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PROCESS VALUE ESTIMATION AT PACIFIC BELL

by

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PROCESS VALUE ESTIMATION AT PACIFIC BELL

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ABSTRACT

The purpose of this thesis is to demonstrate the implementation of the Process Value Estimation methodology now being pioneered at Pacific Bell. The principles of Process Value Estimation are applied to the Network Surveillance Division of Pacific Bell in a field study. There are two main component processes of Network Surveillance. Classification is an automated process, and Decision Making is a manual process. The thesis uses Process Value Estimation to describe the processes in terms of work accomplished. This description permits the comparison of the value of the two processes. This is the first major field study using the Process Value Estimation method.

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I. INTRODUCTION

A. PURPOSE

The purpose of this thesis is to apply the principles of the Process Value Estimation theory in a field study. More precisely, the purpose of this work is to accomplish the first steps in the methodology. The subject of the study is the Network Surveillance Division of the Pacific Bell Company.

The primary goal that must be met to accomplish this purpose is to describe the two component processes of network surveillance, and to use the descriptions to compare the work accomplished by each of the two components.

B. DISCUSSION

Value is an important concept in a business environment. It is the creation of value that generates revenues to the firm. In essence, the company sells the results of its value creating processes.

Corporations are very aware of the significance of value. After all, the marketplace demands value. Techniques such as Value Chain Analysis stress the importance of firms determining if value is created by their business processes.

Businesses often use restructuring and reengineering as tools to enhance value creation. The trend has been to use

cost reduction as the measurement by which reengineering success is measured.

However, cost reduction is not the only goal to be met if the firm is to remain competitive. Cost reduction may lead to lower selling prices (or higher margins), but customers demand that firms provide better value.

Dr. Valery Kanevsky (previously employed by Pacific Bell, and now working as a scientist for Hewlett Packard) and Dr. Thomas Housel (of the University of Southern California) pioneered a new methodology for determining the value of non-saleable processes within a business. This methodology, Process Value Estimation (PVE), uses information and knowledge measurements to determine the fraction of revenue earned by these processes.

At first glance, PVE may seem similar to Activity Based Costing (ABC), an allocation method familiar to management consultants. ABC uses cost drivers to allocate indirect costs to internal products, processes, departments, or divisions within the company (Horngren, 1994). PVE attempts to measure the revenue generated by processes, departments, etc., that an accountant might traditionally view as cost centers.

The distinction between cost allocation and value creation (Porter 1980, 1985) is an important one, especially

for organizations involved in restructuring (Shank and Govindarajan, 1993). Many organizations strive to meet cost-reduction objectives without regard to the value of the various activities. PVE could refocus organizational efforts to streamline operations in new directions.

An important principle of PVE is that more complex processes are relatively more valuable within the given method of operations. PVE employs descriptions of various component processes to determine their complexity. Simply put, complex processes require longer descriptions than simpler processes. The technique used for describing processes must permit comparison of different types of processes. The method of describing a manual process (a bank teller cashes a client's check, for example) and an automated process (client uses an automated teller) must be compatible with both processes. If the two descriptions cannot be compared with each other, then the point of the analysis is missed.

C. OBJECTIVES OF THESIS

There are several objectives that must be accomplished in order to fulfill the purpose of this thesis. First, we must gain an understanding of the (PVE) methodology, and examine what PVE can add to business analysis. After a basic literacy in PVE is obtained, we must gain a broad

level of comprehension of the Pacific Bell organization and the Network Surveillance Division of Pacific Bell.

We must then determine the research methodology that we will use to obtain the data for our analysis. The next stage of our research will be to document the data collection effort, and to document how we use this data to analyze the Network Surveillance Division.

Finally, we will stand back and view our research, and determine how this analysis affects Pacific Bell and the Network Surveillance Division, and how similar analysis might be applied to other commercial and government organizations. We must also acknowledge the limitations in scope of our research, and confess to any assumptions made during the data collection and analysis efforts.

D. LITERATURE

PVE is a methodology in its infancy. As such, the literature focusing on PVE is limited. The following is a list of articles and publications available for a more concentrated look at Process Value Estimation:

Housel, Thomas J., Arthur H. Bell, and Valery Kanevsky, "Calculating the Value of Reengineering at Pacific Bell", *Planning Review*, January/February 1994.

Housel, Thomas J., and Valery Kanevsky, *The Learning-Knowledge-Value Spiral: Tracking the Velocity of Knowledge to Value*, Unpublished Paper.

Housel, Thomas J., and Valery Kanevsky, "A New Methodology for Business Process Auditing", *Planning Review*, May/June 1995.

E. BENEFIT OF STUDY

PVE provides a new way for organizations to evaluate the value of non-saleable processes in profit oriented and non-profit organizations. This includes manufacturing, merchandising, and service organizations. This thesis will provide the first documented application of PVE to a major organizational process.

Most public sector services are non-saleable. The implications of the results of this field study could signal that PVE has a place in the evaluation of the efficiency of government agencies. PVE might be used to identify critical value creating processes or to prioritize cost reductions.

II. BACKGROUND OF PROCESS VALUE ESTIMATION

A. ORIGINS OF PROCESS VALUE ESTIMATION

Researchers at Pacific Bell developed PVE to assist the company in evaluating the effectiveness of reengineering efforts (Hammer, 1990) within the company. PacBell wanted to insure that reengineering increased the value of all business processes, including those without saleable outputs. More precisely, PacBell wanted to assess the return on investment (ROI) on each of the processes, and use ROI as a measurement tool for value.

If we closely examine a business process, we can see that the process is actually a series of sub-processes, or component processes. PVE was designed so that company evaluators could place a value on each component process. Pacific Bell could then compare the value of the process after the reengineering took place with its value before the change was implemented. Using a "return" measurement to evaluate reengineering success allows the company to view processes in terms of the value they create. This is a significant departure from the traditional view of evaluating reengineering in terms of cost reductions within business processes.

B. TYPICAL BUSINESS PROCESS

Business processes can be defined in terms of input (raw materials, for example), transformation of the input, and output or end product. Component processes can be defined in the same terms. Each component has its own input, process, and output. Figure 2.1 illustrates the concept of component processes within a typical business process. Note that the output of Component Process #1 becomes the input for Component Process #2.

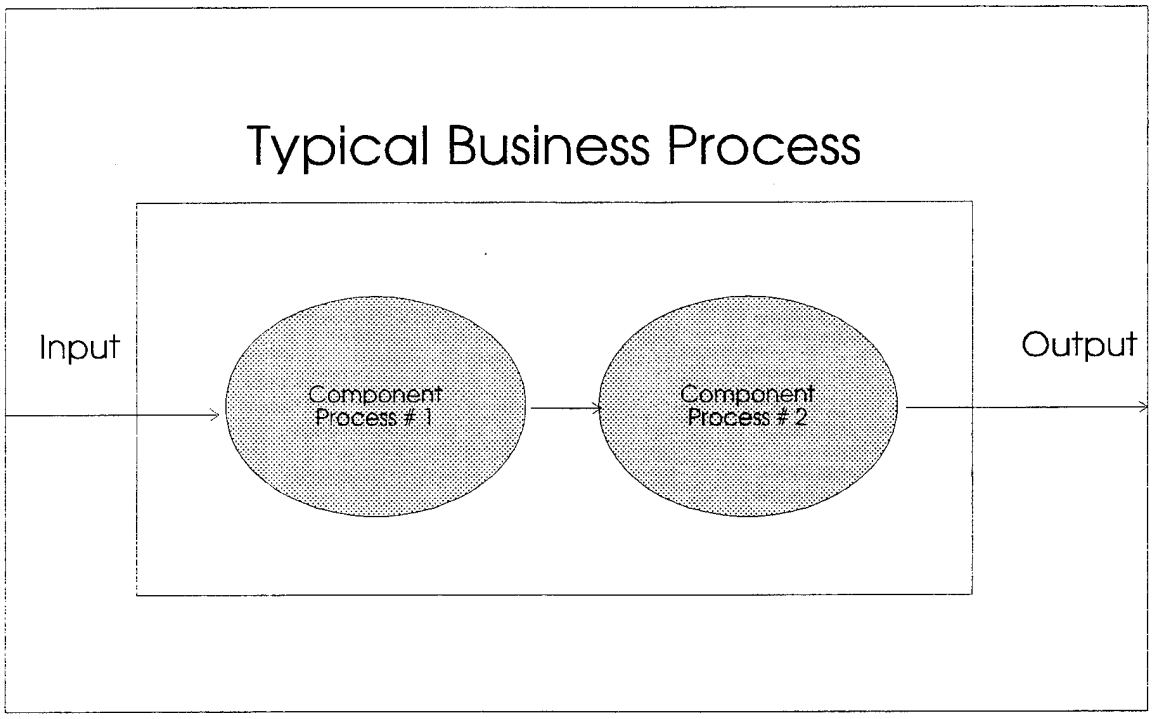


Figure 2.1 Typical Business Process

C. RETURN ON INVESTMENT IN PROCESS

The underlying premise of PVE is that revenue the company earns from the end product can be assigned to each of the component processes that were involved in generating the revenue. The point of PVE is to determine the percentage of that revenue that each component earns, and to assign a corresponding value, and subsequently ROI, to each of the component processes. Calculating a return for each component enables a comparison of the value of different components. Similarly, the success of reengineering a single component can be determined by examining the "before and after" returns.

To determine the value of the component processes, PacBell engineers developed a term known as Return on Investment in Process (ROP). ROP is defined as the return on investment for the component process. ROP is the ratio of revenue earned to cost. The allocated part of the revenue earned by the component process forms the numerator, and the cost of the component process is the denominator. Figure 2.2 presents this ratio as a mathematical equation.

Revenue Allocated to Component / Process Cost of Component	=	Return on Investment in Process (ROP)

Figure 2.2 Return on Investment in Process (ROP) Equation

D. THE PVE METHODOLOGY

The Process Value Estimation method is summarized in Figure 2.3, and is discussed in greater detail in the following sections.

The Process Value Estimation Methodology

1. Define the process and component processes.
2. Describe the component processes.
3. "Measure" the description.
4. Capture sample of output during sampling period
5. Use descriptions to determine work accomplished in sample.
6. Calculate cost for each component
7. Compute ROP for each component

Figure 2.3. The Process Value Estimation Methodology

1. Identication and Definition

The evaluator begins with a definition of the business process and identification of the elements that make up the process. It is important to pinpoint the inputs to the process, the component processes which transform the input,

and the output. In addition, the inputs and outputs of the component processes must be identified.

2. Description of Component Processes

The description of component processes may be accomplished by a simple series of written steps for manual processes, or automated processes might be described by the computer software programming code that accomplishes the component process. In some instances, describing the component processes in the same language or medium can be difficult. Processes which have both manual and automated components can be particularly difficult. The team that is engaged in data collection must agree to some compromise of languages in these situations.

3. Count the Process Language "Words"

The total number of the "words" in each component process forms the basis for allocating the proportion of revenue earned by the various components. More complex operations require relatively more words to describe; therefore, they earn a greater percentage of the revenue. For example, let's say that our large process can be divided into two component processes. Component Process A can be described in twelve steps, and Component Process B can be described in eight steps.

4. Designate a Sample Period

The data collection team must determine a data collection timeframe that is representative of operations being studied. A sampling period of one month may be a good choice for a typical manufacturing or service organization.

If, however, the company's daily output is millions of electronic data bits, then a shorter sampling period may be more appropriate. Conversely, a longer sampling period may be more desireable for some organizations. The team must choose a sampling period in which the skewing effect of non-recurring random events will be minimized. The goal is to choose a sample period in which the events are representative of normal operations.

5. Add "Words" Used to Describe Work Perfomed

Continuing with the example in Step 3, Component Process A, which has twelve steps, is performed 3 times. Component Process B, which has eight steps is performed twice. The percentage of revenue earned by Component Process A is 36 divided by 52, or about 69%. The percentage of revenue earned by Component Process B is 16 divided by 52, or about 31%.

6. Calculate Total Costs to Produce Outputs

Generally Accepted Accounting Principles (Horngren, 1994) or Activity Based Costing may be used for assigning

costs, depending on which is more appropriate. Typically, an organization that produces more than one output will have a cost allocation method already in place. For illustrative purposes, let's arbitrarily assign a cost of $50 for Component Process A, and a cost of $20 for Component Process B for the sampling period.

7. Compute the ROP for each Component Process

Revenue allocated to the component process is divided by the cost to produce the component output to determine the return on investment in process (ROP). If the revenue earned by the total process is $100, Component Process A is allocated $69 of that revenue, and Component Process B is allocated $31 of the revenue. ROP for Component Process A is $69 divided by $50, or 1.38. ROP for Component Process B is $31 divided by $20, or 1.55. Defining value in terms of ROP makes Component B more valuable to the company, even though it earns less revenue. If the costs of Component A were reduced by 10 percent to $45, then ROP would rise to 1.53. This is still below the ROP value established for Component B.

E. BENEFITS TO STAKEHOLDERS

In competitive environments it is important for managers to be aware of the importance of value to

customers. PVE's focus on value offers an analytical alternative to cost-centered evaluation.

Any commercial restructuring effort will fail if the end results are not customer-oriented. PVE centers management's focus on pricing and value. With these concerns driving re-engineering efforts, customers will continue to receive the value that brought them to the company in the first place.

The results of a PVE analysis are not currently disclosed. One can imagine, however, that this information might some day be of great benefit to investors.

Traditional evaluation methods can disguise poor internal practices. Financial statements do not expose redundant, wasteful functions within the company. PVE could allow investors and analysts the opportunity to objectively compare companies across an industry, or to study the performance of a single company over time. Stakeholders can move from cost-based methods of assessment and judge a company's efficiency at a basic level: the transformation of raw materials into end products using information-based value.

PVE provides company managers the opportunity to objectively evaluate processes that are candidates for reengineering. Management can look at the value added by

these processes, as opposed to the past practice of making reengineering decisions based on company politics or intuition. PVE also permits the company to measure the success of restructuring efforts by providing clear, value-based snapshots of component processes before and after reengineering.

In the past, component processes have been evaluated solely on cost-based approaches. Even today, much of current benchmarking is cost reduction oriented. The PVE method provides a new avenue for examining processes within a business. Success can be determined by new criteria focusing on value creation.

III. PACIFIC BELL AND NETWORK SURVEILLANCE

A. OVERVIEW OF PACIFIC BELL

Pacific Bell is the most prominent provider of telephone service in California. The company's mission is fourfold: to provide high-quality, competitively priced, communications services to customers; to lead their markets in customer satisfaction and loyalty; to foster employee commitment, initiative, and effectiveness; and to increase the value of stockholders' investment.

PacBell reported more than $9 billion in revenue for 1994, down slightly from the previous year. An 18 percent reduction in expenses allowed the company to hold 1994 net income fairly steady at $1.17 Billion. The number of customers, whether measured in number of access lines or minutes of telephone use, increased from 1993 to 1994. There was a 6.8 percent decrease in the number of employees. There was also a decrease in capital expenditures of 10.7 percent.

Pacific Bell faces many challenges in the current market. The company's pricing strategy is somewhat restricted by state and federal regulations. Additionally, the increasing number of competitive telephone service providers has created a market-savvy customer base that demands low-priced quality service.

The company's goal is to maintain its market position in the area of traditional home and business telephone service. Concurrently, PacBell is striving to expand in new growth markets, particularly interactive multimedia services (especially the home entertainment market) and new wireless personal communications services.

The company recognizes that a static organizational structure will not provide the flexibility it needs to survive and prosper. Government regulation, increased competition, and new technologies present a rapidly changing business climate. In the midst of the current reorganization, the company president predicts that reorganization will never end at PacBell. Figure 3.1 provides the PacBell organization chart as of July 1, 1995.

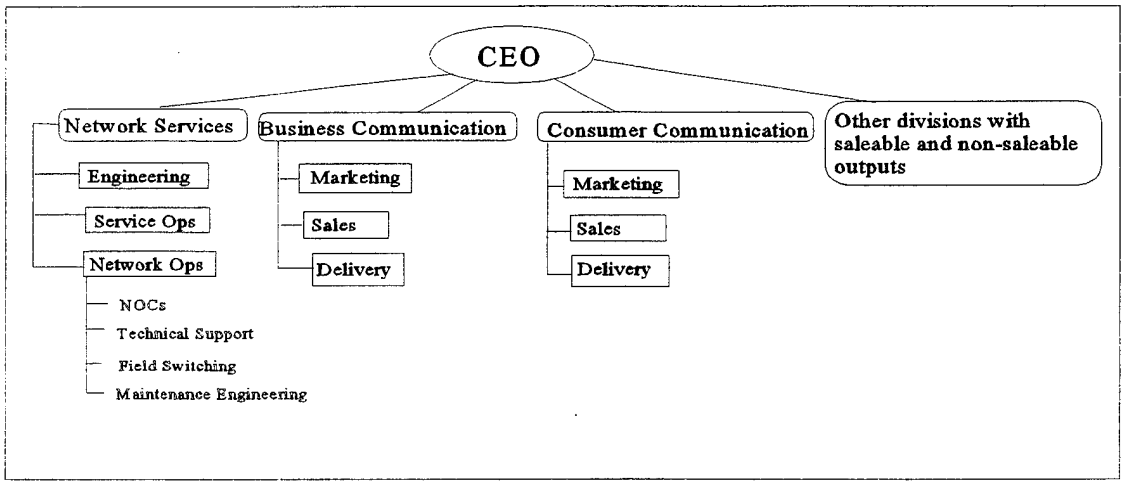


Figure 3.1. Pacific Bell Organizational Chart

The decreased number of employees and the reduction in capital investment are indicative of the current trend of downsizing, or rightsizing, in corporations across the nation. Increased productivity is a focal point for PacBell managers. This environment provides fertile ground for testing the Process Value Estimation methodology. Properly applied, PVE could help management objectively judge the success of reorganization and reengineering efforts.

B. OVERVIEW OF NETWORK SURVEILLANCE

The primary function of the Network Operations Centers is to monitor PacBell's network through the use of surveillance and control devices, and to take action to correct irregularities, problems, and failures within the network. This function is commonly referred to as Network Surveillance. Auxilliary responsibilities include gathering information on failures for Federal Communciations Commission reports, and responding to general information requests from other PacBell divisions. Network Surveillance employees do not interact with PacBell's customers on a routine basis.

The Network Surveillance function can be subdivided into two major component processes. The first component, which we will call Classification, is comprised of electronic monitoring of the network and classification of

alarms. The second component process, Decision Making, involves technicians making decisions in response to the alarms and in choosing alternative corrective actions.

Each of the component processes is a mini-system. Both have their own inputs, functions, and outputs. These components, Classification and Decision Making, are sequential in nature. All incoming data goes through the Classification component, and then, if necessary, the data flows through the Decision Making component. The unity of these components form the primary function of the Network Surveillance operation.

The Network Surveillance process is graphically illustrated in Figure 3.2. The following sections will explain the process in more detail.

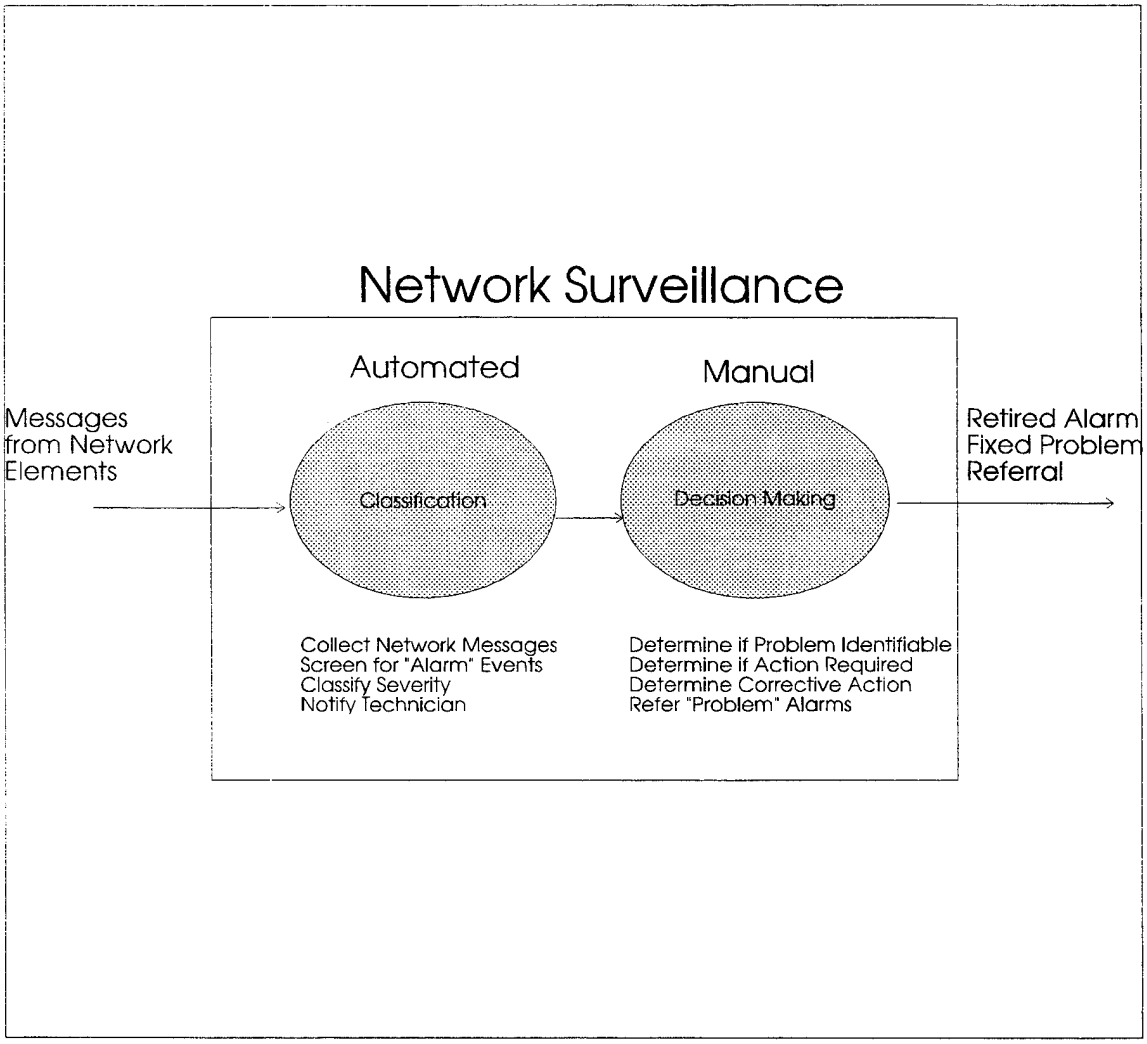


Figure 3.2 Network Surveillance Process

1. Classification Component

a. Input

Classification is an automated function. PacBell has two computer systems with the same functionality, the TNM and the 2BSCCS, that continually monitor, or surveille, the company's network elements. The computers gather a

wide array of data from the network elements in the form of messages. Messages are the method that the network communicates the status of equipment to the monitoring computers.

b. Process

The computers are programmed to evaluate all the messages and pick out messages that meet pre-determined thresholds for alarms. An alarm may be triggered by a single message, by a specific quantity of the same message, or by a grouping of related messages. All messages, including those that do not meet the thresholds for alarms, are stored and can be retrieved by technicians if required. For example, a technician can review the status of an equipment prior to the event that caused an alarm. In addition, the technician can monitor an equipment to see if a particular corrective action has been effective.

c. Output

After the TNM or the 2BSCCS computer recognizes patterns that fit the requirements for alerting technicians, it uses pre-programmed criteria to establish the severity of the alarm. There are four classifications of alarms.

1. A critical alarm would signal the need for immediate action within the system or an emergency such as fire.

2. A major alarm alerts the technician to problems such as blown fuses that require immediate replacement.

3. Minor alarms signify that a small problem may escalate and affect service.

4. Informational alarm tells the technician minor details such as a door opening during normal working hours.

d. Summary of Classification Component

This information allows us to summarize the Classification component. The input is generated by the network switching elements. This component monitors the elements, translates the electronic patterns into messages, filters the messages for events that meet the thresholds, and classifies those events by the severity of the accompanying alarm that notifies the technician. There are five possible outputs of the Classification Component: the four alarms and a state of no alarms.

2. Decision Making Component

a. Input

The Decision Making Component is a manual function. Company technicians are responsible for continually monitoring their computer screens. When an alarm appears on the screen, the technician must decide what steps, if any, should be taken in response to the alarm.

b. Process

The technician has several options when faced with an alarm. For lower severity alarms, especially informational alarms, the technician may simply retire, or silence, the alarm. If the technician determines that action must be taken, then the technician must quickly determine which action is most appropriate for the given situation.

c. Output

If the technician cannot identify the problem which is causing the alarm, then the problem is referred to a nearby, more experienced, technical manager for more in-depth review.

If the technician has identified the problem, then he must determine what response is the best for the situation. If the technician is unable to resolve the problem, then he must refer it to the technical manager, or to the company's repair divisions depending on the nature and the severity of the alarm. A referral of any kind means that the problem has transitioned from the Network Surveillance Process.

d. Summary of Decision Making Component

The description of the second component can be summarized in terms of input, process, and outputs. The input for Decision Making is the message and the

accompanying alarm. The process is determining if action is required, determining if the problem is identifiable, deciding if corrective action can be taken, and deciding what steps to take if the problem cannot be corrected. Outputs include a retired alarm, a fixed problem, an immediate referral, and maintenance requests.

IV. RESEARCH METHODOLOGY AND APPROACH

As with any field study, the primary sources of data will not be from published works. The available literature listed in Chapter I addresses PVE as an evaluation methodology. The researcher's task in this field study is to search for information on the subject of the case which lends itself to an evaluation using the PVE method.

The researcher will employ several research techniques to harvest information concerning the two main component processes of the Pacific Bell's Network Surveillance Division.

A. INTERVIEW

Pacific Bell management and line employees provide an excellent resource for information on both the Classification and Decision Making Components. Interview is an especially important tool for familiarization purposes, as it allows the researcher to tap into company expertise and experience to gain a broad overview of the company and its systems.

Additionally, a situation in which desired quantitative information is not documented or easily obtainable is not an unusual circumstance in a field study. Interviews with knowledgeable company personnel can permit the study to continue using estimates or generalizations as data points.

B. DOCUMENTATION

A review of Pacific Bell's internal publications will be an essential part of this field study. Training and personnel manuals may shed some light on how technicians are prepared to carry out their duties.

Although certain data may not have been collected by Pacific Bell, it may be available through other Bell companies. The data from other companies might be adapted for use in the analysis of Pacific Bell.

The output of the network elements provides the input for the Network Surveillance Process. Information unavailable in Pacific Bell manuals may be available in the documentation provided with the network elements.

C. OBSERVATION

This method of data gathering may prove to be the most helpful. Seeing the computers and associated hardware that perform the various automated tasks can assist understanding of those processes.

Observation should also assist in comprehension of the manual processes. In particular, viewing technicians involved in Decision Making will aid the researcher in defining exactly what is done during that stage. Defining exactly what is accomplished is a critical part of PVE.

D. APPROACH

Prior to delving into documentation or preparing for interviews, the researcher in a field study should have some general idea as to what he is trying to accomplish.

Our goal is to define the work accomplished in both Classification and Decision Making. Further, our goal is to define the components in a manner that permits comparison of the two.

Our approach, then, will be to measure the amount of information transformation in each of the components. We will attempt to measure the transformation in bits of information.

By using this measurement device, the researcher will be able to compare the two components, and to draw some conclusions from the comparison.

V. DATA COLLECTION

A. DATA COLLECTION OBJECTIVES

Once an understanding is obtained of the definition of the processes to be analyzed and the PVE method, the application of the method to the processes can begin. The first step of the application is to determine the type of data that is required to define the component processes in a measurable way.

The PVE method uses the transformation of information as the catalyst for revenue generation. The description of the process is the information that is to be measured. The point of the data collection effort is to gather facts that describe, or define, the transformation of the input within the component processes.

We know that the Classification and Decision Making Components each consist of input, process, and output. In the data collection phase, our goal will be to quantify the input, understand exactly what occurs during the transformation process, and to quantify the output. The results of the data collection will be a description of each component process.

B. CLASSIFICATION COMPONENT

1. Understanding the Process

We know from the broad overview of the Classification Component presented in Chapter III that messages from the Network Surveillance elements are the input for this component. A more precise understanding of this input is required before we progress.

Pacific Bell's Network Operations Centers (NOCs) are responsible for monitoring switching elements from outlying sites within a geographic region. Depending on the technology installed at the sites, the surveillance computers may be gathering information from a variety of technologies, each sending messages in its own language. The mix of technologies that Network Operations Centers must monitor differs from center to center, depending on the switching elements at work throughout each region.

There are at least five switching technologies at work throughout the Pacific Bell system. These technologies differ primarily because they are manufactured by different companies, or because they represent different levels of technology advancement. Three of these technologies are more prevalent, and are surveilled by most of NOC's. These technologies are the 1A ESS (Electronic Switching System), the 5 ESS, and the DMS 100.

2. Research Dilemmas

Already, the researcher faces a dilemma. The exact amount of input for each NOC cannot be summarized from a study of each element because the mix of technologies is not constant for each center. If it were possible to collect data from each technology at a single center, the relevance of the data would have a short life-span because the technologies are in a continual state of modernization and replacement.

Therefore, assumptions and generalizations must be made that allow us to measure the value of the Classification Component based on information from a single data point.

Another research concern is the existence of a data bank from which information can be harvested. Ideally, all the information desired by the researcher in formulating his plan will be readily available, or at least obtainable. If not, then accommodations must be made, and the limitations on the scope of the research must be acknowledged.

3. Measuring the Value of Classification Component

The mechanism by which the Classification Component's value is to be measured is the transformation of incoming messages into alarms. The first step will be to quantify the input. Our goal will be to enumerate the incoming

messages, and to determine how many of them will trigger the alarms of various severity.

a. Determining How Many Messages Trigger Alarms

Information of this nature was obtained from a study of the 5 ESS Output Manual. This manual is published by the 5 ESS manufacturer, and lists the messages that the element is capable of transmitting as it arrives from the factory. Summary data is presented in Figure 5.1.

5 ESS Message Profile

Messages that trigger an alarm	1073
Messages that trigger no alarm	4564

Figure 5.1. Breakdown of Messages for 5 ESS

We will be unable to determine the exact number of messages that are possible for each NOC. There are several reasons why the precise data is unattainable.

1. We have the message profile for only one technology.
2. The mix of technologies suveilled by each NOC differs.
3. The mix of technologies at a particular NOC changes.

4. Technicians at the local level can make temporary or permanent alterations to the alarm severity for a particular message received at the local NOC. In other words, a 5 ESS message can be made to trigger a major alarm at a certain NOC. The same message would trigger a minor alarm at all other NOC's.

However, interviews with several company technicians confirm that the pattern is similar for all technologies. If we assume that each switching technology has a similar message profile, then we can make some helpful statements about the output of the switching technologies.

Although we cannot determine the exact number of messages, we can make a reasonable estimation of the percentage of possible messages that a NOC may receive that would trigger alarms. This estimation is valid because of two factors.

1. If each technology has a similar message pattern to the 5 ESS, then the percentages will be similar.
2. If the percentages are the same for each technology, then the percentages will be similar for all NOC's, regardless of how many, or what type of technology is being surveilled.

We can examine the 5 ESS data in terms of percentages, and apply those percentages to all technologies. Then we have a good estimation of the mix of

messages possible at each NOC. These percentages are presented in Figure 5.2.

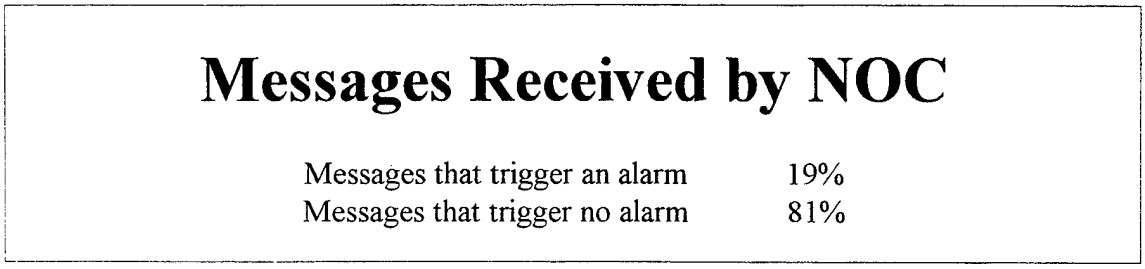


Figure 5.2. Mix of Messages into Network Operations Centers

Although data on the exact number of messages that are transmitted to the Operations Center computers are unavailable, we can make an assumption that will allow estimations based on the percentages presented in Figure 5.2.

If we assume that each message has an equal likelihood of being transmitted to the NOC, then we can estimate that 19% of incoming messages will produce an alarm. The alarm will present the technician with an opportunity to take one of the responsive actions previously discussed.

b. Determining the Mix of Alarms Generated

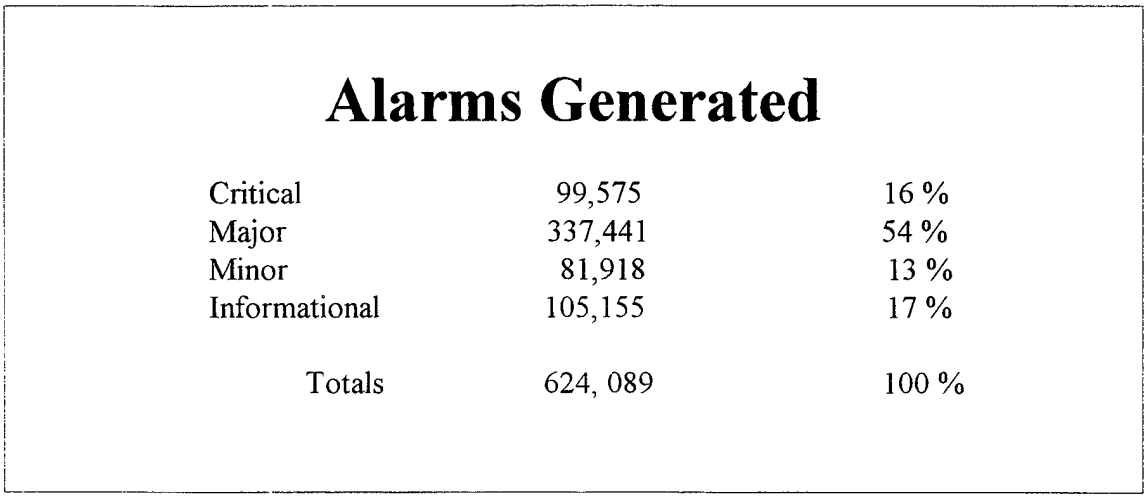
Our next goal is to break the 19% of messages causing alarms into the percentage of alarms with various

severity. Data on alarms in Pacific Bell NOC's is not readily available, although the company is preparing to gather this type of information.

However, we can use data from another Bell Company, Bell South, which has monitored alarm messages in its Louisville, Kentucky, Network Operations Center in an effort to determine staffing requirements.

The Louisville NOC is similar to a Pacific Bell Operations Center in that it monitors the same hardware using the same guidelines and training. Louisville monitors over 800 network elements from various sites. The elements that are monitored include the three primary elements employed by Pacific Bell.

Using the data gathered by the Louisville Center will provide a good approximation of the breakdown of alarms generated in a Pacific Bell Operations Center. Using the data from the month of August 1995 will provide data from a judgement sample period of one month. Figure 5.3 presents the alarms generated in the Louisville Network Operations Center for that period.



Alarms Generated

Critical	99,575	16 %
Major	337,441	54 %
Minor	81,918	13 %
Informational	105,155	17 %
Totals	624, 089	100 %

Figure 5.3 Alarms Generated in Louisville NOC - August 1995

Presenting the data in terms of percentages will allow us to translate the results of this particular month to a general statement concerning alarm distribution at all NOCs. That is to say, that the percentages for this particular month are representative of what could be expected over the long run.

c. Determining Probabilities of Outcomes

The final step of data collection efforts for the Classification Component involves the marriage of data presented in Figures 5.2 and 5.4. Determining the probability of each outcome for any given message will permit us to evaluate the Classification Component using statistical analysis. Figure 5.4 presents the

Classification Component in terms of the probability of each outcome for a message transmitted by the network elements.

Classification Outcome Probabilities

Probability of No Alarm	81%
Probability of Critical Alarm	3%
Probability of Major Alarm	10%
Probability of Minor Alarm	3%
Probability of Informational Alarm	3%

Figure 5.4. Probability of outcomes of Classification

C. DECISION MAKING COMPONENT

1. Understanding the Process

In describing the value of the Decision Making Component, the researcher is again faced with the question of how to document the transformation of information. That is, how to describe the change of the input (the alarms), to the possible outputs (retire the alarm, refer the problem, etc.).

The real issue in the Decision Making Component is to determine how the technicians decide which outcome is the proper course of action for a given alarm. For example, how does the technician know what action is required for a particular critical alarm?

Although extensive training is a priority at Pacific Bell, this specific question was not addressed in any training documentation that was reviewed. Most technicians listed experience as the determining factor in knowing what to do when faced with an alarm. Not surprisingly, the majority of Network Surveillance technicians have been doing this work for many years.

2. Measuring the Value of Decision Making Component

a. Diagnostics

Through interviews with highly experienced technicians, the researcher has compiled diagnostic questionnaires and decision trees that translate the vague "experience" factor into binary questions. These diagnostic aides are the invention of the researcher, and are not part of the Pacific Bell training literature. However, when faced with an alarm of a particular severity, the technician must mentally answer the questions addressed in the aides to reach a conclusion as to which action is most appropriate.

(1) Action Alarms. Because of the nature of the critical, major, and minor alarms, the diagnostic aides for these alarms are quite similar. The major difference between the alarms is the extent to which a loss of service can occur if the alarm goes unresolved. In fact, the same

message might trigger alarms of different severity depending on the message transmission frequency.

The first question in the critical alarm matrix is particularly noteworthy. All fire alarm messages from PacBell facilities have been coded as critical alarms. PacBell management has directed that specific actions be taken in response to fire alarms. If a fire alarm is detected, technicians must follow specified emergency procedures. Although no "decision" is required for a fire alarm, the technician must make the identification effort. Figures 5.5, 5.6, and 5.7 are the questions which are must be answered in order to resolve for critical, major, and minor alarms.

Critical Alarm Questions

1. Is this alarm a fire alarm?
2. Can I identify the cause of the message that has caused this alarm?
3. Have I been previously notified of any maintenance activity that might cause this alarm?
4. Can I correct this situation from my terminal?
5. Can I direct other Pacific Bell personnel to take corrective action?

Figure 5.5. Critical Alarm Questionnaire

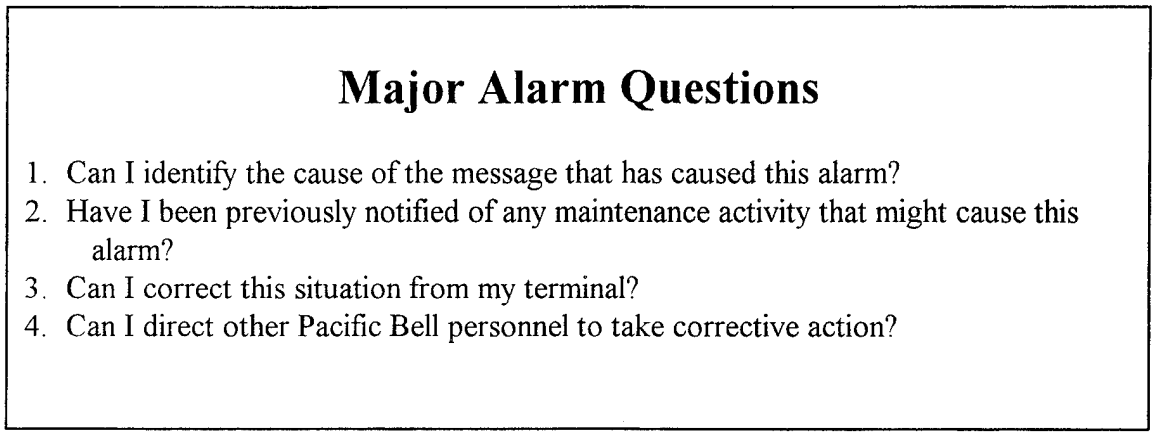


Figure 5.6. Major Alarm Questionnaire

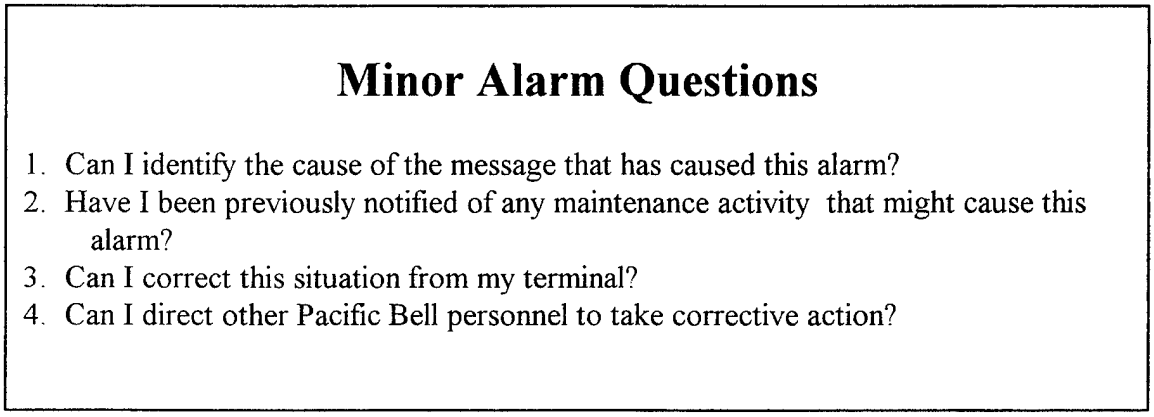


Figure 5.7. Minor Alarm Questionnaire

These questions can be arranged into decision trees which can be used to determine the actions the technicians will take to resolve the alarm. These actions are the outputs of the Decision Making Component.

Figure 5.8 is the decision tree for critical alarms. Figure 5.9 is the decision tree for major alarms. Figure 5.10 is the decision tree for minor alarms. The

ellipses in the decision trees represent the questions in the questionnaires. The rectangles represent the outcomes. The "1" path represents an affirmative answer to the prior question. The "0" path represents a negative response.

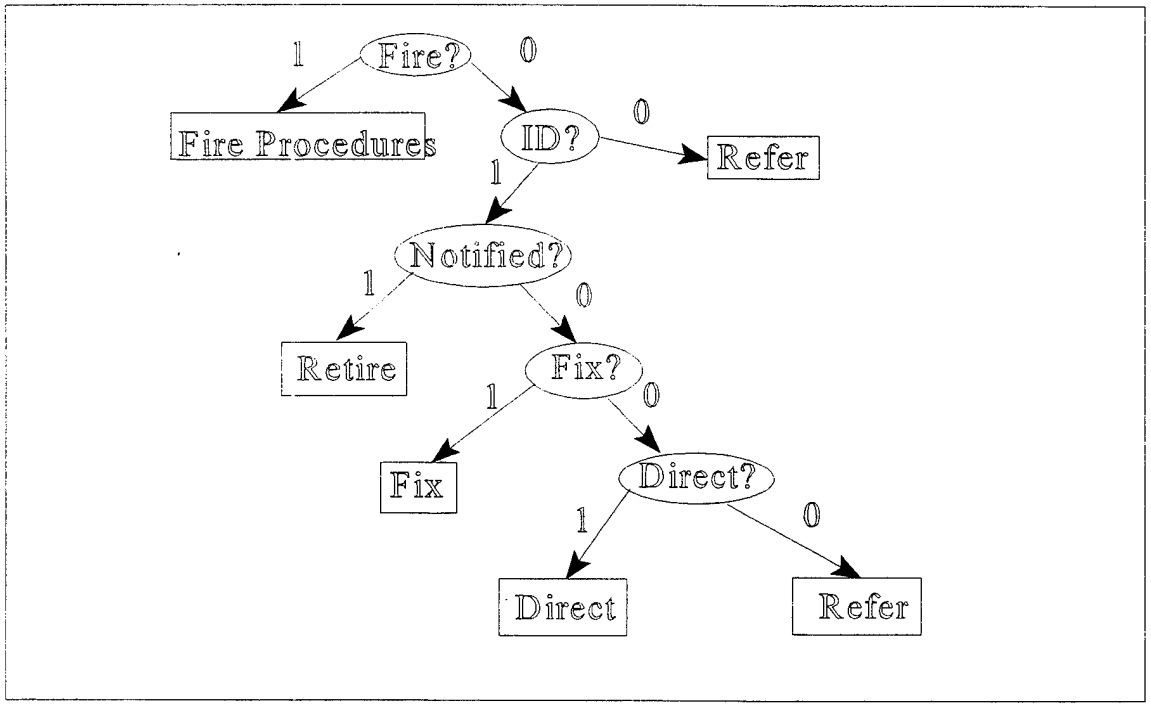


Figure 5.8. Decision Tree for Critical Alarms

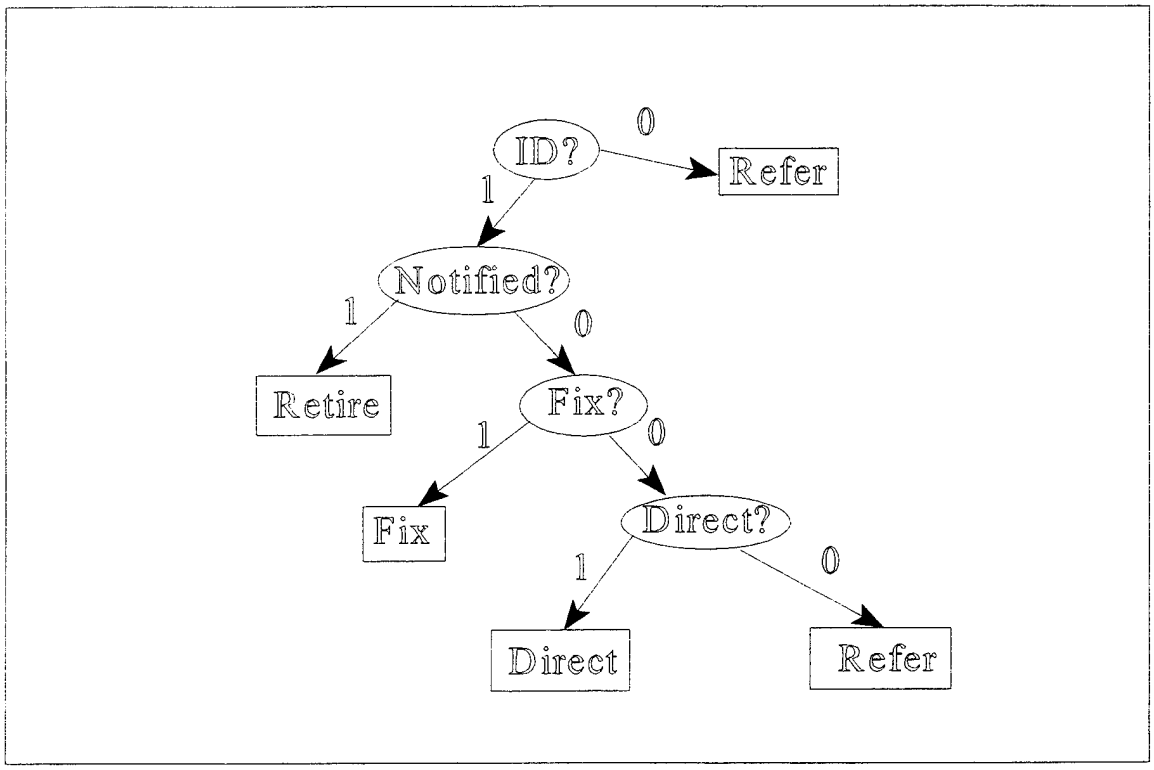


Figure 5.9. Decision Tree for Major Alarms

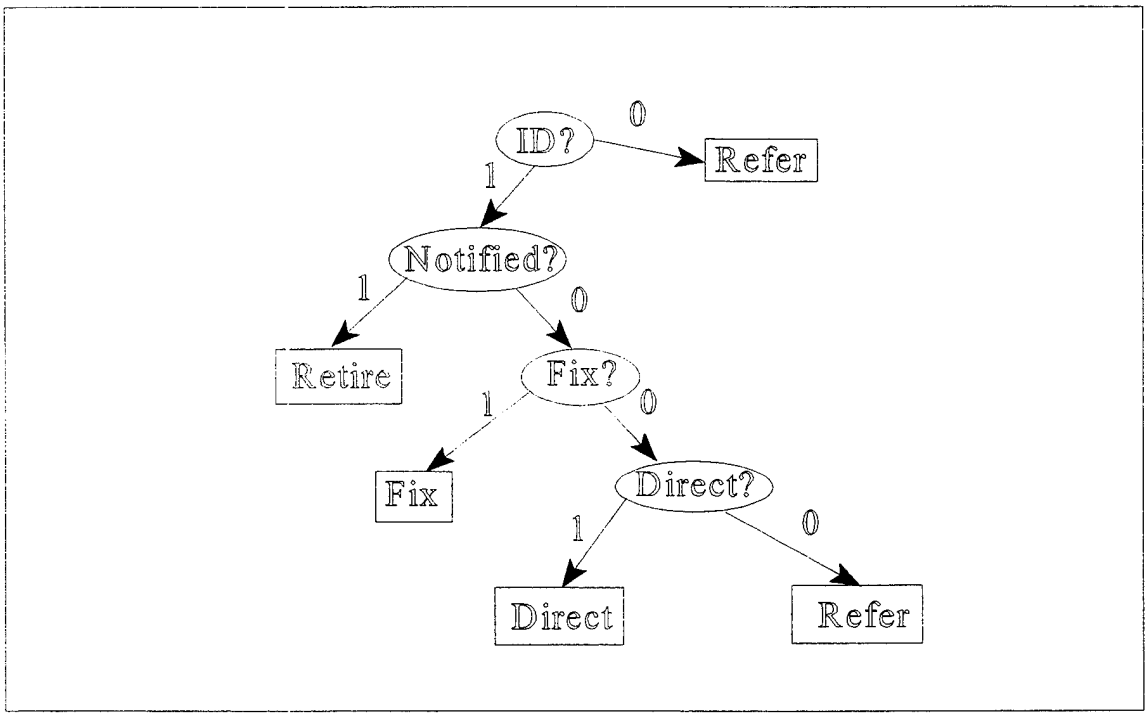


Figure 5.10. Decision Tree for Minor Alarms

(2) Informational Alarm. The final alarm is the informational alarm. The informational alarm differs from the other alarms in that it relays information that would not normally signify that customer service is in jeopardy.

The informational alarm most familiar to Pacific Bell employees is a door alarm. A door alarm tells the technician that someone has entered an area with restricted access, e.g. an equipment room housing switches. This would be expected during normal business hours, but

perhaps not in the middle of the night. Technicians must consider timing when monitoring informational alarms. Figure 5.11 presents the informational alarm questions.

Informational Alarm Questions

1. Can I identify the cause of the message that has caused this alarm?
2. Have I been previously notified of any activity that might cause this alarm?
3. Do I normally expect this message at this time of day?

Figure 5.11. Informational Alarm Questionnaire

These questions can be transformed into a decision tree that would assist the technician in reaching a resolution for informational alarms. Figure 5.12 is the decision tree for informational alarms.

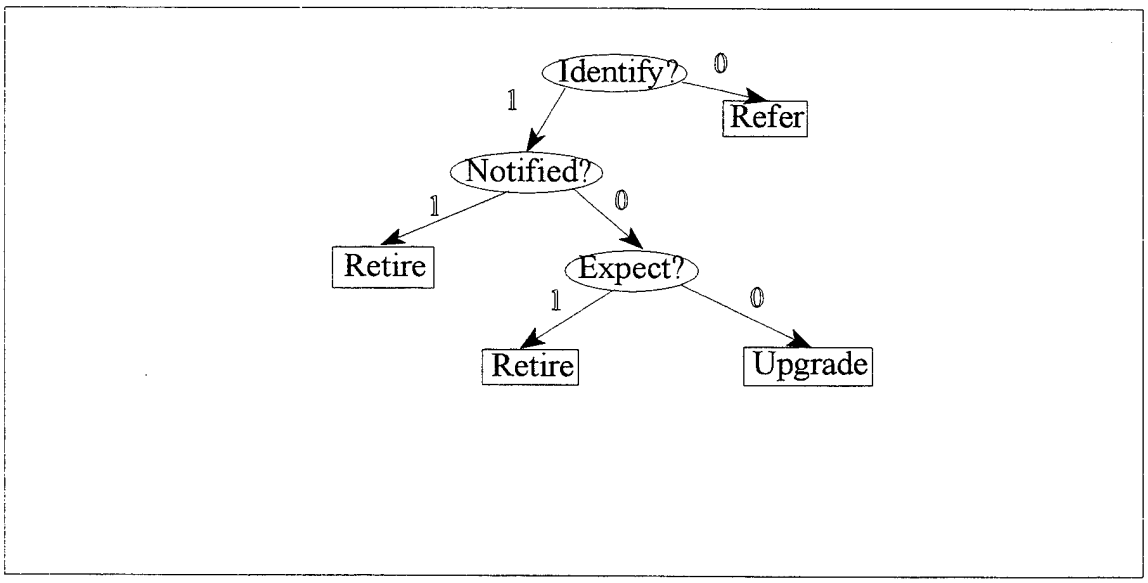


Figure 5.12. Informational Alarm Decision Tree

VI. DATA ANALYSIS

Once the information requirements are determined, and the process descriptions are complete, analysis of the data is a more straight-forward task. The goal of our analysis will be to determine the amount of information, measured in bits, that is processed within the Classification Component and the Decision Making Component. These values will permit us to compare the complexity of the two components.

A. ANALYSIS OF CLASSIFICATION COMPONENT DATA

Dr. Claude Shannon and Dr. Warren Weaver (Shannon and Weaver, 1949) discovered that the total bits of information processed can be determined by applying the formula presented in Figure 6.1.

Formula to Determine Information Processed

$$I = -p_1 \log_2 p_1 - p_2 \log_2 p_2 \ldots - p_n \log_2 p_n$$

Figure 6.1. Formula for Information Processed

In the formula, "I" represents the amount of information processed, measured in bits. "P_1" is the probability of the first event occuring, "P_2" is the probability of the second event occuring, etc. These probabilites are multiplied by their log (base 2), then by negative one, and then summed.

We can apply this formula to the Classification Component by using the outcome probabilities displayed in Figure 5.4. This application is represented in Figure 6.2. In this case, p_1 would be the probability that an incoming message generates no alarm. p_2 represents the probability that an incoming message generates a critical alarm, and so forth.

Classification Component

$$I = -.81\log_2.81 - .03\log_2.03 - .10\log_2.10 - .03\log_2.03 - .03\log_2.03$$

$$I = 1.03$$

Figure 6.2. Information Processed during Classification

B. ANALYSIS OF DECISION MAKING DATA

Figures 5.9, 5.10, 5.11, and 5.12 provide the paths to outcomes for each alarm category. The average bits of information that are processed when a technician resolves an alarm can be obtained by using a weighted average method. By multiplying the percentages that resolution action is taken by the number of steps along the path to that resolution, and summing these figures, a weighted average of the number of steps to resolve an alarm is reached. The weighted average number of steps is equal to the average bits of information processed by the technician for that alarm category.

Figure 6.3 provides the analysis for critical alarms. Figure 6.4 provides the analysis for major alarms, Figure 6.5 provides the analysis for minor alarms, and Figure 6.6 provides the analysis for informational alarms. In all figures, PacBell experts have extimated the percentage that the path to resolution is taken.

Path	Steps on Path	% Path Taken	Total
1	1	1	.01
0 0	2	1	.02
0 1 1	3	5	.15
0 1 0 1	4	40	1.6
0 1 0 0 1	5	50	2.5
0 1 0 0 0	5	3	.15
		Sum	4.43

Figure 6.3 Average bits of info processed - Critical Alarm

Path	Steps on Path	% Path Taken	Total
0	1	1	.01
1 1	2	5	.10
1 0 1	3	40	1.20
1 0 0 1	4	50	2.00
1 0 0 0	4	1	.04
		Sum	3.35

Figure 6.4 Average bits of info processed - Major Alarm

Path	Steps on Path	% Path Taken	Total
0	1	1	.01
1 1	2	5	.10
1 0 1	3	32	.96
1 0 0 1	4	32	1.28
1 0 0 0	4	30	1.20
		Sum	3.55

Figure 6.5 Average bits of info processed - Minor Alarm

Path	Steps on Path	% Path Taken	Total
0	1	1	.01
1 1	2	30	.60
1 0 1	3	34	1.02
1 0 0	3	25	.75
		Sum	1.64

Figure 6.6 Average bits of info processed - Info Alarm

Figure 5.3 shows the distribution of alarms received by technicians. Figures 6.3 through 6.6 provide the average amount of information processed (in bits) for an alarm from each severity.

Figure 6.7 presents the merging of this information, and provides an approximation of the information processed during this component.

Decision Making Component

	Percent	Bits per Alarm	Total
Critical Alarms	.16	4.43	.71
Major Alarms	.54	3.35	1.81
Minor Alarms	.14	3.55	.50
Info Alarms	.17	1.64	.28
Total Information Processed			3.30

Figure 6.7. Information Processed during Decision Making

C. COMPARISON OF COMPONENT PROCESS COMPLEXITY

Comparison is easy now that each of the two major components has been described by the amount of information, generated in bits, that is transformed.

Our analysis indicates that, per event, the Decision Making Component is more complex than the Classification Component. That means that more work is accomplished in this component each time that a unit of input is received.

We can surmise that the Classification Component produces the most work overall, since the research assumes that only 19 percent of incoming messages will trigger an alarm, and provide an opportunity for Decision Making to occur.

To complete the PVE analysis, future researchers would have to measure the number of inputs transformed by each component process over a specified time period, and multiply that number of inputs by the average bits of information for each component (1.03 for Classification, 3.30 for Decision Making.)

ROP is determined by dividing the work accomplished by the cost of the component processes.

VII. CONCLUSION

A. REVIEW OF PURPOSE

The PVE method provides a new way for companies to look at their internal processes. Our application of this methodology to the Network Surveillance Process demonstrates that PVE can be implemented in real world scenarios.

As promising as the results of this thesis are, we must acknowledge that this work represents only the first stage of the analysis. We have shown that different component processes can be described in a manner that permits comparison of the complexity of those component processes.

In the case of Network Surveillance, we were able to compare the complexity of an automated component and a manual component. One can imagine that the complexities of more than two component processes can be compared, providing that researchers can determine the proper "language" that permits the components to be described.

It is important to note that our analysis did not tell us which component was the most valuable. Our analysis tells us which component is more complex. A review of the PVE methodology summary in Chapter II reminds us that Return on Investment in Process (ROP) is the true indicator of value.

We have not determined ROP for the Classification Component or the Decision Making Component. In order to do this we would need to calculate the costs associated with each of the components. We could then use a ratio of cost to information processed (which we determined in our analysis) to give us a "return" number which we could use as a measure for the value of the component process.

This thesis is limited in scope. We did not determine how the Network Surveillance process contributed to the general operations of Pacific Bell. A review of the Pacific Bell Organizational Chart provided in Chapter III of this thesis shows that Network Surveillance is only one of many processes of the company.

B. ASSUMPTIONS, GENERALIZATIONS AND CAVEATS

In completing the data collection effort of this work, certain assumptions were made which allowed the research to continue. Should the assumptions be incorrect, the results reached in this field study may require adjustment. Pacific Bell is currently collecting data which might give more exact approximations of percentages used in this thesis. If new data becomes available, it can easily be substituted for figures used in the analysis, and updated results can be generated.

In this field study several techniques were used to estimate the probability of a message generating one of the five possible outcomes. The exact mix of messages generated by the network elements might be determined by monitoring all messages received by a NOC within a given time period. Should this become possible, the percentages could be substituted into the formula used for analysis of the Classification Component. The resulting figure could provide a more accurate measure of information transformed for that particular NOC.

To measure the complexity of the Decision Making Component diagnostic tools were developed for each possible input to the technicians. Although these aides were developed incidental to interviews with Pacific Bell employees and observation of technicians performing their tasks, the researcher makes no pretenses as to being a communications expert. In the future, more, or fewer, questions could be asked to determine the appropriate outcome for any alarm.

Again, after the appropriate number of questions is determined, updating the amount of information transformed is a matter of substitution into the formula used in the Decision Making portion of the analysis.

C. POSSIBILITIES FOR FUTURE APPLICATIONS

PVE offers promising possibilities for the public sector. While this field study focused on a for-profit organization, the techniques can be used in any organization.

At a time when privatization of some government functions is touted as a cure for budgetary constraints, it would be beneficial to isolate and define the functions of government entities and determine exactly what is accomplished by the various agencies.

Particularly in an era of government downsizing, dispassionate examinations of the value created by various components of government agencies could steer decision makers toward rational choices.

As previously mentioned, this thesis is limited in scope. It provides a starting point for further studies which might apply the PVE methodology to other organizations.

Further study might be directed towards a more complete PVE application. Future researchers might direct their energies toward definition of the component processes (as we have done here) and determination of the costs of the component processes. This would permit evaluation of the

components by relative value to each other using the ROP measurement.

As previously stated, this field study looked at one process of a large organization. Larger groups of researchers might examine an entire organization. Comparison of the value created by larger branches of business (or government) entities could yield interesting results.

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