Organization of Staff Analysts

TRAINING COURSE

FOR THE

ANALYST EXAM

.....

OPERATIONS RESEARCH

AGENDA

OPERATIONS RESEARCH: PART ONE

- DEFINING OPERATIONS RESEARCH
- OFFICE ORGANIZATION
- JOB ANALYSIS
- SYSTEMS AND PROCEDURES
- OFFICE WORK SIMPLIFICATION
- PLANNED CHANGE AND ORGANIZATIONAL DEVELOPMENT

DEFINING OPERATIONS RESEARCH

- Operations research (OR) is an analytical method of problem-solving and decision-making that is useful in the management of organizations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis.

OFFICE ORGANIZATION

- ORGANIZATIONAL CHART
- TYPES OF RELATIONSHIPS
- ORGANIZATIONAL STRUCTURE
- TRADITIONAL STRUCTURES
- MATRIX STRUCTURE
- CENTRALIZATION
- DECENTRALIZATION

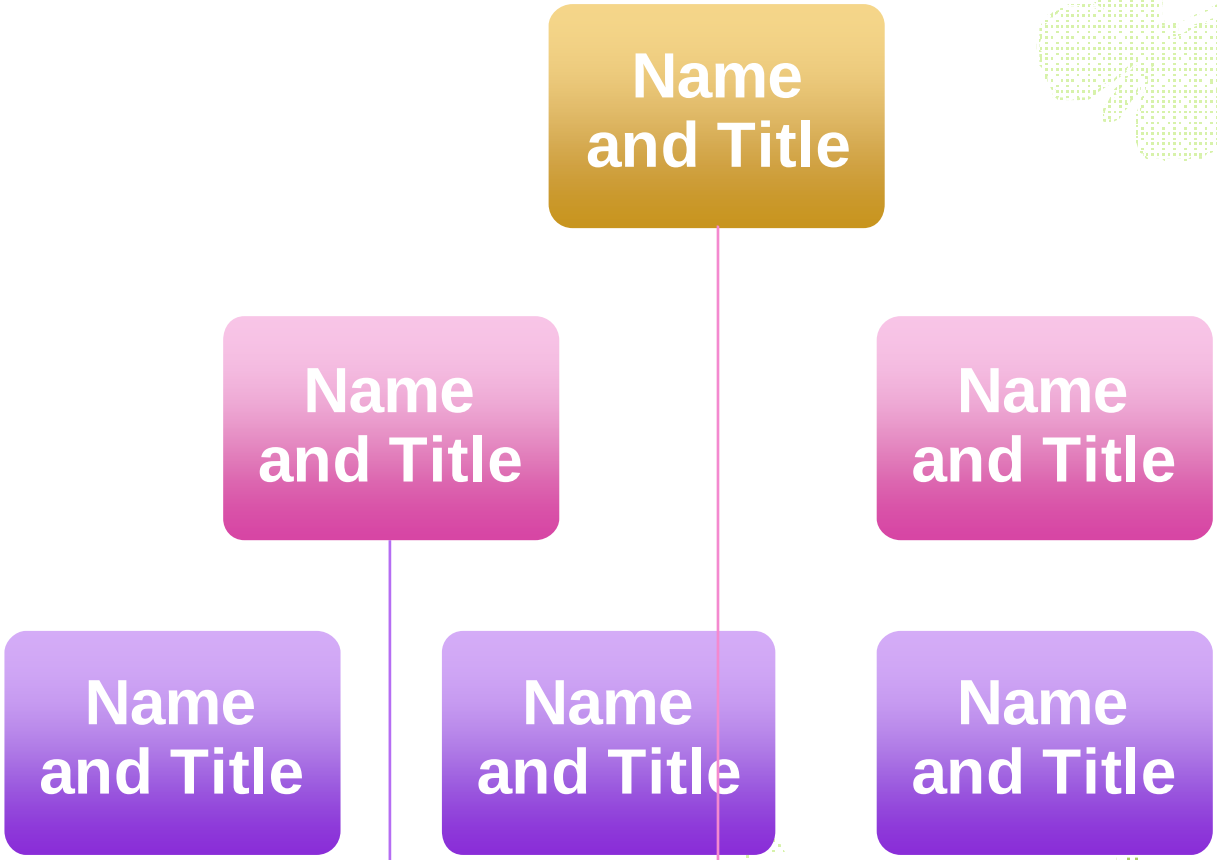
ORGANIZATIONAL CHART

A chart which represents the structure of an organization in terms of rank.

It shows the managers and subordinate staff who make up an organization.

The branches on the organization chart show the relationships between managers and departments, if any.

ORGANIZATIONAL CHART



TYPES OF RELATIONSHIPS

- LINE- direct relationship between superiors and subordinates
- LATERAL – 2 employees in same organization with same level title
- STAFF – the elements of the organization which help the line work effectively
- FUNCTIONAL-Relationship between staff whose duties overlap with others.

ORGANIZATIONAL STRUCTURE

The plan for the systematic arrangement of work is the organization structure.

It is comprised of functions, relationships, responsibilities, authorities, and communications of individuals within each department.

TRADITIONAL STRUCTURE

- Line Structure
- Line and Staff Structure

MATRIX STRUCTURE

- A variation of the line and staff organizational structure.
- Organization is arranged according to projects.

CENTRALIZATION

- Organizations with a centralized structure have several layers of management.
- Control the company by maintaining a high level of authority.
- Focus on top-down management.

DECENTRALIZATION

- Seeks to eliminate the unnecessary levels of management and to place authority in the hands of front line managers and staff.
- Increases the span of control.
- Employees report to one manager.
- Restructuring takes place at mid-management.

WHAT IS JOB ANALYSIS?

The process of identifying the content of a job to determine the duties inherent in the position as well as the qualifications needed to fulfill its responsibilities.

HOW IS JOB ANALYSIS USED?

In Human Resources , JOB ANALYSIS is used to gather information for use in:

- Personnel Selection
- Training
- Classification
- Compensation

JOB ANALYSIS METHODS

- Interviews with workers
- Questionnaires
- Observation
- Gathering background information

JOB ANALYSIS RESULTS

- Job analysis can result in a description of common duties performed on a job as well as descriptions of knowledge, skills, abilities and other characteristics required to perform those tasks.

SYSTEMS AND PROCEDURES

- Coordinate and Control all the organizational objectives of the enterprise
- Individual needs of workers and work units are subordinate and must be directed toward the achievement of these objectives

TOTAL SYSTEMS APPROACH

TEAM WORK AND COORDINATION ASSISTING MANAGEMENT AT ALL LEVELS

DEFINITIONS OF METHOD, PROCEDURE, AND SYSTEM

- A **method** may be defined as the manner in which a clerical operation or task is performed. For example, the data on a form might be filled out electronically by typing (mechanical) or longhand using a pen (manual).

DEFINITIONS OF METHOD, PROCEDURE AND SYSTEM

- A **procedure** may be defined as a series or sequence of related operations, designed to standardize the performance of the various steps which make up a major operation. For example, classifying, coding, and sorting correspondence would be three different procedural units within the filing system of a company.

DEFINITIONS OF METHOD, PROCEDURE AND SYSTEM

- A **system** may be defined as a complex of related procedures designed according to an integrated scheme for the purpose of achieving a major activity of a company.

OFFICE WORK SIMPLIFICATION

A Scientific approach to studying the work processes with an eye towards making the process efficient and effective, raising productivity. It reduces duplication and waste, thereby by viewed as common sense.

GUIDES OF OFFICE WORK SIMPLIFICATION

- Promote “Participation with Know-How” by every office employee by means of training in and encouragement of the use of Work Simplification
- Make the series of activities Productive and Simple
- Combine work activities wherever possible to avoid recopying
- Reduce distances traveled to the shortest amounts feasible
- Arrange activities to provide a smooth flow from one clerical step to another

APPLYING OFFICE WORK SIMPLIFICATION

- Select work to be simplified
- Obtain all the facts about this work
- Devise improvement by analyzing these facts and using the questioning approach
- Apply the derived improved means

Organizational Change and Development

Organizational Structures

Bureaucratic:

1) Specialization of labor
2) Standardized work
3) Centralization of Authority
4) Emphasis on conformity
5) High level of efficiency on repetitive tasks

Planned Change and Organizational Development

Objectives

1. Examine the nature of change and analyze some of the forces making it necessary
2) Pinpoint the differences between haphazard and planned change
3) Itemize and explain commonly used strategies in implementing planned change
4) Define and analyze organizational development and show its relationship to planned change

Resistance to Change

1. Insecurity
    a) Automation may result in loss of jobs of front line workers in the name of efficiency.
    b) High level staff may fear losing their positions as a result of process changes.
2. Economic Reasons
    a) Reduced jobs, reduced hours mean reduced wages

3. Sociopathic Reasons
    a) People are programmed to accept traditional way of operating.

Case Study about resistance to change by Educators

1. Fear of unknown
2. Embrace status quo
3. No reason given for resisting change
4. Feels society will not accept change
5. Colleagues will not accept change so he will not either
6. An alternative idea was identified that they embrace
7. The teachers know what is best based on experience
8. The proposed idea failed before so it will not work
9. Through reasoning, though flawed, this idea will fail.

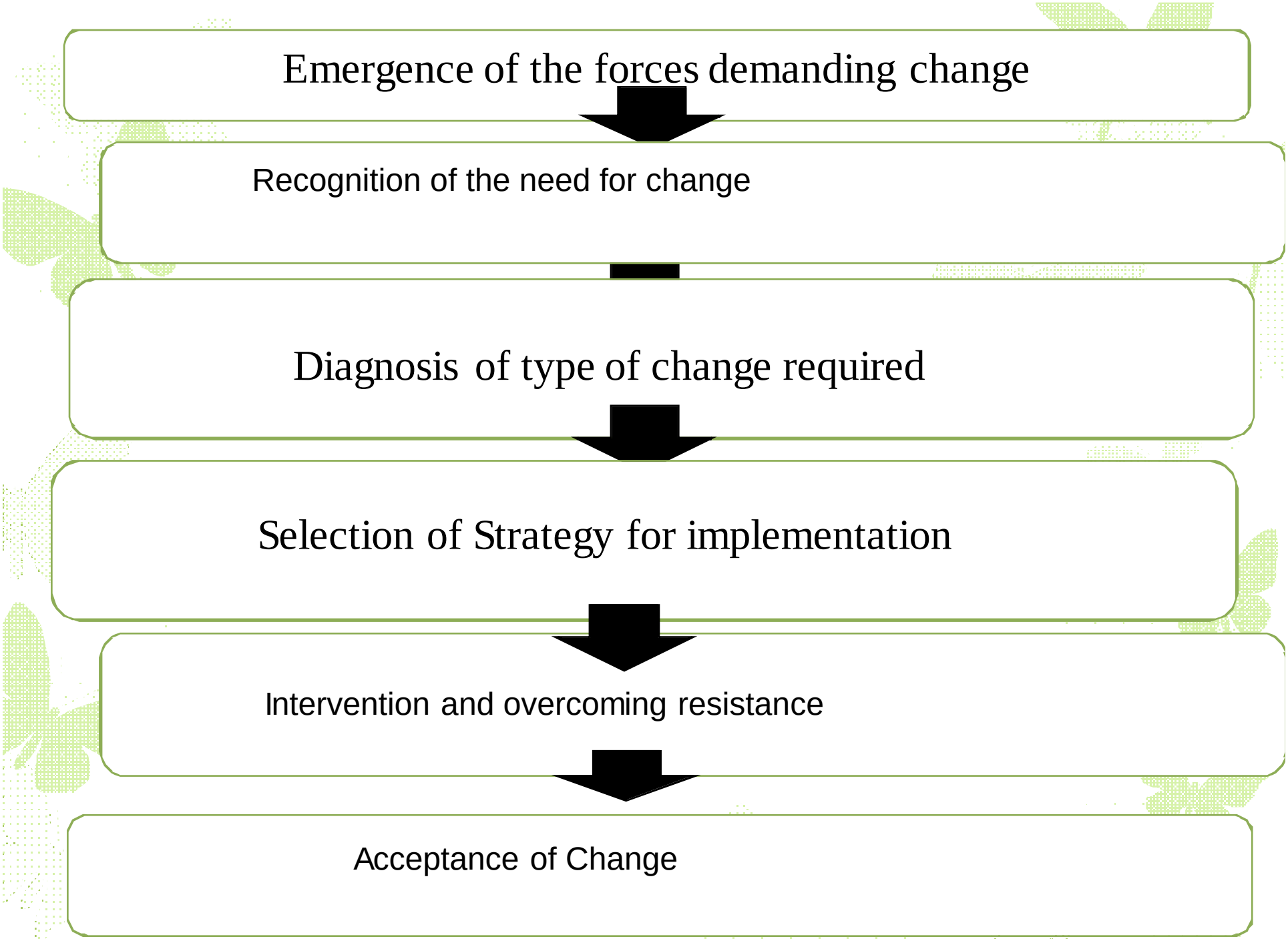
External Pressures for Change

- Technological advances
- Introduction and removal of government regulations
- Changes in societal values
- Shifting political dynamics
- Changes in demographics

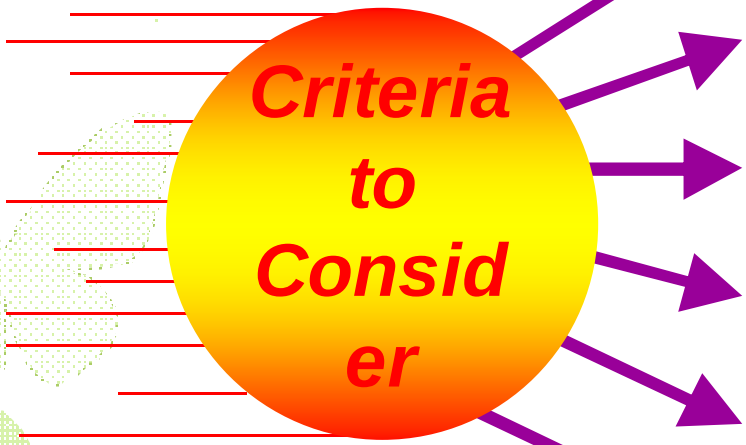
Planned Change

A process involving deliberate efforts to move an organization or a unit from its current undesirable state to a new, more desirable state

Management generally serve as change agents to assist in overcoming resistance to change both from internal and external sources.


Emergence of the forces demanding change
Recognition of the need for change
Diagnosis of type of change required
Selection of Strategy for implementation
Intervention and overcoming resistance
Acceptance of Change

Speed of Change



- **Urgency**
- **Degree of support**
- **Amount and complexity of change**
- **Competitive environment**
- **Knowledge and skills available**
- **Financial and other resources**

Style of Change

Non-participatory – top down, leaders design the change and plan its implementation

Participatory – change leaders seek the ideas and advice of associates and then use many of those ideas. Criteria for evaluating the degree to which the participatory style should be used:

- Urgency
- Degree of Support
- Referent and Expert Power of Leaders

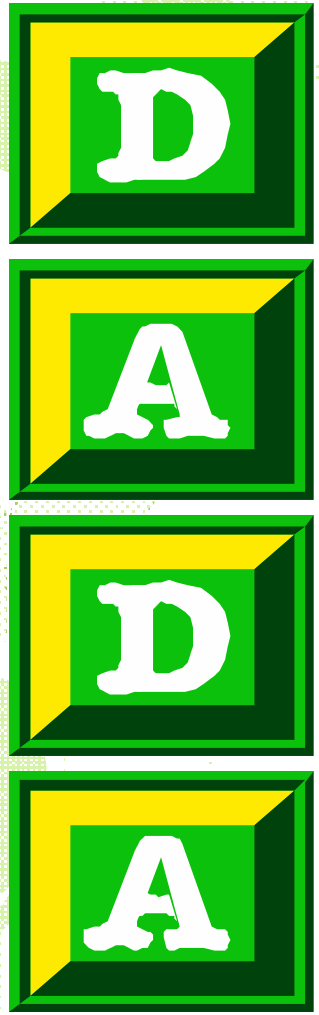
Resistance to Change

Four Factors

Effort to block new ways of doing things

- **Lack of understanding**
- **Different assessments**
- **Self-interest**
- **Low tolerance for change**

The DADA syndrome



Denial – ignore possible or current change

Anger – individuals facing unwanted change become angry about the change

Depression – individuals experience emotional lows

Acceptance – individuals embrace the reality of the situation and make the best of it

PRACTICE QUESTION #1

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WHEN AN ORGANIZATIONAL CHANGE IS BEING INSTITUTED, WHAT OUTCOME CAN ALWAYS BE ANTICIPATED?

A. RESISTANCE
B. FULL COOPERATION IF A DETAILED PLAN IS DEVISED
C. LONG TERM INCREASE IN PRODUCTIVITY
D. A SERIES OF PERFECT SOLUTIONS

PRACTICE QUESTION #2

37

WHAT IS NOT ALLOWED DURING A BRAINSTORMING SESSION?

A. A FREEFORM DISCUSSION OF IDEAS
B. A DISCUSSION OF THE PROS AND CONS OF IDEAS AS THEY ARE PRESENTED
C. A LIST OF CRITERIA
D. FORMAL RULES FOR GROUP BRAINSTORMING

PRACTICE QUESTION #3

38

WHICH OF THE FOLLOWING STATEMENTS MOST ACCURATELY DEFINES "OPERATIONS RESEARCH"?

A. A HIGHLY SOPHISTICATED SYSTEM USED IN THE ANALYSIS OF MANAGEMENT PROBLEMS.

B. A SPECIALIZED APPLICATION OF ELECTRONIC DATAPROCESSING IN THE ANALYSIS OF MANAGEMENT PROBLEMS.

C. RESEARCH ON OPERATING PROBLEMS.

D. THE APPLICATION OF SOPHISTICATED MATHEMATICAL TOOLS TO THE ANALYSIS OF MANAGEMENT PROBLEMS.

PRACTICE QUESTION #4

39

USE OF THE SYSTEMS APPROACH IS MOST LIKELY TO LEAD TO

A. CONSIDERATION OF THE IMPACT ON THE WHOLE ORGANIZATION OF ACTIONS TAKEN IN ANY PART OF THAT ORGANIZATION.
B. THE PLACING OF RESTRICTIONS ON DEPARTMENTAL AUTHORITY.
C. USE OF MATHEMATICAL MODELS TO SUB-OPTIMIZE PRODUCTION.
D. CONSIDERATION OF THE ACTIVITIES OF EACH UNIT OF AN ORGANIZATION AS A TOTALITY WITHOUT REGARD TO THE REMAINDER OF THE ORGANIZATION.

PRACTICE QUESTION #5

40

AN INTERRELATED PATTERN OF JOBS WHICH MAKE UP THE STRUCTURE OF A SYSTEM IS KNOWN AS

A. CHAIN OF COMMAND
B. CYBERNETICS
C. THE FORMAL OPERATION
D. THE MAINTENANCE PATTERN

PRACTICE QUESTION #6

41

WHEN ONGOING PROCESS PROBLEMS ARE OCCURRING IN A UNIT, FOR EXAMPLE INTER-OFFICE MAIL FROM THE MAILROOM IS 3 TO 5 DAYS LATE, WHO SHOULD BE ASKED ABOUT THE NATURE OF THE PROBLEM?

A. THE COMMISSIONER
B. THE DEPUTY COMMISSIONER
C. THE EXECUTIVE MANAGERS
D. THE DELIVERY STAFF

PRACTICE QUESTION #7

42

OF THE FOLLOWING, THE ONE WHICH A LINE ROLE GENERALLY DOES NOT INCLUDE IS

A. **CONTROLLING RESULTS AND PERFORMANCE**
B. **COORDINATING WORK AND EXCHANGING IDEAS WITH OTHER LINE ORGANIZATIONS**
C. **IMPLEMENTATION OF APPROVED PLANS DEVELOPED BY STAFF**
D. **PLANNING WORK AND MAKING OPERATING DECISIONS**

PRACTICE QUESTION #8

43

OF THE FOLLOWING, THE MAJOR DIFFERENCE BETWEEN SYSTEMS AND PROCEDURES ANALYSIS AND WORK SIMPLIFICATION IS

A. THE FORMER COMPLICATES ORGANIZATIONAL ROUTINE AND THE LATTER SIMPLIFIES IT
B. THE FORMER IS OBJECTIVE AND THE LATTER IS SUBJECTIVE
C. THE FORMER GENERALLY UTILIZES EXPERT ADVICE AND THE LATTER IS A "DO IT YOURSELF" IMPROVEMENT BY SUPERVISORS AND WORKERS
D. THERE IS NO DIFFERENCE OTHER THAN NAME

PRACTICE QUESTION #9

44

ORGANIZATIONAL SYSTEMS AND PROCEDURES SHOULD BE

A. DEVELOPED AS PROBLEMS ARISE AS NO DESIGN CAN ANTICIPATE ADEQUATELY THE REQUIREMENTS OF AN ORGANIZATION
B. DEVELOPED JOINTLY BY EXPERTS IN SYSTEMS AND PROCEDURES AND THE PEOPLE WHO ARE RESPONSIBLE FOR IMPLEMENTING THEM
C. DEVELOPED SOLELY BY EXPERTS IN SYSTEMS AND PROCEDURES
D. ELIMINATED WHENEVER POSSIBLE TO SAVE UNNECESSARY EXPENSE

PRACTICE QUESTION #10

45

ON A GENERAL ORGANIZATION CHART, STAFF POSITIONS NORMALLY SHOULD BE PICTURED

A. DIRECTLY ABOVE THE LINE POSITIONS TO WHICH THEY REPORT
B. TO THE SIDES OF THE MAIN FLOW LINES
C. WITHIN THE BOX OF THE HIGHEST LEVEL SUBORDINATE POSITIONS PICTURED
D. DIRECTLY BELOW THE LINE POSITION WHICH REPORT TO THEM

PRACTICE QUESTION #11

46

OF THE FOLLOWING, THE MOST USUAL REASON FOR UNSATISFACTORY LINE STAFF RELATIONSHIPS IS

A. **INEPT USE OF THE ABILITIES OF STAFF PERSONNEL BY LINE MANAGEMENT**
B. **THE HIGHER SALARIES PAID TO LINE OFFICIALS**
C. **EXCESSIVE CONSULTATION BETWEEN LINE OFFICIALS AND STAFF OFFICIALS AT THE SAME ORGANIZATIONAL LEVEL**
D. **A FEELING AMONG THE STAFF MEMBERS THAT ONLY LOWER LEVELLINE MEMBERS APPRECIATE THEIR WORK**

PRACTICE QUESTION #12

47

A DETAILED DESCRIPTION OF THE STEPS TO BE TAKEN IN ORDER TO ACCOMPLISH A JOB IS MOST APPROPRIATELY CALLED A

A. POLICY
B. RULE
C. PROCEDURE
D. PRINCIPLE

PRACTICE QUESTION # 13

48

- **The clerk who worked in Department A earned the following salaries: $15,105 the first year, $15,750 the second year and $16,440 the third year. Another clerk who worked in Department B for three years earned $15,825 a year for 2 years and $16,086 the third year. The DIFFERENCE between the average salaries received by both clerks over a three-year period is**
  - **a. $147**
  - **b. $153**
  - **c. $261**
  - **d. $423**

Please use the chart below to answer the following three questions

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		Salary	Training Materials	Training Facility	Trainer's Fee	
Region	# employees	(cost per employee)	(cost per employee)	Flat Cost	Flat Cost	Total Cost
Northeast	37	$27.00	$9.75	$925.00	$550.00	
Southeast	53	$24.75	$9.75	$425.00	$550.00	
Central	55	$24.00	$9.75	$450.00	$550.00	
Northwest	40	$25.50	$9.75	$875.00	$550.00	
Southwest	42	$26.25	$9.75	$850.00	$550.00	

PRACTICE QUESTION #14

50

- **If five employees resigned from the Southwest Region, how much would its new total cost for the Customer Service Training be?**

- **a. $2,631.00**
- **b. $2,674.00**
- **c. $2,713.00**
- **d. $2,732.00**

PRACTICE QUESTION #15

51

- **If the training facility cost increased by 25% for the Southeast and Northwest Regions, which of the following regions would cost the MOST to conduct the Customer Service Training?**
- **a. Northeast**
- **b. Southeast**
- **c. Northwest**
- **d. Southwest**

PRACTICE QUESTION#16

52

If 20% of the Central Region's employees retired and management decided to use the savings on training additional staff in the Northeast, then how many additional northeast employees will be able to be trained? Answer should be rounded to nearest whole number.

A. 11

- B. 48
- C. 10
- D. 27

PART TWO

DEFINING OPERATIONS RESEARCH

- Operations research (OR) is an analytical method of problem-solving and decision-making that is useful in the management of organizations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis.

AGENDA

OPERATIONS RESEARCH

- FLOW CHART SYMBOLS
- CHARTS FOR REPORTS
- DECISION MATRIX
- PROJECT PLANNING CHARTS

FLOW CHART

- Flowcharts are used in designing and documenting complex processes or programs. Like other types of diagrams, they help visualize what is going on and thereby help the viewer to understand a process, and perhaps also find flaws, bottlenecks, and other less-obvious features within it. There are many different types of flowcharts, and each type has its own repertoire of boxes and notational conventions.

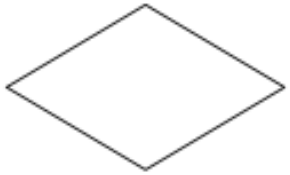
- FLOW CHARTS SHOULD BE CREATED AND READ LIKE AN ENGLISH WRITTEN BOOK.

FLOW CHART SYMBOLS

COMMONLY USED SYMBOLS FOR FLOW CHARTS

- TERMINAL
- PROCESSING
- INPUT/OUTPUT
- DOCUMENT
- DECISION

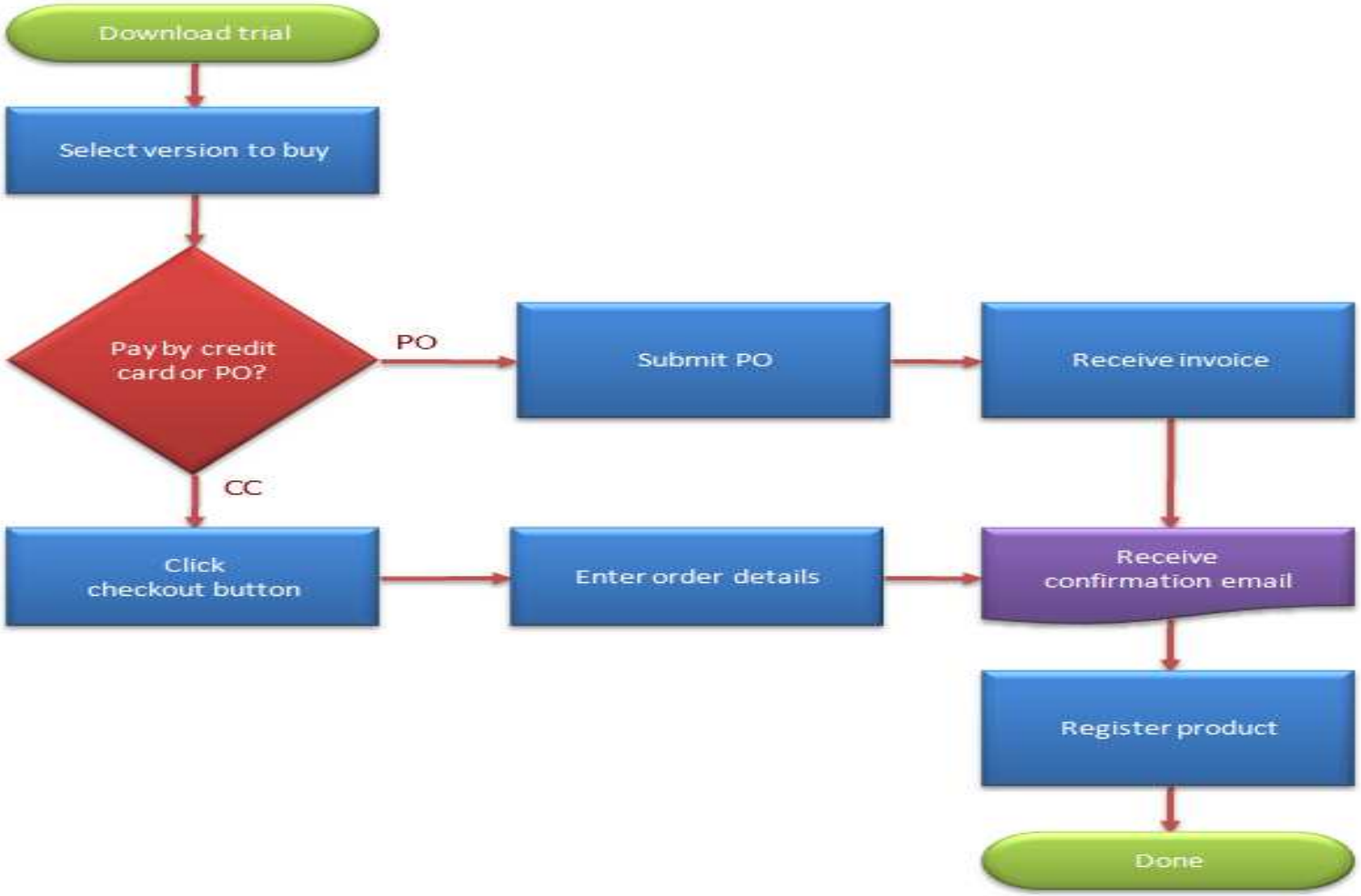
FLOW CHART SYMBOLS

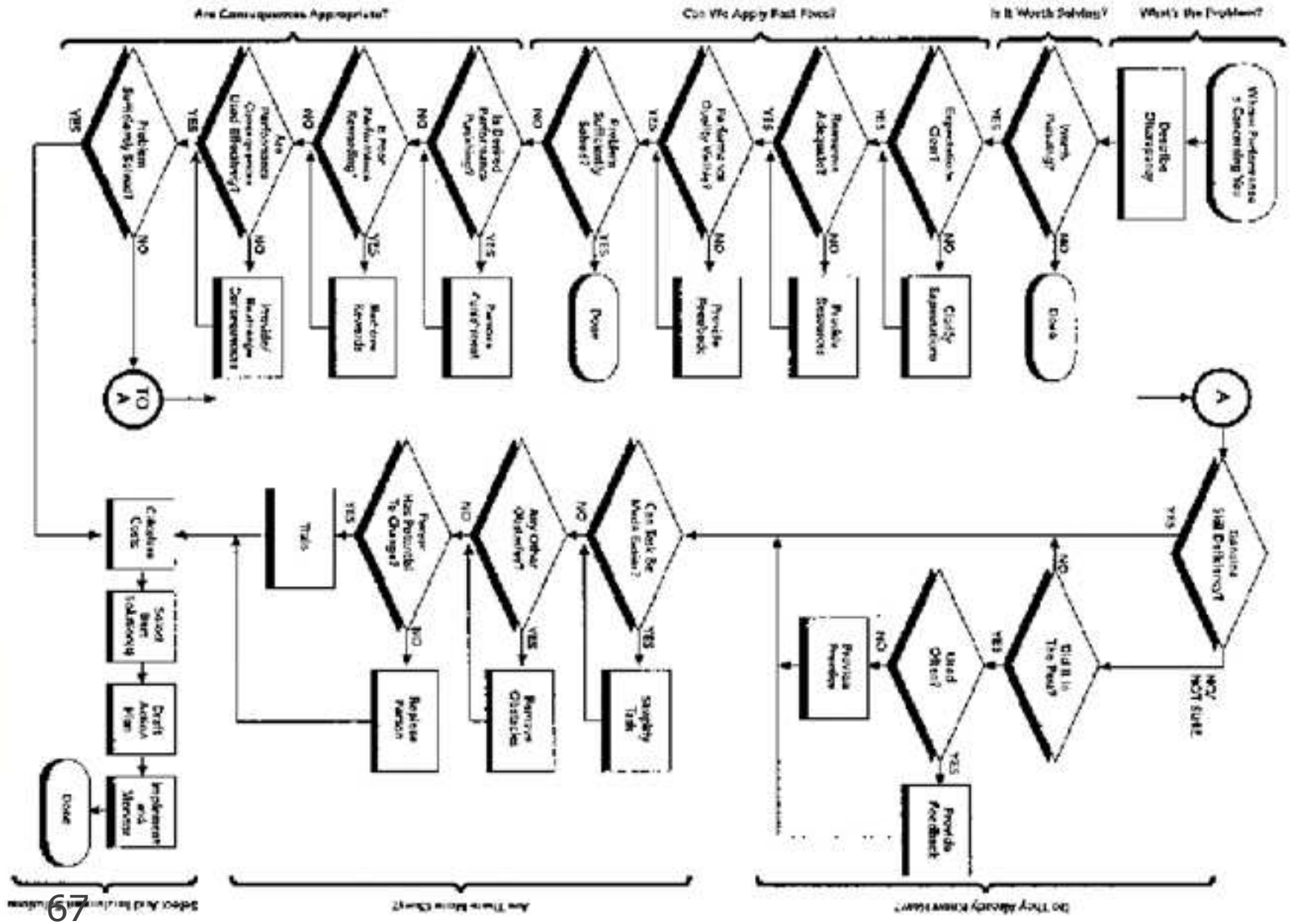
Some Common Flowchart Symbols		
Symbol	Represents	Purpose
	Terminal	Used to indicate the start and end of a flowchart. Flow begins or terminates here.
	Processing	Used whenever data is being manipulated.
	Document	Used to indicate that a hard copy is generated.
	Decision	Used to represent operations in which there are two possible alternatives. One flow line enters and two flow lines exit. (Labeled **Yes** and **No.**)

FLOW CHART SYMBOLS

	Predefined Process	Used to identify an operation that is more fully described in a separate flowchart segment.
	On-page connector	Used to go to another point on the same page.
	Off-page connector	Used to go to another point on a different page.
	Data	Input or Output of data.

EXAMPLE OF A FLOWCHART




What's the Problem?
Describe Discrepancy
Is It Worth Solving?
Worth Pursuing?
Done
Can We Apply Past Focus?
Expectation Clear?
Clarify Expectations
Reasons Adequate?
Provide Resources
Performance Quality Worthy?
Provide Feedback
Problem Sufficiently Solved?
Done
Are Consequences Appropriate?
Is Desired Performance Rewarding?
Remove Punishment
Is Poor Performance Rewarding?
Remove Rewards
Are Consequences Used Effectively?
Provide/ Restore Consequences
Problem Sufficiently Solved?
YES
NO
TO A
A
Is Skill Still Deficient?
Was Skill In The Past?
Was Skill Ever?
Provide Feedback
Provide Practice
Can Task Be Made Easier?
Simplify Task
Any Other Obstacles?
Remove Obstacles
Person Has Potential To Change?
Replace Person
Train
Calculate Costs
Select Best Intervention
Draft Action Plan
Implement and Monitor
Done

COMMONLY USED Charts

- **Bar**
- **Line**
- **Area**

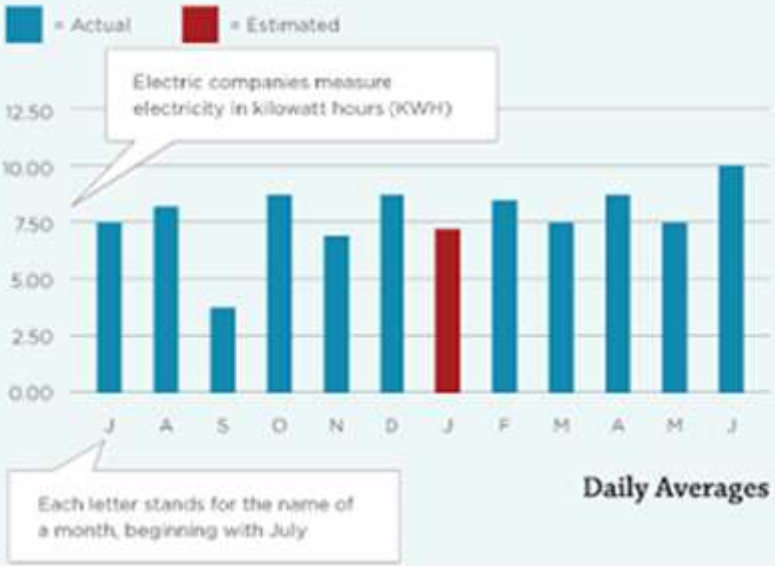
BAR Chart

- Bar charts compare the data for the same item at specific intervals of time.
- The height of each column is used to represent each respective quantity and demonstrate how the quantities vary from time period to time period.
- Consistent time intervals should be used. If more than approximately 12 time periods are going to be used, then a curve chart may be more effective.

BAR Chart

Directions

Electric companies usually include bar graphs in their bills to show how much electricity you've used every day or every month. See what you can figure out from this graph.



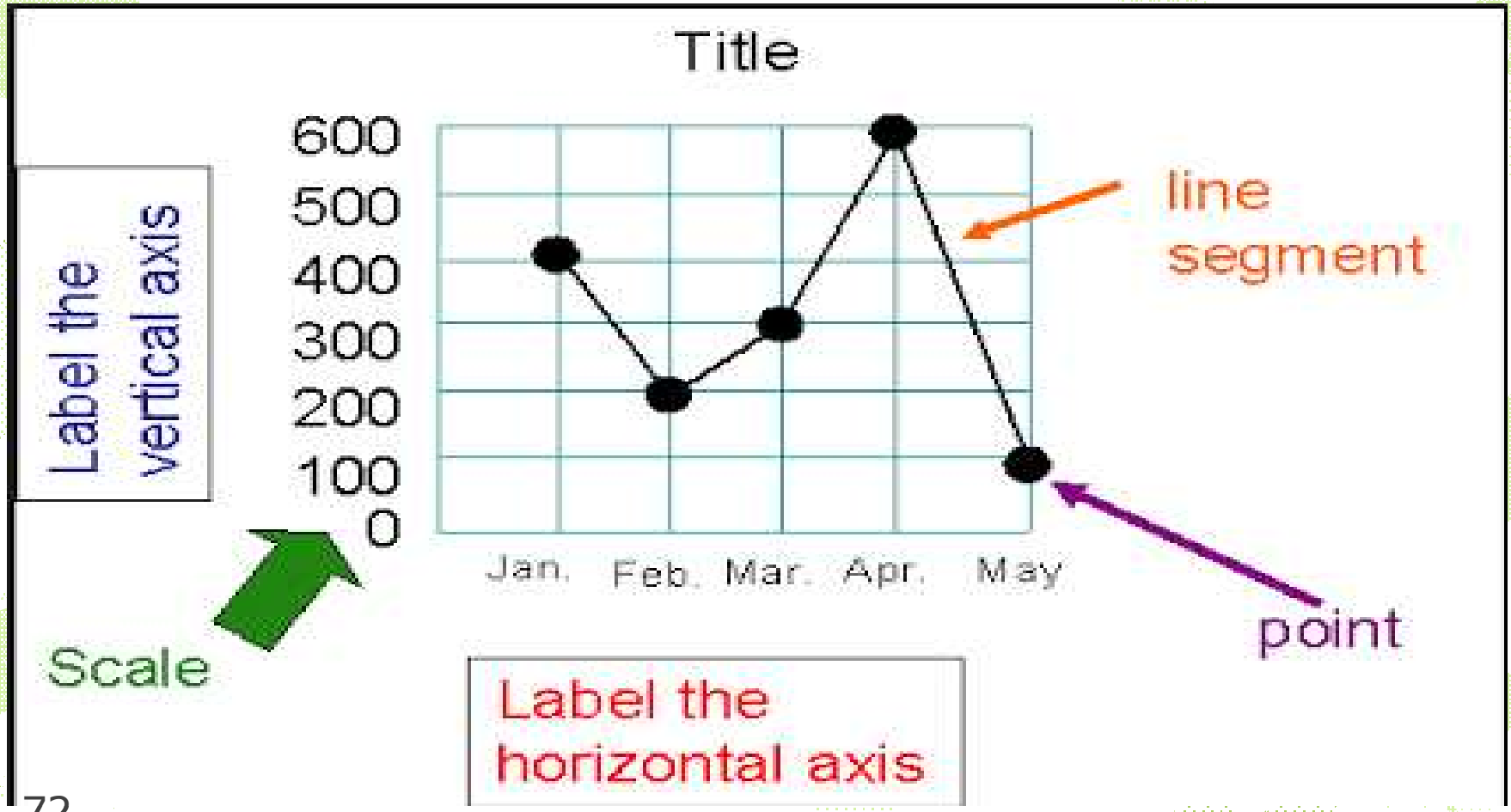
In which month was the most electricity used on an average day?

- October
- July
- May
- June

LINE Chart

- Line charts effectively show trends and time series data by showing one item at different points in time as a single, unbroken line.
- Multiple lines show on a single chart, but each line must be clearly distinguishable from the other lines through the use of patterns or color.
- A good rule of thumb is to place no more than four lines on a single chart.

LINE CHART


Title
600
500
400
300
200
100
0
Label the vertical axis
Jan.
Feb.
Mar.
Apr.
May
line segment
point
Scale
Label the horizontal axis

Area/Band Charts

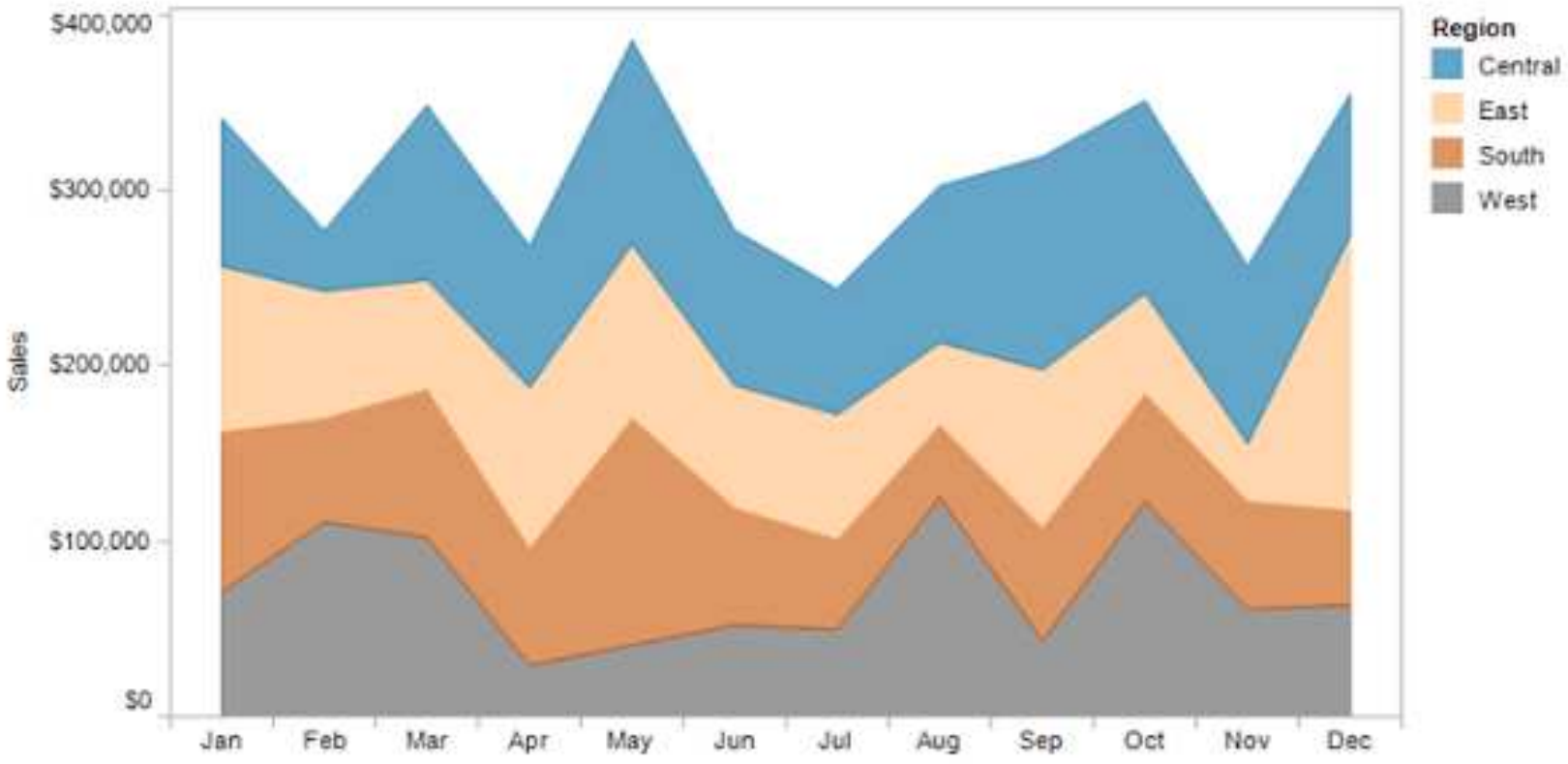
- Area charts are useful for emphasizing the magnitude of change over time. Stacked area charts are also used to show the relationship of parts to the whole.
- Area charts are like line charts that have the areas below the lines filled with colors or patterns.
- Area charts are not normally effective when the curves intersect because it is possible for areas with lower values to be obscured by the higher values.

Area/Band Chart

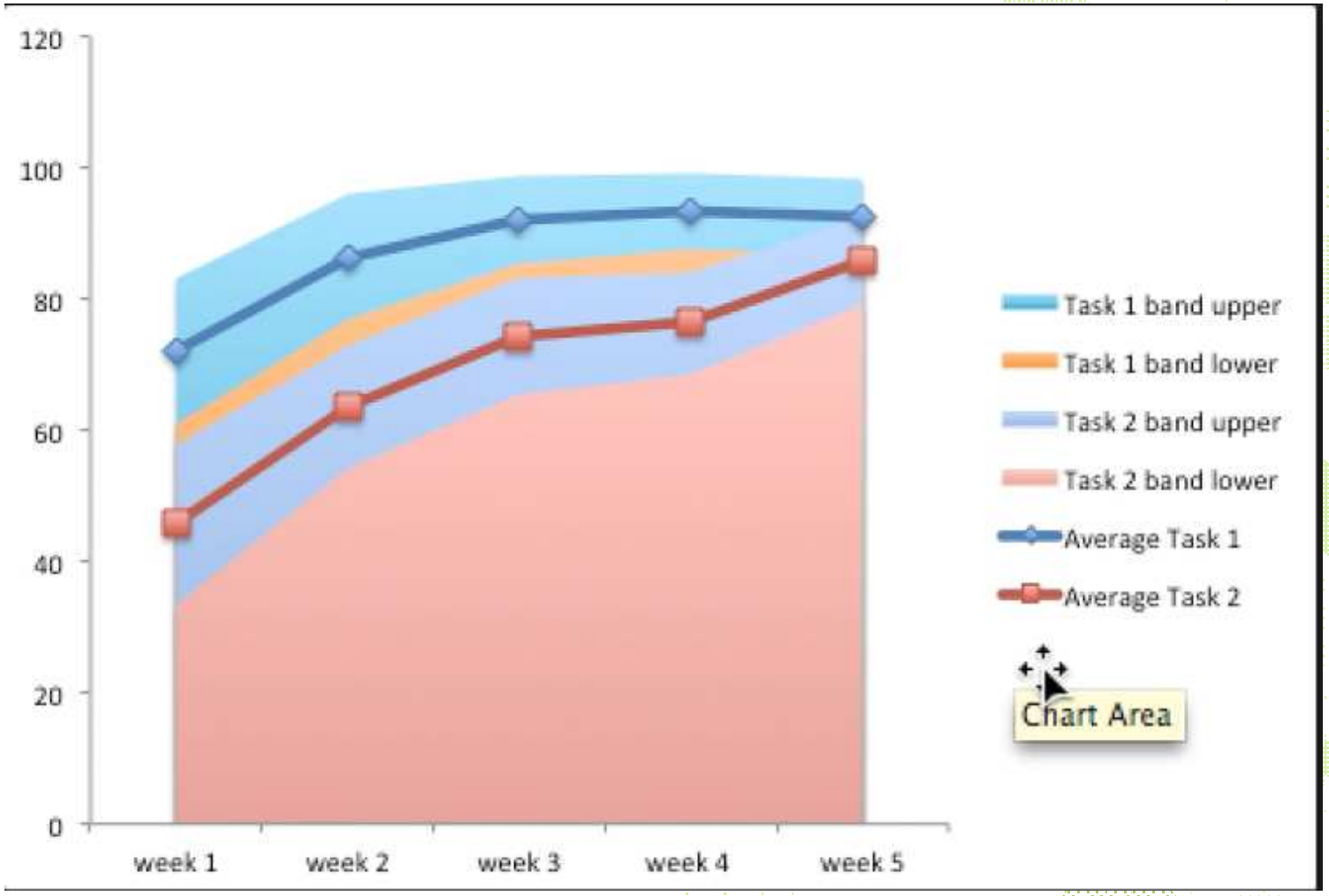
Area chart - Area charts are used to represent cumulated totals using numbers or percentages (stacked area charts in this case) over time.

Band chart - a standard line chart enhanced with a shaded area displaying the upper and lower boundaries of groups of data (e.g. the range between the minimum and the maximum of all members of the category). Band charts are very often supplemented by another lineshowing the arithmetic mean (the average).

Area Chart


$400,000
$300,000
$200,000
$100,000
$0
Sales
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Region
Central
East
South
West

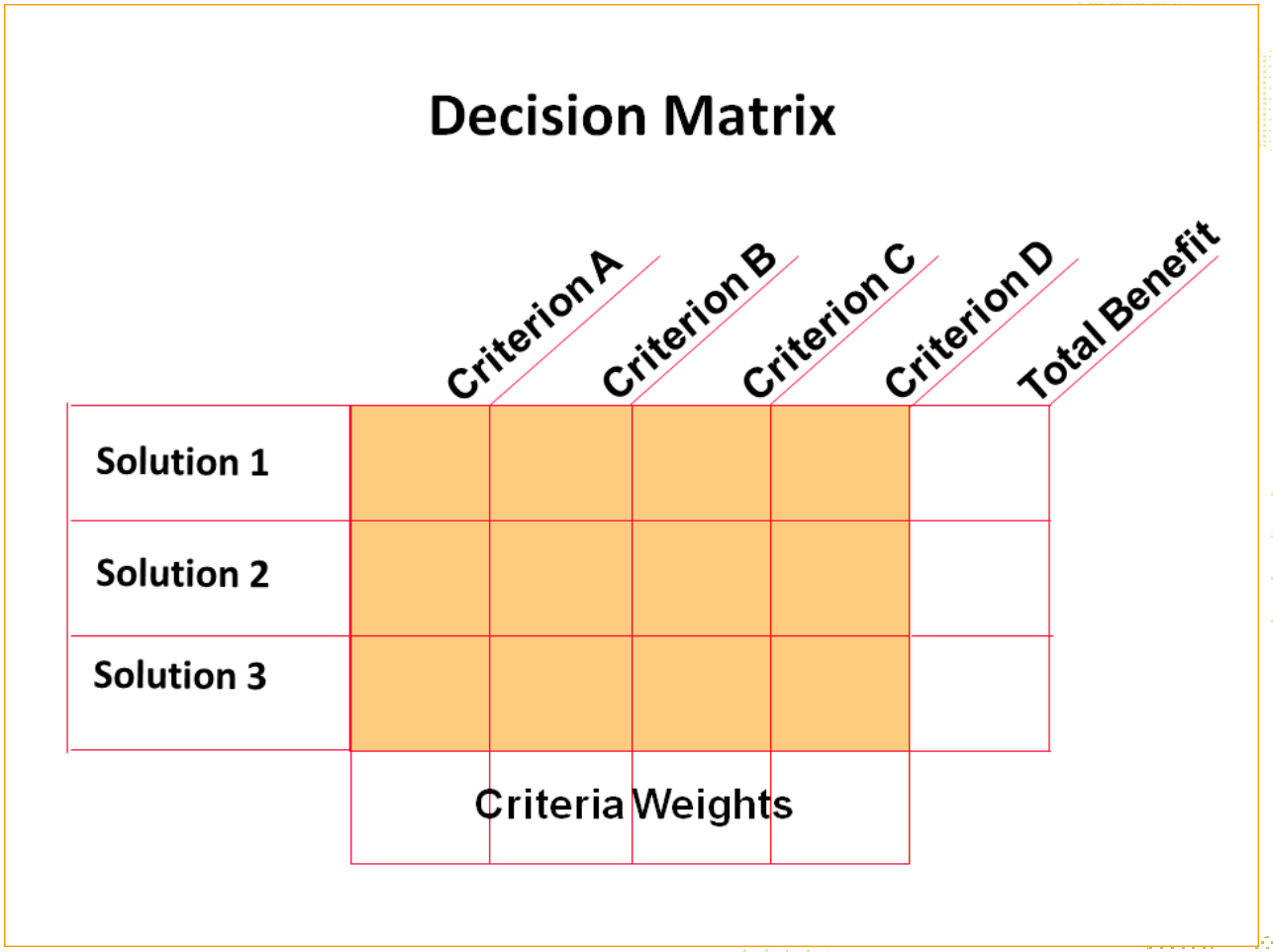
Band Chart


120
100
80
60
40
20
0
week 1
week 2
week 3
week 4
week 5
Task 1 band upper
Task 1 band lower
Task 2 band upper
Task 2 band lower
Average Task 1
Average Task 2
Chart Area

DECISION MATRIX

- A decision matrix is a chart that allows a team or individual to systematically identify, analyze, and rate the strength of relationships between sets of information. The matrix is especially useful for looking at large numbers of decision factors and assessing each factor's relative importance.
- A decision matrix is frequently used during quality planning activities to select product/service features and goals and to develop process steps and weigh alternatives. For quality improvement activities, a decision matrix can be useful in selecting a project, in evaluating alternative solutions to problems, and in designing remedies.

Decision Matrix



Decision Matrix

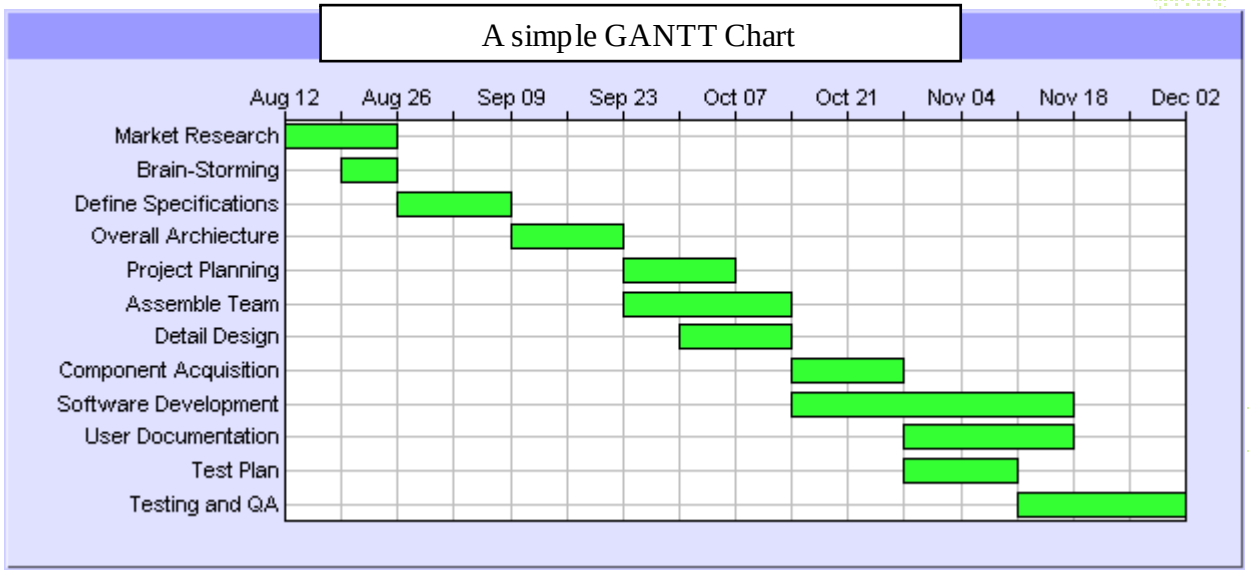
	Cost of building	Parking Space	Security	Room for expansion		Total Benefits
Facility A	5	0	2	5	1 + 0 + 0.5 + 2 = 3.5	**3.5**
Facility B	3	3	2	4	0.6 + 0.45 + 0.5 + 1.6 = 3.15	**3.15**
Facility C	3	1	1	3	0.6 + 0.15 + 0.25 + 1.2 = 2.2	**2.2**
Facility D	2	1	1	1	0.4 + 0.15 + 0.25 + 0.40 = 1.2	**1.2**
	.20	.15	.25	.40		

GANTT Chart

- Definition: A Gantt chart is used to show activities (tasks or events) displayed against time.

- On the left of the chart is a list of activities and along the top is a time scale of hours, days, months, etc,- whatever unit is most suitable.

GANTT Chart

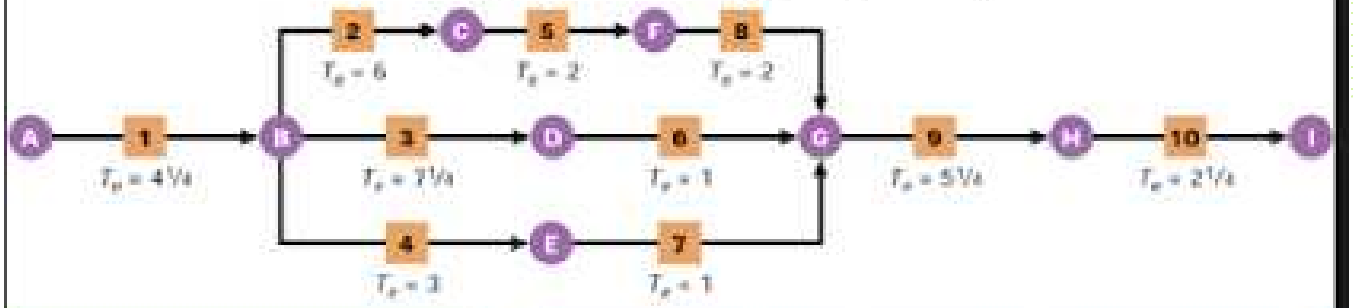

A simple GANTT Chart
Aug 12
Aug 26
Sep 09
Sep 23
Oct 07
Oct 21
Nov 04
Nov 18
Dec 02
Market Research
Brain-Storming
Define Specifications
Overall Archiecture
Project Planning
Assemble Team
Detail Design
Component Acquisition
Software Development
User Documentation
Test Plan
Testing and QA

PERT

- A PERT Chart shows the relationship among various steps in a project. It also serves as a way to calculate the critical path.
- The critical path is the longest time path through the network of steps. It identifies essential steps that must be completed on time in order to not delay completion of the total project.

PERT

TASK: Build three dozen customized golf carts for use by physically challenged adults



PERT events

A. Receive contract
B. Begin construction
C. Receive parts
D. Bodies ready for testing
E. Frames ready for testing
F. Drive trains ready for testing
G. Components ready for assembly
H. Carts assembled
I. Carts ready for shipment

PERT activities and times

Activities	T_o	T_m	T_p	T_e*
1. Prepare final design	3	4	6	4¼
2. Purchase parts	4	5	12	6
3. Fabricate bodies	5	7½	9	7¼
4. Fabricate frames	2½	3	4	3
5. Build drive trains	1½	2	3	2
6. Test bodies	½	1	1½	1
7. Test frames	½	1	1½	1
8. Test drive trains	1	1½	5	2
9. Assemble carts	3	5	9	5¼
10. Test carts	1	2	5	2¼

*Rounded to nearest ¼ workday

PERT

Enables a manager to:

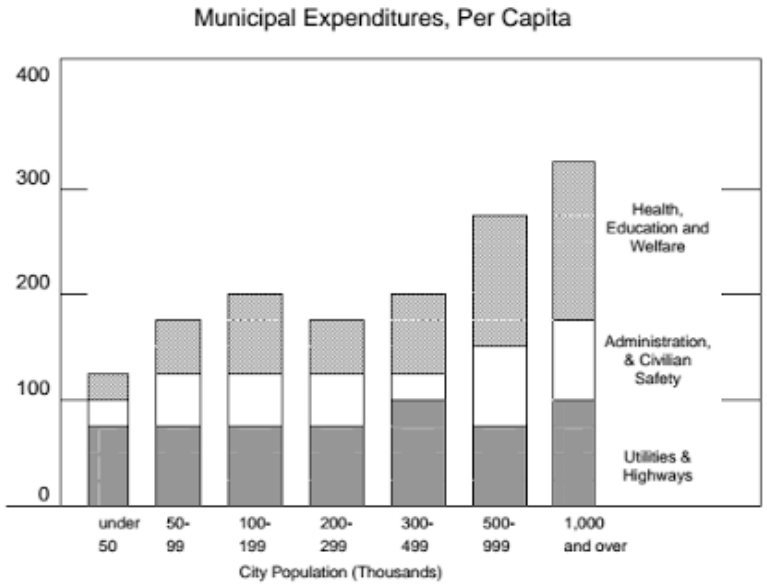
- plan the best possible use of resources to achieve a given goal within the overall time and cost limitations.

- handle one-of-a-kind programs where it is not know exactly how long things will take -- as opposed to repetitive production situations.

- utilize a so-called “time network analysis’ as a basic method of approach to determine manpower, material, and capital requirements.

REVIEW QUESTIONS

SAMPLE TEST QUESTIONS



6. Using the chart above, what is the approximate municipal expenditure per capita in cities having populations of 200,000 to 299,000?
   a. $ 125
   b. $ 175
   c. $ 200
   d. $ 300

Instructions: Read the information provided in the following passage and answer the question that follows.

8. From time to time the State makes surplus property available for sale to the public. This property consists of State property; unclaimed or abandoned personal property and valuables, except those confiscated in conjunction with drug enforcement activities; and unclaimed stolen property. The surplus property is disposed of through sale bids, auctions and donations.

   According to the passage,

   a. the State's personal property brings in the largest sales.
   b. items that are not claimed by their owner will be sold to the public.
   c. the State holds regularly scheduled sales of property to the public.
   d. property obtained by drug enforcement activities is sold through the bid process.

Question 4

The flow chart on the right is meant to show the steps for safely crossing the road. There is a decision box in this flow chart.

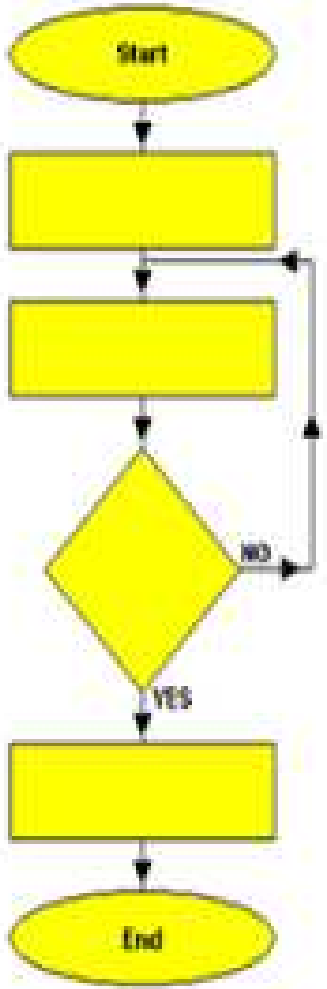
Place the boxes below in the flow chart.

Cross the road carefully

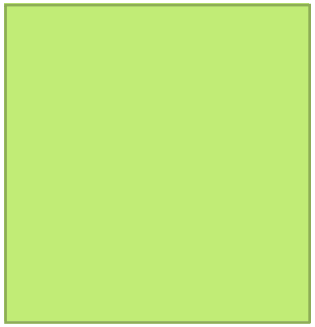
Look left and right

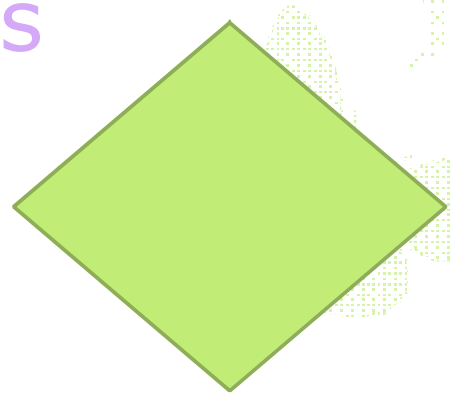
Stop at the curb

Is the road clear both ways?



Flow Charting Symbols



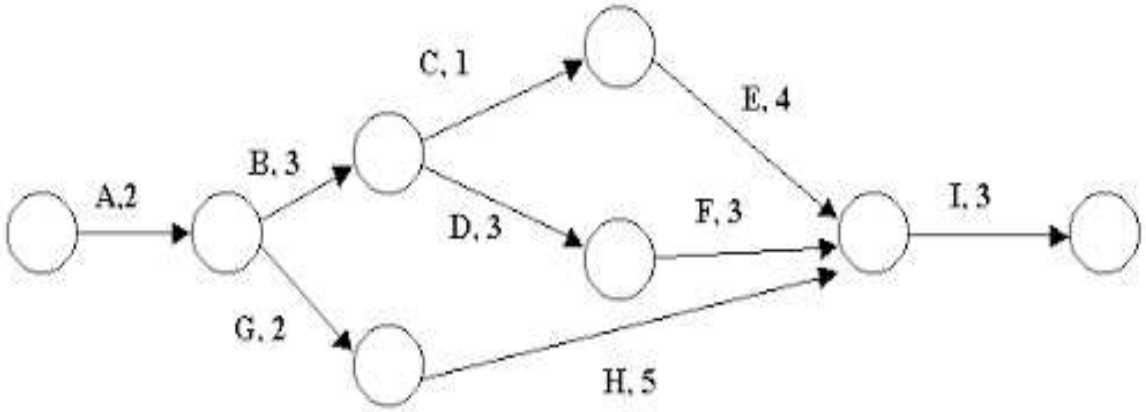


These two flowcharting symbols are

- a. Input/Output and process
- b. Decision and predefined process
- c. Process and decision
- d. Terminal and process

89

Below is a PERT chart drawn to show the development of a system.



EXAM QUESTION 1: Which tasks are on the critical path of the PERT chart above?

90

Which of the following control techniques is most useful on large, unique projects?

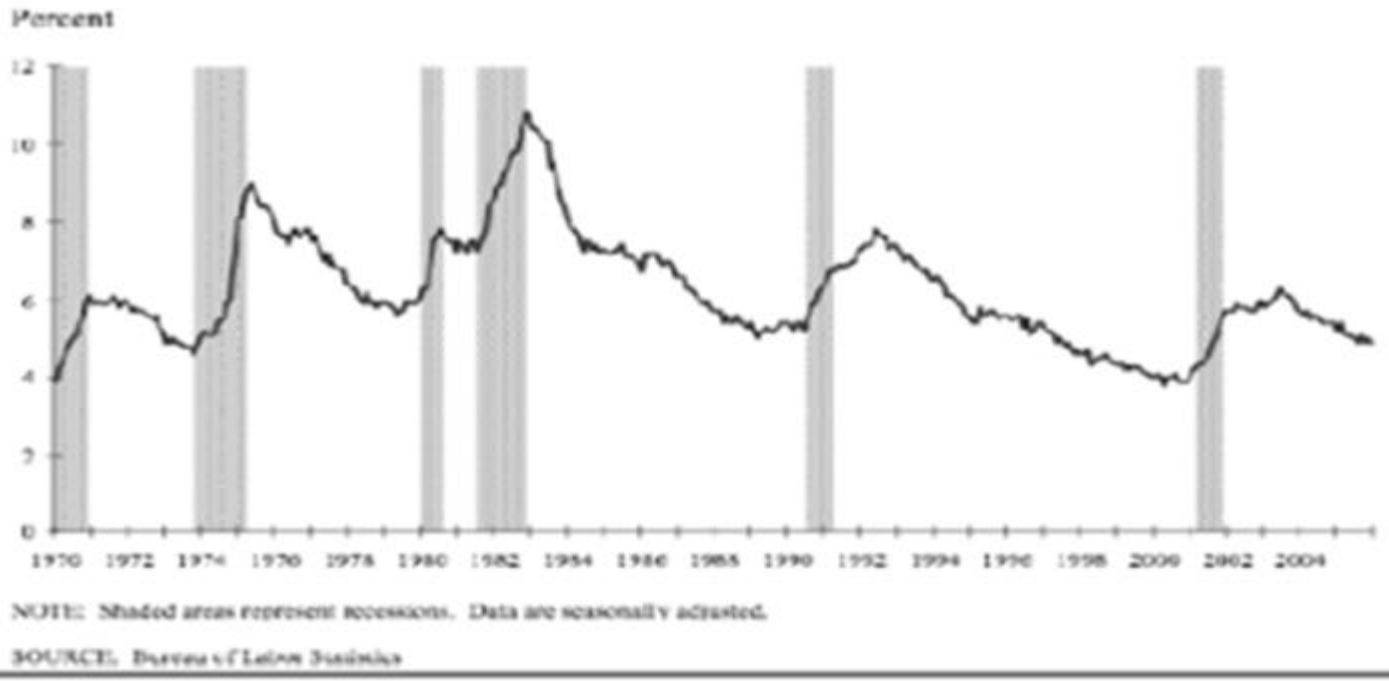
a. A general work plan

b. A Gantt chart

c. Monthly progress reports

d. PERT Chart

Chart 1-2. The unemployment rate is down from its most recent peak in June 2003



NOTE: Shaded areas represent recessions. Data are seasonally adjusted.

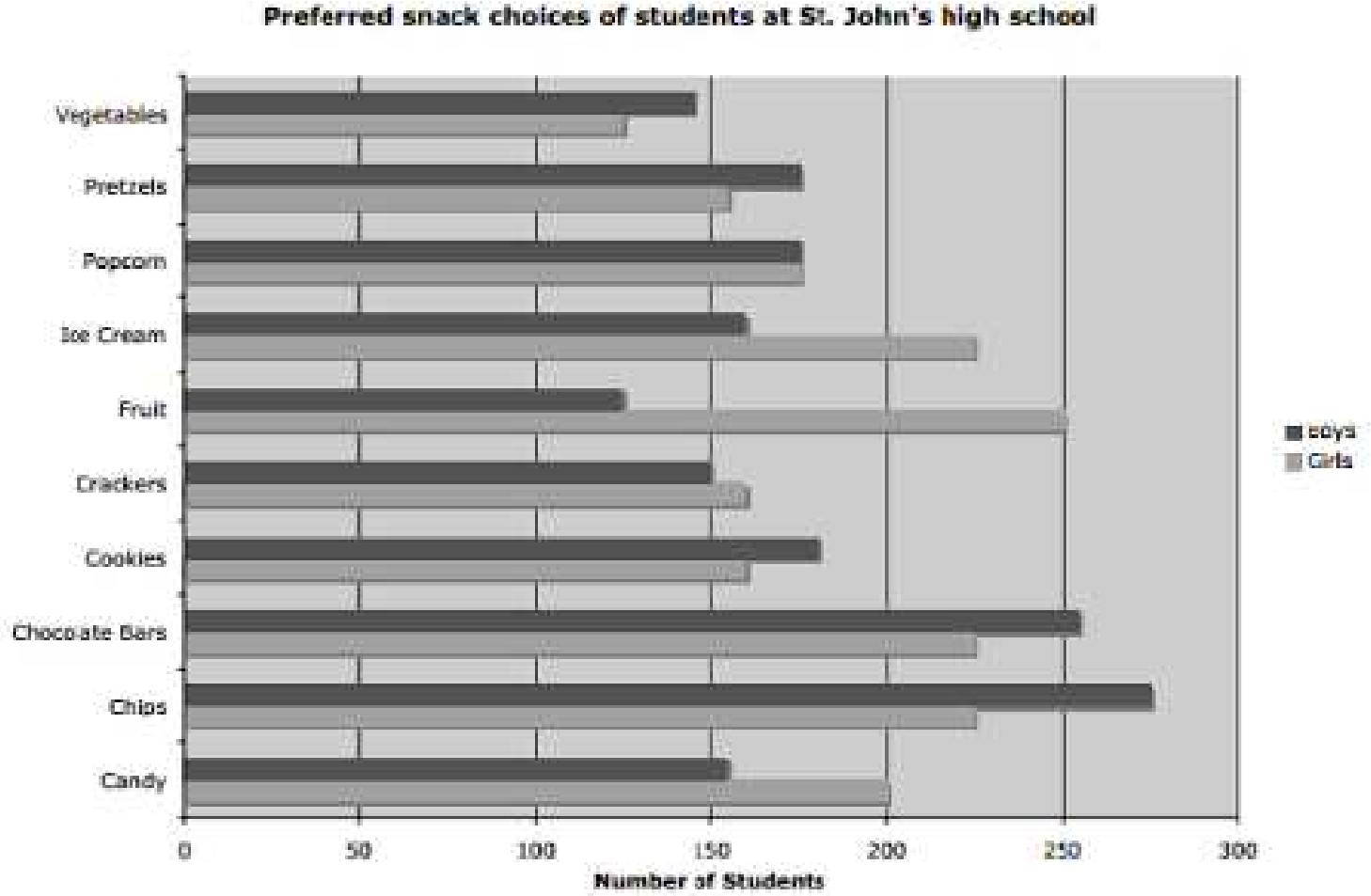
SOURCE: Bureau of Labor Statistics

Q1. What is the difference in percentage between the highest unemployment rate and the lowest unemployment rate in the given time period?

1. 10% **2.** 4% **3.** 7% **4.** 0%

Q2. What period had the lowest overall change in unemployment rates?

1. 1970 – 1980 **2.** 1980 – 1990 **3.** 1990 – 2000 **4.** 2000 – 2006



Q1. What ratio of category preferences did the boys exceed the girls in?

1. 4:5 **2.** 5:4 **3.** 1:1 **4.** 5:5

Q2. Approximately how many students had snacks at the school?

1. 3700 **2.** 1500 **3.** 600 **4.** 275

93

Your supervisor informs you that three of your fifteen employees have complained to her about your inconsistent methods of supervision. You should:

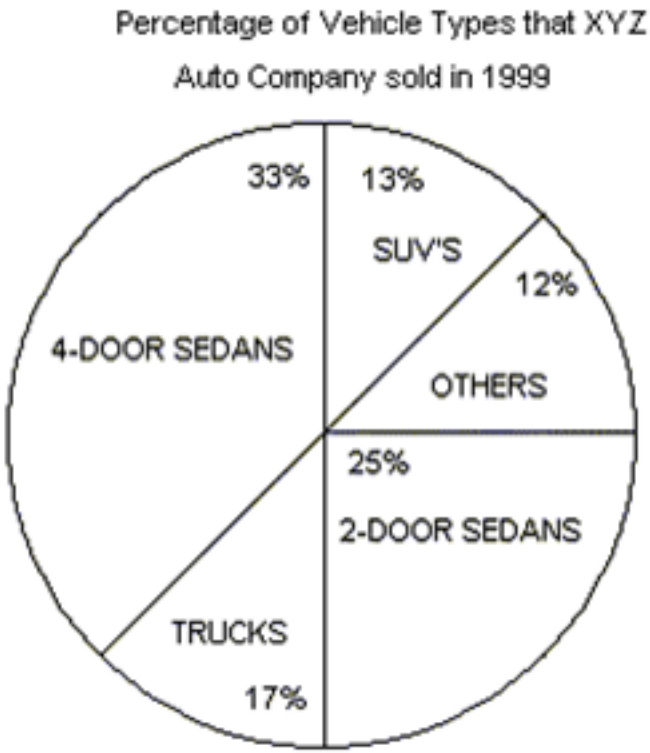
a. offer to attend a supervisory training program.

b. first ask her if it is proper for her to allow these employees to go over your head.

c. ask her what specific acts have been considered inconsistent.

d. explain that you've purposely been inconsistent because of the needs of these three employees.

If XYZ Auto Company sold 23,000 vehicles in 1999, how many were SUV's?



A. 2,990
B. 3,030
C. 3,450
D. 4,760
E. 4,775

95

Operations Research Part I

Answer key to practice test questions

1) A
2) B
3) D
4) A
5) C
6) D
7) B
8) C
9) B
10) B
11) A
12) C
13) A
14) D
15) C
16) C

Operations Research Answer Sheet

page 86 Ans. = B $175

page 87 Ans. = B items that are not claimed by their owner will be sold to the public

page 88 Ans. = B if the symbols are numbered 1, 2, 3, 4 the sequence is 3, 2, 4, 1

page 89 Ans. = C decision and processing

page 90 Ans. = A B D F I

page 91 Ans. D =pert chart

page 92 Ans. 3 = 7% Ans. 2 = 1980 – 1990

page 93 Ans. 5:4 Ans. 1 = 3700

page 94 Ans. C = ask her what specific acts have been considered inconsistent

page 95 Ans. A = 2,990

Practice Questions Operations Research

1. **With a management staff of 15 capable analysts which of the following organizational approaches would generally be best for over-all results?**

   (A) organization by specialists in field, such as management, organization, systems analysts.
   (B) organization by clientele to be served, such as hospitals, police, education, social services.
   (C) organization where all 15 report directly to head of the management staff.
   (D) organization by specialized study groups with flexibility in assigning staff under a qualified project leader.

2. **Which of the following statements most accurately defines "operations Research?**

   (A) a highly sophisticated system used in the analysis of management problems.
   (B) a specialized application of electronic data processing in the analysis of management problems.
   (C) research on operating problems.
   (D) the application of sophisticated mathematical tools to the analysis of management problems.

3. **Use of the systems approach is most likely to lead to**

   (A) consideration of the impact on the whole organization of actions taken in any part of that organization.
   (B) the placing of restrictions on departmental authority.
   (C) use of mathematical models to sub-optimize production.
   (D) Consideration of the activities of each unit of an organization as a totality without regard to the remainder of the organization.

4. **PERT is a recently developed system used primarily to**

   (A) evaluate the quality of applicants' backgrounds
   (B) analyze and control the timing aspects of a major project
   (C) control the total expenditure of agency funds within a monthly or quarterly time period
   (D) analyze and control the differential effect on costs of purchasing in different quantities.

5. **An interrelated pattern of jobs which makes up the structure of a system is known as**

   (A) chain of command
   (B) cybernetics
   (C) the formal operation
   (D) the maintenance pattern

6. An "operational" definition is best defined as one that

   (A) indicates the process of measuring the term itself.
   (B) is a special definition not commonly accepted.
   (C) is a substitute for a dictionary definition.
   (D) stipulates what is intuitively meant by the term.

7. Which of the following control techniques is most useful on large, complex systems projects?

   (A) A general work plan
   (B) Gantt Chart
   (C) Monthly progress report
   (D) PERT Chart

8. The review and appraisal of an organization to determine waste and deficiencies, improved methods, better means of control, more efficient operations and greater use of human and physical facilities is know as

   (A) a management audit
   (B) a manpower survey
   (C) a work simplification study
   (D) an operations audit

9. The ability of operations researchers to solve complicated problems rests on their use of models. These models can best be described as

   (A) mathematical statements of the problem.
   (B) Physical constructs that simulate a work layout.
   (C) Toy-like representations of employees in work environments.
   (D) role-playing simulations.

10. The methods of operations research, statistical decision-making and linear programming have been referred to as "the tool kit of the manager" by Peter Drucker. Utilization of these tools is <u>least</u> useful in the performance of which of the following functions?

    (A) elimination of the need for using judgment when making decisions.
    (B) Facilitation of decision-making without the need for sub-optimization.
    (C) Reduction of time and cost in various management areas.
    (D) Accounting for risks and assumptions in the decision-making process.

Answers: 1D; 2D; 3A; 4B; 5C; 6A; 7D; 8A; 9A; 10A

OPERATIONAL RESEARCH QUESTIONS FOR STAFF ANALYST TRAINEE

1. When ongoing process problems are occurring in a unit, for example inter-office mail from the mailroom is 3 to 5 days late, who should be asked about the nature of the problem?

   a) the commissioner
   b) the deputy commissioner
   c) the executive managers
   d) the delivery staff

2. When an organizational change is being instituted, what outcome can always be anticipated?

   a) resistance
   b) full cooperation if a detailed plan is devised
   c) long term increase in productivity
   d) a series of perfect solutions

3. Which of the following statement most accurately defines "operations research"?

   a) a highly sophisticated system used in the analysis of management problems
   b) a specialized application of electronic data processing in the analysis of management problems
   c) research on operating problems
   d) the application of sophisticated mathematical tools to the analysis of management problems

4. Use of the systems approach is most likely to lead to

   a) consideration of the impact on the whole organization of actions taken in any part of that organization
   b) the placing of restrictions on departmental authority
   c) use of mathematical models to suboptimize production
   d) consideration of the activities of each unit of an organization as a totality without regard to the remainder of the organization

5. Of the following, committees are best used for

   a) advising the head of the organization
   b) improving functional work
   c) making executive decisions
   d) making specific planning decisions

6. Of the following, the one which a line role generally does <u>not</u> include is

   a) controlling results and performance
   b) coordinating work and exchanging ideas with other line organizations
   c) implementation of approved plans developed by staff
   d) planning work and making operating decisions

7. "The Office Layout Chart is a sketch of the physical arrangements of the office to which has been added the flow lines of the principal work performed there.: Which one of the following states the best advantage of superimposing the work flow onto the desk layout?

a) lighting and acoustics can be improved
b) line and staff relationships can be determined
c) obvious misarrangements can be corrected
d) the number of delays can be determined

8. Which one of the following questions should the management analyst generally consider <u>first?</u>

a) How is it being done? and Why should it be done that way?
b) What is being done? and Why is it necessary?
c) When should this step be done? and Why?
d) Who should do the job? and Why should he/she do it?

9. The major failing of efficiency engineering was that it

a) overlooked the human factor
b) required experts to implement the techniques
c) was not based on true scientific principles
d) was too costly and time consuming

10. The general method of arriving at program objectives should be

a) a trial and error process
b) developed as the program progresses
c) included in the program plan
d) left to the discretion of the immediate supervisors

11. An important aspect to keep in mind during the decision-making process is that

a) all possible alternatives for attaining goals should be sought out and considered
b) considering various alternatives only leads to confusion
c) once a decision has been made it cannot be retracted
d) there is only one correct method to reach any goal

12. Implementation of accountability requires

a) a leader who will not hesitate to take punitive action
b) an established system of communication from the bottom to the top
c) explicit directives from leaders
d) too much expense to justify it

13. Of the following, the major difference between systems and procedures analysis and work simplification is:

a) the former complicates organizational routine and the latter simplifies it
b) the former is objective and the latter is subjective
c) the former generally utilizes expert advice and the latter is a "do it yourself" improvement by supervisors and workers
d) there is no difference other than in name

14. Organizational systems and procedures should be

a) developed as problems arise as no design can anticipate adequately the requirements of an organization
b) developed jointly by experts in systems and procedures and the people who are responsible for implementing them
c) developed solely by experts in systems and procedures
d) eliminated whenever possible to save unnecessary expense

15. On a general organization chart, staff positions normally should be pictured

a) directly above the line positions to which they report
b) to the sides of the main flow lines
c) within the box of the highest level subordinate positions pictured
d) directly below the line position which report to them

16. Of the following, the most usual reason for <u>unsatisfactory</u> line staff relationships is

a) inept use of the abilities of staff personnel by line management
b) the higher salaries paid to line officials
c) excessive consultation between line officials and staff officials at the same organizational level
d) a feeling among the staff members that only lower level line members appreciate their work

17. Of the following, the one which generally is the most intangible planning factor is

a) budget dollars allocated to a function
b) square feet of space for office use
c) number of personnel in various titles
d) emotional impact of a proposed personnel policy among workers

18. Agency "x" s moving into a new building. It has 1500 employees presently on its staff and does not contemplate much variance from this level. The new building contains 100 available offices each with a maximum capacity of 30 employees. It has been decided that only 2/3 of the maximum capacity of each office will be utilized. The total number of offices that will e occupied by Agency "x" is

a) 30 b) 66 c) 75 d) 90

19. Listed below are four steps commonly used in trying to solve administrative problems. These four steps are not listed in order. If they were listed in the proper order, which step should be taken <u>first.</u>

1. choosing the most practical solution to the problem
2. analyzing the essential facts about the problem
3. correctly identifying the problem
4. following up to see if the solution chosen really works

a) 3 b) 1 c) 2 d) 4

20. The one of the following which best characterizes an agency in which delegation of authority is practiced on an organization wide level is that the agency is

a) autocratic
b) authoritarian
c) centralized
d) decentralized

21. A detailed description of the steps to be taken in order to accomplish a job is most appropriately called a

a) policy b) rule c) procedure d) principle

22. Of the following, the main purpose of systematic manpower planning is to

a) analyze the levels of skill needed by each worker
b) analyze causes of current vacancies, such as resignations, discharges, retirements, transfers, or promotions
c) save money by eliminating useless jobs
d) provide for the continuous and proper staffing of the workforce

23. Of the following, the one that is not essential in carrying out a comprehensive work improvement program is

a) standards of performance
b) supervisory training
c) work count/task list
d) work distribution chart

24. Which of the following control techniques is most useful on large, complex system projects?

a) a general work plan
b) Gantt chart
c) monthly progress report
d) PERT chart

25. The critical path is defined as that path (or those paths) through a network

a) showing the least number of time units
b) showing the greatest number of time units
c) which consists (or consist) entirely of sequential activities
d) which links (or link) together activities in concurrent relationship to each other

1. d 2. a 3. d 4. a 5. a 6. b 7. c 8. b 9. a 10. c
11. a 12. b 13. c 14. b 15. b 16. a 17. d 18. c 19. a
20. d 21. c 22. d 23. b 24. d 25. c

Job analysis

From Wikipedia, the free encyclopedia

Job analysis (also known as **Work analysis**[1]) is a family of procedures to identify the content of a job in terms of activities involved and attributes or job requirements needed to perform the activities. Job analysis provide information to organizations which helps to determine which employees are best fit for specific jobs. Through job analysis, the analyst needs to understand what the important tasks of the job are, how they are carried out, and the necessary human qualities needed to complete the job successfully. The process of job analysis involves the analyst describing the duties of the incumbent, then the nature and conditions of work, and finally some basic qualifications. After this, the job analyst has completed a form called a *job psychograph*, which displays the mental requirements of the job.[2] The measure of a sound job analysis is a valid task list. This list contains the functional or duty areas of a position, the related tasks, and the basic training recommendations. Subject matter experts (incumbents) and supervisors for the position being analyzed need to validate this final list in order to validate the job analysis.[3] Job analysis is crucial for first, helping individuals develop their careers, and also for helping organizations develop their employees in order to maximize talent. The outcomes of job analysis are key influences in designing learning, developing performance interventions, and improving processes.[4] The application of job analysis techniques makes the implicit assumption that information about a job as it presently exists may be used to develop programs to recruit, select, train, and appraise people for the job as it will exist in the future.[5]

Job analysts are typically industrial-organizational (I-O) psychologists or human resource officers who have been trained by, and are acting under the supervision of an I-O psychologist. One of the first I-O psychologists to introduce job analysis was Morris Viteles. In 1922, he used job analysis in order to select employees for a trolley car company. Viteles' techniques could then be applied to any other area of employment using the same process.[6] Job analysis was also conceptualized by two of the founders of I-O psychology, Frederick Winslow Taylor and Lillian Moller Gilbreth in the early 20th century.[1] Since then, experts have presented many different systems to accomplish job analysis that have become increasingly detailed over the decades. However, evidence shows that the root purpose of job analysis, understanding the behavioral requirements of work, has not changed in over 85 years.[7]

Contents

Purpose

One of the main purposes of conducting job analysis is to prepare job descriptions and job specifications which in turn helps hire the right quality of workforce into an organization. The general purpose of job analysis is to document the requirements of a job and the work performed. Job and task analysis is performed as a basis for later improvements, including: definition of a job domain; description of a job; development of performance appraisals, personnel selection, selection systems, promotion criteria, training needs assessment, legal defense of selection processes, and compensation plans.[8] The human performance improvement industry uses job analysis to make sure training and development activities are focused and effective.[3] In the fields of human resources (HR) and industrial psychology, job analysis is often used to gather information for use in personnel selection, training, classification, and/or compensation.[9]

Industrial psychologists use job analysis to determine the physical requirements of a job to determine whether an individual who has suffered some diminished capacity is capable of performing the job with, or without, some accommodation. Edwin Flieshman, Ph.D. is credited with determining the underlying factors of human physical fitness.[10] Professionals developing certification exams use job analysis (often called something slightly different, such as "task analysis" or "work analysis") to determine the elements of the domain which must be sampled in order to create a content valid exam. When a job analysis is conducted for the purpose of valuing the job (i.e., determining the appropriate compensation for incumbents) this is called "job evaluation."

Job analysis aims to answer questions such as:

- Why does the job exist?
- What physical and mental activities does the worker undertake?
- When is the job to be performed?
- Where is the job to be performed?
- How does the worker do the job?
- What qualifications are needed to perform the job?

Procedures

As stated before, the purpose of job analysis is to combine the task demands of a job with our knowledge of human attributes and produce a theory of behavior for the job in question. There are two ways to approach building that theory, meaning there are two different approaches to job analysis.[11]

Task-oriented

Task-oriented procedures focus on the actual activities involved in performing work.[8] This procedure takes into consideration work duties, responsibilities, and functions. The job analyst then develops task statements which clearly state the tasks that are performed with great detail. After creating task statements, job analysts rate the tasks on scales indicating importance, difficulty, frequency, and consequences of error. Based on these ratings, a greater sense of understanding of a job can be attained.[12] Task analysis, such as cognitively oriented task analysis (COTA), are techniques used to describe job expertise. For example, the job analysts may tour the job site and observe workers performing their jobs. During the tour the analyst may collect materials that directly or indirectly indicate required skills (duty statements, instructions, safety manuals, quality charts, etc.).[9]

Functional job analysis (FJA)[13] is a classic example of a task-oriented technique. Developed by Fine and Cronshaw in 1944, work elements are scored in terms of relatedness to data (0–6), people (0–8), and things (0–6), with lower scores representing greater complexity. Incumbents, considered subject matter experts (SMEs), are relied upon, usually in a panel, to report elements of their work to the job analyst. Using incumbent reports, the analyst uses Fine's terminology to compile statements reflecting the work being performed in terms of data, people, and things. The Dictionary of Occupational Titles uses elements of the FJA in defining jobs.[12]

Worker-oriented

Worker-oriented procedures aim to examine the human attributes needed to perform the job successfully.[8] These human attributes have been commonly classified into four categories: *knowledge*, *skills*, *abilities*, and *other characteristics* (KSAO). *Knowledge* is the information people need in order to perform the job. *Skills* are the proficiencies needed to perform each task. *Abilities* are the attributes that are relatively stable over time. *Other characteristics* are all other attributes, usually personality factors.[12] The KSAOs required for a job are inferred from the most frequently-occurring, important tasks. In a worker-oriented job analysis, the skills are inferred from tasks and the skills are rated directly in terms of importance of frequency. This often results in data that immediately imply the important KSAOs. However, it can be hard for SMEs to rate skills directly.

The Fleishman Job Analysis System (F-JAS) developed by Edwin A. Fleishman represents a worker-oriented approach. Fleishman factor-analyzed large data sets to discover a common, minimum set of KSAOs across different jobs. His system of 73 specific scales measure three broad areas: Cognitive (Verbal Abilities; Idea Generation & Reasoning Abilities; Quantitative Abilities; Memory; Perceptual Abilities; Spatial Abilities; and Attentiveness), Psychomotor (Fine Manipulative Abilities; Control Movement Abilities; and Reaction Time and Speed Abilities), and Physical (Physical Strength Abilities; Endurance; Flexibility, Balance, and Coordination; Visual Abilities; and Auditory and Speech Abilities).

JobScan is a measurement instrument which defines the personality dynamics within a specific type of job.[14] By collecting PDP ProScan Survey results of actual performers and results of job dynamics analysis surveys completed by knowledgeable people related to a specific job, JobScan provides a suggested ideal job model for that position. Although it does not evaluate the intellect or experience necessary to accomplish a task, it does deal with the personality of the type of work itself.

Example

For the job of a snow-cat operator at a ski slope, a work or task-oriented job analysis might include this statement: Operates Bombardier Sno-cat, usually at night, to smooth out snow rutted by skiers and snowboard riders and new snow that has fallen. On the other hand, a worker-oriented job analysis might include this statement: Evaluates terrain, snow depth, and snow condition and chooses the correct setting for the depth of the snow cat, as well as the number of passes necessary on a given ski slope.[11]

Job analysis methods have evolved using both task-oriented and worker-oriented approaches. Since the end result of both approaches is a statement of KSAOs, neither can be considered the "correct" way to conduct job analysis. Because worker-oriented job analyses tend to provide more generalized human behavior and behavior patterns and are less tied to the technological parts of a job, they produce data more useful for developing training programs and giving feed back to employees in the form of performance appraisal information. Also, the volatility that exists in the typical workplace of today can make specific task statements less valuable in isolation. For these reasons, employers are significantly more likely to use worker-oriented approaches to job analysis today than they were in the past.[11]

Knowledge, skills, abilities and other characteristics (KSAOs)

Regardless of which approach to job analysis is taken, the next step in the process is to identify the attributes—the KSAOs that an incumbent needs for either performing the tasks at hand or executing the human behaviors described in the job analysis.[15]

- **Knowledge**: "A collection of discrete but related facts and information about a particular domain...acquired through formal education or training, or accumulated through specific experiences."
- **Skill**: "A practiced act"
- **Ability**: "The stable capacity to engage in a specific behavior"
- **Other characteristics**: "Personality variables, interests, training, and experiences" [15]

Methods

Finally, once the appropriate KSAOs are identified, tests and other assessment techniques can be chosen to measure those KSAOs. Over the years, experts have presented several different systems and methods to accomplish job analysis. Many forms of systems are no longer in use, but those systems that still exist have become increasingly detailed over the decades with a greater concentration on tasks and less concentration on human attributes. That trend, however, has reversed in recent years for the better. Newer methods and systems have brought I-O psychology back to an examination of the *behavioral* aspects of work.[7]

There are several ways to conduct a job analysis, including: interviews with incumbents and supervisors, work sampling,[5] the repertory grid technique,[6] questionnaires (structured, open-ended, or both), observation, critical incident investigations,[7] hierarchical task analysis,[8] and gathering background information such as duty statements or classification specifications. In job analyses conducted by HR professionals, it is common to use more than one of these methods.[3] Traditional job analysis methods of analysis can be laborious and time consuming, and there is always a tendency on the part of management to over analyze some jobs and under analyze some others. These traditional job analysis methods include: one-on-one interviewing; behavioral event interviews; phone interviews; surveys; work assessments; Developing a Curriculum (DACUM); job analysis worksheets; observations and procedural review.[16] Job analysis at the speed of reality. Amherst, Mass.: HRD Press. All of these methods can be used to gather information for job analysis. The DACUM process developed in the late 1960s has been viewed as the fastest method used, but it can still can take two or three days to obtain a validated task list.

1. **Observation**: This was the first method of job analysis used by I-O psychologists. The process involves simply watching incumbents perform their jobs and taking notes. Sometimes they ask questions while watching, and commonly they even perform job tasks themselves. Near the end of World War II, Morris Viteles studied the job of navigator on a submarine. He attempted to steer the submarine toward Bermuda. After multiple misses by over 100 miles in one direction or another, one officer suggested that Viteles raise the periscope, look for clouds, and steer toward them since clouds tend to form above or near land masses. The vessel reached Bermuda shortly after that suggestion. The more jobs one seriously observes, the better one's understanding becomes of both the jobs in question and work in general.
2. **Interviews**: It is essential to supplement observation by talking with incumbents. These interviews are most effective when structured with a specific set of questions based on observations, other analyses of the types of jobs in question, or prior discussions with human resources representatives, trainers, or managers knowledgeable about jobs.
3. **Critical incidents and work diaries**: The critical incident technique asks subject matter experts to identify critical aspects of behavior or performance in a particular job that led to success or failure. For example, the supervisor of an electric utility repairman might report that in a very time-pressing project, the repairman failed to check a blueprint and as a result cut a line, causing a massive power loss. In fact, this is what happened in Los Angeles in September 2005 when half the city lost power over a period of 12 hours. The second method, a work diary, asks workers and/or supervisors to keep a log of activities over a prescribed period of time. They may be asked to simply write down what they were doing at 15 minutes after the hour for each hour of the work day. Or, they may list everything they have done up to a break.
4. **Questionnaires and surveys**: Expert incumbents or supervisors often respond to questionnaires or surveys as a part of job analysis. These questionnaires include task statements in the form of worker behaviors. Subject matter experts are asked to rate each statement form their experience on a number of different dimensions like importance to overall job success, frequency performance and whether the task must be performed on the first day of work or can be learned gradually on the job. Questionnaires also ask incumbents to rate the importance of KSAOs for performing tasks, and may ask the subject matter experts

to rate work context. Unlike the results of observations and interviews, the questionnaire responses can be statistically analyzed to provide a more objective record of the components of the job. To a greater and greater extent, these questionnaires and surveys are being administered online to incumbents.

5. **Position Analysis Questionnaire**: The Position Analysis Questionnaire (PAQ) is a well-known job analysis instrument. Although it is labeled a questionnaire, the PAQ is actually designed to be completed by a trained job analyst who interviews the SMEs (e.g., job incumbents and their supervisors).[2] The PAQ was designed to measure job component validity of attributes presented in aptitude tests. Job component validity is the relationship between test scores and skills required for good job performance. There are 195 behavior-related statements in the PAQ divided into six major sections: information input, mental process, work output, relationships with others, job context, and other job characteristics.
6. **Checklists**: Checklists are also used as a job analysis method, specifically with areas like the Air Force. In the checklist method, the incumbent checks the tasks he or she performs from a list of task statements that describe the job. The checklist is preceded by some sort of job analysis and is usually followed by the development of work activity compilations or job descriptions. The scope of task statements listed depends upon the judgment of the checklist constructor.[17]

Six steps

1. Decide how to use the information since this will determine the data to collect and how to collect it. Some data collection techniques such as interviewing the employee and asking what the job entails are good for writing job descriptions and selecting employees for the job. Other techniques like the position analysis questionnaire do not provide qualitative information for job descriptions. Rather, they provide numerical ratings for each job and can be used to compare jobs for compensation purposes.[18]
2. Review appropriate background information like organization charts, process charts, and job descriptions. *Organization charts* show the organization-wide work division, how the job in question relates to other jobs, and where the job fits in the overall organization. The chart should show the title of each position and, through connecting lines, show reports to whom and with whom the job incumbent communicates. A *process chart* provides a more detailed picture of the work flow. In its simplest, most organic form, a process chart shows the flow of inputs to and outputs from the job being analyzed. Finally, the existing job description (if there is one) usually provides a starting point for building the revised job description.
3. Select representative positions. This is because there may be too many similar jobs to analyze. For example, it is usually unnecessary to analyze jobs of 200 assembly workers when a sample of 10 jobs will be sufficient.
4. Actually analyze the job by collecting data on job activities, necessary employee behaviors and actions, working conditions, and human traits and abilities required to perform the job. For this step, one or more than one methods of job analysis may be needed

5. Verify the job analysis information with the worker performing the job and with his or her immediate supervisor. This will help confirm that the information is factually correct and complete. This review can also help gain the employee's acceptance of the job analysis data and conclusions by giving that person a chance to review and modify descriptions of the job activities.
6. Develop a job description and job specification. These are two tangible products of the job analysis process. The *job description* is a written statement that describes the activities and responsibilities of the job as well as its important features such as working conditions and safety hazards. The *job specification* summarizes the personal qualities, traits, skills, and background required for completing a certain job. These two may be completely separate or in the same document.[18]

Uses of information

1. **Recruitment and selection**: Job analysis provides information about what the job entails and what human characteristics are required in order to perform these activities. This information, in the form of job descriptions and specifications, helps management officials decide what sort of people they need to recruit and hire and select.
2. **Compensation**: Job analysis information is crucial for estimating the value of each job and its appropriate compensation. Compensation (salary and bonus) usually depends on the job's required skill and education level, safety hazards, degree of responsibility, etc. -- all factors which can be assessed through job analysis. Also, many employers group jobs into classes. Job analysis provides the information to determine the relative worth of each job and its appropriate class.
3. **Performance appraisal**: A performance appraisal compares each employee's actual performance with his or her performance standards. Managers use job analysis to determine the job's specific activities and performance standards.
4. **Training**: The job description should show the activities and skills, and therefore training, that the job requires
5. **Discovering unassigned duties**: Job Analysis can also help reveal unassigned duties. For example, a company's production manager says an employee is responsible for ten duties, such as production scheduling and raw material purchasing. Missing, however, is any reference to managing raw material inventories. On further study, it is revealed that none of the other manufacturing employees are responsible for inventory management, either. From review of other jobs like these, it is clear that someone should be managing raw material inventories. Therefore, an essential unassigned duty has been revealed.
6. **EEO compliance**: Job analysis plays a large role in EEO compliance. United States Federal Agencies' Uniform Guidelines on Employee Selection stipulate that job analysis is a necessary step in validating all major personnel activities. For example, employers must be able to show that their selection criteria and job performance are actually related. Doing this requires knowing what the job entails, which in turn requires job

analysis.[18]

Additional purposes: In addition to the 6 purposes above, Ash and Levine[19] listed determining KSAOs needed for promotion, determining workplace hazards to make jobs safer, job classification, job description, designing the content of jobs, and strategic human resource planning.

Job Analysis at the Speed of Reality (JASR)

The Job Analysis at the Speed of Reality (JASR) method for job analysis is a reliable, proven method to quickly create validated task lists. The end product, which can be used for many purposes, is the basis for many potential training opportunities. This method is a tested process that helps analysts complete a job analysis of a typical job with a group of subject matter experts and managers in two to three hours then deliver a validated task list.[20]

1. Job incumbents should know their jobs better than anyone else. They can provide accurate, timely content information about the job.
2. JASR participants want to spend a minimum amount of time providing job data during a session and business leadership wants to minimize disruption to business operations.
3. Since JASR participants do not spend as much time thinking about training as training professionals do, they do not require much orientation to the process.
4. JASR uses the quickest methods and best possible technology to complete the job analysis.[3]

Systems

For many years, the U.S. Department of labor published the Dictionary of Occupational Titles, which was a comprehensive description of over 20,000 jobs. However, the Department replaced the DOT with O NET online database, which includes all occupations from the DOT plus an additional 3,500. This makes O NET very useful for job analysis.[21]

The O*Net[22] (an online resource which has replaced the Dictionary of Occupational Titles (DOT)) lists job requirements for a variety of jobs and is often considered basic, generic, or initial job analysis data. Everyone can use this database at no cost and is continually updated by observing workers from each occupation. O*net also has a Career Exploration Tool which is an assessment to help workers and students who are searching for new careers. Data available from O*Net includes physical requirements, educational level, and some mental requirements. Task-based statements describing the work performed are derived from the functional job analysis technique. O*Net also provides links to salary data at the US national, state and city level for each job.

O*NET was designed with several features in mind, including:

- The inclusion of multiple descriptors and content domains to capture the range of ways that work can be described
- The development of cross-job descriptors in order to enable comparisons between various jobs
- The use of a taxonomic approach to occupational classification to enable full coverage within a content

domain

Using these principles, a content model was developed that identified six content domains and specific categories within each domain. These six domains and categories within them include:

1. **Worker characteristics**: enduring individual attributes that influence the capacities workers can develop - abilities, occupational values and interests, and work styles
2. **Worker requirements**: general attributes developed through education and experience, thus are more amenable to change than worker characteristics - knowledge skills and education
3. **Occupational requirements**: descriptors of the work itself rather than the worker - Generalized work activities, work context, and organizational context
4. **Experience requirements**: types and quantities of experience required for specific occupations - worker experience in other jobs, related training, on-the-job training, and certification requirements
5. **Individual occupation characteristics**: reflects labor demand, supply, and other labor market information
6. **Occupation-specific requirements**: information unique to a particular job - occupation-specific skills and knowledge, tasks and duties, and equipment used [23]

In modern United States

Over the past years, the concept of job analysis has been changing dramatically. One observer put it: 'The modern world is on the verge of another huge leap in creativity and productivity, but the job is not going to be part of tomorrow's economic reality. There still is and will always be an enormous amount of work to do, but it is not going to be contained in the familiar envelopes we call jobs. In fact, many organizations are today well along the path toward being "de-jobbed."."[18]

Jobs and job descriptions, until recently, tended to follow their prescriptions and to be fairly detailed and specific. By the mid-1900s writers were reacting to what they viewed as "dehumanizing" aspects of pigeonholing workings into highly repetitive and specialized jobs; many proposed solutions like job enlargement, job rotation, and job enrichment. *Job enlargement* means assigning workers additional same-level tasks, thus increasing the number of activities they perform. *Job rotation* means systematically moving workers from one job to another. Psychologist Frederick Herzberg argued that the best way to motivate workers is to build opportunities for challenge and achievement into their jobs through job enrichment. *Job enrichment* means re-designing jobs in a way that increases the opportunities for the worker to experience feelings of responsibility, achievement, growth and recognition.[18]

Whether enriched, specialized or enlarged, workers still generally have specific jobs to do, and these jobs have required job descriptions. In many firms today, however, jobs are becoming more amorphous and difficult to define. In other words, the trend is toward *dejobbing*.

Dejobbing, broadening the responsibilities of the company's jobs, and encouraging employees to not limit themselves to what's on their job descriptions, is a result of the changes taking place in business today. Organizations need to grapple with trends like rapid product and technological changes, and a shift to a service economy. This has increased the need for firms to be responsive, flexible, and generally more competitive. In

turn,the organizational methods managers use to accomplish this have helped weaken the meaning of JOB as a well-defined ad clearly delineated set of responsibilities. Here are some methods that have contributed to this weakening of JOB's meaning:

- Flatter organizations: Instead of traditional pyramid-shaped organizations with seven or more management layers, flat organizations with only three or four levels are becoming more prevalent
- Work teams: Managers increasingly organize tasks around teams and processes rather than around specialized functions. In an organization like this, employees' jobs change daily and there is an intentional effort to avoid having employees view their jobs as a specific set of responsibilities.
- The Boundaryless Organization: In a *boundaryless organization,* the widespread use of teams and similar structural mechanisms reduces and makes more permeable the boundaries that typically separate departments and hierarchical levels. These organizations foster responsiveness by encouraging employees to rid themselves of the 'its not my job' attitudes that typically create walls between one employee's area and another's. Instead, the focus is on defining the project or task at hand in terms of the overall best interests of the organization, therefore further reducing the idea of a job as a clearly defined set of duties.[18]

Most firms today continue to use job analysis and rely on jobs as traditionally defined. More firms are moving toward new organizational configurations built around jobs that are broad and could change daily. Also, modern job analysis and job design techniques could help companies implement high-performance strategies.[18]

Systems analysis

From Wikipedia, the free encyclopedia

"**Systems analysis** is a problem solving technique that decomposes a system into its component pieces for the purpose of the studying how well those component parts work and interact to accomplish their purpose".[1] According to the Merriam-Webster dictionary, systems analysis is "the process of studying a procedure or business in order to identify its goals and purposes and create systems and procedures that will achieve them in an efficient way". Analysis and synthesis, as scientific methods, always go hand in hand; they complement one another. Every synthesis is built upon the results of a preceding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results.

This field is closely related to requirements analysis or operations research. It is also "an explicit formal inquiry carried out to help someone (referred to as the decision maker) identify a better course of action and make a better decision than she might otherwise have made."[2]

Contents

Overview

The terms analysis and synthesis come from Greek where they mean respectively "to take apart" and "to put together". These terms are used in scientific disciplines from mathematics and logic to economics and psychology to denote similar investigative procedures. Analysis is defined as the procedure by which we break down an intellectual or substantial whole into parts. Synthesis is defined as the procedure by which we combine separate elements or components in order to form a coherent whole.[3] Systems analysis researchers apply methodology to the analysis of systems involved to form an overall picture. System analysis is used in every field where there is a work of developing something. Analysis can also be defined as a series of components that perform organic function together. An example of system analysis can be system engineering. Systems engineering is an interdisciplinary field of engineering that focuses on how complex engineering projects should be designed and managed. An interdisciplinary field is the combining of two or more fields of study. An example of this would be history (one academic field) and economics (another academic field) department are offering a seminar on Asia.

Information technology

The development of a computer-based information system includes a systems analysis phase which produces or enhances the data model which itself is a precursor to creating or enhancing a database (see Christopher J. Date "An Introduction to Database Systems"). There are a number of different approaches to system analysis. When a computer-based information system is developed, systems analysis (according to the Waterfall model) would constitute the following steps:

- The development of a feasibility study, involving determining whether a project is economically, socially, technologically and organizationally feasible.
- Conducting fact-finding measures, designed to ascertain the requirements of the system's end-users. These typically span interviews, questionnaires, or visual observations of work on the existing system.
- Gauging how the end-users would operate the system (in terms of general experience in using computer hardware or software), what the system would be used for and so on

Another view outlines a phased approach to the process. This approach breaks systems analysis into 5 phases:

- Scope Definition: which is denoting an instrument for observing, viewing, or examining.
- Problem analysis: Analyzing the problem that arises.
- Requirements analysis: encompasses the conditions that need to be met.
- Logical design: look at logical relationship among the objects.
- Decision analysis: where a decision is made.

Use cases are a widely used systems analysis modeling tool for identifying and expressing the functional requirements of a system. Each use case is a business scenario or event for which the system must provide a defined response. Use cases evolved out of object-oriented analysis.

Practitioners

Practitioners of systems analysis are often called up to dissect systems that have grown haphazardly to determine the current components of the system. This was shown during the year 2000 re-engineering effort as business and manufacturing processes were examined as part of the Y2K automation upgrades.[4] Employment utilizing systems analysis include systems analyst, business analyst, manufacturing engineer, systems architect, enterprise architect, software architect, etc.

While practitioners of systems analysis can be called upon to create new systems, they often modify, expand or document existing systems (processes, procedures and methods). Researchers and practitioners rely on system analysis. Activity system analysis has been already applied to various research and practice studies including business management, educational reform, educational technology, etc.

A set of components interact with each other to accomplish some specific purpose. Systems are all around us. Our body is itself a system. A business is also a system. People, money, machine, market and material are the components of business system that work together that achieve the common goal of the organization.

WORK SIMPLIFICATION

Work simplification can be described as the intelligent use of well-established human patterns to encourage and expedite the finding and implementation of more efficient work methods. Over the years the work simplification approach rooted in bio-mechanics has earned a rapidly expanding popularity.

Many industrial companies have sponsored formal work-simplification programs. Most of these have been quite successful in delivering a multitude of cost-reducing and profit-increasing innovations.

Originally, work-simplification was conceived as an application concentrated in the area of production methods. Experience has broaden his applicability. Work-simplification concepts are now utilized to improve performance in many other activities, including clerical functions, supervisory techniques, research, and maintenance.

In fact, the term work-simplification has become almost a synonym for an organized grass-roots methods improvement technique.

The traditional approach to methods improvement has been to employ highly trained specialist in industrial engineering techniques to spend full time on this activity. These experts are assigned the task of studying one activity after another throughout the entire organization.

They are expected to locate opportunities for improved performance develop ways for these improvements to be achieved, evaluate their feasibility, sell their acceptance, and assist in their implementation. A great deal of progress has been achieve in this manner. Nevertheless, it has been found that the effectiveness of this traditional approach may become diluted in two ways:

1 Much time and effort is expended by the expert to become familiar with each new activity studied in order to ascertain that all pertinent aspects and interactions with related activities are uncovered and properly evaluated.

2 Improvements developed by the experts are usually resented by prospective users, mainly due to typical reaction to outsiders usually found among company employees.

The work-simplification approach is designed to minimize these difficulties. Each employee is assisted to become his own expert and is encouraged to study and recommend way to improve the performance of his own job.Motivation is develop by demonstrating the value to both workers and management of the results they can achieve by working together as a team.

Training in the use of a collection of simple but ingenious techniques provides each employee with adequate know-how to make the required methods-improvement studies.

Work-simplification is more productive when there is widespread participation by many individuals from all levels in the company in an organized program.

Carefully planned indoctrination sessions must be provided to develop effective motivation. All participants should receive training in basic methods-improvement tools and techniques.

A means of handling ideas, such as a suggestion system, should be developed to make a method of communication readily available, to provide a way for obtaining prompt management review of improvement proposals, to facilitate recognition for contributions and to provide adequate rewards for achievements.

THE LAW OF INTELLIGENT ACTION

Willian J. Reilly, in his book entitled the law of intelligent action, states that "When confronted with a problem, the intelligence of an individual's actions is dependent upon:

His desire to solve the problem

His ability to perform the tasks required and

His capacity to handle the human relations involved."

DESIRE

Motivations for the actions of human beings can be divided into two basic categories:

1 To gain (What is in it for me?)

2 To avoid loss (That is mine. Hands off)

Thus the employee seeks employment as a means of gaining:

Security or reasonable control over his own future

Material reward or money to buy things

Opportunity to improve his position in an economic or social way.

A sense of participation (belonging to the group and having a say in the activities of the group)

It can be expected that the attitude of the individual toward an opportunity for personal gain will be almost entirely selfish. His controlling interest will be "What is in it for me?" but his decisions and actions will tend to be rational, logical, and based on facts.

A direct appeal toward actions which will result in benefit to him and others can be expected to receive objective analysis.

However, the attitude of the individual toward the possible loss of something he already possesses can be expected to be entirely different. Decisions will tend to be base on emotion rather than facts.

Actions taken in connection with a possibility of losing existing possessions may often be devious and will sometimes appear completely illogical.

This difference in attitudes is of great significance when the acceptance of methods improvement is being sought.

To an individual not directly involved, the introduction of a cost-saving proposal involving the use of a new piece of equipment or a new method can have the appeal of intelligent selfishness, but to a person directly involved, a change from the existing implies the loss of his own know-how applicable to the old procedure or equipment.

The fear generated by the prospect of such a loss can be completely cancel out any appeal of mutual benefit. Therefore, to be successful a work-simplification program must have identified with it specific management policies and practices which will assure the individual that the can gain and will not personally lose as the result of implementation of the proposals.

A suggestion system can provide recognition and financial rewards, but an additional

guarantee by management indicating that participants will not suffer personal loss through downgrading or layoff is essential.

An agreement to achieve force reductions via attrition or transfer of displaced individuals to other expanding activities is often a mutually acceptable approach. With careful planning, this method is usually adequate to absorb force reductions made possible by work-simplification proposals. Reductions via layoffs can eliminate any possibility of a successful program.

After all, the cooperation of the individual just cannot be expected if he can see that this cooperation will result in direct losses to himself, his friends, or his associates.

ABILITY

Until the introduction of participating work-simplification programs, which provided both the receptive climate and the necessary training of the participants, the idea that the average employee could successfully conceive, develop and implement worthwhile methods improvements was only a hypothesis.

Management possessed little evidence and even less faith that such efforts were likely to be really productive of meaningful results. Today, however, the impressive results of many successful industrial work-simplification programs amply documents the validity of this hypothesis.

It has been unquestionably proved that the latent ability to develop methods improvements exists in the majority of individuals and can be effectively utilized if proper motivation and training are provided.

It has been shown that with only minimal training in a few of the simple basic industrial engineering tools the average individual can develop an amazing ability to recognize

opportunities for improvement and to implement workable solutions.

HUMAN CAPACITY TO CHANGE

The basic pattern of human nature has been fairly well established and demonstrated to be essentially unchangeable. Human behavior, however, can be modified and to a certain extent controlled. In fact, human behavior, is relatively predictable and can be measurably influenced by anyone with a thorough understanding of the basic mechanics of human nature plus a willingness to take the prerequisite actions.

In respect to influencing attitudes toward prospective methods-improvement installations, it is usually sufficient to learn to recognize and deal with two of the most basic traits of human nature:

A Resistance to change or to accept something new

B Resentment of criticism

The fundamental idea of searching for a better way to perform a task has the built-in assumption that, when it is found, the new way will be substituted for the old. Thus, improvement implies change.

From the point of view of the user of the old way, change tends to disrupt complacency and create a fear of possible unfavorable consequences. The firm feeling of 'All is well' is replaced with a queasy feeling that perhaps he, the current user, may also become obsolete and have to be retrained, perform a harder task, or perhaps even be replaced.

The user can see nothing in the change for him and an excellent chance of insecurity. Naturally, he resists change. It is almost a conditioned reflex. Everyone tends to be critical or, and resistant to change.

A successful work-simplification program must make provision to assist participants to become familiar with this universal reaction and to learn how to minimize its hampering effect.

Participants must:

1. Learn to avoid confusing fact and opinion. Practice results in habits and can lead to the development of biased opinions that cannot be properly extrapolated. Experience increases knowledge of facts which provide a sounder basis for extrapolation.

2. Learn how to avoid misunderstandings. Failure to ascertain all the facts which provide a sounder basis for extrapolation.

3. Learn how to avoid rush judgment. Time is required for mature judgment. Lack of experience must be taken into consideration in making evaluations.

A change for the better implies criticism of the old method and what is even worse, criticism of the user of the old method. Direct or implied, constructive or destructive, the immediate reaction is fast and always the same. No one likes criticism. It is always taken as a personal affront. It is resented.

To develop a successful work-simplification program, participants must learn to expect this reaction in others and in themselves. They must learn to minimize offending others, to keep criticism from improperly affecting their own judgment and to help others keep it from confusing their decisions.

However, by far the biggest assist in minimizing both resistance to change and resentment of criticism is the basic premise of the work-simplification approach which substitutes the participating development of new methods for the expert approach. The participant is most

unlikely to develop resistance to, or resentment of, what he believes are largely his own ideas.

METHODS FOR SOLVING PROBLEMS

A problem occurs when people believe they want to know the exact relationship between two or more measurable facts. For example, if a person wants to make an increased profit by reducing the costs of materials used in a work process, there is a problem.

What would happen to profits if plastic instead of steel parts were used in a machine? What would happen to quality and safety? Plastic, steel, profit and safety can be measured in exact ways. Therefore, a person can test the specific relationship between these facts to obtain an answer. A result of using the answer would be increased profits and productivity.

All problem-solving techniques have ways of identifying the exact problem, getting facts, testing for results, reaching conclusions and verifying what you believe to be true. Several methods exist for modern problem solving, each has its advantage.

THE SCIENTIFIC METHOD

This how all research in science and industry, medicine and business takes place. A hypothesis (statement of relationship between measurable facts) is formed and test facts gathered. A conclusion is reached based on math (probability theory) patterns and later verified with additional or varied testing.

According to A. D. Little there are four facets to be considered by the scientific approach:

1 The simplicity to wonder

2 The ability to question

3 The power to generalize

4 The capacity to apply

The work simplification approach applies each of these in a very literal fashion.

Maintaining an open mind.-(The simplicity to wonder)

The participant with an open mind wonders about everything. He is willing to explore all alternatives. He is not restricted by past practice, precedent, tradition, habits, customs, or fear of the consequences of change.

Observing the present way.-(The ability to question)

Few people know how to do an adequate job of questioning. Most of them stop asking too soon. Sometimes this is merely to avoid embarrassing the person questioned. To succeed in work simplification, one must get use to question everything. Work simplification provides an organized plan for questioning. It is called the questioning pattern and it is a definite sequence of question:

What is done?

Where is it done?

When is it done?

Who does it?

How is it done?

Why is it done at all?

Why is it done here?

Why is it done then?

Why does this person do it?

Why is it done this way?

This is a training pattern which is to be followed literally at first but which soon becomes simply an organized way of thinking.

Exploring opportunities for improvement.- (the power to generalize)

From the answers, tentative conclusions (generalizations) can be developed. Possibilities for improvement are then investigated:

What?, Where?, When?, Who?, How?, Why eliminate?, Why change place?, Why change sequence?, Why combine?, Why change a person?, Why improve method?
It should be remembered that the person is searching for possible solutions. If it has never been done before, it may be a better way.

Do not admit it cannot be done or you are defeated before you start. Try to find ways to make new ideas work, not to prove then unworkable.

Implementing the new method.-(The capacity to apply)

It is not enough to wonder, ask why and develop a workable improvement. An idea has no value until it is put to use. The capacity to apply implies two things:

The ability to see the application of a general rule to a specific problem.

The ability to convert an understanding of human nature into an approach to the new method which will gain the cooperation of the people involved.

THE STATISTICAL METHOD

Observational facts are gathered until a

recognizable pattern is identified. Comparisons are then made to the experiences we usually expect under normal or average conditions.

THE CORRELATION METHOD

Using records of events that happened in the past, relationships between what you are investigating and what your are measuring can be identified mathematically.

THE BRITISH METHOD

After describing the problem and getting facts, the person or group describes their present and future position. A plan of action is then organized, followed and adjusted periodically.

THE JAPANESE METHOD

This method calls for describing the problem and asking the staff for volunteers. Young, inexperience people usually volunteer. It emphasizes improvement of the situation at a slow but firm pace along with company culture and work satisfaction improvement.

THE ORDIONE METHOD

This method stresses time. Its basic idea is that, if things do not change, results remain the same. Therefore, if your work results change you have a problem. One or more factors must have changed at the same time. Find out what changed in the same time frame and that should correct the deficiency.

THE BRAINSTORM METHOD

This method uses a group to identify several answers rapidly. First you select a group of five to seven people, some with experience with the problem area. Some are warned in advance about the job and others are not. A short time limit is set.

One person records the answers group members rapidly fire; objections or explanations are not allowed at first. What you wind up with is a variety of answers, some better than others.

One offshoot method is called the Delphi method, in which members of the group are hidden from each other. The idea is that some members with a great deal of power or prestige can influence other's ideas excessively, so this method prevents such influence.

DEDUCTIVE REASONING

After gathering specific facts or clues, the solver uses them to reach a general conclusion. For example, a person might say, 'Because the wind is blowing, the clouds are darkening and the lightning is flashing.... I believe the rain will come down in the next thirty minutes.

INDUCTIVE REASONING

In this method, a person starts with a general conclusion and then looks for supporting facts or clues. In law enforcement, an officer might hear a confession and later search for clues or evidence that the crime actually happened in that manner. In business, if a bankruptcy happens, auditors may search for exact problem areas they know may exist.

JUDICIAL THINKING

To solve problems or reach decisions with this method, a businessperson might assign someone to present all the facts possible to support a 'yes' decision to buy a mainframe computer. Another person should then present all the 'no' facts about the possible purchase. The company executive team would then judge where its best interests lie.

NEW THINKING TECHNIQUES

This method suggest that people often think only in straight-line fashion, using normal logic. This can be symbolized by a person thinking one-two-three-four-five-six and so on.

New thinking techniques suggest entirely changing the framework of reference of the problem situation to achieve results in different ways. This kind of thinking could be symbolized by a person thinking one-two-three-four-a-b-c-five-six and so on. An example of this kind of problem solving technique would be the following:

An office building six stories high with old/slow elevators causes tenant complains. Renters are threatening to move out. Lack of profits would be catastrophic for the owners. Engineers are hired to devise a solution. No luck. Repairs to the elevators would be too expensive because they are built into the inner office structure(the engineers are thinking along logical or usual lines).

The problem is solved by an employee in the boiler room who used absolutely different thinking. He purchased six full-length mirrors from a department store. The installed them, one at each of the elevator doors on six floors. People were so busy looking at themselves, they did not notice or complain about the slow elevators afterward.

THE KISSINGER METHOD

This method depends on language. The exact problem is re-described in various ways. Questions by an outside expert are used to encourage two or more arguing parties to define what they can and cannot accept in the way of a settlement or answer. This method is based on the fact that language is vague, and people usually do not get angry if they are asked questions that concentrate on facts instead of repeated emotional statements.

HARD WORK METHOD

In this procedure, you assume hard work will accomplish any task. Past generations were often trained to work hard regardless of any situation. So this method is still popular with supervisors, regardless of results.

LAZY MAN'S METHOD

If you have a problem, just hire and expert to solve it for you. Why try to invent the chicken when you live next to a farmer with a front yard full of the birds? At times consultants or experts are very cost-effective.

THE SUBCONSCIOUS METHOD

With this method, you define your problem and get all the facts you can. Decide which characteristics the solution must have. Relax your mind and body in a quiet, interruption-free place. As your mind moves from relaxation to sleep, it enters the Alpha condition which registers ten megacycles per second on an electronic measuring device.

The average person can better identify the Alpha stage by merely noting that he is fully relaxed and is moving toward sleep. Curiosity disappears, too.

During this stage, people seem to access most of their memory and make creative associations that help find solutions to difficult problems. The answer often comes all at once, not in pieces, so be prepared to write it down quickly! Bio-feedback training can help you train yourself to get into and out of this Alpha condition with ease whenever you wish.

PROBLEM SOLVING GENERAL FACTS

A problem exists when you want to establish the relationship between two or more measurable facts.

All problems have answers. There are no exceptions!

Problems usually have several answers, not just one.

No one solves a problem without first defining it exactly.

Logic is not enough. Since we never have all the facts, we must depend on creative intuition to some degree. Therefore, logic and intuition are equally valid.

All elements of the problem situation must be measurable.

Everything is measurable. There are no exceptions.

Finding the answer is not the last step, merely the last point before taking action.

It is human to seek solutions even before the problem is understood. But do not do it yourself.

Let your purpose guide your choice of alternatives.

THE FIVE STEPS OF METHODS IMPROVEMENT

A definite and permanent advance is seldom made until use is made of measurement. This is particularly true where human factors are involved.

Human performance tends to vary so much that unless some form of measurement is provided and used as a basis for decisions, there is little possibility of repeating a process accurately or

predicting or controlling future conditions sufficiently to allow introduction of improvements.

Mere observations done objectively, is a form of measurement. It can be used to classify, label, and compare. An interesting demonstration is to pick a task with which you are familiar but not directly involved.

Now, subject the performance of this task to your concentrated and undivided attention. Chances are that you will find that you were completely unaware of many important aspects. It can be truthfully said that the commonest article of commerce is misinformation about fundamental things.

An organized pattern of observation is of great assistance. Work simplification suggests a step-by-step program for studying tasks:

1.- Select the task to be studied.

Be careful that only one task is studied at the time. Failure to observe this caution can lead to confusing results or to ineffective efforts.

Because time is valuable, the best possible use of it must be made by doing first things first. Pick the job that needs improvement most. But remember the human problem. do not rush in too fast. Start by improving your own job or jobs in your department.

Remember, if you work on someone else's problems, they will probably resent your help as implied criticism.

Look for situations as:

a. Bottlenecks.

Leave the smooth-flowing jobs alone until you crack troublesome ones.

b. Time-consuming operations.

Lengthy jobs usually offer the greatest opportunity for improvement.

c. Chasing around.

Activities of this type are almost always unproductive and often can be eliminated or drastically reduced.

d. Waste.

We become so accustomed to some forms of wasted materials, time, or energy that we have difficulty in recognizing it as such. Increases go unnoticed. Look carefully.

2.- Observe the present way in which the task is performed.

Get all the facts. Be sure to include all the requirements for the performance of the task. Do not forget to determine interactions with related tasks. Make a process chart. use it to record all details.

3.- Challenge everything. Question what is done.

a. Challenge the whole job being investigated. Why is it done? Is it necessary? Can it be done another way or at another time or place?

b. Next, challenge each 'do' operation. This is because if you eliminate the 'do' you automatically eliminate the make-ready and put-away that go with it.

c. Then supply the checklist of questions to every detail.

WHAT?

What is done? What is the purpose of doing it? Why should it be done? Does it do what it is

supposed to do?

WHERE?

Where is the detail being done? Why should it be done there? Could it be done somewhere else?

WHEN?

When is the detail done? Why is it done then? Could it be done at some other time?

WHO?

Who does the detail? Why does this person do the detail? Could someone else do it?

HOW?

How is the detail performed? Why is it done that way? Is there any other way to do it?

This questioning attitude helps develop a point of view that considers the good of the whole operation rather than that of any one department or individual. It will often bring to light possibilities for eliminating useless or unnecessary work which adds no real value to product.

It tends to bring out the type of operation or equipment needed to perform the required work most economically. Do not overlook the possibility of obtaining ideas from other people working on the same operation. And do not forget that when you ask for these ideas you have a human problem.

You will get the ideas only if they want to give them to you. they must be convinced that improving performance will help them.

4.- Explore opportunities for improvement.

Consider all possibilities. examine each in detail.

Evaluate, compare, and select the best alternative. Use the flow process chart or multiple-activity chart to pretest and demonstrate the feasibility of new methods.

a. Can operations be eliminated?

What is done?, Why is it done?, Is it necessary?. In far too many instances a good deal of time is spent studying major operations for possibilities of improvement without asking the question, 'Why is this operation performed?'

If it is found that an operation has been in the plant in the same way for a year or longer, it should be questioned. A better way is probably available. If operations cannot be eliminated, perhaps there are unnecessary transportation and storage. Question every handling.

Then, if handling is absolutely necessary, look for:

Back-tracking of work
Heavy lifting or carrying
Trucking
Bottlenecks
Skilled operators doing handling work

b. Can activities be combined? Can sequence, place, or person be changed?

This is an important opportunity for improvements. Whenever two or more operations can be combined, they are often performed at a cost approaching or even equal to the cost of one.

Likewise, transportation and storage between the operations may be eliminated. If operations cannot be combined, find out if it is possible to combine a transportation and an operation. By changing the sequence of an operation, one may eliminate backtracking and duplication of work.

The order in which operations are performed may have been derived from the original nature of the process. The process or product design may have been changed since then. But has the order of operations been restudied and changed to regain optimum efficiency?

Sometimes, just changing the place where the work is done or by whom it is done will help. Better lighting, better ventilation, better tools may be available elsewhere. Perhaps another operator is better equipped to do the operation.

c. Can the 'do' operation be improved?

How is it done?, Why is it done that way?, Is better equipment available?, Are other materials available?, Can new techniques be applied?.

Unfortunately, it is here that a great deal of work simplification started in the past. We must learn to consider this step the last resort. Major savings can usually be found, but the price of the new equipment, materials, training, etc., is also usually high, sometimes beyond our reach.

Often relatively small rearrangements, method changes, and layout revisions will accomplish almost as much with negligible cost.

5.- Implement the new method.

See that all people involved understand the objective of the task and desirability of the new method. Take care that each person involved knows and understands his or her part in the new method. Be sure that none involved will lose financially or socially as a result of the change. And, even more important, be sure that they know it!

CHARTING TECHNIQUES

There are many charting techniques which have been designed to assist in the development of

improved methods. They are:

Flow process chart
Multiple-activity process chart
Pareto
What if?
Gantt chart
Critical path network
PERT

All these charting techniques are similar in principle. They are a means of recording and studying activities required to perform a task. The above list is in order of increasing complexity.

The flow process chart is used to record a single sequence of activities. The multiple activity chart is used when several sequences of activities occur at the same time and their relationship with respect to time are significant.

The Gantt chart is utilized when the number of simultaneously occurring sequences of activities becomes large. The use of the critical path method network is desirable when some of the sequences of activities are time-related and some are not. This approach can become quite complicated and then computer programs must be used in conjunction with it.

PERT (program evaluation and review technique) is a variation of the critical path technique into which another variable, probability, has been introduced.

APPLICATIONS OF WORK SIMPLIFICATION TO QUALITY

Quality control work is different from production work in two basic ways:

1. Most quality control work input is assigned and controlled on a job-by-job basis rather than unit-of-time or product-output. For this reason, work content is usually non-repetitive in nature.

2. Direct correlation between work output and product or service output is seldom feasible. This tends to make verification of savings difficult.

These differences do not limit the usefulness of the work- simplification approach. But they do change the emphasis somewhat.

IMPROVING MANAGEMENT EFFICIENCY

The problems encountered in applying intelligent management to quality control are very complex. Effective management usually requires a great deal of data. A huge volume of records are often generated. Work simplification can give a big assist to the streamlining of these activities. For instance:

1. Work-control procedures.

Efficient assignment and control of work on a job-by-job basis requires much planning and a large volume of paper work. This work is very repetitive in nature and an excellent subject for work simplification.

On work of caution: simple elimination of paper work or arbitrary reduction in the number of work orders is not the answer if it results in loss of control. Much can be done, however, to reduce complexity of this documents and decrease the effort and time required to process them without destroying their effectiveness.

2. History records.

The development of maintenance history records is absolutely essential to carrying on a productive quality control program. But these records are often quite voluminous and time-consuming in both preparation and use. The methods used for the assembly and retrieval of information from these records represent an excellent area for work simplification.

IMPROVING TECHNICAL DECISIONS

The following are areas of effort which can greatly benefit from the use of the work-simplification approach, specially when equipment grows more and more complex:

1. Pre-detection of incipient failures.

Effective preventive quality control will require improved techniques for predicting when, where and how failures are likely to be incurred. This probably involve the development of better inspection techniques, the introduction of the use of more diagnostic instruments, and perhaps the introduction of continuous monitoring techniques.

2. Post-failure remedial-action decisions.

The determination of the exact nature and extent of equipment malfunctions and remedial action indicated is becoming increasingly difficult as the variety and complexity of facilities increase. The predevelopment of standard diagnostic routines offers and excellent opportunity for the development of better methods.

3. Repetitive-job standardization.

Use of standardized, pre-selected procedures for the same or similar jobs will increase the volume of work upon which detailed methods-improvement studies can be justified.

IMPROVING MANPOWER AND MACHINE UTILIZATION

The multiple-activity process charting technique provides an excellent vehicle for exploring ways to:

1. Reduce crew sizes.

Use of pre-planned, shop make-ready,

prefabrication or pre-assembly, special-handling equipment or tools, etc., can frequently reduce the amount of work done by field crews.

2. Reduce out-of-service time.

Careful pre-scheduling can often appreciably reduce the total time required to complete jobs. The multiple-activity process chart is a good tool for this purpose. When jobs are large and complicated, it is usually necessary to resort to the more complex critical-path technique.

SIXTEEN

The art of free society consists first of the maintenance of the symbolic code, and secondly, in the fearlessness of revision . . . Those societies which cannot combine reverence to their symbols with freedom of revision must ultimately decay.

Alfred North Whitehead
Beyond Bureaucracy *(Warren G. Bennis)*

PLANNED CHANGE AND ORGANIZATIONAL DEVELOPMENT

OBJECTIVES

1. To examine the nature of change and analyze some of the forces which make it necessary.
2. To pinpoint the differences between haphazard and planned change.
3. To itemize and explain some of the commonly used strategies in implementing planned change.
4. To define and analyze organizational development and illustrate its relationship to planned change.

Change is inevitable. It is a fundamental aspect of historical evolution. The nature of organizations has changed over time. They are not the same as they used to be. And future organizations are not likely to be like those of the present. To complete our analysis of management theory and practice, we must understand organizational change, its causes, and its effects. To do this we will make a final shift in emphasis.

We began our micro-to-macro analysis of administrative theory by focusing on the individual and small group. We then shifted to the

broader topic of the complex organization. We now move away from the internal structural aspects of organization to the external forces that require substantial internal changes.

NATURE OF CHANGE

The nature of organizational change can best be understood in the context of the traditional view of organizational structure. So we will first briefly review the structural approach to organization theory. We will then examine the types of changes that are currently taking place. An organization is not an entity unto itself. It is also a composite of the individuals and groups within it. And people are often reluctant to make changes. Therefore we will also examine the psychological factors that cause this resistance to change.

Traditional Organizational Structures

The structural approach views organizations from a closed-system perspective, with an emphasis on the efficiency of operations. The bureaucratic logic that has emerged is based on the principles of (1) specialization of labor, (2) standardization of work, and (3) centralization of authority. Less structural approaches see such efficient organizations as *monocratic* systems in which the legitimacy of authority flows from the top of the organization.[1] Consequently, the structure is rigid and inflexible and has difficulty adjusting to change. And bureaucracies do tend to emphasize conformity and deny or repel changes that would upset their traditional ways of doing things.[2]

It is probably safe to say that the environment within which an organization develops imposes certain characteristics on its structure.[3] Thus, electronic firms display structural characteristics unlike those in industries less affected by frequent and revolutionary upheavals. Even in rapidly changing industries, however, environmental factors can change faster than the organizations, so flux exists as a major problem in all areas of organizational life. Therefore, organizations and individuals, if they are to function effectively, must be capable of diagnosing situations, possess the ability to act, and be flexible to change.[4]

When we apply the test of efficiency to traditional bureaucratic forms of organization, they generally score rather high. This is especially true in environments where tasks are routine, programmed, and highly predictable. When tasks become more complex, less programmed, and more unpredictable, the case for a bureaucratic structure is less convincing.[5]

Warren Bennis has suggested four major "threats" or categories of conditions that bureaucracies are not adaptable enough to cope with: (1) rapid and unexpected change, (2) growth in organization size and complexity, (3) complexity of modern technology, and (4) changes in management behavior.[6] Although additional categories could be generated, we need look only at these to illustrate the adaptability needed by organizations to cope with change.

Warren G. Bennis: Bureaucratic Foe

Born in 1925. He received his Ph.D. from the Massachusetts Institute of Technology and is a Fellow of the American Psychological and Sociological Associations. He has written widely on organizational theory and behavior and has been primarily concerned with the inability of traditional organizational forms to meet the challenge of change. Among his many books on the subject are Changing Organizations, Beyond Bureaucracy, Organization Development, *and* The Temporary Society. *At the time of writing he is president of the University of Cincinnati.*

Rapid and Unexpected Change

Change is subject to the *law of acceleration*, which states that change takes place at an ever increasing rate.[7] Although there are, of course, practical limits to change, and perhaps theoretical ones, this law indicates that, for example, one set of technological change creates the potential for further advances. The same law applies to such other areas as the legal-political environment of business.

Before the turn of the century, for example, organizations could assume a relatively stable legal environment. At least the philosophy of the legal system could be assumed to be constant. The manager of an organization could set up relatively mechanistic procedures for updating operations based on changes in the legal environment. The contemporary situation is quite different. For example, more than 26,000 pieces of business-related legislation were introduced in the 89th Congress. During the same period the various states passed 41,000 business-related bills into law. In the State of New York alone, a business firm would have to be aware of over 20,000 laws that could potentially influence its operations.[8] With the vast amount of laws and the number of changes they represent, organizations must be adaptable. Inflexible organizations have difficulty surviving in such a setting.

Growth in Organization Size and Complexity

Organizations of all types are becoming larger and more complex. Antony Jay points out that the fifty largest American corporations have revenues greater than the combined revenues of all the fifty states. General Motors, for example, has greater annual revenues than any single state.[9] Educational institutions too have grown in size. Some state university systems now have enrollments that exceed 100,000 students, and at least one private university (Harvard) has an endowment of over $1 billion.

Increases in organization size are usually accompanied by increases in organization complexity. Business firms that engage in multinational expansion, for example, expose themselves to regulation by other than their domestic legal system. They are therefore forced to deal with new and unfamiliar value systems. The result is an increase in the complexity of their operations.

How large can an organization become before the traditional concepts and principles of structural theory are rendered ineffective? For example, how efficient and effective can a structure that is designed for one environment be when it enters another environment that has a different set of ground rules? These are some of the questions that critics of traditional organizations are beginning to ask. And the contingency theory has been put forward as one basic answer. Because it proposes that organizational structure is situational (relative), the contingency view makes adaptability a primary requirement for successful organizations.

Complexity of Modern Technology

Few problems in industry, education, or government can be solved today by drawing exclusively upon the resources and expertise of a single department or group of individuals. Most of the really important problems faced by organizations are *trans-* or *multidisciplinary* in nature. The essence of the modern *systems approach* to management is the recognition that organizations are interrelated units working toward a common goal.

If this is true, organizations must facilitate cooperation among diverse specialists both within and without a single organization.[10] As we saw earlier, some of the technological forecasting techniques used today utilize the expertise of a panel of specialists from a variety of areas to gain insights into the future prospects for a specific industry.

Traditional organizations, which are built on such classical principles as departmentalization, frequently discourage (sometimes prohibit) effec-

tive interaction among diverse specialists. Sales personnel are organizationally and geographically isolated from production operations. And research staff members may never have any meaningful interaction with either group. Technology, according to the law of acceleration, is going to become even more complex. Therefore alterations in *attitudes* and probably in the *structure* of collective behavior will be necessary if such organizations are to be successful in the future.

Changes in Managerial Behavior

The evolution of management thought clearly reveals a trend away from the mechanistic assumptions of structural thinking toward a more humanistic orientation. This emerging orientation requires a more systematic understanding of the determinants of human behavior.[11] Specifically, Bennis argues, new concepts of *man, power,* and *organizational values* are required.[12] The new concept of man should reflect our increased knowledge of the complexity of human needs, while the new view of power should be based on cooperation, collaboration, and reason. And organizational values must change to the humanistic-democratic ideal and away from the mechanistic bureaucratic system. These changes, if effected, would require substantial alterations in the behavior of traditionally oriented managers and would ultimately be reflected in the structure of the organizations themselves.

The new concept of Man, for example, would require more emphasis on participation in decision making and a consequent reduction in the centralization of authority. The new concept of power would require essentially the same type of alterations, while increasing the importance of expert knowledge in the decision making process. The restructuring of organizational values would result in less attention being given to achieving operational efficiency according to codified procedures and rules at the expense of the individual.

RESISTANCE TO CHANGE

The process of change is complex because of the interaction throughout the social system of different yet interrelated factors.[13] Technological advances, for example, often carry significant social implications. Consider automation. In many cases the automation of a production process can result in unemployment for production-line workers. Interestingly, however, most people seem more capable of accepting technological than sociological changes.[14]

There seems to be a variety of reasons why human beings tend to

resist change. Perhaps it is because we are basically creatures of habit and dislike the uncertainty that changes create. More specifically, it has been suggested that resistance emerges because of *insecurity, economics,* and *sociopsychological* factors.[15]

Human beings tend to become satisfied with the status quo. Insecurity emerges when changes occur. Sometimes this insecurity develops because of economic considerations. Lower level workers fear that automation will result in unemployment. Higher level employees might view alterations as threats to their status and eventually to their economic well-being. For example, physicians might resist the professional acceptance of paramedical personnel for fear that the increased volume of work they could handle might reduce the volume available to other physicians.

Finally, there are the sociopsychological factors, which are based on cultural programming. Educators, for example, often resist education innovations because they have been programmed to accept the traditional methods and techniques of teaching and learning.

In reality, changes occur whether people accept them or not.[16] Kurt Lewin provides an interesting analysis which argues that even the status quo is a *dynamic* rather than a static concept.[17] All established procedures and processes are constantly subjected to *driving forces* that are working to bring about change. At the same time there are *restraining forces* attempting to keep things as they are. The situation that exists is what Lewin calls a *quasi-stationary equilibrium,* which can be changed at any time.

Consider the Breakstone Answering Service Company's plan to introduce a new wage incentive program. The present one, which has been in operation for five years, has been generally satisfactory to most employees. The maintenance crews, however, have recently become dissatisfied and actively sought to initiate changes. They represent the driving forces. The personnel department, on the other hand, has been extremely resistant to any alteration in the wage incentive program. It represents the restraining forces. The compromise of these forces which has existed over the years is the quasi-stationary equilibrium. It has at times been close to change and at other times firmly entrenched. In other areas resistance to change has been no less obvious. For example, in a study of the resistance of elementary schoolteachers to the use of audiovisual aids by Gerhard Eichhloz and Everett Rogers (*Innovations in Education,* edited by Mathew Miles), several factors were itemized as accounting for the tendency not to change.

1. *Resistance because of ignorance.* Often concerned individuals simply are not aware of the changes taking place. A businessman, for

example, may continue to use a certain production process because he is unaware of a better method.

2. *Resistance by default.* Sometimes a businessman may reject a change, even though he is aware of another technique, with little justification except the obvious desire not to use a new method.

3. *Resistance on the basis of the status quo.* Here a change is not adopted because it has not been used in the past.

4. *Resistance because of social reasons.* A manager may refuse to change because of a feeling that the "society" within and outside the organization will not accept it.

5. *Resistance on the basis of interpersonal relations.* Because friends and associates have not accepted the change, the businessman does not.

6. *Resistance through substitution.* Another process or technique is selected in favor of the proposed change.

7. *Resistance by fulfillment.* A businessman rejects a change because he knows what is best, thus making change unnecessary.

8. *Resistance because of experience.* A businessman rejects a change when he tries it but does not like it.

9. *Resistance through incorrect logic.* A businessman may reject a change on logical grounds without using well-founded reasons.

Although those points were developed in a study of teachers, it is not difficult to see that they can be operative in all types of organizations.

TYPES OF ORGANIZATIONAL CHANGE

Changes that take place in organizations are of two types. They may be random, or *haphazard.* They simply occur, and no effort is made to prepare for them only to deal with factors as they develop. Changes may also be *planned.* These are the result of any attempts to adjust organizational operations, where the actions are conscious, deliberate, and intended on the part of one or more "agents" who seek to promote the changes.[18]

It will be conceded initially that much of the change in and out of organizations is unplanned. Technology, for example, is ever changing and rarely planned by a single manager. The same is true of worker attitudes, social expectations, and legislation. Quite often changes in these areas are not dysfunctional and may even present unique opportunities and challenges for persons with managerial responsibilities.

The point is, however, that when a manager wishes to capitalize on even unplanned changes, a systematic approach is required. A manager, for example, may recognize that several new recruits "fresh" out of col-

lege seem to have attitudes that are different from those displayed by the previous generation. The manager at this point may simply deny this new reality and continue to operate as before. In doing so, it is likely that the new employees will become unhappy and the organization will lose the benefit of new ideas. On the other hand, the manager might plan systematically to orient new employees into the philosophy of the firm and initiate new means of allowing recruits to accomplish their own goals while making an organizational contribution. In this manner random action is minimized and an orderly approach is taken to dealing with change. Like other organizational approaches, the systematic approach appears compelling, where the actions are conscious, deliberate, and intended on the part of one or more "agents" who seek to promote the changes.

NATURE OF PLANNED CHANGE

Since planned change is a *deliberate* attempt to introduce alterations in an organizational system, it can be considered a process, as illustrated in Figure 16-1. This particular sequence of events, of the many that have been proposed, is most general in its application.[19] And we will discuss briefly each step in this process.

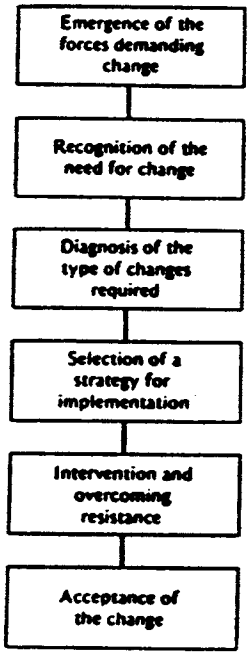


Figure 16-1 One Process of Planned Organizational Change

Emergence of Forces Demanding Change

The forces demanding change may originate inside or outside of the organization. Internal forces can result for various reasons, for example, from decreasing performance levels caused by such things as labor turnover, absenteeism, interdepartmental conflict, and so on. External forces can be familiar forces, such as technological innovation, government regulations, and changing social attitudes. Antipollution legislation, for example, has caused numerous firms to initiate change programs designed to comply with the regulations. And recent economic developments, such as inflation and energy shortages, may demand substantial alterations.

Recognition of the Need for Change

The *imperative* of change may be recognized in a variety of ways by managers or outside consultants who are brought into organizations for the purpose of effecting alterations. Sometimes recognition comes through the analysis of performance reports originating from the controlling function. At other times recognition may simply come as a stroke of luck whereby a perceptive manager anticipates some impending force that will necessitate change.

Diagnosis of Required Change

Once the forces of change are recognized, efforts must be made to determine the types of *actions* the change program will require. For example, a governmental decree that all automobiles must be equipped with specific types of safety equipment or that all organizations must adhere to certain employee safety standards requires considerable analysis.

Another example, the Occupational Safety and Health Act (OSHA), which was passed into law in December 1970, has required a variety of actions by the affected organizations. From the beginning it was obvious that the Department of Labor would have tremendous problems enforcing the act.[28] In analyzing the alternatives, some managers decided to wait and see and hope that their organizations would not be inspected. Others attempted, as best they could, to comply with the standards and requirements of the act.

Selection of a Strategy

Once the decision is made to implement a change, the manager or outside consultant must decide on one or more *strategies* to use in effecting

the alteration. Although various authors classify the available strategies differently, three general categories seem to be inclusive of the more important implementation alternatives.[21]

Force. Perhaps the most simple strategy is the *force* approach. The manager responsible for implementing the change requires that employees adhere to the rules established for the implementation. This approach is fast but rarely acquires the total commitment necessary for successful long-term change.

Suppose the manager of a production firm comes into his office one morning to find that an enforcement officer from the Department of Labor's Occupational Safety and Health Division has submitted his report and found five serious violations during his inspection of the company. The report specifies that these conditions *must* be corrected immediately. The manager's course of action at this point is clear. Without consultation or advice the manager orders that action be taken. A change has been imposed on him that requires immediate response. Thus, he uses legitimate authority and forces a solution.

Self-interest. The *self-interest,* or *persuasive,* strategy recognizes that individuals are motivated primarily by their own self-interest. The manager, therefore, proceeds to show organization members how it is to their personal advantage to alter their behavior. When successful, this approach is fast, efficient, and long lasting.[22] Unfortunately, most changes do not carry favorable effects for everyone so that this approach may have appeal to only certain segments of the organization.

Consider the case of the public official who is faced with the responsibility of enforcing pollution guidelines imposed on local industry. Although she could simply force them by law, she chooses to show businessmen how new equipment designed to reduce the emission level also increases efficiency. Therefore, the official develops data to illustrate how the purchase of new equipment will rapidly return the investment and reduce pollution at the same time. In other words, it is to be argued that the new equipment is a good investment in monetary terms and the "rational" thing to do.

Education. The third alternative, the *training* or educational strategy, does not deny the self-interest motivation. It does, however, recognize that when no *evident* advantage exists, value systems may be changed through training so that the alterations are more acceptable. Since information transfer is necessary for a successful change attempt, this educative element is likely to be part of all change attempts. It has the advantage

of developing commitment to the plan but requires a long period to accomplish.

To assist in comparing the alternative strategies, a check list of advantages is given in Table 16-1. It can easily be seen that where appropriate the self-interest appeal provides the greatest advantage.

TABLE 16-1
Check List Comparing the Advantages of Alternative Change Strategies

Advantages	Strategies		
	Force	Self-Interest	Education
Speed	x	x	
Commitment		x	x
Ease of implementation	x	x	
Minimization of resistance		x	x

Intervention and Overcoming Resistance

In reality, it should be recognized that most comprehensive change programs involve the utilization of more than a single strategy.[22] Assume, for example, that a manager is faced with implementing a decision to add a third shift at a production facility in a firm. He or she might begin by observing that higher management has required the action and starts operations immediately. In doing so, force is applied. In order to minimize resistance, however, various actions are taken, as shown in Figure 16-2. First, employees may be asked to *participate* in working out the

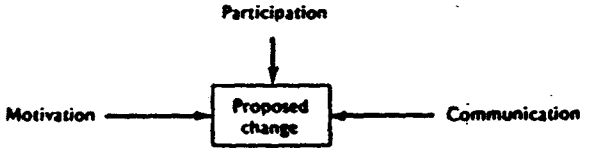


Figure 16-2
Elements of a Comprehensive Change Effort

details of the transition. Through participation, workers may feel more a part of the decision and begin to identify some self-interest in the change. This aspect may be further developed by providing *motivation*, perhaps in the form of higher pay for those working the third shift. The manager may also reduce resistance by informing employees of the factors necessitating the change. In this manner, *communication* (educative information) is provided to justify the decision. In this example, participation, motivation, and communication become interrelated elements in the effective change program. The intervention of a manager (or consultant) is thus designed to increase the likelihood of reducing resistance and ensuring the successful implementation of the program.

Acceptance of Change

If the change agent accurately identifies the proper strategy or strategies to use in a particular situation, organizational members are more likely to be receptive to the implementation of the change. As an effective user of behavioral science concepts, the agent will be careful to ensure that an adequate opportunity for participation has been offered, that the change concept has been communicated to employees, and that incentives have been offered for the acceptance of the required alterations. Like any other motivational program, care must be taken to utilize the current strategy or strategies in accord with the unique needs and situations faced by every organization and group.

USING MANAGEMENT KNOWLEDGE

Managers as Agents of Change

When we defined planned change we emphasized that it was a deliberate attempt by one or more agents seeking to promote the alteration. Often such a change agent is thought of as an outside consultant who comes into the organization, or *client system*, and in association with the insiders attempts to apply expert knowledge to the problem(s) under examination.[24] This, to be sure, is a valid concept of an agent of change.

It is important to recognize, however, that managers, in performing their administrative roles, must constantly serve as change agents and assist in overcoming resistance to necessary alterations.[25] In this respect, managers share a number of characteristics with outside professionals.

For example, those who are charged with the responsibility for implementing change assume that the goal is *organizational effectiveness* and that the primary means for accomplishing this end is to change human behavior. They may function as trainers, consultants, counselors, or managers.[26] When managers assume such roles, it is important to recognize that the functions performed are as important as the other management tasks—planning, organizing, controlling. When changes are effected, regardless of the agent involved, expert knowledge is applied to the practical problems of organizational change.

Knowledge Flow System

When managers of organizations serve as change agents, the realities of organizational life are easily, perhaps automatically, incorporated into the change effort. When outsiders are "brought in," which is frequently

the case, various problems are likely to develop in attempting to transfer sound management theory to practical decision making.

It has been argued that the transfer of management theory to practice can be visualized as a macrocommunication system.[27] If the knowledge generated at the research or theory stage is to be used for practical purposes by managers, the managers must be made aware of or utilize experts familiar with the expanding management knowledge. This is basically the problem of *knowledge flow,* or the transfer of theory to practice. Figure 16-3 provides a diagram of this process.

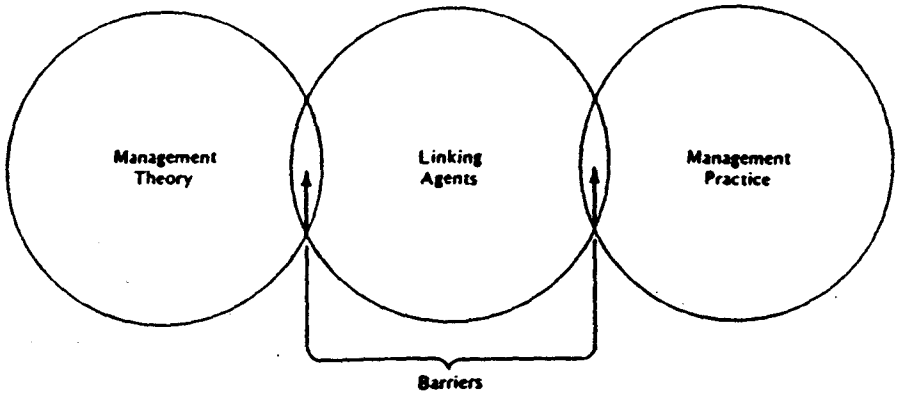


Figure 16-3 Knowledge Flow System

Source: Adapted from Ronald G. Havelock, *Planning for Innovation* (Ann Arbor, Mich.: Institute for Social Research, University of Michigan, 1969).

As new knowledge develops through research, forces are activated to apply, at some future date, the newly developed concepts to real-world problems. Implementation is facilitated by individuals or organizations who attempt to *link* the theory and the practice. This is the point at which the agent of change becomes important. The difficulty associated with the linking occurs because researchers and managers sometimes view their functions as independent of each other, although they may desire meaningful interaction.[28] Even when cooperation and understanding exist, differences in researcher-practitioner attitudes and value systems may present problems.

Potential Problem Areas

A recent survey has proposed that managers and researchers do generally agree on many of the requirements for the effective transfer of theory to a form in which it may be ultimately utilized.[29] However, substantial disagreement was noted with respect to certain philosophical aspects of

the problem. For example, managers and researchers generally disagreed on where management knowledge actually originates. Obviously, until the origin of new concepts and practices is recognized, there is little hope in effectively transferring the knowledge. Disagreement also existed about what criteria should be applied in deciding when theory is actually worthy of utilization by managers. There is, however, one relatively new technique that shows signs of assisting a supportive relationship between the two groups. This concept is known as *organizational development*.

NATURE OF ORGANIZATIONAL DEVELOPMENT

Organizational development (OD) has been defined as a *process designed to increase organizational effectiveness by integrating the desires of individuals for growth and development with organizational goals.*[30] Bennis provides further insights by referring to it as a *complex educational strategy* used as a response to change which is designed to alter beliefs, attitudes, values, and structures of organizations to enable them to adapt to alterations.[31]

Organizational Development versus Management Development

Organizational development represents a major departure from more conventional methods of management development and training. To gain greater insight into OD, we will compare it with the more traditional concept of *management development*. OD is an attempt to *change the total system* and restructure it in line with the individuals within the system. Management development accepts the existing structure and its policies and rules and attempts to *change the individual supervisors* to make them more effective in accomplishing goals within that framework.[32] Warner Burke and Warren Schmidt carefully itemize several areas where the two concepts differ. We will look at a few of the more important ones.[33]

Objectives. It can be said that the primary purpose of management development is to equip managers to contribute their potential to the accomplishment of organizational goals. This objective is accomplished through all the familiar methods used in organizations. One of the most frequent is to encourage businessmen to participate in continuing education and familiarize themselves with developing concepts and techniques of the behavioral sciences and systematic decision theory. OD, on the other hand, seeks to alter the nature of the organization itself.

Sensitivity Training

Sensitivity training is a laboratory technique sometimes referred to as T-Group training. This technique is associated with OD, and Bennis states that the T-Group is the basic "strategy of intervention" in efforts to alter organizations.[37]

The goals of sensitivity training are numerous and varied, and the more commonly recognized ones are:

1. *Self-awareness and sensitivity to others.* This involves building a person's competence as a manager and group member by making him or her more familiar with his or her own attitudes and emotions as well as those of others.
2. *Learning from experience.* T-Groups are often designed to assist members in perceiving and learning from the consequences of their behavior.
3. *Role awareness.* Sensitivity training attempts to provide individuals with an understanding of their roles within an organization and their relationship with others.
4. *Diagnosing change.* This technique attempts to assist organizations in diagnosing, defining, and working toward problem solving in groups rather than with individuals acting alone.[38]

The conduct of a sensitivity training program is also subject to variation. The group may be composed of a collection of "cousins," that is, of people who work in the same organization but who do not work directly with one another. Or, they may be "family" groups, that is, individuals who work with one another such as a supervisor and his or her work group.

One of the more familiar approaches is to assemble a group of "strangers" who participate in a program sponsored by an organization such as the National Training Laboratories. This organization's sessions are often conducted in places that are geographically separated from the work place. When the strangers come together for a weekend or longer period, emphasis is placed on teaching them to become more sensitive to others. Sensitivity, or awareness, training has been used to a limited extent in dealing with the increased number of hard-core unemployed coming into business firms through affirmative action programs. Some companies have encouraged supervisors to attend sessions designed to make them more aware of the problems of the hard core. Exercises are developed whereby managers actually assume the roles of the hard-core worker, and situations are created to show supervisors "how it feels" to

be in the other person's place. Increased sensitivity is gained when both parties voice their attitudes and relate them to such things as family value systems, environmental backgrounds, and similar factors.

Regardless of the composition of the group, session formats usually follow a standardized pattern. First, leadership and formality are minimized so that participants interact. Next, the leader (trainer) begins to exert influence by expressing his or her own feelings with a low degree of evaluation. Feedback among participants is encouraged. In the third phase, interaction is in full gear, and interpersonal relations develop. Finally, the group, with the trainer's assistance, attempts to relate the group experiences to real-life problems.[39] Contrary to the criticisms of some, this is *not* manipulative brainwashing or psychoanalysis.[40]

From a practical point of view, there seems to be no overwhelming evidence that laboratory techniques such as sensitivity training actually change a person's self-awareness, sensitivity to others, or attitudes and beliefs.[41] Individuals who participate in these sessions do seem more open in their relations with others, which suggests that such techniques do have some value in organizational development. If one is to maximize the values of T-Group sessions, care must be taken in selecting participants. Generally, these people should be relatively free from internal conflicts, have *strong* egos, and have defenses that are low enough to allow for effective interaction.[42]

Organization Task Laboratory

The organization task laboratory (OTL), like sensitivity training, is a laboratory technique. The basic component of the technique is a small group composed of between five and fifteen people. In the OTL, representative management situations and decisions are created with the hope of allowing managers and the work group to experience and learn about the following:

1. *Recognition of conflict.* Emphasis is placed on how managers can work more effectively with his or her group and other managers so as to increase individual and goal accomplishment.
2. *Reconsideration of established practices.* Participants are encouraged to examine their own behavioral styles and those of others.
3. *Formulation of explicit goals.* The OTL stresses the importance of explicit, clear objectives and their advantages over vague guidelines.
4. *Experimentation.* Groups are designed to assist participants in experimentation and innovation and the development of means to evaluate the consequences of creative action.[43]

Compared with sensitivity training, OTL places more emphasis on task-oriented team experience and less on self-awareness and sensitivity in interpersonal relations. Essentially, the OTL places emphasis on group problem solving. Members of various units come together not so much to become sensitive to one another, although this may well happen, as to utilize group processes in formulating goals and experimenting with innovative ways of accomplishing them. As we noted in Chapter Seven, groups are often capable of stimulating individual behavior in positive or functional directions. OTL is one attempt to make the most of the group problem solving concept.

Transactional Analysis

In 1964, a well-known psychiatrist, Eric Berne, wrote a book entitled *Games People Play;* Thomas Harris later followed with *I'm OK—You're OK.* Both authors utilized *transactional analysis* (TA) as a means of improving relationships between individuals. In transactional analysis an attempt is made to analyze the social interchange (transaction) among people with the objective of *understanding* and eventually improving interpersonal relations.

According to Berne, an individual has three *ego states:* parent, child, and adult. When the *parent* state is exhibited, a person is responding to a situation in a parental nature. This ego state is said to be *directly active* when the individual acts as his or her own parent has acted in the past. The parent state is *indirectly active* when the individual responds as he or she would have wished the parent to respond. For example, an authority-oriented supervisor who tells an employee to do something "because I said to" is responding as a parent.

The *adult* state is displayed when a person acts in an autonomous, objective, and logical manner. A decision maker acts in this way when he or she calculates the pros and cons of a situation, logically selects an alternative course of action, and attempts to implement the decision in a mature manner.

The *child,* as the name implies, responds in an immature manner. The *adaptive* child acts as he or she perceives the parent would want them to respond. The *natural* child responds spontaneously by rebelling or in some other manner. The bureaucrat who "does what he is told" without thinking responds as an adaptive child. The employee who immediately rebels against a new rule without analyzing it displays the natural child state.

In each relationship, one of the ego states dominates behavior. When a person, through transactional analysis, learns to perceive the

state of himself or herself and others, relations can be better understood and the transaction improved. Consider the following hypothetical transaction between a supervisor and employee:

Supervisor: After reviewing your performance records, I see that your output has fallen for the past three months. Continued reduction in performance will make it necessary to terminate your employment.
Employee: At last your true thoughts about me come through! You have been looking for an excuse to get me! Now you are using performance records.

Assuming that we have all the information about the situation, it would appear that the supervisor acted in a logical, adult way, using supporting information and stating facts. The employee, however, emotionally responded as a child.

As an OD technique, transactional analysis encourages organizational members to act more as adults and less as children or parents, thereby making them more flexible to change and capable of responding in a mature manner.[44] To date, a number of companies (for example, American Airlines, Bank of America, and Westinghouse) have exposed their executives and managers to TA. According to Dr. Hedges Capers of the San Diego Institute of Transactional Analysis, numerous organizations have found that this method can actually make money. Employees, for example, develop respect for others and cultivate good customer relations. One advantage in particular is said to be that TA carries implications beyond organizational boundaries. Employees take it "home" and develop better relationships with their families.[45]

Confrontation Meetings

The organizational *confrontation meeting* is a technique designed to mobilize the resources of the organization toward problem identification, the establishment of priorities and goals, and an action plan for accomplishing them.[46] This concept of OD is frequently used when an organization faces a crisis such as a major reorganization or massive personnel changes. The process, or format, is reasonably well defined. A group is informed of the problem and assigned the task of identifying the problems facing the organization. Heterogeneous groups (with representation from various functional areas) are then assigned and asked in an honest and open way to identify organizational problems. The groups then come back together as a larger group and each segment reports its list of problems and may propose solutions. The leader (change agent) then classifies the problems, and the larger group is broken down into homo-

geneous segments. Marketing personnel, for example, are assigned marketing problems; financial managers get the financial problems, and so on. The groups then establish priorities and suggest solutions or plans of action. The groups periodically report their progress and receive feedback from other units. Less periodic meetings are then scheduled to keep all areas of the organization informed about the progress being made.[47]

The confrontation meeting technique appears to be particularly valuable in bringing the total resources of an organization to bear on the solution of common problems. And it provides employees with a feeling of participation in the problem solving operation.

MBO

When we dealt with MBO as a partial philosophy of management, we noted that it can be useful in integrating organizational and individual objectives. Because of this, it has become closely associated with OD.

Conceptually, MBO integrates individual and organizational goals by encouraging participation in the goal formation process and in developing action plans and evaluating by results.[48] Therefore, some argue that the proper implementation of either OD or MBO necessarily results in the implementation of the other.[49] There does seem to be a close relationship between the two concepts, although they do not seem to always relate directly to one another.

Grid Development

Another technique that has become closely associated with organizational development is the *managerial grid,* developed by Robert Blake and Jane Mouton. The developers frequently refer to the grid as "operation bootstrap" because the concept is designed to lift up the entire organization to maximum production and profits.[50]

The managerial grid acquired its name from the graphic representation of the concept, as illustrated in Figure 16-4. The two-dimensional diagram (grid) measures an individual's *concern for production* (task orientation) and *concern for people* (employee orientation).

Using the grid, Blake and Mouton are able to itemize various positions that an individual might assume with regard to his or her orientation toward production and people.[51] The first position, beginning in the lower left corner, is described by the ordered pair (1,1). This position is considered the least desirable of all because a person located at this point displays a minimum concern for production and for people.

Moving to the upper left corner we come to the (1,9) position,

where there is a high concern for people and a minimum concern for production. In a case such as this the manager surrenders control to the group and places a disproportionate emphasis on maintaining harmony and relatively little on production considerations.

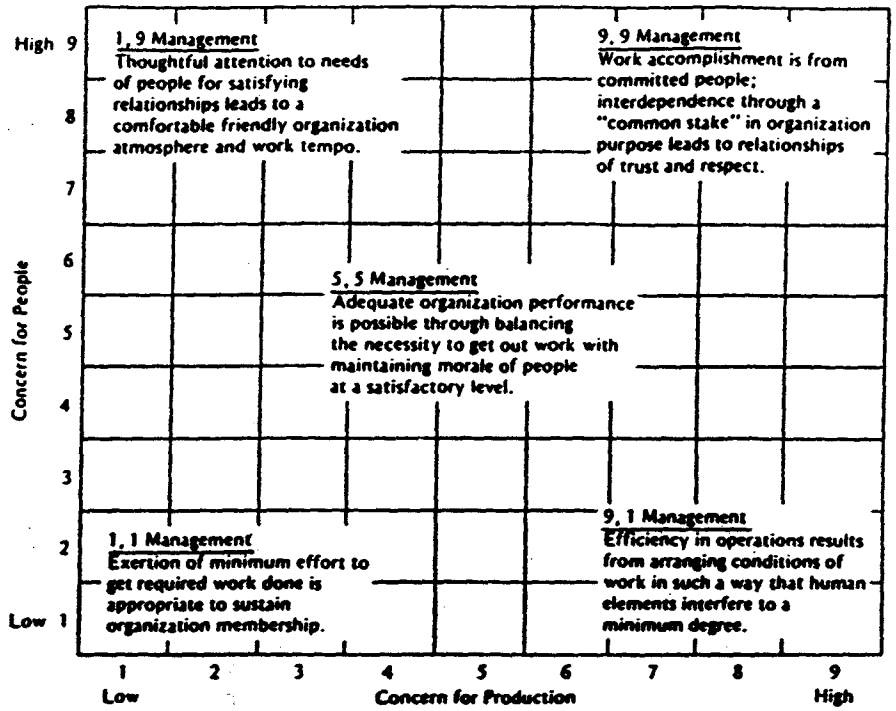


Figure 16-4 Managerial Grid

Source: Adapted from R. R. Blake and J. S. Mouton, *The Managerial Grid* (Houston, Texas: Gulf Publishing Company), p. 10.

The (9,1) position is just the opposite—little consideration is given to people while maximum concern is directed toward the task or production. This is commonly associated with an autocratic approach to supervision.

At the center of the grid (5,5) is the middle-of-the-road manager who displays only moderate concern for production and people. Emphasis is placed on compromising the demands of the task and the people.

Finally, in the upper right corner is the ultimately desirable position (9,9) where maximum concern is revealed for people and production. This type of manager views people and production as complementary

Robert Blake and Jane Mouton: Managerial Grid

Robert R. Blake, born in 1918, is president of Scientific Methods, Inc., and a former professor at the University of Texas. He has been a leader in the application of behavioral science knowledge to the problems of organizations. He has served as a lecturer at Harvard University and the University of Reading in England where he served as a Fulbright Scholar.

Jane Srygley Mouton, born in 1930, is a social psychologist and a former member of the faculties at the University of Texas and Florida State University. She presently is vice-president of Scientific Methods, Inc. She and Dr. Blake were instrumental in the development of the managerial grid.

rather than conflicting or competing concerns and attempts to accomplish organizational goals through the development of mutual trust and respect within the group he or she supervises.[82]

In practice, the grid is only a technique used in effecting organizational change. Usually a change program begins with participants taking a test that places them on the grid in one of the locations. This is done for self-reflection only so a person can understand how he or she personally rates on the grid.

After each participant becomes aware of his own orientation, a seminar is initiated, with the individuals divided into heterogeneous groups representing different specialties and organizational levels.[83] At this point important behavioral concepts are introduced. The next step is directed toward *team development* and begins with top level executives. Participants function as superiors and subordinates. *Intergroup problems* are the next to be analyzed, and organizational members such as department heads who have responsibility for group cooperation and coordinates are involved. Methods of improving interaction are developed.

The insights developed to this point are then applied to the formulation of a *strategic model:* goals are specified, structures are developed, customers and markets operationally defined, and policies formulated to guide decision making. Finally, an *implementation plan* is devised that takes into account the uniqueness of the firm and the industry. Review and reevaluation are also recognized as important aspects of the program.

Some impressive experiences have been reported in the use of the grid technique. One study illustrated how the grid program had resulted in several millions of dollars of cost savings, in production increases, and in better intergroup relations.[84] At one point, the grid approach was being used by over 160 of *Fortune*'s top 500 companies.[85]

ORGANIZATIONAL DEVELOPMENT IN PERSPECTIVE

The discussion of OD techniques was intentionally broad and descriptive. The objective was to acquaint prospective managers with selected techniques, not to train individuals as OD specialists. Although numerous success stories have been associated with all the OD techniques discussed, it is important to note that only qualified personnel should use them. The same techniques which may prove useful in the hands of qualified persons can be dangerous when used improperly.

There seems to be a tendency on the part of many practitioners to become overly impressed with a single technique. At one time a technique such as sensitivity training comes into vogue, and everyone rushes to use it. Then, some other approach, maybe confrontation meetings, captures the attention of behavioral scientists and managers. The fact is that OD techniques, like the strategies of planned change, must frequently be used in combination with one another.[66]

As organizations develop they change, as do the individuals within them. And it is ironic that the individuals who function as agents of change sometimes become inflexible in their approach to OD. Thus, it is always important to be aware of and understand the advantages and disadvantages of the techniques available and the unique aspects of the organization to be altered. With that kind of overview the correct technique or combination of techniques is more likely to be selected.

It is especially important to recognize that major organizational alterations take time. They do not take place overnight. Sometimes periods of five years or more are required to see a change program through to its completion. Obviously, this requires considerable commitment on the part of the organization's management if OD programs are to be successful.

SUMMARY

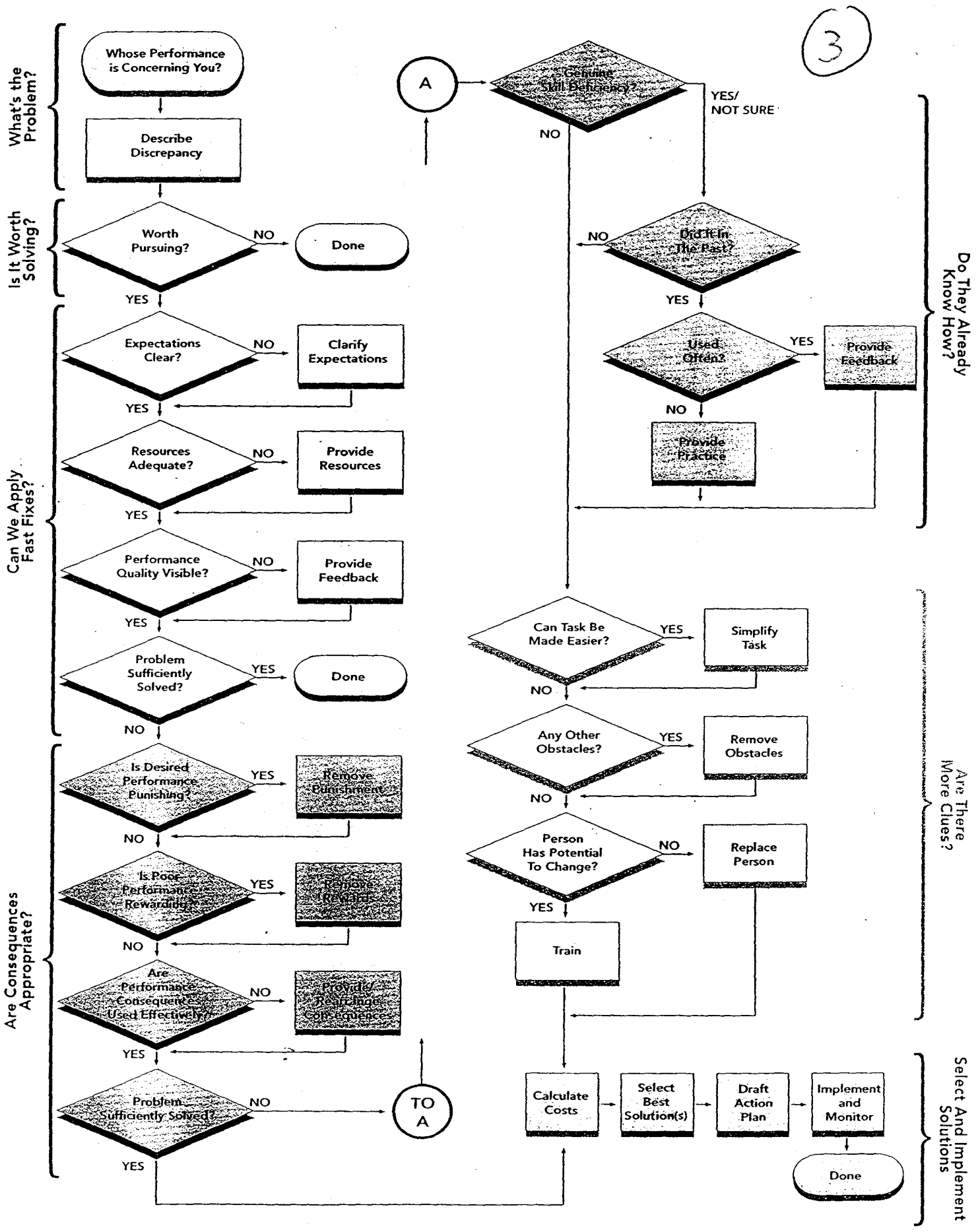
The traditional model of bureaucracy is the one most frequently encountered in today's organizational society. The primary reason for its popularity is its capability for developing efficient operations. But the bureaucracy is not easily adaptable to change. The environments of organizations require that successful organizations be not only efficient but adaptive as well, although adaptability is not always easy to achieve. There is considerable evidence to suggest that a certain amount of *resistance to change* is inherent in human behavior.

Therefore, *planned*, or deliberate and conscious, changes are necessary for organizational survival. Managers must learn to function as *agents of change* or at least familiarize themselves with the process of change so that the services of outside consultants can be effectively utilized.

Several *change strategies* are available to an agent of change when he or she attempts to apply behavioral knowledge to practical problems. The agent may use the rational approach and emphasize the *self-interest* advantage in accepting change. Or, *educative techniques* may be used to inform concerned individuals about the reasons why alterations are necessary. Finally, organizational members may be *forced* to change. Each strategy has its own advantages and disadvantages. However, it is generally conceded that force should be minimized because of its inability to effect long-run attitude changes. In reality, comprehensive planned change programs are a combination of all three strategies.

One popular technique of planned change is *organizational development* (OD), which employs such techniques as sensitivity training, transactional analysis, confrontation meetings, and so on. OD represents a major departure from more conventional methods of management training and development because it concentrates on altering entire organizational systems rather than individual supervisors.

PERFORMANCE ANALYSIS FLOWCHART



Quick Reference Guide

Use the following guide as a way to help others see why they "really oughta wanna" re-evaluate solutions they have already decided upon.

I. Describe the problem

1. a. What is the performance discrepancy?
   b. Whose performance is at issue?
   c. Why is there said to be a problem?
   d. What is the actual performance at issue?
   e. What is the desired performance?

2. a. Is it worth pursuing?
   b. What would happen if I let it alone?
   c. Are our expectations reasonable?
   d. What are the consequences caused by the discrepancy?
   e. Is that cost enough to justify going on?

II. Explore Fast Fixes

3. a. Can we apply fast fixes?
   b. Do those concerned know what is expected of them?
   c. Can those concerned describe desired performance? Expected accomplishments?
   d. Are there obvious obstacles to performance?
   e. Do these people get feedback on how they are doing?

III. Check Consequences

4. a. Is desired performance punishing?
   b. What are the consequences of performing as desired?
   c. Is it actually punishing or perceived as punishing?

5. a. Is undesired performance rewarding?
   b. What rewards, prestige, status, or comfort support the present way of doing things?
   c. Does misbehaving get more attention than doing it right?

6. a. Are there any consequences at all?
   b. Does desired performance lead to consequences that the performer sees as favorable?

IV. Enhance Competence

7. a. Is it a skill deficiency?
   b. Could they do it if their lives depended on it, i.e., could they do it if they really had to?

8. a. Could they do it in the past?
   b. Could they once perform the task but have forgotten how?

9. a. Is the skill used often?
   b. How often is the performance displayed?
   c. How often is the skill applied?
   d. Is there feedback on how things are going?
   e. Is the feedback available regularly?

10. a. Can the task be simplified?
    b. Particularly for "hurry up" demands, can I reduce the standards by which performance is judged?
    c. Can I provide some sort of performance aid?
    d. Can I redesign the workplace or provide other physical help?
    e. Can I parcel off part of the job to someone else or arrange a job swap?

11. a. Any obstacles remaining?
    b. Does something get in the way of doing it right?
    c. Lack of knowledge about what's expected?
    d. Conflicting demands?
    e. Restrictive policies?

12. a. Do they have what it takes?
    b. Is it likely that this person could learn to do the job?
    c. Does this person lack the physical or mental potential to perform as desired?
    d. Is this person over-qualified for this job?

V. Develop Solutions

13. a. Which solution is best?
    b. Have all potential solutions been identified?
    c. Does each address one or more parts of the problems(s)?
    d. Have estimates of any intangible costs of the problem(s) been included?
    e. What is the cost of each potential solution?
    f. Which solution(s) are most practical, feasible, and economical?
    g. Which yields most value, solving the largest part of the problem(s) for least effort?

Flow Charts

The complexity of various business processes requires us to intricately study their details so that we can have a thorough understanding of that particular process. Flow charts are a pictorial tool used to depict the underlying logic of a sequence of events. Combining industry-standard symbols into a grouping that symbolizes a process creates flowcharts. Flowcharts can be created by hand, from pre-made plastic templates, or by computer programs such Visio and PowerPoint.

The following guide is not intended to give you a thorough understanding of flowcharts; rather it will give the user a guide to creating flowcharts that can be easily understood by others.

In general, flowcharts should read like an English written book. The beginning of a process in a flowchart should start from the top left area of a page and follow through the process by going to the bottom right area of the page. When additional pages are needed to continue the process an 'Off-Page' connector should be utilized (See examples below). Standard flowchart symbols, like the ones shown below should be used whenever possible. Using your own symbols can easily confuse others and lead to mis-representation of a process. When using symbols, all symbols with the exception of the decision process should have only one exit point (The decision process must have two exit points). All symbols that are not the termination of a process should have a directional arrow indicating the next area to be analyzed. Decision symbols will have two arrows going to the respective answer box of a question (Decision boxes should ask a yes or no question).
Finally, all instructions inside a box should be clear, short and to the point.

The following are examples of flow chart symbols with explanations of each. While there are additional symbols that may be used, these represent the standard symbols necessary to complete a diagram and should be adequate to finish any process.

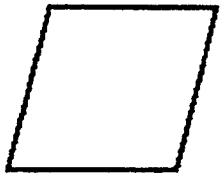
STANDARD FLOWCHARTING SYMBOLS

Terminal

Used to indicate the start and end of a flowchart. Single flowline. Flow begins or terminates here.

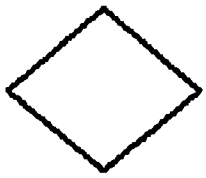
Processing

Used whenever data is being manipulated, most often with arithmetic operations. A single flowline enters and a single flowline exits.



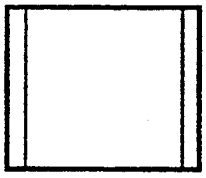
Input/Output

Used whenever information is entered into the flowchart or displayed from the flowchart. A single flowline enters and a single line exits.



Decision

Used to represent operations in which there are two possible alternatives. One flowline enters and two flowlines (labelled yes and no) exit.



Predefined Process

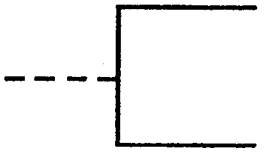
Used to identify an operation that is more fully described in a separate flowchart segment. One flowline enters and one flowline exits

On-page Connector

Used to connect remote flowchart portions on the same page. One flowline enters or exits.

Off-page Connector

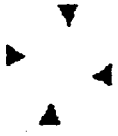
Used to connect remote flowchart portions on different pages. One flowline enters or exits.



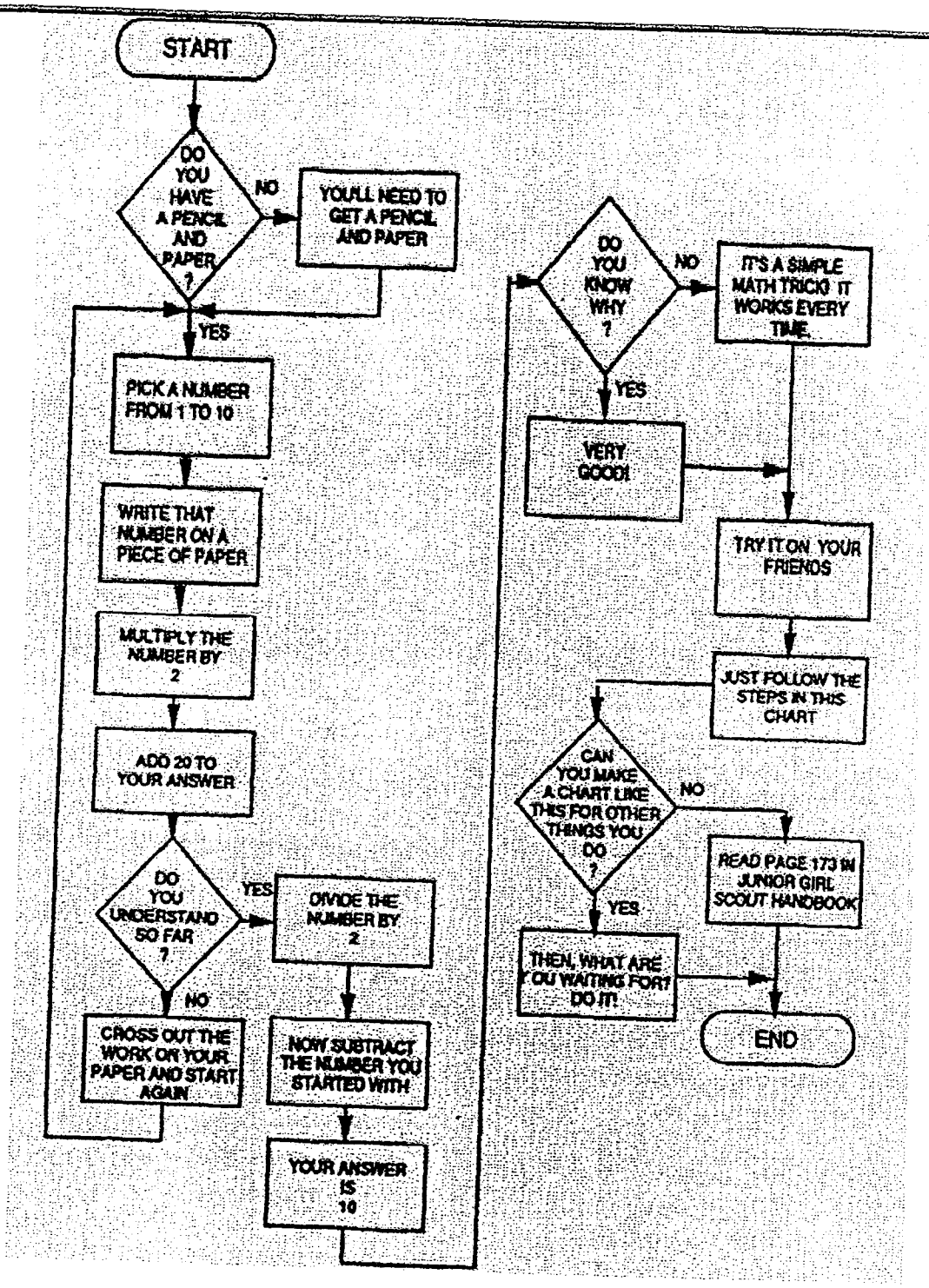
Comment

Used to add comments or clarification.

Flow Line



Flow Arrowheads


START
DO YOU HAVE A PENCIL AND PAPER ?
NO
YOU'LL NEED TO GET A PENCIL AND PAPER
YES
PICK A NUMBER FROM 1 TO 10
WRITE THAT NUMBER ON A PIECE OF PAPER
MULTIPLY THE NUMBER BY 2
ADD 20 TO YOUR ANSWER
DO YOU UNDERSTAND SO FAR ?
YES
DIVIDE THE NUMBER BY 2
NO
CROSS OUT THE WORK ON YOUR PAPER AND START AGAIN
NOW SUBTRACT THE NUMBER YOU STARTED WITH
YOUR ANSWER IS 10
DO YOU KNOW WHY ?
NO
IT'S A SIMPLE MATH TRICK! IT WORKS EVERY TIME.
YES
VERY GOOD!
TRY IT ON YOUR FRIENDS
JUST FOLLOW THE STEPS IN THIS CHART
CAN YOU MAKE A CHART LIKE THIS FOR OTHER THINGS YOU DO ?
NO
READ PAGE 173 IN JUNIOR GIRL SCOUT HANDBOOK
YES
THEN, WHAT ARE YOU WAITING FOR? DO IT!
END

4

Common Questions for Investigating an Out-of-Control Process

☐ Yes ☐ No	Are there differences in the measurement accuracy of instruments/ methods used?
☐ Yes ☐ No	Are there differences in the methods used by different personnel?
☐ Yes ☐ No	Is the process affected by the environment, e.g., temperature, humidity?
☐ Yes ☐ No	Has there been a significant change in the environment?
☐ Yes ☐ No	Is the process affected by predictable conditions? Example: tool wear.
☐ Yes ☐ No	Were any untrained personnel involved in the process at the time?
☐ Yes ☐ No	Has there been a change in the source for input to the process? Example: raw materials, information.
☐ Yes ☐ No	Is the process affected by employee fatigue?
☐ Yes ☐ No	Has there been a change in policies or procedures? Example: maintenance procedures.
☐ Yes ☐ No	Is the process adjusted frequently?
☐ Yes ☐ No	Did the samples come from different parts of the process? Shifts? Individuals?
☐ Yes ☐ No	Are employees afraid to report "bad news"?

A team should address each "Yes" answer as a potential source of a special cause.

Conducting a Survey

- Clarify the purpose
- Define the study population
- Sample and estimate the sample size
- Decide how to measure the information
- Collect the data
- Record, analyze and interpret the data

2.3 Presentation Approaches

Presentation and display of data resulting from measuring and monitoring a process or product involves more than just drawing graphs. Effective data presentation includes understanding the type of data to be utilized, who the intended audience is, and how the information will be used. This section provides ideas to consider using when determining the most effective method to present your information.

Effective Data Presentation

Before actually presenting any information, it is beneficial to evaluate and understand a few key areas:

- Who is the audience?
- What is the intended use of the data? Will it be used to support decisions and take actions or is it just to monitor performance?
- What is the basic message you want to communicate (here is where we are and how we are doing)?
- What is the presentation format (report, brochure, oral presentation, etc.)?
- What is the underlying nature of the data and any assumptions?

A key point to keep in mind is that decisions should not be made based on graphs alone. No graph can tell you everything you need to know. The purpose of presenting the data graphically is to provide information to assist in decision making and to monitor activities or progress. Combine graphs with narrative discussions to help the reader understand the data in the proper perspective related to operations. Consider including the following:

- Explain what the values mean for your organization.
- Relate to historical performance.
- Identify influencing factors (nature of operations, seasonal changes, significant management initiatives).
- Relate to management performance goals.
- Explain significant increases or decreases.

Use the data to try to answer the following questions for the reader:

- Is there a trend over time?
- Should I take any action? What kind of action?
- What contributes the most to the total (focus on the vital few)?
- Are we focusing on the highest priority actions?

Figures 2.5 through 2.10 demonstrate how the chart type you choose can influence the message you are trying to convey.

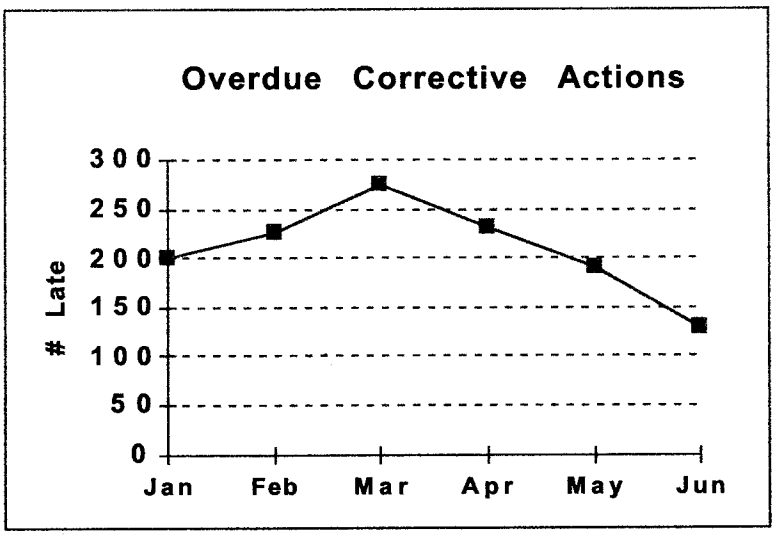


Figure 2.5
Is there a trend over time?
A commonly used approach

We often look at information to determine if there is a trend over time. Figure 2.5 shows an example of a graph commonly used to present data over a period of time. However, looking only at the total late items over time provides limited information. A more meaningful approach might be to look at the overdue rate, which allows you to factor in changes in both the number of open actions and the number that are late. This could be represented by the number of late corrective actions divided by the total number of open corrective actions, such as in Figure 2.6.

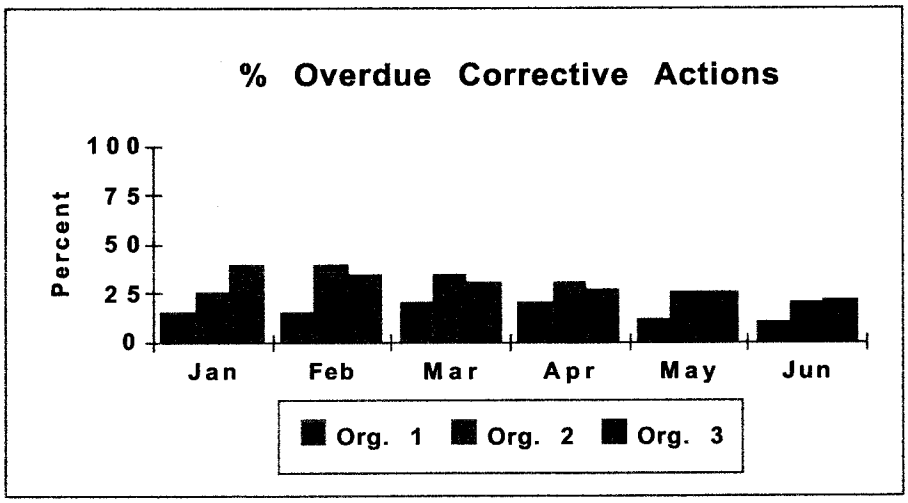


Figure 2.6
Is there a trend over time?
Same data, more information

Figure 2.6 uses the same data as Fig. 2.5, but provides more information by presenting the data differently. The combination graph shows both trends in the overall rate and the individual organizations' rates over time. Apply statistical analysis techniques to determine the presence and significance of any trends. Evaluate individual components of the rate (numerator and denominator) to determine which organization is influencing the overall rate the most.

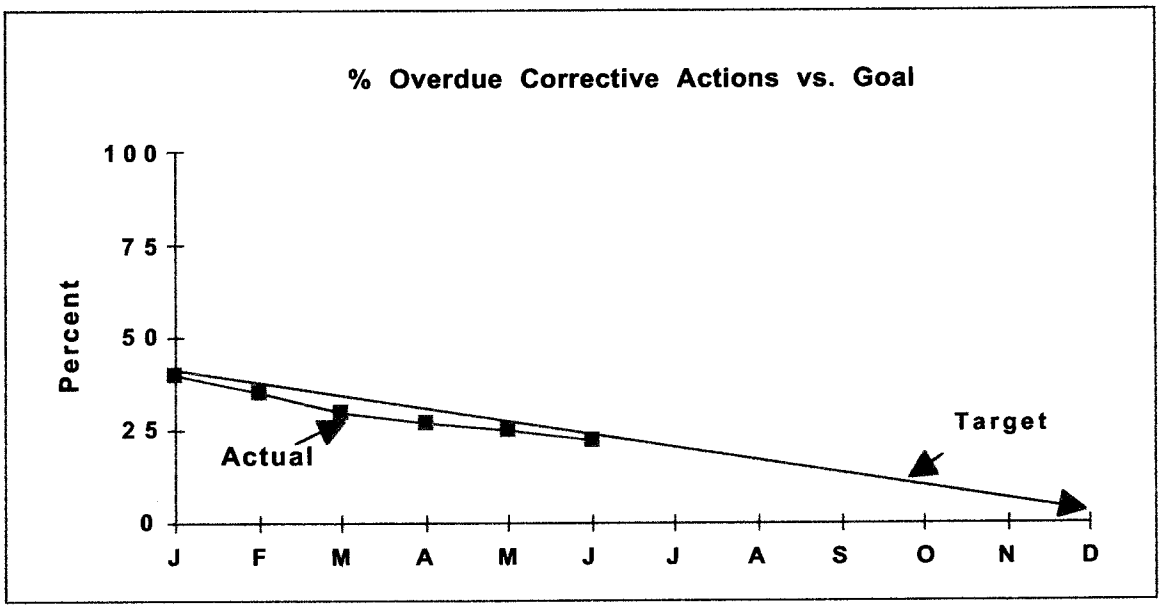


Figure 2.7
Progress toward a defined target

If targets are used, they should be realistic and achievable. The graph shown by itself in Figure 2.7 infers that the target will be met.

A control chart, as shown in Figure 2.8 for example, may lead you to question the assumption that the defined target will be met. Different types of actions are needed to influence the overall totals for systems in control versus systems out of control.

Notice how axis scale selection can significantly influence the impression given. Additionally, horizontal grid lines can make control lines difficult to read.

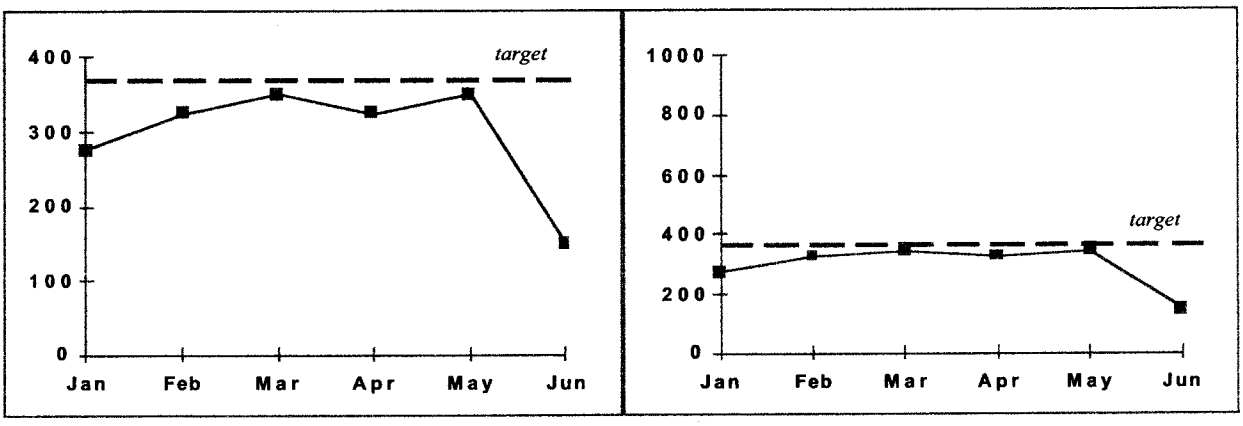


Figure 2.8
Should I take any action??
What kind of action?
System stability must be considered

A chart such as the one shown in Figure 2.9 will help you determine where to focus attention to have the most impact on the overall rate. In this chart, consideration is given to both components of the overall rate to determine what contributes the most to the total.

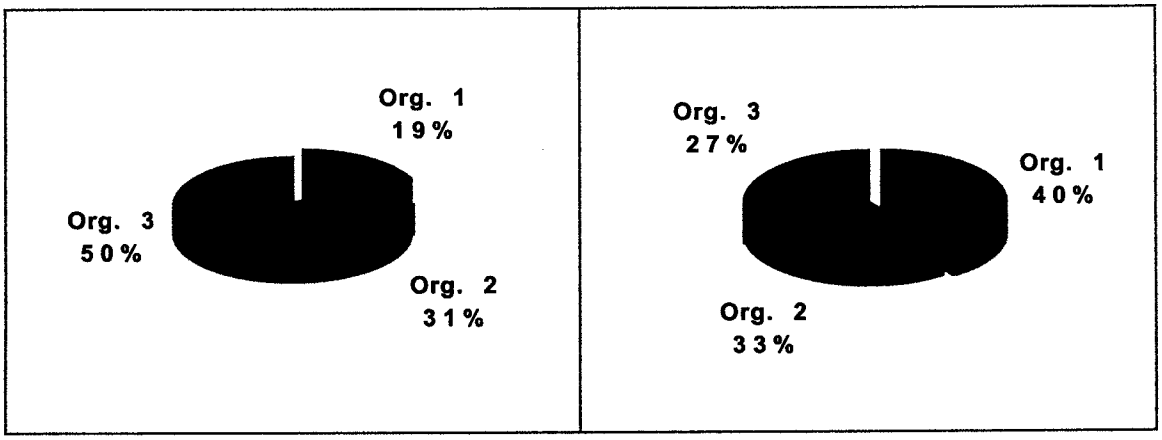


Figure 2.9
What contributes the most to the total?
Focus on the vital few

The graph shown in Figure 2.10 tells you whether high and/or medium priority actions are dominating the overdue items. It also shows historical trends for overdue items for each priority level and for the total overdue. If your presentation is in color, you can choose traditional colors to indicate priority levels (red showing danger for high priority overdue items, yellow showing warning for medium priority, and green indicating low priority).

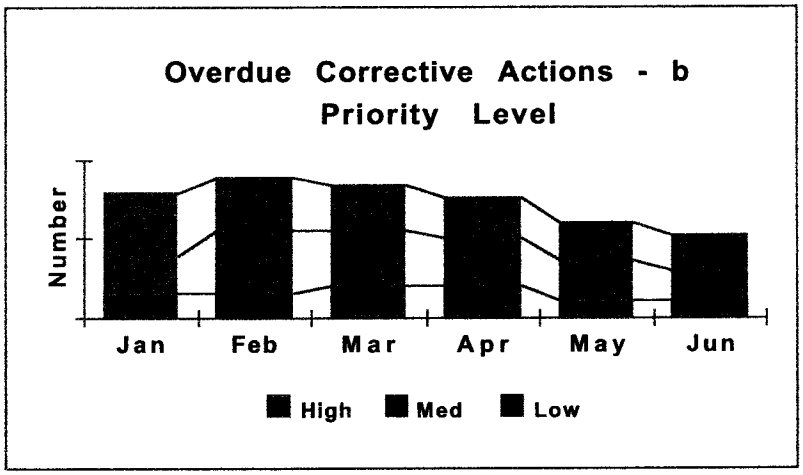


Figure 2.10
Are we focusing on the highest priority actions?
Focus on the critical areas

Choosing the Right Chart Type

There are a few universal rules about which chart type best portrays any given set of data, and in many cases the same data set can be shown many different ways. The hard part is determining which chart type emphasizes the point you are trying to make or puts the right "spin" on the data. The following provides some general comments on different chart types.

Vertical bar chart: Vertical bar charts are used to show how values change over time. They are typically used for a limited time series (i.e., just a few years, quarters, months, or whatever time period you are working with). Vertical bar charts are good for handling multiple series for comparison purposes.

Stacked vertical bar chart: Stacked vertical bar charts convey the same information as ordinary vertical bar charts, but allow you to display subelements which contribute to the overall bar. This may be helpful in understanding changes from one period to another.

Vertical line chart: Vertical line charts are best for showing changes in a group of values over longer periods of time. They are also recommended if you are displaying several groups of data simultaneously. Control limits are often included in vertical line charts to evaluate variability.

Horizontal bar chart: Horizontal bar charts are best for simple comparisons of different individual values at one time. A vertical bar, line, area or 3-D riser chart would be more beneficial if you want to evaluate change over time.

Pie chart: Pie charts are often the best way to portray the contribution of parts to a whole. They are used to show a "snap-shot" at a specific time.

Scatter chart: Scatter charts show the correlation of two sets of numbers by plotting where the variables intersect. Scatter charts are useful when the coordinates on the horizontal scale, often time intervals, are irregular.

Histogram: Histograms show the frequency of the values in a set of data. Data is plotted in increasing or decreasing order based on the frequency count for each data value.

Chart Design: A Few Tips and Hints

The charting area is the focal point of the chart. The graphical, dramatic representation of numbers as bars, risers, lines, pies, and the like is what makes a chart so powerful. So make your charting area as prominent as possible without squeezing other chart elements off the page. If you can still get your point across without footnotes, axis titles, or legends, do so to make the charting area bigger. However, remember that the document needs to communicate enough information to be a stand-alone document. The following is a list of tips to keep in mind when designing your chart.

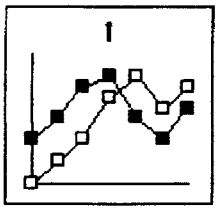
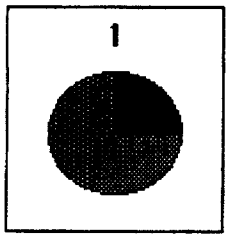
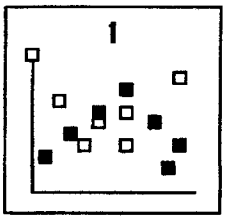
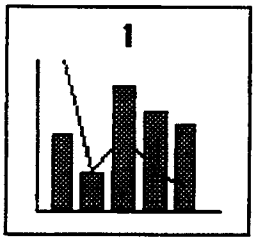
- ***Less is more:*** Do not try to put too many series in a chart. Line charts are especially intolerant of overcrowding. More than three or four lines, particularly if the lines follow much the same direction, is visually confusing. The only exception to this rule is creating a line chart of several series that people would not expect to be similar.
- ***Group bars to show relationships:*** Group bars together tightly if you are trying to suggest that they belong together. If you are showing a group of bars over a series of years, for example, it makes sense to cluster the bars for each year and leave a little extra space between years. If there is no need to do this with your chart data, put more space between your bars and make them a little wider so they are easier to see.
- ***Add definition with black outlines:*** Give the bars in bar charts, the slices in pie charts, and the risers in 3-D charts a little definition by making their outlines black, or a dark, brilliant color. If you are making your chart into a slide, the people at the back of the room will appreciate being able to distinguish the elements.

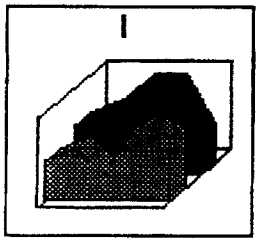
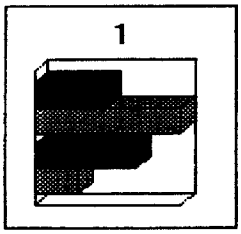
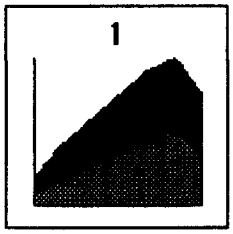
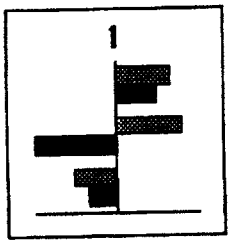
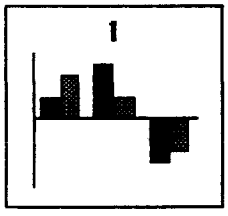
- ***Use grids in moderation:*** When using grid lines in your charting area, use only as many as are needed to get an approximate idea of the value of any given data point in the chart. Too many grid lines create visual clutter. Balance horizontal and vertical grid lines so that the rectangles they create are not too long and narrow or tall and narrow. Use soft colors, such as gray, for grid lines. Once you have defined the color and weight of the grid lines, make sure the chart frame (the frame around the charting area) is black or a dark, brilliant color and heavier than the grid lines.
- ***Choose colors carefully:*** When choosing colors, use your company's corporate colors where possible and appropriate. Failing that, you can use software-supplied templates or color wheels. Also consider where your chart will appear. If it is going to be part of a computer screen show or a slide presentation in a large room, use strong, coordinating colors that attract attention and help the people at the back of the room distinguish the individual series. However, if it is going in a publication where it will be examined at close range, keep the colors softer so you do not overwhelm the reader.
- ***Limit use of typefaces:*** Use one typeface, or at most two, on each chart, and use the same size and weight for similar elements such as the axes and legend text. A recommended setting for these is in 12 to 18 points and bold. If you use the bold and italic fonts in a typeface, as well as different sizes, you can generate enough typographic variety without going outside that type family.
- ***Choose legible typefaces:*** Pick a typeface that looks clear in smaller sizes and in bold, especially if your chart is to be printed in a small size in a publication, or if it will be viewed by a large audience in a big room. If your title is big enough, you can use just about any typeface for it, and it will be legible. However, for legend text, axes, footnotes and the like, take more care. Use faces that are neither too light nor too heavy.
- ***Set type against an appropriate background:*** Be careful about the background behind your type. Some color combinations, such as pink or violet type and a medium or dark blue background, could make your audience feel a little dizzy. If you are using a dark background color, your type must be bright enough to be readable; it should not look as if the background is trying to "swallow it up." If you are using light type on a dark background, use a bold weight, especially with smaller type sizes. Complex fill patterns in the background can also make type hard to read, particularly smaller items like legend text and axis scales.
- ***Use pattern fills with moderation:*** Many charting software packages can create just about any kind of color combination or fill pattern you can imagine. But do not become carried away with color and patterns without thinking about your output device. Sophisticated fill patterns take up more disk space and take longer to print on color printers.

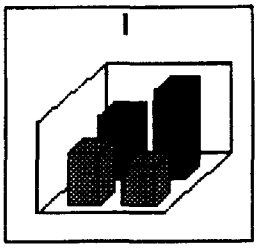
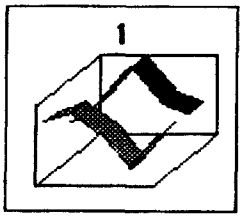
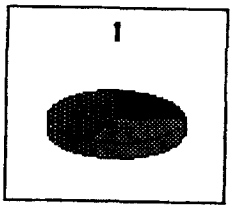
Sample Charts

Table 2.1 provides sample charts that may be helpful when choosing the appropriate chart type for your presentation.

Table 2.1 Sample Charts

	**LINE** Shows trends or changes in data over a period of time; similar to an area chart, but emphasizes time flow and rate of change, rather than amount of change.
	**PIE** Shows the relationship or proportions of parts to a whole (always contains just one data series); good for highlighting a significant element.
	**XY (Scatter)** Shows the relationship or degree of relationship between the numeric values in different groups of data; useful for finding patterns or trends and for determining whether variables are dependent upon or affect one another.
	**COMBINATION** Shows related data that are measured in different units (up to four axes can be used in a combination chart); combines different data to show comparisons and relationships that might not otherwise be recognized.

	**3-D AREA** Shows a 3-D view of an area chart, emphasizes the sum of plotted values, and separates data series into distinct rows to show differences between the series.
	**3-D BAR** Shows a 3-D view of a bar chart; similar to a column chart, but categories are organized vertically instead of horizontally.
	**AREA** Shows the relative importance of values over a period of time; similar to a line chart, but emphasizes the amount of change (magnitude of values) rather than the rate of change.
	**BAR** Shows individual figures at a specific time or draws comparisons between items, but not to a whole; similar to a column chart, but categories are organized vertically instead of horizontally, placing less emphasis on time flow.
	**COLUMN** Shows variation over a period of time or draws comparison between items, but not to a whole; horizontal orientation suggests time flow more than a bar chart.

	**3-D COLUMN** Shows a 3-D view of a column chart; emphasizes comparison of data points along two axes - a category axis and a data series axis - so that you can compare data within a data series more easily and still view data by category.
	**3-D LINE** Shows lines in a line chart as 3-D ribbons; makes individual lines easier to view, particularly when they cross, while still showing all data series in one chart for comparison.
	**3-D PIE** Shows a pie chart with height to the slices; places additional emphasis on data values that are in front.

Simplified Graph/Report Generation

Spreadsheet and database software can be used to generate pareto charts, bar charts, pie charts, and scatter diagrams. The choice of which software to use is often based on personal preference or company policy.

However, software for more complex analyses and presentation beyond that performed by common spreadsheet and database software packages can be difficult to find. A comprehensive list of software used for data acquisition, data presentation, statistical analysis, and other subjects related to quality assurance and quality control is provided in the annual Quality Progress Software Directory produced by the American Society for Quality Control (ASQC). The 1995 report, published in March 1995, listed over 500 software packages. There are two parts to the annual Quality Progress Software Directory:

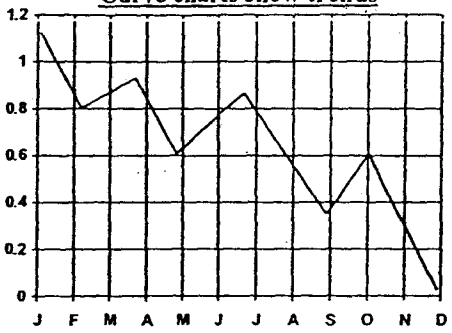
- A two-dimensional matrix lists each software package and indicates its applicability across 19 categories, such as calibration, data acquisition, and management.

- An index of each of the software packages (alphabetical by company) that includes a brief description of the software, hardware requirements, and price. Included in the description are company telephone and fax numbers and addresses, so the company can be contacted directly for more information.

The annual ASQC Quality Progress Software Directory can be obtained by writing to: ASQC Quality Press, P.O. Box 3005, Milwaukee, WI 53201-9488; or by telephoning 1-800-248-1946.

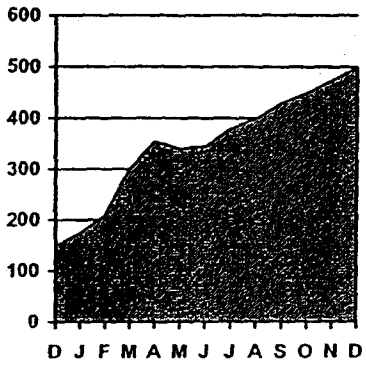
Curve or Line Charts. Curvé charts effectively show trends and time series data by showing one item at different points in time as a single, unbroken line. Multiple lines shown on a single chart, but each line must be clearly distinguishable from the other lines through the use of patterns or color. Again, there is no absolute rule concerning the maximum number of lines to place on a single chart, but a good rule of thumb is to place no more than four lines on a single chart.

Curve charts show trends



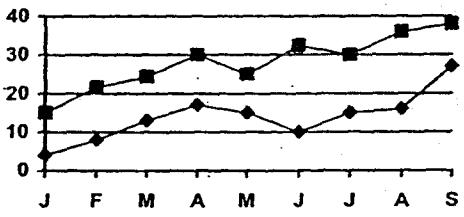
Surface Charts. A surface chart is simply a single line chart that is emphasized by shading under the line. This sounds like a very subtle change, but it completely changes the viewer's perception of the chart. Shading emphasizes the size of the total amount rather than the differences or changes in amounts. Shading also obscures points along the line and encourages the viewer to compare the area under the line against the area above the line.

Surface charts emphasize area



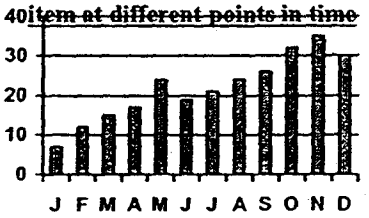
Band charts. A band chart is a line chart with two or more lines and the area underneath each line shaded differently. Band charts focus attention on the area between the curves and emphasizes the differences between them. This difference may be used to depict inventory levels, shortfalls, etc. Band charts are best used when each curve always represents an amount greater than the curve under it. Band charts are not normally effective when the curves intersect.

Band charts emphasize differences

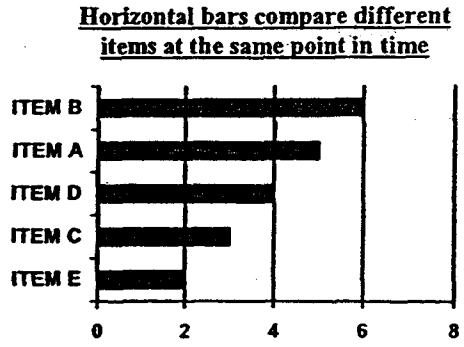


Vertical Bar or Column Charts. Vertical bar charts compare the data for the same item at specific intervals of time. The height of each column is used to represent each respective quantity and demonstrate how the quantities varies from time period to time period. Consistent time intervals should be used. If more than approximately 12 time periods are going to be used, then a curve chart may be more effective.

Columns compare data for one item at different points in time

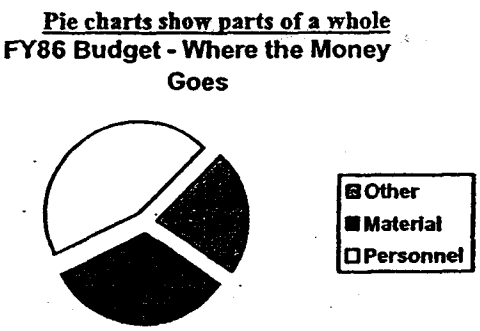


Horizontal Bar Charts. Horizontal bar charts are similar to vertical bar charts except that horizontal bar charts are generally used to compare the data for different items at the same point in time. Here, length of the bar is used to represent each quantity. The bars should not be broken, but they should be arranged in ascending or descending order to help the viewer identify trends or rank order the items.



Histograms. Frequency polygons or histograms show distributions. Histograms group items in a population of like items into groups by magnitude of a particular attribute of interest. These groups are then displayed as columns which represent the proportion of the entire population which falls within each respective group. A particular attribute is selected as a basis of comparison. This attribute is generally divided into equal intervals which span the entire range of values for the population. These intervals are represented on the horizontal axis of the chart and the height of each respective bar represents the proportion of the entire population which had values falling within the respective interval.

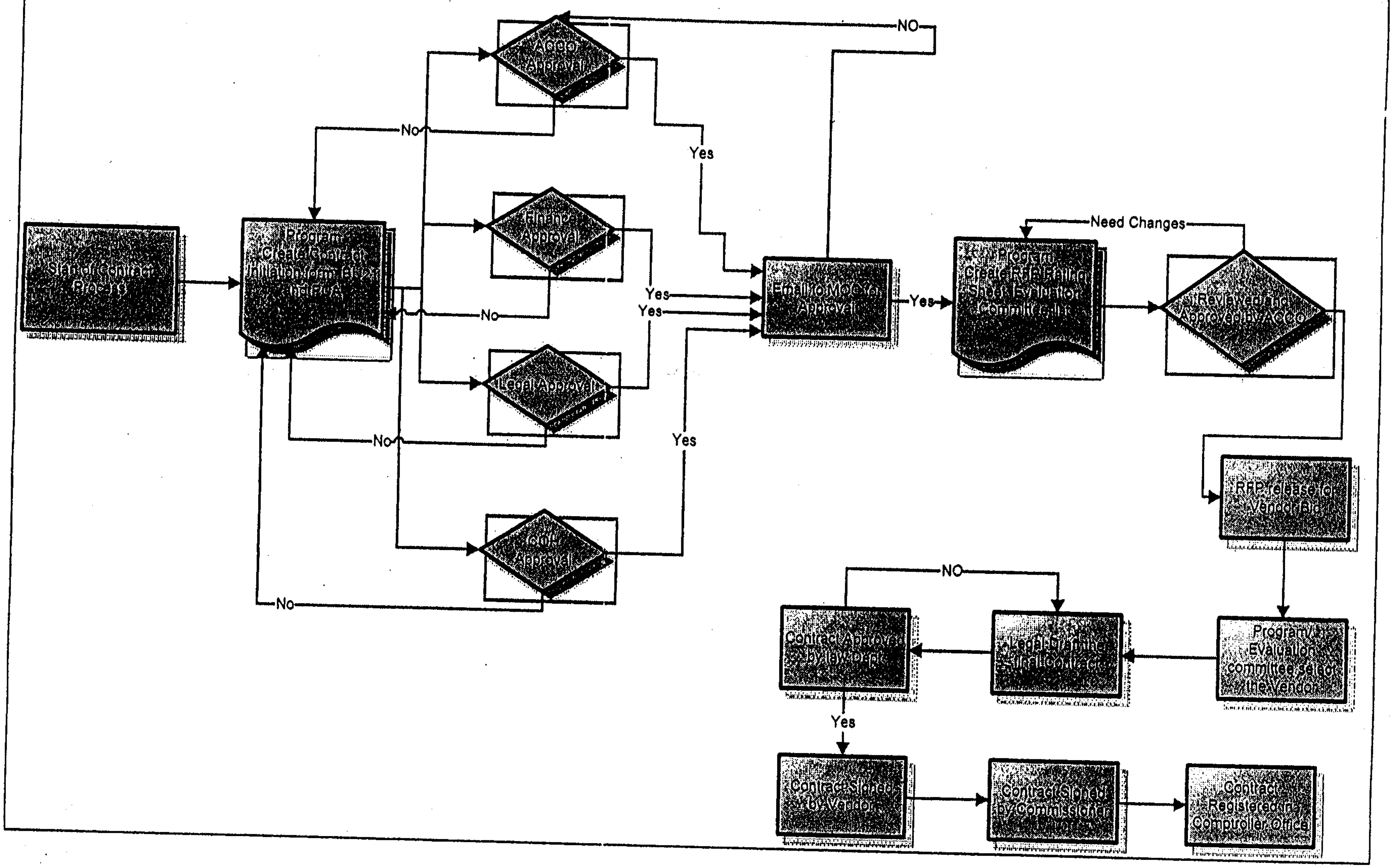
Pie Charts. Pie charts show a composite whole and the proportion that each component part represents of the composite whole. The composite whole cannot get larger, so any increase in any one component must occur at the expense of another component. When using pie charts, it is important to label each "slice" of the pie. Without labels, it is extremely difficult to compare accurately the differences between the slices.



Pictographs. Pictographs are similar to vertical bar charts and are often used to make the same kind of comparisons that are made using either vertical or horizontal bar charts. The difference with pictographs is that, rather than using bars as a basis for comparison, pictures or icons representing the item of comparison are used.

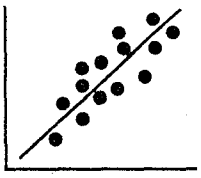
The basis for comparison is usually height, but the pictures or icons are generally drawn to scale. As the icons are drawn proportionally, comparisons between items become greatly exaggerated, distorting the quantitative differences in the actual data. The viewers tend to compare items on the basis of area rather than height. For this reason, *pictographs are generally a poor graphic for presentation use.*

Generic Contract Workflow (Only for Demo)



Scatter Diagram

Measuring relationships between variables



Why use it?

To study and identify the possible relationship between the changes observed in two different sets of variables.

What does it do?

- Supplies the data to confirm a hypothesis that two variables are related
- Provides both a visual and statistical means to test the strength of a potential relationship

How do I do it?

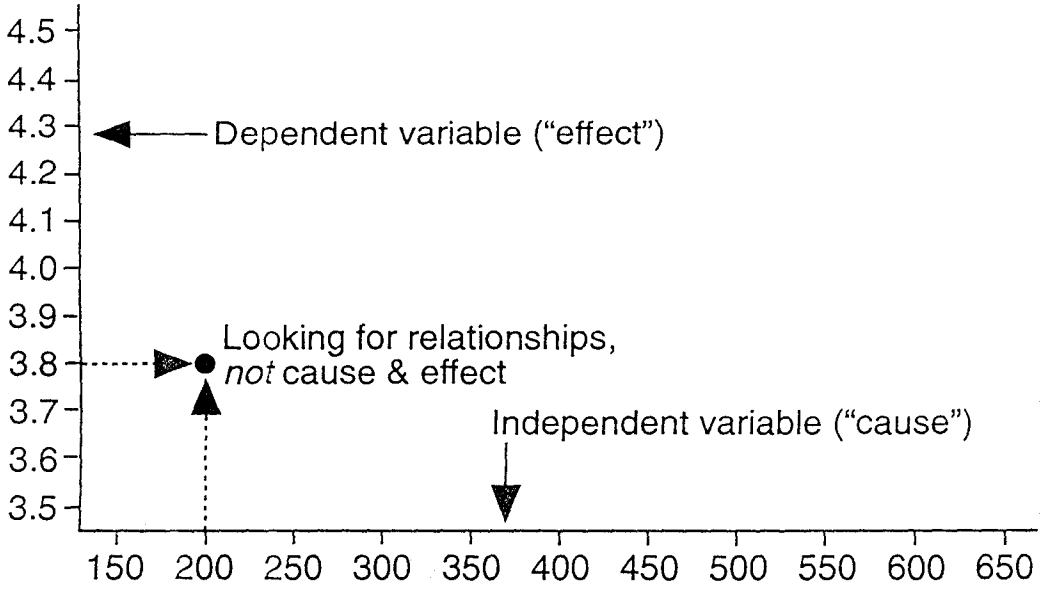
1. **Collect 50–100 paired samples of data that you think may be related and construct a data sheet**

Course	Average Session Rating (on a 1–5 scale)	Average Experience of Training Team (days)
1	4.2	220
2	3.7	270
3	4.3	270
•	•	•
•	•	•
•	•	•
40	3.9	625

Theory: There is a possible relationship between the number of days of experience the training team has received and the ratings of course sessions.

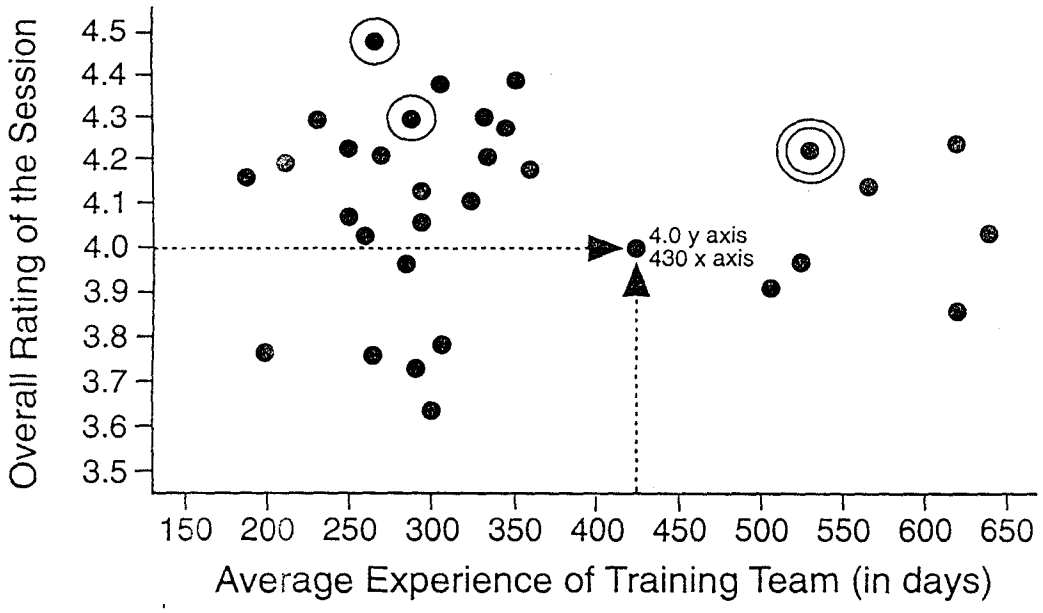
2. **Draw the horizontal (x axis) and vertical (y axis) lines of the diagram**

   - The measurement scales generally increase as you move up the vertical axis and to the right on the horizontal axis.



3. **Plot the data on the diagram**

   - If values are repeated, circle that point as many times as appropriate.



Information provided courtesy of Hamilton Standard

20

Decision Matrix When to Use

- When a list of options must be narrowed to one choice.
- When the decision must be made on the basis of several criteria.
- After the list of options has been reduced to a manageable number by list reduction.

Decision Matrix Procedure

- Brainstorm
- Discuss and refine the list of criteria.
- Assign a relative weight to each criterion. Do this by distributing 10 points among the criteria.
- Draw a L-shaped matrix. Write the criteria and their weights as labels along one edge and the list of options along the other side.

Decision Matrix

- Write the criteria and their weights as labels along one edge and the list of options along the other edge. The group with fewer items occupies the vertical edge.
- Evaluate each choice against the criteria.

Decision Matrix

- Establish a rating scale for each criterion. Some options are:
- 1, 2, 3: 1 = slight extent, 2 = some extent, 3 = great extent
- 1, 2, 3: 1 = low, 2 = medium, 3 = high

Decision Matrix: Long Wait Time

Problems

Customers wait for host

Customers wait for waiter

Customers wait for food

Customers wait for check

Criteria

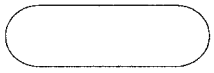
- Customer pain - 5 points
- Ease to solve – 2 points
- Effect on other systems – 1 point
- Speed to solve – 2 points

Flow Charts

- A pictorial tool used to depict the underlying logic of a sequence of events.
- They should read like an English written book.
- The beginning of a process in a flowchart should start from the top left area of a page and follow through the process by going to the bottom right area of a page.

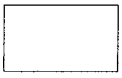
FLOW CHART SYMBOLS

- Terminal – Used to indicate the start and end of a flowchart.



Flow chart symbols

- Processing – Used whenever data is being manipulated. A single flow line enters and a single flow line exits.

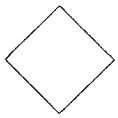


Flow Chart Symbols

- Input/Output – Used whenever information is entered into the flowchart or displayed from the flow chart. A single flow line enters and a single line exits.

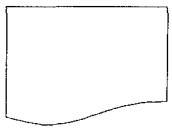
Flow Chart Symbols

Decision – Used to represent operations in which there are two possible alternatives. One flow line enters and two flow lines (labeled yes and no) exit.



Flow chart Symbols

- Document – Forms, Data Sheets



Flow chart Symbols

- Delay

Conducting a Survey

- Stage A. Planning the Plan
- Stage B. Elaborating on the Plan
- Stage C. Outlining Programs and Projects
- Stage D. Estimating Results
- Stage E. Determining Personnel Needs and Other Developmental Costs
- Stage F. Comparing Accomplishments with Estimates
- Stage G. Determining Adjustments
- Stage H. Coordinating

Planning the Plan

- Define clearly the organizational boundaries within which the objectives of the plan are to be limited.
- Outline the overall objectives of the plan and set a completion date.
- Boundaries and objectives are flexible if future changes must be made.
- Delegate authority and assign duties.

Elaborating on the Plan

- Describe, by using a graphic model, the basic systems and organizational structures needed to achieve overall objectives.
- Compare present and future structures.
- Point out segments of the basic structure which may be progressively accomplished by individual effort.

Outlining Programs and Projects

- List the significant functions performed by every major organizational segment.
- Fix relationships among inter and intra departmental functions.
- Spell out the major procedures for each major function.

Estimating Results

- Provide for segregation of estimated outcomes for all projects by such classifications as cost savings, morale improvement, marketing advantage, etc.
- Collect information, screen and record it in a format that lends itself to comparison with actual results after development.
- Set dates for when results in each classification should be achieved.

Determining Personnel Needs and Other Developmental Costs

- Determine skills and type of organizational representation required for each project.
- Determine type and number of locations to be studied in each project as well as the size and structure of the survey team in each stage of development.
- Estimate personnel requirements from data collected.
- Estimate other developmental costs such as forms, manuals, equipment, etc.

Comparing Accomplishments with Estimates

- Record estimates with results reported after completion of project development.
- Analyze differences to determine reasons for discrepancies.
- Recommend action required to improve on results, if possible.

Determining Adjustments

- Set bench marks, at appropriate intervals in the developmental stages of projects, for review to spot any factors which might need modification.
- Review these factors to see whether the plans should be adjusted.
- Adjust, if necessary, any parts of the plan.

Coordinating

- Ascertain that all individuals and groups participating in the master plan are doing so, and get from these individuals and groups departmental plans which have been developed.
- Screen departmental plans with departmental representatives within the total enterprise and get their agreement on all plans.

Preparing Reports

- Maintain control over the progress of planning and project development so that summaries, periodic reports of progress may be written and distributed to all concerned.
- Coordinate developmental progress reports with the master report.

Questions

5

AN INTRODUCTION TO PERT . . . OR . . .

NOW THAT WE'VE ALL FINALLY AGREED ON WHERE WE WANT TO GO, HOW DO WE ARRANGE TO GET THERE FROM HERE.

Suppose you wake up on Saturday morning and decide to take the family on a picnic.

Going through your head is a jumble of activities and tasks that need doing in order to get the picnic organized. "Coffee. Is the thermos clean? Remember this time to take some fly-spray. Do we have any beer? What kind of sandwiches would everyone like? "

How to accomplish all the preparations? Obviously, you need the help of the rest of the family. But if everybody is involved in the task, how will it be coordinated? How avoid two people getting the napkins and nobody remembering to get the first-aid box? How to assign responsibility for the can-opener? And how to decide what must be done first, and what can be done at any time?

These kinds of questions *could* be all answered by one person, who would assign tasks and maintain supervision, settle disputes and respond to the inevitable complaints about work-loads, tasks neglected, and so forth.

Or there could be a non-directed kind of process in which the family periodically stops what it is doing to argue about everything from where we want to go down to which kind of olives to take.

But there is a planning method that permits a group to . . .

Be mutually aware of the process and sub-goals. Contribute to and share in the decisions made about how, when and by whom activities are done

Make more efficient use of resources by concentrating effort and time on the *critical tasks* rather than devoting time to sub-tasks while tasks of greater priority lack hands.

Re-evaluate the project while it is underway, and re-allocate resources to cope with unexpected blocks to task accomplishment, or to take advantage of unanticipated success in meeting some sub-goal.

This planning method is called PERT, one of those acronyms to be sure, but no less valuable for that. It stands for Program Evaluation and Review Technique, and it has saved government and industry many millions of man-hours and dollars. A variation of PERT is known as CPM, or the Critical Path Method, a name that expresses something about how the thing is done. In this brief paper, we can only glimpse the bare outlines of PERT/CPM. Please consult the references for more detailed discussions.

PERT is a group analysis and flow-charting procedure that begins with identifying the sequences of dependent activities.

One begins, in true Lewis Carrol fashion, at the end.

Before we can arrive at the picnic grounds, we must travel there in the car. Before we can travel in the car, we must fill up with gas and check the oil. Before we can do that, we must have traveled to the service station. Before we can start out for the service station, we must have loaded all the supplies in the car . . . except ice, which we can get at the gas station.

The example we have given is thus seen to be trivial, indeed, but at the same time a paradigm of the planning process.

PERT is seen to be a tool of communication, and not just an abstract exercise performed only by the staff planners, thereafter executed under duress by the grumbling line.

PERT is a method that permits revision of the plan when things don't work out like the original plan said they should.

Plans never work out right.

But *the planning process is indispensable.*

The Psychological Corporation, 304 E. 45th Street, N.Y., N.Y. 10017.
Psychological Services, Inc., 4311 Wilshire Blvd., Los Angeles, Cal. 90005.
RBH, (Richardson, Bellows, Henry, and Company), 1140 Connecticut Avenue, N.W., Washington, D.C. 20036.
Science Research Associates, Inc., 259 E. Erie Street, Chicago, Ill. 60611.
Sheridan Supply Company, P.O. Box 837, Beverly Hills, Calif. 90213.
Stanford University Press, Stanford, Cal. 94305.
C.H. Stoelting Company, 424 North Homan Ave., Chicago, Ill. 60624.

Texts:

Buros, Oscar Krisen, ed., "The Seventh Mental Measurement Yearbook," Highland Park, N.J., Gryphon Press, 1972.
Stone, C. Harold and Kendall, William E., "Effective Personnel Selection Procedures," Englewood Cliffs, N.J., Prentice-Hall, 1956.

Cross References: *Executive Selection; Industrial Psychology; Personnel Testing.*

PERT (PROGRAM EVALUATION AND REVIEW TECHNIQUE)

The advancing technology of the Space Age brought an explosive growth of a new family of planning and control techniques. Much of the development work was done in the defense industry, but the construction, chemical, and other industries have also played an important part. Perhaps the best known of all the new techniques is Program Evaluation and Review Technique, commonly referred to as PERT.

The new techniques have several distinguishing characteristics:

(1) They give management the ability to plan the best possible use of resources to achieve a given goal within overall time and cost limitations.

(2) They enable executives to manage "one-of-a-kind" programs, as opposed to repetitive production situations.

(3) They help management handle the uncertainties involved in programs where no standard time data of the Taylor-Gantt variety are available.

(4) They utilize a so-called "time network analysis" as a basic method of approach to determine manpower, material, and capital requirements.

Development of PERT. Project managers increasingly noted that the techniques of Frederick W. Taylor and Henry L. Gantt, introduced during the early part of the century for large-scale production operations, were inapplicable for a large portion of the industrial effort of the 1960s and 1970s, an era that has aptly been characterized as the "Age of Massive Engineering."

The Special Projects Office of the U.S. Navy, concerned with performance trends on large military development programs, introduced PERT on its Polaris Weapon System in 1958, after the technique had been developed with the aid of the management consulting firm of Booz, Allen & Hamilton. Since that time, PERT has spread rapidly throughout the U. S. defense and space industry. Currently almost every major government and military agency concerned with Space Age programs is utilizing the technique, as are large industrial contractors in the field. Small businesses wishing to participate in national defense programs have found it increasingly necessary to develop PERT capability.

At about the same time the Navy was developing PERT, the duPont company, concerned with the increasing costs and time required to bring new products from research to production, initiated a similar technique known as CRITICAL PATH METHOD (CPM) which has spread quite widely, and is particularly concentrated in the construction industry. (For an overview discussion of the various control techniques, see INTEGRATED PROJECT MANAGEMENT.)

What PERT Is. In the early 1960s, PERT was in practice restricted largely to the area of time. (Later extensions are described below.) The basic requirements of PERT/time as established by the Navy were as follows:

(1) All of the individual tasks to complete a given program must be visualized in a clear enough manner to be put down in a *network*, which is comprised of *events* and *activities*. An event represents a specified program accomplishment at a particular instant in time. An activity represents the time and resources which are necessary to progress from one event to the next. Emphasis is placed on defining events and activities with sufficient precision so that there is no difficulty in monitoring actual accomplishment as the program proceeds. Exhibit I shows a typical operating-level PERT network from the electronics industry. Events are shown by the circles in the network, and activities are designated by the arrows leading from one event to its successor event or events.

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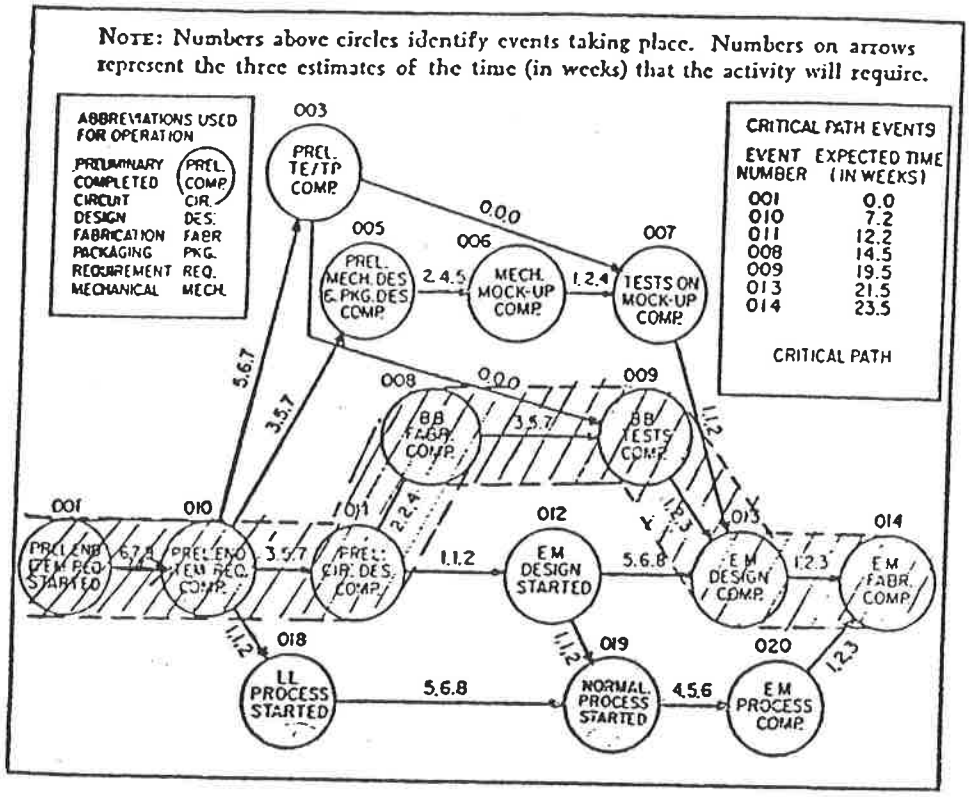
EXHIBIT I

TYPICAL OPERATING-LEVEL PERT NETWORK



(2) Events and activities must be sequenced on the network under a highly logical set of ground rules which allow the determination of important critical and subcritical *paths*. These ground rules include the fact that no successor event can be considered completed until all of its predecessor events have been completed, and no "looping" is allowed, i.e., no successor event can have an activity dependency which leads back to a predecessor event.

(3) Time estimates are made for each activity of the network on a three-way basis, i.e., *optimistic*, *most likely*, and *pessimistic* elapsed-time figures are estimated by the person or persons most familiar with the activity involved. The three time estimates are required as a gauge of the "measure of uncertainty" of the activity, and represent full recognition of the probabilistic nature of many of the tasks in development-oriented and nonstandard programs. It is important to note, however, that, for the purposes of computation and reporting, the three time estimates are reduced to a single expected time (t_e) and a statistical variance (σ^2).

(4) *Critical path* and *slack times* are computed. The critical path is that sequence of activities and events which will require the *greatest expected time to accomplish*. Slack time is the difference between the total expected activity time required for any specific path and the total for the critical path. Thus for any event it is a measure of the spare time that exists at the moment in each of its subsequent sequence of events.

If the size and complexity of the network call for them, computer routines are available to calculate the critical path, as well as the amount of slack for all events and activities not on the critical path. If total expected activity time along the critical path is greater than the time available to complete the project, the program is said to have *negative slack*. Negative slack time is a measure of how much acceleration is required to meet the schedule objective dates.

Time Estimates. Interpretation of the concepts of optimistic, most likely, and pessimistic elapsed times has varied. The definitions which represent a useful consensus are as follows.

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Optimistic—An estimate of the *minimum* time an activity will take, if unusual good luck is experienced and everything "goes right the first time."

Most likely—An estimate of the *normal* time an activity will take, a result which would occur most often if the activity could be repeated a number of times under similar circumstances.

Pessimistic—An estimate of the *maximum* time an activity will take, if unusually bad luck is experienced. It should reflect the possibility of initial failure and fresh start, but should not be influenced by such factors as "catastrophic events"—strikes, fires, power failures, and so on—unless these hazards are inherent risks in the activity.

Averaging formulas have been developed by which the three time estimates are reduced to a single expected time (t_e), variance (σ^2), and standard deviation (σ). Thus (approximately):

$$t_e = \frac{a + 4m + b}{6}$$

$$\sigma = \frac{b - a}{6}$$

where a is the most optimistic time, b is the pessimistic time, and m is the most likely time. The choice of probability distribution and the approximations involved in these formulas are subject to some question, but they have been widely used and seem appropriate enough in view of the inherent lack of precision of estimating data. The variance data for an entire network make possible the determination of the *probability of meeting an established schedule date*, as shown in the Appendix at the end of this article.

Exhibit II contains data on the critical path and slack times for the sample network of Exhibit I. The data are shown in the form of a *slack order report* (lowest to highest slack), perhaps one of the most important of PERT reports. Other output reports, such as event order and calendar time order reports, are also available.

Review and action by responsible managers, generally on a biweekly basis, are required, concentrating on important critical path activities. Where required, valid means of shortening lead times along the critical path must be determined by applying new resources or additional funds, obtained from those activities that can "afford" them because of their slack. Alternatively, sequencing of activities along the critical path may be changed. A final alternative may be, perforce, a change in the scope of the work of the critical path to meet a given schedule.

EXHIBIT II
SLACK ORDER REPORT

PERT SYSTEM
Airborne Computer– Slack Order Report
Date 7/12/73 Week 0.0 Time in Weeks Page 1

Event	T_E	T_L	T_L-T_E	T_S	pr	
001	0.0	0.0	0			T_E = Expected event date
010	7.2	7.2	0			T_L = Latest allowable event date
011	12.2	12.2	0			
008	14.5	14.5	0			T_L-T_E = Event slack
009	19.5	19.5	0			T_S = Scheduled event date
013	21.5	21.5	0			
014	23.5	23.5	0	23.5	.50	P_r = Probability of achieving T_S date
020	20.6	21.5	+ .9			
019	15.6	16.5	+ .9			
012	14.4	15.3	+ .9			
018	9.4	10.3	+ .9			
007	18.2	20.3	+2.1			
006	16.0	18.1	+2.1			
005	13.2	14.3	+2.1			
003	14.2	19.5	+5.3			

PERT requires constant updating and reanalysis, since the outlook for the completion of activities in a complex program is in a constant state of flux. Highly systematized methods of handling this aspect of PERT have been developed.

Benefits Gained. A big advantage of PERT is the kind of planning required to create a major network. Network development and critical path analysis reveal interdependencies and problem areas which are either not obvious or not well defined by conventional planning methods.

Another advantage, especially where there is a significant amount of uncertainty, is the three-way estimate. If the decision maker is statistically sophisticated, he can examine the standard deviation and probability of accomplishment data. If there is a minimum of uncertainty, the single-time approach may, of course, be used, while retaining the advantages of network analysis.

Finally, PERT allows a large amount of data to be presented in a highly ordered fashion, bringing the management-by-exception prin-

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ciple to an area of planning and control not hitherto readily susceptible to it. Additionally, many individuals in different locations can easily determine the total task requirements of a large program.

Implementation Techniques. When a well-thought-through network is developed in sufficient detail, the first activity time estimates made are as accurate as any, and these should not be changed unless a new application of resources or a trade-off in goals is specifically determined. Further, the first time estimates should not be biased by some arbitrarily established schedule objective, or by the assumption that a particular activity does not appear to be on a critical path. Schedule biasing of this kind, while it obviously cannot be prevented, clearly atrophies some of the main benefits of the technique—although it is more quickly discovered with PERT than with any other method.

In the case of common resource centers, it is generally necessary to undertake a loading analysis, making priority assumptions and using the resulting data on either a three-time or single-time basis for those portions of the network which are affected. It should be pointed out that the process of network development forces more problems of resource constraint or loading analysis into the open for resolution than do other planning methods.

Application to Production. It is sometimes viewed as a disadvantage of the PERT technique that it is not applicable to all manufacturing effort. PERT deals in the time domain only and does not contain the quantity information required by most manufacturing operations. Nevertheless, PERT can be, and has been, used very effectively through the preliminary manufacturing phases of production prototype or pilot model construction, and in the assembly and test of final production equipments which are still "high on the learning curve." After these phases, established production control techniques which bring in the quantity factor are generally more applicable.

It should be noted, however, that many programs of the Space Age never leave the preliminary manufacturing stage, or at least never enter into mass production. Therefore, a considerable effort is going forward to integrate the techniques of PERT within some of the established methods of production control, such as LINE-OF-BALANCE or similar techniques that bring in the quantity factor.

PERT and Computers. There is a common impression that the technique is only applicable when large-scale data-processing equipment is available. This is certainly true for large networks, or aggregations of networks, where critical path and slack computations are involved for several hundred or more events.

However, several ingenious manual methods have been developed, ranging from simple inspection on small networks to more organized but clerically oriented routines for determination of critical path, subcritical path, and slack times on networks ranging from fifty to several hundred events. Exhibit I shows the network for a relatively small electronics program. Developed in less than a day, the whole network required only two hours for manual computation.

PERT Extensions. A considerable amount of research has been put into the extension of PERT into the areas of manpower, cost, and capital requirements. The ultimate objective is the determination of "trade-off" relationships between time, cost, and product or equipment performance objectives.

PERT/Cost. Most job-costing structures in industry on complex development programs need a great deal of interpretation to relate *actual costs* to *actual progress*. They are rarely, if ever, related in any explicit manner to the details of the scheduling plan. Yet cost constraints either in the form of manpower shortages or funding restrictions have a great deal to do with the program's success. For this reason, an approach called basic PERT/cost was developed. This involves establishing job cost estimates *directly from an activity or group of activities on a time network* [1]. The networks themselves are based upon the framework of a *work breakdown structure* for the complete program.

Regarding development of actual cost figures in basic PERT/cost, an estimate of manpower requirements, segregated by classification, is usually the easiest place to start, since these requirements were presumably known at the time the network was established. A single-valued scheduled time figure generally replaces t_e in the basic PERT/cost approach, as a matter of convenience in developing manpower leveling data. The summation of such data often reveals a manpower or funding restriction problem, and forces a replanning cycle if no alternatives are available.

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SECTION 8

GLOSSARY OF PERT TERMS WITH PAGE REFERENCES

	Text Pages
ACTIVITY: A time-consuming element of a project which is represented on a chart as an arrow between two events. An activity cannot be started until the event leading it has been accomplished. A follower event cannot be accomplished until all activities leading it are complete. The arrowhead points toward the follower event.	1-3 to 1-9
ACTIVITY, DUMMY: A zero-time activity which constrains its follower event by requiring its leader be completed first. The dummy activity is represented on the chart by a dash-line arrow.	4-1 to 4-7
CHAINING, BACKWARD: The predicting and listing of a sequence of activities in reverse order. Generally used to prevent inadvertent ommission of necessary steps or requirements.	1-1 to 1-5
CHART, PERT: A visual representation showing the logical sequence and relationships among the various activities and events in a project.	1-15 to 1-19
CONSTRAINT: The relationship of activities to their follower events showing that an event cannot occur until all the activities leading it have been completed. Also, the term is used to indicate the relationship of an event to following activities wherein the activities may not start until their leader event has occurred.	4-3
CRITICAL PATH: The sequence of activities in a project that forms the longest time path from the first to the last event. If the project has a scheduled completion date, the critical path will be that path which has the greatest amount of negative slack, least amount of positive slack, or zero slack.	3-25 to 3-28
EVENT: A specific definable accomplishment in the project plan, which is recognizable as a particular instant in time when activities start or finish. Events do not consume time or resources and are represented in the chart by numbered circles.	1-5 to 1-13
EVENT FIRST: The start of all activities leading to the achievement of the project's goals.	1-10

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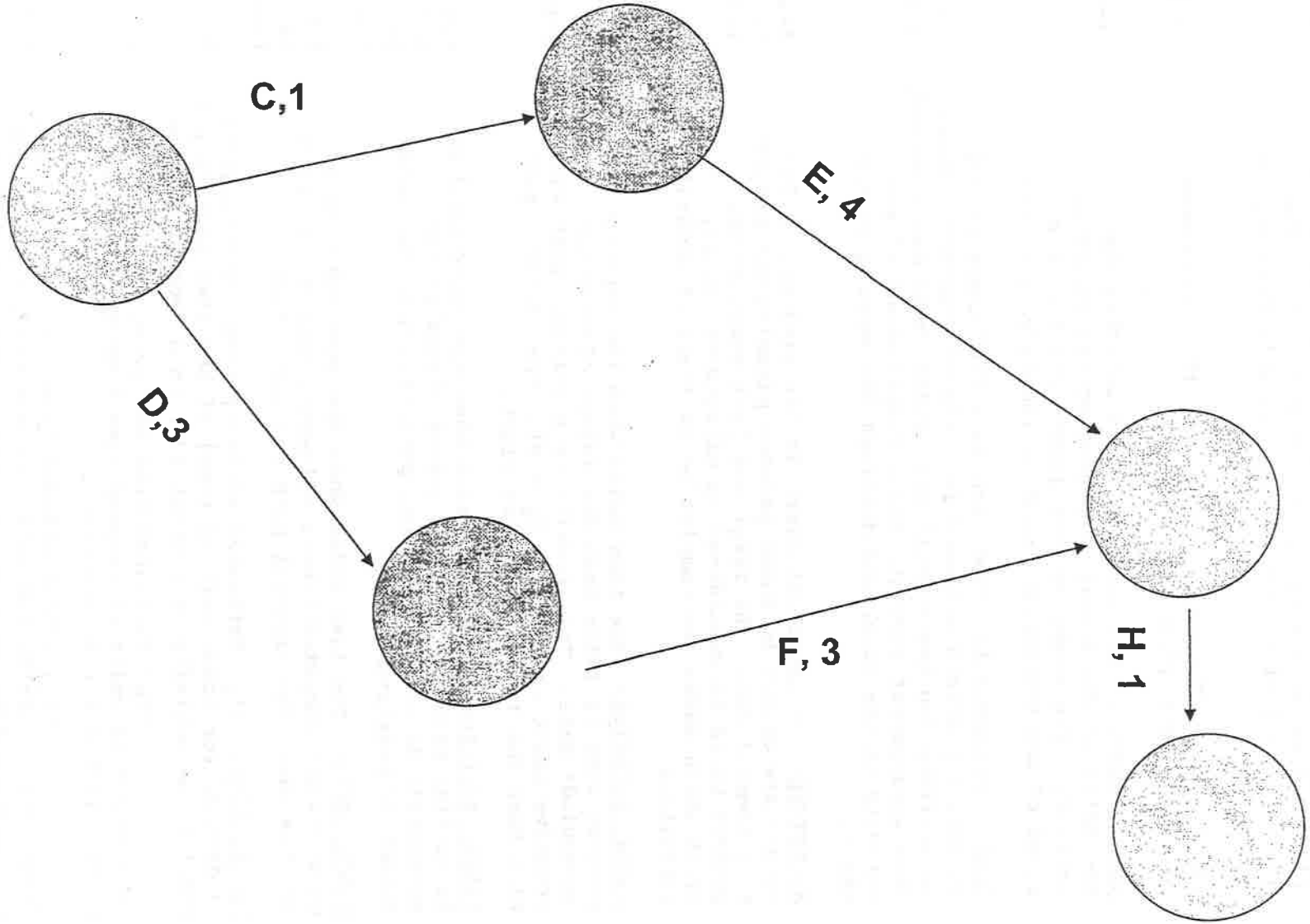
	Text Pages
EVENT, FOLLOWER: The event which denotes the accomplishment of an activity. The number of this event is the second of the two numbers used to identify an activity.	1-8
EVENT, LAST: The event which marks the achievement of the project goals.	1-10
EVENT, LEADER: The event which establishes the beginning of the actual work that occurs during an activity. The number of the leader event is the first of the two numbers used to identify an activity.	1-8
LOOP: An impossible condition in a PERT chart formed by activity arrows arranged in a closed sequence. Since no activity can begin until its leader event has occurred, this arrangement prevents the accomplishment of any activity in the loop, and destroys the meaning of the chart.	2-21 to 2-22
MILESTONE: An important event in the project. Milestones are chosen by those persons planning the project. As a general rule, the first and last event of the project would be considered as milestones, or any event which marks the completion or start of several activities.	1-12 to 1-13
SLACK, NEGATIVE: The time value when the expected completion date is later than the latest allowed (or scheduled) date. This results in a critical path with negative slack value ($T_L - T_E = S$). The critical path will have the largest negative slack.	5-9 to 5-19
SLACK, POSITIVE: The time value when the expected date is earlier than the computed latest allowable (or scheduled) date. The critical path will have the least amount of positive slack.	4-9 to 4-30 and 5-13 to 5-17
SLACK, ZERO: The time value when the expected date is equal to the computed latest allowable date for an event. In this case, the critical path has zero slack.	4-9 to 4-30
TIMES, PERT: (t_e) Estimated activity time. The estimate in days or (or other unit of time) of the time necessary to complete an activity or a chart path in a specified manner.	3-1
(T_E) Estimated time for event to occur. It is measured in units of elapsed time from any event back to the first event or milestone.	3-23
(T_L) Latest allowed time for event to occur which will not delay completion of the project beyond the time indicated by the critical path. Latest allowed time (T_L) minus estimated time (T_E) equals slack time (S).	4-15

PERT CHART



From the Master List, you transfer the activities to your workload for the day, the next day, the next week, and the next month. Psychologically, the Master List lets you know everything that you know of that you must do and that there's an end to it—at least until you add more items the next day! The Master List becomes a storage facility for all your ideas until you can distribute them to your daily, weekly, and monthly planners, or until you can delegate them to other appropriate staff members.

Milestone chart. The Milestone Chart graphically displays the relationship of the steps in a project (Figure 18). When you create this type of chart, you first list all the steps required to finish the project and estimate the time required for each step. The steps are listed down the left side of the chart, with dates shown along the top. A line is drawn across the chart for each step, starting at the planned beginning date and ending on the completion date of that step. Once you complete the Milestone Chart, you can see the flow of the action steps and their sequence. Several steps can overlap and be in progress at the same time. As the project progresses, you can chart the progress by drawing lines in another color beneath the original target lines. These new lines will indicate to you the "actual" as opposed to "targeted dates" of completion for each step in the project.

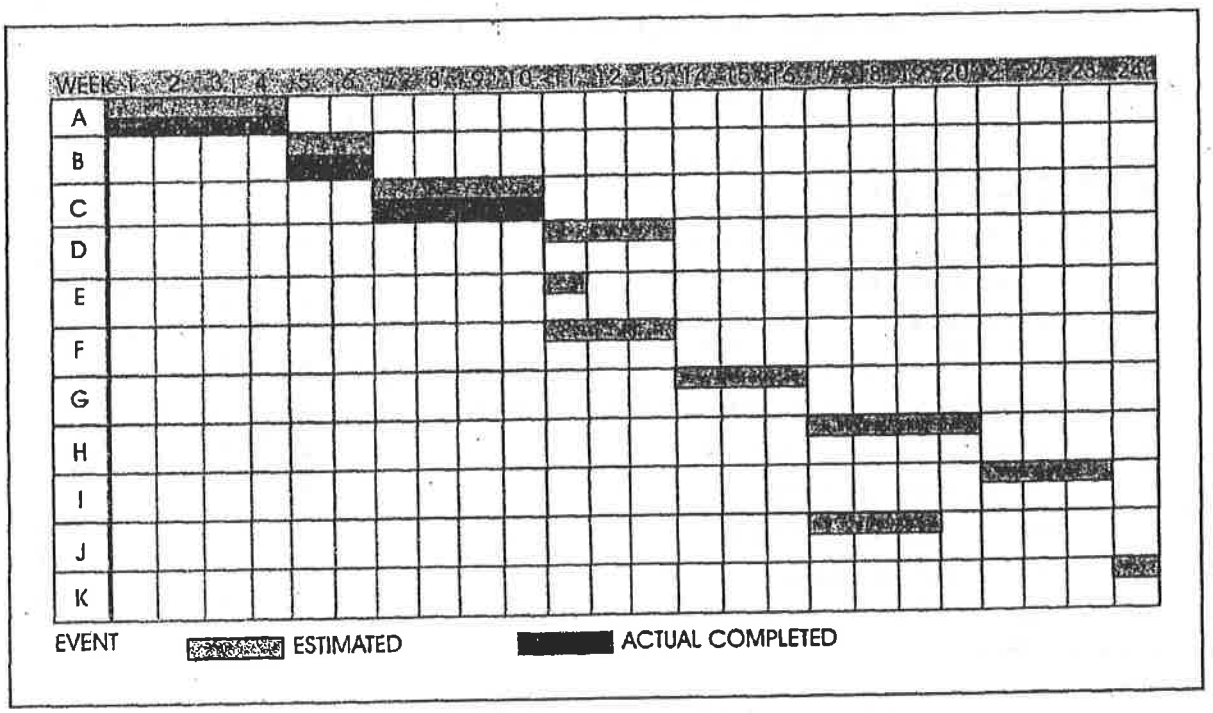
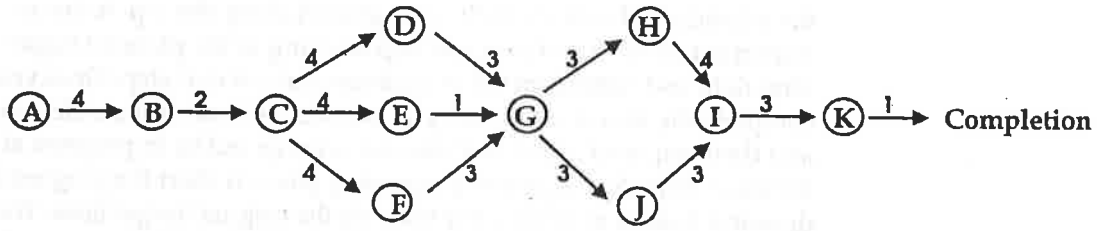


FIGURE 18—A Milestone Chart

PERT chart. PERT stands for Program Evaluation and Review Technique. It's a more sophisticated way of depicting the various steps in a project (Figure 19). These events (A–K) correspond with the steps listed in Figure 18. To formulate a PERT Chart, you list the steps required to finish a project and estimate the time required to complete each step. Then, you draw a network of relationships among the steps. The number of the step is shown in a circle, and the time to complete the step is shown on the line leading to the next circle. Steps that must be completed in order are shown on one path to clarify proper sequencing. Steps that can be underway at the same time are shown on different paths.



The critical path is ABCDGHIK. It will take 24 weeks from event A to event K.

EXAMPLE OF A PERT CHART TO BUILD A HOUSE

Event	Description	Time (in weeks)	Preceding Event
A	Approve design and obtain permit	4	None
B	Dig and prepare footers	2	A
C	Put up frame and siding/stucco, or brick	4	B
D	Put in floors, tubs, showers	3	C
E	Put in windows	1	C
F	Put on roof and shingles	3	C
G	Put in wiring, plumbing, gas lines, phone lines, security system	3	D, E, F
H	Put in walls and paint, carpet	4	G
I	Install doors, trim, appliances, carpet	3	H
J	Grade and landscape, sidewalks	3	G
K	Turn over house to owners	1	I

FIGURE 19—A PERT Chart

A PERT Chart shows the relationship among various steps in a project. It also serves as an easy way to calculate what's called the "critical path." The critical path is the longest time path through the network of steps. It identifies essential steps that must be completed on time in order to not delay completion of the total project.

GANTT CHART

The Gantt Chart is a visual management control device developed during World War I by HENRY L. GANTT, one of the pioneers in scientific management. It is a linear calendar on which future time is spread horizontally and work to be done is indicated vertically.

In any activity, the only constant is time, and therefore the scale of the Gantt chart is time—future time—the calendar spread horizontally across a sheet. Any suitable divisions and subdivisions of time can be used—months, weeks, days, or hours.

The Planning Chart. There are two basic types of Gantt chart. In the first form, the "planning" chart, the things to be done are entered in symbols and descriptions under the portions of the calendar in which it is planned to do them. (See Exhibit I.) (The standard symbols are described in Exhibit Ia.)

It should be noted that the heavy progress line always starts at the opening angle and never runs beyond the closing angle. The heavy progress line does not necessarily bear any relationship to the *amount* of time actually spent or to *when* it was spent. The chart has no value as a historical record and is usually thrown away after all operations are completed. The important thing in reviewing progress is the position of the ends of the progress lines in relation to the current date (V).

The Progress Chart. This form is used in production control to show cumulative work against time in relation to schedules. In Exhibit II, for example, figures in the upper left-hand corners are outputs in units scheduled for that particular period (in this case charting is done by five-day weeks). Figures in the upper right-hand corners show the cumulative schedule. As work progresses, a light bar is drawn in each period, its length proportional to the percentage of the work scheduled for that period completed in that period. (Note that for week 8-4, 20% more work was done than was scheduled for that week, represented by the double

light line.) In this illustration, "today" is the end of Week 8-4. A vertical chain or weighted string can be suspended from hooks at the top of a Gantt wall chart and readily moved to today's date to show status at any time.

EXHIBIT Ia
STANDARD SYMBOLS FOR GANTT PLANNING CHART

⌜ = the "opening angle," entered under the date when an operation is planned to start.

⌝ = the "closing angle," entered under the date when an operation is planned to finish.

⌜——⌝ = the time span during which the operation is to be active.

⌜—⌝ = the state of progress, as shown by the length of the heavy line compared to the planned. In R&D, the length of the heavy line is determined by reestimating the time still needed for completion and then measuring back (toward the left) from the closing angle—in other words, the open space between the end of the heavy line and the closing angle is the time still needed to complete the work.

V = the date when progress was posted, and is entered at the top of the calendar columns.

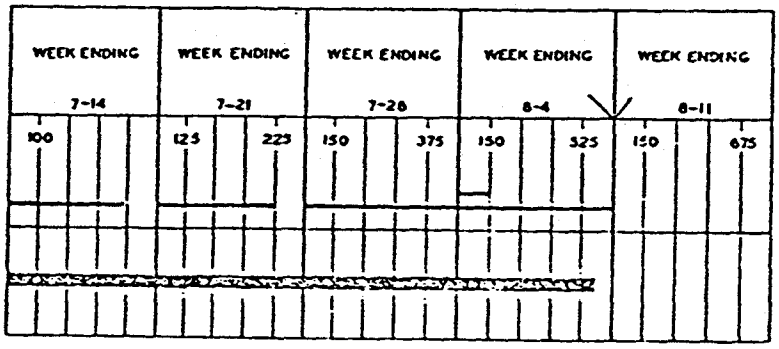
Opening and closing angles are not used. The heavier bar at the bottom shows *cumulative amount finished*. This line is posted at the scale of the week through which it passes.

On individual projects, the chart can be used to show *and watch* expenditures of man-days or dollars in relation to budgets. A project budget might be $1,000 per month, but it can (and probably does) build up to a period of greatest activity and then taper off—e.g., $500 in the first month, $750 in the second, three months at $1,500, then down to $1,000 or $500.

Actual figures are not shown on the chart but are included in an accompanying tabulation, usually bound facing the chart. The actual figures are of little consequence and need not be referred to, except in cases of significant overrun or underrun (end of heavy line to the right or left of the V).

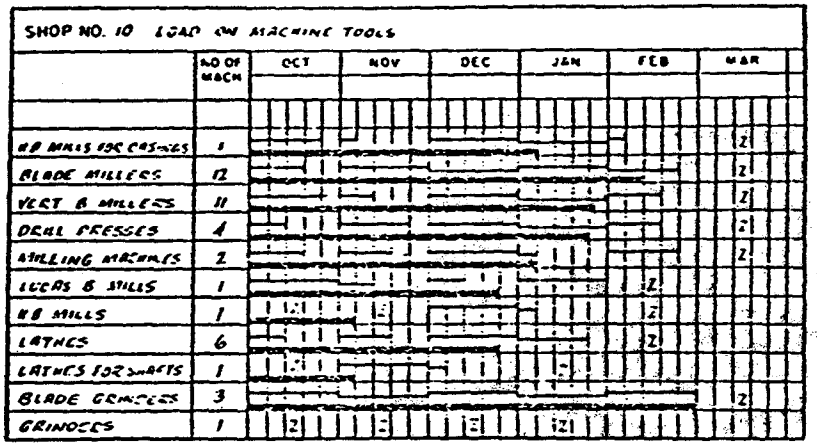
When this form is used for presenting load, the figures represent capacity in man-days or man-weeks. The V is not used here, because all time is future (the chart is redrawn periodically with the first future month at the left.) The light lines show overloads or unused capacity, *in the months in which they will occur*. The heavy line indicates the date when a department or section would be "out of work" if no new work came in. Experience usually leads to discovery of a normal or optimum total load—one in which adequate service can be rendered without idle staff or equipment. Exhibit III, for example, shows how far into the future machine tools in a certain shop will be kept busy by orders in the plant at the time it is drawn up. The heavy bars show the total amount of work ahead of the machines. "Z" indicates months in which no work is scheduled.

EXHIBIT II
GANTT CHART, PRODUCTION CONTROL



Figures in upper left are schedules for the week shown; figures in upper right are cumulative schedules. Light bars are actual production. Heavy bar is cumulative production as of end of week 8-4. Complex schedules covering large numbers of parts and assemblies can readily be controlled.

EXHIBIT III
GANTT LOAD CHART



Light lines indicate portion of month machines are scheduled to be utilized as of day chart was drawn. Heavy bars are cumulative load ahead of machines. "Z" means no work scheduled for that month. (Cf. Clark, Wallace, "The Gantt Chart.")

On Gantt planning charts, new work can readily be added without erasure to take precedence over work already planned—in fact, no erasing is ever required. The charts are "self-adjusting" for delays or inaccurate time estimates.

The use of the Gantt chart makes a definite plan for each project necessary. This is one of its advantages. It forces the thinking through of the things that will be encountered and must be provided for.

Percentage-Complete Progress Measure. The most common method of measuring progress is estimating the percentage complete. If one is dealing with the production of common units—the fabricating of a quantity of identical machines or machine parts—the numerator and denominator for the percentage are readily at hand. A project in research or development, however, is not composed of a number of identical parts—there is no common denominator applicable to both the portion completed and the portion uncompleted. Lacking any recourse other than a "blue-sky" guess, the tendency is to assume that the project is moving in relation to the allotted time plan—until the allotted time is nearly exhausted. Successive periodic reports of "percentage complete" sometimes appear like this: 25, 33, 50, 75, 90, 91, 92, 93, 94, etc. Since the figures were given at equal periods of time, it is fair to assume either that the earlier figures were too optimistic or that unforeseen difficulties have arisen in the later periods. At best, management has no assurance that the next reports may not be 94.5, 95, 95.25, etc.; and it cannot forecast *when* the project will be completed.

Where man-days or man-hours can be pre-estimated, hours can be used as units of measurement, and the percentage complete can be calculated:

$$\frac{\text{Hours spent to date}}{\text{Total hours estimated}} = \%$$

This does, however, require a timekeeping and reporting system. Also, it is accurate only when the original total estimate is accurate. This objection can be overcome by using the formula:

$$\frac{\text{Hours spent to date}}{\text{Hours spent to date} + \text{Hours estimated necessary to complete}}\% =$$

Re-estimating Progress Measure. The status or position versus plan is also secured in another way where Gantt planning charts are in use. This method is: first, to estimate the *time still necessary to complete*; and second, to subtract this time from the planned date of completion. This gives a date, on the plan, to which the project has progressed.

Where Gantt charts are used, the estimated weeks necessary to complete are counted back from the planned "closing angle" (⁀) to a point at which the heavy progress line is to be terminated. The advantage of this method is that it does not, in itself, alter the original plan.

but compensates for inaccuracy in it (based on latest knowledge). Progress is indicated ahead of or behind the plan, and by how much.

Rescheduling. Where formal methods of planning have been introduced, the tendency has been to change schedules almost as soon as performance fails to meet the schedules. It is obvious that this will lead to complacency with any performance. It is possible to be "on schedule" always, if the schedule is changed to conform with current progress. The habit of frequently revising schedules also leads to lack of thoroughness in thinking through the original plan for a project.

Of course, a change in direction, objective, area of investigation, or general method requires a new plan. However, changing schedules because of overoptimism in the original planning or failure to pursue the plan with vigor destroys the very usefulness of planning: It accomplishes nothing—that is, it does not expedite the project; and it weakens the confidence of management in information furnished for its plans.

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Clark, Wallace, "The Gantt Chart," 3rd ed., London, Pitman, 1952.

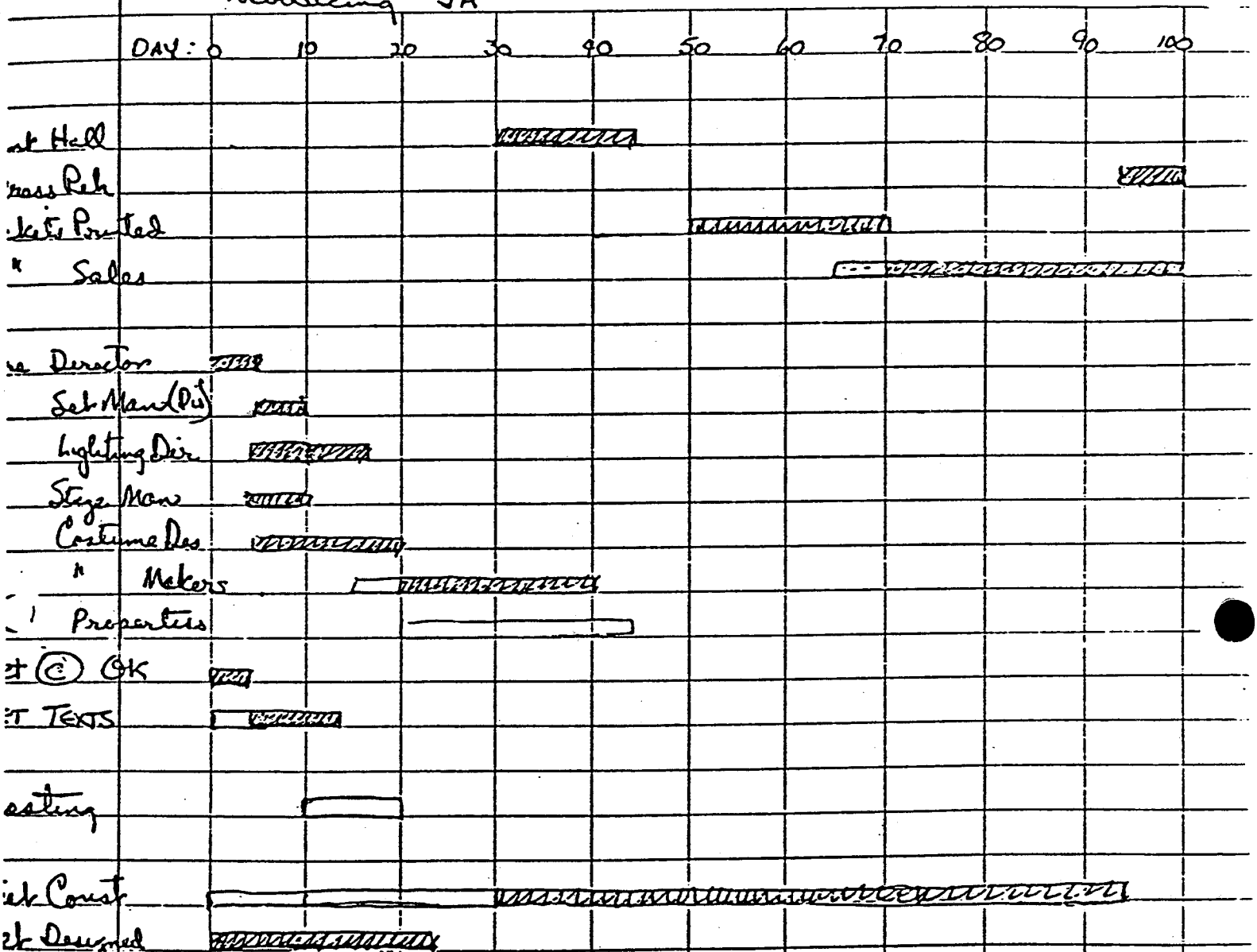
Clark, Mrs. Wallace, "The Gantt Chart," Ch. 7–3, in "Industrial Engineering Handbook," Maynard, H. B., ed., 2nd ed., New York, McGraw-Hill, 1963.

Cross References: *Integrated Project Management (and cross references there given).*

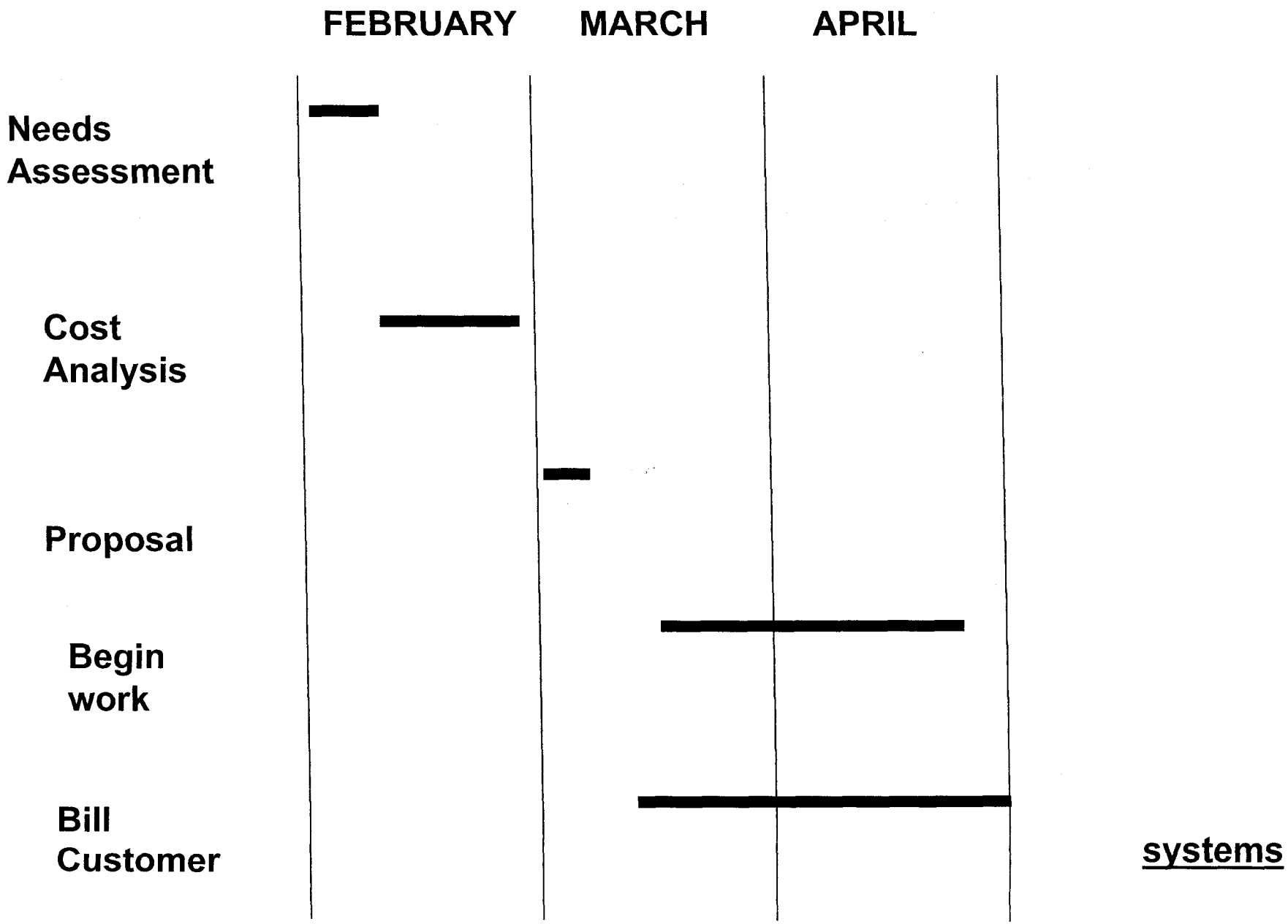
GANTT, HENRY L.

Henry Laurence Gantt (1861–1919), a pioneer American industrial and management engineer, taught natural sciences and mechanics, worked as a draftsman, and held a succession of increasingly responsible technical and executive positions in industry from 1887 through 1901. From 1902 until his death he served as a consultant. In 1917 he relinquished his private activity to accept a Government assignment in the Frankford Arsenal, and later in the building of ships for the Emergency Fleet Corporation. A contemporary of Taylor in the MANAGEMENT MOVEMENT, Gantt was one of the earliest to give major attention to human-relations aspects in industry, as distinguished from Taylor's primary emphasis on financial incentives. At the Midvale Steel Co. in Philadelphia (1887–93) he became Assistant to the Chief Engineer (F. W. Taylor) and then Superintendent of the Casting Department. There he made his first original contribution to management with his "task and bonus" system wage payment, which worked successfully at Midvale Steel earlier than Taylor's differential piece-rate system, and won acceptance long afterwards because it was simple, generally applicable, and less severe than Taylor's when the worker failed to attain standard. The GANTT CHART for which his name is now so widely known, was a revolutionary improvement in the planning and control of production in terms of time as well as quantity. But more enduring than his techniques is the new outlook he brought to bear upon industrial leadership. "In his later years, his influence in bringing American industry, and particularly the American engineering profession, to accept the new concepts of management was enhanced by his success in insisting that the training of workers should become a responsibility of management. In 1908 he was putting forward views not generally accepted until the end of the First World War. By then he was already thinking further ahead, to 'democracy in industry' and the humanizing of the science of management. In his later writings he rose to philosophical stature in his proposals for equality of opportunity in industry, and for the identification of the interest of employers and employed on the basis of scientifically ascertained facts" [1]. Gantt's books include "Work, Wages, and Profits," 1910 (Engineering Magazine Co.): "Industrial Leadership," 1916, (Yale Univ. Press): and "Organizing for Work," 1919 (Harcourt, Brace, and Howe, New York). Important among the papers he read before the American Society of Mechanical Engineers are, "A Bonus System of Rewarding Labor," 1902 (*Transactions*, vol. 23); "A Graphical Daily Balance in Manufacture," 1903 (*Transactions*, vol. 24); "Training Workmen in Habits of Industry and Cooperation," 1908 (*Transactions*, vol. 30); "The Relations Between Production and Costs," 1915 (*Transactions*, vol. 37); and "Efficiency and Democracy," 1918 (*Transactions*, vol. 40). Gantt was a prolific writer and

Sample Gantt Chart



GANTT CHART



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