RAPTI INTEGRATED RURAL DEVELOPMENT PROJECT

THE RURAL DEVELOPMENT CONSTRUCTION MANAGEMENT MANUAL

Joel M. Boch-Isaacson

A COOPERATIVE EFFORT OF
HMG AND USAID
WITH ASSISTANCE FROM PADCO

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In April and May of 1985 the first Training Program in Construction Management (for rural works and field level engineers) ever to take place in Nepal was held in Tulsipur, Dang, in Nepal's Midwestern Development Region. The training was part of Nepal's observance of The United Nations International Year of Youth under the auspices of His Majesty's Government of Nepal's Rapti Integrated Rural Development Project and the United States Agency for International Development with assistance from PADCO (Planning and Development Collaborative Inc.).

PCO had commissioned Mr. Joel M. Boch-Isaacson as an expatriate trainer and Mr. Jyoti P. Lohanni as a local trainer - both management specialists - to design the course and to run the Construction Management Training. Both of them worked hard to make the training successful in a limited amount of time by using their expertise skills and techniques during the different phases of the Construction Management Training like assessment, planning, curriculum development, implementation and evaluation. I am deeply indebted to both Mr Joel M. Boch-Isaacson and Mr. Jyoti P. Lohani for their hard work as well as for their intellectual and emotional sustenance. Furthermore, Mr. Joel M. Boch-Isaacson was assigned to prepare this valuable Construction Management Manual. Not only did his patience and devotion lead to this achievement, but his long working experience with field level engineers and technicians also counted much to enrich this manual. I am very grateful to Mr. Joel M. Boch-Isaacson for his commendable contribution.

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Khem Raj Nepal

Project Co-ordinator

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GLOSSARY OF ABBREVIATIONS, TECHNICAL/SPECIAL TERMS, NEPALI LANGUAGE TERMS

A&E	Architecture and Engineering (firm)
Amanat	Force account construction
C.G.I. or CGI	Corrugated Galvanized iron
Chowkhat	Frame (door or window)
CPM	Critical Path Method (network analysis)
cu.ft.	Cubic foot or feet
Dakarmi	Mason, bricklayer
D.E.	Divisional Engineer
Doko	A large basket for carrying things on the back.
DPC	Damp-Proof Course
D.T.O. or DTO	District Technical Officer
Fast Track	A construction system in which construction is started before designs are complete, in order to reduce project duration.
G.I.	Galvanized Iron
H.D.P.	High Density Polythene
H.M.G.	His Majesty's Government of Nepal
I.R.D. or IRD	Integrated Rural Development
L.D.O	Local Development Officer
m^3	Cubic meter or meters
m/d	man day (days) or man per day
Mistri	Craftsman
Naike	Leader, chief
PCO	Project Co-ordinator's Office
P.C.V.	Peace Corps Volunteer
R.I.R.D.P. or RIRDP	Rapti Integrated Rural Development Project

PREFACE

The planned accelerated development of less developed countries has been identified by the responsible global community as one of the major tasks facing humanity today. Acceptance of this task was relatively recent. Methods, tools and ideas are still being developed to accomplish it.

Construction is a major consumer of resources and creator of wealth. It is a major component of economic and social development programs. The people responsible for implementing construction projects in developing countries are under increasing pressure to complete high quality works within limited time and cost budgets. In order to meet these targets they require adequate management tools.

These are people whose training or experience is primarily technical They are competent to handle the technical aspects of construction but often encounter difficulties in the area of construction management. This is not surprising. Modern construction management is a relatively new subject even in schools in developed countries. The following quotations are taken from THE CONSTRUCTION INDUSTRY IN ASIA: A SURVEY, published by the Asian Productivity Organization.

> "The survey has revealed that the present education for civil engineering diploma and degree courses is not oriented towards practice of civil engineering, namely, the "construction activity". All the contractors and the engineering departments draw their management and technical manpower from the civil engineering diploma and degree holders. The opinion has been that those who have been trained more on theoretical subjects and not taught the important subjects of resource management, of material, finances and human relationship and construction equipment, find it difficult to cope with these problems which they face in the execution of the jobs.

Construction activity being more labour-oriented, human resource management becomes an important factor. Again the environment in which they have to manage, the number of participants in the industry, ever changing types and places to work, technology and equipment all put a great strain on them, as they have not been oriented towards these. The present degree and diploma courses contain almost nothing on the management aspects of construction activity."[1]

and

"At present there are no courses in construction [in Nepal]. The diploma course in civil engineering has only about 4 percent of its time given in the final year to construction management."[2]

and

"The lack of proper knowledge of project management among administrators and contractors is one of the main hindrances to the proper execution of construction projects.
Most civil engineers in Nepal obtained their civil engineering degrees from India where the management content of the degree course is not very high, even though of late some universities and institutions in India have started post-graduate training in construction engineering. In general, a lack of urgency among contractors for completion of work , and a lack of control technique on the part of the administrative bureaucracy in contract management, affect project execution."[3]

These perceptions by engineers and managers from Nepal and other Asian countries are encouraging. They show that the problem has been identified, and that is the first step in solving it. This manual is an attempt to take another step toward that solution.

[1]The Construction Industry In Asia: A Survey, Tokyo,Asian Productivity Organization, 1983, p.18.

[2]ibid., p.100.

3ibid., p.108

INTRODUCTION

The tools and methods of modern construction management that are described in this manual have been tested in Nepal over a period of more than eight years. They have been used on both rural and urban construction projects. During this period they have been modified to make them more suitable for use under local conditions.

They are presented here as practical tools that can assist the engineers and technicians who are responsible for managing construction projects in the context of rural development. Tools are meant to be used, not looked at. These tools are no differant. Merely reading this manual will not improve anyone's management skills. It is only by picking these tools up and applying them to your work that any benefit can be gained from them.

Naturally one is cautious when using an unfamiliar tool for the first time. At first, it should be used on a relatively small piece of work, so that experience can be gained without great risk. With practice, skill will be developed and the tool will prove it's value.

Since construction is a team effort, requiring the coordinated work of many people, it will be necessary to have the cooperation of colleagues and subordinates to put many of these tools to work. The best way to get this cooperation will be to apply the tools in areas where people are having problems, so that they can directly benefit from them. If the tools are applied haphazardly, to situations where people are doing well without

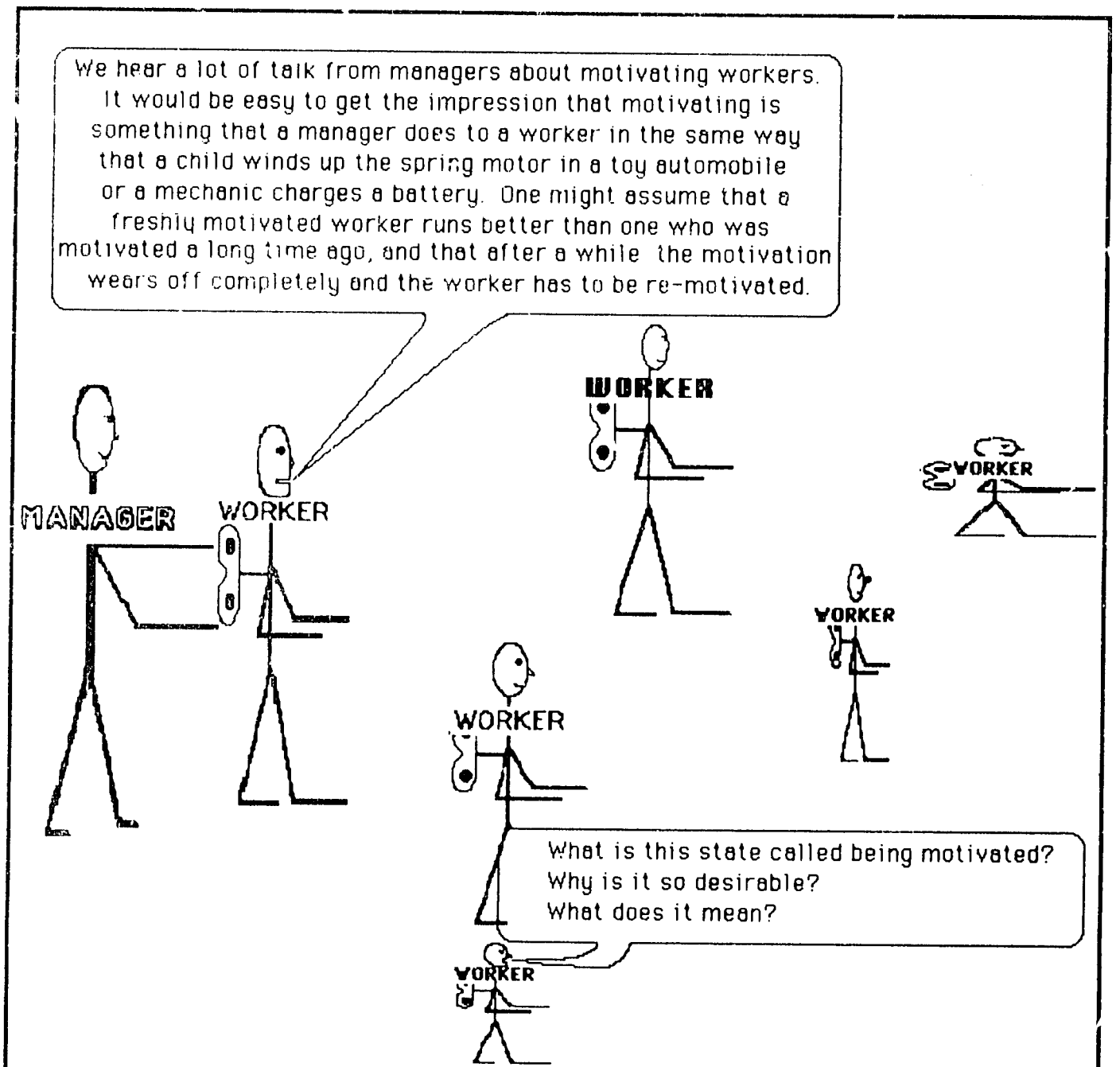
them, the tools may be seen as a nuisance and people may resent them.

Although it has been necessary to divide the manual into different sections in order to present the material clearly, it must be realised that construction management is a total process. In actual practice feedback, schedules, contracts, site-management, and community relations are not isolated compartments. They are like the limbs and organs of a body; each one has a specialized function, but they act as a whole. For this reason, it is suggested that the manual be read through completely at least two times before trying to study or focus on any one subject. By doing this, the reader will see how the different techniques support one another.

As an example, the section *Motivating the Construction Team* presents tools and principles that will help managers to develop their subordinates' commitment to organizational goals. In the section *Scheduling*, some of those tools and principles are applied to the problem of maintaining the schedule during construction implementation.

These techniques also work as a whole in another way, they provide a disciplined, organized way of thinking about the construction process. Their regular use develops an active, aggressive approach to that process which is the heart of construction management.

MOTIVATING THE CONSTRUCTION TEAM



THE WIND-UP TOY THEORY OF MOTIVATION

Let's examine this business of motivation before we rush out to *do it* to our subordinates. When we asked a group of thirteen engineers working in rural development in Nepal to list the ways in which a motivated worker behaves, they produced the following list.

A MOTIVATED WORKER:

1. Takes pride in his work
2. Takes responsibility for his work
3. Shows enthusiasm
4. Uses creativity & intelligence in his work
5. Is highly productive
6. Is helpful to other workers
7. Willingly does his work

One of the classic modern texts on construction management[4] states that management must keep morale (spiritual condition) high in order for workers to be motivated. According to this work the indicators of high morale among workers are:

1. Interest
2. Enthusiasm
3. Harmony
4. Cooperation
5. Loyalty
6. Keenness
7. Self-discipline
8. Confidence
9. Sense of duty & responsibility for organization's affairs
10. Acceptance of necessary rules & regulations
11. Ambition
12. Absence of frustration

[4]R.E. Calvert, Introduction To Building Management, London, Butterworths, 1982.

These two lists come close to what most people mean when they talk about motivated personnel. Most of us would be glad if the people we worked with behaved in these ways. The question is:

HOW DO WE MAKE IT HAPPEN?

Engineering managers such as District Technical Officers and their colleagues work within a highly structured and tightly regulated bureaucracy. People in this position often feel that they do not have any means to motivate their subordinates because they do not have the authority to hand out rewards such as salary increments, bonuses, and promotions or punishments such as demotions, firing, and transfers.

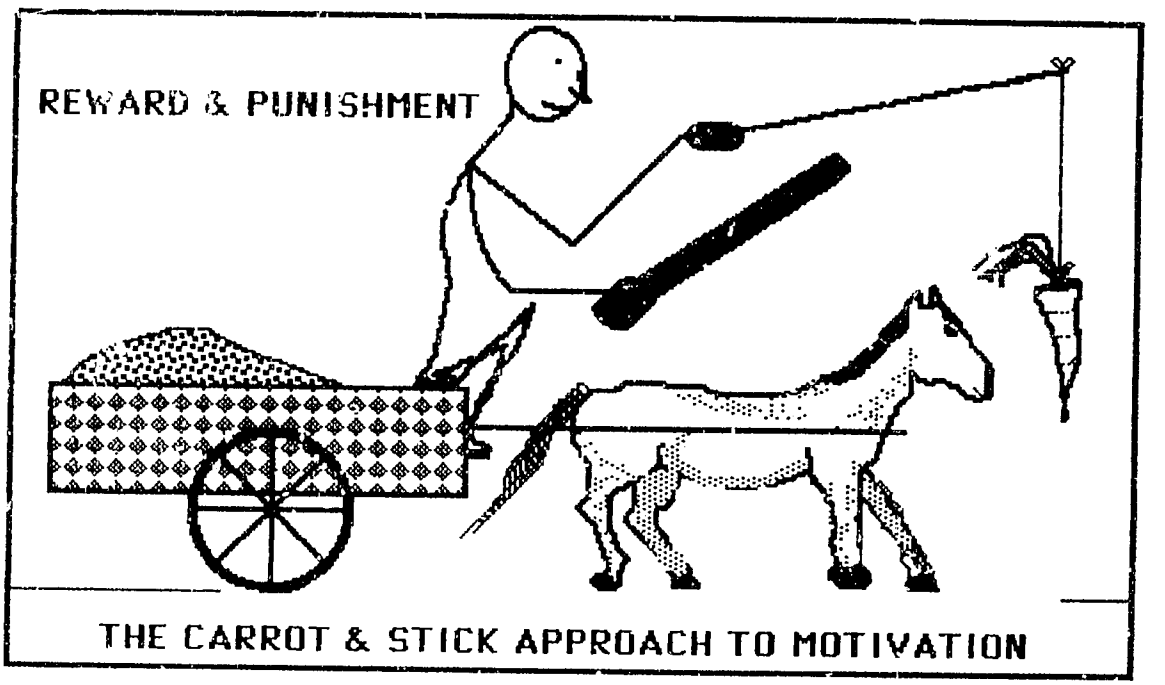
Let's examine this assumption

it's very important

it shapes the thinking of a great many managers

and

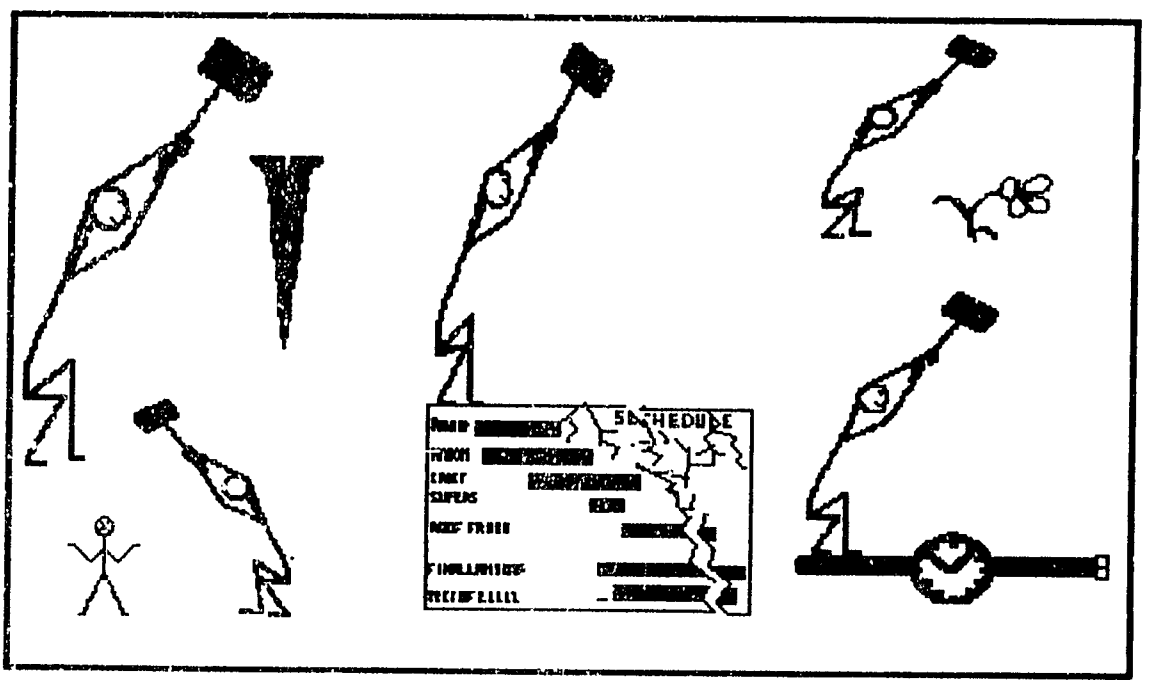
IT'S NOT TRUE!



This method of "motivating" through external rewards and punishments is what we call the "*CARROT & STICK*" approach . It's the trick used to make an old horse or donkey pull a wagon. First we hold a fat juicy carrot in front of the donkey to get him to go forward. If he moves, the cart moves. Hooray! Success! But only until the donkey realizes that he can't ever reach the carrot or until he has eaten the carrot and refuses to go forward anymore until we offer another one (this can get expensive). But we are not defeated. We have another resource to call upon, a big stick. We may not always have to beat the donkey. Sometimes just fear of the stick makes him pull. Sometimes though, we do have to beat him. After a while he gets used to the beatings and they don't "*motivate*" him anymore. If we beat harder the donkey will eventually die or run away or become unfit for work.

The biggest problem with this approach is that whether we use the carrot or the stick, we can't take our attention off the donkey for one second. As soon as we do - he'll stop.

Rewards and punishments, carrots and sticks, threats and bribes; these tools don't work very well. If you want an illustration of this, turn back to the lists of ways that motivated workers behave on page* 12 and ask yourself if it's really possible to make someone take pride in his work by threatening him. Can we really bribe someone into having confidence or self-discipline?



"WHEN THE ONLY TOOL YOU HAVE IS A HAMMER YOU TEND TO TREAT EVERYTHING AS IF IT WERE A NAIL"

A. Maslow

This reliance on motivation through rewards and punishments imposed from outside the work itself is an example of a philosophy of management known as Theory X.[5]

According to Theory X:

1. The average human being has a built-in dislike for work and will avoid it whenever he can .

2. Since they dislike work, most people must be threatened, controlled, directed, punished and/or bribed in order to get them to produce.

3. Most people prefer to be directed, wish to avoid responsibility, have little ambition, and want security above all.

Another management philosophy, known as Theory Y[6] takes a different view.

According to Theory Y:

1. Work is as natural to human-beings as recreation or play.

2. External control, threats and punishment are not the only ways to make people work. People will direct themselves and exercise self-control in attaining objectives to which they are committed.

3. If a job is satisfying in itself, a worker is more likely to commit himself to the goals of the organization.

4. Under the proper conditions the average human being not only accepts responsibility, but seeks it.

5. The majority of people are capable of exercising creativity, ingenuity and imagination in solving work-related problems.

6. Under the usual conditions of employment, only a small part of a worker's intellectual and creative powers are utilized.

[5]D. McGregor, The Human Side Of Enterprise, N.Y., McGraw-Hill, 1960.
[6]Ibid.

We can see that these two philosophies of management represent two completely different views of human nature. Functionally, the main difference between the two is the assertion by Theory X that people are motivated only by forces coming from outside of themselves and their work, such as pressure, bribes, threats, etc. While theory Y asserts that people's motivation also comes from forces inside the person or his work such as job-satisfaction, personal achievement, etc.

We will not concern ourselves with the question of which theory is the correct one. There are probably appropriate situations for each of them. We will ask ourselves a more practical question. Which theory is more useful to the engineering manager whose authority to reward or punish is limited by the rules & regulations of his department or ministry? The obvious answer is Theory Y, with it's stress on encouraging the workers natural inclination toward doing a good job.

The average managing engineer working within a bureaucracy (a D.T.O. for example) is not in a position to fire a subordinate, raise his salary, or promote him. The worst he can do is to make a person's working life difficult. This is not likely to improve the quality or quantity of that person's work. The best he can do is to treat a person as a favorite. This might result in improved work from that person but it will probably cause jealousy among the rest of the staff and have a negative result in the long-run.

When we examine our old ideas about motivation in this way, we not only discover that they're not very effective, but we see that we're not even in a position to apply them on the job.

Let's look at some recent discoveries about what really motivates people to work and what causes them to be dissatisfied and de-motivated.

Two hundred engineers and accountants as well as other employees were surveyed by Frederick Herzberg[7] He found that the motivation to work is associated with a certain group of factors, and that job-dissatisfaction is related a different group altogether. He called the sources of job-dissatisfaction HYGIENE FACTORS. He called the sources of the motivation to work MOTIVATORS.

HYGIENE FACTORS
(Sources of job-dissatisfaction)

These are conditions that must be present if a worker is to maintain a reasonable level of social, physical and mental health. If they are absent, or insufficient, workers become dissatisfied and performance tends to fall to un-acceptable levels. If they are present, workers are satisfied enough to perform their jobs at a more or less acceptable level. Herzberg called this the MAINTENANCE LEVEL. The presence of hygiene factors will not motivate a worker to perform at any level higher than the maintenance level. Some of the hygiene factors are:

1. Organization policy and administration
2. Working conditions
3. Salary
4. Fringe benefits
5. Security

[7]F. Herzberg, Work And The Nature Of Man, N.Y., The World Publishing Co., 1966. and
F. Herzberg, B. Mausner, and B. Snyderman, The Motivation To Work, N.Y., John Wiley, 1967.

The idea that a workers salary is not a motivator surprises many people. Salary and fringe benefits are usually thought of as being the main motivators for a worker. Herzberg's studies show that an increased salary may cause a worker to produce at a higher level for a short time, but after a while he begins to consider his new salary as normal and appropriate. His productivity then falls back to the old comfortable maintenance level. According to the motivation/hygiene concept:

SALARY IS NOT A MOTIVATOR

BECAUSE

IT DOES NOT INCREASE A WORKER'S COMMITMENT

TO

ORGANIZATION GOALS OR JOB PERFORMANCE

This can only be acheived by motivators, which include:

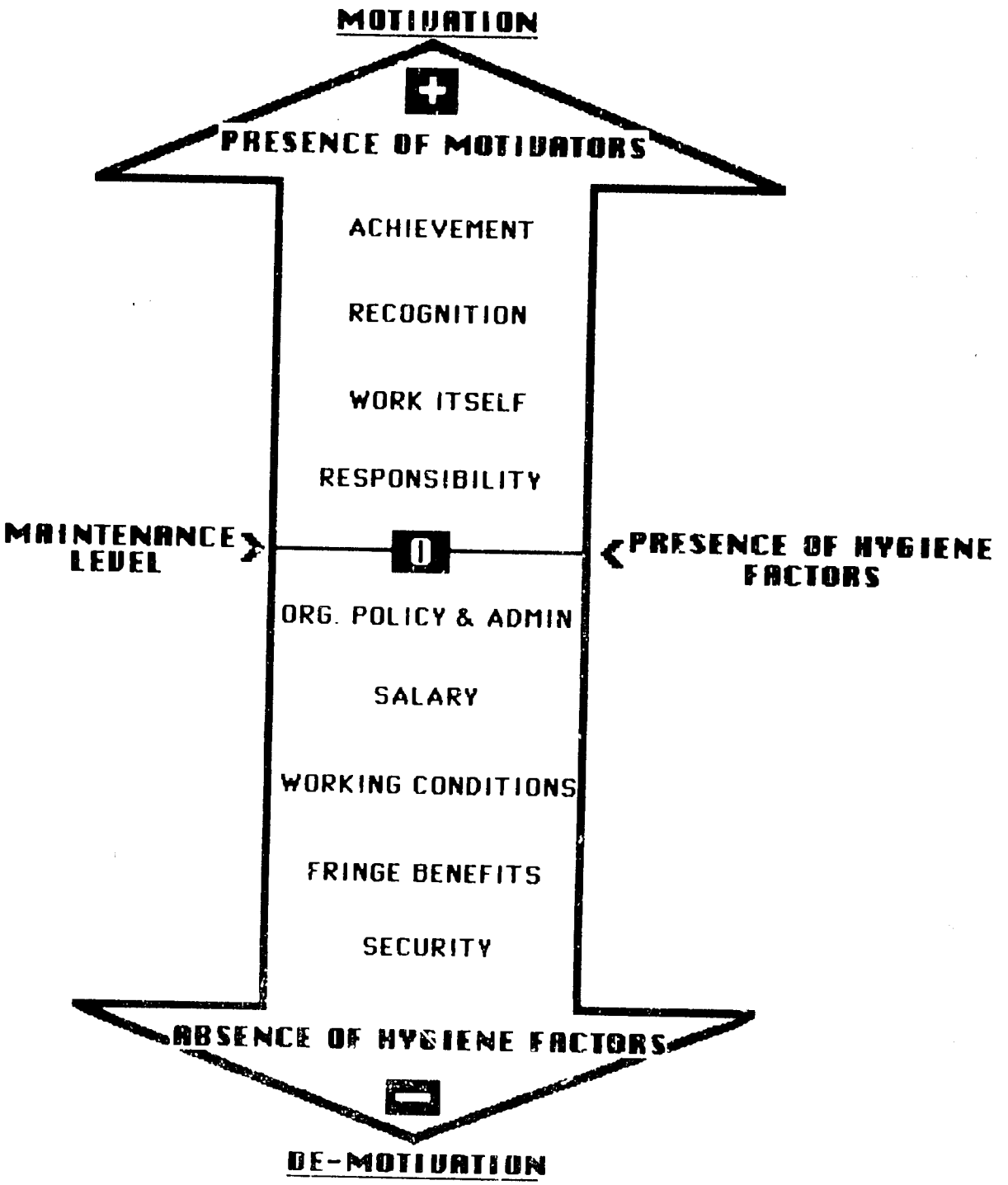
1. Responsibility
2. Work itself
3. Recognition
4. Achievement

The motivators are psychological factors and motivation is a psychological condition.

MOTIVATION IS COMMITMENT

NOT

JUST A STEPPED-UP LEVEL OF SOME VARIABLE SUCH AS PRODUCTION



Adapted from:
UNDERSTANDING PEOPLE: MODELS & CONCEPTS
W.C. Boshear & K.G. Albrecht
San Diego, CA: University Associates, Inc., 1977

MOTIVATION/HYGIENE CONCEPT

This should come as very good news to the engineering manager who works within the government bureaucracy.

1. You may not be able to authorize a salary increment for a subordinate, but you can certainly offer recognition by letting him know that you appreciate the importance and quality of his work. For specific details of how to do this, turn to pages 28-31.

2. You may not be able to change departmental policy, but you can certainly delegate responsibility in proportion to a workers capability.

3. You may not be able to change the fundamental conditions in which you and your subordinates work, or hand-out fringe benefits, but you can assign meaningful units of work. If a worker can see a whole task through from beginning to end he is far more likely to be motivated by the work itself. Success in accomplishing his task will be more likely to give him a sense of achievement.

Another reason why this is good news is that it makes our work much more interesting. We are leaving the "wind-up toy" theory of motivation behind. We are starting to think about people as people, not as things. People are far more complex and interesting than things. They require a different kind of handling.

Things can be stacked, stored, bought, sold, loaded onto trucks, cut into lengths, broken-up as scrap, and thrown away. People don't appreciate that kind of treatment. When we work with people, as managers, we have certain organizational goals in mind. We will have greater success in attaining these goals if the people that we work with are committed to the organizational goals.

Once again we ask the question:

HOW DO WE MAKE IT HAPPEN?

Here's how. First recognise your need as a manager -to accomplish your organizational goal or objective. Then try to see what your subordinate or colleague needs. Once you are aware of these two needs, try to look for a way that both needs can be satisfied. It's a 3 step process. Let's review the steps before we go on.

1. Identify the organizational objective.
2. Identify the worker's need.
3. Combine the two so that the worker satisfies his own need by accomplishing the organizational objective.

MOTIVATION

MEANS

COMMITMENT TO ORGANIZATIONAL OBJECTIVES

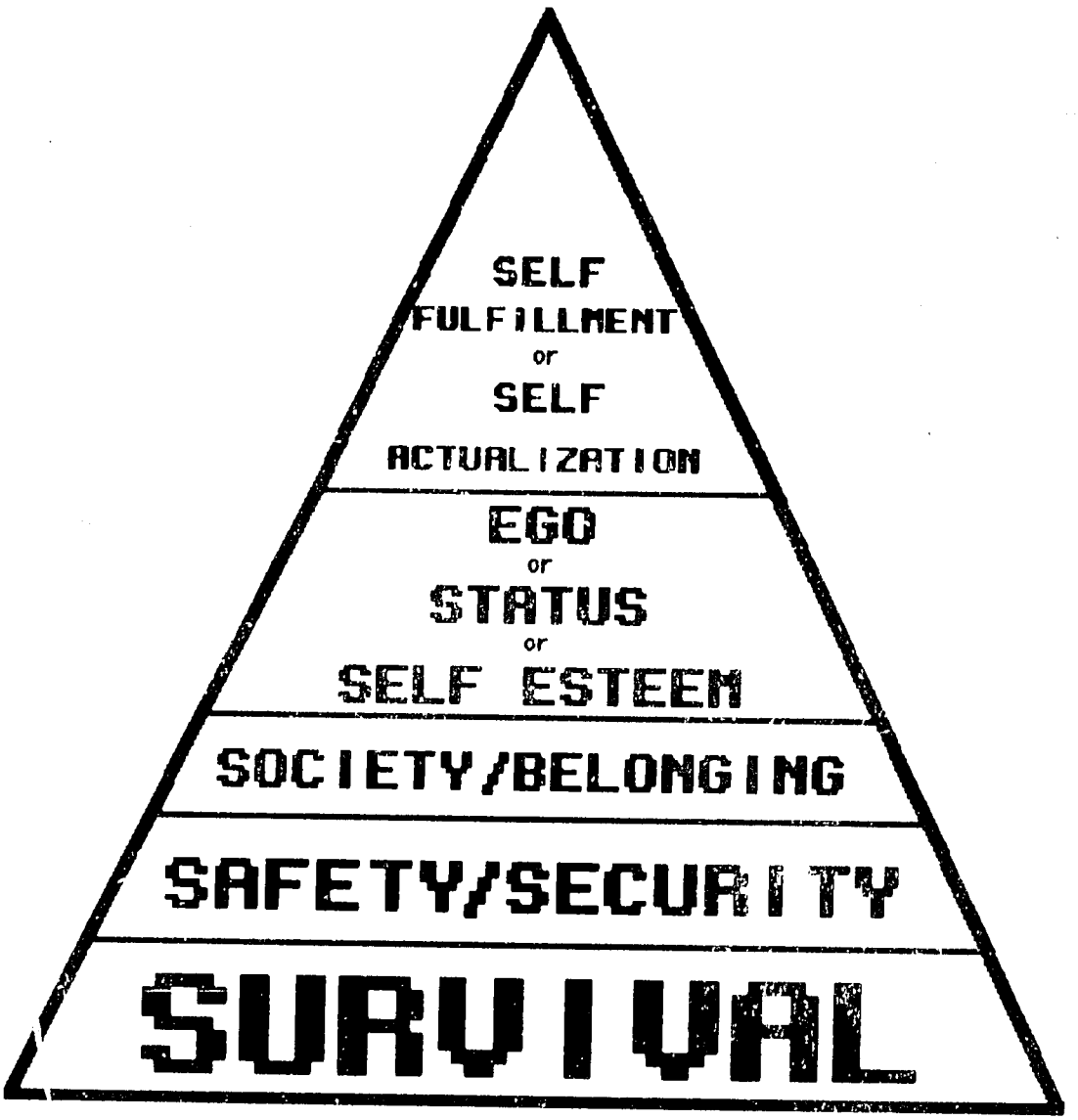
If the organizational objective is achieved, the worker's need is satisfied. The worker is therefore committed to the organizational objective. If you win, he wins. If you lose, he loses.

You as a manager have an interesting exercise to carry out in order to use this management tool. **You have to be able to discover what the worker needs.** It will take some practice to do this skillfully. You will have to develop your intuition and some skill as a practical psychologist.

TURN THE PAGE TO FIND ANOTHER TOOL TO HELP YOU TO DO THIS.

Abraham Maslow's

HIERARCHY OF HUMAN NEEDS

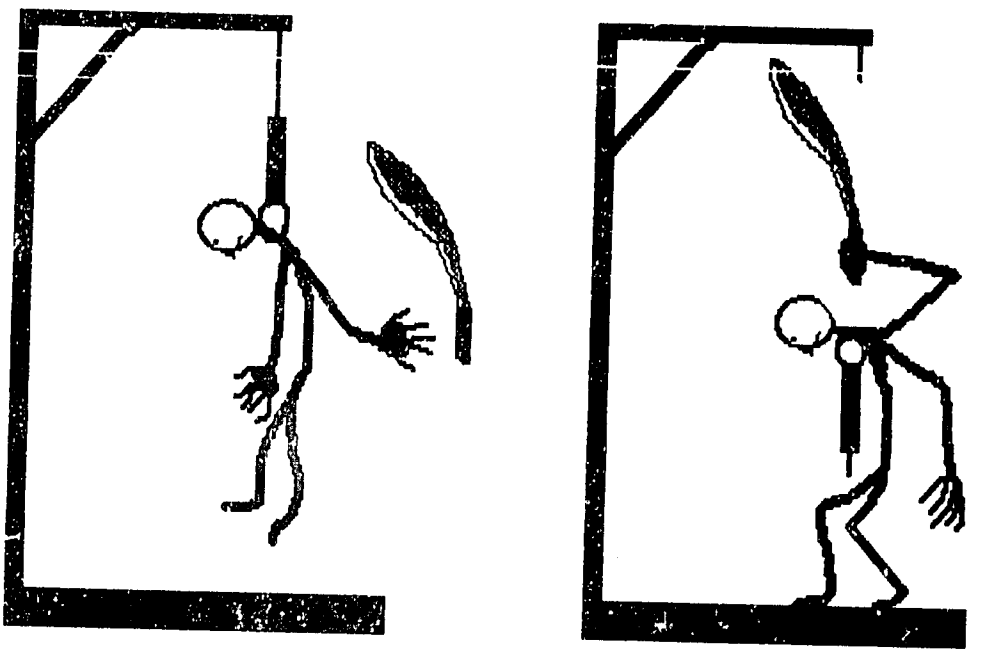


By needs, we mean certain drives in a person which require satisfaction. An unsatisfied need creates inner tension. This tension energizes and motivates the persons behavior. According to Abraham H. Maslow[8] needs have different priorities. A high priority need motivates behavior until it is at least partly satisfied. A lower priority need will then begin to motivate behavior. There are always needs demanding satisfaction. The illustration above shows the 5 levels of need with the highest priority needs at the bottom and the lowest priority needs at the top.

[8]Abraham H. Maslow, Motivation And Human Personality. (2nd Ed.),N.Y., Harper & Row, 1970.

Quite naturally basic survival forms the base of the pyramid. It is the highest priority human need. Survival is concerned with such things as food, clothing, shelter, air, water, etc. The organism's basic needs - what a person requires to stay alive. When we say that this is the highest priority need what we mean is that if a person's survival is threatened, all of his behavior will be directed toward satisfying his need to survive.

EXAMPLE



THE PERSON IN THE ILLUSTRATION ON THE LEFT IS MOTIVATED BY THE NEED TO SURVIVE.

He will do anything to reach the kukri so that he can cut the rope which is threatening his survival. You would not be able to motivate such a person by appealing to his needs for status, self actualization, belonging or security. The fact is he can't breathe, and breathing is the only thing that will motivate him.

THE PERSON IN THE ILLUSTRATION ON THE RIGHT HAS SATISFIED HIS NEED TO SURVIVE.

He is no longer motivated by the need to reach the kukri or cut the rope. You would not be able to motivate him by offering him more kukris or more ropes to cut. Since he can now breathe, his need for basic survival has been satisfied for the moment. He can now turn his energy to satisfying the next level of need.

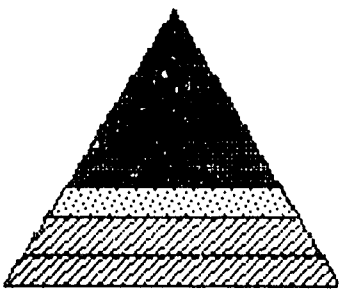
Let's use another example. If I am in a desert dying of thirst (motivated by the need to survive) I will do anything for a drink of water. Once I have found sufficient water and have drunk enough to survive I will not be motivated by the offer of another drink. I will try to make myself safe and secure. If I live in the desert, this may mean digging a deep well or building a tank so that I can be safe and secure from dying of thirst in the future.

As a higher priority need becomes satisfied it ceases to motivate or energize behavior, and a lower priority need takes it's place. A person who's survival is <u>not</u> being threatened and who is more or less safe and secure can turn his attention to the society around him. His need to belong to a human group and to be accepted by his neighbors, family and community. Since he does not need to struggle to stay alive, and feels secure and safe enough, he can take part in social activities.

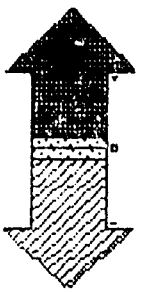
Security for one person may mean the guarantee of employment for two years. Another person may require a house with iron grilles on the windows and a lock on the door. Still another may need money in a Swiss bank and an insurance policy before anything other than the need for security will motivate him. Every human has the same levels of need, but the means for satisfying the need can vary from person to person.

This variation seems to increase as we go up the pyramid to lower priority needs. The level of need which we describe with words like ego-satisfaction, status, or self-esteem can be satisfied in a great variety of ways by different people. For one person it may mean owning beautiful clothing or other possessions. For another, the need will be satisfied by a university degree. Another may need power, and still another person may satisfy this need by knowing that he is an honest, fair and religious person.

The means for satisfying the level of need pointed to by the words self-fulfillment or self-actualization is probably different for every person. It has to do with reaching one's highest potential, becoming all one can become. It can involve creating an external representation of one's inner experience; as in artistic creation.



Maslow's
HIERARCHY OF HUMAN NEEDS



Herzberg's
MOTIVATION/HYGIENE
CONCEPT

If we compare Maslow's Hierarchy of Human Needs with Herzberg's Motivation/Hygiene Concept, we notice that Maslow's survival & safety/security roughly correspond to Herzberg's hygiene factors. Belonging is probably a borderline item. Maslow's fourth and fifth levels of human need, relate to the motivators in Herzberg's model.

We can appeal to the human needs for:

SELF-FULFILLMENT/
SELF- ACTUALIZATION

EGO/STATUS/
SELF-ESTEEM

By offering the motivators:

ACHIEVEMENT
RECOGNITION
WORK-ITSELF
RESPONSIBILITY

It's through the fourth and fifth level of human needs, and perhaps the third, that the engineering manager has his best opportunities for raising the level of motivation among his staff. We now have the background information to examine some of the ways that these opportunities can be used.

FEEDBACK

PRAISING AND REPRIMANDING

You as an engineering manager either set the goals that your staff must meet, or transmit those goals to them. If you want those goals to be met, it is your job to make sure that the goals are clearly understood. If someone is to do a good job, he or she must know what a good job looks like.

The first step is to explain and, if possible, show to the person what you expect. Although this seems obvious, many managers act as if part of a subordinate's job is to find out for himself what he is supposed to do. Others will give only vague instructions like "supervise construction at that site."

Once the goal has been communicated, give the person a chance to <u>try</u> to accomplish it himself. If he fails - go back to the first step. Explain the goal again and show the person how to go about the task you're setting for him. If he succeeds <u>even partially</u>, it's time to praise him. Partial success is fine. It's the first step toward complete success. <u>This is a key point to remember when you are setting goals or training a new staff member.</u>

As the manager, you could look at a partial success as either a partial success or a partial failure. Experience shows that it's far more useful for a manager to see it as partial success. Because of this, you should never scold or reprimand someone who is learning a new job. (We'll give you a very important reason for this in a little while). So as soon as you see a sign of success, praise.

There is a technique for praising. It consists of three parts.

1. Praise immediately
2. Praise specifically
3. Tell the person how you feel.

1. PRAISE IMMEDIATELY: As soon as you learn that a person has done something right, achieved a goal, met a target, learned a skill - praise him. Don't assume that he knows that he's done a good job. Don't assume that he knows that you appreciate it. Don't save-up praising him for some special occasion like an employee evaluation several months away. Praise right away. You don't want your staff to save their best efforts for special occasions, do you? Why save up your praise then?

2. PRAISE SPECIFICALLY: It's important that people know exactly what it is they've done to earn praise. You must connect praise to a specific accomplishment. Use formulations like these:

"That was an excellent survey that you carried out." Or " Thank you for doing such a fine design." Or " I really appreciate the extra work you did to finish your report in time for the review meeting."

Praising in a general way doesn't work so well. It's not very useful to go around telling people things like "Your work is very good." Such things are not true in general and every worker knows it. No one is always a good worker or always efficient. Even the best of us has some not so good days and some bad days. You don't want to praise the bad days.

3. TELL THE PERSON HOW YOU FEEL: Emotional content is a very important part of praise or recognition. You and your subordinates are human beings with human feelings. The needs of the ego, the need for status and self esteem are not intellectual abstractions. Let the worker who has done a good job know how good you feel about his accomplishment. If you feel happy, say "I feel happy." Try formulations like :

> "That was an excellent survey that you carried out Hari, thanks for the fine job. I want you to know that I'm very happy about that piece of work." Or "You helped us greatly by completing those drawings on time Meena. I'm delighted with the effort you put out to do such a fine piece of work so quickly."

Unfortunately, we can't praise all of the time. This is too bad, since correct praising is one of the best motivators of a workforce. For this reason, a good manager actively looks for people doing a good job. Too often managers do just the opposite. They think their job is to look for people doing something wrong. In fact, there is no need to do this. Just look for people doing something right. From time to time, you will find people doing something wrong. When you do, it's a good idea to see if it's because of some reason outside the person's control such as sickness etc.

When you find someone doing something wron, and the person already knows how to do it right, and if there is no reason outside the person's control; it's time to reprimand.

Just as there are effective ways of praising or giving recognition for doing good work, there are effective ways of reprimanding a subordinate who has done bad work. A reprimand, or scolding does not always work. If it is given in the wrong way, it can have a bad effect on a workers attitude toward his job and it can ruin his relationship with you, his manager.

There are three points in this technique of reprimanding effectively. The first two are similar to effective praising:

1. Reprimand immediately
2. Reprimand specifically
3. Tell the person how good he is

1. REPRIMAND IMMEDIATELY: (There is one exception to this rule; never reprimand a subordinate in public. If you discover that a subordinate is doing something wrong you may delay giving a reprimand until you can talk to him privately, but no longer). There are three good reasons for reprimanding a subordinate immediately rather than delaying. First, you want the worker to understand that the reprimand is connected with bad job performance. Second, a worker who knows how to do a good job also knows when he's done a bad job. He expects a reprimand. If the reprimand doesn't come quickly he will waste energy waiting for it to come; this energy could be going into his work instead. The third reason is that if you wait too long to reprimand a worker for a bad job, you may get around to doing it when he's in the middle of doing a good job. This will be confusing for him and awkward for you.

2. REPRIMAND SPECIFICALLY: It's important that the subordinate understand that the reprimand is the result of a specific action on his part, not to your feeling about him personally or his work in general.

3. TELL THE PERSON HOW GOOD HE OR SHE IS: This is important. Just as soon as you've issued an immediate and specific reprimand such as:

> "Your design for the Dãdagãon drinking water supply system was not very good, Ram. You didn't follow the design standards that we agreed on."

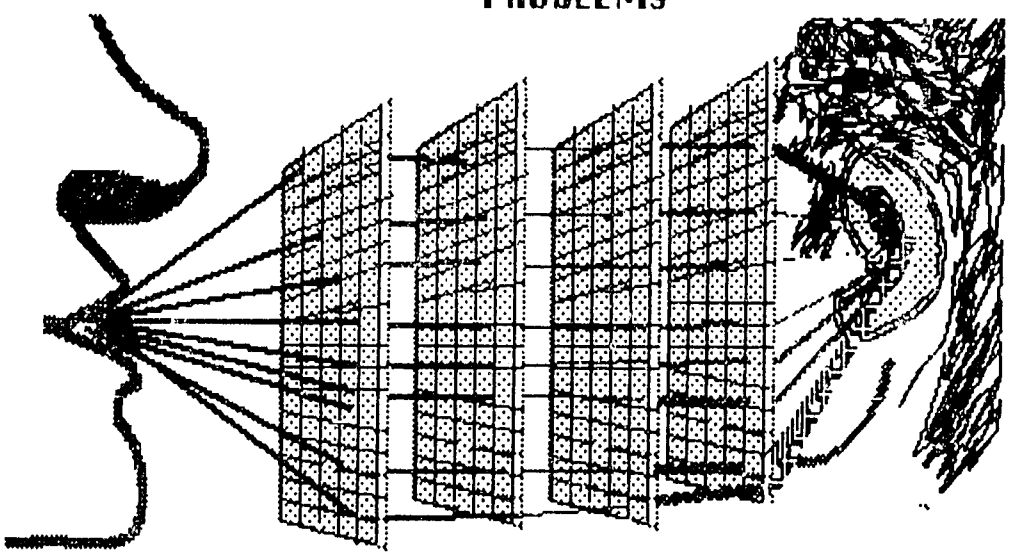
You must let the person know that the reason you are reprimanding him is that you know that he can do better work. (This is the reason why you were told back on page 29 never to reprimand or scold someone who is learning a new job. If he is just learning, he can't do better work and you can't tell him how good he is.) Try a formulation like:

> "Your design for the Dãdagãon drinking water supply system was not very good, Ram. You didn't follow the design standards that we agreed on. I know that you are a first class design engineer and I'm not going to accept such a low standard of work from you. I know that you are capable of something much better."

COMMUNICATION

CLINIC

SOME GUIDES TO SOLVING COMMUNICATION PROBLEMS



"I know you believe you understand what you think I said, but I'm not sure you realize that what you heard is not what I meant."

The picture above illustrates the idea that all communications pass through filters (which distort and alter the message) before they reach the receiver of the message. This is an oversimplification of the situation. In truth, the message begins to pass through filters before it leaves the speaker's mouth and continues to pass through them after it enters the receiver's ear.

example: a sad story

I have an idea. I want to tell you about something that happened to me 30 years ago. I realize that you are 28 years old and are not familiar with the situation that I lived in 30 years ago. In addition, this happened to me in Portugal where you have never been. I have to modify my description to suit my idea of what you can understand. I am afraid that I will bore you, so I decide to leave out a lot of the details. (The words have not yet taken shape in my mouth and already the idea has passed through nearly as many filters as are shown in the drawing on the previous page).

When I finally do speak the words, I must make myself heard above the typewriter in the next office, the concrete mixer outside and my neighbor's radio. Even if I can speak loudly enough, you may become distracted by the song on the radio which reminds you of someone you knew at school. Since you know that I'm a joker, you have assumed that my story is leading up to some funny ending; you are smiling and preparing to laugh at my joke. I see your smile and I begin to wonder what you find so funny in the tale of my best friend's death. I come to the climax of the story and begin to tell about the car skidding around the turn. You have never seen anything faster than a Volkswagen (while I am talking about a formula racing car). I tell you that the car was going very fast, but you are thinking of 90 kph and I mean 175 mph. At the end of the story you are polite and laugh a little. You actually didn't think it was such a funny joke. You will probably try to avoid listening to my stories in the future. Now there is a new filter in your mind; the idea that I am a bore. I have changed my opinion of you too. I used to think that you were an intelligent and sensitive person. Now I wonder.

the end

Since every communication is a unique event, we can't give any fixed rules for how to succeed. If you pay attention to a few basic principles though, you will see mistakes and be able to correct them. The first basic principle has already been communicated. Did you get the message?

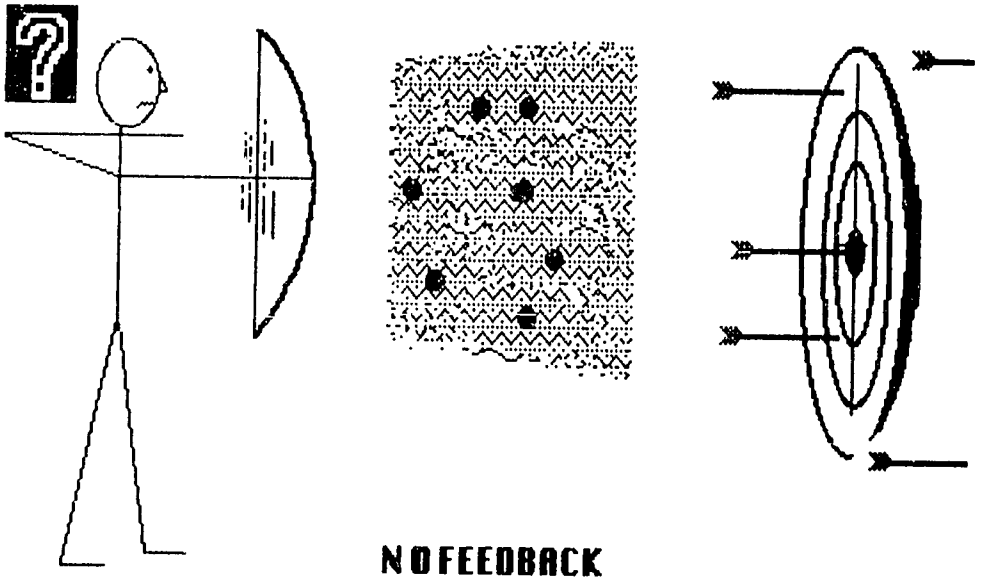
1. Every communication is a unique event.
2. Feed-back is the key to effective communication.

   Where there is no feed-back, communication can only be one-way. As you read this manual, I have no way of knowing if my message is being received or not. I can not get any feed-back from you through the medium of the printed page.

example:

I SAY	I MEAN	YOU UNDERSTAND
Big project	US$50000000.	Rs.50000000.
Tight schedule	6 months	1 year
Noon	around lunchtime	12:00 sharp
Fast	175 mph	90 kph

This happens in face to face communication as well as in print, but when we are face to face I have a chance of <u>actively seeking feedback.</u> If I am telling someone about a project schedule and I can't tell whether he thinks it's practical or not, I can say "What do you think about this timetable Hari?" If I'm giving you a set of instructions, I can ask you to repeat them back to me in your own words. I can ask questions about what I've been saying from time to time to see if the message is being understood. Without feedback, I am like a man shooting arrows at a target through a curtain. I may be hitting the bulls-eye every time, or I may be missing by a mile. <u>I can't tell.</u>



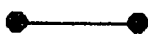
NO FEEDBACK

LIKE SHOOTING ARROWS AT A TARGET THROUGH A CURTAIN

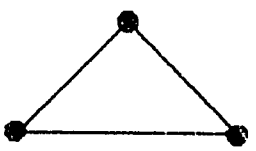
3. <u>WHEN MORE PEOPLE BECOME INVOLVED, COMMUNICATION BECOMES MORE COMPLEX</u>

There are several reasons for this. One is that you have to gather feed-back from many sources, not just one. Another is that there are more possible <u>lines</u> of communication between people when the number of people in a group increases.

SOME POSSIBLE LINES OF COMMUNICATION IN GROUPS OF 2



GROUPS OF 3



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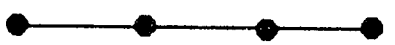
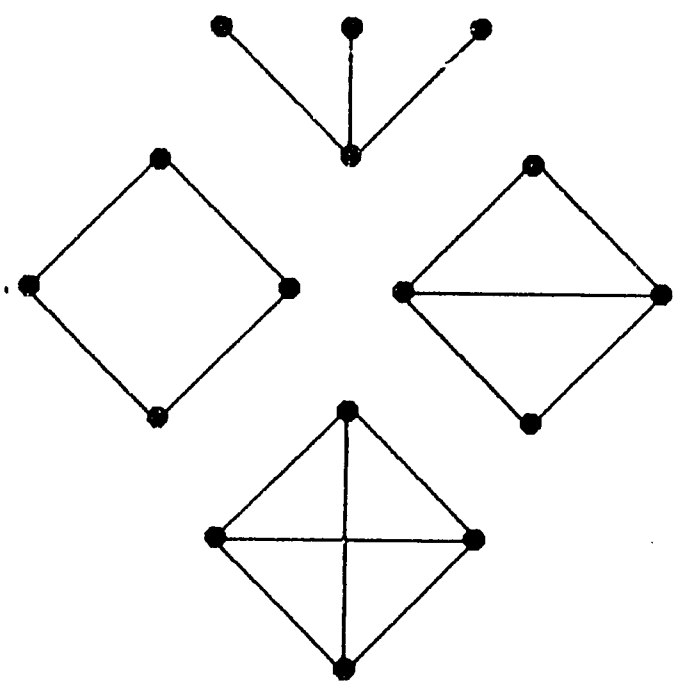




4. EVERY COMMUNICATION HAS AN INFORMATION MESSAGE & AN EMOTION MESSAGE

If the information message and the emotion message work against each other, communication won't be effective. For example: if I am delivering a lecture to a group and I say "Are there any questions?" but my tone of voice says "I don't want to be bothered with your stupid questions!" No one is likely to ask any questions.

5. THE SENDER AND THE RECEIVER MUST SHARE MEANINGS IF THERE IS TO BE GOOD COMMUNICATION

Different people can use the same words to mean different things. FAST can mean 50 kph to one person, and the speed of sound for another. If I say HOME COOKING, I probably mean the kind of cooking done in my home, not yours. Everyone's experience is a little different, there will always be some difference in the way we use words. When it comes to key terms that we use in communicating with the people that we work with though, it is important that our meanings are the same, or shared. If a supervisor says that progress is good, I have to know what his schedule is in order to share the meaning of that statement with him.

6. OUR IDEAS ABOUT A PERSON EFFECT COMMUNICATION

Advice from a person that I respect will be received differently than the same advice from someone I think is a fool. As managers, we must make sure that our ideas about the people that we work with don't become frozen. People change. We

have to be sure that our evaluation of them changes too. If it doesn't, communication will be hurt. So will the development of our staff. A new person in the office may lack experience but that will change with time. I was once amused to hear someone referred to as "the new girl" even after she had worked at her job for 2 years; it was clear that peoples' idea of her was frozen.

7. EXPECTATIONS ALTER COMMUNICATION

Sometimes we have such strong expectations about what someone is going to say, that we miss what he actually says. As a manager, you may not like the subject of salary increments when they are brought up by a subordinate. This can have a harmful effect on your ability to hear what someone is saying when you think she is leading up to the subject of salary increments. In the same way, a subordinate who expects to be scolded for something, may react to whatever you say as if you were scolding her. A manager ought to become sensitive to hidden expectations, his own and other peoples.

8. NO TRUST-NO COMMUNICATION

If there is an atmosphere of distrust and suspicion in a department or an office, communication will not be very good. People will be looking for lies and hidden meanings in messages and will not communicate freely themselves. There must be an atmosphere in which communication is possible before any other communication aids will be effective.

IN ADDITION TO THE ABOVE BASIC PRINCIPLES THERE ARE SOME BEHAVIOR PATTERNS THAT EFFECT COMMUNICATION

NOT LISTENING AS A SIGN OF STATUS

This is a fault that causes communication problems for many managers. IT IS a serious fault because it can become a habit. It can happen like this:

A subordinate enters his boss's office, greets him and begins to speak about some subject that concerns him. The boss continues with his work or looks out of the window or looks at the subordinate for a while. He then interrupts the subordinate by starting to speak about a completely different subject, totally ignoring what the subordinate has been saying.

What has happened here? Since a person in a lower status position would seldom ignore or interrupt a subject of discussion started by someone in a higher status position; <u>what the boss has done is to demonstrate his higher status by not listening</u>. He may have done this for many reasons. We don't have room here to discuss the possible psychological motivations for this kind of behavior. What we can do though, is look at the probable result of that behavior.

From the subordinates point of view we can see that a kind of

communication has taken place. The subordinate has received a message from his boss. The message is : "I have no interest in what you have to say. I don't consider you important."

From the boss's point of view another communication has taken place. The boss has sent a message to himself. The message is something like: "See what an important person I am. I can make other people pay attention to what I say even if they have other concerns."

From the point of view of the organization's goals the effect will be negative. The subordinate does not want to be made to feel small, so he will probably avoid situations in which the boss can make him feel small. This means that he will try to avoid communication with his boss. The boss, if he felt good after the incident, will try to repeat it. If he does, he will reinforce the negative effect on the organization's goals. He has set up a situation in which communication between himself and his subordinate is one-way only. From boss to subordinate. This means that he has cut himself off from feedback, the key to effective communication. He can now make decisions and give orders, and never find out if they were understood or not. He is like the man shooting arrows at a target, through a curtain. He has also taken away a motivator (see page 19) from his subordinate by refusing to give him recognition.

RECEIVING BAD NEWS WITH ANGER

In ancient times, rulers sometimes killed messengers who brought bad news. Although modern managers seldom go that far, some of them make it very unpleasant for their subordinates to give them bad news. They create this unpleasantness by showing anger when bad news is brought to

them. The manager's anger may not be directed at the subordinate personally, but the subordinate may still feel that the boss blames him for causing the anger. Unconciously, this may even be true. Whether it is or not, a manager must be careful not to create this feeling. If he sets up this kind of atmosphere, he will get just what he asked for, only good news.

This is a terrible situation for a manager to be in. He is not totally cut off from feedback, but he is receiving only positive feedback, that is, feedback that tells him that things are fine and that his decisions and actions are correct (even if they aren't). He is cut off from what is called negative feedback, or feedback that tells him that there is a problem and that a decision or action needs to be corrected or adjusted. Since taking corrective action is a big part of the managers job, his effectiveness as a manager is greatly decreased. Why? Only because he wasn't able to control his anger when someone brought bad news.

There are other behavior patterns that damage communication. You can learn about them by reading the publications suggested in the bibliography at the end of the manual. The two that have been discussed here were chosen because they are so common and because they have the effect of cutting the manager off from feedback, which is essential to his task.

As you have seen, communication is not a separate area of a manager's work. It is something that circulates throughout all of his tasks, just as blood circulates throughout all the organs of the body. You have also noticed that motivation and feedback are very closely linked with

communication. Motivation is discussed in some detail in the chapter "Motivating the Construction Team" Let's take a moment to look at feedback and a related principle known as management by exception. We won't go into great detail. Entire books have been written about both of these ideas. We will look at them as tools that a manager can use to do a better job.

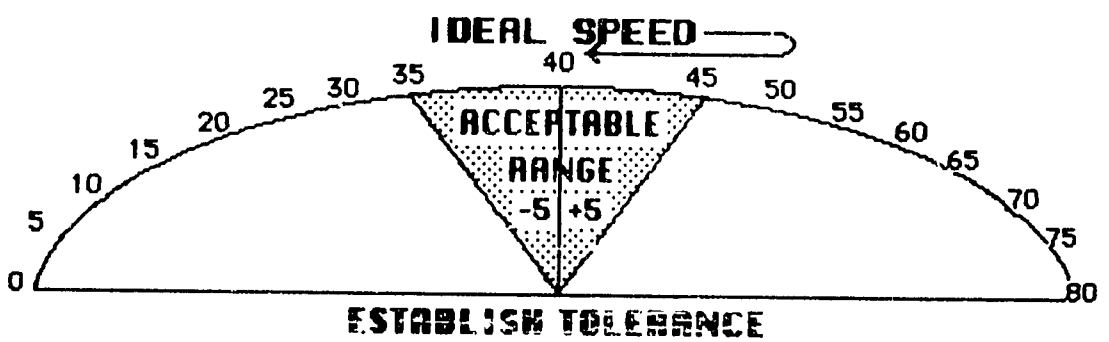
FEEDBACK
AND
MANAGEMENT BY EXCEPTION

The dictionary tells us that feedback is "a process in which the result modifies the factors producing the result." We use feedback systems all of the time without having to think about them. Our body temperature is regulated by a feedback system. If the body senses that it's temperature has fallen slightly below or risen slightly above 98.6° F., the mechanisms by which it generates heat increase or decrease their functioning so as to raise or lower body temperature until it senses that normal body temperature has been restored. So long as body temperature remains normal, the heating mechanism functions at a more or less constant rate.

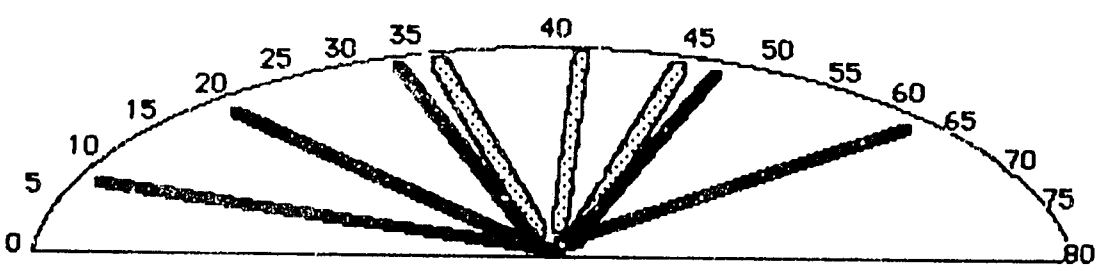
There are 2 types of feedback, negative feedback and positive feedback. To illustrate the difference between the 2 types of feedback we can use the example of driving a car. Let us say that we have decided that for maximum fuel efficiency and safety, the ideal driving speed is 40 kph. We get feedback by looking at our speedometer as we drive. When we see the needle pointing to 40, we are getting positive feedback; feedback that gives us the message, "Normal condition-don't change anything." When we see the needle pointing to any number above or below 40 we are getting negative feedback; feedback that gives us the message, "Abnormal condition-change is required".

The problem with driving this way is that we will probably have an accident, because in order to drive at precisely 40 kph, we will have to watch the speedometer continuously. This means we can't watch the road.

To correct the problem, we need to establish our tolerance, an acceptable range of variation from the ideal speed of 40 kph. We may say that 5 kph plus or minus is acceptable. We can now drive between 35 and 45 kph. This is much more realistic. It is close to the ideal speed, and it allows us to pay attention to the rest of the procedure of driving the car.



ESTABLISH TOLERANCE



= EXCEPTION - *ACTION BY MANAGER REQUIRED*

= NORMAL - *NO ACTION BY MANAGER REQUIRED*

INTERPRET THE FEEDBACK

IN BRIEF

1. Quite simply, management by exception (M.B.E.) means that you manage exceptions. Anything that is not an exception does not need management intervention
2. In order to have exceptions, there must be a rule or a norm or an ideal or a standard or an acceptable range.

3. In order to know if something is normal or an exception there must be a feedback device or indicator.

In our example of driving a car, we took corrective action only when speed fell above or below the acceptable range of 35 - 45 kph. We established this range because it was as close to the safest and most economical speed (40 kph) as we could steer while still paying attention to the whole process of driving. If we had set closer tolerances, we would have required more of a limited resource; attention. We used the car's speedometer as the feedback device.

COST EFFECTIVENESS

1. Closer tolerances usually cost more to adhere to than wider ones. For this reason a balance must be achieved between technical requirements and cost.
2. Feedback systems can be costly to install. For this reason it is best to obtain feedback from some already existing indicator whenever possible.
3. Significant areas must be chosen for setting up feedback systems.

MANAGEMENT BY EXCEPTION IS A TOOL WHICH HELPS THE MANAGER TO IDENTIFY PROBLEMS (OR POTENTIAL PROBLEMS) BEFORE THEY BECOME CRISIS

This is an example of how the tool might be used in practice.

First decide what it is that you are going to pay attention to. In this example, we will say that you are paying attention to construction costs for a building project at a village called Dãdagãon.

As a feedback device, you will use the percentage of total project completion compared to the percentage of the total budget expended as reported on a monthly basis by the site in charge. There will be no installation costs for this feedback device since it is an already existing indicator which appears in the monthly construction progress report.

The norm or acceptable range that you have established is a ten percent difference between these two percentages.

At the end of the first month of work, CONSTRUCTION PROGRESS REPORT #1 arrives at your headquarters. You find the following information on it:

PERCENTAGE OF TOTAL BUDGET EXPENDED------ 15%

PERCENTAGE OF TOTAL COMPLETION TO DATE--- 12%

Simple arithmetic (15 - 12 = 3) shows you that the difference between percentages is three percent which is within the acceptable range. You don't interfere.

Another month passes. CONSTRUCTION PROGRESS REPORT #2 arrives. You look at the feedback:

PERCENTAGE OF TOTAL BUDGET EXPENDED------ 19%
PERCENTAGE OF TOTAL COMPLETION TO DATE--- 13%

and you interpret the feedback: 19% - 13% = 6% difference; still within the acceptable range of ten percent. You note that the difference between the percentages has doubled over the past month. Perhaps you do a <u>simple check</u> of the month's expenditures to see if there is some obvious explanation for this, such as a mobilization advance to a contractor. You do not waste time on the matter. You do not interfere.

During the following month you are happy that you don't have to take any special action on the Dãdagaõn project, because one of your other projects has serious problems. You also have to play host to an evaluation team for five days which puts you behind in your routine administrative work. Just after the end of the month you receive CONSTRUCTION PROGRESS REPORT #3. You read:

PERCENTAGE OF TOTAL BUDGET EXPENDED------ 16%
PERCENTAGE OF TOTAL COMPLETION TO DATE--- 25%

Ah! That looks like good news. A gain of thirteen percent in project completion in one month with an increase of only one percent in expenditure. That might indicate that the volunteer labor is very hard-working. On the other hand, it might indicate that sub-standard materials are being used. It might indicate several other things as well; none of them matter, <u>25% - 16% = 9% is what matters</u>, nine percent is

still within your acceptable range of ten percent difference. You don't interfere.

A month later this reaches you:

DÃDAGAÕN CONSTRUCTION PROGRESS REPORT #4
PERCENTAGE OF TOTAL BUDGET EXPENDED------18%
PERCENTAGE OF TOTAL COMPLETION TO DATE--- 29%

29% - 18% = 11% difference!

RED FLAG!

ALARM BELLS!

THIS IS AN EXCEPTION!

For reasons that you know best, you decided that if a difference of greater than ten percent between the percentage of total construction complete and the percentage of total budget expended, was reported by the site-in-charge, managerial action would be required.

Now the Dãdagaõn project becomes a high priority concern. It is time for you to step in, investigate the situation, and take whatever corrective action is necessary. Fortunately, the evaluation team has left, you have caught-up with your routine work, and the other project that had problems two months back is now back to normal.

The principles of feedback and management by exception don't eliminate problems, but they can help a manager to identify problems before they become crisis. They assist him in setting priorities and directing his attention to where it is needed most.

NO ONE CAN PAY ATTENTION TO EVERYTHING AT ONCE

LEADING THE TASK GROUP

One of the many roles that a construction manager has to play is the role of leader. Some people are what we call natural leaders. For them leading a group is easy. People seem to follow them automatically. Most of us don't have this talent. What are we to do when our duties demand that we act as leaders?

One solution is to watch how natural leaders work, and imitate them as best we can. This is fine up to a point, but much of the natural leader's success may depend on his personality or that elusive quality that we call charisma. These can't be imitated.

We know that different leaders work in different ways. If we can identify these ways (or leadership styles) we can study them to find out the difference between the styles. We can then choose a style that suits us best. This choice can be made in several ways. We can select a style that seems to come to us naturally and easily and work on perfecting it. This is a good first step, especially for someone who has a lot of difficulty as a leader.

Another way of selecting a leadership style is to consider the specific group, the specific situation, yourself as a leader, your immediate goals, and your long-range objectives and strategy. You can then match your leadership style to the specific task at hand. A good manager ought to be able to use more than one leadership style.

As a general rule though, it's not wise to jump from one style to another with one group. This confuses people and they don't know what is expected of them.

There are a great many leadership styles to choose from. We will examine six of them. We will look at these six from a special point of view. <u>The balance between the leader's use of authority and the group's freedom.</u>

The way in which a group leader uses authority influences the productivity of the group and the freedom of it's members. The more authority/power he or she uses, the less freedom there is for the rest of the group. The less the leader uses his or her power/authority, the more freedom there is for the rest of the group.

On page#52 we see a chart which is divided into six verticle columns. Each column represents one of six leadership styles. The lines separating the columns are not solid, nor are they straight. This indicates that the six leadership styles almost always overlap a little. We almost never see any style in a 100% pure form. Please don't let the names of the styles confuse you. They are meant to be suggestive; they are not exact definitions.

At the left side of the chart, we read the label <u>LEADER-CENTERED</u>. At the right side, <u>GROUP-CENTERED</u>. The diagonal line shows that as we move from left to right less authority is retained by the leader and more freedom is permitted to the group.

TELLS	SELLS	TESTS	CONSULTS	SHARES	AVOIDS

LEADER-CENTERED

DECISION-MAKING RETAINED BY LEADER
(USE OF AUTHORITY BY LEADER)

GROUP-CENTERED

DECISION-MAKING SHARED WITH GROUP
(AREA OF FREEDOM FOR THE GROUP)

AUTOCRATIC	BUREAUCRATIC	DIPLOMATIC		DEMOCRATIC	ABDICRATIC
LEADER MAKES DECISION, THEN ANNOUNCES IT.	LEADER MAKES DECISION, THEN EXPLAINS & PERSUADES.	LEADER PRESENTS PROPOSALS OR TENTATIVE DECISIONS SUBJECT TO CHANGE.	LEADER PRESENTS BACKGROUND, INVITES SUGGESTIONS THEN MAKES DECISION.	LEADER DEFINES LIMITS, SHARES IN GROUP DECISION.	LEADER PROVIDES NO DIRECTION, GROUP MAKES DECISION.

LEADERSHIP STYLES – AFTER SHMIDT, LASSEY, BOSHEAR, ALBRECHT & OTHERS.

SIX LEADERSHIP PATTERNS

DESCRIPTIONS AND EXAMPLES OF THE SIX LEADERSHIP STYLES.

(A brief description of the style is followed by an example of what a leader might sound like using that style).

TELLING/AUTOCRATIC - The leader, after identifying the problem and considering alternative solutions, chooses one solution on his own. He then tells the members what they are to do. He may or may not use threats or coercion. Members do not take part in the decision making.

> "Building designs are taking up too much time. From now on, all roofs are to be of C.G.I. sheets held down with "L" bolts. I don't want to see anyone specifying anything other than C.G.I. sheet roofs, and we won't have any more discussions about how to fasten the sheets to the purlins. If there are any really exceptional cases bring them to me and I'll let you know what to do. Any questions?"

SELLING/BUREAUCRATIC - The leader makes the decision entirely by himself (as in telling) but he tries to convince the group that it is the best possible decision. He explains that he has considered the members interests and the goals of the group. He tries to persuade the members that they will benefit from carrying out the decision. He trys to sell his decision to the group, and his success as a leader depends on his skill as a salesman.

> "I've been thinking about how to reduce building construction costs and time. It seems to me that we waste a lot of time and money buying C.G.I. sheets and transporting them out to the districts. From now on, we're going to use local materials for roofs wherever possible: thatch, tile, or slate. I think this will make life easier for all of us. You people working out in the districts won't have to wait for C.G.I. roofing sheets, "L" bolts, nuts, washers and so forth to reach you. In addition, you won't

have to get sawn timber to make a good connection with the roof sheets-you can use local jungle poles.
You designers will have 3 standard modular designs to work from and since the local people know all the standard details for traditional roof materials, your job will be simplified.
The users won't have to endure the heat that develops under a C.G.I. sheet roof. They won't have to shout to be heard when it rains. Their roofs won't blow away so often, and if they do, the people won't be in danger of getting killed by a flying sheet. In addition, the local people will be able to repair and maintain the roofs themselves at very little cost.
I know that some of you are worried about the danger of people getting injured by slate or tile roofs falling in during an earthquake, but compared to high winds, earthquakes are pretty rare. As I already mentioned, traditional roofs are safer in high winds.
I'm sure that all of you will appreciate the the fact that savings in the initial cost of roofs will be on the order of 100%. We can also anticipate indirect savings from the increased efficiency of the central procurement section since they will no longer have to handle such an awkward material as C.G.I. sheet.
Let's start implementing this new policy from today so that we can begin enjoying the benefits of of the new system immediately!"

TESTING/DIPLOMATIC#1 - The leader defines the problem and solves it himself. He presents his solution to the group and asks for comments and suggestions. He may make changes or modifications based on the group's suggestions.

"I'd like to get some feedback from you on a proposal. As you know, traditional roofs of tile and slate present a real danger to human life in an earthquake prone region like Nepal's hills. I know that there are many reasons why these traditional materials are preferred by some of you but my feeling is that, as engineers, we must set priorities, and safety has to be priority number 1.
For this reason, I'm planning to specify C.G.I. sheets as the only approved roof material for buildings constructed by the Rapti IRD project.

I've gone over the arguments for and against this decision pretty carefully, but before making it official I'd like to hear your response. Perhaps I've overlooked something."

CONSULTING/DIPLOMATIC*2 - The leader presents the problem along with background information to the group. The group is invited to suggest solutions. The leader chooses the solution that he considers to be the best.

"As most of you know there's been some conflict among us concerning whether to use traditional materials like thatch, slate and tile as the standard roof on our buildings or C.G.I. sheet. As you know there are two distinct schools of thought on this matter which argue as follows.

The traditional materials school says:

1. Local materials are cheaper than C.G.I. sheets by 100-500% and even cheaper when you calculate transport costs in the high hills of Nepal.
2. Local materials can be collected by volunteer labor.
3. Local materials can be repaired and maintained with local skills at little or no cost.
4. Local/traditional roofing materials can be used with rough jungle poles, while C.G.I. sheets require sawn timber for good fastening.
5. If a traditional roof fails in a high wind, it's not as dangerous as the sharp iron edge of a flying roof sheet.
6. If a traditional roof fails in a high wind, it won't carry away the structural members, whereas a C.G.I. roof often does.
7. Buildings with C.G.I. sheet roofs are very hot in the hot season and very noisy in the rain. This makes them especially unsuitable for use in schools and child care centers.
8. C.G.I. sheets are difficult to transport, and often arrive damaged.
9. C.G.I. sheets don't blend well with a village environment.
10. Unnecessary use of manufactured materials causes the villagers to lose respect for their own traditions.

On the other hand, we have the pro C.G.I. sheet school which argues:

1. C.G.I. sheet roofs require little or no maintenance for the first 8-10 years.

2. Villagers want C.G.I. sheet roofs because it is a high status material.
3. Slate and tile roofs are dangerous in an earthquake.
4. The burning of clay tiles consumes too much wood and contributes to de-forestation.
5. Thatch roofs are a fire hazard and vermin like insects, rats and snakes live in them.

I myself am undecided. Both schools of thought seem to have some very valid points. I'd like to hear what you have to suggest before making a final decision."

SHARING/DEMOCRATIC - The leader presents the problem and defines the limits within which the group can operate. He then shares in the decision making process with the group.

"We're faced with the problem of deciding what kind of roofs to specify and build in the districts. Our most obvious options are: C.G.I. sheet, slate, tile, or combinations of these. Thatch is out, because H.M.G. won't approve thatch on any permanent structures. Of course we might consider a research and development program to increase our options. In some areas, ferro-cement, cement-fiber and cement tiles have been effective. That would require a special budget though, and probably coordination with the Appropriate Technology Unit.
I think we need to discuss all the pros and cons, and come to a decision that we can all live with."

AVOIDING/ABDICRATIC - The leader informs the group that there is a problem. He provides no structure or direction. The group makes the decision. Note: This should not be confused with ordinary delegation of a decision. In that case, some guidance or direction is usually given.

"My superior wants us to come up with a policy on roof materials. Please consider the alternatives and make a decision."

We now have a few leadership styles available to us. The question is, how do we decide which one to select? This is something that has to be decided on a case by case basis. Here are some guidelines that will assist you in making the decision. Your chances of choosing the right style will be better if you consider each of the following four areas: I. Forces In The Leader, II. Forces in The Other Group Members, III. Forces In The Situation, & IV. Long-Range Objectives And Strategy. These considerations have been divided into four areas for convenience; they may not be so clear-cut in real situations.

I. FORCES IN THE LEADER -

1. His value system; How strongly does he feel that individuals should have a share in making decisions that affect them? Or, how convinced is he that the official who is paid and chosen to assume responsibility should carry the full burden of decision making? What is the relative importance that he attaches to organizational efficiency - personal growth of subordinates?

2. His confidence in group members; Leaders differ in the amount of trust they have in other people generally. After considering the knowledge and competence of a group with respect to the problem at hand, a leader may have more confidence in his own capabilities than in those of group members.

3. His own inclinations or "natural style"; Different leaders seem to be more comfortable with certain styles.

4. His feelings of security in an uncertain situation; When a leader turns more decision making power over to the group, he reduces the predictability of the outcome. Leaders with a greater need for stability and predictability are more likely to "tell" or "sell" than "share" or "consult".

II. FORCES IN THE OTHER GROUP MEMBERS -

Before he decides how to lead a certain group a leader should remember that each member, like himself, is influenced by personality traits and expectations. Generally speaking the leader can allow the group more freedom in the decision-making process if the following conditions exist.

1. If members have relatively high needs for independence.
2. If members are ready to assume responsibility.
3. If they can accept a non-authoritarian situation.
4. If they are interested in the problem and feel that it is important.
5. If they have the necessary knowledge and experience to deal with the problem.
6. If they expect to share in decision making.

III. FORCES IN THE SITUATION -

Some of the critical environmental pressures on the leader.

1. The nature of the problem itself; Do the members have the required knowledge and background? Does the complexity of the problem require special experience?
2. Time pressure; The more strongly the leader feels the need for an immediate solution, the more difficult it is to involve other people.

IV. LONG-RANGE OBJECTIVES AND STRATEGY -

As he works with his daily problems, the leaders choice of leadership styles is usually limited. He may, however, regard some of the forces mentioned as variables over which he has some control in the long run, and wish to consider such long-range objectives as:

1. Raising the level of member motivation.
2. Improving the quality of all decisions.
3. Developing teamwork and morale
4. Upgrading the capabilities of individuals.

COMMUNITY RELATIONS

THE CONSTRUCTION SITE IN A VILLAGE ENVIRONMENT

A construction site
Appears one day in the middle of an environment
Changes that environment
And then disappears

As builders, it's easy for us to forget that the environment in which we build was there for a long time before we came along with our project and will be around for a long time after we leave. Environment doesn't only mean the topography, climate, plants and wildlife. There is also a human environment in which individuals, groups and communities live their lives.

It is taken for granted that the construction that we implement is for the benefit of the local environment, especially for the benefit of the local human population Why is it then, that we hear about so many problems in completing construction projects due to friction between the environment and the project? More important, how can we avoid or solve this kind of problem? This is a complex issue. There is no single answer to the question. Some of the management tools discussed elsewhere in this manual will be helpful in dealing with it, especially the sections: *Motivating the Construction Team*, *Leading the Task Group* and *Communication Clinic*.

To some extent the problem may be caused (or at least made worse) by the attitude that <u>some</u> technical people who were educated and in many cases

raised in cities have toward villagers. We hear talk among educated people about the backwardness of villagers. This term is neither accurate nor useful in the context of planned development. It must be understood that where communities have survived for a long time under difficult conditions, this has been possible because of the intelligence and resourcefulness of the members of that community, not through backwardness. In planning and implementing rural works, the best results will be acheived when this intelligence and resourcefulness is allowed to work together with modern technical knowledge. Technically trained people must make an effort to understand traditional methods. This will usually result in their learning to respect these methods; in this way a truly appropriate technology can emerge.

In one sense, interactions between urban engineer/technicians and villagers can be seen as cross-cultural interactions. The participants share a common nationality and may share a common religion and ethnicity; they may not share many values. For this reason, the formally educated urban person working in remote areas must develop tact and sensitivity. He must be able to put himself into the mind of another and see things from his point of view. Of course it might be argued that it is the villager who needs to change his point of view, but the villager doesn't have to function outside of his environment very often; the development worker does.

One of the most useful ways of avoiding problems at the construction implementation stage, is to carry out a thorough site verification and feasibility study. Such studies should reveal

the social political, economic and technical situation at the site so that measures can be taken to solve or avoid problems in these areas before implementation begins. Some critical areas effecting the success of a construction project in a rural area are discussed below.

USERS' GROUPS

The users' group is the grass roots level organization that insures peoples' participation in rural works. Users groups are often headed by the Pradhan Panch of a village, and the members are those people who will be using the new works. There will usually be between seven and eleven members in a users' group, depending on the size of the project and the area that it serves.

Users' groups can be a useful link between the technical office and the people. Before construction they will be a source of information about the needs and problems in the villages. They should be consulted before designs are prepared so that their valuable input can be incorporated into the designs. Careful consultation with the user's group during the feasability stage and site selection will help to eliminate future problems and bring to light special conditions and situations at the project site that might not be noticed by an engineer or technician who did not have the benefit of their advice.

Besides the practical value of their advice, it is important to involve the users' group early in the life of the project so that they feel that the project is truly theirs. Without this feeling, it will be more difficult to

get the necessary cooperation of the group.

Part of the cost of construction is often met through volunteer labor provided by the users' group. When this is the case, the site-in charge must maintain contact with the users' group to keep them informed of the labor required to keep the project on schedule and all other matters relating to the work.

After construction is complete, the users' group is responsible for maintaining the system, whether it is a drinking water supply system, irrigation works, suspended bridge, trail or building. The District Technical Office can offer support to the users groups by providing information on maintenance procedures, and possibly arranging for the training of village level technicians.

In the past, the users' group was a more informal body, and was previously called a construction committee. The Decentralization Act has made formal provision for the users' group, and should be consulted for details.

WATER

Your project may be a water project, either drinking water supply or irrigation that will permanently alter the water supply/distribution pattern in the area. It may be a road or a building for which water is mainly required during construction. In either case, remember that water is very often a sensitive subject in an agricultural community. Disrupting the pattern of water supply and distribution can have far reaching

consequences for a construction project and the way in which villagers relate to it.

FACTIONS & POWER STRUGGLES

It is well known that close neighbors quarrel. This is true for city dwellers and villagers alike. If a construction project is proposed in a village where there is friction between two or more groups, the project-in-charge and the site-in-charge will be wise to find out all they can about the quarrel and the members of the groups involved. The information will be useful to them in completing their work. It will help them to understand their environment better. They should not take sides or become involved in the quarrel. They should make it clear that the project is neither on one side nor the other. If the people responsible are not careful, the project itself may become an issue in the struggle between village factions. This will not help to complete construction on schedule and within budget.

COMMUNITY LEADERS

Every community has leaders. Sometimes the leaders are in easy-to-identify positions of power, like elected or appointed officials. Sometimes they are respected, influential, or wealthy people who don't hold any official position. Whatever the case, a manager of construction ought to acquire skill at identifying community leaders. These people can help in getting the cooperation of the other villagers.

THE IMPACT OF CONSTRUCTION IMPLEMENTATION ON A VILLAGE

Works constructed in rural areas are intended to have an impact on the

local environment when they are complete and functioning. In fact, they begin to effect the environment long before they are completed, and often long before they are started.

If a surveyor spends a day working with a theodolite and chain near a village, you may be sure that the local farmers will talk about how this will effect their crops and the value of land. If there is talk about construction in a village, people will start thinking about the money that can be earned as a laborer, porter, or craftsman. Local contractors will be alert for transport and building contracts. Ward chairmen will want to make sure that their constituents benefit from the work. Even the keeper of the local tea shop will think about the profit to be made.

A construction project in a village, even a relatively small project, is a major event. It represents a major change in the normal social and economic routine. It can become the focus of attention for many people for many different reasons. Some see the benefits of the completed project, some see employment, some see entertainment, some see business, some see politics. It would be difficult to find even one villager who didn't care about the project at all.

The manager of construction in rural areas must become a practical social-scientist. He must be able to look at his project from the villagers point of view.

THE SITE DIARY

The one most useful tool for recording, reporting and communicating in construction is the SITE DIARY. We could almost go so far as to say that keeping a diary is the beginning of real management on a construction site.

The SITE DIARY is first of all a tool for recording information. It is used to record information for a great many purposes. Some of these purposes are:

1. Generating regular and special construction progress reports
2. Updating work schedules
3. Evaluating contractors' claims
4. Resolving disputes
5. Training /briefing new personnel in case of transfer
6. Identifying the source or cause of:
   a) instructions
   b) communications
   c) structural failures
   d) mis-understandings
   e) delays
   f) decisions
7. Developing productivity standards
8. Planning future projects with regard to:
   a) Work procedures
   b) Scheduling
   c) Specifications and choice of materials
   d) Special local conditions & problems
   e) Contractor or work-force performance
   f) Contract preparation
   g) Other

This is a very wide range of uses for one tool. Yet it's not expensive to buy a SITE DIARY. It's not hard to operate one. The only thing you really need to do to use one is do it. The key is to do it every day. What should you record? That depends on the specific project that you're managing and the information that you need most. It's something that you'll get a feeling for after a while. Keeping a SITE DIARY is a skill that you will develop as you go along. Because of this, you'll find that your diaries become more and more useful as you gain experience.

Here is a list of items that you should include in your first SITE DIARY. If you're 100% sure that you don't need an item; leave it out. If you're not quite sure, leave it in for the first 6 months and then make a new decision. List these items as headings on the page for each day. If there is nothing to record under any heading, write "nothing", but don't eliminate any heading unless you have nothing to record for 6 months.

1. WEATHER CONDITIONS
   very hot, very cold, rain,snow, hail, high wind.

2. LABOR FORCE ON SITE
   total number of workers, numbers of workers in each contractors crew, number of volunteer laborers, number of paid day-laborers, size of gangs, number of each trade, (carpenters/laborers/masons/etc.). You'll never have to record all of these on one job.

3. NEW WORK STARTED
   by structures (ie. clinic building), element (ie. ground floor walls), and operation (ie. painting), so that an entry might read "Started painting ground flr. walls of clinic today."

4. WORK COMPLETED
   by structures, elements and operations as in #3. above.

5. WORK IN PROGRESS
   by structures, elements and operations as in # 3. above, (example: continue random rubble masonry in ground flr.-clinic building walls).

6. WORK STOPPAGES OR DELAYS (ACTUAL OR POTENTIAL)
   state reasons

7. CHANGES REQUIRED IN THE WORK
   a) suggested changes should be noted as soon as they are identified.
   b) approved changes should be noted as soon as approval is granted (with name of authority granting approval)

8. CONCRETE WORK
   mix ratios, pours, inspections, removal of forms, curing, interruption of curing

9. INSPECTIONS/TESTS
   record of any tests made such as pressure in pipes, concrete cubes, structural steel before concrete casting, pipes/cables before burial, etc. as well as casual inspections like the appearance of new concrete when forms are removed.

10. INSTRUCTIONS GIVEN
    any instructions that you give to contractors, mistris, suppliers, users committee, etc.**special note of instructions regarding bad workmanship.**

11. INSTRUCTIONS RECEIVED
    any instructions that you receive from a superior officer, official, etc.

12. QUERIES RECEIVED
    questions regarding details of the work or the contract

received from contractor, mistri, users committee, etc.
a) that must be referred to superior
b) that can be answered by site-in-charge (include answer given).

13. INFORMATION REQUESTED
information requested by site-in charge from superior or central office

14. REPORTS RECEIVED

15. REPORTS MADE

16. MEETINGS OR DISCUSSIONS HELD

17. CONDEMNED WORK
any work that must be demolished

18. MATERIALS DELIVERED TO SITE
give sufficient detail, but don't duplicate the stock-book

19. ACCIDENTS
a) damage to structures completed or under construction
b) injury to workers on site, even if the project is not responsible (including names of persons who witnessed the accident and treatment given if any)

20. VISITORS TO SITE
time of arrival & departure, reason for visit, comments (for visits by officials, dignitaries, agents of the contractor who don't usually work on site, etc.)

21. RUMORS
it is useful to record rumors about events that can affect the project. It is important to show that they are not fact, only rumors which may prove true of false later on.

22. POTENTIAL PROBLEMS
labor shortage, water shortage, trail or bridge to project site

damaged, transport strike, material in short supply, etc.

23. UNUSUAL EVENTS
this can cover almost anything that the site-in-charge thinks is important.

Twenty three headings. You'll probably eliminate about three of them in many smaller rural works. On any one day there will probably only be about ten entries. The rest of the headings will be listed on the page with the word *none* or *nothing* written beside them. The act of writing the heading will help the site-in-charge to recall the events of the day. Keeping the SITE DIARY will probably take up about 10 minutes per day on the average.

After a while, the site-in-charge will find that he consults the SITE DIARY at least once a day to locate some piece of information that will help his work. He may use it to recall how many days ago he requested more laborers from the users' committee. He may want to know the date on which a water line was damaged. He may need information to up-date a bar-chart. This constant use will cause the site-in charge to become very familiar with the SITE DIARY and it's contents. As this happens, the SITE DIARY becomes even more valuable. It begins to change from an information storage tool to an information storage and retrieval tool. This simply means that information can be easily put into it and easily found again. Of course an index could be prepared, but this would take a lot of time. The site-in-charge's familiarity will work just as well and the page number of any really key entries can be noted in the front. We have used color codes for special entries in the past; using red for changes, green for concrete, blue for new work started and work completed, etc. This is a big

help when you want to find all of the concrete pours that took place over a six month period.

I suggest using a high quality, sturdy book for the SITE DIARY. It gets a lot of use, and is used for years after a project is complete. A large ledger book (about 10"x14") with ruled lines but no columns is suitable. It should have enough pages for 1 year. Don't get a ready-made diary with the dates printed on the page because on some days you'll need more than one page, while on others a few lines will be enough. On holidays, you'll probably only note *weekly holiday no work on site*. Be sure to make an entry for each day.

The D.T.O. or D.E. will appreciate the SITE DIARY if there is a sudden transfer, illness, or resignation, and the site-in-charge is not available for de-briefing or to train his replacement. He will also appreciate the improved quality of the construction progress reports that he receives from overseers and supervisors who learn to keep a SITE DIARY. This improved communication will help the managing engineer to keep better informed of conditions and progress in the field. Because of this, he will be able to do his job better and with greater ease. Any engineering manager who wishes to begin introducing modern management tools into his organization ought to start with this one.

ON SITE
CONSTRUCTION MANAGEMENT

"You can observe a lot just by watching."
Yogi Berra

Construction takes place under such varied conditions that it is difficult to lay down hard and fast rules for managing a construction site. Some ideas and guidelines are presented here which will serve as useful tools if they are applied with a bit of common sense.

SITE LAYOUT

The work of a site manager begins when the construction site is identified but before construction starts. It is at this time that the site layout is planned. It is essential that the manager visit the site to gain first hand knowledge of conditions on the ground. If possible, take a site plan along on this visit, and check the plan against the actual site in order to discover any errors in the site plan. It is best that these are found as early as possible. During the visit, the manager must keep in his mind the types of activity that will be going on at the site, the location of works, and the temporary structures (warehouses, offices, toilets, water storage tanks, equipment platforms, etc.) that will be required. It will be useful to try to visualize the site at various stages of completion and consider any special requirements for materials storage and movement around the site at the various stages.

Back at the office, a sheet of tracing paper can be laid over the site plan, and possible locations for temporary structures can be sketched on it. An

alternative way of doing this is to cut out cardboard templates of the temporary structures (and large plant if any) and move these around on the site plan to compare possible layouts.

When the site layout is being planned it is useful to consider the activities of construction as falling into 5 categories.

1. OPERATION - Operations are the main steps in processes, methods or procedures. A part, material or product is usually modified or changed by an operation.
2. STORAGE - An activity in which material is stored for future use in a controlled way (not just set aside casually).
3. TRANSPORT- An activity in which materials, equipment, or workers move from place to place.
4. INSPECTION- An activity in which quality or quantity is checked.
5. DELAY - An interruption in the planned sequence of events, which may involve material being set down until it is used, or workers standing idle until a piece of equipment arrives.

The site layout planning can begin by locating the areas in which major operations will take place. In a building project these may include the steel cutting and bending area, the concrete mixing area, the carpenters' workshop, as well as the buildings themselves. The points of entry into the site can then be identified, and the storage areas located so as to minumize the transport between these points. In hilly areas, special attention must be given to on-site transport routes. For example, we try to arrange for porters to carry loads downhill, and return uphill unloaded

where possible.

The planning of transport routes around a site is often left too much to chance. If, for example, 10 laborers carry rocks from point "A" to point "B" along a route that takes 3 minutes to travel, and they make this trip 15 times per hour, 7 hours per day, 6 days per week on a project that lasts for one year; they will have spent 16,380 hours walking that route over the life of the project (or 2340man-days). If this route could be reduced even by one minute, 780 man days would be saved over the life of the project in this operation alone, without even considering the time saved by other people walking the same route less frequently. If a laborer earns Rs.15.- per day, the saving is ≥ Rs.11700.- over the life of the project. In many cases it would be possible to make this reduction in the travel time at a cost well within this amount. Perhaps with a solution as cheap and simple as cutting a run of steps into a slope, leveling a stretch of broken ground, laying a simple walkway across a ravine, or even burning away a patch of stinging nettles (*sisnu*).

METHOD STUDY

Method Study is the systematic examining of ways to do work in order to make improvements. There are many method study techniques. One of the most useful is the CRITICAL QUESTIONING TECHNIQUE presented here. This tool assists us to examine a task in a systematic way, to determine if any of the steps in that task can be improved upon or even eliminated.

Five areas are examined:

1. The **purpose** for which the task is done.
2. The **place** at which the task is done.
3. The **sequence** in which the task is done.
4. The **person** who does the task.
5. The **means** by which the task is done.

Twenty questions are asked about these five areas. The questions are divided into two groups. The first ten questions (the primary questions) establish what the present situation is, and why it is that way. The second group of ten questions (the secondary questions) looks at what alternatives are possible, and which of them should be implemented (if any).

PRIMARY QUESTIONS are about the present situation.

What is it	Why is it this way
1. **What** is achieved?	1. **Why** is it necessary (if it is necessary)?
2. **Where** is it done?	2. **Why** there?
3. **When** is it done?	3. **Why** then?
4. **Who** does it?	4. **Why** that person?
5. **How** is it done?	5. **Why** is it done that way?

SECONDARY QUESTIONS are about alternatives.

What are they	Which ones should be adopted
1. **What else** could be done?	1. **What should** be done?
2. **Where else** could it be done?	2. **Where should** it be done?
3. **When else** could it be done?	3. **When should** it be done?
4. **Who else** could do it?	4. **Who should** do it?
5. **How else** could it be done?	5. **How should** it be done?

SELECTING THE TASK TO BE STUDIED

Since this is a disciplined methodical approach toward improving performance, it takes time and effort to apply. For this reason, the tasks to be questioned in this way should be chosen with care. Tasks where improvements are likely to have a major effect on overall project performance should be attacked first.

Several methods can be used to identify these tasks. You can choose :

1) Tasks that are done most frequently.
2) Tasks that represent the highest cost.
3) Tasks that cause the most fatigue.
4) Tasks that present special safety risks.
5) Tasks that are new or unfamiliar.
6) Tasks that are taking more time than was scheduled.
7) Tasks that are costing more than was bugeted.

Remember that of the five types of on-site construction activity, only operations actually advance the process of production. Therefore the activities of inspection, storage, transport, and of course delays should be the first targets.

CRITICAL EXAMINATION SHEET

DESCRIPTION OF OPERATION: LAYING STONE MASONRY IN CEMENT MORTAR.
DESCRIPTION OF ELEMENT: CLEANING STONE BEFORE IT IS LAID BY MASON.

AREA:	PRESENT SITUATION	WHY IS IT THIS WAY	POSSIBLE ALTERNATIVES	SELECT ALTERNATIVES
PURPOSE:	what is acheived? Masonry stone cleaned.	is it necessary, why? Dirt weakens cement mortar.	What else could be done? No alternative clean stone required.	What else should be done? Clean masonry stone.
PLACE:	where is it done? In Drum, near stone pile.	Why there? Stone is stored here.	Where else could it be done 1. At quarry. 2. At mason's work place.	Where should it be done At mason's work place (Drum shifted as required).
SEQUENCE:	When is it done? Before loading into Dhokos to carry to mason.	Why then? If cleaned too early it will get dirty again.	When else could it be done? 1. Before delivery to site. 2. After carrying to mason.	When should it be done? After carrying to mason.
PERSON:	Who does it? Laborer who loads Dhokos.	Why him/her? He handles stone anyway.	Who else could do it? 1. Material contractor. 2. Mason's helper. 3. Laborer	Who should do it? Porter dumps stone from DHOKO into drum. Mason's helper removes.
MEANS:	How is it done? Soaking in water.	Why that way? Soaking removes dirt without effort.	How else could it be done? Wire-Brush.	How should it be done? Soaking in water.

This standard form is useful for applying the critical questioning technique.

CONTRACTS

According to the dictionary, a contract is "an agreement to do something, especially one that is enforcable by law." Contracts are so important in construction, that the common name for someone who constructs or builds is CONTRACTOR. Why is it that contracts are used in construction? What purposes do contracts serve? The following list shows some.

1. To make an agreement law-enforceable.
2. To record the terms of an agreement.
3. To specify what the contractor must do and what the owner must pay.
4. To specify what will be done if either party fails to perform.
5. To specify the quantity and quality of work to be done.
6. To specify the time-frame within which the work is to be completed and payment made.
7. To specify the means, method, terms and time of payment.
8. To identify the parties to the agreement.
9. To identify the official agents or representatives of the parties to the agreement and define their authority & responsibility.
10. To set out in advance the courses of action that will be taken in different possible situations.
11. To define words and establish common meanings.
12. To specify what is and what is not included in the contract.
13. To specify how the contract will be terminated.

14. To specify the responsibilities of the parties not just to each other, but to third parties such as: the government, the community in which the work is to be done, the workers, subcontractors, materials suppliers, unions, etc.

Even this partial list shows us that a contract serves many very real needs in construction. It is unfortunate that contracts are often treated as mere formalities which have little to do with the work to be accomplished.

The contract should be used like the script in a theater performance. It should be designed to suit the specific needs of the project and referred to throughout the life of the project to guide the performers through the drama. Whenever any actor is not sure of what he is supposed to do, he can refer back to the contract.

Before the contract is signed and work started, both parties to the contract agree to the terms We do this because we understand that we act more rationally at some times than at others. In the heat of conflict, we may see only one side of an argument. Therefore, we set up a program of procedures in advance, which we hope will safeguard the interests of everyone involved.

It is extremely important that we prepare contracts with as much foresight as possible. We need to use our own experience and that of others to make sure that any situation that can arise during the life of the contract is provided for.

If a contract is prepared with this kind of foresight and care, it becomes a powerful tool in the hands of a construction manager. We shall discuss some of the points to be considered in preparing a construction contract so that it can be used as a management tool.

THE CONTRACT MUST BE FAIR

Since it is usually the owner who prepares the contract, there is a tendency for the contract to be biased in the owner's favor. We must be careful about this. It's important to honestly look at the motives that both parties have for entering into a contract.

<u>The owner wants to have his project constructed.</u>

<u>The contractor wants a profit.</u>

Both of these are legitimate motives, and the contract drawn up between the two parties must protect both interests. The owner who takes advantage of the contractor by writing an unfair contract will pay for this advantage. He may pay in several ways.

The first way will be through high tender prices. Since the contractor feels that the contract terms make it difficult or risky for him to earn a profit, he will naturally charge more money to cover his risks and difficulty.

If there is a lot of competition for the contract, so that the contractor can't submit a high bid in order to cover his increased difficulty and risks, <u>prudent contractors will refrain from tendering at all</u>. This leaves the owner with tenders from imprudent contractors. These contractors will

have to bid low, and resort to other methods to make their profit margin. They might resort to making excessive claims for extra payment, reducing services to the owner, or cheating.

One of the worst consequences of an unfair contract is that the contractor won't take it seriously. From the very beginning of the project, he will have no intention of working according to the contract. This kind of situation sets the scene for two possible working relationships between the contractor and the construction manager.

1. One in which the owner must fight with the contractor at every stage of the contract in order to prevent bad practices(which often leads to default and/or litigation).
2. One in which the contractor tries to gain the favor of the manager so that the manager will overlook the contractor's bad practices (which leads to corruption and bribes).

Quite clearly, neither of these cases serve the interests of the project. Fairness then, is one of the main qualities that a manageable contract must have.

THE CONTRACT MUST BE CLEAR

The intention of the contract is <u>to communicate precise information to people who must act on it</u>. Construction errors are costly and difficult to correct. There is no need to use confusing legalistic language in a contract. Contract language must be clear and precise. It does not have to impress anyone with the use of "heretofore", "whereas", "hereinafter" or any other terms that don't serve the interest of clarity.

CONTRACT LANGUAGE MUST BE CONSISTENT

We often see contracts that use five or more words to refer to the same thing or person. This can be quite confusing. There is no need to use: the owner, the project, the party of the first part and the client, when all of these mean the same thing. In literature, variety is important. In writing contracts the need for clarity comes first.

Similarly, we must take care not to call two different things by the same name. Drawings, contract drawings, approved drawings, plans, shop drawings, working drawings, detail drawings, design drawings etc. must be defined and used in a restricted way.

DON'T REPEAT

Unless there is some special reason for doing so, there is no need to put the same requirement or term in three different places in the same contract. This can lead to difficulty later on if you need to change the term. The working rule is:

SAY IT ONCE - SAY IT IN THE PROPER PLACE - LET IT BE.

USE EACH PART OF THE CONTRACT FOR IT'S PROPER PURPOSE

Don't put technical specifications in the General Conditions. Don't put commercial terms in the Technical Specifications. This makes it difficult to find specific information when it is needed.

One common error is worth special mention. Don't make notes on a drawing when the same purpose could be served by writing a requirement into the Technical Specifications. If a change has to be made in the

future, it's much easier to make a change in the Technical Specifications than it is to revise every set of drawings that has been issued.

CONTRACT INFORMATION MUST BE RETRIEVABLE

Remember that the contract is going to be used to guide and manage the construction process. It's not enough to put the right information into the contract; the users have to be able to find it when they need it and they have to be able to find it quickly. Number each article, each section, each clause, each page. Provide a clear index.

USE FORESIGHT

Try to foresee any possible areas of confusion and clear them up in advance.

IF YOU WANT IT- GET IT IN THE CONTRACT

The contractor can't read your mind. If the contract doesn't clearly state that something is to be done, don't expect the contractor to guess that you want it done. The contractor isn't giving things away. He is in business to make a profit. When he submits a tender, he is bidding on the work specified in the contract. It doesn't matter whether you think it's obvious that a water tank must be provided; if it's not specified in the contract, it's not part of the contract. If it's not part of the contract, it's not included in the contract price. If it's not included in the contract price, it's an extra cost item.

CHOOSING A CONSTRUCTION STRATEGY

After the decision to build has been taken, the next decision will be how to build. In order to make this decision, we must be aware of the choices available and the implications of each choice. In this section, we shall discuss several building strategies. All of these are not in common use in Nepal at this time, but it is not unlikely that they will be introduced in the near future.

Since there is no one best strategy for all circumstances we shall look at the five major alternatives in use today. These five strategies are discussed from the owner's point of view, with attention to the:

1) advantages
2) disadvantages
3) appropriate uses
4) most important owner function.

This will provide guidance for choosing the strategy most appropriate to the work being considered.

DESIGN AND BUILD OR THE TURNKEY APPROACH

Under this option, the owner selects a firm which (as the name implies) both designs and builds the work. Sometimes the firm will engage subcontractors.

ADVANTAGES

1. Less administrative work required than with any other method.
2. Only one contract to manage.

3. No need for the owner to co-ordinate contractors.
4. Lower staffing requirements than with other methods.
5. Easiest method to use on fast-track projects, where a short project duration is the most critical consideration (usually because of high financing costs).
6. Contract can be awarded and work commenced while design details are being completed.

DISADVANTAGES

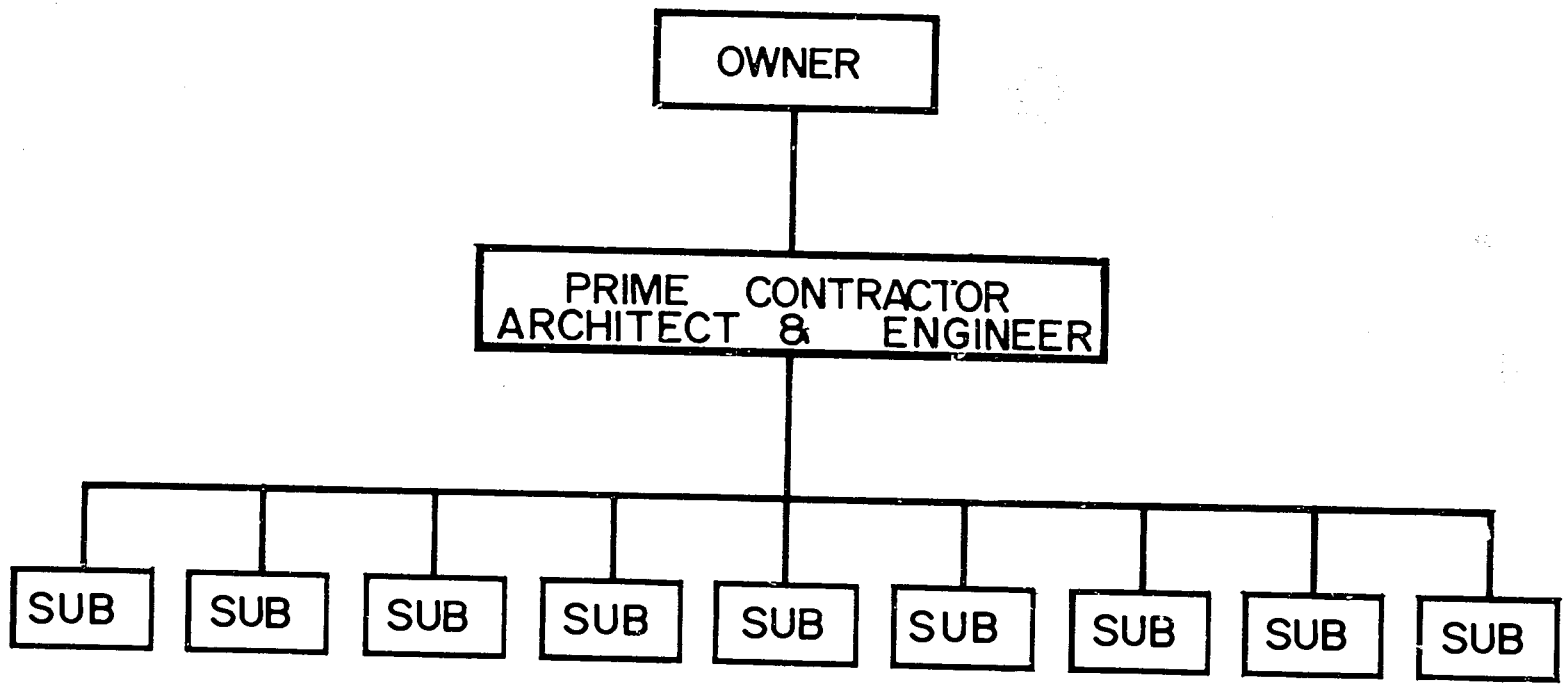
1. The owner must put all his faith in one contractor. If the contractor proves deficient technically, financially, managerially or in any other way, it will be very difficult to replace him without serious damage to the project.
2. Since design and build contracts are usually begun before a great deal is known about the work (the design is yet to be done) their final cost is difficult to determine. For this reason, they are usually let on a cost plus basis, rather than as lump sum contracts.

APPROPRIATE USES

1. Projects with high finance costs, where short project duration is essential.
2. Other situations where short project duration is essential.
3. Projects in which the owner wishes a minimum of involvement in the construction process.

MOST IMPORTANT OWNER FUNCTION

The owners most important act in a turnkey contract is the selection of the contractor. The owner must satisfy himself that the firm selected



DESIGN + BUILD (TURNKEY) CONTRACT

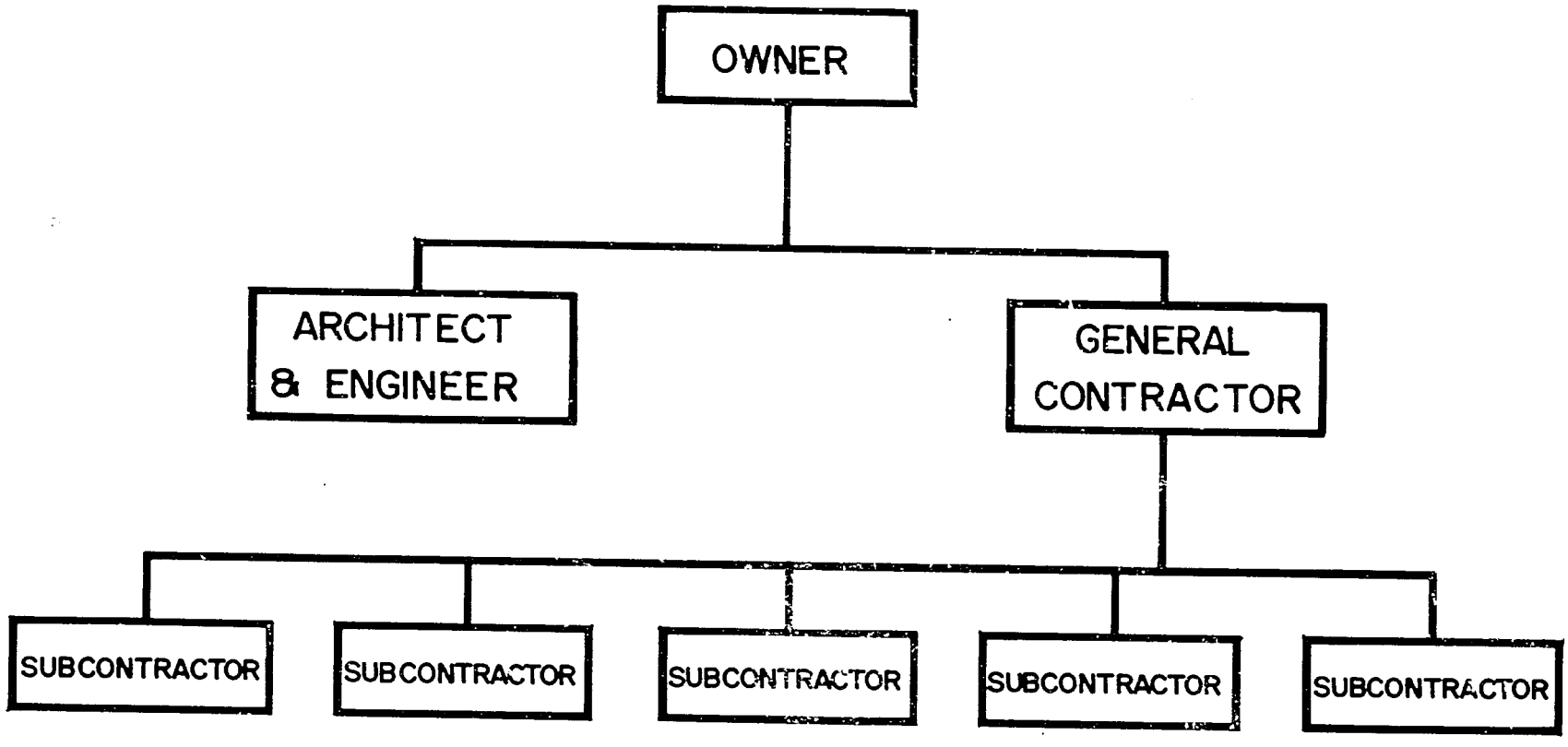
is fully competent to carry out all operations efficiently, economically, and in a managerially and technically sound manner.

THE GENERAL CONTRACTOR APPROACH

This is the most traditional and best known construction contract option. In this strategy, the owner contracts with the general contractor for construction only. The design is carried out by a seperate A & E (Architecture and Engineering) firm or other party. The general contractor may sub-contract all or any part of the work out to other contractors, but these have a contractual relationship with the general contractor, not with the owner. The general contractor is responsible for coordination between his forces and the sub-contractors forces. The owner may retain or delegate functions like inspection, testing, procurement, scheduling and reporting.

ADVANTAGES

1. If designs are complete or very advanced at the time of tendering, the contract can be let on a fixed price basis.
2. The owner can easily retain control over areas of the project which he feels require his personal attention such as:
    a. procurement
    b. scheduling
    c. inspections
    d. testing
    e. reporting.
3. Coordination of specialist sub-contractors and various trades is not the owner's responsibility, but the general contractor's.
4. The owner has only two contractual relationships:
    a. A & E



GENERAL CONTRACTOR APPROACH

b. General Contractor

5. The owner can, if he wishes, delegate some non-design functions to the A & E firm , such as:

   a. procurement

   b. scheduling

   c. contract preparation & management including tendering process.

   d. testing

   e. inspections

   f. reporting

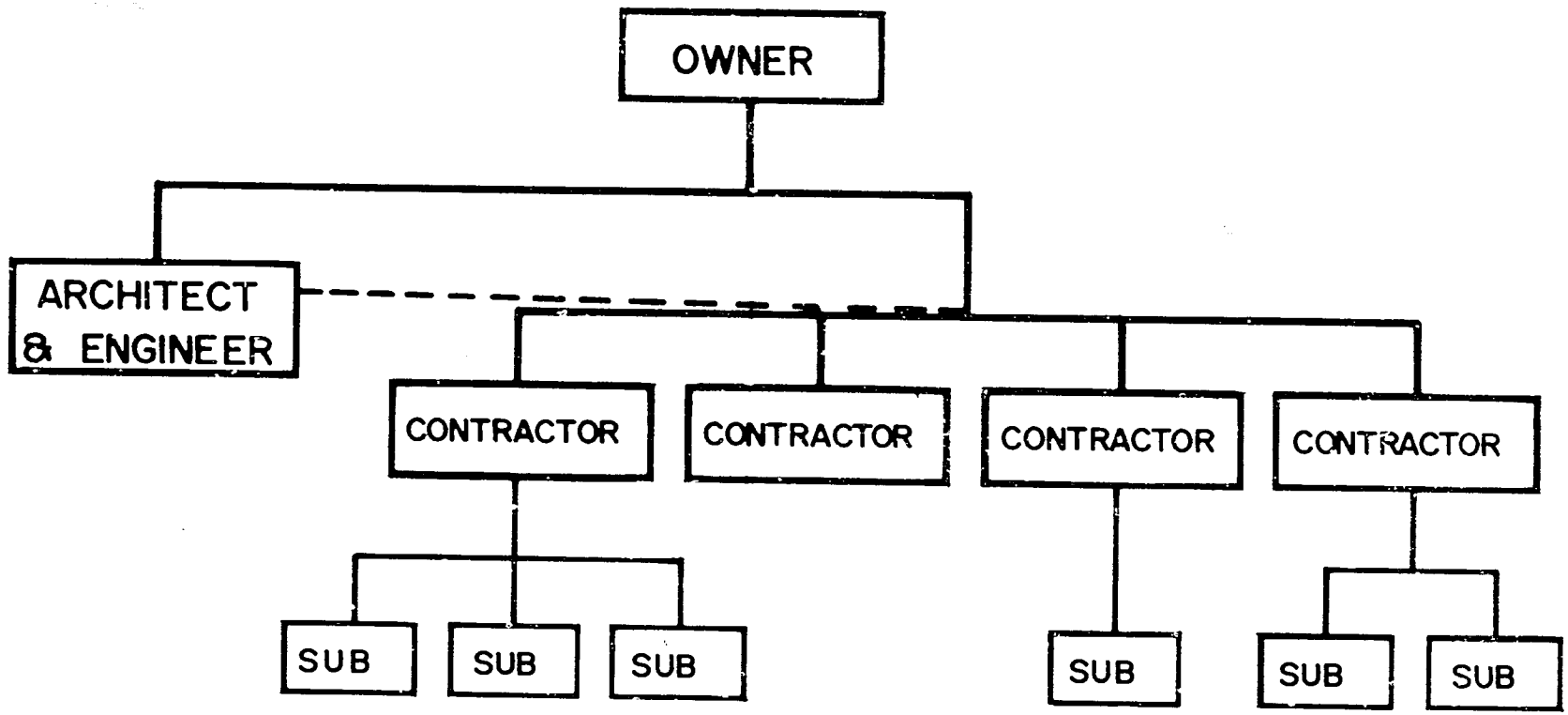
6. This is a very well known method.

DISADVANTAGES

1. As in the design and build approach, but to a lesser extent, the owner is very dependent upon one party, the general contractor. If the general contractor is not able to carry out his functions in a satisfactory manner, the owner will not be able to get rid of him without serious negative consequences for the project.
   The owner will have to be in the position of a coordinator between the general contractor and the A & E firm. This can be a demanding job.
   Staffing requirements on the owner's part will be greater than in the case of a turnkey contract because of the need to manage two prime contracts.

APPROPRIATE USES

1. Situations in which the design and build option would be best, but where the owner lacks the confidence to entirely trust one firm.
2. Situation in which the owner has fairly complete designs.



MULTIPLE PRIME CONTRACTOR APPROACH

3. Smaller projects.

MOST IMPORTANT OWNER FUNCTIONS

1. The selection of the general contractor.
2. Coordinating between the general contractor and the A & E firm.
3. Monitoring the work of both the general contractor and the A & E firm.

THE MULTIPLE PRIME CONTRACTOR APPROACH

This term really describes a wide range of similar situations. The term *prime contract* refers to a direct contract with the owner, rather than with an intermediary such as a general contractor. This strategy is sometimes broken into two categories: a) multiple primes, b) few primes. For our purposes we can deal with both of them together.

The multiple prime approach is one in which the owner has prime (direct) contracts with several contractors. On a large project we may find many separate contractors such as: excavation, foundations, steel erection, grouting, tunneling, roofing, soil stabilization, masonry, mechanical, electrical, climate control, etc. On a smaller project, we might find just a few prime contractors. One might even be a general contractor with some sub-contractors under him doing most of the work, but there would be other prime contractors as well.

ADVANTAGES

1.As portions of the design are completed they can be let as separate contract packages. This permits construction to begin before the entire design is complete.

2. Different pricing methods can be used for different contract packages on the same project. In this way, the maximum cost advantage can be obtained. For example, items of work that are well defined can be let out on a fixed price basis, while less well defined items can be let out as cost-plus contracts.
3. Items of work such as final grading, or landscaping can be let out as separate packages late in the life of the project, when the scope of the work is better known.
4. The owners risk is spread over several contractors, so that a contractor who fails to perform well can be replaced without endangering the entire project.

5. Contractors already working on the project who wish to be awarded additional packages have a great incentive to perform well.

DISADVANTAGES

1. The owner must handle the scheduling which the general contractor would do under a general contract approach.
2. The owner must coordinate between all the prime contractors.
3. The owner must coordinate between each prime contractor and the A & E firm.
4. There will be several contracts, often of different types, to administer.
5. There will be a high demand on the owner to participate in the construction process.
6. The owner's staffing requirements will be high.

APPROPRIATE USES

1. Fast-track projects where design and construction must go on simultaneously.

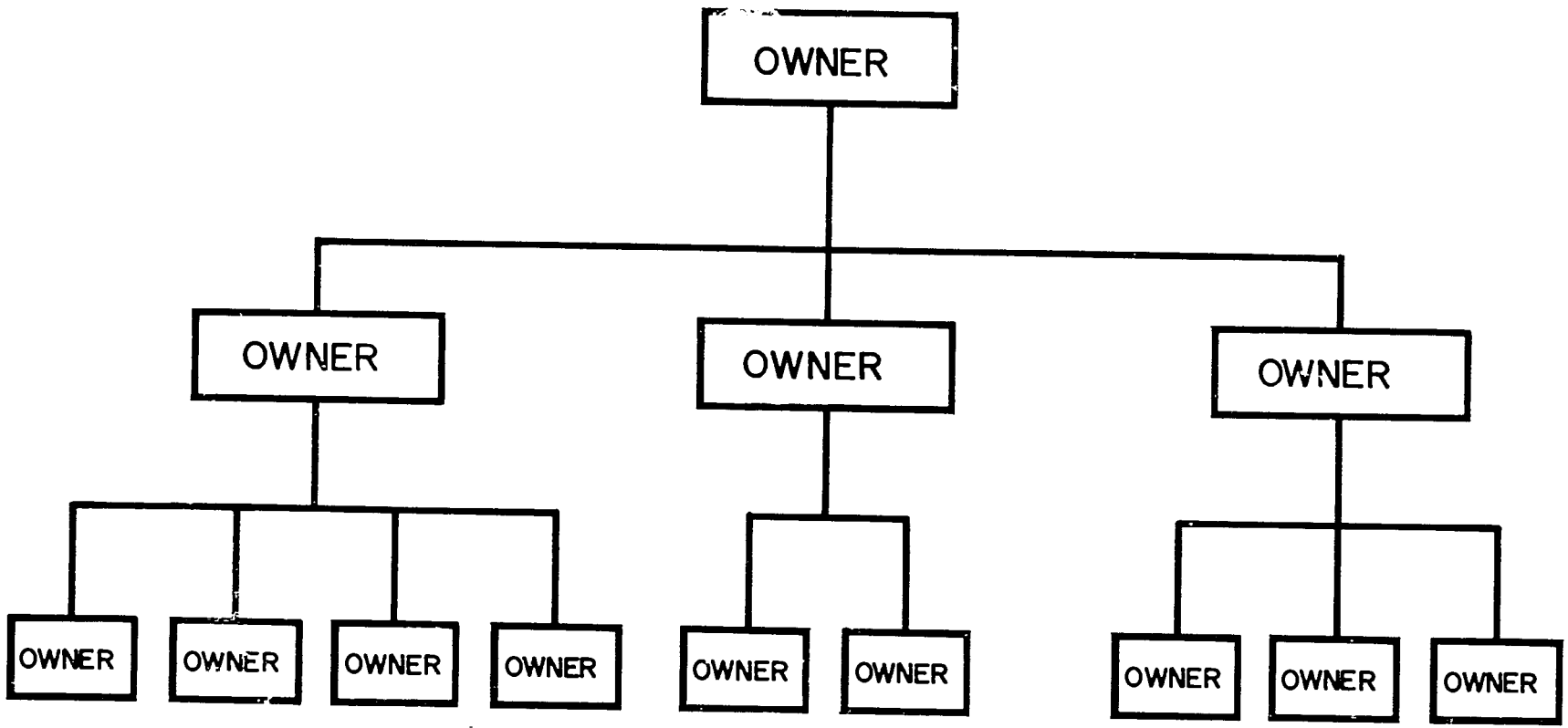
2. Large projects on which it is necessary or desirable to employ smaller contractors.
3. Situations in which contractor capabilities are not known, and it is desirable to try them out on small packages before awarding larger packages.
4. Other situations where it is desirable to break a project into small packages.
5. Situations in which the owner or his staff have construction management experience.

MOST IMPORTANT OWNER FUNCTIONS

1. Contract administration.
2. Scheduling
3. Coordinating between construction contractors
4. Coordinating between the designer and the construction contractors
5. Monitoring
6. Evaluating
7. Controlling
8. Recruiting and maintaining a staff adequate to cope with items 1 - 7 above, or alternatively;
9. Hiring a professional construction management firm to carry out these functions.

THE FORCE ACCOUNT APPROACH

[In Nepal this is known as *amanat*. In H.M.G. departments it is sometimes called *departmental work*
It is also called the *owner built* approach.]



FORCE – ACCOUNT APPROACH

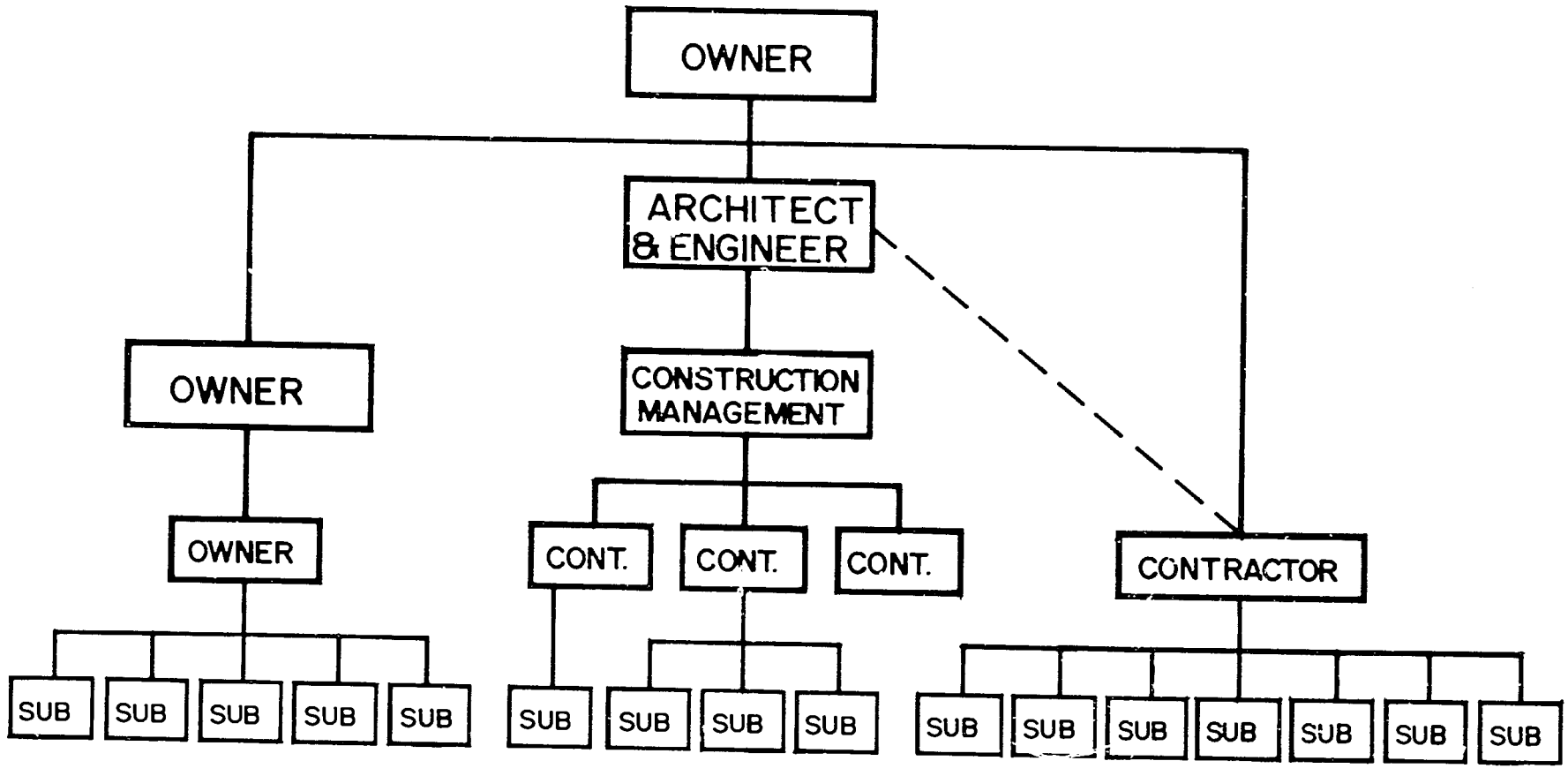
Under this system, the workforce is on the owner's payroll or account. Therefore the name force account. The owner constructs the works using his own tools, staff, equipment, etc. He himself handles procurement, logistics, supervision, scheduling, testing, inspections, etc. He may obtain labor through a broker whose only responsibility is to provide workers who work under the direction and supervision of the owner.

ADVANTAGES

1. The most obvious advantage is that the owner retains the money that would pe paid out under other approaches as the contractors profit and overheads.
2. The owner has direct day to day control over all operations.
3. There are no contractor claims to deal with, no contracts to prepare and administer.
4. There are none of the problems associated with poor contractor performance and none of the risk of having to change contractors during construction.

DISADVANTAGES

1. The owner assumes the full responsibilities of a contractor.
2. Owner's staffing requirements are high.
3. Owner must handle procurement, logistics, recruitment, training, labor relations, security, safety, site amenities, scheduling, payroll, inspections, testing, legal obligations, etc., etc.



A HYBRID APPROACH

APPROPRIATE USE

1. Situations where the owner is continuously involved in construction such as:
   a. A government building department, roads department, irrigation department, etc.
   b. A development authority such as an integrated rural development project in Nepal, or the Tennesee Valley Authority in the United States (which is the worlds biggest force account builder).
2. Situations where the owner has construction experience for example, a building contractor constructing his own offices.
3. Very small works.
4. Areas in which contractors are not willing to work.
5. Areas in which the contractors who are willing to work can't be trusted.
6. Projects on which responsive bids can't be obtained.
7. Projects in which it is necessary or desirable to employ local inhabitants.
8. Where the owner hires a construction management professional to manage the project.

MOST IMPORTANT OWNER FUNCTION

1. Recruiting and maintaining an adequate staff.

HYBRID OR MIXED STRATEGY APPROACH

In actual practice, we see mixtures of the four previously mentioned strategies more often than we see any one of them in a pure form. One very common example would be a project that uses a general contractor for most work, but procures and installs special equipment by itself

(force-account). Another example would be the case of a building constructed using the force-account method for everything except mechanical and electrical works which could be let out as prime contracts. There are so many possible combinations of the design & build, general contract, force account, and multiple prime systems that not much can be said about the hybrid approach in general. Success will depend upon the skill that is used in putting the combination together and managing the project.

PREQUALIFICATION OF CONTRACTORS

Lack of space prohibits a thorough discussion of the procedure for prequalifying contractors. Some points will be mentioned which can help the managing engineer to make sure that the contractors invited to submit tenders are the ones who are likely to be able to complete the work according to the terms of the contract.

The first concern is whether the bidder is actually registered with H.M.G. as a contractor, and if he is, what is his classification. The different classifications of contractors are shown on page100 along with the characteristics of each classification. It is extremely important to investigate a contractors previous work, interview previous clients, and if possible, visit a site at which he is currently working; in this way you will get an idea of the kind of performance that you can expect of him.

It is essential to find out if the contractor has experience in the kind of work which you are doing. This factor is not considered in the classification and registration process. **As a result, a contractor might have class 'A' status and an excellent performance record, but still have no experience at all in some specific field such as building construction, irrigation or bridges.**

One must also find out what other contracts the contractor will be working on at the same time as one's own. Contractors sometimes over-extend themselves. That is, they accept more work than they can manage, finance, supervise or prosecute with the resources at their

disposal. In this situation, all of the contractor's clients suffer, but smaller rural works will tend to suffer most.

On pages 101-107 you will find a set of four prequalification questionaire forms which may prove useful to you. They are issued to and filled in by contractors who wish to prequalify to tender for specific contracts. We are grateful to Mr. Ravi M. Kachhapati of USAID for providing us with the forms.

CONTRACTOR CLASSIFICATION IN NEPAL

Showing the characteristics of each class of contractor

(1) Class	(2) Contract Value Ceiling NC Rs.	(3) Class Certificate Issued By	(4) Registration Deposit With Dept.of Industry NC Rs.	(5) Min. Standing Bank Guarantee NC Rs.	(6) Min. Permanent Staff	(7) Min. Equipment Owned NC Rs.	(8) Min. Previous Experience-Execution of:
D	Below 10 lakhs	Cheif District Officer	50,000.	50,000.	1 overseer	None	Tot.of 1 lakh of work
C	Below 30 lakhs	Ministry of Works and Transport	1 lakh	1 lakh	1 engineer 2 overseers	1 lakh	4 different contracts of more than 2 lakhs each
B	Below 100 lakhs	Ministry of Works and Transport	1 lakh	3 lakhs	2 engineers 4 overseers	5 lakhs	4 different contracts of more than 5 lakhs each
A	Above 100 lakhs	Ministry of Works and Transport	3 lakhs	10 lakhs	2 engineers 4 overseers	15 lakhs	4 different contracts of more than 20 lakhs each

Registration of firms of all classes is done by the Ministry of Industry.

Note that there is no classification according to type of work, such as roads, buildings, bridges, etc.

PREQUALIFICATION QUESTIONAIRE FORMS

FORM I: IDENTIFICATION

Date of Submission:
Certified by NAME:_____
TITLE:_____

Name of Construction Firm:_____
_____

Type of Organization:_____

Postal Address:_____Phone No.:_____
_____Cable Address:_____
_____ _____
_____

Year Organized:_____Registration No.*_____

Names and Position of Principal Officers in Order of Seniority:

No.	NAME	POSITION	Associated Firms With Some Financial Interest
1			
2			
3			
4			
5			

*Attach photocopy of registration certificate from Ministry of Industry and classification certificate from Ministry of Works and Transport or C.D.O. (for class D contractors).

FORM I: IDENTIFICATION (CONTINUED)

If a corporation, provide the following information:

TITLE	NAME	NATIONALITY
Managing Director		
Assistant Managing Directors		
Secretary		
Major Stock Holders:		

If a partnership, give the name, position and nationality of all partners and state whether partnership is general or limited.

No.	NAME	POSITION	NATIONALITY
1			
2			
3			
4			
5			
6			

Partnership Type: (check one) LIMITED ☐ GENERAL ☐

FORM II: FINANCIAL

1.Bank Reference(s):_____

_____

_____

_____

2.Bonding Capacity:

Bondable Amount:_____

Institution:_____

Attach letter from institution confirming this amount

_____

3.Total Assets: NC Rs._____

In Words: _____

_____

4.Total Liabilities: NC Rs._____

In Words:_____

_____

5.Net Worth (#3 minus #4): NC Rs._____

In Words:_____

_____

6.Liquid Assets: NC Rs._____

In Words:_____

_____

7.Current Credit Resources: NC Rs._____

In Words:_____

_____

8.Value, number and type of contract (s) for which firm would like to tender:

Type of contract:_____

Maximum NC Rs._____No. of contracts:_____

Minimum NC Rs._____No. of contracts:_____

REMARKS IF ANY:

NOTES: a) Attach an up-to-date copy of tax clearance.

b) Attach a letter of reference from contractor's bank to this office verifying bonding capacity.

FORM III: PERSONNEL

A. Number of personnel presently employed by the firm.

a) Graduate engineers (highly skilled):_____.

b) Surveyors & overseers (skilled):_____.

c) Supervisory staff (semi skilled):_____.

B. Names and qualifications of the responsible site-in-charges (graduate engineers) proposed for this contract. Attach dossier of these key personnel

S. No.	NAME	QUALIFICATION (DEGREE)	YEARS OF CONSTRUCTION/ SURVEY EXPERIENCE	DESCRIPTION OF WORK DONE
1				
2				
3				
4				
5				

C. Names and qualifications of site engineers proposed for this contract.

S. No.	NAME	QUALIFICATION (DEGREE)	YEARS OF CONSTRUCTION/ SURVEY EXPERIENCE	DESCRIPTION OF WORK DONE
1				
2				
3				
4				
5				

ATTACH EXTRA PAGES AS REQUIRED

FORM III: PERSONNEL (CONTINUED)

4. Names and qualifications of surveyors and overseers proposed for this contract:*

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

5. Supervisory staff proposed for this contract (Foreman, Ganger, Head-Laborer, etc.):

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

*** if above persons are not employed by your firm place an asterisk (*) beside name**

NOTE: Attach extra sheets as required.

FORM IV: EXPERIENCE RECORD

Detailed experience record (for last 10 years only)

1. COMPLETED PROJECTS:(attach extra sheets as required)

Description of project in detail	Client	Contract value	date started	date completed	Litigations YES/NO

2. PROJECTS UNDER CONSTRUCTION:(attach extra sheets as required)

Description of project in detail	Client	Contract value NC Rs.	date started	Target date for completion	Percentage Complete NC Rs.

NOTE: Attach letter of reference for each contract.

AFFIDAVIT

I the undersigned certify that all the statements made in the prequalification forms and in the required attachments are true and correct.

The undersigned authorizes and requests any bank, person, firm or corporation to furnish pertinent information requested by_____

_____

deemed necessary to verify this statement or regarding my (our) competence and general reputation.

The undersigned understands and agrees that further qualifying information may be requested, and agrees to furnish any such information at the request of _____.

_____ _____

(Signed by an authorized officer of the firm) (DATE)

_____

(TITLE OF OFFICER)

_____

(NAME OF FIRM)

(SEAL)

CHANGES
(IN THE WORK)
AND
VARIATIONS
(IN PRICE)

When we prepare budgets, draw up contracts and work out schedules we are involved in the planning aspect of management. There is great satisfaction to be had from gathering the best available information and applying various skills and techniques to devise a plan for attaining our objectives. In real life though, things seldom proceed exactly according to plan, and construction implementation is especially open to unforeseen occurrances which can upset our plans.

A change in the implementation plan for a construction project can have harmful effects such as overrun budgets and time schedules. If, for example, the plan called for the use of material 'X', and for some reason material 'X' is not available when we begin to build, we may have to substitute material 'Y' which is more expensive or material 'Z' which requires more time and labor to install.

The physical environment can also provide surprises that force a manager to change his implementation plan after construction has begun. If hard rock is encountered during excavation this will probably affect both time and cost budgets. If a key road or trail is destroyed by a landslide this can seriously affect the supply of materials and movement of personnel and information to a construction site. Rural works suffer more from these environmental hazards than projects in cities.

The need for re-planning or changing parts of a plan requires that the manager of construction implementation be aware of the various alternative tactics that can be employed to attain the same strategic objective. He must also have a clear idea of the limits within which he can operate.

When a professional contractor is engaged to execute a project, the need to change plans during the implementation of construction presents even greater problems than when a force-account system is employed. This is true because the contractor has usually entered into a legally binding contract to perform a specified quantity of work, in a specified way, under specified conditions. For example, he may have contracted to lay 200 feet of HDP pipe in a 2 foot deep trench excavated in soft rock. If (for whatever reason) we change the quantity, type, methods or conditions of the work; the contractor cannot be expected to do the changed work for the same price. If we find that the pipe must be buried 3 feet deep instead of 2, the contractor must be paid for the extra work. If we find that instead of soft rock the excavation will be in soft clay, the project may be in a position to demand a reduced price.

Although we may not know in advance the exact nature of the changes that will take place in a construction implementation plan; we can be nearly 100 percent certain that some changes will occur. The ability to deal with changes in a responsive and orderly manner is often the real test of a construction management system.

Failure to deal with changes efficiently will nearly always result in big and unpleasant surprises. These surprises have a way of occurring toward the end of a project. They take such forms as: cost overruns, delays in the work, inefficient procurement, multiple claims and bills from the contractor for the same piece of work, inability to clear advances, un-traceable costs, litagation, ill will, bad community relations and in extreme cases; charges of corruption, malfeasance or misappropriation.

As a simplified definition, we can say that changes are items of work not included in the original contract which the owner wishes to add, or items of work included in the original contract that the owner wishes to omit. Often, additions and omissions are included in the same change. For example, if we change a specification from HDP to GI pipe, we omit HDP pipe and add GI pipe.

PLANNING FOR CHANGES

The first step in dealing with changes is to make some provision for them in the contract. This is a very simple procedure. We distinguish between two types of changes: formal changes and informal changes. Formal changes are identified by the owner, usually before the affected work begins. For example, the owner may have agreed to procure some roof material which the contractor agreed to install. If that material becomes unavailable or too expensive, the owner may wish to change to another material.

Informal changes are identified by the contractor, often after the

affected work begins. For example, he may discover some unusual underground condition after he starts excavating; some material that he is responsible for procuring may become unavailable; or he may be delayed in his work because the owner does not provide him with drawings on time. In either case, it is always the owner who authorizes and orders the change, not the contractor (except in emergencies where the contractor must do some work to prevent damage or injury).

Provision for formal changes would insure:

a) That the owner has the right to make changes.

b) That the owner must notify the contractor in writing if he requires changes in the work.

c) That no changes may be made without the written instructions of the owner, except in emergencies.

Provision for informal changes would insure:

a) That the contractor must notify the owner in writing as soon as he discovers a situation which may require a change in the work.

b) That no work may be done in the affected situation until the contractor receives instructions in writing from the owner.

c) That no claims or charges for extra work will be accepted by the owner unless written authorization was received by the contractor to proceed with the extra work.

You will notice that written instructions play an important part in managing changes in the contract work. This is true throughout the change procedure, and it insures that the procedure is controlled at every step, so as to protect the interests of everyone concerned.

PRICING THE CHANGED WORK

The price of changed work can be decided by several methods. The method used does not have to be the same one by which regular contract work is priced. It is not uncommon to find several methods for pricing changed or extra work in the same contract. The most common methods for pricing extras and changes are:

a) Unit pricing at the same cost per unit as regular work

b) Unit pricing at a different cost per unit as regular work

i. sometimes because there is no unit price for some type of work in the contract

ii. these unit prices may be set out in the contract, or negotiated as required

c) Lump sum (lump sum means a fixed, all inclusive fee)

d) Cost Plus (cost plus means the direct cost of doing the work plus an amount added on for overheads and profit)

i. cost plus a lump sum

ii. cost plus a percentage of the cost

iii. either type of cost plus price may be set out in the contract or negotiated as required

The pricing method for changes can be:

a) Specified in the terms and conditions of the contract

This is the most common method in Nepal.

b) Included in the tender package as one of the items for which quotations are requested

This can result in lower prices, since the contractor is bidding in competition with other contractors and must make his bid attractive.

c) They can be left open to be negotiated as the need arises during the implementation of the work.

This is the worst possible situation from the owner's point of view, since the contractor may insist on high prices for changed work and it would be costly to bring in another contractor.

PROCESSING CHANGES IN THE WORK

The correct procedure for processing changes in contract work requires that a five step sequence be followed. The sequence is illustrated graphically on page* 117 and is described below:

STEP I: IDENTIFY

1. As soon as the owner suspects that change in the work may be required, the contractor should be notified in writing. This is best done by using a standard form called a NOTIFICATION OF PENDING CHANGE and REQUEST FOR QUOTATION. This will insure that the contractor receives all information relevant to the change, whether it has been officially approved or not. This is important because:

   a) The contractor is liable to begin work in the affected area, which will have to be demolished later on.

   b) The contractor may procure materials which will no longer be required because of the change.

   c) The contractor may need to change his set-up or his manpower or other resource plans as a result of the change.

   d) Any of the above occurrences can result in additional costs to the owner.

   e) A quotation for the cost of the changed work will be required before final approval for the change can be given.

2. The contractor is required to notify the owner as soon as he becomes aware of any condition that may require that a change in the contract work be made.

   a) Ideally this notification takes the form of a CONTRACTOR CHANGE REQUEST in which the contractor identifies the work which he feels ought to be changed, and states his reasons for requesting the change.

b) Sometimes the first official notification that the owner receives from the contractor regarding changed work is a claim for extra payment. This may be acceptable in the case of an emergency where the contractor acted quickly to protect life or property which was in danger. In general though, it is a dangerous practice and the owner should as a matter of policy refuse any claims for changed or extra work which he has not approved in advance and in writing.

STEP II: EVALUATE

1. If the owner has issued a Notification of Pending Change In Work and Request For Quotation or if he has been advised of the change through a contractor claim, he will already know the contractor's price for the work. Otherwise he will have to request and receive a quotation from the contractor.

2. The Owner will also have to prepare his own estimate of the cost of the changed work so that he can decide whether to accept the contractor's quotation. This is called a fair price estimate. If the contractor's price is too high, the owner may:

   a) Negotiate with the contractor for a better price.

   b) Call tenders or request quotations from other contractors for the changed work. (This is seldom economical on small works).

   c) Execute the work using day labor (force-account).

3. The owner will also prepare a VARIATION ACCOUNT which is a comparison of the cost of the original work (which is to be omitted from the contract) to the change (which is to be added to the contract). The variation account finally shows the net effect of the change on the original contract price either as an increase or a reduction. A case where work is only added and no work is omitted is (technically speaking) an extra rather than a change, but may be processed using the same procedure as for changes.

STEP III: APPROVE

1. The technical officer in charge of construction is seldom empowered to authorize changes in the contract work. If he does have such power, it is usually limited to changes below a certain value. His job is to evaluate the change technically and make recommendations to the officer (or officers) empowered to approve the change. A standard form of APPROVAL OF CHANGE IN WORK is prepared and submitted to the concerned authority along with a copy of the variation account and all other relevant drawings and documents. Remember that the higher authority may not be a technical person. It is important that all information regarding the change, the reasons for the change, and any necessary background information be presented to the concerned authority in a clear concise manner so that the decision can be made rationally.

   a) The standard approval form combines the request for approval with the certificate granting approval. This simplifies the process for the concerned officer or officers and can help to get the change processed in a timely manner so as not to delay the progress of construction.

   b) The granting of approval by the higher authority does not authorize the contractor to proceed with the changed work. It only authorizes the project-in charge to carry out the next step in the sequence. It is vital that none of the five steps be jumped over.

STEP IV: INCORPORATE

1. At this point the project in charge may issue a standard form CHANGE ORDER to the contractor. The change order is the contractors authorization to proceed with the changed work. It contains references to all relevant documents and informs the contractor that the change order has become a part of the legal contract documents.

STEP V: PAY

1. Payment for the changed work is made in the same manner as regular contract work.

   a) Changed work must be noted as such in contractors requests for payment.

   b) Changed work must be noted as such in payment certificates issued to contractors.

   c) It is recommended that changed work be specially noted in construction implementation progress reports and in estimates of cost to completion.

GENERAL

STANDARD FORMS

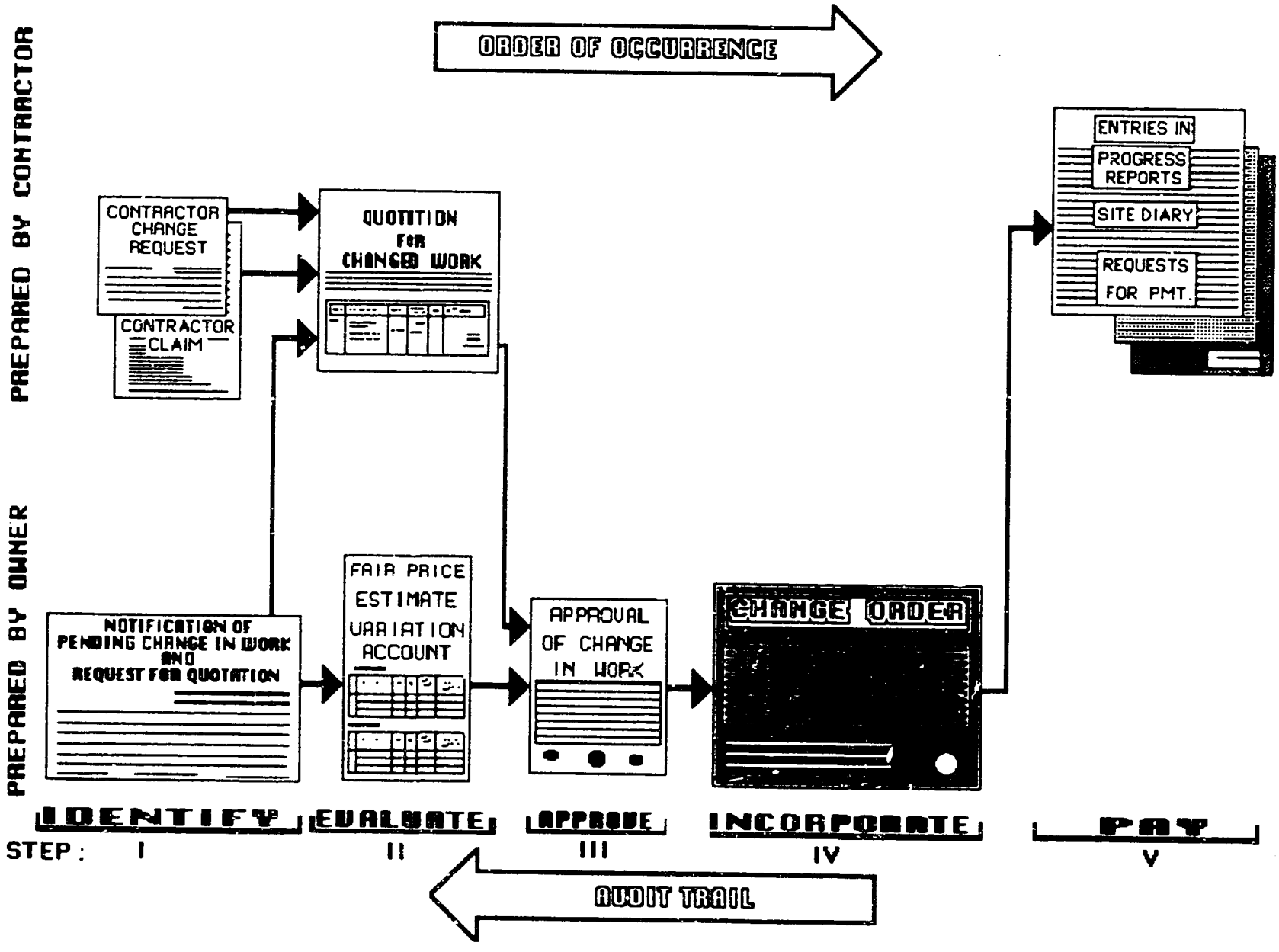
On the following pages you will find samples of the four standard forms mentioned above. You may copy them and use them to help you to manage the changed work procedure efficiently. Note that in some projects under the auspices of HMG, changes are not permitted. In other projects, however these forms should be quite useful. You may find that some of the forms are too detailed for your particular work. In that case, delete those parts of the form that you don't need, and re-draft them to suit your needs.

IDENTIFICATION NUMBERS & THE AUDIT TRAIL

Be sure to notice that as the change/variation sequence procedes,. each standard form has a place for the identification number of all preceding forms that relate to the same change. In the case of the Approval of Change in Work, and the Variation Account there is even a space to enter the identification number of forms that will be issued later on in the sequence. This insures that there is a clear "audit trail" which can be followed at any future time by auditors, accountants, or other officials concerned with the history of the project.

OTHER RECORDS

On projects in which there are about 20 or more changes, it is helpful to keep a register for recording all changes and the relevant document numbers. Otherwise this information may be recorded in the Daily Site Diary. It can be transferred to the appropriate files afterward for auditing.



CHANGE/VARIATION SEQUENCE
ADAPTED FROM GILBRETH

NOTICE OF PENDING CHANGE IN WORK

NOTICE #_____
DATE_____
CONTRACT_____
CONTRACT#_____

TO:_____

The following change(s) has (have) been proposed in the work related to the contract noted above.

WORK AS ORIGINALLY DESCRIBED:_____

PROPOSED CHANGES IN WORK:_____

☐ Refer to your copy of the following drawing(s) or document(s)
☐ Refer to attached drawing(s) or document(s)
which are ☐ are not ☐ approved for construction as of this date.

after reviewing the above, please proceed according to the instructions

INSTRUCTIONS

☐ For information only.
☐ No change in contract required, proceed with affected work.
☐ No change in contract required, do not proceed with affected work until further notice.
☐ Change in contract work, submit proposal including all impacts on cost, schedule, completion date and other work affected by-DATE:_____

COST TO BE CALCULATED ON THE FOLLOWING BASIS:

☐ Contract unit prices. Submit estimated quantities.
☐ Unit prices not in contract. Submit prices and estimated quantities.
☐ Lump sum amount. Quote amount.
☐ Cost-Plus, in accordance with contract provisions. Submit estimated man-hour and material costs.
☐ Other:_____
☐ Proceed with affected work starting-DATE:_____
☐ Do not proceed with affected work until further notice.

Issued by:_____Signature:_____Date:_____
Receipt acknowledged
by:_____Signature:_____Date:_____
(Keep copy# 1 and return all others after signing)
Changes in the work are dealt with under the following sections of the contract named above:_____

APPROVAL OF CHANGE IN WORK

APPROVAL#_____ DATE:_____

CONTRACT:_____ CONTRACT#_____

NOTICE OF PENDING CHANGE IN WORK#_____ DATE ISSUED_____

CHANGE ORDER#_____ DATE ISSUED_____

To:_____

As the officer(s) authorized to approve changes in contract work according to the following provisions:_____

of the contract noted above; you are requested to approve a change in the work under that contract. The nature and location of the changed work is described below:

WORK AS ORIGINALLY DESCRIBED IN CONTRACT:_____

WORK AS CHANGED BY THIS APPROVAL_____

The following relevant drawings and/or other documents are attached:

This change is recommended for the following reason(s):_____

Recommended by:_____ Title:_____

Signature:_____ Date:_____

ORIGINAL CONTRACT AMOUNT.....

NET VALUE OF ALL PREVIOUS CHANGES (+ or -).....

AMOUNT OF THIS CHANGE (+or-).....

REVISED CONTRACT AMOUNT.....

SEE ATTACHED VARIATION ACCOUNT FOR DETAILS OF COSTS

Other impacts on construction implementation are as follows:

SCHEDULE:_____

REVISED TARGET DATE FOR COMPLETION:_____ OTHER:_____

APPROVAL IS GRANTED FOR EXECUTION OF THE CHANGED WORK DESCRIBED ABOVE

Approved by:(Name)_____ Title:_____

Signature:_____ Date:_____

Approved by:(Name)_____ Title:_____

Signature:_____ Date:_____

Witness:_____

SEAL SEAL SEAL

VARIATION ACCOUNT

CONTRACT_____No._____
VARIATION ACC.#____ _____PREPARED BY:_____DATE PREPARED_____
APPROVAL OF CHANGE IN WORK #_____CHANGE ORDER #_____NOTICE OF PENDING CHANGE#_____

BILL OF OMISSIONS

S.#	ITEM	QTY.	UNIT	RATE	AMOUNT
1.	OMIT 2 pairs 1" salwood window shutters. 3'-0"x 5'-0"x 2 nos.=30 as shown in drawing# DW4/33	30	sq.ft.	35.-	1050.-
2.	TOTAL OMISSIONS CARRIED SUMMARY				1050.-

BILL OF ADDITIONS

S.#	ITEM	QTY.	UNIT	RATE	AMOUNT
1.	ADD 2 pairs fully glazed salwood shutters 3'-0"x 5'-0" x 2 nos.=30 as indicated in revised drawing #DW(4)-R2/33	30	sq.ft.	40.-	1200.-
2.	TOTAL ADDITIONS CARRIED TO SUMMARY				1200.-

SUMMARY OF VARIATION ACCOUNT

TOTAL ADDITIONS.....+1200.-
TOTAL OMISSIONS.....-1050.-
ORIGINAL CONTRACT PRICE WILL BE INCREASED BY.....+150.-

CHANGE ORDER

CHANGE ORDER #_____ DATE:_____

CONTRACT:_____ CONTRACT #_____

VARIATION ACC.#_____ APPROVAL #_____ NOTICE OF PENDING CHANGE#_____

TO:_____

YOU ARE AUTHORIZED AND INSTRUCTED To carry out the following changes in the work related to the contract noted above.

WORK AS ORIGINALLY DESCRIBED IN CONTRACT:_____

WORK AS CHANGED BY THIS ORDER:_____

For complete details refer to drawings and/or other documents mentioned below which are:

☐ attached ☐ already in your possession_____

Unless otherwise noted, this change order and the related approved drawings and documents are now part of the legal contract documents of the contract noted above.

AFTER REVIEWING THE ABOVE CAREFULLY, YOU ARE REQUESTED TO SEEK CLARIFICATION FROM _____ OF ANY POINTS WHICH SEEM UNCLEAR TO YOU BEFORE STARTING THE CHANGED WORK.

THE ABOVE WORK IS TO COMMENCE ON-DATE:_____ AND BE COMPLETED BY-DATE:_____

ORIGINAL CONTRACT AMOUNT.....

NET VALUE OF ALL PREVIOUS CHANGES (+ or -).....

AMOUNT OF THIS CHANGE (+ or -).....

REVISED CONTRACT AMOUNT.....

As a result of this change contract duration is: not changed ☐ extended ☐ reduced ☐ by_____ working days. The new target **date** for contract completion is:_____

Changes in the construction **schedule** resulting from this change are:_____

Other areas affected by this change are:_____

Changes in the work are dealt with under the following sections of the contract named above:_____

Issued by:_____ Title:_____

Signature:_____ Date:_____

On behalf of the owner.

SEAL

Received and Accepted by:_____ Title:_____

Signature:_____ Date:_____

On behalf of the Contractor.

SEAL

(Keep copy#1 and return all others after signing)

ENFORCING THE CONTRACT

QUESTION:

How are you going to make a D class contractor take a contract seriously

when he is not in the habit of taking contracts seriously

and

He may not be able to read the contract

and

He doesn't expect you to take it seriously

?

ANSWER:

1. You are going to have to introduce a program to change contractor attitudes in your district.
2. You will probably need to get the support of your fellow district officers to do this.
3. Before you begin, you will have to educate your overseers and supervisors.

The education of your own staff will involve giving them all of the information contained in the contract documents that they will need to carry out their work. They don't need to become contract management experts. They do need to know the technical specifications for the work, and they must have a copy of the contract on site.

QUALITY CONTROL

The job of insuring that a contractor's work meets the standard of quality specified in the contract, will be done by the site-in charge. It is important that this key person be given the tools, information and authority to do his job properly. He must be in a position to enforce the technical specifications of the contract without being accused of being unfair.

Too often, technical specifications are written in such a way that there is a great deal of room for disagreement as to whether a piece of work does or does not meet the required standard. For this reason, it is helpful to use descriptions like:"*Uncoursed random rubble masonry*", or "*random rubble masonry brought up to course every two feet*", or "*coursed stone masonry*". These specifications are easier to enforce than such descriptions as "*stone masonry*".

If there are special requirements for a type of work, it will not be sufficient to simply call for "*first class work*", or to specify that masonry must be "*adequately bonded*. It is far more useful to give specifications that can be specifically checked and measured. Instead of saying that "*masonry should be adequately bonded*"say (for example), "*At least fifty percent of the stones shall extend back from the face of the wall to a depth of two thirds of the thickness of the*

wall." Or *"A minimum of one through stone, passing through the entire thickness of the wall shall be provided for each square meter of wall face."*

Such exact specifications leave no room for arguement. They can be inspected and verified. Either there is or there isn't a through stone for each square meter. It's not a matter of opinion.

It is also possible to require a contractor to erect a small specimen of some type of work which can be approved and used as a standard for comparing future work against. This can be a small piece of masonry, a patch of cement plaster on a wall, a part of a wall with the masonry joints pointed, or some other type of work. The contractor and the site-in-charge will then always be able to compare new work to the approved standard. Such specimens of work need to be protected from damage so that they last throughout the construction period.

Concrete is often a source of quality control problems in rural works since it is not a traditional material, and many mistris don't know how to handle it properly. For this reason, mix designs must be specified in the contract, and there must be a contract provision that prohibits the contractor from doing any concreting without direct supervision by the site-in-charge.

Whether concrete is to be mixed by hand or by machine, the procedure for mixing should be set out in the contract. The order in which ingredients are to be added to the mix should be specified, as well as the amount (time) of mixing to be done. In the case of hand mixing, the type of surface on which the mixing is done should be specified, and mixing should not be

allowed in high winds that will blow away the cement. The method for compacting or rodding the concrete should also be set out in the contract. Care must be taken to insure that the concrete is not contaminated by mud or other foreign material; this is a point which many rural mistris are careless about. It is also wise to check the dimensions of the contractor's measuring boxes to insure that the correct amounts of aggregate are being used.

The quantity of water in the mix affects the final strength of the concrete. Generally, the drier the mix, the stronger the concrete. If the mix is too dry, however, it will be more difficult to place and compact. This will be especially important where reinforced concrete is concerned, as it is important that the concrete completely surround the reinforcing bars and that there be no voids. The surest way to control the quantity of water in the field is to specify the permitted amount of slump in the contract, and carry out slump tests with a standard cone. If this is not possible, the site-in-charge will have to rely on his experience. For further technical details see *Appendix I* at the back of this manual.

Regardless of how well the technical specifications are written, or how much experience the site-in charge has, he can't enforce a standard of quality if he doesn't have the authority to do so. This authority is less a question of official authority than one of respect. Many contractors won't listen to a supervisor or overseer. The District Technical Officer or other managing engineer must support his subordinates in the field. Contractors should realize that an overseer will be backed-up by his office in matters relating to the quality of work.

CHANGING CONTRACTOR ATTITUDES

The tender call is the time to begin changing contractor attitudes. When contractors are invited to bid, they should be advised that the terms and conditions of the contract will be strictly enforced, and that any party not willing to work according to those rules should not bid on the work.

When contractors come to the project office to collect tender documents this point must be made again. Since contractors sometimes send peons to collect the tender documents it is wise to have a printed notice for distribution along with the tender documents. This notice should state that parties not willing to comply with the terms of the contract should not submit tenders.

A third opportunity to convince the contractors that the contract is going to be seriously enforced will be at the official opening of the sealed tenders. Every bidder will be present at that meeting. People will be in a serious mood and will be alert and listening to everything that you say. Tell the assembled contractors quite clearly that before the tenders are opened they may still be returned at the bidder's request, but after they are opened they are legally binding and cannot be re-called. Ask any contractor who is not willing to follow the conditions of the contract strictly, to ask for his tender to be returned.

By this time your message will have been presented three times, in public, and in writing. When work commences it will be your job to show that you mean business. The first time that the contractor violates the terms of the contract in such a way as to hurt the project; you must take positive action. At minimum you should call the contractor to your office for a meeting and issue a written warning.

SCHEDULING

There is no need to explain the importance of time in the implementation of construction. Anyone with enough interest to be reading a manual such as this is quite aware that it is essential for the construction manager to acquire skill in time management. The chief tool that we use for managing time is the schedule. Very sophisticated methods for scheduling have been developed in the years since the end of the Second World War. Use of the computer has made it possible to work with schedules that are more complex and contain greater detail than was ever possible in the past.

Most of the construction undertaken in Nepal (especially in rural works) does not require such highly detailed or complex schedules. There is however, a great benefit to be gained by becoming familiar with the logic and the basic concepts which underlie modern scheduling methods. They help us to develop a disciplined way of thinking which is useful even on the simplest of projects, and which can make even partial or intuitive scheduling a meaningful exercise.

Even if <u>individual projects</u> may not require the strict application of sophisticated scheduling methods, <u>groups of projects</u> such as those which share a common resource may benefit from such techniques as network analysis and the identification of critical activities. For example, if the period of peak demand for a limited resource can be scheduled in a balanced way through resource leveling, (so that all projects don't require the same resource at the same time) the individual projects can proceed more smoothly without the expense of additional

resources.

WORK MEASUREMENT AND PRODUCTIVITY STANDARDS

A schedule based on mixing concrete with a machine will be different from one based on hand mixed concrete. Brick laying crews (or gangs) of three men will have a different output from crews of two. The difference between an on-site water source and a source two hundred meters away from the site will affect the progress of construction. If a construction schedule is to be useful, planning and implementation must be linked. Production methods and productivity standards are of special importance in this linkage.

In the chapter "*On Site Construction Management*"; Method Study is introduced. Method Study and Work Measurement are two complementary parts of the broader subject of Work Study. Method Study helps us to examine the way in which work is done, so that we can make improvements in the means of production. Work Measurement is concerned with establishing standards for human effort and deals with the time required for carrying out a specific job. It is through the use of Work Measurement techniques that productivity standards are established for various types of work.

Precise Work Measurement is a time consuming process which is carried out with such equipment as the flyback stopwatch, the TYMLOG recorder and sometimes a movie camera. It is best suited to operations which are repeated over and over again under conditions that change very little. It's

main application is in production management under the controlled conditions of factory type production. Even here it is understood that Work Measurement is far from an exact science. Because construction takes place under such varied and often unusual conditions: on different sites, in changing weather etc. Work Measurement is applied in a much broader way than in controlled manufacture.

Although most often a rule-of-thumb productivity standard is used, taken either from experience, a department standard, or a reference work; a construction manager must be willing to check and verify those standards as the need arises. He must be able to establish productivity standards for special types of work and he must be able to adjust them to special conditions. In addition, he must be able to translate productivity standards into measurable production goals for his subordinates whose job is the day to day implementation of construction.

It will be useful therefore, for the manager of construction to have some general guidelines for Work Measurement. This can improve the accuracy of the intuitive or common-sense methods that he uses in the informal exercises that he carries out in working with productivity standards and production goals.

SELECTION PROCESS

1. SELECTING THE JOB TO BE STUDIED

Work Measurement requires an investment of that limited resource, the manager's attention. Each and every job can not be measured. The manager must select those jobs which will yield the maximum return on his

investment. The ones which are most frequently repeated, the ones with highest costs, and the ones that seem to be taking too much time are among the best targets. Application of Method Study techniques described elsewhere in this manual will often reveal an area worth examining further.

2. SELECTING THE METHOD FOR DOING THE JOB

In establishing and checking productivity standards the method by which the work will be done must be selected with care. If an inefficient method is chosen, the productivity standard will be low (that is, it will take an excessive amount of time to do a given piece of work). It becomes clear that Work Measurement and Method Study cannot be completely separated in practice.

3.SELECTING THE WORKER OR CREW (GANG) WHOSE WORK WILL BE MEASURED

In addition to selecting the job and the method to be measured; selection of the worker or gang whose work is measured is important. The average worker or average gang is the ideal subject, since an unusually fast or slow individual or gang will give results that won't be generally applicable. Unfortunately, the average worker or average gang don't exist except as ideal concepts. Therefore, observations of several workers or gangs will have to be averaged out or some approximate correction will have to be applied.

OTHER CONSIDERATIONS

1. CONDITIONS UNDER WHICH THE WORK IS DONE

The conditions under which a job is carried out are another factor which must be taken into consideration when carrying out a Work Measurement

exercise. To appreciate the importance of this factor, consider the difference between laying bricks in a foundation trench at ground floor sill level, and on a high scaffold many stories above the ground. Conditions that increase a worker's fatigue such as temperature, wind, noise, light, etc. will also affect the results.

2. LEVEL OF WORKER MOTIVATION/COMPENSATION AND INSTRUCTION

Bear in mind that the worker or workers under observation must understand the work they are doing (they should not, for example be doing a task for the first time). There may also be a difference in the level of performance of volunteer workers, day laborers and contractor's forces. Also consider such factors as whether the workers are operating under a bonus system or are otherwise being paid adequately.

3. RELAXATION ALLOWANCE

No one can be expected to work continuously at a task without going to the toilet, stopping for tea, lighting a cigarette, or conversing with a fellow worker. Work Measurement exercises must allow for some relaxation. One standard considers that a worker (British) works for approximately 52 minutes of each hour on the job.

4. EFFECT OF THE OBSERVER ON THE WORK

If you spend the day standing over a gang of masons with a stopwatch and a clipboard in your hand, you can't expect them to work at a normal pace. Workers know that they are being observed, and deserve to be told why. Be sure to explain (at least to the mistri or naike) what you are doing, and

why. Be sure that they understand that you are not checking up on their personal performance, but only trying to find out how long various jobs should take in general.

It will be clear by now that Work Measurement is a subjective process requiring the Work Measurement engineer to make judgements which are more or less accurate, depending on his experience and skill. When formal Work Measurement techniques like: time study, activity sampling, rated activity sampling and analytical estimating are applied, various checks are employed in an attempt to control human error. There are even Rating Clinics where Work Measurement engineers can re-calibrate their ability to assess the tempo at which gangs are working. Work Study engineers consider that they can acheive degrees of accuracy within five percent in these assessments.

Such refinements are cost effective in very large operations where skilled operatives perform specialized tasks. They are not in a small rural project employing workers who serve as masons, form builders, cabinet makers, rough carpenters or plumbers according to the requirements of the job, and consider themselves first of all as farmers. There is too much variation in the way work is done to permit such accurate measurement or to make it worthwhile. The guidelines presented in the previous pages, along with your common sense (which will improve with experience), should allow you to establish and verify productivity standards that will be accurate enough for use in scheduling the implementation of rural works.

The fact is that <u>any</u> productivity standard is better than none at all. It is always possible to adjust the standard if it proves too high or too low in practice.

THE SCHEDULE AS A LINK BETWEEN PLANNING AND IMPLEMENTATION

When you prepare your schedule, you take the volume of work to be done and divide it by a productivity standard. For example:

excavation $100\ m^3 \div 2.5m^3$/man/day = 40 man days (m/d)

You then schedule the work on the basis of available manpower and other considerations such as the need to complete within a certain period. Thus, if the work must be completed in three days and ample labor is available:

$$14 \text{ men} \times 2.5m^3/m/d = 35m^3/\text{day} \times 3 \text{ days} = 105m^3$$

which provides a bit of contingency.

Anyone who has ever prepared a schedule has carried out this sort of calculation, even though he may have worked in a different sequence or done it in a less formal way. When the calculation is transferred onto the schedule form though, it may appear like this:

CONSTRUCTION IMPLEMENTATION SCHEDULE

WORK	DAYS													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13ETC.
EXCAVATION														

This is a kind of a code, and in order for the person responsible for day to day implementation of construction to decipher the code he needs a key. If he knows the quantity of work and the productivity standard that you used, he has the key. He can reverse the calculation that you carried out:

$$100m^3 \div 3 \text{ days} = 33.33m^3/\text{day}$$

$$33.33m^3 \div 2.5m^3/m/d = 13.33 \text{ (say 14) men/day}$$

If he does not have the quantities and the productivity standard, he does not have the tools that he needs to calculate his labor requirement.

Even if he does have these tools there is no guarantee that he will carry out the calculation. Most supervisors and many overseers are not trained for or oriented towards this kind of thinking. Very frequently we find that the method for doing the work that the schedule was based on has been changed. Sometimes this happens simply because no one on site considered the importance of the method used in relation to the time and other resources budgeted.

Site supervisors and overseers often see their job as a kind of custodianship. Recording hours worked, keeping track of materials used and looking after site security. These are important tasks and they have to be done, but implementing construction so as to maintain a schedule and meet targets requires a more aggressive attitude.

By using the tools and methods discussed in the chapter "*Motivating the Construction Team*", you can turn your schedule from an academic planning exercise into a dynamic tool for construction implementation. If you are not familiar with the tools presented in that section, you may

want to turn to it now and read it before continuing with this chapter since we will be applying some of the motivation tools that are presented there.

The essence of this method is to challenge your subordinates. The first step is to involve them in the scheduling process. The very best way to do this is to have the person responsible for implementing a schedule prepare that schedule himself. Of course his ability to do that will depend on the individual's:

1. experience
2. training
3. skill

and 4. willingness.

Item 4, willingness, relates back to the idea of challenging and is most important of all. Experience is what you are going to provide, along with training; skill will come with practice.

What you wish to do is to appeal to your subordinates fourth level of human need* by offering: recognition of his worth and potential, responsibility for the schedule, achievement of a measurable goal, and an opportunity to derive satisfaction from the work-itself by carrying out a meaningful unit of work.

*Refer to *Part I "Motivating the construction team"*

The more common situation, where a subordinate is handed a schedule and told to implement it, is not challenging. It doesn't provide any of the motivators mentioned above. The subordinate doesn't know the basis for the schedule. Why three days instead of ten days? He probably (unless he's quite experienced) doesn't really know if it's practical or not, if it can really be met. Why should he worry about the methods and productivity standards that were used in planning the schedule?

If on the other hand, he is involved with the schedule from the beginning, it becomes his schedule. He will know how and why it was planned the way it was because he had a hand in preparing it. This will be true to a great extent even if you actually have to do most of the work of preparing the schedule yourself (which might be the case with a very inexperienced supervisor). The important thing is to involve the person and let him do as much of the work as he is capable of. If that's not much at first, consider that you have invested the time in training. Next time he'll be more capable. Often you'll be surprised at how practical people with field experience can be (once they feel challenged).

By next time he will probably have learned a great deal about scheduling, because your next step will be to translate the productivity standards that you used in preparing the schedule (and which the supervisor or overseer now understands) into goals. The way to meet the final target is by setting and meeting smaller targets along the way.

SETTING GOALS

These goals can take the form of daily production targets. Twenty-five cubic meters of excavation per day. Five hundred bricks laid per day by

each gang, etc. Production targets have the advantage of being easily presented to the workers, the contractor or to the users' committee. If they set up as daily goals they provide frequent satisfaction and quick feedback. In many cases, weekly or two-weekly goals are more practical.

Competition between gangs will assist meeting targets if it is not allowed to get out of control. A competition between gangs to see who can meet the daily target for the most consecutive days is much better than a competition to see who can lay the most bricks or excavate the most earth in one day. The first competition assists in making steady progress toward the target. The second only assists in making people too tired to work well on the following day.

Another form of short term or interim goal is the project milestone: having the DPC complete by day X, collecting all of the stone boulders by day Z, or completing the headworks in time for some special occasion such as a festival or national holiday.

THE ANNUAL CYCLE

Climate, religion and agriculture play important parts in the preparation and implementation of construction schedules. Anyone who ignores these major influences on the annual cycle will have to pay the consequences. It may be more correct to speak of climates, religions and agricultures, because depending where your project site is, you may have to deal with different agricultural seasons, different religious festivals, and different climates. You may even need several calenders to do your calculations.

RELIGIOUS FESTIVALS

The majority of the population use the official Bikram Sambat calendar, but if you are working in in an area with a large Newar population remember to include the Newar festivals in your calculations. If there are a large number Bhotes or Sherpas on your construction crew you will have to consult a Tibetan calendar to find out when Lhosar (Tibetan New Year) occurs and prepare for a quiet week on the site. There are in addition many festivals that are celebrated by small groups in rural areas which don't appear on any calendar.

CLIMATE

In the parts of the Kingdom where most of the population lives, the most important climatic events are monsoon, the pre-monsoon dry season, and the cold months. Each of these affects the work that can be done on a construction project.

In much of the country it's not wise to excavate foundations etc. during the monsoon. This invites collapse and usually requires the extra expense and work of de-watering. There is also the danger of triggering landslides on an unstable site. Roads, trails, and bridges leading to the construction site can be washed out during the monsoon, stopping the flow of materials. Procurement schedules should allow for this.

During the pre-monsoon dry-spell, serious water shortages can occur. This can have a bad effect on such work as concrete pours and the

wet-curing of freshly poured concrete,*† the washing of sand and aggregates, and any other work that requires water.

Sometimes there is insufficient drinkng water on site. The pre-monsoon and monsoon seasons are the peak periods for water-borne diseases. This can result in low-productivity and a high level of absenteeism. The provision of pure drinking water on site may be considered during this period. If weak iodine solution is added to the water (about 2 drops/liter) harmful organisms will be destroyed. This is not an expensive solution.

In years when there is little or no monsoon rain, the dry-season can last from mid-March through mid-September. This will cause especially severe problems for construction projects in the hills where the water supply is limited even at the best of times.

*"The strength of concrete that is not damp cured will be 50% less than the strength of concrete that is damp cured for 14 days. If damp curing is continued for about a month, strength will increase by about 25%."
P.N. Khanna, *Indian Practical Civil Engineers' Handbook (Ninth Edition*

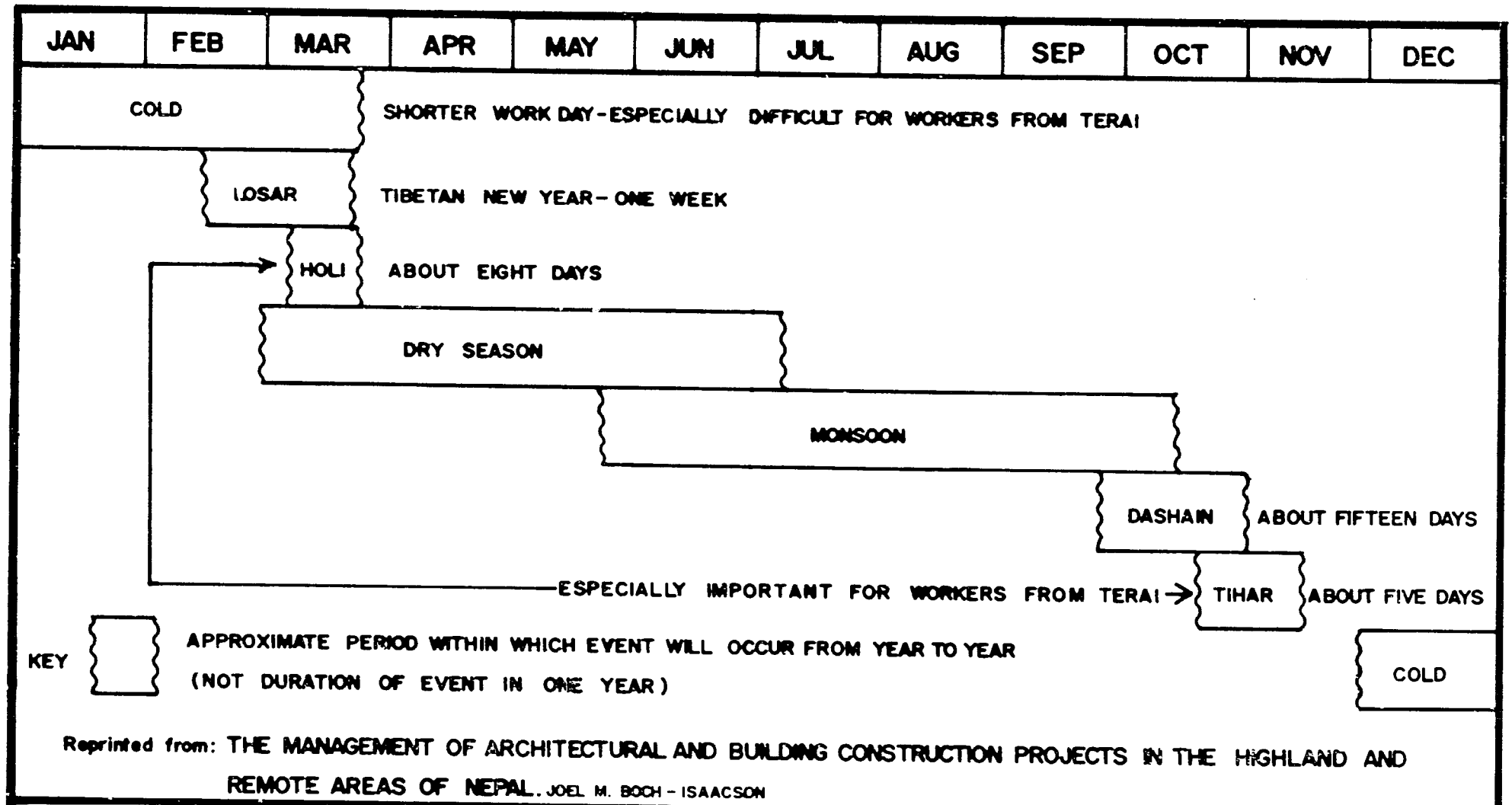
† See Appendix 1 for water requirements for various concrete mix ratios. Also see page 124 in *Part VIII "Contracts "*

The winter cold will prevent work from starting early in the morning. Workers from the Terai or India will be especially bothered by the cold mornings in the hills, which they are not accustomed to.

AGRICULTURE

Most of the construction workers in rural works are drawn from an agricultural population. They are usually those members of families who can be spared from agricultural work. During the seasons of peak labor requirement on the farms, they will not be available for construction work. These periods of labor shortage can be predicted and allowed for in a construction schedule. If you contact a local rural development project or similar office, you should be able to get this information, which is a function of the local cropping pattern. It will vary in different parts of the country.

On the following two pages you will see two useful tools for use in preparing and implementing schedules. One is an illustration of the major seasonal events (climatic and religious) that can affect the progress of construction. The other is a calendar for major cropping patterns (this one is for the Kosi Hills Area).



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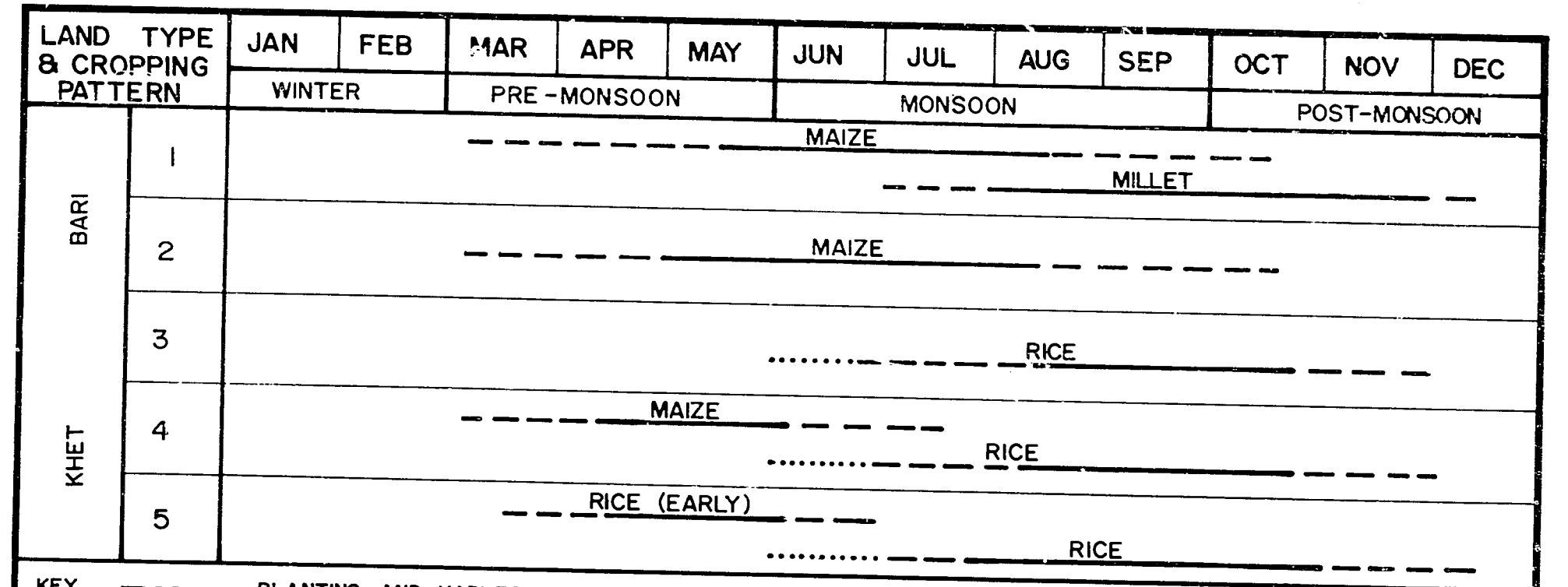
MAJOR SEASONAL EVENTS AFFECTING THE PROGRESS OF CONSTRUCTION PROJECTS



KEY. — — — — PLANTING AND HARVEST PERIOD (PLANTING AND HARVEST TIMES DEPEND ON ALTITUDE)

———— MAIN GROWING PERIOD

····· LAND PREPARATION PERIOD FOR MONSOON PADDY (ONSET OF MONSOON)

Reprinted from: THE MANAGEMENT OF ARCHITECTURAL AND BUILDING CONSTRUCTION PROJECTS IN THE HIGHLAND AND REMOTE AREAS OF NEPAL. JOEL M. BOCH-ISAACSON

CALENDAR FOR MAJOR CROPPING PATTERNS BY LAND TYPE IN THE KOSI HILL AREA

AFTER S. CONLIN AND A. FALK, A STUDY OF THE SOCIOECONOMY OF THE KOSI HILL AREA: GUIDELINES FOR PLANNING AN INTEGRATED RURAL DEVELOPMENT PROGRAMME (WITH ADDITIONS)

CRITICAL PATH METHOD

CPM may be looked at as a three phase process:

1) Planning

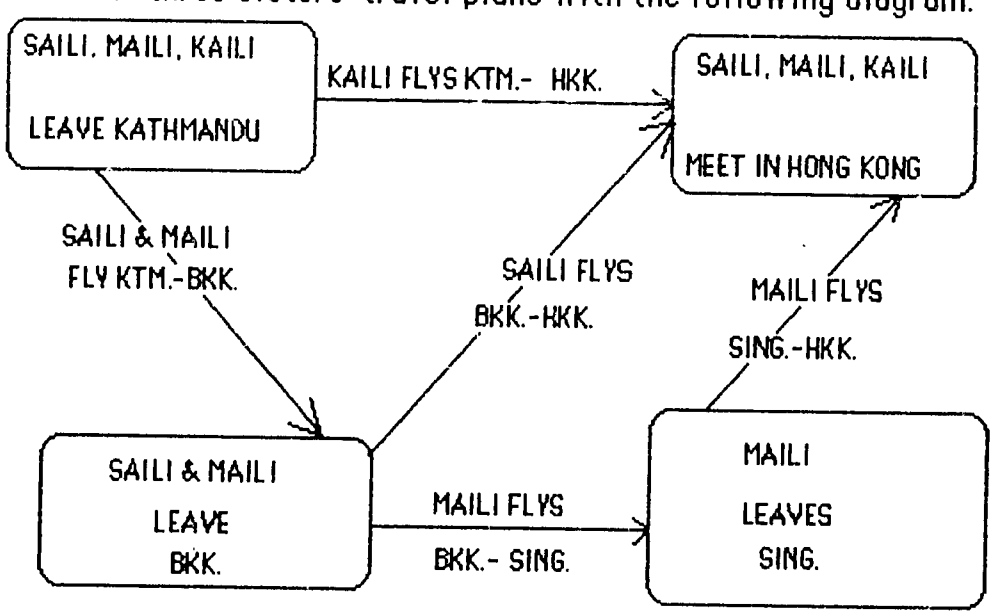
2) Analysing/Scheduling

3) Controlling

The three phases are not entirely independent. The second phase (analysing) may show an error in the original plan (phase one). This would require a return to the first phase for re-planning.

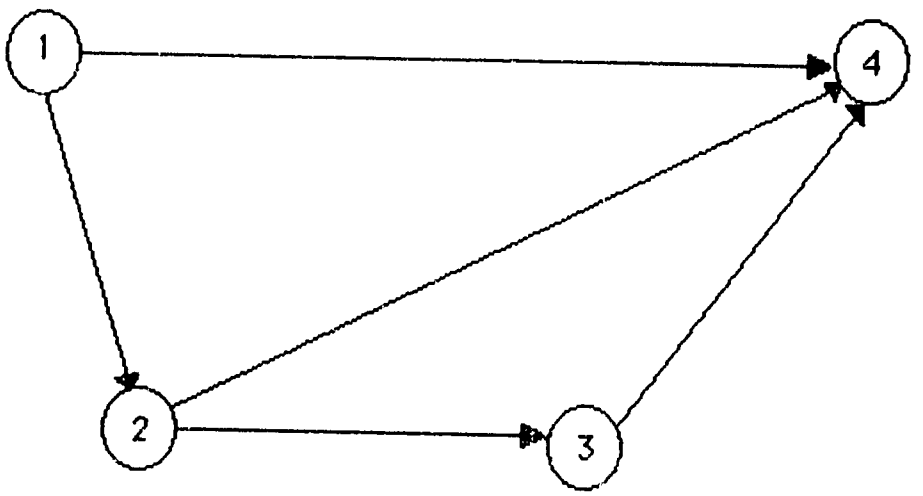
PHASE I PLANNING

We shall take as an example, a very simple project. Three sisters: Saili, Maili and Kaili leave Kathmandu and agree to meet in Hong Kong. Kaili, the youngest, flys directly to Hong-Kong. Saili and Maili fly together from Kathmandu to Bangkok, where they separate. Saili flys from Bangkok to Hong Kong. Maili flys from Bangkok to Singapore to Hong Kong. We can visualise the three sisters' travel plans with the following diagram:



but this would be too awkward for a more complex project, so we will

simplify the diagram by using some standard CPM symbols.



Two symbols are used in the diagram.

ARROWS

An arrow represents an
ACTIVITY

An activity is an operation that consumes time and perhaps other resources.

and

CIRCLES

A circle represents an
EVENT

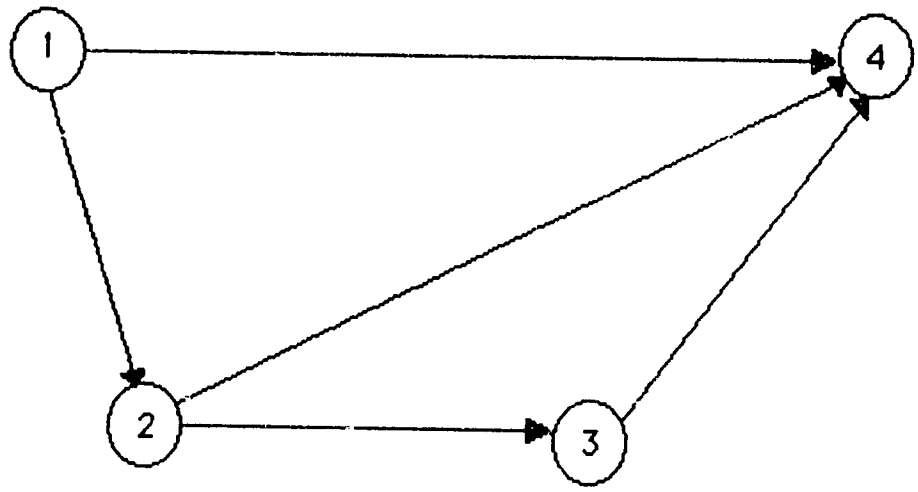
An event is a stage or milestone in a project, reached after the completion of all preceding activities but before the start of any succeeding activities. An event does not consume time or any other resource.

NETWORK DIAGRAM RULES OF LOGIC

1) No activity can start until the event that it emerges from has occurred.

2) No event can occur until all of the activities that lead into it have been completed.

The diagram is now referred to as a network



Events are referred to by the number in the circle, as event number 1, 2, 3, 4, etc.

Activities are referred to by the numbers of the events that precede and succeed them, as activity 1-2, 1-4, 2-4, 2-3, 3-4, etc.

EVENT DEFINITIONS

Event 1 = leave Kathmandu.
Event 2 = leave Bangkok.
Event 3 = leave Singapore
Event 4 = meet in Hong Kong

ACTIVITY DEFINITIONS

Activity 1-2 = fly from Kathmandu to Bangkok.
Activity 2-3 = fly " Bangkok " Singapore.
Activity 1-4 = fly " Kathmandu " Hong Kong.
Activity 3-4 = fly " Singapore " Hong Kong.
Activity 2-4 = fly " Bangkok " Hong Kong.

Now that the network has been drawn we may enter the time that will be budgeted for each activity. The operation is known as time loading the network. (For the purposes of this exercise we will count only flying time, not time on the ground).

FLYING TIMES BETWEEN AIRPORTS SERVED BY CPM AIRLINES

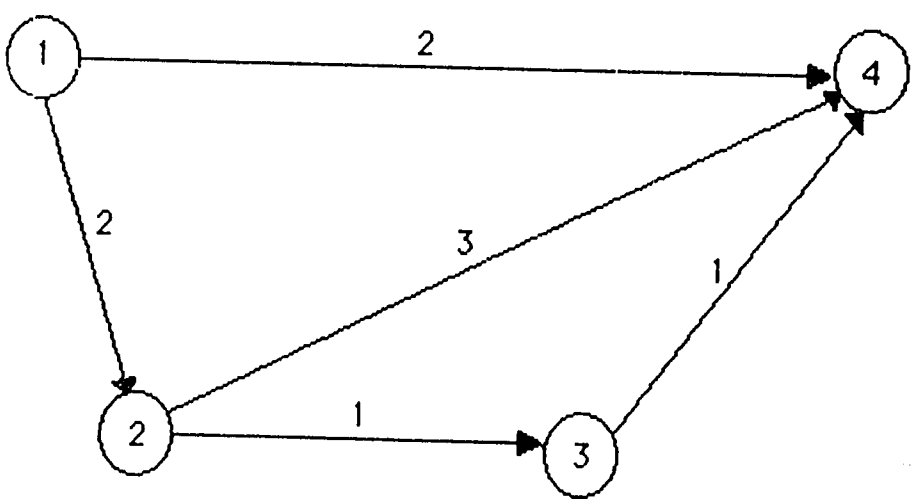
from	to	time
Kathmandu	Bangkok	2 hours
Bangkok	Singapore	1 hour
Kathmandu	Hong Kong	2 hours
Singapore	Hong Kong	1 hour
Bangkok	Hong Kong	3 hours

Therefore, the time budgeted for the activities will be:

Activity 1-2--------2 hours
Activity 2-3--------1 hour
Activity 1-4--------2 hours
Activity 3-4--------1 hour
Activity 2-4--------3 hours

These activity durations are written above the activity arrows on the network diagram.

Thus:



PHASE II ANALYSING/SCHEDULING

The first information that we want is the total project time. The shortest time in which the project can be completed is the shortest possible time in which all three sisters can meet in Hong Kong. Another way of putting this is to say *the shortest possible time between event 1 and*

event 4.

The network diagram shows that event 4 can't take place until three activities have been completed: 1-4, 2-4, and 3-4. There are therefore three <u>sequences or paths</u> leading into event 4. They are:

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

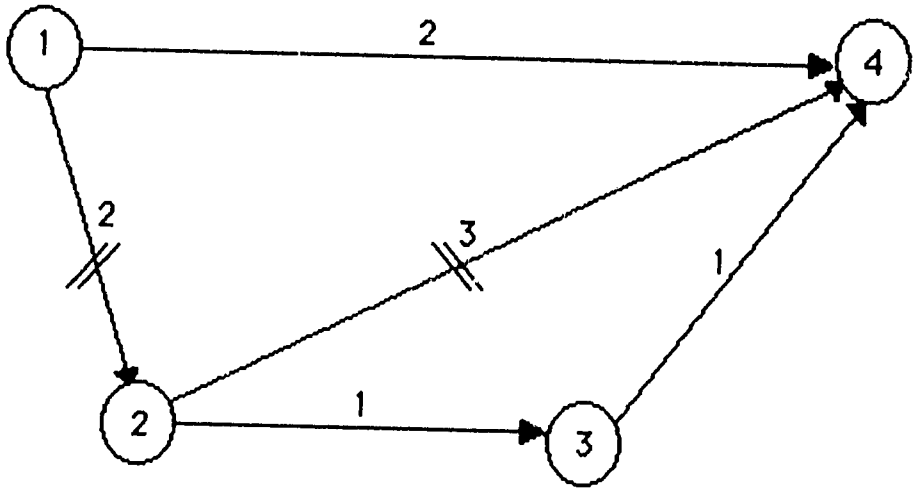
Their durations are:

a)	2	= 2 hours
b)	2+3	= 5 hours
c)	2+1+1	= 4 hours

<u>The time required to complete the sequence with the longest duration will be the shortest time in which the whole project will be completed.</u>

The shortest possible project completion time is 5 hours. This is determined by sequence b) 1-2-4. This sequence is called the <u>critical path</u>, because it's duration is *critical* to the duration of the total project. Any delay along the sequence 1-2-4 will delay completion of the project. Some delay along the other sequences could occur without affecting project completion. The other sequences are therefore called *sub-critical*. (The critical path is drawn in red if color is available. Otherwise a pair of short parallel lines is drawn across each activity arrow on the critical path.)

This is valuable information for a project manager. It shows where attention must be concentrated and which activities have the highest priority. If the project must be completed in 4.5 hours, the critical path (1-2-4) must be reduced by 0.5 hours. Reducing sequence 1-4 or 1-2-3-4 by 0.5 hours will not speed-up project completion at all. Any resources used in an attempt to shorten project duration by speeding-up these *sub-critical* paths will be wasted.



If the overall project duration of 5 hours is acceptable, then the sub-critical activity 1-4 can be allowed to take up to 5 hours instead of only 2 without delaying project completion. Or, if the project starts at hour 0, and the 2 hour duration is kept, activity 1-4 can start as early as hour 0 or as late as hour 3. If it starts at hour 0 (*earliest start*) it will finish at hour 2 (*earliest finish*). If it starts at hour 3 (*latest start*) it will finish at hour 5 (*latest finish*). Activity 1-4 is said to have 3 hours of *float*. We can analyse each of the activities in the network in the same way and prepare a table:

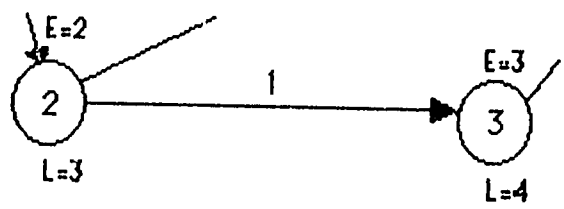
		START		FINISH		
ACTIVITY	DURATION	EARLIEST	LATEST	EARLIEST	LATEST	FLOAT
1-2	2	0	0	2	2	0*
1-4	2	0	3	2	5	3
2-3	1	2	3	3	4	1
2-4	3	2	2	5	5	0*
3-4	1	3	4	4	5	1

*NOTE THAT ACTIVITIES ON THE CRITICAL PATH HAVE NO FLOAT.

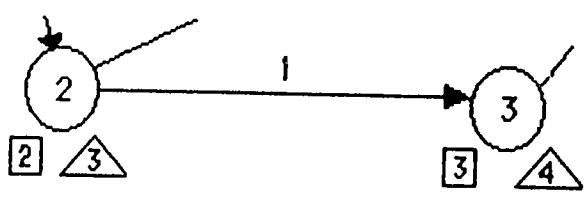
This information can be shown on the network diagram in several ways. Each of the ways shown below uses the earliest and latest event time. The earliest event time is the earliest time at which the event can occur. It is the same as the earliest finish for the preceding activity (the activity leading into the event). If there is more than one activity leading into an event, the later earliest finish is the earliest event time.

In our network, event 2 is preceded by activity 1-2 which has as it's earliest finish; 2. Earliest event time for event 2 is therefore 2. Event 3 is preceded by activity 2-3 which has as it's earliest finish; 3. Earliest event time for event 3 is therefore 3.

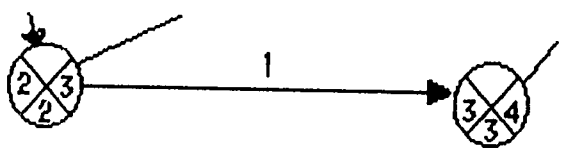
In the figure below, the earliest event time is shown as E, and the latest event time is shown as L.



Here a square encloses the earliest event time, and a triangle encloses the latest event time



The technique below divides the event circle into four sections. The earliest event time appears in the left section. The latest event time appears in the right section. The event number is in the lower section. The top section will be used to record the actual event time during implementation.



At this point the second part of phase II, *scheduling* can be done. That is, calendar dates can be assigned for the various activities and events. In this process, we can take advantage of the knowledge about float that we gained in the analysis. For example, the start and finish times for activities having float can be scheduled to make the most efficient use of resources.

PHASE III CONTROLLING

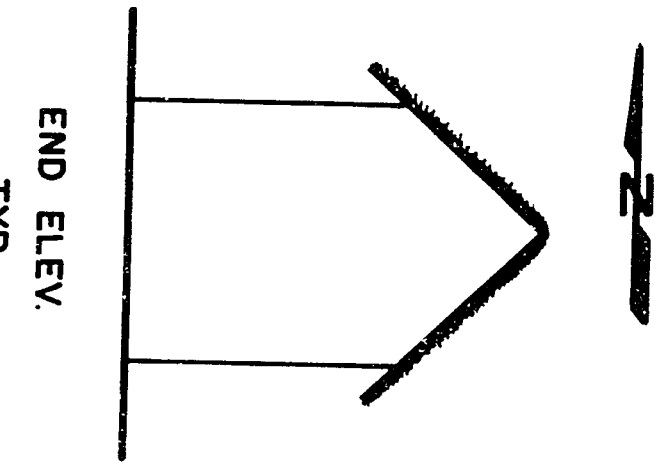
When implementation of the project begins, the plan that was developed during the analysis/scheduling phase becomes a fine instrument for comparing planned to actual progress, and for deciding when and how to take corrective action. If, for example, 2 hours after the project begins, event 2 has not taken place, the entire project will be late. Unless of course activity 2-4 can be speeded-up.

Now that the general principals of CPM have been introduced, we can leave Saili, Maili and Kaili at the airport, and turn our attention to a more practical application of this useful management tool. We will apply CPM to the construction of the small rural building illustrated on page#152

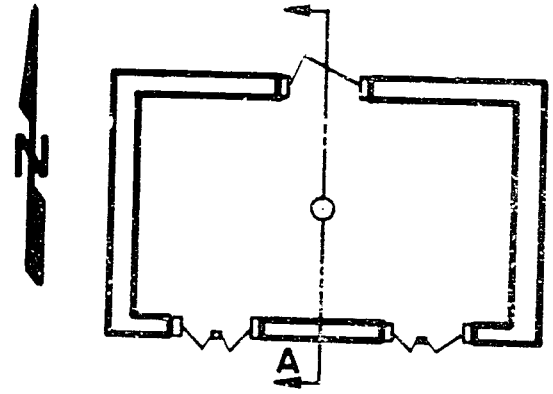
In order to keep the exercise fairly simple, we shall begin our network with the start of physical construction, and assume that the building lines are already laid out, and that all of the materials are at the site. If it had suited our purpose, however, we could have started with project identification, or with the feasibility study, or at <u>any other point</u>.

Throughout this exercise the idea of suiting the network to our purpose should be kept in mind. We shall select activities and events according to the needs of the project and our purposes for drawing the network. It would be possible to include more or less detail if we wished. If the purpose was to analyse a regional building program comprising two hundred similar buildings, this entire building might appear as a single activity with a name like *"Construct Building #108"*. At the opposite extreme, every cubic foot of stone masonry might be considered an activity (if it served some purpose) in which case there would be a great number of activities and events in the network with names like *"Lay cu.ft. #223, Lay cu.ft. #224,* "etc.

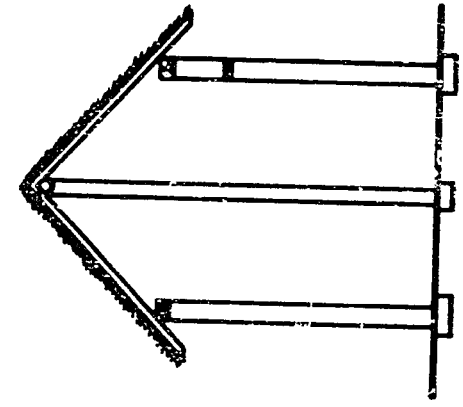
Some people begin to break the project down into it's component activities and events by starting at the final step and asking the question "What was the last thing done to complete the building?" And then asking "What had to be done before that could be done?" And so on, working back to the beginning. Others prefer to start at the beginning and proceed step by step



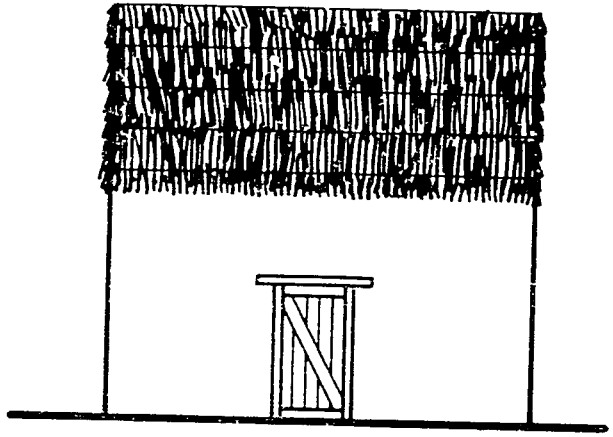
END ELEV.
TYP.



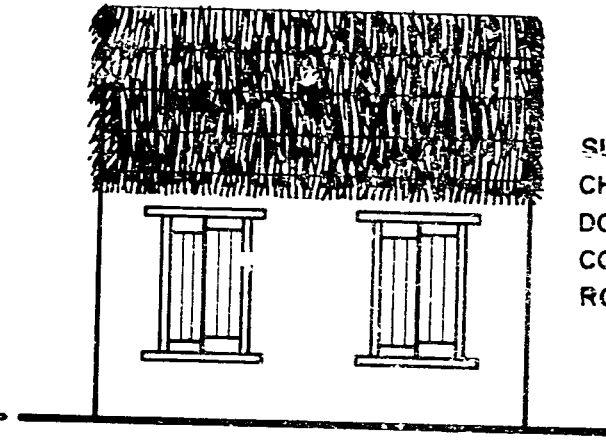
FLOOR PLAN



SECTION AT A-A



NORTH ELEVATION



SOUTH ELEVATION

SPECIFICATIONS:

FOUNDATIONS } RANDOM RUBBLE STONE MASONRY
SUPERSTRUCTURE } IN MUD MORTAR
CHOWKHATS: 3" X 4" SAL WOOD
DOOR & WINDOW. SHUTTERS: 1" SALWOOD
COLUMN: 8" DIA. JUNGLE POLE
ROOF STRUCTURE: { RIDGE: 6" DIA. JUNGLE POLE. RAFTERS: 2" DIA. JUNGLE POLE.
ROOF CLADDING: THATCH OVER SPLIT BAMBOO PURLINS
FLOOR: EARTH. WALL PLATE: 2" X 6" PINE

HOUSE DESIGN

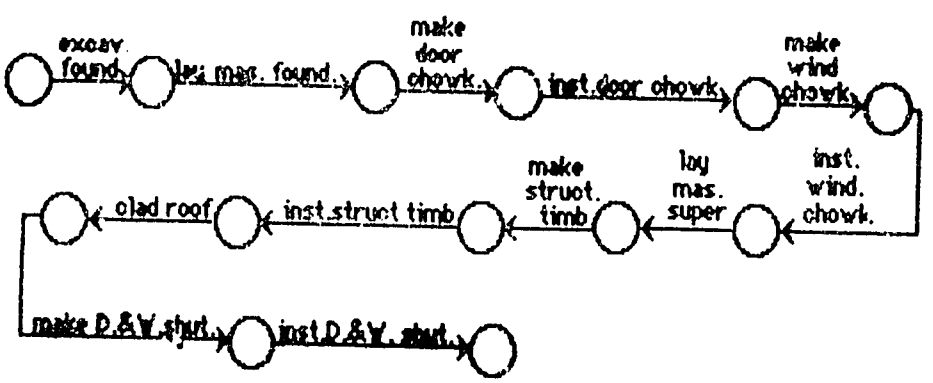
EXAMPLE FOR SCHEDULING EXERCISE

BY: S. SHRESTHA

to the end. Both methods are valid and whichever one is used, the other can be employed as a check. This exercise will start at the beginning, identifying the operations of construction.

OPERATIONS
Excavate Foundation Trenches
Lay Masonry Foundation
Make Door Chowkhat
Install Door Chowkhat
Make Window Chowkhat
Install Window Chowkhat
Lay Masonry Superstructure
Make Structural Timbers
Install Structural Timbers
Clad Roof
Make door and window shutters
Install Door and Window Shutters

When one is satisfied that the major operations have been listed, a rough network (arrow diagram) can be drawn more or less as shown below. This is a first approximation of the network, but it usually must be re-drawn several times before it is accurate.



Arrow Diagram - First Attempt

No careful planning has gone into it. The operations have simply been listed in approximate sequence and shown above activity arrows which emerge from, and end in, events (shown as circles). Since the page is too small to draw the network in a single line, the convention of drawing the

sequence from left to right has been ignored, and the network has been allowed to double back on itself. The sequence of activities is therefore shown by the direction of the arrows only.

By applying the dependency rule of CPM logic, which states that no event can occur until all of the activities leading into it are complete, and that no activity can start until the event that it emerges from has taken place, several errors in the rough network are seen.

A) The third activity, *make door chowkhats* is shown in the diagram above as being dependent on laying the masonry foundation (that is, it can't start until the masonry foundation is complete). We know that this is not true.

B) The fifth activity, *make window chowkhats* is shown as being dependent on the fourth, *install door chowkhat*. This too is not true.

C) The relationship between the sixth and seventh activities, *install window chowkhats* and *lay masonry superstructure* is not correct because although the superstructure can't be completed until the window chowkhats are installed; the window chowkhats can't be installed until the superstructure has been started and laid up to sill level.

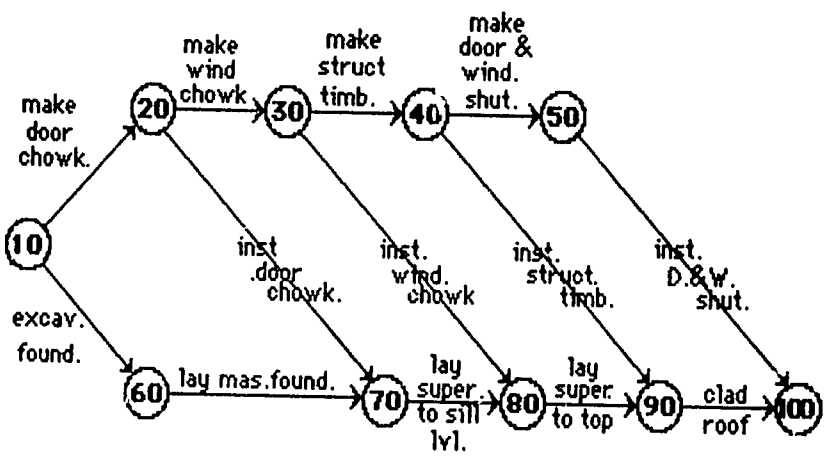
D) The eighth activity, *make structural timbers* is incorrectly shown as being dependent on the seventh, *lay masonry superstructure*.

E) The eleventh and twelfth activities, *make door & window shutters* and *install door & window shutters* are shown as being dependent on the tenth *clad roof* which is not true.

Most of these false dependencies result from two separate resources being shown as a single chain: 1) the masonry/general construction gang and 2) the carpentry gang. So long as a single chain is used, activities can

only be shown as following one after the other. It is usually not worth trying to make the first arrow diagram completely correct, especially when one is inexperienced in the method. It is more useful to get <u>something</u> down on paper in order to overcome the resistance to drawing the network which most beginners experience.

The events are not numbered in the first rough arrow diagram. In the second attempt, below, numbers are entered, but note that there is a gap between the numbers used. This is done so that if it is realised later that an activity or event has been forgotten (which often happens) each event will not have to be re-numbered. A new number can simply be inserted. Notice how the five errors in the first attempt to draw the network have been corrected in the second.



Arrow Diagram - Second Attempt

In this second attempt to draw the network an additional activity has been added. By dividing the original activity *lay masonry superstructure*, into the two activities *lay masonry superstructure to sill level* and *lay masonry superstructure to top,* the total number of activities has been increased from twelve to thirteen.

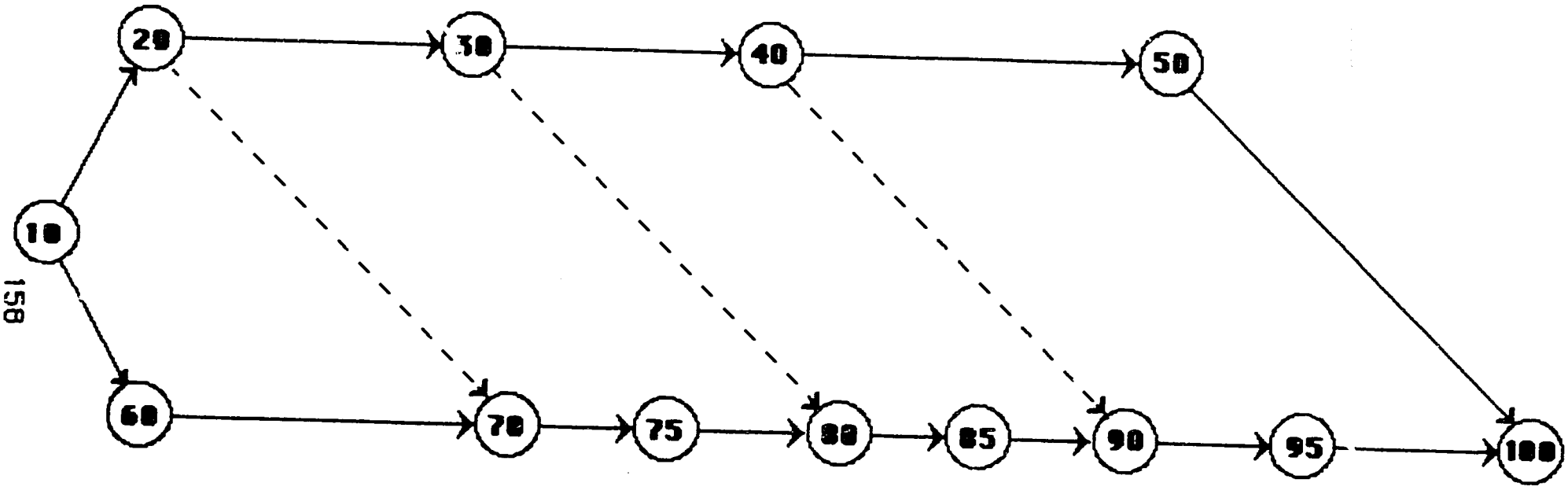
Since the events are now numbered, activities can be referred to by number rather than by name. The event that has been referred to as *excavate foundation* up to this point, can now be called 10-60. *Clad roof* can be called 90-100, and so on for each activity. The event that an arrow emerges from is known as it's tail event. The event that the arrow leads into is known as it's head event. Thus, event 90-100 has event 90 as it's tail event and event 100 as it's head event.

The arrow diagram is now examined again to see if it correctly represents the process. The dependency rule is applied; no event can occur until all activities leading into it are complete, and no activity can start until it's tail event has occurred. The rule implies that an activity can begin as soon as it's tail event has occurred (although it doesn't have to begin as soon as it's tail event has occurred). This means that according to the way the network has been drawn in the second attempt, activity 20-70 could start as soon as event 20 had occurred. That is, *install door chowkhat* could start as soon as *make door chowkhat* was complete. In fact, this is not true, since the door chowkhat can't be installed until at least some portion of the foundation masonry is complete. To represent the situation correctly, *install door chowkhat* must be shown to be dependent on both 10-20 and on 60-70.

Further examination shows that activities 30-80 and 40-90 contain the same error as 20-70 does. That is, they can not start as soon as their tail events have occurred (as drawn in the second attempt to show the network). A third attempt to represent the construction process accurately is shown on page*158. Activity names are not written on the arrows, instead, the list on page*157 should be used.

ACTIVITY DEFINITIONS:

Number	Description
10-20	make door chowkhat
10-60	excavate foundation trenches
20-30	make window chowkhats
20-70	dummy
30-40	make structural timbers
30-80	dummy
40-50	make door and window shutters
40-90	dummy
50-100	install door and window shutters
60-70	lay masonry foundations
70-75	install door chowkhat
75-80	lay masonry superstructure to sill level
80-85	install window chowkhats
85-90	lay masonry superstructure to top
90-95	install structural timbers
95-100	clad roof

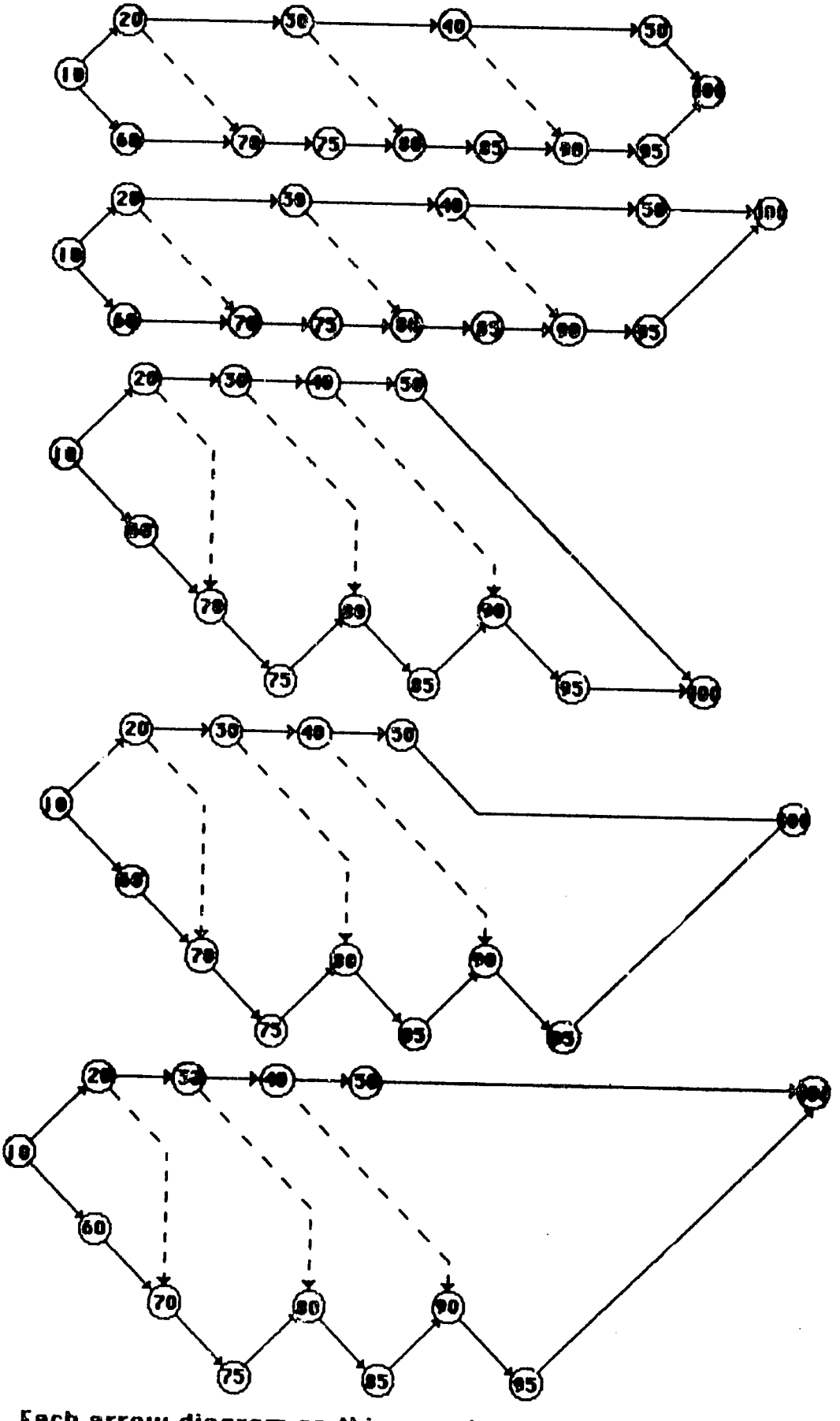


Arrow Diagram - Third Attempt

At first it may seem inconvenient not having activity names written on the arrows, but one soon becomes familiar enough with the network not to need them. It is far more inconvenient to have to write out the name each time the arrow diagram is re-drawn. The written names also tend to clutter up a network which contains thirty or more activities.

The third drawing of the network contains three broken activity arrows: 20-70, 30-80 and 40-90. These are noted on the *activity definitions list* on page*157. as *dummy*. The dummy is used here to show dependency. Activity 70-75 can't start until event 20 has occurred. Activity 80-85 can't start until event 30 has occurred. And activity 90-95 can't start until event 40 has occurred. No resources are used in the dummies, and for that reason, they are not activities. They are conventions that are used to maintain the logic of the network. When dummies are used in this way they are called logic dummies.

Since application of the logic rules reveals that this third attempt to draw the network is a correct representation of the construction process, it can be used as the basis for the next steps. Before going on to these steps, however, it is worth noting that the network could have been drawn in other ways which would have been equally correct. Some of these are shown on page*160. If they are compared to the arrow diagram on the previous page, it will be seen that all of them satisfy the requirements of network logic equally.



Each arrow diagram on this page is a valid representation of the same network.

When the word *time* is used in connection with critical path method, or network analysis, it usually refers to a specific day or date. The word *duration* is used for the number of hours, days, weeks, etc. required to complete an activity. An activity that will take three days to complete from start to finish is said to have a *duration* of three days.

Durations for activities are estimated in various ways. Work measurement may be employed, (*see the section on Work Measurement elsewhere in this manual*) historical data or personal experience can be used, or standard references may be consulted. Since no system can yield good results if incorrect data is fed into it, care must be taken that <u>realistic duration times</u> are used. The most probable duration is somewhere between the optimistic and the pessimistic views.

Duration estimates must be consistent with the resources available (*see On Site Construction Management, Work Measurement, and Productivity Standards elsewhere in this manual*) and the <u>levels of resources used in estimating activity durations must be recorded and communicated</u> or the site in charge will not have the information required to maintain the schedule that will be developed from these duration estimates. Remember:

$$\text{number of men (or gangs)} = \frac{\text{quantity of work}}{\text{time} \times \text{output per man (or gang)}}$$

Or

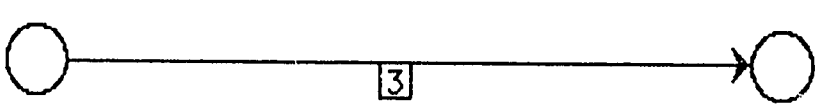
$$\text{time} = \frac{\text{quantity of work}}{\text{no. of men (gangs)} \times \text{output per man (gang)}}$$

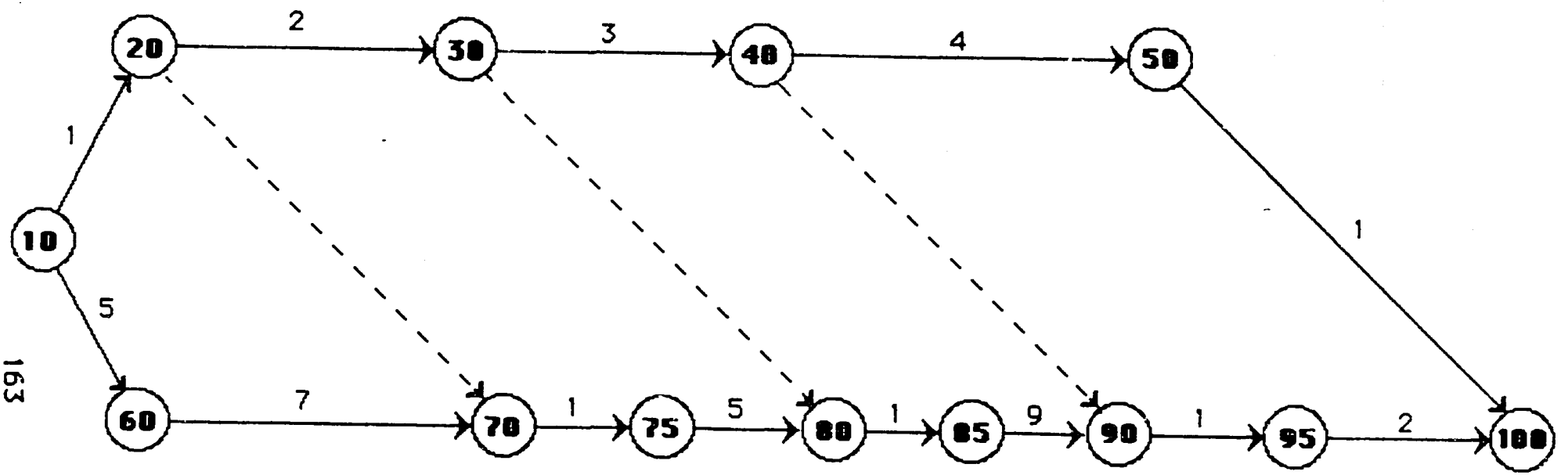
The durations noted below will be used in this example.

ACTIVITY DURATIONS:

Number	Description	Duration
10-20	make door chowkhat	1 day
10-60	excavate foundation trenches	5 days
20-30	make window chowkhats	2 days
20-70	dummy	XXXXXX
30-40	make structural timbers	3 days
30-80	dummy	XXXXXX
40-50	make door and window shutters	4 days
40-90	dummy	XXXXXX
50-100	install door and window shutters	1 days
60-70	lay masonry foundations	7 days
70-75	install door chowkhat	1 days
75-80	lay masonry superstructure to sill level	5 days
80-85	install window chowkhats	1 days
85-90	lay masonry superstructure to top	9 days
90-95	install structural timbers	1 days
95-100	clad roof	2 days

These durations are entered onto the network above the activity arrow as shown on the following page. An alternative method of noting duration, by showing it in a box under the arrow, is illustrated below.





Network
(Arrow Diagram)
with durations noted above activity arrows
(Note that since dummies take no time
they have no duration)

The planning phase is complete for the time being. Developments in later phases may require that changes in the plan be made, and possibly that the network be re-drawn.

The second phase, analysing/scheduling now begins with the question "How long will the total project take?". Which is another way of saying "What is the earliest time by which event 100 can occur?". In order to answer the question, it will be necessary to start with event 100 and trace back along each path that leads into it. The total durations of all of the activities on the path that takes the longest to complete will be the earliest event time for event 100.

Five paths lead into event 100.

Let the path: 10-20-30-40-50-100 be called path A.

Let the path: 10-60-70-75-80-85-90-95-100 be called path B.

Let the path: 10-20-70-75-80-85-90-95-100 be called path C.

Let the path: 10-20-30-80-85-90-95-100 be called path D.

Let the path: 10-20-30-40-90-95-100 be called path E.

Path A has five activities*; durations are: 1+2+3+4+1=11 days.

Path B has eight activities; durations are: 5+7+1+5+1+9+1+2=31 days.

Path C has eight activities; durations are: 1+0+1+5+1+9+1+2=20 days.

Path D has seven activities; durations are: 1+2+0+1+9+1+2=16 days.

Path E has six activities; durations are: 1+2+3+0+1+2=9 days

*Dummies are not really activities, the term is applied to them here for convenience only.

PATH B IS THE CRITICAL PATH, therefore, the earliest possible time for completion of the entire project (earliest event time for event 100) is day 31. If this was considered unacceptably long, the next step would be to return to the planning stage and look for ways of reducing the duration of activities along path B. This might be done by allocating more resources like additional gangs of masons or more laborers to assist the existing gangs. It should be noted that if the total duration of path B was ever reduced to eleven days or less, path A would become critical. It is possible to have more than one critical path through a network.

The next step in analysing the network is finding the earliest and latest times at which events can occur. Event 10-20 can start no earlier than 0, which is the beginning of day 1. (Note that when an event is said to take place on day 1, or day 3, or any day, it should be understood as meaning the end of that day. For this reason, the first event, which occurs when work begins is said to occur at 0.) The earliest start for activities which have event 10 as their tail event (ie. activities 10-20 and 10-60) is 0, although they do not both have to be started at 0.

The earliest event time is found by adding up the duration of all the activities in the longest chain leading into an event. Event 20 has one activity leading into it, activity 10-20 which has a duration of 1 day; therefore the earliest time at which event 20 can take place is day 1.

If the duration of activity 20-30 (2 days) is added to the duration of activity 10-20 the earliest event time for event 30 is found: 1+2=day 3.

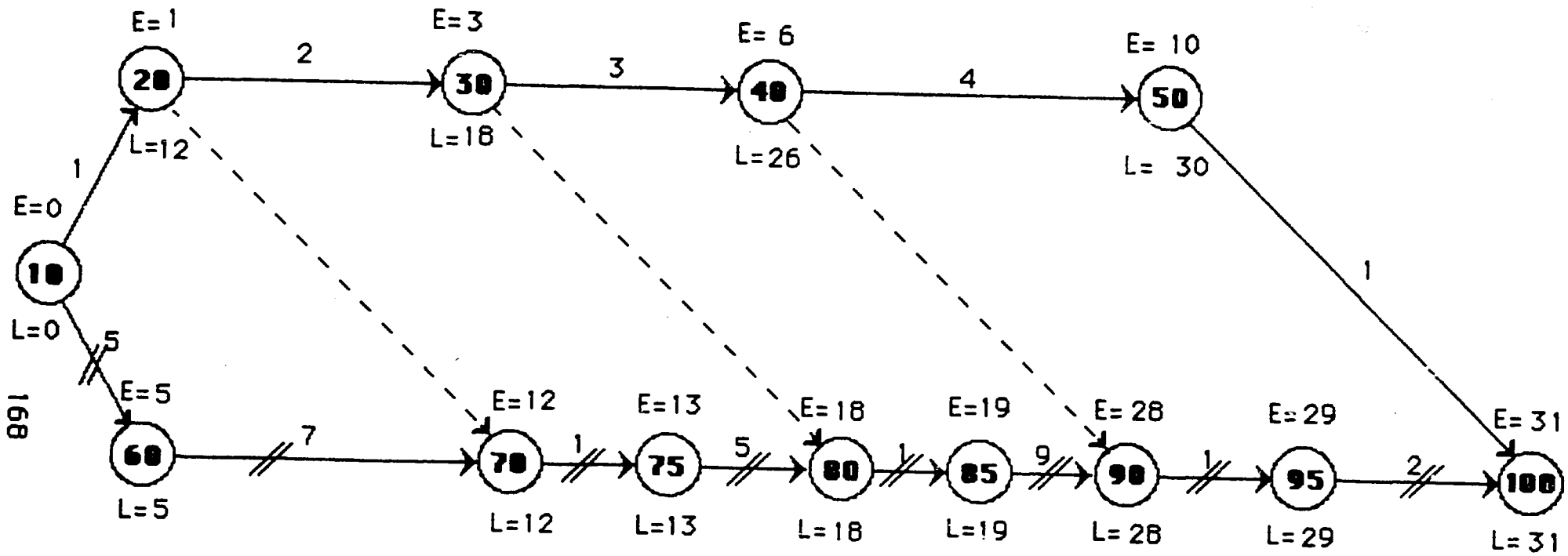
Add to this the duration of activity 30-40 (3 days) to find earliest event time for event 40; day 6.

It must be remembered that if an event has more than one chain leading into it, the chain that has the longest duration will determine the earliest event time. In the case of event 100 the chain with the longest duration was path B rather than path A, C or D. As a second illustration of this, look at event 70. Two chains lead into it. The chain 10-20-70 has a duration of one day (remember that a dummy has no duration). The chain 10-60-70 has a duration of 5+7=12 days. This longest chain determines the earliest event time for event 70.

The latest event time is the latest time at which an event can occur without affecting the total project time (as established in the planning phase). To find the latest event times start with the last event in the network and subtract the duration of of each activity leading into it. This will give the latest event time for the tail events of those activities.

In the case of the building construction that we have been examining, event 100 has an event time of day 31. Activity 95-100 has a duration of 2 days; 31-2 = day 29. Unless event 95 occurs by day 29 at the latest, the project can't finish by day 31. By subtracting the duration of activity 90-95 (1 day) the latest event time for event 90 is found: 29 - 1 = day 28. Note that the critical path lies along those activities whose earliest and latest times for head events and tail events are the same, and whose duration times are equal to the difference between the head and tail event times (both tests must be applied to identify the critical path).

Event 40 has two activities leading out of it. <u>In such cases, it is the longest chain that determines the latest event time.</u> The chain 100-50-40 has a total duration of 1+4 = 5. The chain 100-95-90-40 has a total duration of 2+1+0 = 3. Therefore, the chain 100-50-40 determines the latest event time for event 40. The duration of that chain, subtracted from the event time for event 100 (31 - 5 = 26) gives the latest event time for event 40. If the shorter chain were used, the result would be 31 - 3 = day 28. If event 40 didn't occur until that time, the chain 40-50-100 (which has a duration of 5 days) couldn't be completed before day 33, causing project completion to be 2 days late. Earliest event time "E" and latest event time "L" are noted on the network that appears on page #168.



Network
(Arrow Diagram)

showing earliest and latest event times

durations are noted above activity arrows

activities on critical path are shown thus: //

From the earliest and latest event times, the earliest and latest start and the earliest and latest finish can be derived for each activity. The earliest start for an activity is the moment that it's tail event occurs. The earliest finish is the earliest start plus the duration of the activity. The earliest possible start for activity 20-30 is the earliest event time for it's tail event (event 20) which is day 1. The earliest finish is day 1 plus the activity duration of 2 days or day 3.

The latest start for an activity is the latest event time of it's head event minus the duration of the activity. ,The latest possible start for activity 20-30 is the latest event time for it's head event (event 30) minus the activity duration or 18 - 2 = day 16.

The latest possible finish for an activity is the latest possible event time of it's head event.

When the earliest and latest starts and finishes for each activity in the network are known, it will be possible to calculate the amount of float possessed by each activity. Float is the manager's area of freedom. Activities possessing float can be scheduled to start and finish anywhere within their period of float. Activity 10-20 must be complete by day 12 at the latest and can start as early as 0. Since the duration of the activity is only one day, this activity has 11 days of float. We could say that <u>float is the time available for an activity in excess of it's duration.</u>

Earliest and latest starts and finishes for the activities in the sample network are shown in the table on page 170.

ACTIVITY	DURATION	START EARLIEST	START LATEST	FINISH EARLIEST	FINISH LATEST	FLOAT
10-20	1	0	11	1	12	11
10-60	5	0	0	5	5	0
20-30	2	1	16	3	18	15
20-70	0	X	X	X	X	X
30-40	3	3	23	6	26	20
30-80	0	X	X	X	X	X
40-50	4	6	26	10	30	20
40-90	0	X	X	X	X	X
50-100	1	10	30	11	31	20
60-70	7	5	5	12	12	0
70-75	1	12	12	13	13	0
75-80	5	13	13	18	18	0
80-85	1	18	18	19	19	0
85-90	9	19	19	28	28	0
90-95	1	28	28	29	29	0
95-100	2	29	29	31	31	0

With the analysis of the network more or less complete, it is useful to re-examine the decisions taken during the planning phase in the light of the results of the analysis. The network contains a number of decisions about the way in which the work will be carried out. Some of these decisions were taken with awareness of their consequences. Others were perhaps made without even noticing that they were decisions; which is to say that they were not really decisions, but assumptions about the way the work would be carried out that were accepted without question.

The decision to employ two gangs, one for masonry and general construction, and another for carpentry, was taken with awareness of the way in which different mistris work. On the other hand, a look at activity 50-100, shows that this activity *install door and window shutters* can take place as soon as the shutters are made. The earliest start for the activity is day 10. If the door and window shutters are installed on day 10 though, the chowkhats that they are attached to will not have been mounted in the walls of the building, since the earliest start for activity 70-75 *install door chowkhat* isn't until day 12.

Although it is possible to pre-hang door and window shutters, and mount the pre-hung unit in a wall; special precautions (such as cross bracing) must be taken if this done, to insure that the chowkhat does not deform.

The shutters must also be protected from damage during construction. Under different conditions it might or might not be desirable to pre-hang the shutters.

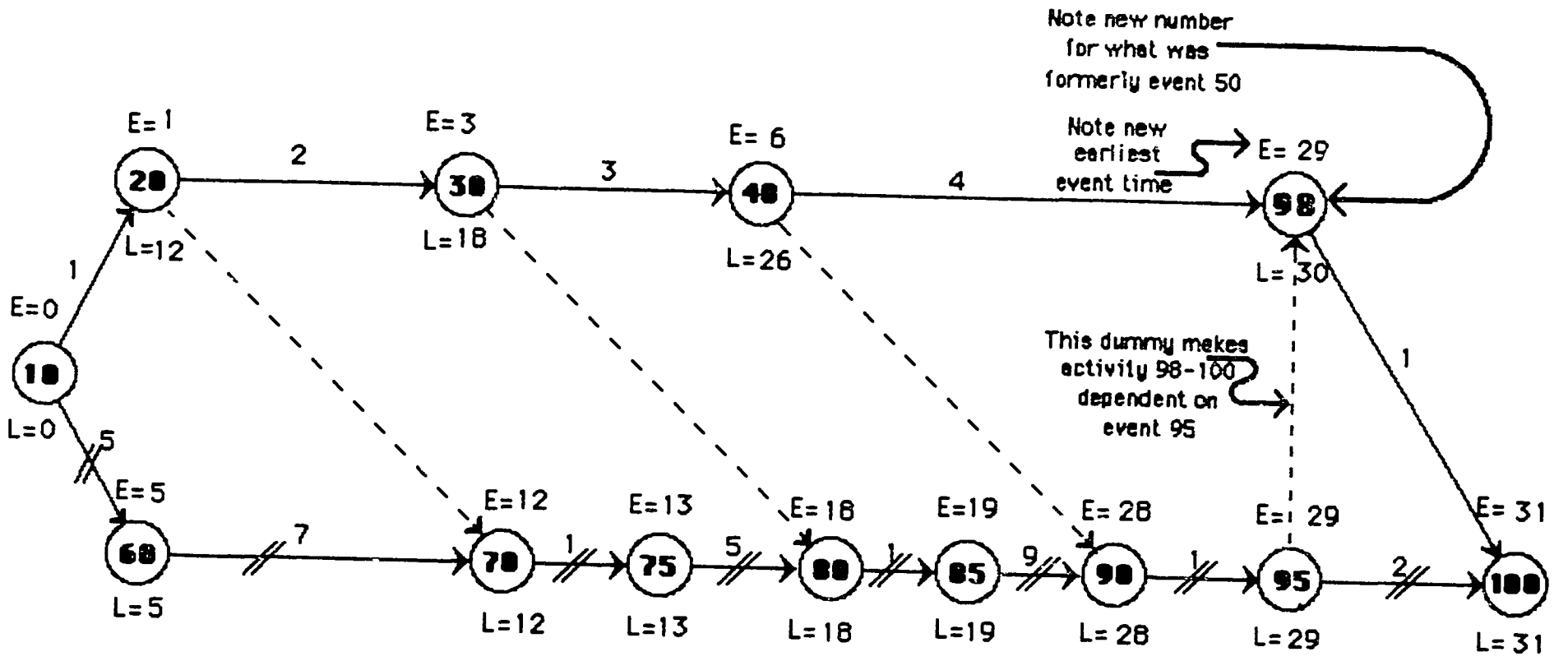
If it were important that the carpentry gang begin work at another site as soon as possible, it might be decided to pre-hang the shutters so that event 50 could take place at it's earliest possible time (day 10) after which the carpentry gang could leave. The cost of protecting the chowkhats and shutters might be less than the cost of delaying work at another site. On the other hand, there might be no need to pre-hang the shutters, and since doing so would involve unnecessary cost or damage to the work, it might be advisable to eliminate the float possessed by activity 50-100.

The major constraints are:
A) the need to complete the activity by day 31 (which means that work would have to start at day 30 at the latest) and
B) the need to avoid extra costs or damage to the woodwork. Which means that the mesonry ought to be as dry as possible and that as little work as possible ought to take place after hanging the shutters.

Ideally then, *install door and window shutters* would take place after the structural timbers had been installed (since that operation will involve moving large timbers into the building as well as scaffold material). This means that it must begin after event 95 which takes place on day 29. Since *install door and window shutters* has a duration of only 1 day, it can be completed before day 31.

The network would be re-drawn to show the activity *install door and window shutters* as being dependent on activity 90-95 *install structural timbers*. A dummy "activity" 95-50 will emerge from event 95 and lead into event 50. This indicates that event 95 must occur before event 50 can occur. Since event 95 has an earliest event time of day 29, the installation of shutters has been prevented from happening before that day.

Because of the convention which states that an activity's head event must have a higher number than it's tail event; event 50 will have to be assigned a new number between 95 and 100. This complicated sounding adjustment in the plan will be seen to be fairly simple when the adjusted network on page* 172 is compared to the network that we have been using.



Network
(Arrow Diagram)

adjusted to delay installation
of door & window shutters

In the scheduling phase, calendar dates are assigned to events and activities. The schedule may be transferred to a bar chart in order to communicate with people who don't read networks, but a bar chart won't show the critical path, it won't show float, and it has several other disadvantages when compared to the network diagram. You will have to make a point of informing the site-in charge about these details, unless of course you had the good sense to let him work on the schedule with you.

This discussion has presented only the barest essentials of CPM. (Refer to the bibliography at the end of this manual for a source of more detailed information.) If the three concepts of DEPENDANCY, FLOAT, and THE CRITICAL PATH are understood and integrated into a manager's thinking, his ability to work with schedules will be vastly improved.

Of course the examples used to illustrate these concepts were over-simplified. The real value of CPM will be seen when you apply it in more complex situations.

RIRDP STANDARD SCHEDULING FORMATS

The Rapti Integrated Rural Development Project has overcome some of the limitations of the bar chart by developing four separate scheduling formats, each of which deals with a different aspect of scheduling. The *Scheduling and Budgeting Format* makes it possible to show the cost of major steps in construction in relation to the time schedule. This is very useful for planning cash flow and monitoring costs. The *Implementation Time Schedule* is a bar chart which divides the time line into both weeks and trimesters. This simplifies the task of

correlating it with other time frames. *The Materials Transportation Schedule* insures that special attention is given to moving materials out to construction sites. This is very appropriate in the high hills of Nepal where the supply of materials must be watched especially closely. The *Trimesterly Workplan* is a tool for scheduling the activities of personnel. It is useful for co-ordinating the work of individuals, and assisting them to plan their time productively.

ONE FINAL WORD ABOUT SCHEDULES

Since we are human, we can't see into the future, therefore our schedules always suffer from the effects of unforeseeable accidental occurrences. Because we are human, though, we have the intelligence to realise this, and to plan accordingly.

A <u>contingency</u> is a possible, unforeseen, or accidental occurrence. Any realistic schedule must contain some provision for contingencies. <u>Any schedule that doesn't contain such a provision must be considered unrealistic, regardless of how good it is in other respects.</u>

The extra time that must be allowed in a schedule for unforeseen accidents depends on the specific details of the work, the site, the season and many other factors. These have to be weighed for each schedule. As a general principle, a minimum of ten percent of the total project duration may be added on, to allow for contingencies.

BIBLIOGRAPHY

This is a list of books that may be of interest to: managers, administrators, engineers, District Technical Officers and other personnel concerned with the implementation of construction in Nepal. Books are also mentioned which may be of use to trainers and facilitators conducting training programs in construction management and related subjects in Nepal.

Titles marked - Δ are rated by the author as USEFUL to personnel managing construction projects.

Titles marked - □ are rated by the author as VERY USEFUL to personnel managing construction projects.

Titles marked - ' are rated by the author as useful to persons conducting training programs.

Bold Type - is used to denote those books which the author considers outstanding because of some unique quality.

Unmarked titles contain valuable material but tend to be less directly useful under local conditions.

Gilbreth, R.D., *MANAGING CONSTRUCTION CONTRACTS*, N.Y., John Wiley & Sons, 1983 □'
(This is the best introductory book on contract management that I know of.)

HANDBOOK FOR CLERKS OF WORKS (2ND EDITION), Greater London Council Dept. of Architecture & Civic Design, Lond., The Architectural Press, 1979. Δ'

THE CONSTRUCTION INDUSTRY IN ASIA: A SURVEY, Tokyo, Asian Productivity Org., 1983. '

STANDARD FORM OF BUILDING CONTRACT, 1980 EDITION, LOCAL AUTHORITIES WITH QUANTITIES, CONDITIONS ONLY, Joint Contracts Tribunal for the Standard Form of Building Contract, Lond., RIBA Publications Ltd., 1980. □'

Davies, I. K., *THE ORGANIZATION OF TRAINING*, Maidenhead, Berkshire, McGraw-Hill UK Ltd., 1973. '

Khanna, P. N., *INDIAN PRACTICAL CIVIL ENGINEERS' HANDBOOK*, New Delhi, Engineers' Publishers, 1984. □'
[In this price range (less than NC Rs.90.-) there is probably no better day to day technical reference for use on the sub-continent]

Srinivasan, A. V., *CRITICAL PATH ANALYSIS*, New Delhi, East-West Press, 1976.

Lockyer, K. G., *AN INTRODUCTION TO CRITICAL PATH ANALYSIS*, Lond., Pitman, 1979 □'
[The best introduction to CPM that I know of]

Calvert, R. E., *INTRODUCTION TO BUILDING MANAGEMENT (4TH EDITION)*, Lond., Butterworths, 1981 □'
[This is the classic general work on construction management if you can afford only one such book, this is the one to choose]

Oxley, R. & Poskitt, J., *MANAGEMENT TECHNIQUES APPLIED TO THE CONSTRUCTION INDUSTRY (3RD EDITION)*, Lond., Grenada Publishing, 1980. Δ'

Pilcher, R., *PRINCIPLES OF CONSTRUCTION MANAGEMENT (2ND EDITION)*,
Maidenhead, Berkshire, McGraw-Hill UK Ltd., 1976. Δ'

McNulty, A.P., *MANAGEMENT OF SMALL CONSTRUCTION PROJECTS*,
N.Y., McGraw-Hill, 1982

Gobourne, J., *SITE COST CONTROL IN THE CONSTRUCTION INDUSTRY*,
Lond., Butterworths, 1982

Wood, R. D., *PRINCIPLES OF ESTIMATING (6TH EDITION)*,
Lond., The Estates Gazette Ltd., 1982

Turner, D. F., *QUANTITY SURVEYING PRACTICE AND ADMINISTRATION (3RD EDITION)*,
N.Y., Longman Inc., 1983.

Boch-Isaacson, J. M., *THE MANAGEMENT OF ARCHITECTURAL AND BUILDING PROJECTS IN THE HIGHLAND AND REMOTE AREAS OF NEPAL*,
Kathmandu, Canadian Mission to Nepal, 1985. Δ'

Seeley, I. H., *BUILDING QUANTITIES EXPLAINED (3RD EDITION)*,
Lond., The MacMillan Press Ltd., 1982.

Stokes, M., *INTERNATIONAL CONSTRUCTION CONTRACTS (2ND EDITION)*,
N.Y., McGraw-Hill, 1981.

Davis, L. N., *PLANNING, CONDUCTING, AND EVALUATING WORKSHOPS*,
Austin, Texas, Learning Concepts Inc.,

Lassey, W. R. and Fernandez, R. R., *LEADERSHIP AND SOCIAL CHANGE*,
San Diego, Ca., University Associates Inc.

Boshear, W. C. and Albrecht, K. G., *UNDERSTANDING PEOPLE, MODELS AND CONCEPTS*,
San Diego, Ca., University Associates Inc., 1977. Δ'

Pfeiffer and Heslin and Jones, *INSTRUMENTATION IN HUMAN RELATIONS TRAINING*,
San Diego, Ca., University Associates Inc., 1976.

Maier, and Solem, and Maier, *THE ROLE PLAY TECHNIQUE: A HANDBOOK FOR MANAGEMENT AND LEADERSHIP PRACTICE*,
San Diego, Ca., University Associates Inc., 1975.

Shaw, and Corsini, and Blake, and Mouton, *ROLE PLAYING: A MANUAL FOR GROUP FACILITATORS*,
San Diego, Ca., University Associates Inc., 1980.

Dellinger, S., and Deane, B., *COMMUNICATING EFFECTIVELY, A COMPLETE GUIDE FOR BETTER MANAGING*,
Radnor, Pa., USA, Chilton Book Co., 1980. Δ'
[Clear and thorough treatment of the subject]

Goad, T. W., *DELIVERING EFFECTIVE TRAINING*,
San Diego, Ca., University Associates Inc., 1982.
[A methodical 5 step approach to training]

APPENDIX 1

QUANTITIES OF WATER AND AGGREGATE PER 1 BAG (50 kg.) OF CEMENT

WATER QUANTITIES ARE FOR HAND COMPACTED CONCRETE.
IF MECHANICAL VIBRATOR IS USED THE QUANTITY OF WATER MAY BE REDUCED BY ABOUT 20 PERCENT

MIX RATIO	WATER IN LITRES	FINE AGGREGATE IN LITRES	COARSE AGGREGATE IN LITRES
1:1:2	**21 to 27**	35.0	70.0
1:1 1/2 : 3	**26 to 30**	52.5	105.0
1:2:4	**29 to 32**	70.0	140.0
1:3:6	**34 to 36**	105.0	210.0
1:4:8	**45 to 47**	140.0	280.0

NOTE: 1. If the sand is wet: 1. Increase sand quantity by 25%
and 2. reduce water quantity by 20%.

NOTE: 2. THE WATER REQUIREMENTS GIVEN ABOVE ARE FOR MIXING CONCRETE ONLY. ADDITIONAL WATER WILL BE REQUIRED FOR MOIST CURING.

STRENGTH REQUIREMENTS OF ORDINARY CONCRETE- in kg./cm.^{2}

GRADE OF CONCRETE	MIX RATIO	CRUSHING STRENGTH	
		7 DAYS	10 DAYS
M 100	1 : 3: 6	70	100
M 150	1 : 2: 4	100	150
M 200	1 : 1-1/2 : 3	135	200
M 250	1 ; 1 ; 2	170	250

Source of information: P.N. KHANNA, *INDIAN PRACTICAL CIVIL ENGINEERS' HANDBOOK(NINTH EDITION)*, New Delhi, Engineers' Publishers, 1984, pp. 8/25, 8/106.