There are several useful tools available for defining the process.

- Flowcharts are particularly useful for highlighting process complexities.
- Process maps provide an additional level of detail to indicate functional responsibilities for each process step. Process maps were previously discussed in Chap. 6.
- SIPOC is a tool for identifying the process inputs, outputs and stakeholders.

Generally, these tools will be used in conjunction with one another.

Flowcharts

A flowchart is a simple graphical tool for documenting the flow of a process. In the flowchart, each task is represented by a symbol. There is an ANSI standard which lists symbol types, primarily for computing processes, but most practitioners find rectangles appropriate for most tasks, and diamonds for decision tasks. Decisions should have only two outcomes (yes or no), so decision points must be phrased in this manner. For example, rather than having three options A, B, and C at a decision point, the decision would be constructed as a series of decisions, each of which has a simple yes or no resolution. The first decision might be Option A?, whose No path leads to a second decision of the form Option B? Since Option C is the only remaining choice, the No path from the second decision leads to Option C.

A rather simple flowchart is shown in Fig. 7.1. Notice the diamond decision points have two outcomes: one outcome continues down the main process flow, while the other diverts to a secondary path. Also note that these secondary paths may result in a jump to a later point in the process (as shown in the first decision's "yes" path) or to a prior point in the process (as shown in the second decision's "yes" path). Decision paths, as well as endpoints for processes, may also branch to other process flowcharts, as indicated by the circle in the last step of this process. In this example, the gray-toned symbols indicate external process steps.

Flowcharts are used in the Measure stage to document the current (as-is) process. In the Analyze phase, the flowchart will be reviewed to uncover complexities in the form of an excessive number of decision points that may contribute to delays or even defects. We can use symbol color or shape to indicate process delays, functional responsibility for each step (for example, oval is customer service), or points in the process where measurements are taken.

SIPOC

Virtually all Six Sigma projects address business processes that have an impact on a top-level enterprise strategy. In previous chapters, a great deal of attention was devoted to developing a list of project candidates by meticulously linking projects and strategies using dashboards, QFD, structured decision making, business process mapping, and many other tools and techniques. However, Six Sigma teams usually find that although this approach succeeds in identifying important projects, these projects tend to have too large a scope to be completed within the time and budget constraints. More work is needed to clearly define that portion of the overall business process to be improved by the project. One way to do this is to apply process flowcharting or mapping to subprocesses until reaching the part of the process that has been assigned to the team for improvement. A series of questions are asked, such as:

1. For which stakeholder does this process primarily exist?
2. What value does it create? What output is produced?

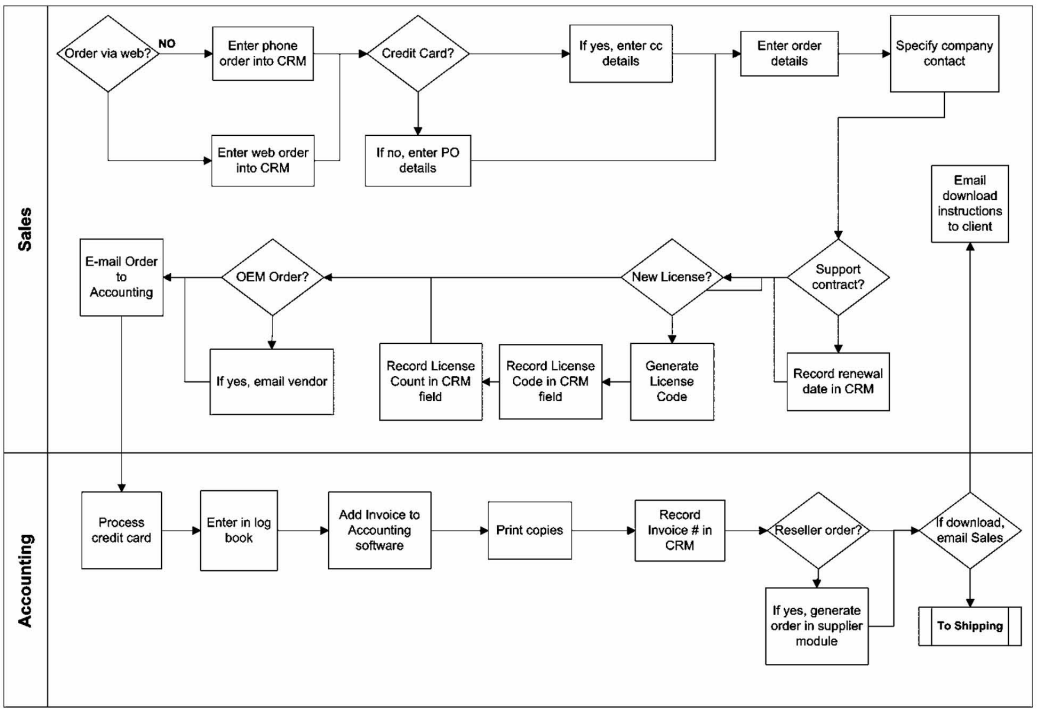

FIGURE 7.1 Example flowchart.

3. Who is the owner of this process?
4. Who provides inputs to this process?
5. What are the inputs?
6. What resources does this process use?
7. What steps create the value?
8. Are there subprocesses with natural start and end points?

These questions, which are common to nearly all processes addressed by Six Sigma projects, have been arranged into a standard format known as SIPOC. SIPOC stands for Suppliers-Inputs-Process-Outputs-Customers.

SIPOCs begin with people who know something about the process. This may involve people who are not full-time members of the Six Sigma team. Bring the people together in a room and conduct a "focused brainstorming" session. To begin, briefly describe the process and obtain consensus on the definition. For example:

- "Make it easy for the customer to reach technical support by phone"
- "Reduce the space needed to store tooling"
- "Reduce the downtime on the Niad CNC machine"

- "Get roofing crew to the work site on time"
- "Reduce extra trips taken by copier maintenance person"

Post flip charts labeled suppliers, inputs, process, outputs, customers. Once the process has been described, create the SIPOC diagram as follows:

1. Create a simple, high-level process map of the process. Display this conspicuously while the remaining steps are taken to provide a reminder to the team.
2. Using brainstorming rules, identify the outputs of this process. Record all ideas on the outputs flip chart without critiquing them.
3. Using brainstorming rules, identify the customers who will receive the outputs. Record all ideas on the customers flip chart without critiquing them.
4. Using brainstorming rules, identify the inputs needed for the process to create the outputs. Record all ideas on the Inputs flip chart without critiquing them.
5. Using brainstorming rules identify the suppliers of the inputs. Record all ideas on the suppliers flip chart without critiquing them.
6. Clean up the lists by analyzing, rephrasing, combining, moving, etc.
7. Create a SIPOC diagram.
8. Review the SIPOC with the project sponsor and process owner. Modify as necessary.

SIPOC Example

A software company wants to improve overall customer satisfaction (Big Y). Research has indicated that a key component of overall satisfaction is satisfaction with technical support (Little Y). Additional drill down of customer comments indicates that one important driver of technical support satisfaction is the customer's perception that it is easy to contact technical support. There are several different types of technical support available, such as self-help built into the product, the web, or the phone. The process owner commissioned Six Sigma projects for each type of contact. This team's charter is telephone support.

To begin, the team created the process map shown in Fig. 7.2.

Next the team determined that there were different billing options and created a work breakdown structure with each billing option being treated as a subproject. For this example we will follow the subproject relating to the billing-by-the-minute (BBTM) option. After completing the process described above, the team produced the SIPOC shown in Fig. 7.3.

Note that the process is mapped at a very low level. At this level the process map is usually linear, with no decision boxes shown. The typical SIPOC shows the process as it is supposed to behave. Optionally, the SIPOC can show the unintended or undesirable outcomes, as shown in Fig. 7.4.

This "bad process" SIPOC is used only for team troubleshooting. It helps the team formulate hypotheses to be tested during the Analyze phase.

SIPOC analyses focus on the Xs that drive the Ys. It helps the team understand which "dials to turn" to make the top-level dashboard's Big Y move. In the example, let's assume that the team collects information and determines that a significant

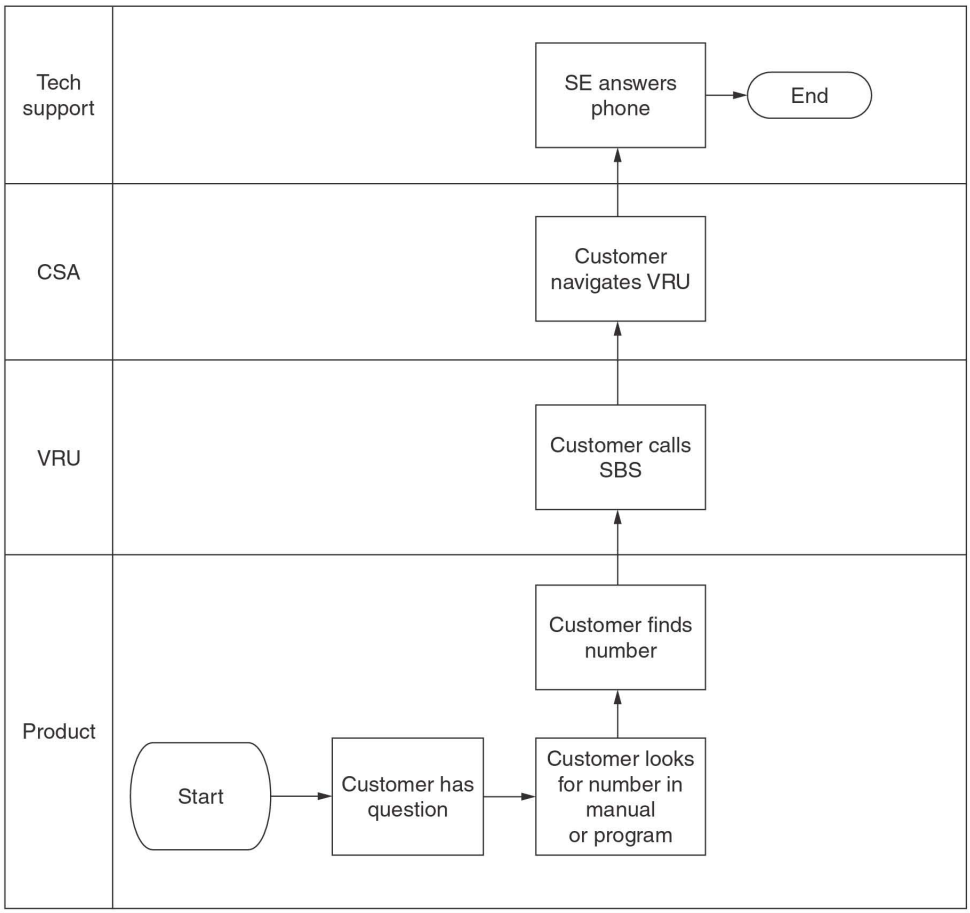

FIGURE 7.2 Process map for contacting technical support by telephone.

percentage of the customers can't find the phone number for technical support. A root cause of the problem then is the obscure location of the support center phone number. Improving overall customer satisfaction is linked to making it easier for the customer to locate the correct number, perhaps by placing a big, conspicuous sticker with the phone number on the cover of the manual. The Big Y and the root cause *X* are separated by several levels, but the process mapping and SIPOC analysis chain provides a methodology for making the connection.

The SIPOC will be further reviewed in the Analyze phase to remove non-value-added outputs, inputs, or tasks.

Metric Definition

A key objective of the Measure stage is to establish a process baseline, as discussed later in this chapter. The process baseline provides a quantifiable measure of the process performance before any improvement efforts have been initiated. In establishing

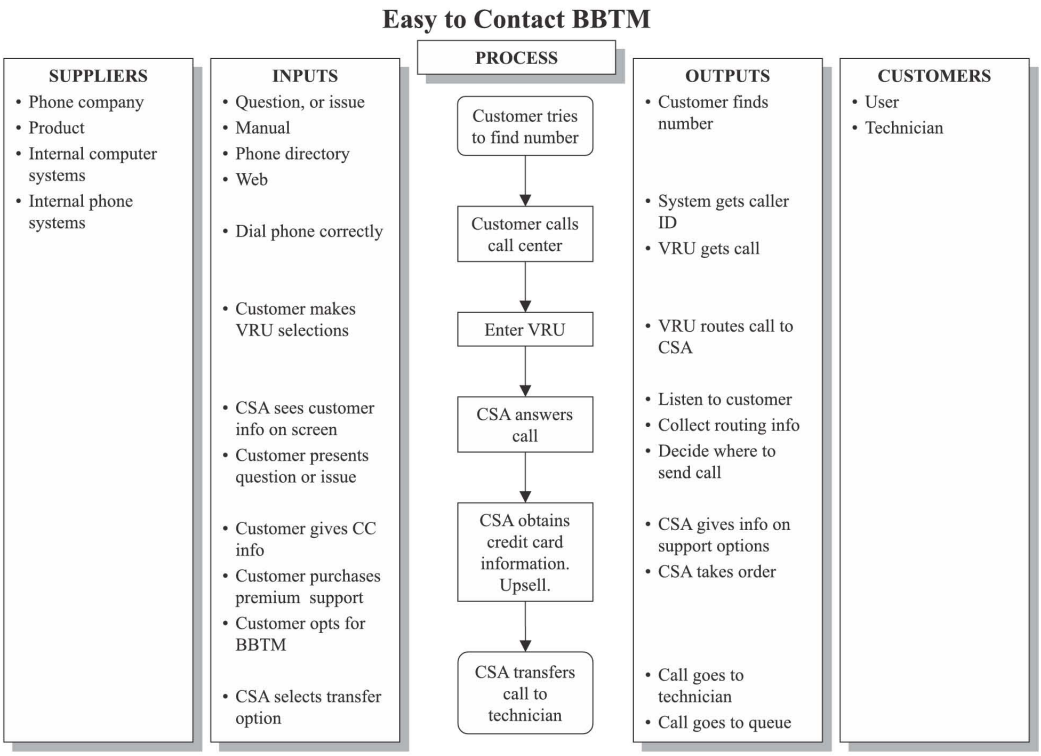

FIGURE 7.3 SIPOC for easy to contact BBTM.

a process baseline, one or more suitable process *metrics*, related to the previously-defined project deliverable, is defined and measured. These metrics are sometimes easily defined with existing process expertise. For example, if key customers are concerned with the *time to delivery* for an order, then that may be a suitable metric, assuming it meets the conditions discussed below. In some case, however, the customers' key metrics do not provide a meaningful measure of process performance, as related to the deliverables previously defined. For example, in chemical and some manufacturing processes, it's not uncommon for the customers' key characteristics to be process endpoint measurements, whose properties are defined much earlier by internal process settings unknown to the end users. In those cases, the internal metrics, or the project deliverables themselves, may provide suitable process performance estimates. In all cases, the metric must be evaluated for its validity and accuracy, as discussed later in this chapter.

A *measurement* is simply a numerical assignment to an observation. Measurements convey certain information about the relationship between the element observed and other elements. Measurement involves a theoretical domain, an area of substantive concern represented as an empirical relational system, and a domain represented by a particular selected numerical relational system. There is a mapping function that carries us from the empirical system into the numerical system. The numerical system is manipulated

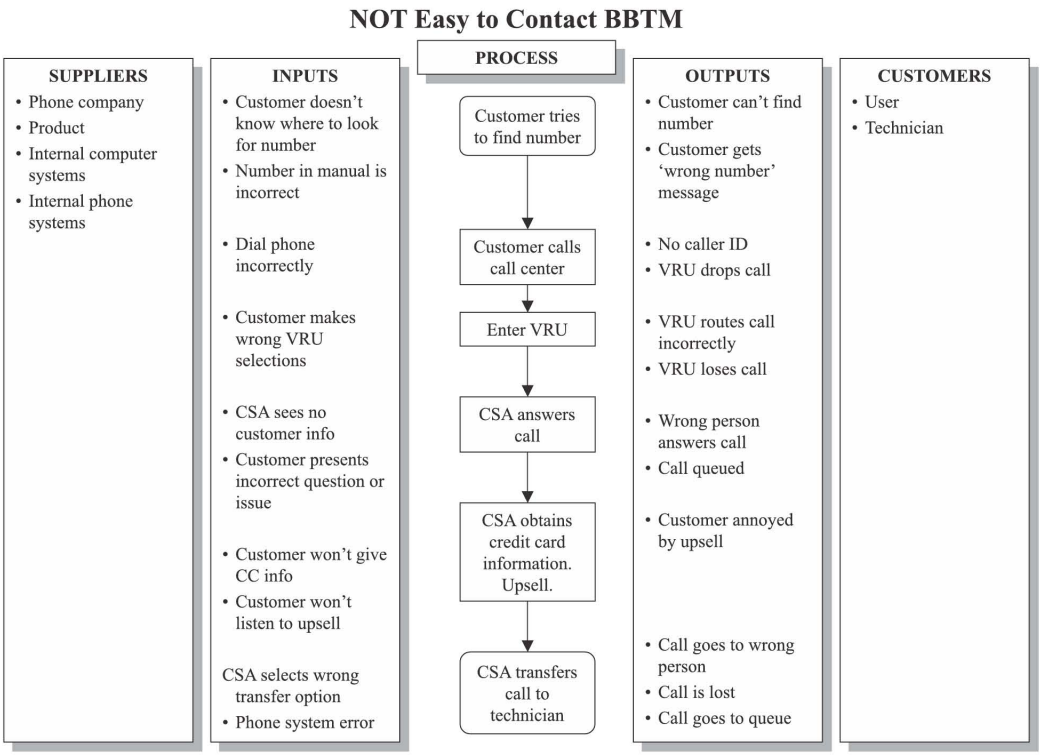

FIGURE 7.4 SIPOC for undesirable outcomes.

and the results of the manipulation are studied to help the analyst better understand the empirical system.

In reality, measurement is problematic: the analyst can never know the "true" value of the element being measured. The numbers provide information on a certain scale and they represent measurements of some unobservable variable of interest. Some measurements are richer than others, that is, some measurements provide more information than other measurements. The information content of a number is dependent on the scale of measurement used. This scale determines the types of statistical analyses that can be properly employed in studying the numbers. Until one has determined the scale of measurement, one cannot know if a given method of analysis is valid.

Measurement Scales

The four measurement scales are: nominal, ordinal, interval, and ratio. Harrington (1992) summarizes the properties of each scale in Table 7.1.

Numbers on a *nominal scale* aren't measurements at all; they are merely *category labels* in numerical form. Nominal measurements might indicate membership in a group (1 = male, 2 = female) or simply represent a designation (John Doe is 43 on the team). Nominal scales represent the simplest and weakest form of measurement. Nominal variables are perhaps best viewed as a form of classification rather than as a measurement scale.