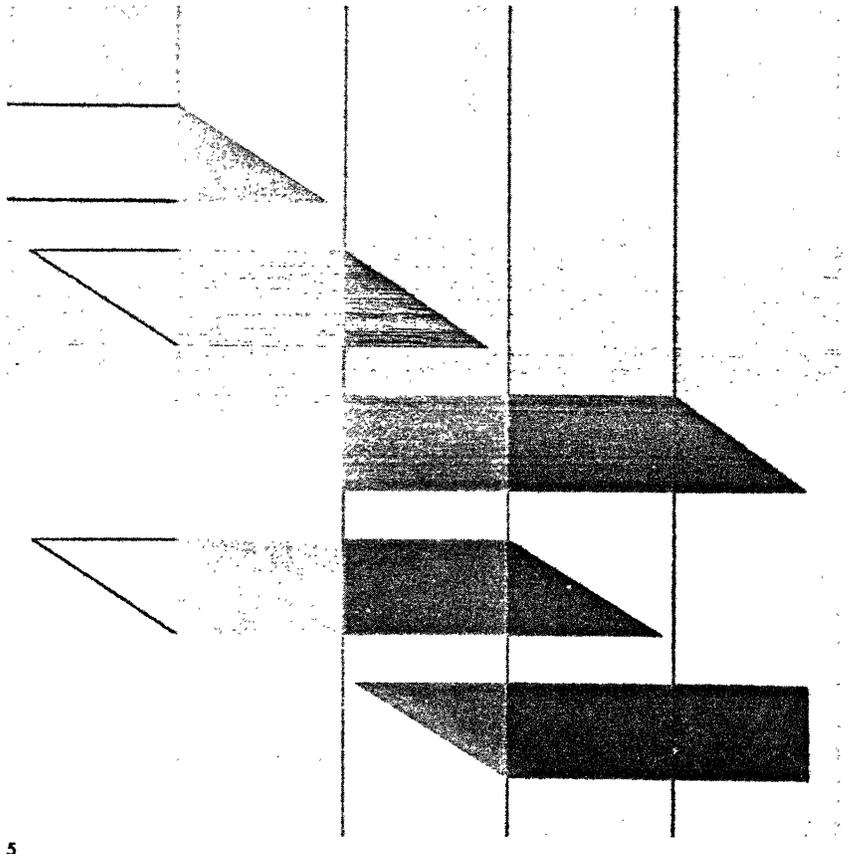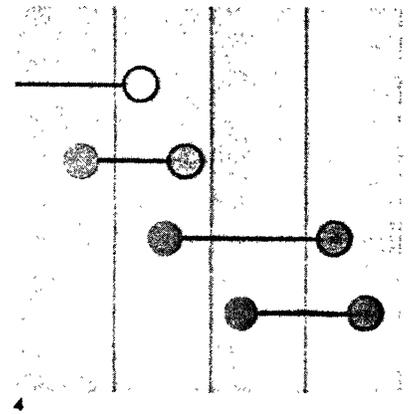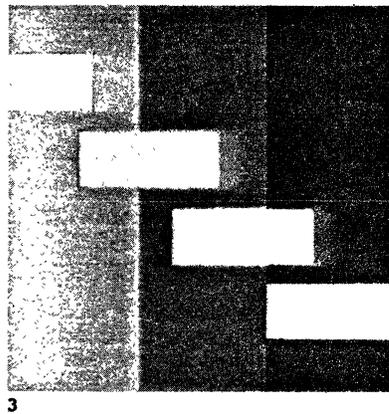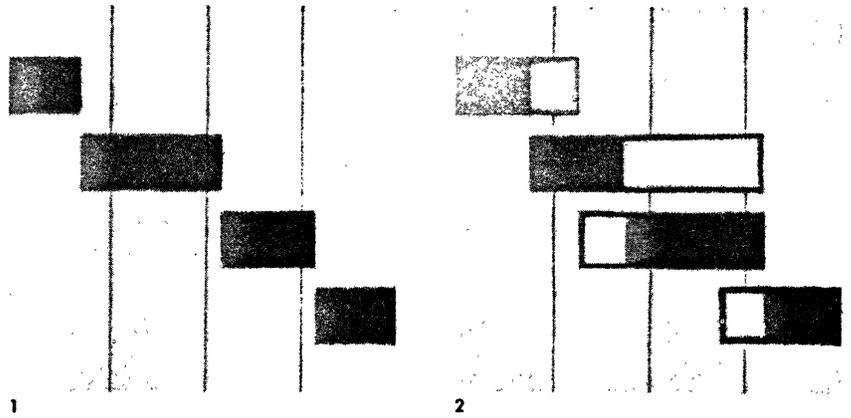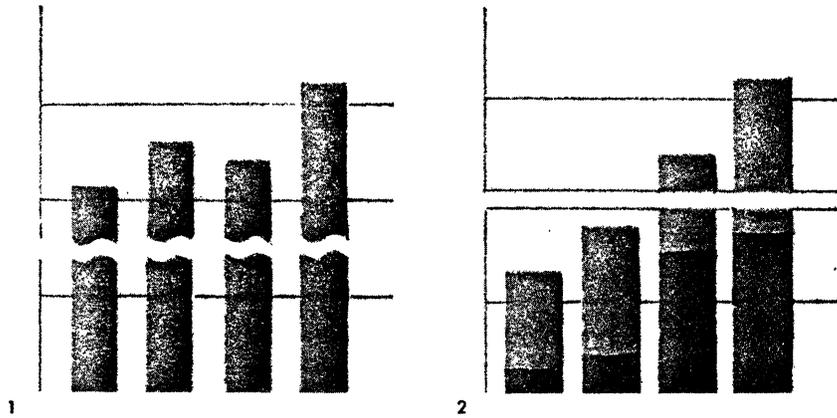
INTERRUPTED quantity is where the measured amount is broken in form and/or scale to omit unnecessary segments or to enlarge important ones for detailed description of its components. While omission interruptions serve the visual economy of the figure, enlargement interruptions serve its visual clarity in representing small amounts.
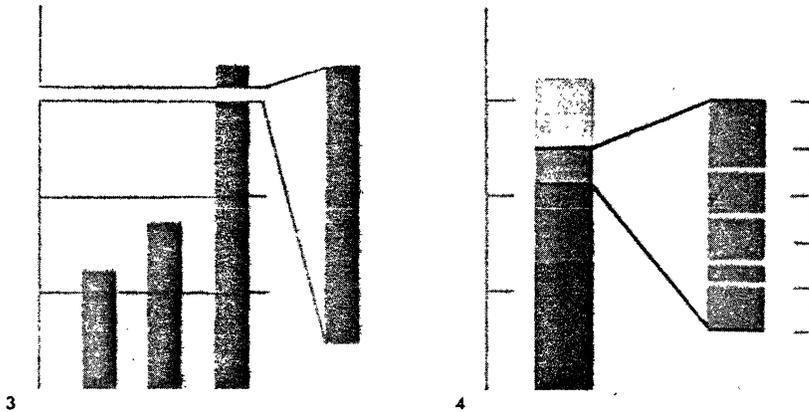
FIGURE 1. The removal of a central area from a series of very similar quantities, to permit a scale for bar differentiation that would otherwise be too tall to be manageable.

FIGURE 2. An interrupted scale, clearly defined so that only the last two quantities appear broken. Here, the interruption is used to accommodate widely differing amounts within an economical image.
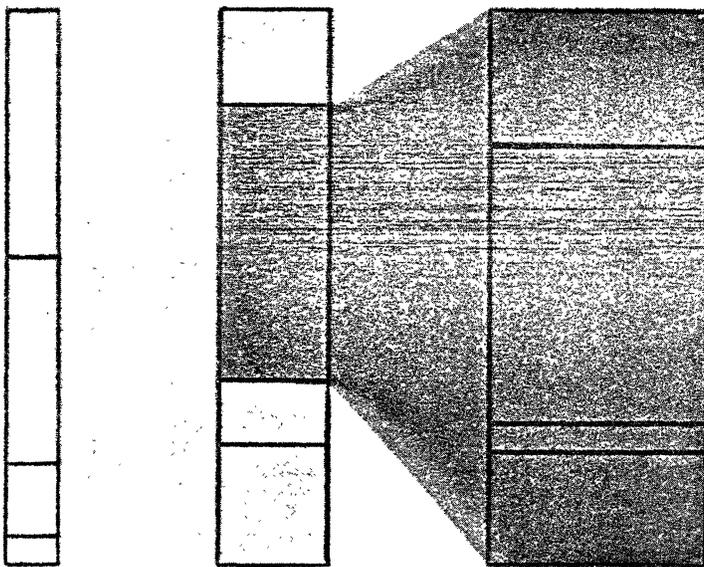
FIGURE 3. An interrupted large quantity in which the removed segment is visually represented for reference.

FIGURE 4. An enlargement of a quantity segment to show its subdivided amounts.

FIGURE 5. A double enlargement to show multiple levels of detail in one element of a quantified subject.

COMPOSITE quantity is shown as a product of two separate numerical factors. In plane form, it is represented by a rectangular shape whose height shows one quantitative factor while its width shows the other. The area created represents the total quantity as quantity per unit multiplied by number of units.

FIGURE 1. A series of composite quantities similar in area totals but varying in height and width factors.

FIGURE 2. Composite quantities in which the vertical factor represents percentage of a whole.

FIGURE 3. Composite quantities in which divisional variations in quantity are shown in terms of standard vertical percentage.

FIGURE 4. A composite quantity in a two-dimensional whole showing divisional percentage in terms of two scaled factors.

FIGURE 5. A complex version of figure 4 in which the vertical scale factor is also variable rather than constant.
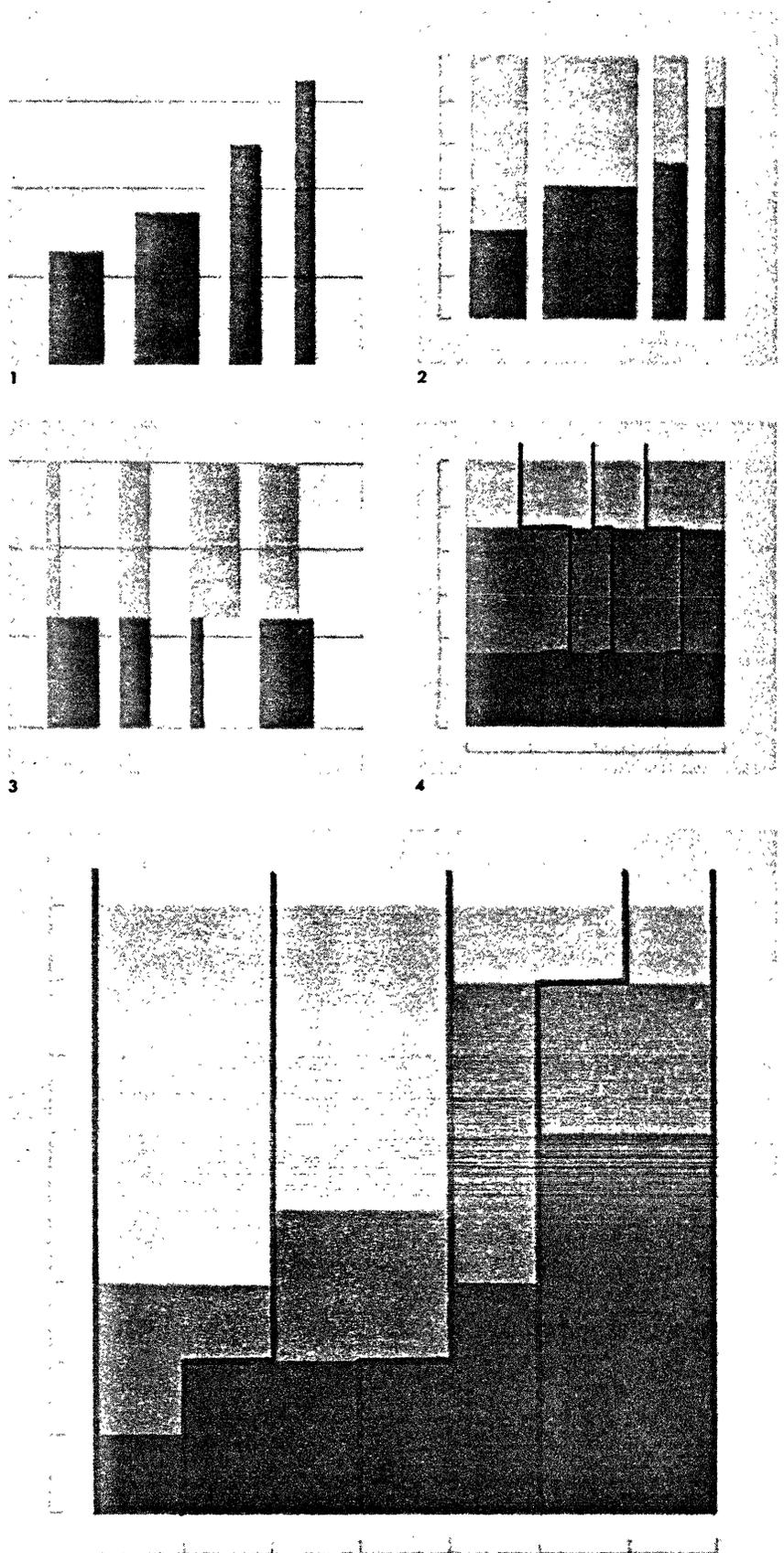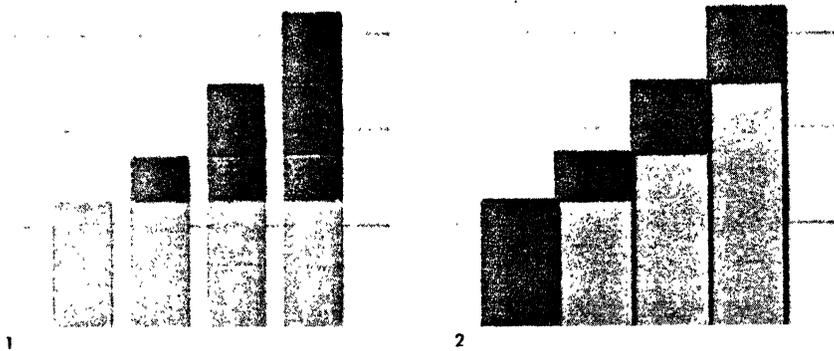
CUMULATIVE quantity shows the progressive increase of an amount through incremental additions. In representing each cumulative element, the previous total is brought forward as the base quantity and is added to the amount of increase for that occasion.

FIGURE 1. A series of cumulative amounts in which each additional amount is differentiated by shade value, to maintain its identity throughout.
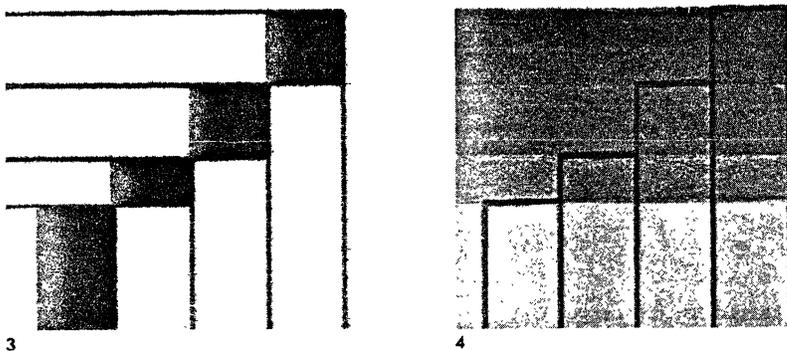
FIGURE 2. Cumulative increases emphasized as black and joined for continuity.

FIGURE 3. The cumulative pattern of figure 2 showing ordinate guidelines for direct measurement and representing only the increases.

FIGURE 4. Cumulative increase shown as subordinate description of total quantity bars and related directly to the ordinate scale.
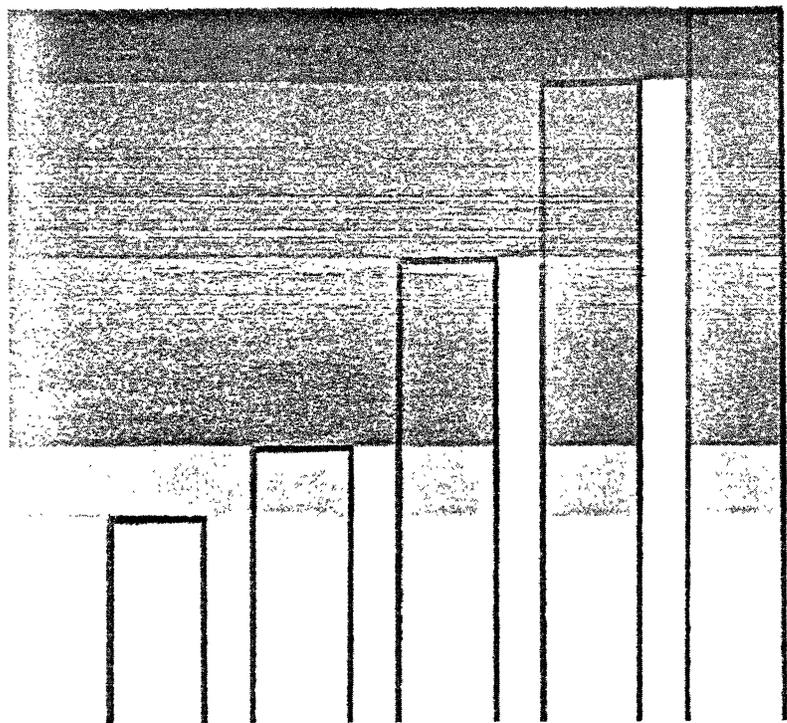
FIGURE 5. A modified version of figure 4 in which bars are spaced to separate and identify the cumulative components. Gray values differentiate each successive addition.

RELATED quantity is where the relationship between varying amounts is visually identified and represented as a directional increase, decrease, or trend. Form differentiation is essential to separate actual quantities from their generalized trend patterns.

FIGURE 1. Related outline quantities in which upper and lower measurements are connected and the divisional area between emphasized as a solid shade.
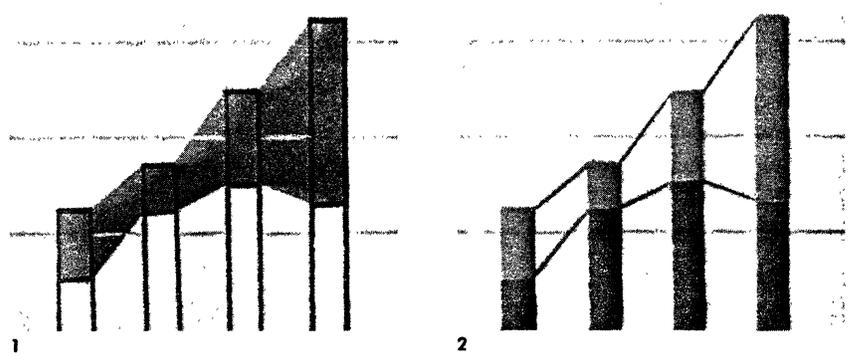
FIGURE 2. The quantities of figure 1 emphasizing the non-related amounts as black and unifying the related segments with gray line and shade.
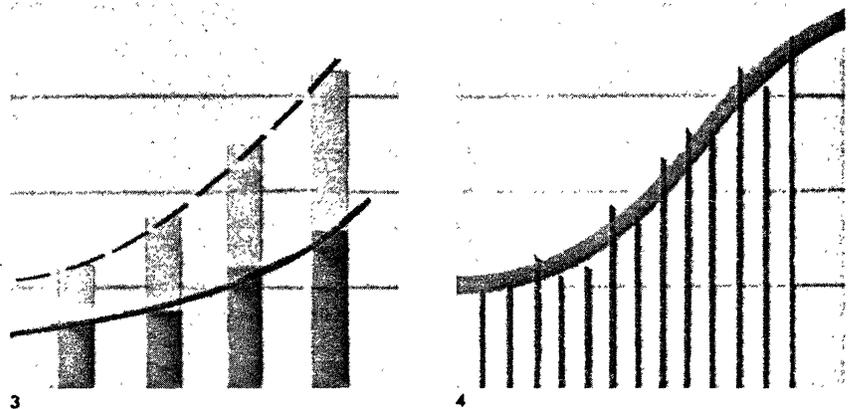
FIGURE 3. The same quantities in which the trends of the divisional amounts are generalized by curves.

FIGURE 4. Concentrated linear quantity bars whose averaged trend is indicated by an emphatic gray curve.
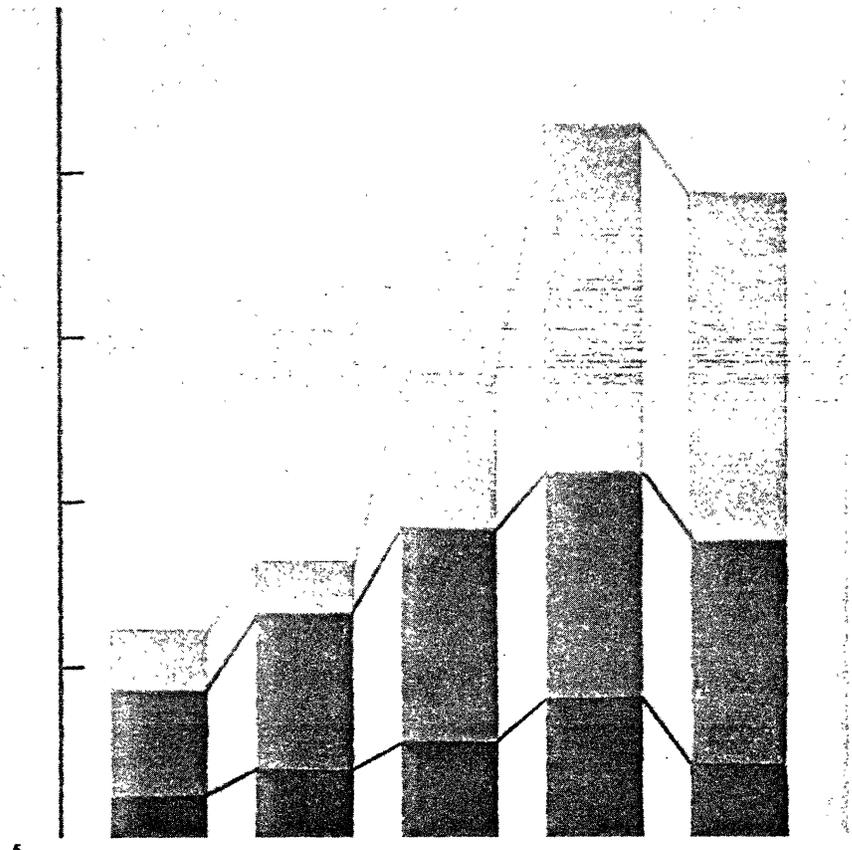
FIGURE 5. A complex version of figure 2 in which multiple quantity divisions are related by connecting lines of corresponding gray values.

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