1.5. Tools and Skills Categories

1.5.8. The Communication Skill

1.5.8.7. Information Portrayal

1.5.8.7.1. COMMUNICATING IS DIFFICULT—GRANT WOOD

1.5.8.7.2. How We Portray Information.

When you portray information, you want to bring forth an image in the mind of your audience that matches the image you have in your mind.

When you portray something—an idea you have, a description of something, directions, etc.—you're representing it. You're portraying information and representing something. You portray information to bridge the information portrayal/information perception interface in the Management System Model (MSM). You're trying to communicate, or transfer information, across that interface. Why is portrayal so important in understanding information and using information for decision making (management)?

Except perhaps in mathematics, every portrayal involves a betrayal—that is, you omit or add something. The idea of betrayal involves the principle of identity. Nothing ever consents to be anything other than it is. But you override this lack of consent and you bias and interpret what you see or feel or understand. If we start with x, that which is to be portrayed (the percept), and go to y, the portrayal, we must go through z, the action of abstracting the essence of x and translating it into y.

Think about a red vase. You see a red vase because whatever color you see you call red. Another person may see something extremely different—but they also have learned to call it red. And as long as we consistently see the same thing and can distinguish between different colors, we'll agree the vase is red. So, we need nomenclature or definitions of what we're trying to represent so we can transfer the information—which brings us to the idea of format.

Format is the organization, plan, style, or type of what we're portraying, or its appearance. And we end up finally dealing with our senses. We portray information in visual, auditory, tactile, etc. formats.

Of course we can portray information by combining senses. For example, if you're giving an oral presentation and using visual aids, you're combining visual and auditory senses. If you speak the words (auditory) on a visual aid as the audience reads it (visual), the senses are working together and the information transfer (communication) is far greater than double that for using only one sense. (We've gotten synergy.)

You can see ("see"?) that this generalized idea of information portrayal is tough for most engineers to handle. Most of us don't spend as much time as some other people thinking about art (visual), music (auditory), sculpture (tactile and visual), and other ways of expressing ourselves—especially in terms of what we're feeling or thinking. (Thank goodness, these days many engineers do spend a lot of time in these ways of expression.)

Much of our informal information portrayal or informal communication uses more of our senses than our formal information portrayal. Consider gestures and body language, for example. Since information is biased, we need to get a look ("look"?) at the bias of the person portraying the information. How helpful body language is in doing that.

Formal information portrayal is easiest to deal with because it's more tangible. So, the information portrayal formats we understand best and can talk the most about are written for-

mats. The written formats are visual. We can use illustrations, photographs, maps, logic diagrams, data flow diagrams, and other visual formats. But the most common are text, checklist, table, and graphic. And simply because they're most common, I'll talk mostly about them. You can, however, extrapolate in your mind to other formats the ideas of logic and structure that I'll present for these common formats.

A management information system (MIS) can portray any of these more common written formats. So we'll consider the role the MIS plays in portraying information and then concentrate on the different common written formats.

1.5.8.7.3. PORTRAYALS FROM MANAGEMENT TOOLS.

Like all management tools, the output from a management information system portrays information to be used by a decision maker depending on how they perceive that information.

We can classify MIS information portrayals several ways. Normally, we emphasize end-user information use—the information portrayals on the management tool side of the information portrayal/ information perception interface in the MSM. We also produce information in the form of reports and query responses we use in the operation of the management tool or to tie management tools together.

Perhaps the best way to classify the outputs of an MIS is by how we use the output. MIS outputs serve three main purposes:

1) Delivering Information. We use an MIS primarily to communicate information to users on a timely and accurate basis.

2) Storing Information. A computer-based MIS can store information in forms and formats to be retrieved later. We can keep some archival information in the computer for ready access, and we can put most of it on tape or other long-term media storage for access when needed. The MIS can hold archival information for a long time in a very small space.

3) Transferring Information. Computers can produce information for other computers. Computers can produce specially encoded outputs so we can enter data into computers as transactions are completed.

The first purpose (delivering information) crosses the information portrayal/information perception interface of the MSM. The other two purposes remain inside the what is used to manage component.

Delivering Information

The first function of MIS outputs is delivering information. We portray information so we can communicate data and information to people who need it. We produce this output in human-readable form. We can present human-readable output in a variety of formats using different types of media.

We can classify information from outputs of information systems in the form of l) a comprehensive document, 2) a short answer to a query, and 3) a transaction report.

A comprehensive document is a report predesigned to give a comprehensive closed set of information to managers. I'll classify comprehensive documents by content and group them in three general categories:

l) Detail reports present all or nearly all of the data content of one or more files from a database. Managers use detail reports to monitor their day-to-day activities. Staff people use detail reports to respond to specific inquiries. Detail reports can be produced weekly or daily to give the manager operational-level information needed to formulate and execute work effort for their operational endeavors. In some organizations, managers get a daily MIS report. Many managers close to the work flow want detail reports, specifically relating to problem areas they're watching.

2) Summary reports show accumulated totals from detail reports—rather than complete file contents. Managers use these reports for reviewing tactical and sometimes stra-

tegic-level endeavors. When managing these endeavors, we must be careful not to depend solely on summary reports. Aggregations (being integration as opposed to differentiation) can lose or obscure as much or more information as they surface or highlight. Summary reports show information for a current time period, with projections and figures for that time period along with projections and figures for other time periods. With this information, the manager can compare current operating results with expected results and with prior operations. Managers use discrepancies between actual and expected results to determine corrective action to bring the operation back on course.

3) Exception reports call attention to conditions outside normal operating limits. For example, we can scan a customer status file to find overdue accounts. Rather than a detail report listing all accounts and the action dates or a summary report giving the total sales by sales region, an exception report would list only those long overdue accounts so managers can take action on them. With an exception report, we try to identify the crucial data and trends to readily differentiate the points for managerial attention. Exception reports can be more effective than detail reports for day-to-day control of operational endeavors.

A short answer to a query is like a report in its data content. However, a short answer to a query is dramatically different in its presentation method, data currency, and delivery cost.

A comprehensive document is printed, uses one or more files, and presents a snapshot of a part of the organization as it was when the report was run. On the other hand, a short answer to a query involves a real-time output presenting up-to-date information for immediate use. Query response capabilities respond to managers with current and detailed information. So, the source files for queries must be updated frequently. Query responses normally report at a detail level. However, query responses can also access summary and exception reports.

A transaction is an act of doing business. A transaction moves something of value (product, money, information, resources, etc.) from one place to another. An order is a transaction. Transactions represent both input to and output from a system. Transactions play a central role in many computer information systems.

When doing business, an organization generates data representing their transactions. Data provide evidence of transactions, and, by capturing transaction data, the organization maintains records of business activity. The data about transactions go to company files as documentation on the organization's operations. We use the comprehensive documents containing these data to provide management with the information needed to control the organization's activity.

We can capture transaction data using source documents or we can put the data directly into the computer. However we capture the data, transactions serve other purposes besides collection of data for historical files. One of the most important uses of transaction reports is to help work flow through the production and distribution processes of the system. A transaction is either a physical document or a computer record and transmits information between people. So the transaction is a process control device. Transactions trigger activities—and are controlled by the information contained on them.

Consider the following example. In a manufacturing and sales operation, work begins when a customer orders something. This order transaction triggers the preparation of a pro-

duction order transaction requesting a manufactured product. Then we produce several other transactions to gather the material to produce the item, to specify work orders, and to integrate the materials, people, machines, and manufacturing processes to produce the item. In the meantime, we use the sales order transaction to prepare invoices and statements requesting payment from the customer. These transactions enter the accounting system and are maintained as historical records for reporting and control purposes. Documents sent to customers request and provide evidence of payment for the products. These transactions, in turn, enter the accounting system to be balanced against production and distribution costs and expenses.

As this scenario suggests, transaction records are part of many systems. They provide mechanisms for getting the work done. They represent the key data flows in a system, activating and controlling system processes.

Storing Information

The second function of MIS outputs is archival storage. Archival records are permanent documents. Sometimes archival records are business reports and transaction documents. Sometimes we copy these reports and documents in either human or machine readable form and use the right materials for long-term retention and use.

We have three reasons for archival storage. First, we're legally required to retain certain business transactions. Second, business records give us an historical commentary on business activity. Long-term trends contained in this information can be used to project and plan for future activity. Third, archival records give us backup security. If we destroy active records through fire or other disaster, we can restore business files, reports, and turnaround documents from archival files. So we must be able to easily access archival records.

Transferring Information

The third function of MIS outputs is turnaround documents. Turnaround documents are computer output documents we use as input documents to a follow-up processing activity. In its output form, a transaction document triggers some action on the part of its recipient. Usually the action is then indicated on the document itself or accompanies the document on its return. The returned document activates the next processing step in the system.

Some years ago, we used turnaround documents for college class registration. In those days, the outputs were punched cards representing individual seats available for each class. A student registering for a particular class was given a card identifying a taken seat. Those class cards, together with cards containing student identification information, were collected and reprocessed through the computer to produce registration records and lists of students enrolled in particular classes.

A turnaround document triggers a transaction and produces an output document. A returned output document is evidence of the transaction and becomes input to the next processing phase. Turnaround documents can take physical forms besides punched cards.

A turnaround document helps automate data entry. In the class registration example, class cards were punched with identification information already in input form. We didn't have to keyboard those data. We only had to enter the student identification numbers, saving time and reducing the possibility for error.

Turnaround documents help collect data. For example, in a billing system for an electric utility, meter reading books serve as turnaround documents. The computer can print the books so the pages are ordered by the sequence in which the meters will be read and

can contain meter location and other information helpful to the meter reader. Usage data are then collected by meter readers who record the data in these books.

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1.5.8.7.4. Portrayal Design

1.5.8.7.4.1. WRITTEN FORMATS.

In written formats, we must make meaning for our audience.

Many system analysts design information systems by first considering the design of the output formats. They come at the information specialist part of the MSM for the information portrayal/information perception interface.

We design output documents or displays by first establishing data content. The system analyst works with the user to identify the information needed to support certain decisions. Then he or she can figure out the list of data elements to be included in each of the outputs for the system. This listing leads toward the creation of a data dictionary for the new system. The user must be involved in generating this list. Before you start designing forms, display screens, or report layouts, you must know what the content requirements will be.

Once content is established, analyze and formulate output requirements. The user and the analyst together should consider questions such as these:

- What is the business purpose of the output?
- Who will use the output and how will they use it?
- What decisions will the manager make using the output?
- Is each data element in the output essential?
- Are any data elements missing, given the intended use?
- Is the same information to be included in other outputs?
- How often should the output be produced?
- How many copies are needed?
- What is the best form and format for presentation of the data?

Answers to these and other, similar questions will help the analyst establish a business understanding of the problems the system will solve. By specifying content, format, and scheduling for output documents, users indicated how important the reports will be and the role they will play in the new system.

Common Written Formats

Recall the MSM and focus on the information portrayal/information perception interface. I'll discuss the distinction between data and information and explain logical ways to determine which of the four portrayal formats—graphics, checklists, tables and text—is appropriate for the various characteristics of the data that must become information to be useful.

The model has three components: who manages, what is managed, and what is used to manage; and three interfaces: the decision/action interface, the measurement/data interface, and the information portrayal/information perception interface. The manager, the who, is the forcing function, driving the system through decisions that lead to actions that affect what is managed. Measurements of what is managed become the data that feed what is used to manage: plans, policies, procedures, reports, and briefings, supported by the people and machines that collect, store, retrieve, manipulate, and portray these data, which the manager perceives in various formats and uses to make decisions.

What do I mean by data becoming information? Aren't data and information the same thing? I just happen to have here 18 volumes of census data for Czechoslovakia, by province, for the years 1920 - 1932. So what? But suppose I was studying Czech demographics over that period to determine the effects of increased industrialization on farmers' migrations to urban areas.

It's like clues in a mystery. Until some Sherlock perceives a *pattern* of meaning, in which a bunch of things that-are-the-case add up to something that tells whodunnit, a clue isn't a clue at all. It doesn't *have* meaning all by itself but must be *made* meaningful by someone who figures out how to ask the question to which the clue becomes part of the answer. "Data," after all, means "what is given." Data are the mere results of measurements, either by instruments or by the inventor of all instruments, the human mind. Whereas "information," or in-formation, is an internal pattern, a schema into which data are incorporated by an organizing principle that selects data that fit and rejects as noise those that don't. Depending on the schema, that in turn depends upon the schematizer's reason for having or wanting or needing it, the data's pattern and therefore meaning will differ. In short, data are a matter of what is given, and information is a matter of what is received, or perceived, or conceived—all three words coming from a root signifying "to gather."

Nothing counts as information unless it responds to someone's question and therefore fulfills a purpose. For purposes of management, information is anything that helps a manager make decisions and take actions that affect what is managed. Data become information—or rather, managers use data to generate information—when they apply a bias or slant or interpretation to a set of data. I can make the best decisions—that is, the most informed decisions in the shortest time—when the information comes to me the way I want it: when it answers all the questions I need to have answered, none that I don't need to have answered, and in a format that is as easy and pleasant to understand as possible.

Part of managing is measuring what is managed; these measurements yield data that a variety of people and machines working on operational endeavors will store, access, manipulate, and portray for strategic-level decisions. To manage effectively, the manager must see to it that the format(s) generated by these people and machines—by what we call the data-to-information chain, answer his or her needs for making the best decisions (down the line) and the best presentations (up the line). In other words, a manager of hardware inventories is not simply in charge of quantities of nuts and bolts on hand and on order. This manager is also in charge (or should be if he or she isn't) of the formats in which the data-to-information chain converts data to information for his or her use.

The characteristics of information portrayal depend on the characteristics of the data. Data characteristics differ along two dimensions: purity and volume. On the purity dimension, data may be seen as isolated from everything except that which was measured, the means of measurement, and (though this last is usually overlooked or lumped in with the means), the agency of measurement, i.e., the measurer. Data lose rawness (if they ever have it!). After all, to measure anything is to distort it, as Heisenberg showed; so even measurement as measurement, as well as the decision to measure *this* and not *that*, constitutes interpretation and yields the quantitative equivalent of a metaphor.

A datum, which is a straightforward quantitative physical measurement—for example, the

millimeters of mercury in a thermometer—is impure in proportion as the device itself is imperfect. If the thermometer is read by a second device, then the original impurity, or limit of error, is increased by that of the device. If the thermometer is read by a human, then the impurity grows by at least the imperfection inherent in the best human perception. In short, though objectivity is in principle impossible since it always involves a human subject's perception of an object, the bias in physical measurement is the lowest attainable and grows less as instruments mitigate human perceptual limitations.

At the other end of the purity scale are subjective, qualitative, conceptual data, as in William Blake's perception of the sun as "an innumerable company of the heavenly host shouting 'holy, holy, holy is the Lord God Almighty.'" Between these poles come subjective responses given within an objective and therefore quantifiable scale or framework, like grades A to F or the response to

> I like meatballs. (circle one number.)
> DISLIKE 1 2 3 4 5 6 7 8 9 10 LIKE

The data-volume dimension is simple: data can be few or many.

These characteristics and their combinations (many/pure, many/biased, few/pure, few/biased—with all possible gradations) help us logically to determine the appropriate portrayal format. They only *help* us, because portrayal logic is one thing, but perceptual preference, or cognitive style, may be quite another. No vendor has ever succeeded in selling Proctor and Gamble graphics packages for their computers because the company wants and hires managers who love tables—detail people, not visualizers.

Strictly speaking, converting data to information is always a matter of losing something and gaining something else. What you lose is some purity, by the very process of selection (which, you recall, is already a form of interpretation); what you gain is a point of view, a bias—which means a cut or an angle. So, portraying data into information isn't "lying" in the sense of deception with intent to protect oneself and/or harm another. It is, rather, deciding what *part* of the whole truth to tell, for a particular purpose, to a particular audience, for a particular occasion.

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1.5.8.7.4.2. Graphics

1.5.8.7.4.2.1. WHAT GRAPHICS DO.

A graphic provides a pictorial representation of data with implied comparisons for making information. The question is: Which representation implies a particular type of comparison best?

All presentation formats begin with raw data and add the perspective or goal of the individual who creates information from the data. The form closest to the raw data, which includes greatest purity and least perspective, is the table. The arrangement of data for a table allows the presenter to choose titles, rows, and columns, and arrangement of rows and columns. The data in the table can carry as much precision as available. The graphic is the next most pure representation of the data. In the transition from table to graphic, much precision is lost and much perspective or bias is added. Within this hierarchy of presentation formats, the checklist follows; and the final form is the narrative or text. The narrative includes little precision and much perspective, opinion, and conclusion. An important point is the danger in producing a format from a higher-ordered format. That is, a graphic would not be produced from a checklist or narrative because there doesn't exist sufficient purity in those forms. Rather, a graphic should be produced from a table or from the raw data.

Figure 1.5.8.7.4.2.1.a., the presentation formats flowchart, allows the manager to choose the appropriate presentation format. By looking at the data characteristics, the manager will be logically moved to select text, tables, checklists, or graphics.

Graphics

Some managers, perhaps intuitive managers, should receive the best decision-oriented information from graphics. In support of these graphics, a management document may contain tables of data, checklists, and narrative, explanatory, or analytical text. The key to a good document is that the graphics will display the crucial points of information, while the tables, checklists, and text will provide the backup data and information the manager would want when more specific analysis and interpretation are required.

While graphics can be a concise way to communicate information in a book, paper, report, briefing, or management information document, they can also be confusing or misleading when improperly designed. The increased availability of computer-generated graphics has led to a proliferation of charts and graphs. Graphics should simplify, not confuse. They must focus, not distract. Some managers dislike a particular type of chart; and while preferences are to be expected, given various cognitive styles, chances are that much of this dislike comes not from the chart type itself but from experience with the misuse of that chart type.

Each graphic should be designed to communicate one idea or point. Once the point is defined, a logical, structured procedure can be followed to design an appropriate graphic. While the following approach contains certain specific guidelines for graphic design, it also incorporates considerable flexibility. Since the selection of points to be made depends upon the manager's personal approach and style, this design flexibility is one of the strengths of the presentation format procedure. My approach is to structure the process of designing graphics through a set of logic diagrams. These diagrams provide guidelines whereby anyone can address vast amounts of data and render effective graphics.

The general principles for the design of graph-

ics arise from two basic criteria. The graphic must be easy to read (i.e., clear). And the graphic must strongly make the desired point about the data, or conclusion from the data. The steps described below are intended to create graphics that satisfy these criteria.

The first and most important step in graphic design is to determine the main idea to be communicated. Then an appropriate graphic can be selected to communicate this idea. Since the number of points or ideas successfully communicated by a graphic is inversely proportional to the number of ideas or points exhibited on the chart, it is important to minimize this number, ideally to one.

Graphics display five different types of comparisons:

1. Component comparison—shows the relative importance of the component parts of a whole.

2. Item comparison—shows the relative importance, ranking, or performance of related items.

3. Time-series comparison—shows the distribution of an item over time.

4. Frequency distribution—shows the distribution of an item over several categories or classifications.

5. Co-relationship comparison—shows how two variables relate to one another.

We must determine the main idea to be communicated before we can select the type of comparison we want. Then we can identify the type of comparison that will best communicate this idea. The third step in the graphic design is to select the appropriate chart type. The final step is to create the graphic following the design principles for the chart type selected.

There are seven basic types of charts. Figure 1.5.8.7.4.2.1.b. [from *Choosing & Using Charts* by Zelanzny and Roche] shows how each of these chart types applies to the five types of comparisons. Figure 1.5.8.7.4.2.1.b. is the basic tool for selecting a chart type.

There are many possible variations and combinations of these seven basic chart types. For example, bar and column charts can be subdivided into components that make up each bar or column; several curves can be superimposed on the same chart with varying scales. The best general guideline is to design the simplest chart that will communicate the main point. A graphic with two curves is not necessarily twice as good as a chart with one. Each of the seven chart types and a few of the individual design rules are given in the following sections.

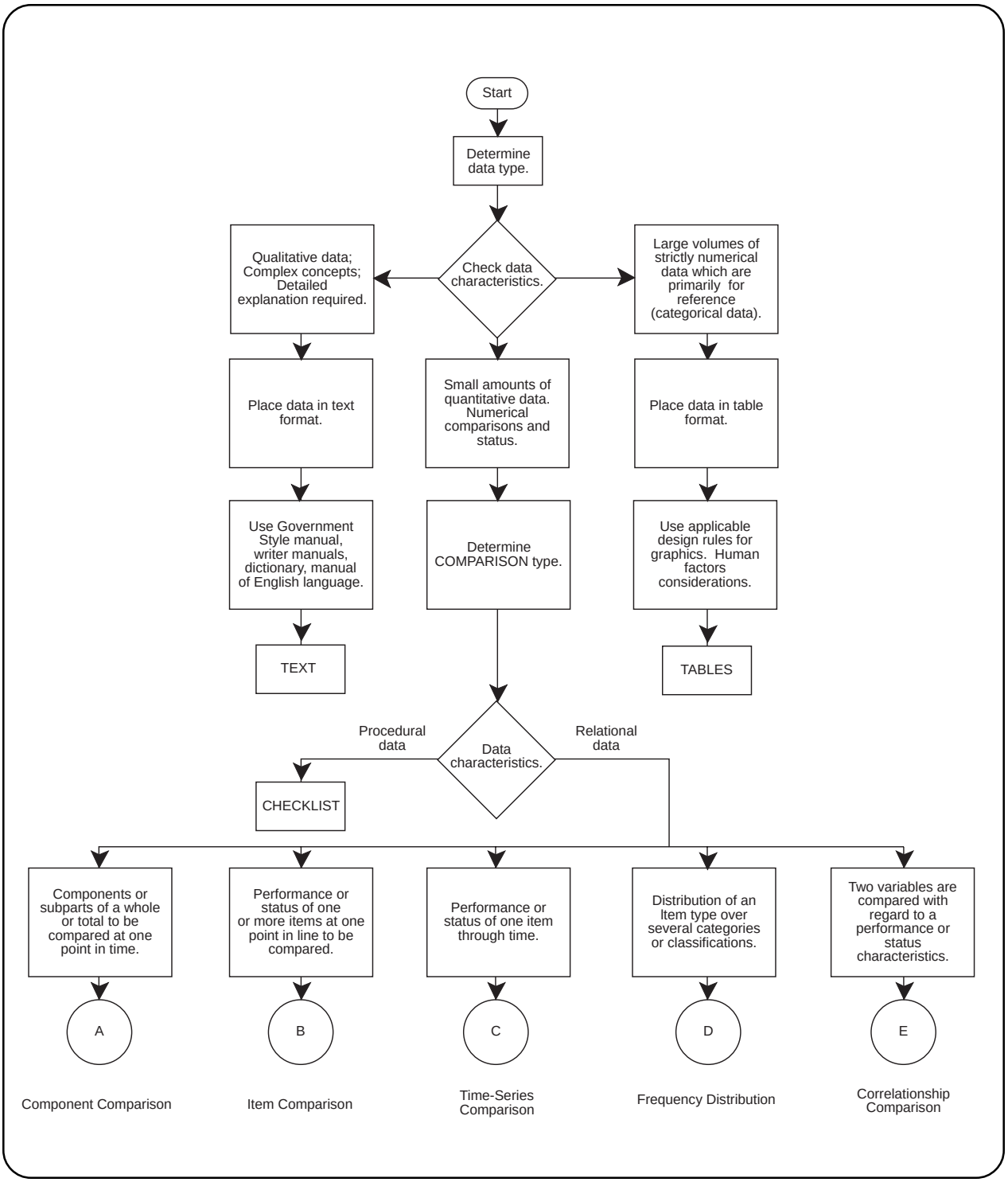


Figure 1.5.8.7.4.2.1.a. *We can flowchart presentation formats to help us logically choose the presentation format most suitable to the data and to the conclusion we're trying to make.*

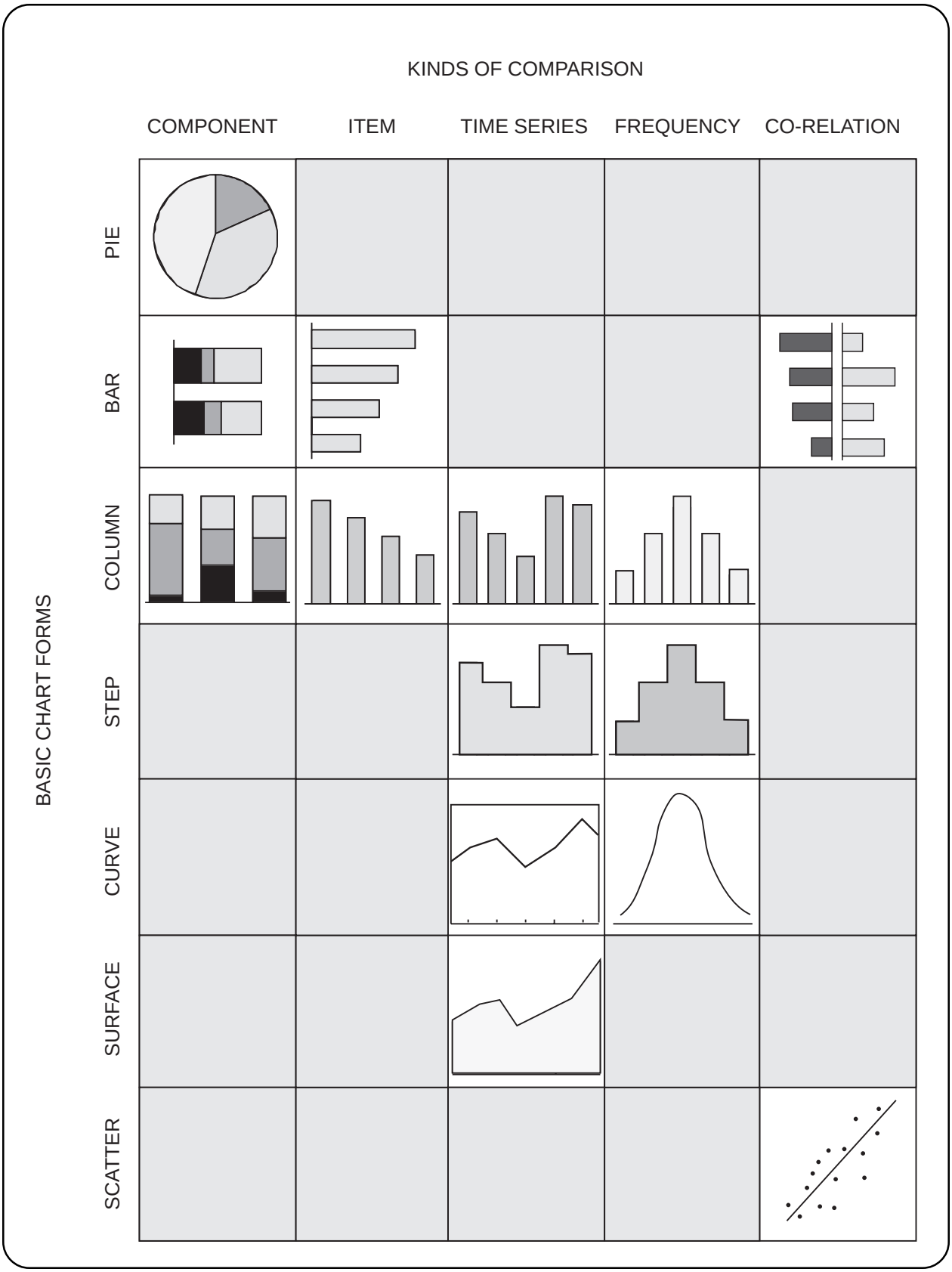


Figure 1.5.8.7.4.2.1.b. *Several types of graphical presentation formats show the different types of comparison for data.*

1.5.8.7.4.2.2. COMPONENT COMPARISON.

We use component comparison when the main point of the graph is to show the relative importance of the component parts of a whole.

The logic diagram for component comparisons is displayed in Figure1.5.8.7.4.2.2. We use component comparisons when the main point of the graph is to show the relative size of component parts of a whole. A component comparison is often described using words such as "percent of total," "contribution," "portion," or "share." Three types of charts are best for graphically portraying this type of information: pie charts, 100% bar charts, and 100% column charts.

As the first decision node of the logic diagram in Figure 1.5.8.7.4.2.2. indicates, component comparison is only appropriate when the number of components is less than five. The next decision node concerns the number of totals or wholes involved. When information is to be given concerning one total, the pie chart is best. If a particular component of a pie chart requires emphasis or if the components can be ranked by importance, then the component receiving emphasis should be placed in the pie starting at the 12 o'clock position and proceeding clockwise. Darker and denser colors should be used for the most important components and for those components that need emphasis.

The logic diagram in Figure 1.5.8.7.4.2.2. shows that when the components of several different totals are to be portrayed on a single chart, the 100% bar chart or the 100% column chart is indicated. If there is a time orientation to the components, the column chart is indicated. Time is normally displayed on the abscissa. When there is no time orientation to the components, the bar chart is most appropriate. The bars are easier to label, fit in less space, and make comparisons between separate totals easier than two or more pie charts placed side by side.

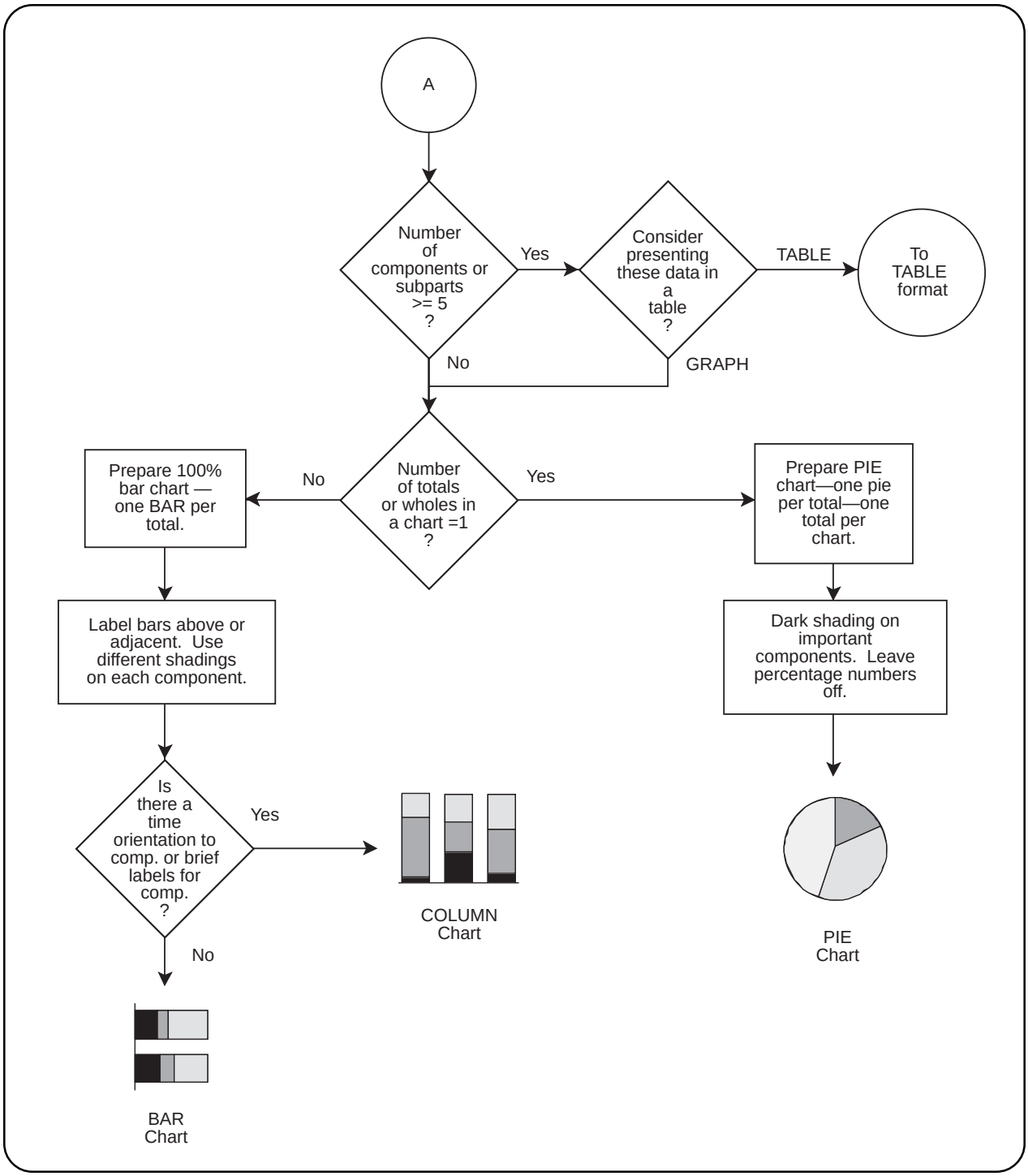


Figure 1.5.8.7.4.2.2. *We use component comparison when the main point of the graph is to show the relative importance of the component parts of a whole.*

1.5.8.7.4.2.3. ITEM COMPARISON.

We use item comparison when we want to show the relative importance, ranking, or performance of related items.

The logic diagram for item comparison is displayed in Figure 1.5.8.7.4.2.3. Item comparison differs from component comparison in that related items are compared on a scale which is labeled with absolute units. As the first decision node of Figure 1.5.8.7.4.2.3. indicates, if the items aren't on the same scale, a text or table should be used, or the items should be placed on the same scale and the bar chart used. These units may be any physical or monetary scale or a percentage. When the scale is a percentage, the 100% mark doesn't represent the sum of the items graphed.

Each item in an item comparison is shown with a value for the characteristic being displayed in the graphic. For example, a chart showing a year's production (in pounds) of various chocolate bars made by one company would be an item comparison. The focus of item comparisons is to show the sizes of, or quantities achieved by, each item.

Although either the horizontal-bar or vertical-bar chart can be used, current thinking in the field of graphic art recommends that the primary tool for item comparisons should be the horizontal-bar chart. The horizontal-bar chart allows sufficient room for a textual description or name for each item in the comparison. Thus the vertical scale in such a chart is not really a scale at all. Item names may be arranged alphabetically, randomly, or by some other criteria. A major advantage of the horizontal-bar chart is that it will not be mistaken for a time-series chart. A horizontal-bar chart is a "snapshot" of the status of the items involved at a single point in time.

In a bar chart, the main point of the graphic affects the order of the items. For example, the order may be randomized to emphasize the unevenness of performance among items. On the other hand, items may be ordered by increasing or decreasing value of the characteristic being displayed. This is often done to show where particular items lie in the ranking.

There are several variations of the horizontal-bar chart. These include range bar charts, which show a range of performance on the characteristic scale, and deviation bar charts, in which bars may extend in either direction from a vertical base line. Horizontal-bar charts may even have bars split into several components. While this practice may make the chart appear similar to a component-comparison chart, the difference lies in the emphasis on the comparison between items rather than among components of a single item.

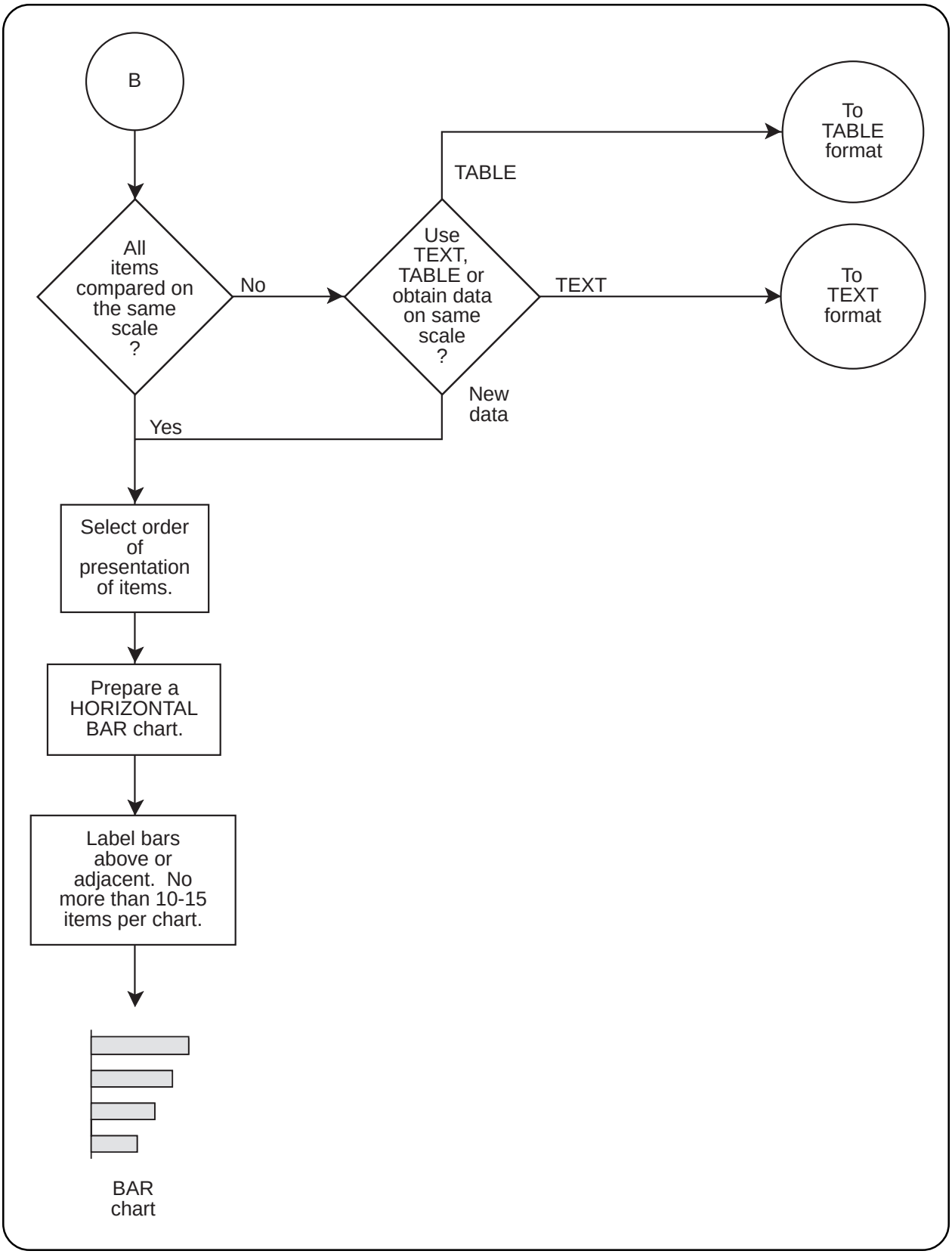


Figure 1.5.8.7.4.2.3. *We use item comparison when we want to show the relative importance, ranking, or performance of related items.*

1.5.8.7.4.2.4. TIME-SERIES COMPARISON.

We use time-series comparison when we want to show the distribution of an item over time.

The logic diagram for time-series comparison is displayed in Figure 1.5.8.7.4.2.4. A time-series comparison shows how the performance of a single item changes through time. It highlights fluctuations or trends and exposes patterns. Figure 1.5.8.7.4.2.4. requires two key decisions that narrow the choice among the four chart types. The first question is whether or not the data have been kept on the same scale over the time period. If yes, the next decision is whether the data are discrete or continuous. If they're continuous, the surface chart or curve chart is most appropriate. We select the surface chart if the emphasis is on magnitude, the curve chart if the emphasis is on trends or changes.

If the data are discrete, the column or step chart is indicated. The key question for selection between these two types is whether or not the number of time periods is fifteen or fewer. If the number is less than fifteen, proceed to the column chart; if it's greater than fifteen, proceed to the step chart.

Customarily, time is placed on the horizontal axis in all time-series comparisons. The vertical axis represents the scale of the characteristic that is being measured for the item.

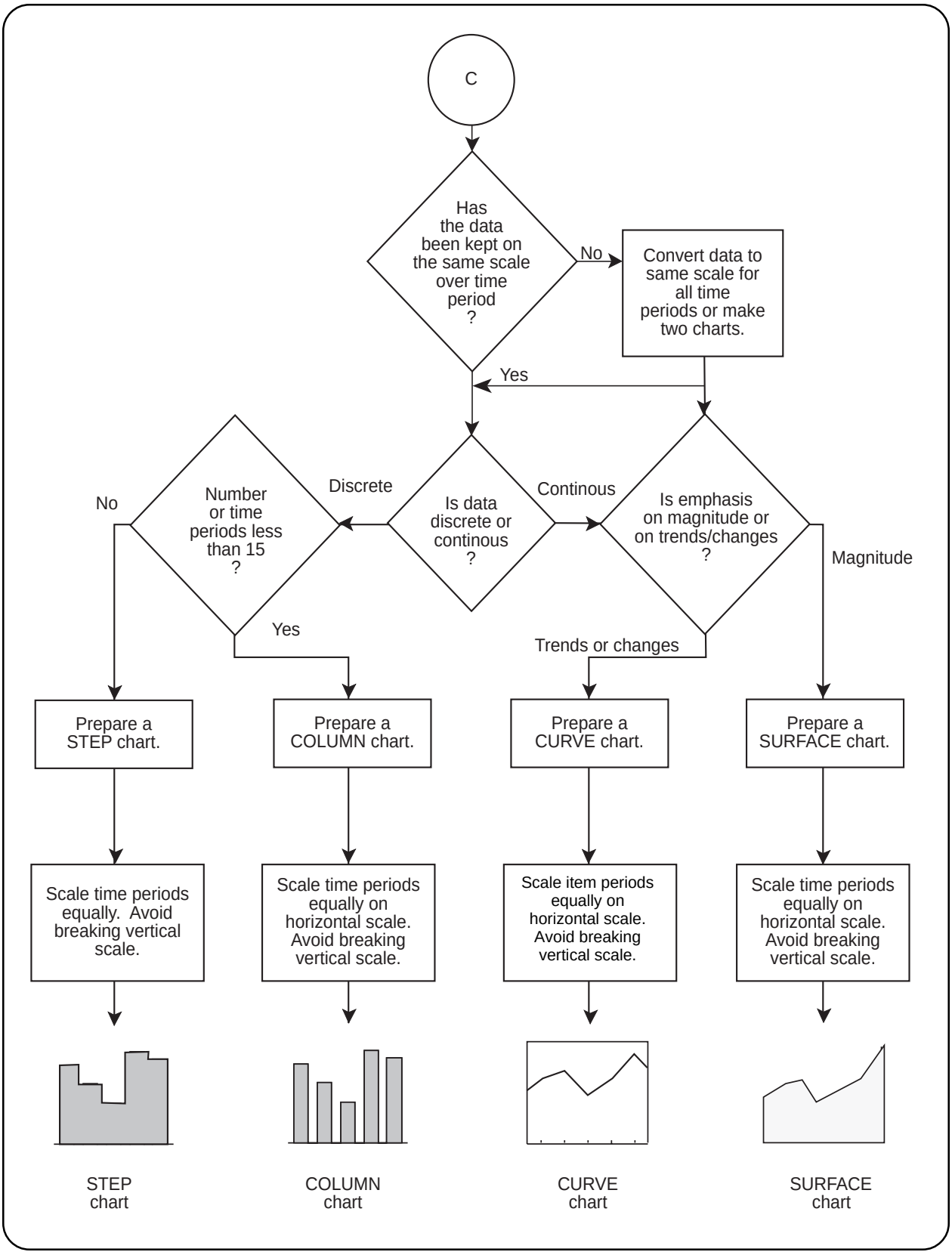


Figure 1.5.8.7.4.2.4. *We use time-series comparison when we want to show the distribution of an item over time.*

1.5.8.7.4.2.5. FREQUENCY DISTRIBUTION

We use frequency distribution when we want to show the distribution of an item over several categories or classifications.

The logic diagram for frequency distribution is displayed in Figure 1.5.8.7.4.2.5. A frequency distribution comparison shows the number of occurrences or events in each of several ranges along a scale that measures a particular characteristic. Suppose, for example, you wish to understand something about the patterns of service calls for various brands of microcomputers in August 1992. A frequency distribution could be created from daily service call reports from that month.

Column, step, and curve charts can be used to display a frequency distribution. Generally-accepted practice is to place the scale that measures the characteristic of interest along the horizontal axis in these charts. The vertical axis in all of these charts is either a simple frequency count or a percentage of the total number of occurrences.

As the first decision node of Figure 1.5.8.7.4.2.5. indicates, the key decision for selection of graph type is whether the data are discrete or continuous. If the data are discrete and we have more than ten valid points and more than fifteen class intervals, we select the step chart. If we have fewer than fifteen class intervals, we select the column chart (or histogram).

As indicated in the first decision node in Figure 1.5.8.7.4.2.5., if the data are continuous, the curve chart (or frequency distribution) is indicated. The curve chart will show continuous data where differences between intervals are infinitesimally small and the number of intervals is large.

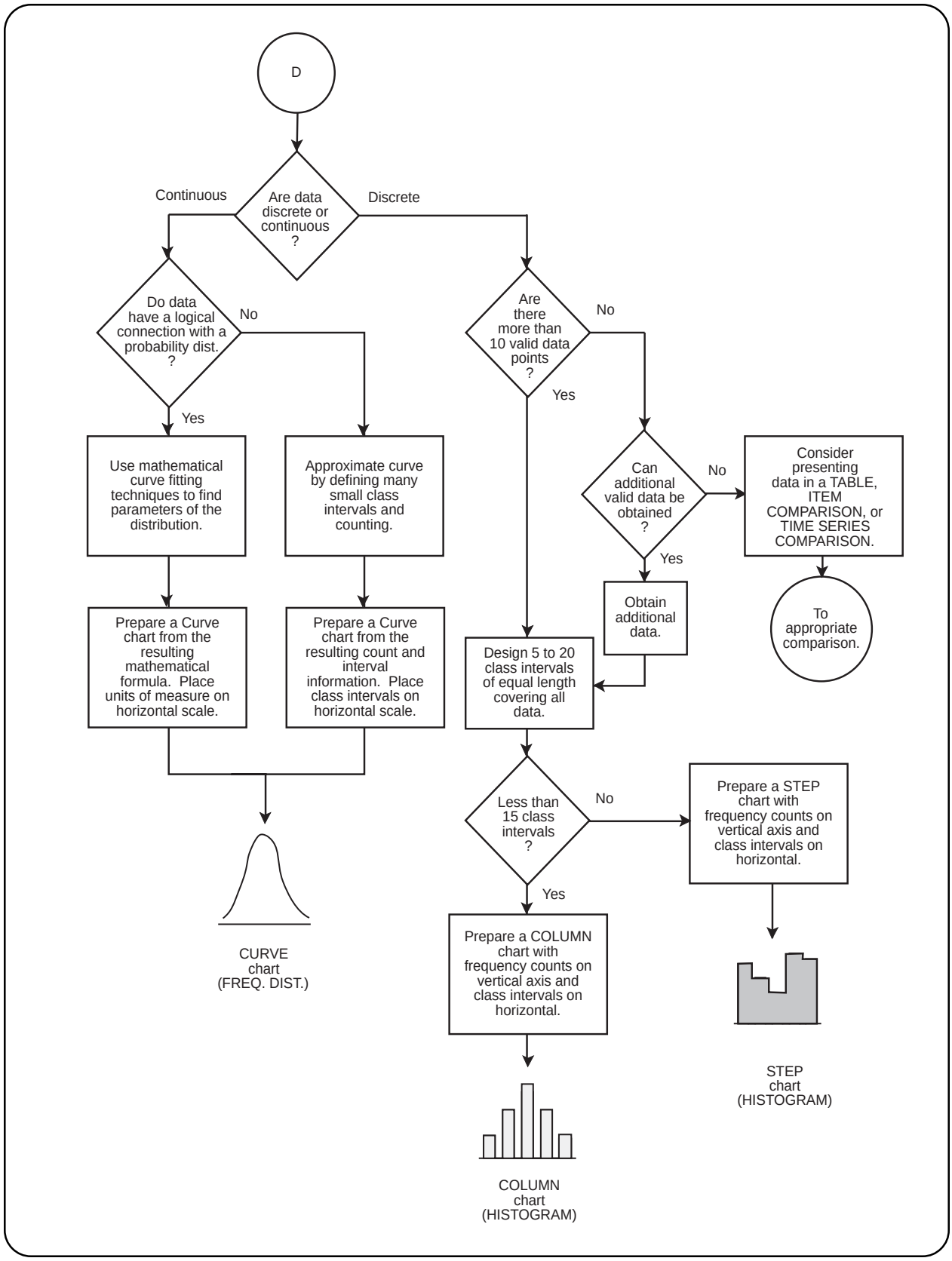


Figure 1.5.8.7.4.2.5. *We use frequency distribution when we want to show the distribution of an item over several categories or classifications.*

1.5.8.7.4.2.6. CO-RELATIONSHIP COMPARISON

We use co-relationship comparison when we relate variables to each other.

The logic diagram for the co-relationship comparison is displayed in Figure 1.5.8.7.4.2.6. Co-relationship comparisons relate two variables to each other in a manner similar to the way variables are examined in regression and correlation analysis. The typical purpose of a chart of this type is to expose a relationship between the two variables. For example, we may want the relationship between the output from a particular nuclear reactor and the amount of energy consumed by that reactor.

There are two chart types used to graphically portray co-relationship comparisons: the dot chart, also known as a scatter diagram; and the paired bar chart. As Figure 1.5.8.7.4.2.6. indicates, the key decision node for selecting chart type is whether data points must be individually labeled.

Labeling each dot in a dot chart is difficult to do so that the reader may easily understand the source of each data point. The paired bar chart solves this problem by using a pair of bars (one bar for each variable) to represent each data point. This type of chart provides the reader with more confidence in apparent relationships by clearly indicating the source of each data point.

The scatter diagram contains data in the form of dots, each of which represents a pair of variable values, usually obtained from historical data. Data for the comparison between reactor output and energy consumption could be collected on an annual basis for ten years, which would result in ten data points (dots).

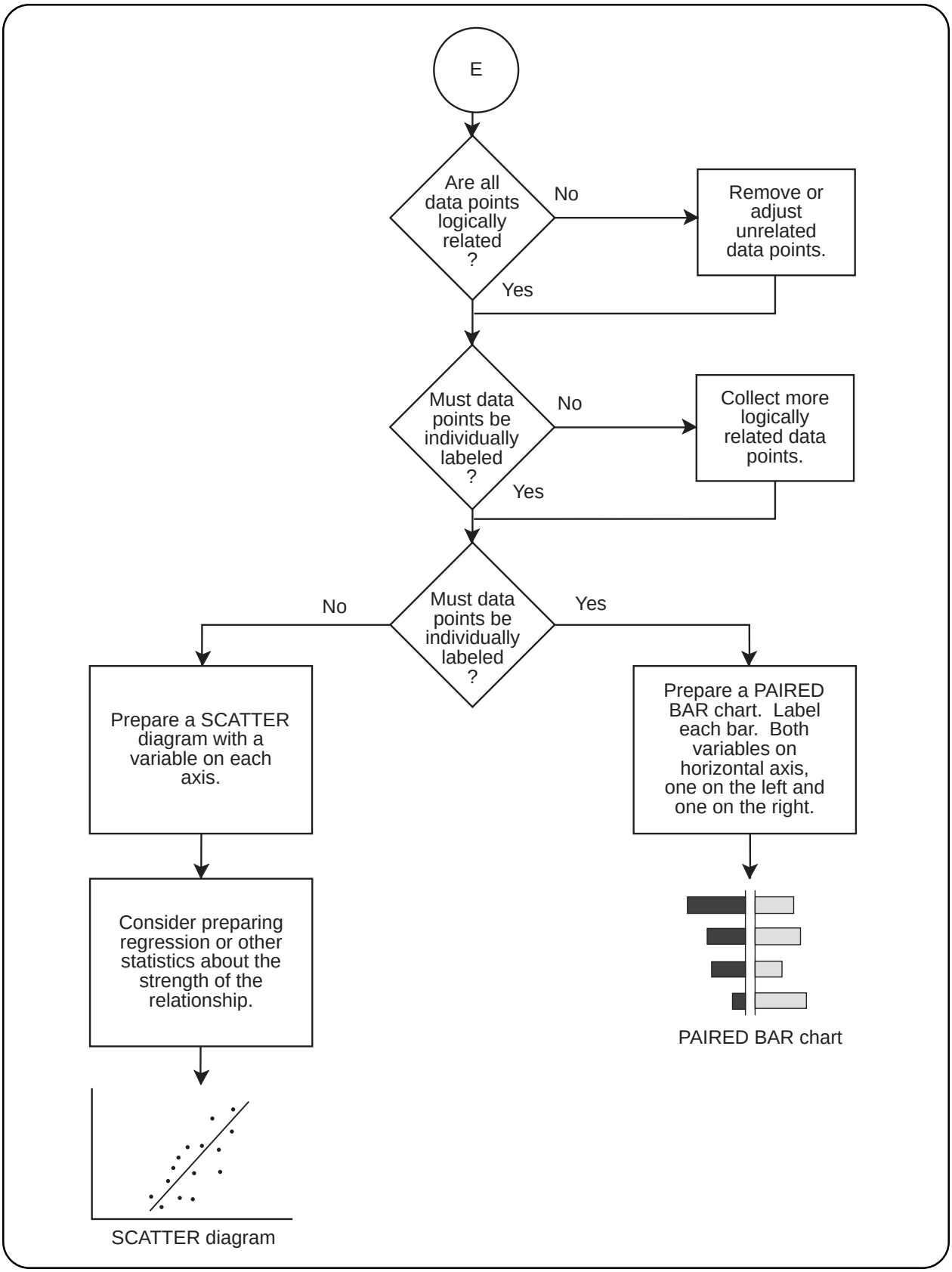


Figure 1.5.8.7.4.2.6. *We use co-relationship comparison when we relate variables to each other.*

1.5.8.7.4.3. TABLES

Tables provide the most unbiased format for data.

Tables

A table is rectangular array of usually numerical data, designed to show relationships between the horizontal and vertical categories. A table is a container for data points; each cell of a table is a point specified by two coordinates. Thus, and in accordance with the dictum that a purer format can be used to generate an exhibit in a less pure format, a table can yield a set of one or more graphics, checklists, texts, or a combination of these. The table, on the purity dimension, is one step removed from raw data. Raw data are in principle infinite in quantity, and even the longest table is finite and therefore a *selection* of data; to select is to bias. Further, the table is selective in the relationship(s) it portrays through the table maker's choice of categories.

The purpose of a table is to provide easy access to a (usually) relatively large number of reference data. Thus, unlike a graphic, a checklist, and (usually) a text, a table is a randomly accessible database, used primarily only in part or parts—a table of logarithms or English/metric conversions or even a telephone book.

Table Design

The logic diagram for constructing tables is shown in Figure 1.5.8.7.4.3. First, the preparer must, as with all portrayal formats, name the table, i.e., choose what shall be portrayed for what purpose. The title or name should indicate the precision and the relative completeness or incompleteness of the data presented. When possible, the title or name should be given as a complete sentence, preferably no longer than 10 words. This recommendation, which follows the central criterion of the Perry Method for constructing briefing charts, is apt because a sentence, unlike a word or a phrase, expresses a complete thought. The table maker can thereby unequivocally establish his or her slant on the data by making clear who's doing what to whom (or what's doing what to whom, or what's doing what to what). The normal pattern of an English sentence—subject, verb, object—is also (and probably for deep reasons that neurophysiologists may never understand) the pattern, the heuristic, that makes data into information.

Beyond naming, the aim is to make the table as easy to use as possible. Given that a user will look down (or up) and across to find each data point, this task should be easy on the eye, with possibly a network of orthogonal lines boxing in the points if there are many and they're physically close together.

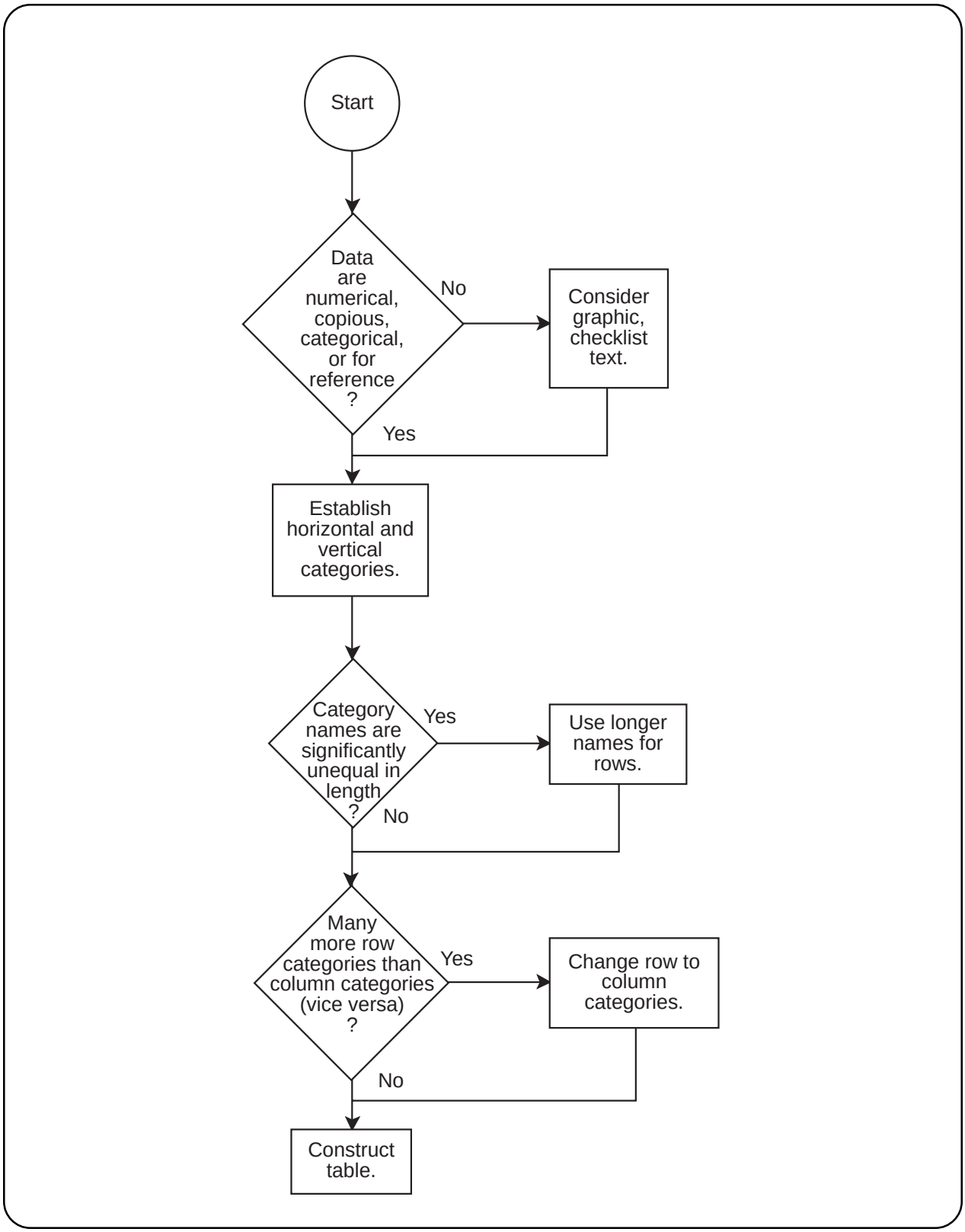


Figure 1.5.8.7.4.3. *The construction flowchart for a table starts with the number and type of data.*

1.5.8.7.4.4. CHECKLISTS

The checklist guides your thinking in a predetermined direction.

Checklists
A checklist is a mnemonic, a set or sequence of procedural steps, sometimes appearing as just a list of items of any sort, for example, a grocery list. In fact, the grocery list *is* a set of procedures, for the verb "buy" [or in some neighborhoods, "steal"] must be understood, as must the verb "mix" or "combine": for the items in another species of checklist, the recipe.

The checklist *may* be randomly arranged—like a grocery list of items in the order in which they came to mind—but the most effective list will be in *some* logical order. For shopping, the order might be that of related items (meat, milk, cereal, etc.) or of location, classifying items by aisle; it might equally be in order of importance: if money runs out, buy the first items first. In short, the checklist must carry some bias and direct the user to follow the simplest path to the desired goal. Normally, unlike a table, which is used for reference and in part, a checklist is meant to be completed.

The purpose of a checklist is to move a user through a process to achieve a specific goal. The user is not to argue with or interpret or make selections from the list; he or she is to be controlled by it. All interpretation—the purpose of the process, the selection and ordering of the steps—is done beforehand by the preparer. Sometimes the order will matter little, when for example one is to buy eggs and milk; it's no great question whether to pick up one or the other first. But say a spouse makes a morning checklist containing the items

wake up
kiss husband/wife
brush teeth

In this case, the order is everything. If the purpose of the procedure is to celebrate and prolong the marriage, the brush precedes the kiss; if, however, the goal is to show contempt or slowly to poison the union, then the kiss should come first. The distinction is thus between necessary and conditional constraints.

Checklists Design
The logic diagram for constructing checklists is given in Figure 1.5.8.7.4.4. As with graphics and tables, the checklist must be easy to read and follow. Ease will partly be a function of layout—size of type, spacing, etc.—and partly of length. The general rule here is that fewer is better. The preparer must not, however, sacrifice clarity for brevity by combining into one step two or more sub-steps that the user may not recognize as indicating more than one action. The preparer will do well to keep in mind, if not always to practice, the rule concerning what has been called "the magic number 7 plus or minus 2." Human short-term memory, researchers have found, can store only between five and nine bits. To remember many more than nine bits, an individual must "chunk" bits into larger units—as we do with telephone numbers, the three-digit prefix becoming not three separate pieces but one single chunk. Thus, if a checklist contains many more than nine items, the preparer should try to organize these items into a smaller number of groups or categories.

The ease-of-use criterion applies more or less strongly in proportion to "what's in it" for the user. Someone using a checklist for bomb disposal is likely to pay the fullest possible attention to each step. An experienced pilot, however, is likely occasionally to neglect—or

wish to neglect—steps in the start checklist and must be persuaded, insofar as possible, by the very simplicity of the format, to follow it through. In some instances, the preparer may find it advisable to make what must necessarily be a long procedure into a series of shorter ones—two or three separate checklists, perhaps, instead of one.

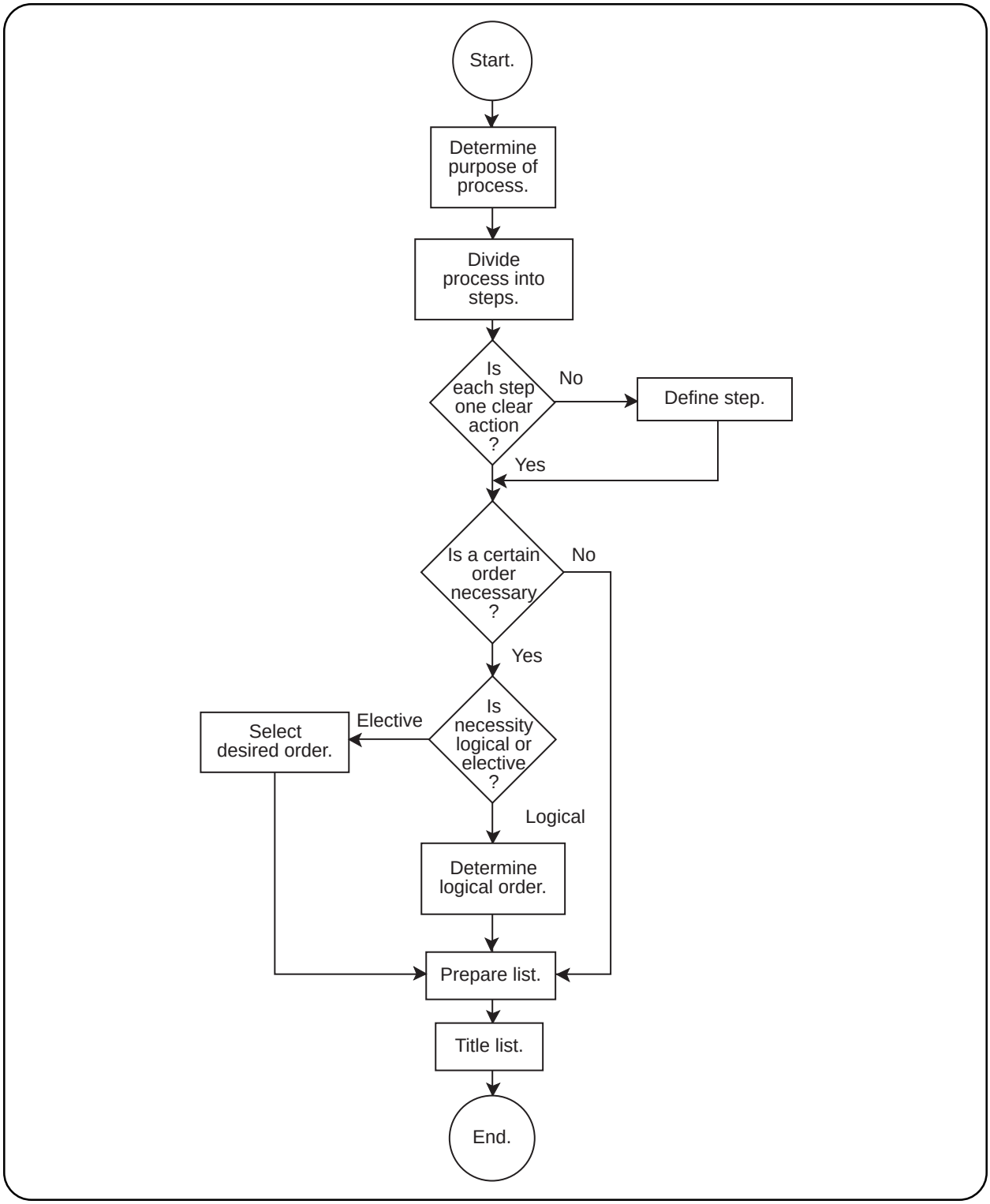


Figure 1.5.8.7.4.4. *The checklist construction flowchart focuses on clarity and usefulness of the checklist.*

1.5.8.7.4.5. TEXT

With text, we can portray our bias easily and we can interpret the meaning in many different ways. Text carries the maximum richness, biasedness, and opportunity of ambiguity.

Text

Text (discourse) permits the presenter the most control or bias, for the rules and constraints governing text production exist only at the most formal levels (use of conventional letters, numerals, and other symbols; and accepted standards for spelling, grammar, and syntax), leaving more to the producer's choice than any other medium (except music and visual art, which is not to the point here).

Textual presentation is appropriate when data are primarily or entirely qualitative, abstract, or conceptual, and when the producer must supply detailed explanation, description, narration, or argument. Text is also the only format that can have a voice—that is, call clearly to mind a *persona*, a character behind the words.

Text may be made randomly accessible by the use of tiles, headings, and other symbols, but the smallest unit of text is the sentence, whether fully represented or elliptical. The text producer must, like the producer of any other format, take into account both the purpose of the text and the needs and desires of the audience. Given that text communicates both objective information (facts and hypotheses) and subjective information (attitudes and feelings), the writer must decide in advance what he or she wants the reader

a) to know or know how to do as the result of reading the text, and

b) what attitude toward this knowledge or ability he or she wishes to elicit.

The schema in Figure 1.5.8.7.4.5. shows the priorities and subtasks of the process of text production, moving from matters of choice at the top to matters of convention at the bottom.

Text Design

So much attention has been paid in recent years to the cognitive processes underlying the production of text that even the briefest summary would occupy many pages. For my purposes, let it suffice to highlight those assumptions shared by all theorists and researchers. Instead of providing a flowchart in this section, I'll highlight the salient premises, comment on them, and suggest useful applications.

1. Writing is not merely the transcription of already-formed thought; it is, more, a technology for knowing, thinking on paper (or monitor!).

   Comment:
   In *Rhetoric, Romance, and Technology*, Walter Ong observes that writing makes possible not only the *storing* of information outside the mind (this storing refers equally to any presentation format, any set of marks on paper); more importantly, writing, discourse, makes it possible *to have thought* that would be impossible in a strictly oral culture.

   Every writer surprises himself or herself by thinking something unexpected. E. M. Forrester's "How do I know what I think till I see what I say?" jibes with B. F. Skinner's assertion that "It is strictly im-

possible for a person to see all one's verbal behavior until he emits it."

APPLICATION:
Practically no writer "gets it right the first time." Few writers are what British poet Stephen Spender calls "Mozartian" composers—writers who do all the conception, generation, revision, and polishing in their heads so that when words meet paper they are fully formed, springing like Athena from the head of Zeus. Most of us are, rather, "Beethovenian"—explicitly messy in our composing, with all the stages in the production of a final draft exhibited. (Word-processing equipment makes it easier to forget this fact, since changes—additions, deletions, combinations, separations, substitutions, and transpositions—can be made without preserving the evidence.)

Therefore:
Write first to find your thoughts, second to please yourself, and finally to shape your message to the characteristics of your audience.

2. Writing, in the paradigm proposed by Murray, is a non-linear, iterative process of collecting, connecting, writing, and reading. That is, these four activities go on during the process that begins with the need or desire to write and terminates when a piece of text is transmitted to its intended audience. But though each activity may properly designate most of what the writer is doing at any one time, the stages continually overlap. In theory, a piece of writing is never finished; it is rather simply abandoned at some point because the writer has to get on with his or her life.

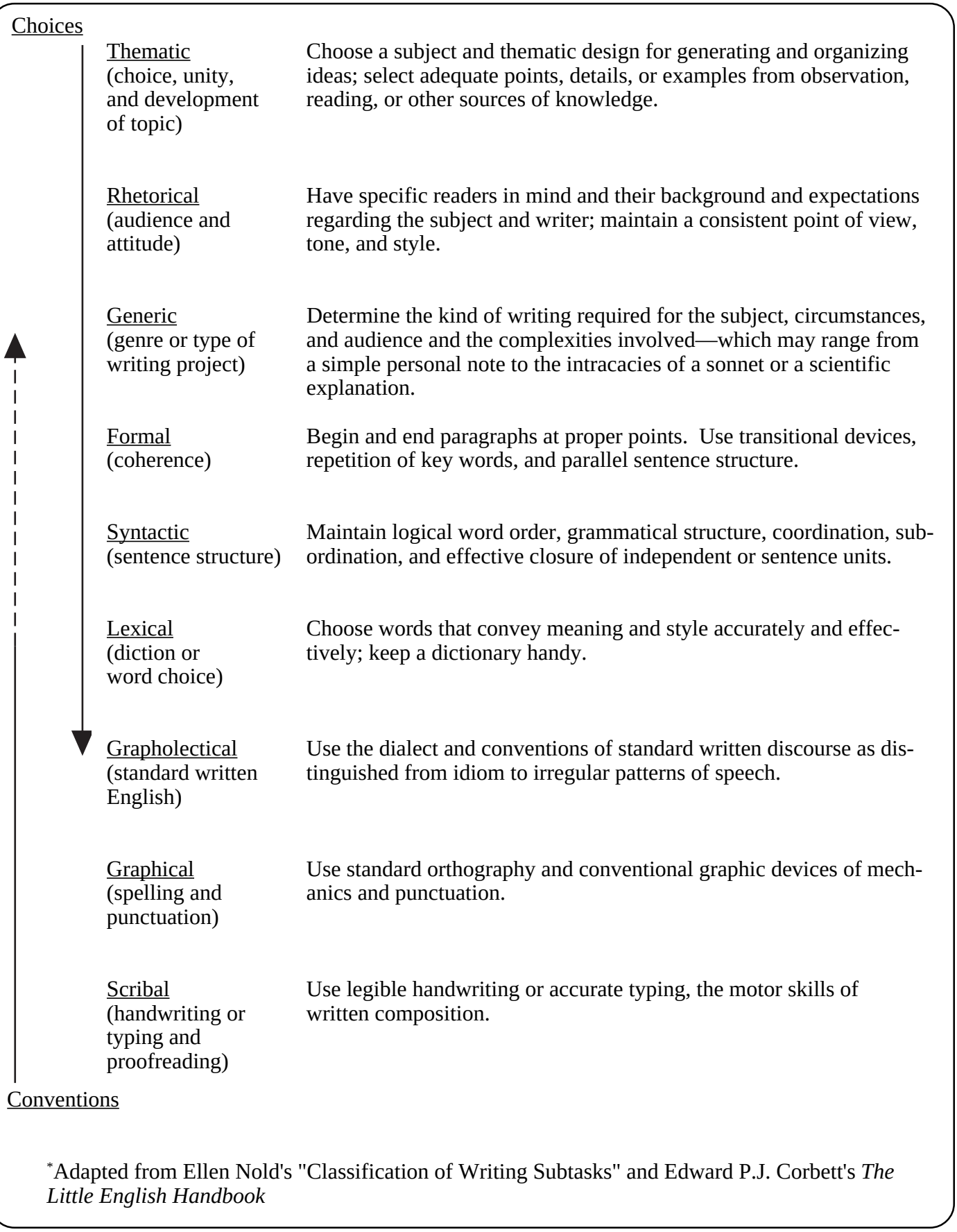
   Comment:
   The writer is the first reader of his or her text but should not be the only reader. It's too easy to overlook information or logic that, while plain to the writer, will be absolutely missed by the reader.

   APPLICATION:
   Get peer commentary on a document before sending it out. You won't have time to do this with everything you write, but for the most important documents, it's essential. Writing is always to some extent gambling, floating a trial balloon: there's simply no way to insure that a one-to-one correspondence exists between the writer's intentions and the reader's response. This difficulty is specific to the textual format because of the degree to which people can misunderstand by imposing on a set of words the interpretation they bring to them rather than being brought by the words to the interpretation the writer desires.

3. Every professional manager is also a professional writer and reader, and no manager has time to read all that comes into his or her mail slot.

   Comment:
   Every manager will agree with the premise given above as it applies to what he or she receives; few will realize that it applies also to what they send out. Somewhere in the mind of every manager lurks the erroneous assertion that "I know I get a lot of junk; thank goodness what I write gets read immediately and with pleasure by all receivers."

   APPLICATION:
   Write as simply, clearly, and briefly as possible. This is terribly difficult and takes practice. The harder the writer works, the easier it is for the reader.



*Adapted from Ellen Nold's "Classification of Writing Subtasks" and Edward P.J. Corbett's *The Little English Handbook*

Figure 1.5.8.7.4.5. *Priorities and Subtasks of the Writing Process*[*]

1.5.8.7.5. EVALUATING PORTRAYALS

For the outputs of management tools, we evaluate information portrayals for performance criteria.

We evaluate outputs of management tools against criteria involving a number of trade-offs. Since information portrayals are the outputs of the data-to-information conversion processes within the management tools, we'll focus on these portrayals. The criteria for evaluation include:

1) Timing
2) Use
3) Volume
4) Quality
5) Cost

The age of information is driven by our need for the right information in the right form at the right place and the right time. We develop better computer tools because of the larger quantities of more-rapidly changing information. Timing has to do with the ability of data to rot. Data have shelf lives just like tomatoes do. And like running a grocery store, different kinds of data have different shelf lives. The problem is that data don't stink like food does when it rots. So, it's harder to sniff out rotten data. It's the decisions that stink when data rot. Is the information in the portrayal current? Is the information what is needed for this decision at this time? These are a couple of timing issues that affect the value of the information portrayal.

What will we use the information portrayal for? Is the use important? It's nice to have a birthday list of all our employees. It's more important to have a wage rate for all our employees. As we look at uses of information, we need to look at uses inside our domain of responsibility and uses outside our domain. In Module 1.6.1.1., I'll talk about information portrayals inside our domain as red-loop portrayals or information flows and information portrayals from our domain to another as blue-loop portrayals. We don't want people in other domains to necessarily see our internal information. We also want to make sure we address the audience when we prepare information portrayals for someone else.

Internally, we want to use information to help us manage better. This information is usually process-oriented information. We either want summaries and aggregations or details. When aggregating data, we get a bottom line or a trend. We're integrating data. When we look for details, we're differentiating data. We're looking for potential problems we can nip in the bud. All problems telegraph themselves first as small details. If we see the problem early enough, the problem is easy to fix. We may want standard reports, specialized responses to queries, work-process reports, or business transactions. If we look for the right details, we'll manage better. If we look for the wrong details, we'll manage poorly. Ultimately, we want to know if we're managing better as a result of having information available to us.

Externally, we tend to use information to show others what we're accomplishing for them or what we need from them. This information is usually result-oriented information. People in other domains of responsibility, if they're thinking total quality management, will want process-oriented information. Unfortunately, not many people have realized yet the value of looking at the supplier's or the customer's process rather than the results. For external domains, the valuable details are usually dif-

ferent than the best details for internal use. The information portrayals typically for those who want results are reports, invoices, shipping orders, and so on.

The volume of information we can produce is unlimited. So today, the measure of success is the least amount of information to get the job done. Throwing data at a problem is as inefficient as throwing money at a problem and about as expensive. With modern computer equipment and techniques, we can supply a vast amount of information in a small amount of space or time. Always remember the information portrayal to information perception interface and the equation audience plus purpose equals design. We have to carefully fit the amount of information to the needs of the audience. We can do great harm by producing large amounts of information to people who don't know where the details they need are or don't know how to use the information they get.

Quality of data and information and of the information portrayal depends on the ratios of bad, good, and relevant data and information discussed in Module 2.1.9.3. and on the fit of the portrayal format to the use of the information discussed in Module 1.5.8.7.4. The quality we need for an information portrayal depends on its use.

The cost of the information portrayal depends on the quality and quantity of the data and information, the process for accessing the data and information, and on the portrayal mechanism. The cost depends somewhat on the timing of the data and information, although today speed of delivery is so quick that seldom is timing a cost factor.

As with all sets of criteria, we have tradeoffs among them. Higher quality usually begets higher cost. Lower volumes usually mean lower costs.

1.5.8.7.6. EXERCISE ON DESIGNING PORTRAYALS STUDENT REGISTRATION

When we register for classes, we use many different portrayal formats, each needing improvement.

Scenario

The University Registrar manages academic information and some other personal information about students, like permanent and local addresses. We're only interested in academic information here. Most academic information deals with conducting classes, but some is regularly needed for things like graduation and some is sporadically needed for things like finding out how many classes are held in McBryde 100.

The Registrar's Office is the hub for data input and output on student registration. The users of the information are l) students; 2) faculty; 3) department heads; 4) college deans; and, of course, 5) the Registrar and the Student Systems organization that maintains the databases. The primary inputs to the system come from the students and the department heads. The assistant department heads (acting for the department heads) fill out course requests identifying for a course who teaches, class size, number of sections, requested time and room number, and other data. The Registrar produces the timetable (output format!). The students use the timetable to produce the other key input instrument to the Registrar—the registration op-scan sheets. The Registrar's Office is responsible for inputting to the Student Systems' database and for outputting class rolls and approved class tickets. The Student Systems organization maintains the databases for everyone to access. In addition to the users I've listed earlier, Student Housing, Student Affairs, the Office of Institutional Research, and others can access information. Both the Registrar and Student Systems report to the same Associate Provost.

I'll list the users of the information about registration and for each user. I'll identify documents they need by the name you're most familiar with.

Student
- timetable
- registration op scan sheet
- approved class ticket
- grade report
- graduation analysis
- drop/add form

Faculty
- class roll
  - initial—before first class
  - revised—after add deadline
  - final—after drop deadline
- individual student information—on request, for advising
- grade sheet
  - preliminary—for graduating seniors
  - final—for all students
- change of grade

Department Heads
- management report—showing class enrollment for all classes, no student names—used to assign faculty before classes begin
- class roll—the three versions listed for faculty
- grade sheet—copy from faculty—both versions
- student grade report—for student's file
- graduation analysis

College Deans
- grade report—for student's file
- graduation analysis

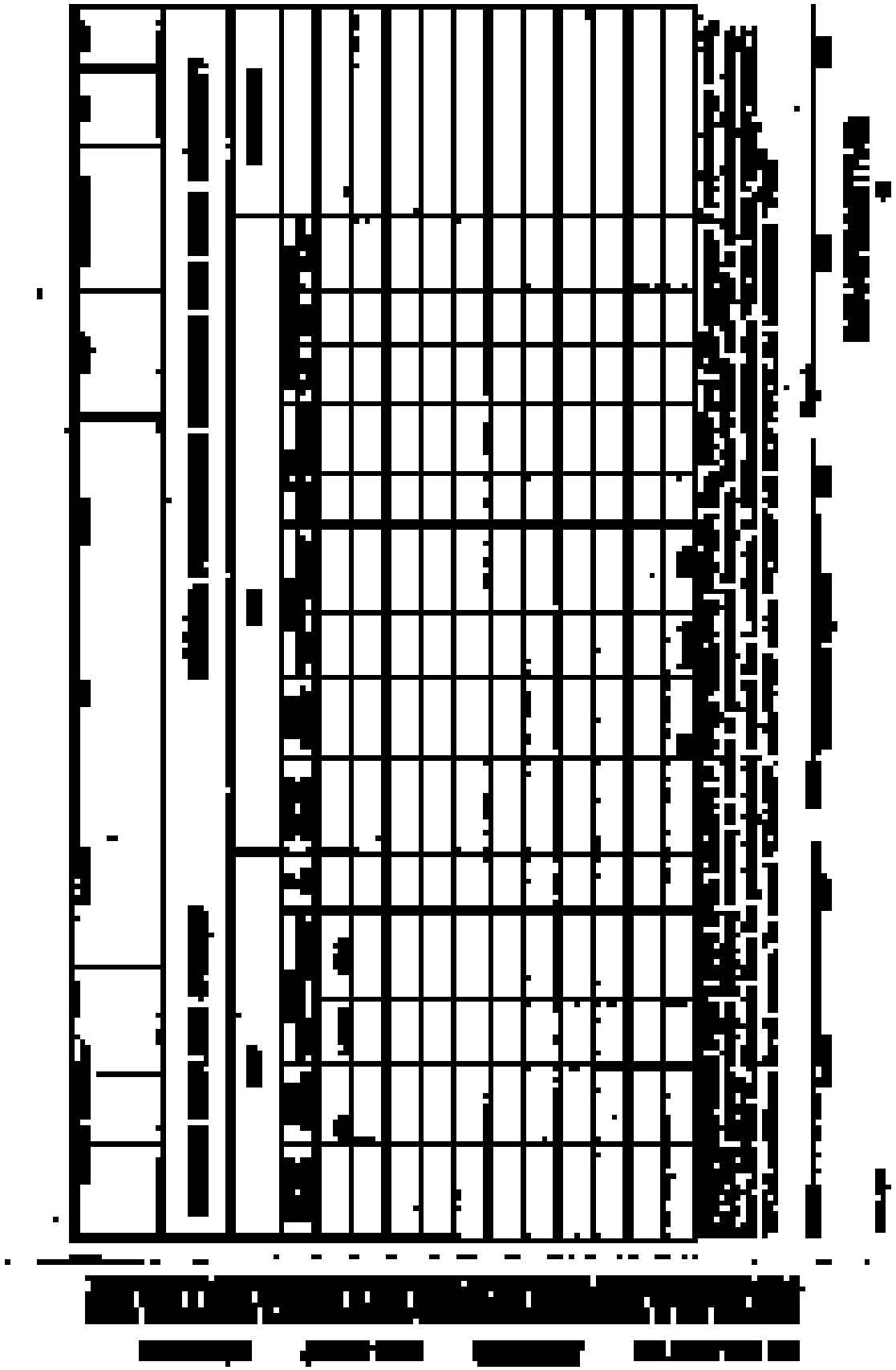
candidates for degree report—listing all students who applied for degree
any other report on request
special reports from STUCENFL (student census file), like those for all classes with more than 30% failures or all classes taught in McBryde 100

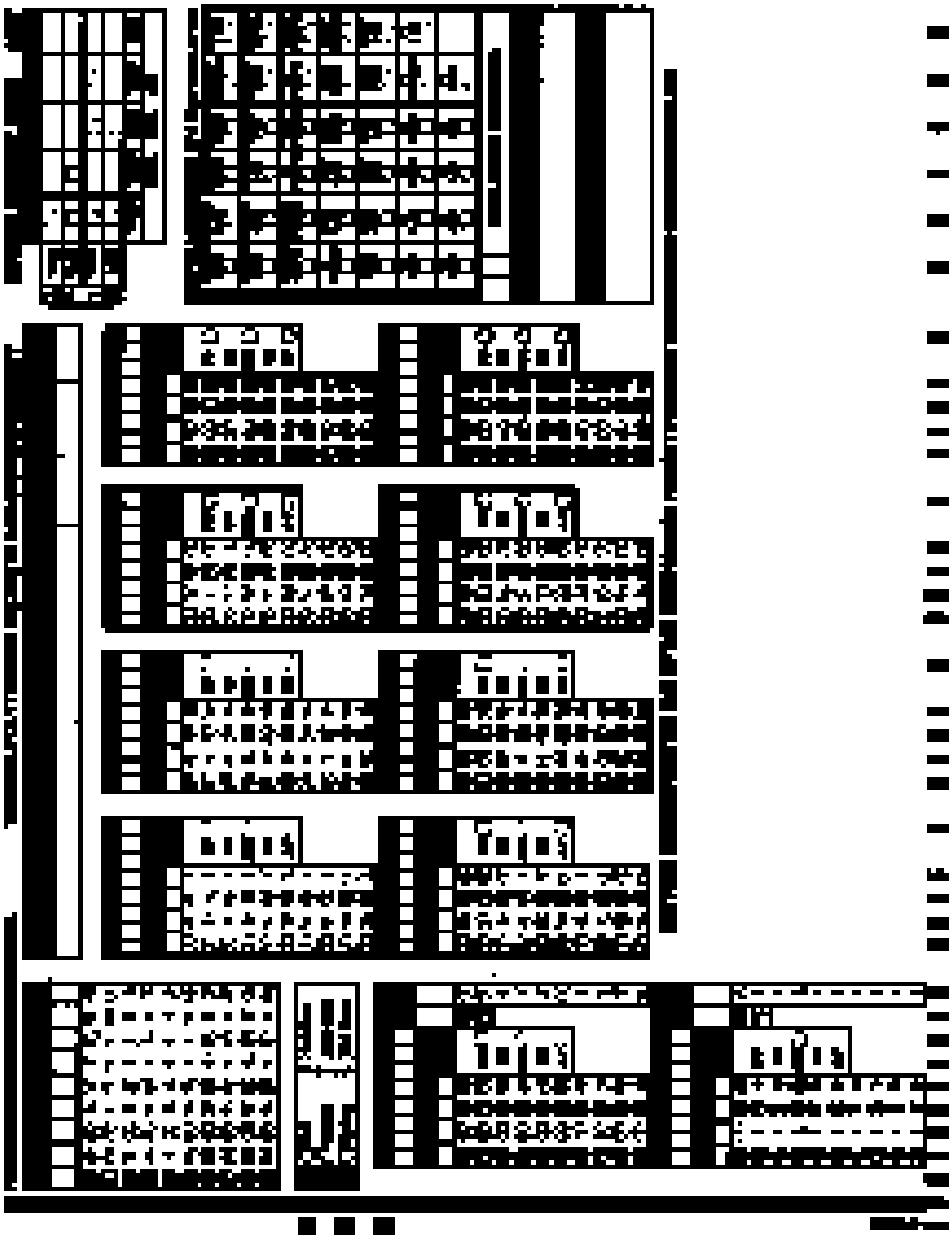
Registrar
requested course schedule—from department heads (to generate time tables)
registration op scan—from students
request for graduation analysis—from students application for degree—from students

Student Systems supports all this by maintaining the databases. They do no input. They code programs and maintain databases. They produce STUCENFL, which is a read-only file for archival use and is all data for all students. The data are frozen ten days into the semester. They also maintain a current file for up-to-date, live data for requests.

Another document all users need is the University Catalog (both undergraduate and graduate editions) written by each department and coordinated and published by the Registrar. Many departments update and extend the catalog by producing curriculum flow charts to help students schedule their classes in the right sequence.

Exercise
Your job is to pick three different information documents for three different users and develop student registration documents or output formats to help the users make their decisions. You can either improve in some significant way an existing document or you can design a new document. Show what you've done by drawing each format and stating the purpose of the improvement in the new document. (I've attached a few of the formats you're now familiar with.)





APPLICATION FOR DEGREE / DIPLOMA

Name as it should appear on diploma (Please Print)

____ ______________________
First Name Middle Name Last Name Jr., Sr., III Social Security Number

Degree ____________ Major ____________________ Double Major (if any) ______________

Minor (if any) ____________ Option (if any) ____________ Expected date of completion ____________

CURRENT MAILING ADDRESS

Place of Residence (for Commencement Listings and News Release)
City ____________________
County ____________________
State ____________________

Street ______________________________

City and State ______________________ Zip

Name and address of parents or guardians (For mailing Commencement Invitations)

____
Last Name if Different

____
Number and Street or Route and Box Title (Mr. & Mrs.)

____
City State Zip Code Last Name if Different

____
Signature of Candidate Date of Application

If degree requirements are not completed by the date indicated on this application, it is the responsibility of the student to notify the Office of the University Registrar of the change of completion date.

1.5. Tools and Skills Categories

1.5.9. The Gathering-Information Skill

1.5.9.1. GATHERING INFORMATION–JACQUES-LOUIS DAVID

1.5.9.2. How and Where to Collect Data

If you don't know how to gather data and information, you won't be able to make management tools work or make good decisions.

Importance of Information Gathering
In the analysis stage of developing an information system or any management tool, you'll need to study and learn about specific portions of the domain of responsibility and about how information is now processed in that domain. Therefore, you must gather information before you can figure out how to build the management tool. Much of the pre-existing information you gather may be out of date, so you'll have to make contacts and observations and update the information you need. Gathering information about a domain of responsibility and its present activities isn't an easy task, but you must do it to build the management tool. For that matter, you must be good at gathering information to figure out any problem you'll solve as an engineer or as a manager.

Categories of Information
In building an information system, you'll search for four categories of information. The first category is information about the organization. Organizational information includes MVP (mission, vision, and guiding principles) and goals of the company; organizational structure; work flow charts and objectives and purposes of functional units; and policies, plans, and procedures.

The MVP and the goals and objectives of a company guide the organization and set the tone and direction for much of the systems analysis and development work. Policies are rules or guidelines for directing the objectives of the business. These policies should implement overall goals and objectives. Such long-term statements may be found in orientation brochures, procedures manuals, or in annual reports. Organizational structure indicates management's intentions and directions and should correspond with statements of the goals.

A good place to begin your search for information about the organization is to ask for organization charts, work flow charts, and procedures or production manuals. Each subdomain of the organization should have objectives and purposes stated for its functional units which network with those of the overall domain.

The second category of information you'll gather is information about the people in the domain of responsibility. This category should include information about authority and responsibility relationships, job duties, interpersonal relationships, and information needs. Authority and responsibility relationships may be presented by an organization chart, but actual working relationships may be very different. You must discover these actual working relationships, but this information may be sensitive and you'll have to keep it confidential in some work environments. Make sure the organization charts are up-to-date and be ready to draw up some of your own charts to show the lines of authority in the organization and other relationships among people (the who manages in separate domains) and their responsibilities.

Job duties are what each person does in connection with the ongoing operation of the existing system. This type of documentation may be found in manuals for task performance, but these formal, written procedures may be different from the way work is done. You can also find position descriptions in an

organization to find out who's responsible for what. Remember that being able to determine what is occurring is the job of information gathering.

Gathering information about interpersonal relationships is another piece of information you'll need to learn about the people. This information will be used to confirm suspicions established by formal organization charts. As people do whatever they have to do to get the job done, the flow of information may differ both from organization charts and from systems designs. Finally, you should learn about people's information needs. You should find out what information each person needs and what information is received.

We'll learn about information flow diagrams. They're more popularly called data flow diagrams. These diagrams help us capture and organize how information flows in the organization. If we do the diagrams right, they also help us talk with people in the organization to make sure we know what's really going on. When we get this information, we usually have trouble distinguishing between *what the information flows are* from what the person we're talking to *would like for them to be.* For that reason, we get the best information about information flows from observing information flows.

The third category of information gathering is information about work which includes tasks and work flows, methods and procedures for performing the work, work schedules and volumes, performance criteria, and control mechanisms. Gathering information about tasks and work flows may begin by collecting flow charts for the work process and associated forms and logs that include entries made at each point in the system. You should look for processing steps that center around individual personalities, skills, or experience.

The best method for capturing work flow based on your observations is to use diagrams called work flow diagrams. These work flow diagrams look like computer programmers' flow charts. You should use these diagrams to discuss and verify the work flow with people in the domain. Your flow chart shows the relationships among all the processes in the domain.

A document flow chart (similar to a work flow chart) is one means of representing this type of information graphically. Methods and procedures for performing the work focus on the physical process. A system flow chart can often help supply this type of information. Work schedules and volumes include the amount of work to be accomplished in a given period of time. You should note the variations in work loads for the areas under study. Performance criteria are standards against which the work can be measured. These standards should apply to schedules and volumes, as well as, to quality, accuracy, and reliability of information processing work. Control mechanisms are checkpoints at which feedback from processing is evaluated according to specifically defined criteria.

I was working with an Office Director in the Department of Energy. On one of my visits he called me into his office and said, "Harold, I've noticed you're spending a lot of time helping my secretary make copies of documents. Why do you do that?" I said I not only helped make the copies but I helped distribute the copies. I told him my job was to gather information about information flow and use. If I asked him what the information flows were in his organization, he would tell me either what he thought they were or what he wanted them to be. Because I worked with the physical evidence, I knew what the information flows were. I also knew who put the information in their file cabinet or in the trash can or kept the information on their desk handy for use. I wasn't gathering information about

information in his acquisition from interviews or questionnaires. I was gathering information through observation and direct experience.

The fourth category of information gathering is information about the work environment. This information includes physical arrangement of work areas and available resources. Physical arrangement of work areas may be illustrated in a diagram of desks and work positions, along with a series of arrows showing how data move in the course of processing. This information is essential when evaluating the efficiency, effectiveness, and degree of control within the existing system. Resources available focuses on the specific items of physical equipment in use, along with their costs. You should document the kinds of equipment and facilities available at each work station including available resources which are not being used in the existing system for this functional area.

Notice how much we can use diagrams and charts to help us capture, organize, understand, and discuss information about the domain of responsibility. Information overlays all the workings of the domain. The manager will use information about everything in the domain to make decisions. To get the right information to the right people at the right time, we must understand the workings and relationships of everything in the domain. Organization charts, document flow charts, work flow charts, information flow charts, and office layouts help us analyze the organization.

Sources of Information

One source of information is existing documentation which includes organization charts, policy manuals, methods and procedures manuals, job descriptions, forms and reports, document flow and work flow diagrams, systems flowcharts, computer program documentation, data dictionary listings, and computer operations manuals. You should evaluate these things before using other methods of information gathering. Another source of information is information gathered from people such as system users and managers. Finally you may have to gather information from external sources such as other companies, equipment and software vendors, and business publications, seminars, workshops, or visits to showrooms or other companies for demonstrations.

Methods for Gathering Information or Collecting Data

Data collection is an important component of any measurement system. And you'll use one or more of several methods to gather information as you analyze the situation you find in any organization you're developing an information system for. Six primary methods for acquiring facts are identified below. Each has its advantages and disadvantages, which are summarized in Figure 2.1.5.2. These methods are briefly described below.

1. Interview. Conducted face-to-face or over the phone.

2. Questionnaire. Can use a variety of response formats, such as multiple choice, open-ended answers, rating and ranking scales, and semantic differentials.

3. Observation. Conducted continuously over a time period (standard), or intermittently at different times (time sampling).

4. Document Analysis. Accomplished by analyzing documents such as MIS reports, appointment books, minutes of meetings, office memos, and customer correspondence.

5. Critical Incident Review. Focuses on events that interrupt business as usual. Only those things which are especially important, unique, or revealing are considered. According to Ruddock (1981) "much that is usual may have no obvious

explanation. To explain it may require analysis, reference to purposes, to common perceptions, to hidden interests and sometimes to theory." Critical incidents tend to expose reality often with uncommon clarity.

6. Work Sampling and Measurement. Involves statistical techniques for gathering information about a large work volume by studying a carefully selected portion of the total.

You can combine data-collection techniques. Charting is a most-effective method for gathering information and collecting data. If you do a workflow chart, for example, you observe, ask questions (interview), and evaluate documents to identify the activities and decision points in the work flow. The draft workflow chart becomes a good discussion point to determine what information you're missing and what information is wrong. Another method for gathering information is in a participative decision making or information sharing meeting. You surface ideas and capture information to be shared and evaluated. How could you use a panel discussion or gripe session to gather information? Are some meetings called only for the purpose of gathering or sharing information?

The choice of data collection method depends upon a number of factors, including the potential for embarrassment, sensitivity of information sought, number of people to be contacted, importance and possible impact of the evaluation, routineness and repeatability of procedures, degree of scrutiny to which the evaluation will be subjected, and personal preferences of the manager or evaluator. Often, you may use more than one method. The method you choose must be agreeable to the client and colleagues, must be technically sound (reliable, valid, and measure what it should), must be within the evaluation budget, and must allow sufficient time for gathering and interpreting the data.

When planning an interview, the first step is to identify the sources of information. As a rule, you should always interview from the top down. Another step in planning an interview is to define your objectives and prepare for the interview by writing down an outline of points to be covered in the interview. You should always advise the interview subjects about the objectives of the interview, the topics to be covered, and the types of documents that might be needed. When possible you should hold the interview in the subject's own office or department. The best interview is one in which the interviewer does most of the listening. Always follow up the interview by sending information collection summaries to interview subjects so they'll have a chance to edit them.

An effective questionnaire should have certain basic characteristics which include validity, reliability, face validity, and ease of administration and scoring. Validity means that the questionnaire measures what it's supposed to measure. One way to measure validity is to compare the tabulated results of the questionnaire with other measures such as interviews. Reliability means that the respondents answer redundant questions in the same way. Much of the same information is sought in different ways through the use of multiple questions. Face validity implies the respondent feels that items on the questionnaire have a valid purpose. Ease of administration and scoring means that the directions should be clear and easy to follow. When possible, the questionnaire should be structured for machine scoring. There are many things to consider when planning a questionnaire. You should refer to a good source before attempting to use a questionnaire.

An important characteristic of observation is

that a highly-trained person must do the observing. These people usually have to be experienced systems analysts or industrial engineers.

All the data collection methods require a great deal of skill. You need to learn to look (observe), listen, and probe. You want information. You talk or ask questions only to get the best information you can. Your success as an engineer or manager will depend on your ability to ask questions or probe to get the information you need to make decisions with. Being able to collect data (ranging from technical situations to personnel situations) and to gather information is one of the most important things you'll ever learn. Think about it! Do something about it! Don't forget it!

SIX DATA COLLECTION METHODS ARE COMMONLY USED

Method	Advantage	Disadvantage
Interview • Face-to-face • Phone	Permits in-depth probing. Permits discussion of sensitive issues. Good for eliciting new ideas.	Expensive and time-consuming Inter- and intra-rater reliability may be difficult to obtain.
Questionnaire • Multiple-choice • Short answers • Rating scales • Ranking scales • Semantic differential	Anonymity encourages truthful response to embarrassing questions. Can be administered to large groups at low cost. Reduces judgmental data into a manageable form.	May need follow-up to obtain adequate number of responses. May require respondents to draw distinctions that don't exist. May produce no response if poorly designed (complex instructions; lengthy; ambiguous).
Observation • Standard • Time-sampling	Permits first hand observation of events. Skilled observers can obtain insightful facts.	Observer can change the environment. Inter- and intra- observer reliability may be difficult to obtain.
Document Analysis • MIS reports • Correspondence • Financial records • Office memos • Timesheets	Unobtrusive. No new data collection required.	Documents may be disorganized, unavailable, or too voluminous. Can be expensive. Only formal communications are likely to be recorded.
Critical Incident • Internal events • External events	Exposes facets which are otherwise not obvious. Focuses only on particularly important or revealing events.	Can be difficult to interpret. Insiders may not notice situations which appear very unusual to an outsider.
Work Sampling and Measurement	Uses limited and specific results to make inferences about a large population.	Requires services of highly qualified individuals with experience in research design and statistics.

Figure 1.5.9.2. *Methods for data collection. (Sources: adapted from Koscoff and Fink, 1982: Figure 3 on pp. 117-119).*

1.5.9.3. EXERCISE ON GATHERING INFORMATION

Scenario:
Some years ago Virginia Tech decided to convert from the quarter system to the semester system. All courses had to change from thirty class periods to forty-five class periods. Also, so students could possibly finish an undergraduate degree in four years we had to decrease the number of courses required to graduate by one-third.

Each professor wanted to protect his or her course from elimination. Clearly we had to review all courses and determine what to eliminate, what to combine, and what to preserve. The ISE Department selected a curriculum transition committee to figure out what was best for the Department. The committee had to submit its new slate of courses for the semester calendar to the faculty for approval.

Exercise:
You're on the curriculum transition committee. Your committee has decided not only to convert to the semester calendar but to use this opportunity (make lemonade out of lemons) to review each course toward improving the ISE curriculum. Remember, over the years, the courses have evolved based on changes in technology, the latest emphasis in industrial engineering, or the professor who's teaching the class. It's time to look at each course and see if it's relevant to the curriculum and to determine how the course might fit into the curriculum objectives.

Your committee has assigned you the job of gathering all the information they might need to improve the ISE curriculum. You have three months to get the job done. Some data (or information) gathering techniques take time to implement, some techniques depend on the results of others. You need to develop a brief plan (about one page) to make sure you've thought of everything and can set priorities and schedules for gathering information.

Just for fun:
How might you gather information for completing this homework assignment?