CHAPTER 4
DEFINING AND DOCUMENTING A PROCESS

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Chapter Objectives

- To define and document a process in an analytic study
- To discuss the construction and use of a flowchart for communication and process improvement
- To discuss the importance of operational definitions in defining and documenting a process

4.1 Introduction

Almost every aspect of life is a process: the aging process, the business life cycle process, and the educational process, among others. A process transforms inputs into outputs to accomplish an aim or mission. For example, a basic business statistics course (process) transforms students (inputs) into professional users of data (outputs) to create knowledgeable business people (mission). We saw in Chapter 3 that an analytic study is a statistical investigation of a process with the purpose of predicting the future nature of its output. However, an analytic study can only be performed on a process that has a known identity; that is, the process must be defined and documented. We will see in this chapter that processes can be defined and documented with flowcharts, or pictorial summaries that clarify the steps and decisions in a process. Data from the process is then operationally defined and generated through feedback loops, enabling further process improvement activities using the PDSA cycle.
4.2 Defining and Documenting a Process

Defining and documenting a process is an important step toward improvement and/or innovation of the process. The following example demonstrates this point. In a study of an industrial laundry, an analyst began to diagram the flow of paperwork using a flowchart. While walking the green copy of an invoice through each step of its life cycle, he came upon an administrative assistant feverishly transcribing information from the green invoice copy into large black loose-leaf books. The analyst asked, "What are you doing?" so that he could record it on his flow diagram. She responded, "I'm recording the numbers from the green papers into the black books." He asked, "What are the black books?" She said, "I don't know." He asked, "What are the green papers?" She said, "I don't know." He asked, "Who looks at the black books?" She said, "Easy. I know the answer to that question. Nobody." He asked, "How long have you been doing this job?" She said, "Seven and one half years." He asked, "What percentage of your time do you spend working on the black books?" She said, "About 60 percent."

Next, the analyst did two things. First, he examined the black books. Second, he asked the administrative assistant how long ago the person who hired and trained her had left the company: "Seven years ago." At this point, the consultant realized he had solved a problem the company did not know it had. From examining the black books he realized that they were sales registers. Every day all sales, by item, were entered into the appropriate page in the black book. At the end of each month, page totals were calculated, yielding monthly sales by items. Nobody was looking at the books because nobody knew what the administrative assistant was doing. The current manager assumed the administrative assistant was doing something important. After all, she seemed so busy.

This problem is an example of a failure to define and document a process to make sure that it is logical, complete, and efficient. As an epilogue, the administrative assistant was reassigned to other needed duties because the sales registers had been computerized five years earlier.

Considering the following questions will help you define and document a process:

- Who owns the process? Who is responsible for the process's improvement?
- What are the boundaries of the process?
- What is the flow of the process?
- What are the process's objectives? What measurements are being taken on the process with respect to its objectives?
- Are process data valid?
4.3 Who Owns the Process?

Every process must have an owner (an individual who is responsible for the process). Process owners can be identified because they can change the flowchart for a process with no more authority than their own signature.

Process owners may have responsibilities extending beyond their departments, called cross-functional responsibilities; they must be high enough in the organization to influence the resources necessary to take action on a cross-functional process. In such cases, a process owner is the focal point for the process, but each function of the process is controlled by the line management within that function. The process owner will require representation from each function; these representatives are assigned by the line managers. They provide functional expertise to the process owner and are the promoters of change within their functions. A process owner is the coach and counsel of her process in an organization.

It is usually a waste of time to be involved in process improvement activities without the complete commitment of the process owner. The process owner must champion all process improvements to ensure that all steps of the PDSA cycle are followed over time, especially the Act stage, to make sure the process does not backslide to its former, inferior state.

4.4 What Are the Boundaries of the Process?

Boundaries must be established for processes; in other words, a flowchart of the process must clearly indicate where the process starts and stops. These boundaries make it easier to establish process ownership and highlight the process's key interfaces with other (customer/vendor) processes. Process interfaces frequently are the source of process problems, which result from a failure to understand downstream requirements; they can cause turf wars. Process interfaces must be carefully managed to prevent communication problems. Construction of operational definitions for critical process characteristics that are agreed upon by process owners on both sides of a process boundary will go a long way toward eliminating process interface problems. Operational definitions will be discussed in depth later in this chapter.

4.5 What Is the Flow of the Process?

A flowchart is a pictorial summary of the flows and decisions that comprise a process. It is used for defining and documenting the process. Figure 4.1 shows an example of a flowchart for one type of quality of design study, a production design study. In the design phase, design engineers determine detailed specifications for the product. Next, they prepare a prototype of the product. Then the prototype is tested and evaluated. It can be judged as good or bad. If it is bad, it returns to the design stage for redesign. If it is good, it moves to the
next phase, trial production. After this stage, the product is again evaluated. If it is bad, it returns to the design stage. If it is good, the production design is accepted and full-scale production begins.

**Figure 4.1**
*Quality of Design Study*

1. Start
2. Design of trial prototype specifications
3. Evaluation of prototype
   - bad
   - good
4. Trial production of units
5. Overall evaluation of trial production units
   - bad
   - good
6. Production design accepted
7. Stop
A flowchart can help a manager, designer, analyst, or anyone else understand, define, document, study, improve, or innovate a process.

4.5.1 Flowchart Symbols

The American National Standards Institute, Inc. (ANSI) has approved a standard set of flowchart symbols that are used for defining and documenting a process. The shape of the symbol and the information written within the symbol provide information about that particular step or decision in a process. Figure 4.2 shows the basic symbols for flowcharting that standardize the definition and documentation of a process. [Silver and Silver, 1976, pp. 142-47]

**Figure 4.2**
**Flowchart Symbols**

- **Basic input/output symbol**
  - The general form that represents input or output media, operations or processes is a parallelogram.

- **Basic processing symbol**
  - The general symbol used to depict a processing operation is a rectangle.

- **Decision Symbol**
  - A diamond is the symbol that denotes a decision point in the process. This includes attribute type decisions such as pass-fail, yes-no. It also includes variable types of decisions such as into which of several categories a process measurement falls within.

- **Flowline symbol**
  - A line with an arrowhead is the symbol that shows the direction of the stages in a process. The flowline connects the elements of the system.

- **Start/stop symbol**
  - The general symbol used to indicate the beginning and end of a process is an oval.
4.5.2 Types of Flowcharts

This section describes two types of flowcharts. [Fitzgerald and Fitzgerald, 1973, pp. 230-37]

Systems Flowchart. A systems flowchart is a pictorial representation of the sequence of operations and decisions that make up a process. It shows what is being done in a process. Figure 4.1 is an example of a systems flowchart. It represents each phase or stage in the process of a quality of design study using standard flowcharting symbols.

Layout Flowchart. A layout flowchart depicts the floor plan of an area, usually including the flow of paperwork or goods and the location of equipment, file cabinets, storage areas, and so on. These flowcharts are especially helpful in improving the layout to more efficiently utilize a space. Figure 4.3 shows a layout flowchart before and after flowcharting analysis and flow improvement. The existing system is shown in Figure 4.3a; the new proposed system appears in Figure 4.3b. This flowchart includes the flow of work along with the floor plan and location of desks and files. Comparing the existing and proposed systems is simple when the process's flow is documented this way.

Figure 4.3
Layout Flowchart
4.5.3 Advantages of a Flowchart

Flowcharting a process, as opposed to using written or verbal descriptions, has several advantages:

- A flowchart functions as a communications tool. It provides an easy way to convey ideas between engineers, managers, hourly personnel, vendors, and others in the extended process. It is a concrete, visual way of representing complex systems.

- A flowchart functions as a planning tool. Designers of processes are greatly aided by flowcharts. They enable a visualization of the elements of new or modified processes and their interactions while still in the planning stages.

- A flowchart provides an overview of the system. The critical elements and steps of the process are easily viewed in the context of a flowchart.

- A flowchart removes unnecessary details and breaks down the system so designers and others get a clear, unencumbered look at what they're creating.

- A flowchart defines roles. It demonstrates the functions of personnel, workstations, and sub-processes in a system. It also shows the personnel, operations, and locations involved in the process.

- A flowchart demonstrates interrelationships. It shows how the elements of a process relate to each other.

- A flowchart promotes logical accuracy. It enables the viewer to spot errors in logic. Planning is facilitated because designers have to clearly break down all of the elements and operations of the process.

- A flowchart facilitates trouble-shooting. It is an excellent diagnostic tool. Problems in the process, failures in the system, and barriers to communication can be detected by using a flowchart.

- A flowchart documents a system. This record of a system enables anyone to easily examine and understand the system. Flowcharts facilitate changing a system because the documentation of what exists is available.

Flowcharts can be applied in any type of organization to aid in defining and documenting a process, and ultimately to improve and innovate that process. Flowcharts are simple to use, providing that appropriate following guidelines are followed, in keeping with standard practices. [Fitzgerald and Fitzgerald, 1973, pp. 227-84] These guidelines are shown in Exhibit 4.1.
4.5.3 Constructive Opportunities to Change a Process

Process improvers can use a flowchart to change a process by paying attention to the following three points:

1. Process improvers find the steps of the process that are weak (for example, parts of the process that generate a high defect rate).
2. Process improvers improve the steps of the process that are within the process owner’s control.
3. Process improvers isolate the elements in the process that affect customers.

If these three conditions exist simultaneously, an excellent opportunity to constructively modify a process has been found. In general, process improvements have a greater chance of success if they are either non-political or have the appropriate political support, and either do not require capital investment or have the necessary financial resources.

4.6 What Are the Process’s Objectives?

A key responsibility of a process owner is to clearly state process objectives and indicators that are consistent with organizational objectives. An example of an organizational objective is "Provide our customers with higher-quality products/services at an attractive price that will meet their needs." Each process
owner can find meaning and a starting point in the adaptation of this organizational objective to his process's objectives. For example, a process owner in the Purchasing Department could translate the preceding organizational objective into the following subset of objectives and metrics:

**Objective:** Decrease the number of days from purchase request to item/service delivery.  
**Metric:** Number of days from purchase request to item/service delivery by delivery overall, and by type of item purchased, by purchase.

**Objective:** Increase ease of filling out purchasing forms.  
**Metric:** Customer satisfaction survey by quarter.

**Objective:** Increase customer satisfaction with purchased material.  
**Metric:** Customer satisfaction survey by quarter.

**Objective:** Continuously train and develop Purchasing personnel with respect to job requirements.  
**Metric:** Number of errors per purchase order.  
**Metric:** Number of minutes to complete a purchase order.

Whatever the objectives of a process are, all involved persons must understand them and devote their efforts toward those objectives. A major benefit of clearly stating the objectives of a process is that everybody works toward the same aim.

### 4.7 Are Process Data Valid?

Management's (process owner's) attempts to define and document a process must include precise definitions of process objectives and sub-objectives, specifications, products and services, and jobs. [Deming, 1982, pp. 323-24] Such definitions are a prerequisite for understanding between process members. Operational definitions used to collect data must have the same meaning to everyone so that the data can be used as a basis for action.

It is useful to illustrate the confusion which can be caused by the absence of operational definitions. The label on a shirt reads "75% cotton." What does this mean? Three quarters cotton, on the average, over this shirt, or three quarters cotton over a month's production? What is three quarters cotton? Three quarters by weight? If so, at what humidity? By what method of chemical analysis? How many analyses? Does 75 percent cotton mean that there must be some cotton in any random cross-section the size of a silver dollar? If so, how many cuts should be tested? How do you select them? What criterion must the average satisfy? And how much variation between cuts is permissible? Obviously, the meaning of 75% cotton must be stated in operational terms; otherwise confusion results. [Deming, 1986, pp. 287-89]
As another example, one operation in a production process is a de-burring operation. Clearly, it is reasonable to ask for the definition of a burr. The supervisor in charge of the de-burring operation was asked for a definition and stated that a burr is a bump or protrusion on a surface. “And,” he added, "de-burring's five inspectors all have at least 15 years of experience and certainly know a burr when they see one."

A test was conducted to determine if the definition of a burr was consistent among all five inspectors. Ten parts were drawn from the production line and placed into a tray so that each part could be identified by a number; each of the inspectors was shown the tray and asked to determine which parts had burrs. Table 4.1 shows the results.

Table 4.1
Identification of Burrs on 10 Parts

<table>
<thead>
<tr>
<th>Part Number</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Legend: 0 = No burr on part 1 = Burr on part

Although inspectors B and C always agree, they always disagree with inspector E. Inspector A agrees with inspectors B and C 40 percent of the time, with inspector E 60 percent of the time, and with inspector D 50 percent of the time. Inspector D also agrees with inspectors B, C, and E 50 percent of the time. This information does not paint a pretty picture. Absence of an operational definition of a burr creates mayhem. De-burring's manager (the process owner) and inspectors have no consistent concept of their jobs. This creates fear (Deming's Point 8) and steals their pride of workmanship (Deming's Point 12).

4.8 More on Operational Definitions

Major problems can arise when process measurement definitions are inconsistent over time, or when their applications and/or interpretations are different over time. Employees may be confused about what constitutes their jobs. Major problems between customers and suppliers may result from the
absence of agreed-upon operational definitions. Endless bickering and ill will are inevitable results.

Operational definitions establish a language for process improvement and innovation. An operational definition puts communicable meaning into a process, product, service, job, or specification. For example, specifications like defective, safe, round, 5 inches long, reliable, on-time, good service, hot, cold, and tired have no communicable meaning until they are operationally defined. Everyone concerned must agree on an operational definition before action can be taken on a process. A given operational definition is neither right nor wrong: its significance is that there is agreement between the stakeholders involved with the definition. As conditions change, the operational definition may change to meet new needs.

An operational definition consists of (1) a criterion to be applied to an object or to a group, (2) a test of the object or group; and (3) a decision as to whether the object or group did or did not meet the criterion. [Deming, 1986, p. 277] The three components of an operational definition are best understood through some examples.

A firm produces washers. One of the critical quality characteristics is roundness. The following procedure is one way to arrive at an operational definition of roundness, as long as the buyer and seller agree on it.

**Step 1:** Criterion for roundness.

Buyer: "Use calipers, as shown in Figure 4.4, that are in reasonably good order." (You perceive at once the need to question every word.)

Seller: "What is 'reasonably good order'?"

(We settle the question by letting you use your calipers.)

Seller: "But how should I use them?"

Buyer: "We'll be satisfied if you just use them in the usual way."
Seller: "At what temperature?"
Buyer: "The temperature of this room."
Buyer: "Take six measures of the diameter about 30 degrees apart. Record the results."
Seller: "But what is 'about 30 degrees apart'? Don't you mean exactly 30 degrees?"
Buyer: "No, there's no such thing as exactly 30 degrees in the physical world. So try for 30 degrees. We'll be satisfied."
Buyer: "If the range between the six diameters doesn't exceed .007 centimeters, we'll declare the washer to be round."

(They have determined the criterion for roundness.)

*Step 2*: Test of roundness.
   a. Select a particular washer.
   c. The range is 3.369 to 3.363, or a 0.006 difference. They test for conformance by comparing the range of 0.006 with the criterion range of 0.007 (*Step 1*).

*Step 3*: Decision on roundness.
   Because the washer passed the prescribed test for roundness, it is declared to be round.

If a seller has employees who understand what round means and a buyer who agrees, many of the problems the company may have had satisfying the customer will disappear. [Gitlow and Hertz, 1983, pp. 138-39]

As another illustration, a salesperson is told that her performance will be judged with respect to the percent change in this year’s sales over last year’s sales. What does this mean? Average percent change each month? Each week? Each day? For each product? Percent change between December 31, 2012 and December 31, 2013 sales?

How are we measuring sales? Gross, net, gross profit, net profit? Is the percent change in constant or inflated dollars? If it is in constant dollars, is it at last year's prices or this year's prices? Under what economic conditions?

A loose definition of percent change can only lead to confusion, frustration, and ill will between management and the sales force -- which is hardly the way to improve productivity. How should management operationally define a percent change in sales?

*Step 1*: Criterion for percent change in sales. A percent change in sales is the difference between 2013 sales and 2012 sales divided by 2012 sales:
Percentage change (12, 13) = (S_{13} - S_{12})/S_{12} \tag{4.1}

where:
S_{13} = dollar sales volume for the period January 1, 2013 through December 31, 2013.
S_{12} = dollar sales volume for the period January 1, 2012 through December 31, 2012.

$S_{12}$ is measured in constant dollars, with 2011 as the base year, using June 15, 2011 and June 15, 2012 prices to derive the constant dollar prices, and total unit sales less returns (due to any cause) as of December 31, 2012 for each product.

\[
S_{12} = \sum_{i=1}^{m} \left[ \frac{P_{i11}}{P_{i10}} \left( T_{S_{i12}} - R_{i12} \right) \right] \tag{4.2}
\]

where:
m = number of products in the product line.
P_{i10} = price of product i as of June 15, 2011.
P_{i11} = price of product i as of June 15, 2012.
T_{S_{i12}} = total unit sales for product i between January 1, 2012 and December 31, 2012.
R_{i12} = total unit returns (for any reason) for product i between January 1, 2012 and December 31, 2012.
R_{i12} recognizes that products sold late in 2012 that may be returned will be reflected in R_{i13}, next year’s return for product i.

$S_{13}$ is measured in constant dollars, with 2011 as the base year, using June 15, 2011 and June 15, 2013 prices to derive the constant dollar prices, and total unit sales less returns (for any reason) as of December 31, 2013, for each product. ($P_{i11}$ remains the same for all products.)

\[
S_{13} = \sum_{i=1}^{m} \left[ \frac{P_{i11}}{P_{i13}} \left( T_{S_{i13}} - R_{i13} \right) \right] \tag{4.3}
\]

where:
all items are defined as in Equation (4.2) with the appropriate shift in time frame.

This procedure for computing the percentage change in sales between 2012 and 2013 will be in effect regardless of the economic conditions. Further, management may revise the definition after the 2013 sales evaluation, but not before, unless the sales force and management agree.

Step 2: Test on percent change in sales.
The sales manager will use all 2012 and 2013 invoices and sales return slips to compute the net number of units sold for each product in 2012 and 2013. The sales manager will record the computations and results.

**Step 3: Decision on percent change in sales.**

The sales manager communicates the percentage change in sales to the salesperson.

The prior definition of sales might not suit another manager and sales force. However if the sales manager adopts it, and the sales force understands and accepts it, it is an operational definition.

Operational definitions are not trivial; if management does not operationally define terms so that employees and customers agree, serious problems will result. Statistical methods become useless tools in the absence of operational definitions.

### 4.9 Summary

This chapter discussed defining and documenting a process. A process is defined as the transformation of inputs into outputs, and it involves the addition of value in time, place, or form. Processes exist in all aspects of all organizations, including administration, sales, training, vendor relations, and production. Two important characteristics of processes are (1) they all have customers and suppliers and (2) process improvement requires feedback loops, which enable information about outputs to be communicated back to the input stage.

Before a process can be improved or innovated, it must be defined and documented. This is accomplished by answering the questions: Who owns the process? Who is responsible for the process's improvement? What are the boundaries of the process? What is the flow of the process? What are the process's objectives? What measurements are being taken on the process with respect to its objectives? Are process data valid?

Flowcharts provide a structured means to define and document a process. This enables enhanced communication, planning, simplification and clarity of the process elements, identification of roles and interrelationships, logical accuracy; and effective trouble-shooting.

Operational definitions bring about increased communication between the stakeholders of a process because they provide precise meanings for specifications, products and services, and jobs; that is, they establish a language for improvement and innovation of a process. Operational definitions consist of: a criterion to be applied to an object or to a group; a test of the object or group; and a decision as to whether the object or group did or did not meet the criterion. If
operational definitions are not used, or are not agreed upon, by all concerned parties, serious problems can occur.

EXERCISES

4.1 Give an example of a process with no feedback loop.

4.2 Give an example of a process with a “special cause only” feedback loop.

4.3 Give an example of a process with a “special and common cause” feedback loop.

4.4 Set up a flowchart for studying for an examination.

4.5 Set up a flowchart for a person performing his/her job responsibilities who is concerned about starting time, stopping time and lunch time.

4.6 Set up a flowchart for selecting a course from your University.

4.7 Set up a flowchart for a pre-operative evaluation process.

4.8 Construct an operational definition for a product quality characteristic.

4.9 Construct an operational definition for a service quality characteristic.

REFERENCES AND ADDITIONAL READINGS


