OCTOBER 1987

NSRP #0276

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

BASIC PRINCIPLES OF INDUSTRIAL ENGINEERING

U.S. DEPARTMENT OF TRANSPORTATION
Maritime Administration
& U.S. NAVY

in cooperation with
National Steel and Shipbuilding Company

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
OCT 1987	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The National Shipbuilding Research Program, Basic Principles of Industrial Engineering	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Building 192 Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**190**	

BASIC PRINCIPLES
OF
INDUSTRIAL ENGINEERING

In three Parts:

Part I	What is Industrial Engineering
Part II	Operational Questions for Industrial Engineers
Part III	Communicating your Ideas

Prepared especially for

SNAME PANEL SP-8 ON INDUSTRIAL ENGINEERING

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

By

STANDARDS, INTERNATIONAL INC.

Chicago, Illinois

PART I

WHAT IS INDUSTRIAL ENGINEERING

TABLE OF CONTENTS

SECTION 1

DEFINITION OF INDUSTRIAL ENGINEERING

Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of men, materials, and equipment. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences, together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results to be obtained from such systems. *

* (INSTITUTE OF INDUSTRIAL ENGINEERS)

SECTION II
BENEFITS OF INDUSTRIAL ENGINEERING

BENEFITS FOR THE COMPANY

Industrial Engineering, provides support service for the workers, supervisors, staff, and management. Its assistance helps the company to be competitive in the market place. Through operational analysis, Industrial Engineering assistance will lead to lower costs for producing a quality product.

Once the method for producing a product is specified, standard hours should be applied for performing that particular method. The company, by doing so, will-be able to price its product to meet or beat the competition in the market place. The company must deliver an attractive product. It must do so in time to satisfy customer demand, and be confident the customer is in agreement with the price tag.

In trying to achieve better value for the customer, it is important to have confidence that it will be achieved. The positive attitude that costs are <u>too high</u> and there is something that we <u>can</u> do about it must prevail. Effective action is necessary. Almost everything being produced today is replaceable by something that would perform the same function better at a lower cost.

Industrial Engineering techniques are only tools for achieving <u>better value</u>. No matter what the product,

defining and evaluating the tasks to be accomplished are two of Industrial Engineering's most effective tools. This assistance helps in planning and producing a better product. The company will be in position to stay in business, to satisfy customer and stockholder needs and expand in the marketplace.

BENEFITS FOR THE WORKERS

Once the company is more productive than the competition, demand for its products will increase. With demand, comes job security for the workers, and the feeling they are contributing. A product “wanted by the consumer" can be produced because of their effort.

Job security and job satisfaction are two important motivators or reasons why workers will respond to a particular work task. If they know there is a demand for the product they are producing, they feel secure. This demand will allow for a constant income, a higher standard of living, and development of their particular skills.

Industrial Engineering can contribute to this "feeling of being wanted” by providing the line supervisor with consistent and fair schedules. Workers must know what their job consists of in order to earn their rate of pay. Industrial Engineering can satisfy this need through evaluation of the job and through development of job descriptions. It can also service this need by assisting in job instruction, and specification of methods.

Most workers will be productive workers when attention is paid to their needs.

BENEFITS FOR MANAGEMENT

Be it line supervision, staff, middle or top management, all can benefit through effective Industrial Engineering support and assistance in

1. Identifying where problems are.
   Where is the bottleneck? aren't work schedules being met? What action is necessary to reduce the rework hours. How can we decrease our scrap losses? When can management expect improvement?

2. Recognition of work force requirements.
   Work flow charts, with manning requirements supplied by Industrial Engineering, will enable management to schedule properly.

3. Calculation and reduction of costs.
   Industrial Engineering can be of assistance to management in providing manufacturing routings of parts. It can help assign time values to operations, and specify tools and equipment. This help can be based upon information gained from historical records, reasonable expectancies, regression analyses, appropriate time studies, etc. It is essential that this information be

realistic and clearly explained. Through programs for work simplification, and work participation, it can effectively assist in reducing costs.

4. Selection of Machines and Equipment

The Industrial Engineering Department must communicate upward and downward in providing reports for justifying the selection of machines and equipment. This will assist management in making cost effective decisions in use of its capital.

5. Specifying What the Best Method Is

Work identification and methods engineering go hand in hand. Industrial Engineering uses these "tools" to assist management. The workers, the company and the community benefit because of this assistance.

SECTION III

WHAT IS THE FUNCTION OF INDUSTRIAL ENGINEERING ?

PLANNING AND PRODUCING A PRODUCT

The primary function of industrial engineering is to assist in planning and producing a product. Work identification and methods engineering basically provide the means for industrial engineering to perform this function. Through these means it can analyze the factors involved in the manufacturing system -- land, capital, labor, and management thereof.

Through the many forms of work identification and methods engineering, engineers and production supervisors can assist in managing and controlling the cost of labor. These "tools" of industrial engineering provide assistance for preparing bids, for improving productivity, and for maintaining and controlling production operations. Industrial Engineering can also assist by developing systems for maintaining methods and updating schedules.

Motion economy and methods analysis are used by industrial engineering for effective use of capital. The man-made instruments of production - Materials, Machinery, and Facilities - can be analyzed and-evaluated by industrial engineering. By providing this service, it will assist in the management and control of capital.

Through analysis of the “gifts of nature" -- the surface, above the surface and below the surface -- industrial engineering can provide technical assistance through analysis of materials, Processes, and labor reporting.

DEVELOPING METHODS AND SCHEDULES

A work identification system can be a catalyst and transmission for moving strategic planning for production into high gear." This aid in determining the best way to produce, and how to produce it, will allow for profitability. It can only take place through application of work simplification techniques, through methods specifications, and through efficient application of operational facts for estimating, scheduling, and producing standards.

The need to consider the effect that noise, vibration, stress and climate conditions have on workers, will require analysis and evaluation by industrial engineering. Work methods and schedules must be developed with additives in the form of operating and personal allowances, to compensate for health and safety requirements.

Operating allowances are usually reflective of needs for starting and finishing a work shift. Some consideration is given to protective clothing or equipment worn in regard to the exposure to noise, vibration , and climate or working conditions. Reporting of production during the shift is considered as well as instructions for performing scheduled work. In some operations, there would be allowances for

machine warm up, or maintenance of the workplace, and tool allowances.

Personal allowances primarily consider production delays, interference, stress and recovery, mental and physical demands, and personal needs of the worker. These needs usually include wash ups and utilization of toilet facilities, as well as rest (recovery) breaks.

SUPPLYING FACTUAL DATA FOR FOREMEN/SUPERVISORS

Industrial engineering can assist foremen and supervisors by supplying factual data in setting up the work place. Through the use of motion economy and work simplification techniques, it can provide assistance for the foremen and supervisors. Supervision will use their assistance in determining operational methods and work place layouts for those operations.

Industrial engineering can analyze the work content and required skills necessary to perform a job. By analyzing the work to be performed, it can assist in preventing a “square peg in a round hole" application of labor.

When the foremen, supervisors, and workers are involved with Industrial Engineering in specifying job performance requirements, a reduction of costs can be attributed to team participation. After the preferred method is specified, work schedules can be used for

- setting prices
- planning production
- estimating capacity and manpower

In estimating time and costs, industrial engineering should be certain to “assemble” all of the operational data, materials and information available at the facility. This information should be "tuned" in with factual requirements of the “customer”. The impact of the new product on space and manning requirements, along with machine and equipment availability, must be considered. The department must work closely with supervision, production control, quality control, and product engineering in “assembling” the time and costs.

All employees can contribute to work simplification programs through analysis of what must be done to make a worker’s job easier to perform. Any suggestion by the worker to improve the operation must be reported and identified. This communication of contribution by the worker, can activate significant savings.

To assist the foremen and supervisors in determining and evaluating tooling and facilities requirements, industrial engineering can provide

- multiple activity charts
- man and machine charts
- flow charts
- plant layouts.

The design of any workplace should be in harmony with the required-tasks to be performed by the workers. The design should ensure the workers will be at ease and comfortable in doing their jobs. It must ensure efficient handling of the product with the least amount of effort and time. The design should also take into consideration the means of producing an acceptable quality part. If testing or measurement by the workers is involved, the tools or process equipment must be at a minimum distance.

In evaluating facility and manning requirements, multiple activity charts are helpful in determining the work of scheduling for different crews. A man-machine chart likewise is helpful in planning man and machine work. These charts are helpful in planning and scheduling how the combinations fit together into a working unit.

Flow charts help determine requirements for manning, space and necessary equipment. They are more meaningful when current operational data is available. Industrial engineering can provide space and personnel, and alternates in routings and flow, when it knows which tasks take extra time or are "bottlenecks" .

Plant layout aims at an arrangement of work areas and equipment that will be the most economical to operate. Considerations should be given to

1. material moving a minimum distance
2. work flowing through the plant
3. space effectively utilized
4. satisfaction and safety for employees
5. a flexible arrangement that can be easily readjusted
6. integration of considerations

Industrial engineering can materially enhance its standing in the company by the conduct of its staff. To promote good relationships with line personnel it should

1. Recognize the support role of the department

The industrial engineering department must build confidence, take care not to disparage production efforts, and observe department protocol.

2. Respect line management's prerogative

In its support capacity, industrial engineering must work through line supervision. The supervisor should be contacted before support analyses or studies are undertaken in his or her department.

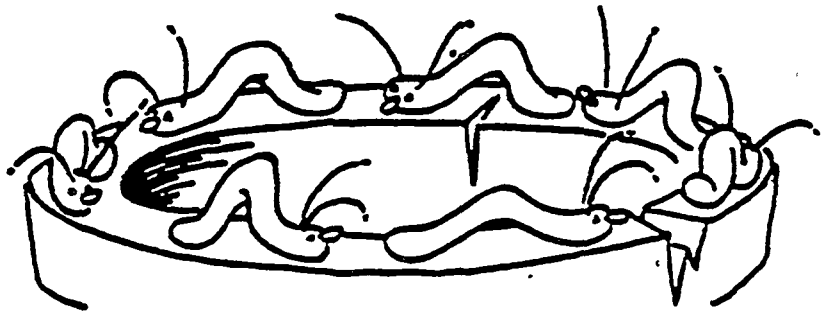
3. Give proper credit for contributions

Industrial engineering should be quick to give others credit for contributing to the development of sound recommendations. Such recognition will enhance its standing. It gives the department a reputation as a catalyst. The department's work will be easier, for operating personnel will come forward with good suggestions.

In making recommendations, industrial engineering should support its elected course of action by sound reasons. It must be certain the proposal submitted offers the best possible solution. Industrial Engineering must never disregard the opinion of line management. It should not lose sight of the fact that its first concern is to strengthen the over-all operations of the company.

SECTION IV

TECHNIQUES USED BY INDUSTRIAL ENGINEERING

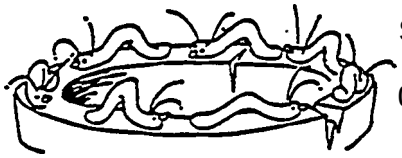


DON'T MISTAKE ACTIVITY FOR ACCOMPLISHMENT

Some of the folks who look and act the busiest, work the hardest, and mean the best, accomplish exactly nothing in the way of progress.

We compare this type of personality to the Processionary Caterpillars --fuzzy insects that feed upon pine needles. These caterpillars move through the trees like follow-the-leader, each one with its eyes half closed and its head snugly fitted against the rear extremity of the comrade ahead.

A naturalist once enticed a squad of these caterpillars to the rim of a flower pot, and managed to get the first one connected up with the last one, thus forming a complete circle, which started moving around and around in a procession with neither beginning nor end.



He expected that after a while the caterpillars would get hep to the situation and start off in some other direction.

An ample supply of food was provided -- just a bit outside the range of the circle.

The caterpillars marched around and around the rim of the pot for seven days and seven nights and would have continued longer except for exhaustion.

They were following instinct - habit - custom - tradition - precedent - STANDARD PRACTICE - PROCEDURE - or whatever you may choose to call it.

They mistook activity for accomplishment.

They meant well and they plugged along against all odds - but they got no place.

A profitable company is usually the result of people within-the company giving a strong, effective push in the direction of improvements. People like you -- people who want to win recognition, and to feel secure in their jobs. Shipbuilding is a highly competitive industry. Your company needs your assistance in reducing costs. It needs your ideas, your common sense, your desire to improve. It needs the best product at the lowest possible cost in order to be competitive.

Work Simplification is a powerful tool you can use for sparking ideas. It is a series of proven, common sense, practical steps that will help you identify opportunities -- opportunities that will not only put your COMPANY in a more favorable, competitive position but these opportunities will put YOU in a more favorable competitive position.

It's something like winning basketball games. Usually after a game is won, the most valuable players are chosen. Players who contributed the most to the victory are recognized. And with each recognition the players feel more secure. They no longer feel they may be cut from the team. This recognition has earned for

them a spot on the first team. And we all know that number one players receive more recognition and are more secure than those who sit on the bench!

Work Simplification is designed to help YOU get that recognition and the SECURITY you want. Because in so doing, you will give your company the PUSH it needs to make a profit and be more competitive in the marketplace.

Let's be sure we all understand that Work Simplification is NOT a speed-up system. It is NOT a new way of getting YOU or those who work for you to work harder or faster. It is the modern method for finding out how to do a job better -- WITH LESS EFFORT!

Most of you are already saying to yourselves: "So what isn't that what everybody is trying to do? I'd like to see someone try these jobs and show me how to make them easier."

Work Simplification will show you where to look for ways to eliminate non-productive effort -- how to find ways of doing a job with LESS effort. When you use this powerful tool, you will be applying your own good common sense to on-the-job problems. And, you will know

how to train those who work for or with you to do the same.

Just because you tried to simplify a job once and failed, don't give up. Failure should only be a challenge to try harder the next time. Just because some in your organization have resisted a change once, don't hesitate to approach them again.

If you have the DESIRE to improve jobs and improve productivity, then YOU CAN IMPROVE JOBS!

Remember that Work Simplification is just as much a human problem as it is a technical problem. If you are going to successfully overcome the resistance of others to your ideas, roll up your sleeves! Show and Tell!

STRESS the fact that you are eliminating unnecessary motions. DEMONSTRATE that you are simplifying difficult, fatiguing motions. SHOW what can be done with less effort. Remember that workers welcome praise and resent criticism. Most people do their best when given a pat on the back -- not criticism.

Above all, be yourself. Use your good old common sense in reviewing any activity you want to improve.

P E O P L E

R E S I S T

C H A N G E

Most folks will agree
that changes and improvements
are needed -
on the other fellow's job!

The greatest obstacle
to Work Simplification
is nothing technical at all -
it is the mental attitude
of people doing **the work -**
who feel that they
are already using
the one best way.

YOU must recognize the fact that it is human nature to -

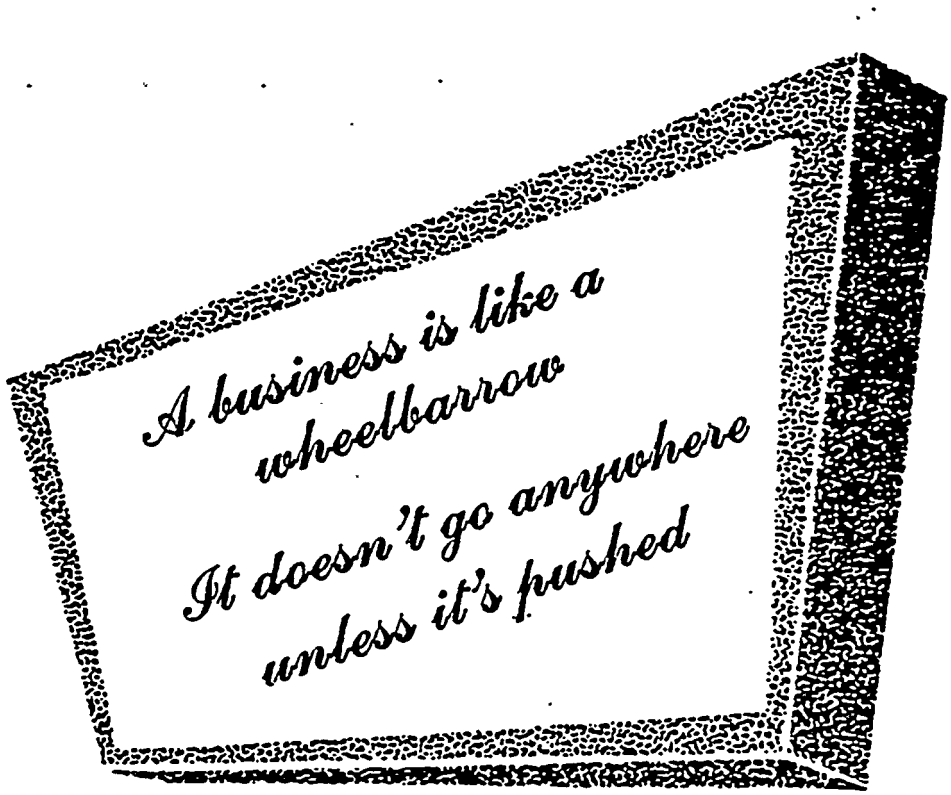
- RESIST CHANGES
- RESIST NEW IDEAS
- RESENT CRITICISM

It is only natural
when a "new idea”
is suggested
to say
"It won't work
we tried it years ago” -
or “It can’t be done".

Regardless of this
we are now doing many things --
SUCCESSFULLY
THAT WERE TRIED AND DISCARDED
ONCE BEFORE.
Times change -
circumstances change -
and an idea,
whether it is new or old,
should never have a door
shut in its face.

Keep your mind open -
reject an idea
only after you
have given it a whirl -
studied it -
tried it out -
changed it around a little -
given a little thought
to see
if the problems it presents
are really problems -
ask some other folks
what they think of it.

so remember now -
don't be a skeptic.
Don't throw up a barrier
of NO ADMISSION
to new ideas.
Try very hard
not to resist changes.



The push comes from the people doing the job who want --

- To win recognition.
- To feel secure in their jobs.

When the people within a company give a strong, effective push - the company makes progress - and profits.

And the people who work for a profitable enterprise have an opportunity to earn more money - win recognition - and feel secure in their jobs.

Some people push a wheelbarrow. . .

the hard way. . .

implification can help you

propelled wheelbarrow. . .

WORK SIMPLIFICATION is designed to help YOU get the

- Promotions,
- Recognition,
- Security

You want --- because in so doing, you will give your Company the push it needs to make progress.

The three best ways of wasting time are:

1. HURRY
2. POOR PLANNING
3. PROCRASTINATION

Let's consider each of these three time killers and see what we can do about them.

Probably the greatest killer, all things considered, is

hurry!

When you hurry at your work you may accomplish nothing. You think you are making speed and accomplishing more. Instead, you may be falling into slipshod ways, and decreasing your output. When you hurry, your mind

and body are kept at a fever pitch of excitement. Accordingly you may perform many useless or unnecessary motions.

It is easy to confuse hurry and speed, believing them to be the same. But there is a great difference between work done at high speed and work done in a hurry. By eliminating all unnecessary motions, you can do perfect work at high speed. Work done in a hurry with many unnecessary motions is often not good work. When we hurry, our work is often slowed up.

Try to eliminate hurry from your program of life. Concentrate on the task at

hand. Eliminate waste motion, and soon you will be able to accomplish twice as much with comparatively little effort.

This difference between work at high speed and work in a hurry is important in Work Simplification and one that many workers do not understand.

If you can make this point clear to. all those who work with you, you will find it extremely helpful.

REMEMBER . . .

ELIMINATE unnecessary motions.

SIMPLIFY difficult motions.

CONCENTRATE on accomplishment, instead of needless hurry.

Poor planning

Victor Hugo wrote:

"He who every morning plans the transactions for the day and follows out that plan, carries a thread that will guide him through the maze of the most busy life.

But where no plan is laid, where the disposal of time is surrendered merely to the chances of incidence, chaos will soon reign".

This is good advice. But say it the modern way -

Plan your work and work your plan

There is no supervisory or executive job that is so routinized that planning is unnecessary or won't improve performance.

Even when the work is highly repetitive, there are improvements in methods, interviews with employees, special reports, changes in procedure, problems to be solved, budgets to be made.

All these should be accomplished on a planned basis. Have some method for planning each day's, week's or month's work-in advance.

RUN THE JOB -DON'T
LET THE JOB RUN YOU.

Everyone has his own method of planning his work. But there are simple and effective ways that can help you in your planning. For example, an Individual Planning Sheet for the coming week helps you schedule

-- AND SIMPLIFY --

your week's work in advance.

And you can see exactly what is being accomplished as the week progresses. This scheduling will require some study of your job.

We've all heard that
procrastination
is the "Thief of time" -
but there is also evidence that procrastination is the cause of that horrible modern condition known as the "Jitters".
We put off things that should be done today -
Tomorrow comes, and our burden of work is doubled.
So - we get the jitters - and the other two time wasters move in on us. The more we think of all the things we haven't time to do, the less we are inclined to do. The burden grows, like a rolling snowball, and gets bigger, Bigger, and BIGGER we go haywire -

We lose our tempers - Have a **tantrum** -And-collapse in a helpless pile.
This is human nature.
PROCRASTINATION is a human failing -
Let's DO something about it.

It's not the work itself that brings nerve strain unless the person is in the wrong job.
If you are on top of your job - if you are running it instead of letting it run you - the heaviest burden can be carried easily and without friction.
It's not work that *causes* trouble, but bad arrangement of tasks and poor budgeting of time. Those who KNOW this - and act accordingly - keep abreast of their obligations and never seem hurried or flustered.

Surely you have noticed that until the people who seem nearest to a nervous breakdown are

often those who have the fewest real responsibilities: These people usually have a tremendous load of worries, regrets, and unsolved problems. Nothing in the world can produce a nervous tension as fast as PROCRASTINATION.

The subconscious mind is conscientious - it protests vehemently against slip-shod work. The protest takes the form of “nerves.."

Eliminate procrastination from your life.

THE BEST WAY TO GET RID OF WORK IS TO DO IT!!!

DO TODAY’S WORK TODAY

Waste steals profits and endangers wages - so elimination,of waste is a major objective.

To eliminate WASTE of energy, and materials, we must pool the intelligence of our whole organization - and it must be an ENTHUSIASTIC organization.

To generate enthusiasm you must be capable of changing an indifferent attitude to an enthusiastic outlook. The ways of doing this vary depending on the individual with whom you are dealing. People display enthusiasm as a result of different stimuli: financial rewards - promotion - pride of accomplishment - "a desire to get in good with the boss.

PRAISE and CRITICISM are the most helpful - and also the most dangerous - weapons at your command for influencing the attitude of those who work with you.

But REMEMBER that it is human nature to WELCOME PRAISE and RESENT CRITICISM. So be sure to praise and criticize FAIRLY - and you can accomplish much.

Most people do their best when given proper encouragement not criticism.

We all welcome the approval of our fellow men - and we all resent criticism. The worst criticism that you can give is to ignore the efforts of those who work with you.

A BIRD'S-EYE VIEW . . .

It is sometimes difficult for a person close to a job to see it in the same way that an outsider does.

That is why a beginner can often ask a question or make a suggestion that results in major improvements. He has a "bird's-eye", while the man on the job is looking at details.

The Flow Process Chart will help you to get a bird's-eye view.

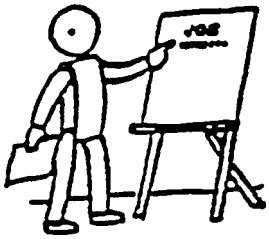
It is a graphic picture of the sequence of events in any process or procedure, and gives information necessary for analysis - such as time required and distance moved.

The material type of Flow Process Chart presents the process in terms of what happens to the material.

The operator type presents the process in terms of the activities of the operator. The chart is of great value in presenting information in condensed form.

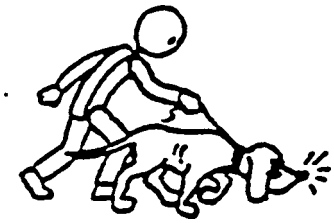
Many an executive has found himself irritated and often baffled by his inability to visualize the whole process under his direction. He must make decisions based on incomplete knowledge which are little better than guesses.

HOW TO MAKE A FLOW PROCESS CHART



STATE THE JOB TO BE STUDIED 1

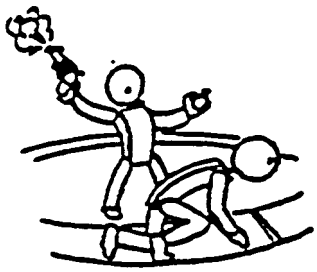
State clearly what the job is. Then be sure you stick to THAT JOB as you make the breakdown.



CHOOSE THE SUBJECT TO BE FOLLOWED 2

A PERSON...A PART OR ARTICLE...A PAPER FORM

Follow the same subject all the way through. **Don't** change! Every detail on the chart must be about the one chosen subject.



PICK A STARTING AND ENDING POINT 3

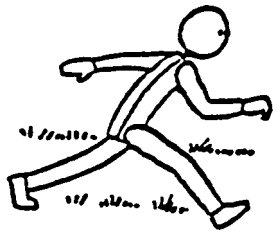
Decide how much ground you wish to cover - then cover no more and no less. Start and stop at the proper points. But in between those points, put down EVERY step of the job.

WRITE A BRIEF DESCRIPTION OF EACH **DETAIL** 4

Step by step, no matter how short or simple or incidental

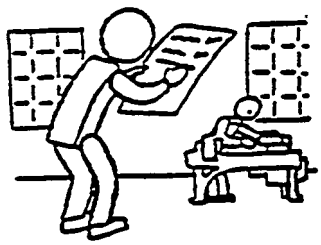
...EVERY OPERATION... EVERY TRANSPORTATION ...EVERY STORAGE...EVERY INSPECTION.

POINTERS IN MAKING THE FLOW PROCESS CHART AND FLOW DIAGRAM



1 Do not cover too much ground.

2 Your charts will be accurate, complete and useful - only if you ACTUALLY FOLLOW THE SUBJECT WHILE MAKING THE CHART.



3 Indicate each and every step - Operation, Transportation, Storage, Inspection.

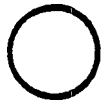
4 Stick to the subject - as closely as your shadow sticks to you.

FLOW CHART CLASSIFICATIONS

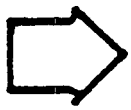
The work done in any process can be divided into four classifications:

1. Operation,
2. Transportation,
3. Storage,
4. Inspection.

In making a Flow Process Chart, each classification is designated by a symbol. Samples of Flow Chart Forms are shown at the end of this section. Flow Chart symbols and their definitions are discussed on the following page.

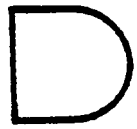


OPERATION An operation occurs when an object is worked upon, is changed in any way, or is arranged or prepared for further work - generally whenever the use of the hand is involved. An operation occurs also when information is given or received or when planning or calculating takes place.

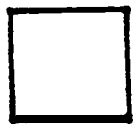


TRANSPORTATION
A transportation occurs when an object or person moves from one place to another.

STORAGE: A storage or hold occurs when an object is kept in an area or place as a planned part of an operation.



DELAY: A delay occurs when a person waits or is idle for a measurable period of time.



INSPECTION: An inspection occurs when an object is examined for identification, checked or verified for quality or quantity, but where no change is made.

The Flow Process Chart shows the route of the object or person being followed. It helps to focus attention on one thing and follow it from the beginning of the process to the end.

With the use of these five symbols we can show what happens at each step in the process. With these symbols any work can be completely described no matter what it is.

Now that you have written a brief description of each detail of work performed - and chosen one of the symbols to apply to each - you are ready to consider the three parts of the job:

PREPARE

PERFORM

PUT AWAY

Every job is made up of these three parts and you will find it easy to distinguish them.

1. PREPARE is that part of the job which involves getting ready to do the work. This includes collecting materials and preparing the work place.

2. PERFORM is the actual work done. This is *the* heart of the job - the objective of the entire operation.

3. PUT AWAY is the cleaning up after the PERFORM is finished. It naturally follows the PERFORM part of the job.

As soon as these three divisions have been decided upon, fill in the large circle symbols for those operations which are PERFORM operations. This will help you in later analysis.

You will soon discover that the best opportunity for improvement is in the elimination of work in the PREPARE and PUT AWAY, since they add nothing to the operation and are little more than necessary evils.

Next enter the distance for all transportations - just jot down the approximate number of feet. If you know the time elements involved enter them on the chart.

Now summarize the distance traveled, and the number of operations, transportations, storages and inspections. Well - there you have the steps involved in making a FLOW PROCESS CHART. Before going on to the analysis of the chart here are a few pointers.

1. STICK TO THE SUBJECT. If you are making a chart of the flow of an object, record only what happens to that object. Do not deviate from it to follow any other object or person.

2. ACTUALLY FOLLOW THE ITEM. Do not try to "arm-chair" a flow process chart. Take to your feet and actually follow the item or person being charted.

3. INCLUDE ENOUGH DETAIL. Many opportunities for improvement will be overlooked if the job is not broken down in sufficient detail. Include all steps in the process no matter how simple they may seem.

4. DISTINGUISH BETWEEN OPERATIONS AND INSPECTIONS. Use the square symbol only when it is really an inspection for quality or quantity: Looking for a folder in a file, for example, would NOT be considered an inspection. Use the operation symbol in this case.

5. REFER TO THE SUBJECT. The subject charted becomes the subject of each statement on the process chart. The active voice is used for a person. Example: "Clerk signs requisition." The passive voice is used when charting an item. Example: "Requisition signed by clerk."

To develop any new method, study the possible answers indicated by five reminders of Work Simplification. Take the attitude that the present way CAN'T be the only way or the best way. Then break down the method and search for a BETTER WAY. Study the operation closely. Think about every step in terms of how to improve it.

Apply the question "WHY" to these five reminders - WHAT, WHERE,WHEN,WHO and HOW. This technique will lead to the possibilities of eliminating, combining, changing, and SIMPLIFYING WORK.

WORK SIMPLIFICATION SUMMARY

Objectives

* Work Smarter
* Less Effort
* Improve Safety
* Improve Quality
* Reduce Costs

Basics

* Common Sense Use of Proven Ideas
* Question, Question, Question:

What?	Why?
How?	why?
When?	why?
Where?	why?
who?	why?

* Be creative in searching - Don't take anything for granted!
* Be practical in implementing - consult all who are involved.

Overcome Resistance to Change

* Early Involvement of Those Affected.
* Be Yourself.
* Show as well as Tell.
* Go for Team Effort.
* Ask for Suggestions
  - On Causes
  - On Solutions
  - On Implementing.
* Ask for, Don't Demand Cooperation.
* Can YOUR Ideas become OUR IDEAS?
* Shake a Hand, Pat a Back,
  Give Praise Readily.

Work Simplification Opportunities

* Looking for Items
* Chasing after Items
* Difficult Physical Effort
* A Lot of Physical Effort
* Difficult-to-Learn" Tasks
* The Right Tools and Equipment
  - In Good Condition?
  - Available?
* Parts & Material
  - Good Quality?
  - On Time?

* Different Material or Parts be Better?
* Make instead of Buy?
* Buy instead of Make?
* Scrap Problems?
* Rework Problems?
* Fit/Tolerance Problems?
* Layout Requires
  Back-Tracking?
* Work Place Wastes
  Motions?
* Tools
  - The Proper Ones?
  - Convenient Locations?
* Jigs?
* Fixtures?
* Conveyors?

Motion Economy Opportunities:

* Can, Distance Be Reduced
  - Walking?
  - Reaching?
  - Moving?

* Can Motions
  - Be Combined?
  - Be Eliminated?

* Awkward Motions
  - Bending?
  - Stooping?

* Difficult Motions
  - Stretching?
  - Heavy Lifting?

THINK-THROUGH THE BENEFITS OF WORK SIMPLIFICATION FOR

- Yourself.
- Your Department.
- Your Company.

* More Results with Less Effort.
* Feeling of Accomplishment.
* The Fun of Improvement.
* Cost Reduction.
* A More Competitive Company.
* Increased Job Security.

REFERENCE SOURCES

D'Aprix, R. D., "The Oldest (and Best) Way to Communicate with Employees", Harvard Business Review, September-October 1982, Boston, Mass.

Fenn, D. H., and Yankelovich, D., "Responding to the Employee Voice", Harvard Business Review, May-June, 1972, Boston, Mass.

Gelfand, L. I., "Communicating Through Your Supervisors", Harvard Business Review, November-December, 1970, Boston, Mass.

Lynch, J. J., "Why Listening is Good for You", Readers Digest, August, 1986.

Matlon, R. J., Cox, E., Waldron, V., and Walther, J., "Beware of Muddled Messages", Consulting Engineer, June, 1984, Technical Publishing, Barrington, Illinois.

McCormick, E J., Human Factors Engineering, Second Edition, McGraw-Hill, New York, N. Y., 1964.

Nichols, R. G., and Stevens, L. A., "Listening to people", Harvard Business Review, September-October, 1957, Boston, Mass.

Rennie, H., "What Did You Say?", Achiever, Fall, 1986, Associated Management Institute.

Schantz, J. J., "Videotape Recording Saves Time for I.E. 's", Industrial Engineering, Institute of Industrial Engineers Management Press, Norcross, Ga., July, 1981.

Sims, E. R., "Understanding of the Corporate Culture Helps I.E.'s Present Solutions Effectively", Industrial Engineering, Institute of Industrial Engineers Management Press, Norcross, Ga., October, 1982.

Stafford, R.E., "Videotapes Expand I.E. Ability", Industrial Engineering, Institute of Industrial Engineers Management Press, Norcross, Ga., January, 1980.

.MOTION ECONOMY PRINCIPLES

ŽTHE WORK SHOULD BE DONE UNDER THE MOST COMFORTABLE CONDITION POSSIBLE

Correct desk or work place height; correct type and height of chair: Provision to alternatively sit and stand at the job if possible; proper lighting, color of tools; work place and background: good ventilation; reduction of noise, other disturbances or interruptions, all contribute to the comfort of the worker.

While a worker under tension, mental or physical, due to outside stimulus may perform at top speed, the duration of such performance must be limited. For a continuous high level of performance, all factors must contribute to make the operator at ease, mentally and physically relaxed.

Finally, to be at ease, the worker should be convinced that the better and easier way is actually a better an-d easier way for him. Maybe, the best way of doing a job is not the best way, unless the worker thinks it is the best way..

If you have operator resistance: Have you looked at the job the way the operator thinks it should be done? Have you found out why? Have you explained the new way? Does the operator understand the new way?

Can he explain it back to you? To accept it, the worker must be sold by the person who developed the new method. Better yet, the operator should have participated in developing the better and easier way which in itself assures acceptance.

* **TOOLS AND MATERIALS SHOULD BE LOCATED** DIRECTLY IN FRONT OF THE OPERATOR SO AS TO BE WITHIN EASY REACH OF THE HANDS

Usually the work place, a bench, machine, desk, or table is laid out with tools and materials placed in straight lines. This can be improved, for a person naturally works in areas bounded by lines which are arcs of circles. Compare the piano with the organ in the big movie theatre.)

Let's look at the work place over the operator's shoulder -- see the job as he sees it. It becomes apparent that there is a definite and limited area which the operator can use with a normal expenditure of effort.

The normal working area may be determined by holding a piece of chalk in the hand and drawing an arc across the table or bench with the arm pivoted at the elbow.

The forearm only is extended. The upper arm hangs at the side of his body in a natural position. It tends to swing away as the hand moves toward the outer part of the work place. The normal working area for the right

and left hands will cross each other at a point in front of the worker. The overlapping area constitutes a zone in which two-handed work may be done most conveniently. Long reaches, hunting for material or tools, and carrying material or tools further than necessary, should be reduced to a minimum.

* SIMPLE FIXTURES, JIGS OR OTHER HOLDING DEVICES SHOULD BE USED WHEREVER-POSSIBLE

The value of our hands is so great we cannot measure it in terms of money. Yet we see hands used as holding devices in many operations -- 50%, 75%, and even as high as 95% of the total cycle time. As holding devices, our hands are unsteady, inaccurate, and unsafe. Anyone who has ever cracked a thumb with a hammer will agree. Yet many factory and office operations are performed with one hand used as a *vise* for a large part of the cycle.

One of the most common errors that we make on bench work, light assembly jobs, and short production runs is to imitate a small boy whittling a willow stick. A boy who holds his work in one hand, his jackknife in the other.

The crudest clamp is better than the hand on any job. The hand is the poorest and most unsafe holding device.

* EJECTORS AND QUICK-ACTION CLAMPS REDUCE HANDLING TIME

Any operation may be divided roughly into three parts: (1) Get Ready; (2) Do; (3) Dispose. Only the second element -- DO -- represents productive time. Time saved on the other two elements means more time for productive work. Quick acting clamps will reduce the time required to "get ready" and to “dispose". Time spent in screwing tight a part in a drill jig can be saved by a simple cam or toggle-actuated clamp. An air chuck or vise will often increase production substantially -- simply by reducing the time and effort of "get ready.”

Additional increase in production is often made possible by the use of ejectors. Sometimes a knockout pin can be used to remove a part from a jig. In other cases, a small air cylinder with a plunger can be used to eject the part as soon as the operation has been completed.

* GRAVITY FEED BINS FOR MATERIALS AND DROP DELIVERY FOR FINISHED PIECES SHOULD BE USED

Do the operators in your department have to bend over to pick up pieces from the floor or tote box on the floor? Considerable energy and time is often lost and the machine is idle while the operator hunts for parts. Perhaps the use of a bin with a sloping bottom will save backaches and vitally important man-hours. The material is fed to the front by gravity.

Automatic eject devices and drop deliveries will eliminate or reduce non-productive motions. The quickest way to dispose of any object is to drop it. The quickest way to get rid of a completed part is to drop it. Try to find an arrangement whereby the finished article may be "put away" by simply releasing it in the position in which it was completed. Try to eliminate the necessity of moving to dispose of it.

Many materials are of a type which may be dropped or slid down a chute without damage. However, if this treatment does result in damage to the finish or cause breakage felt or canvas may solve the problem".

The time saved in transporting the work to its destination is not as important as making sure both hands are free. Free to proceed simultaneously in unbroken rhythm - and rhythm is an important factor in skill.

Idleness of either hand obviously is not productive. Use both hands to work.

* THERE SHOULD BE A DEFINITE AND FIXED PLACE FOR ALL TOOLS

Physical activity or motions should be productive. This means that every non-productive motion should be eliminated if possible. An orderly work place (“A Place for Everything And Everything in Its Place") is the first step in accomplishing this objective. Keep everything within easy reach.

The operator should always be able to find the tools and materials in the same location. Likewise, finished parts and assemblies should be disposed of in fixed places. Definite stations for materials and tools aid the operator in habit formation, and permit him to quickly reach standard performance. It is to the operator’s advantage to be able to perform the job with the least mental direction. Frequently, materials and tools are scattered over the work place. They are scattered in a disorderly fashion. The operator must hunt around in order to locate the part or tool needed at a given instant.

The operators are very much in favor of having definite stations for materials and tools, since this reduces fatigue and saves time. There can be no virtue in requiring the operator to exert unnecessary effort.

Effort to decide just what tool to pick up next or what part to assemble next is not productive effort. If the workplace is pre-planned by simply arranging the materials and tools properly, the operator will automatically perform the work in sequence. Productivity will be improved because of minimal requirement of mental and physical effort.

* TOOLS AND MATERIALS SHOULD BE PRE-POSITIONED WHEREVER POSSIBLE

When tools are used, be sure that you have the best tools for the job. And be sure they are kept easy to use.

Pre-positioning of tools and materials can frequently eliminate much wasted motion. All tools, whenever possible, should be pre-positioned. This means they should be returned to a suitable holder after use. This holder should be designed to allow rapid release. It should also permit the tool to be grasped in a position ready to use.

Pre-positioning eliminates shifting the eye from the point of assembly to search for tools or materials. Eye fatigue is far more serious than most people realize.

The obvious office application of this principle is the fountain pen desk set. First, this eliminates the waste of time and motion required to remove the cap from a standard pocket pen. Next, a fountain pen in a desk holder is pre-positioned. The pen is ready to be used without changing its position.

In a shop tools should be placed as nearly as possible in the position in which they will be used.

Material coming from one machine should be passed on to the next machine in proper position for use.

Too often the parts are dumped in a tote box and have to be sorted and positioned before the next operation can be performed. In the case of tools, many times they are laid on the bench or floor after they are used. An easier and more convenient way is to pre-position the tool in a fixed location ready for use. Also, tools and material should be located to permit the best sequence of motions.

APPLICATION OF THE PRINCIPLES OF MOTION ECONOMY WILL LEAD TO lMPROVED METHODS AND SCHEDULES FOR DOING WORK. IT WILL BE A CATALYST FOR PRODUCTIVITY IMPROVEMENT.

> "There is no quicker way to go out of business than by having better methods and work techniques in the hands of a competitor ."

Schedules to be of value must be consistent, must be understood, and must be up-to-date with the current methods.

It is not desirable to have a work schedule remain in effect after a methods change takes place, regardless of who created the change.

Updated schedules are needed when there is a change required in:

1. Manual Work Content
2. Material or Design of Product
3. Machine (Speeds and Feeds)
4. Tools or Equipment

METHOD OUTLINE OF TASKS PERFORMED

Industrial Engineering can assist the workers and supervision by developing method descriptions or outlines of work specified. This will aid the supervisor in setting up a job and allow the worker to identify with the method of doing the job.

In the following exhibit of a machining standard method outline, the identification heading is shown at the top of the page and followed by a basic workplace layout of material positioning.

The method description of how the job is done is referenced to a coded analysis. The outline follows the tasks required to complete the operation from start to finish.

INSTRUCTING THE WORKERS IN THE NEW METHOD

Avoid waste of time, energy, and materials by instructing under methods that are modern.

Here is a tested and proven outline for use in training workers on any job.

I. PREPARING FOR INSTRUCTION

Have a time table -

Plan on how much skill the worker should have developed at a given date.

Break down the job -

List important steps

Pick out key points.

(Safety is always a key point).

Have everything ready -

The right equipment, materials, and supplies.

Have the work place properly arranged -

Just as the worker will keep it.

II. INSTRUCTING THE WORKER

Step 1 - Prepare the worker

Put him at ease. Explain the purpose and importance of the job.

Get him interested in learning the job.

Step 2. Present the operations -

Tell, show and illustrate one IMPORTANT STEP at a time.

Stress each KEY point.

Instruct clearly, completely and patiently.

Present only as much as he can master.

Hold attention by questioning him.

Have him explain each KEY point as you do the job. Repeat the points where he seems unsure.

Step 3- Try out Performance

Have him do the job one step at a time. Correct errors.

Have him explain each KEY point as he does the job. Make sure he understands. Continue until YOU know HE knows.

Step 4 - Follow Up

Put him on his bwn.

Designate to whom he should go for help.

Check frequently. Encourage questions.

Taper off extra coaching and close follow-up.

REMEMBER... “IF THE LEARNER HASN’T LEARNED, THE TEACHER-HASN’T TAUGHT”

Give serious thought to the effect this change of yours may have on the people you work with.

The test or trial r of a new method is often helpful in introducing a new method to the workers. Such a test can help sell the idea as sound. This trial run often prevents the upsetting of regular routines when the change is finally made.

REMEMBER TWO THINGS:

1. Most people resent criticism. Make it clear that the new method has been developed and adopted without any criticism of old methods. There must be no hint of criticism of the old method -- only the thought of improvement. All of us resent the implication that we have been doing things the wrong way.

2. Most people resist change -- this situation can be overcome by encouraging those who work with you to develop their own new ideas.

Ask them for their opinions and their suggestions on your improved method.

No one will resist a change that he himself had originated or helped to perfect.

Get your people "On the team" by letting them be "part" of the idea. They will eagerly help to push it through.

FACILITIES ANALYSIS

Industrial engineering assists in plant layout by analyzing the following objectives:

1. To minimize delays and handling
2. To maintain flexibility
3. To utilize manpower and space effectively
4. To provide for good housekeeping
5. To assure effective maintenance

To accomplish the objectives, industrial engineering helps in determining:

1. Space requirements
2. Inter-relationship among all activities
3. Alternate layouts
4. How the objectives can be implemented

Industrial engineering advises in the selection of mechanical handling equipment by analyzing the ability of the equipment to:

1. Reduce damage and waste
2. Reduce inventory requirements
3. Reduce handling costs
4. Expedite shipments

5. Improve space utilization

6. Simplify product flow

7. Improve safety and working conditions.

Production flow analysis is provided for operational sequence and the routing of parts through the work centers. Parts with common operations are grouped as “families”. Machines are grouped, also, to form “cells”.

ANALYSIS FOR COST CONTROL

LABOR REPORTING

Some industrial engineers believe labor reporting is a powerful force involved in improvement of productivity. They believe labor reporting is a powerful force in maintaining productivity levels. They believe it is the most powerful control of labor. There is even a stronger contribution (by reporting) when it is coupled with factual labor requirements vigorously backed by management.

A good report will show all of the hours worked by employees. It will show their totals, the departmental totals, and the plant totals. It will show productive hours worked, operations performed, pieces produced, productive labor hours earned, efficiency percentage, non-productive hours worked, and productivity percentage. It must be circulated within a short period of time, after the performance, to be of value to all concerned.

PRODUCTION AND INVENTORY CONTROL

PRODUCTION CONTROL encompasses the forecasting and overall planning, scheduling, loading, and dispatching of work and materials to manufacture a product, to control the cost of that product, and to deliver that product on the date promised to the customer. Production control is a basic requisite of good industrial management. It ties together and applies all phases of industrial engineering and is the coordination medium of effective management. Without it, a company can never be fully efficient.

INVENTORY CONTROL means the proper management of raw materials, parts, sub-assemblies, and assemblies as guided by decisions of top management. In those decisions they determine the minimum stocks necessary to insure proper coverage of the business, the proper flow of the in-process inventory with relationship to the current business level, and the turnovers desired from such inventories.

FORECASTING

One cannot develop the importance of inventory control without relating to it the great need for forecasting sales. It is up to management to decide at which level they want to forecast. Industrial Engineering can assist in determining:

1. Production personnel, work space and equipment required to meet the objective.

2. Assembly personnel and line assembly capacity required.

3. Purchased goods inventory that should be maintained to meet the projected sales picture.

4. Procurement of the needed raw materials, parts, and sub-assemblies.

A forecast must be rescheduled-or readjusted from time to time to meet the current economy or demands of the customers. It is an ever-moving item and requires constant attention.

CRITICAL LIST

Industrial engineering can be of assistance in preparing critical lists for items having long procurement times. These items must be specified as soon as their need is established and specifications determined.

Critical Lists should have the quantity, description, part number, tool or pattern numbers, and other identification posted to the form. Production control is usually responsible for posting the purchase order numbers and vendor promise dates as well as signifying the availability of stock items.

DISPOSAL OF OBSOLETE INVENTORIES

The industrial engineering department can research individual inventory items to detect evidence of over-investment or obsolescence. The usual test to be applied is the relationship of quantities on hand to the rate of sale or use during recent months. In addition, the impact of product changes is considered.

The real need is to make certain that the disposal of obsolete inventories is a highly organized and continuing activity. It must not be just a “house cleaning” procedure. Clear cut policies must be established to specify the conditions under which inventories will be written off against profit and loss. These conditions should be tightly drawn. The sooner the inventories can be written off, the greater the control over costly errors. These errors in sales forecasting, production planning, inventory replenishment, and the timing of design or model changes will be reduced substantially.

A good share of obsolete inventory is prevented through proper action by Product Engineering. It is their function to specify the disposition of affected materials whenever the product is changed or modified.

REGRESSION ANALYSIS

Industrial Engineers are often faced with the problem of testing for differences between several mean values. Testing for differences among average production times using different operators, different machines, and different raw materials is an example. This testing introduces compound results. In general, the procedure is difficult to analyze, but it can be done through analysis of variance.

Regression analysis is a technique for measuring and explaining variability in a system. It is a method for improving forecasting or production. Multiple linear regression should not be a process that follows a fixed path. Differences in goals require different paths of analysis. The statistical requirements for establishing scientific truth are more stringent than the requirements for decision making. Supervision cannot wait for the ultimate truth in most cases. Ordinarily, the industrial engineer must support the decision made by management in a timely manner.

The various goals can be put into five categories:

Ž Exploration - Fishing, hypothesis finding.

- Specification - Hypothesis testing, confirmation of the model form.

- Estimation - Estimating model parameters.

- Prediction - Use of the model for anticipation.

- Control - use of the model to prescribe change. To direct or guide policy of a system.

In multiple linear regression, understanding variation is the basis for problem solving. Variation in the response is made up of two parts:

- The variation signal, in response to changes in the predictors.

- The leftover variation noise, called residual or experimental error.

The least squares estimates are universally minimum variance estimates for normally distributed residual errors. They are minimum variance among all linear estimates regardless of the residual error distribution shape.

Analysis of variance related to linear regression can be used when at least one value of X has two or more Y values associated with it.

Ž Compute the sum of squares for the variation explained by linear regression.

• Compute the residual sum of squares.

• Check calculations by finding sum of squares.

• Calculate mean square for the variation explained by linear regression.

• Calculate residual mean square.

Ž Calculate F

• Find fix.

• If F $\leq$ fix, accept the hypothesis that the linear relation is not statistically significant.

If F $\geq$ fix, reject the hypothesis.

Extension to multivariable analysis proceeds with more extensive computational work. The same general concepts used for two variables are used for multi-variable analysis, however.

GET IT DONE TODAY

ATE _____ COMPLETED

1 _____ ☐

2 _____ ☐

3 _____ ☐

_____ ☐

_____ ☐

_____ ☐

_____ ☐

_____ ☐

_____ ☐

_____ ☐

_____ ☐

_____ ☐

_____ ☐

STANDARDS, INTERNATIONAL
INCORPORATED
WORK MANAGEMENT SPECIALISTS

FOUR FUNDAMENTALS

1. FACTS
2. PLANS
3. ACT
4. SUPERVISE

☐

FLOW CHART

NO. _____
PAGE ____ OF ____

SUMMARY

	PRESENT		PROPOSED		DIFFERENCE	
	NO.	TIME	NO.	TIME	NO.	TIME
○ OPERATIONS						
⇨ TRANSPORTATIONS						
□ INSPECTIONS						
D DELAYS						
▽ STORAGES						
DISTANCE TRAVELED		FT.		FT.		FT.

JOB _____

☐ MAN OR ☐ MATERIAL _____

CHART BEGINS _____

CHART ENDS _____

CHARTED BY _____ DATE _____

DETAILS OF (PRESENT / PROPOSED) METHOD

		OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	DISTANCE	QUANTITY	TIME	POSSIBILITIES: ELIMINATE	COMBINE	SEQUENCE	CHANGE: PLACE	PERSON	IMPROVE	NOTES
1		○	⇨	□	D	▽										
2		○	⇨	□	D	▽										
3		○	⇨	□	D	▽										
4		○	⇨	□	D	▽										
5		○	⇨	□	D	▽										
6		○	⇨	□	D	▽										
7		○	⇨	□	D	▽										
8		○	⇨	□	D	▽										
9		○	⇨	□	D	▽										
10		○	⇨	□	D	▽										
11		○	⇨	□	D	▽										
12		○	⇨	□	D	▽										
13		○	⇨	□	D	▽										
14		○	⇨	□	D	▽										
15		○	⇨	□	D	▽										
16		○	⇨	□	D	▽										
17		○	⇨	□	D	▽										
18		○	⇨	□	D	▽										
19		○	⇨	□	D	▽										
20		○	⇨	□	D	▽										
21		○	⇨	□	D	▽										
22		○	⇨	□	D	▽										
23		○	⇨	□	D	▽										
24		○	⇨	□	D	▽										

FLOW CHART

NO. 1
PAGE 1 OF 1

SUMMARY

	PRESENT NO.	PRESENT TIME	PROPOSED NO.	PROPOSED TIME	DIFFERENCE NO.	DIFFERENCE TIME
○ OPERATIONS						
⇨ TRANSPORTATIONS						
□ INSPECTIONS						
D DELAYS						
▽ STORAGES						
DISTANCE TRAVELED		FT.		FT.		FT.

JOB

☒ MAN OR ☐ MATERIAL

CHART BEGINS Walk to IBM

CHART ENDS Release Power Tool on Ben

CHARTED BY R H H DATE 11/17/82

DETAILS OF (PRESENT / PROPOSED) METHOD

	DETAILS OF (PRESENT / PROPOSED) METHOD	○	⇨	□	D	▽	DISTANCE IN FEET	QUANTITY	TIME	POSSIBILITIES: ELIMINATE	COMBINE	REDUCE	CHANGE: PLACE	PERSON	SEQUENCE	NOTES
1	Walk to IBM						6		.03							
2	Read IBM								.04							
3	Walk to Stock Bin						8		.04							
4	Pick Up Molding								.08							
5	Walk to Unit						6		.03							
6	Snap on Molding								.15							
7	Walk to Work Bench						6		.03							
8	Pick Up Power Tool								.03							
9	Walk to Screws						3		.02							
10	Pick Up 2 Screws								.03							
11	Return to Unit						8		.04							
12	Open Door								.03							
13	Attach Screw at Front								.10							
14	Attach Screw at Rear								.10							
15	Close Door								.08							
16	Return to Bench						10		.05							
17	Release Power Tool								.03							
18																
19																
20	TOTAL						47		.86							
21																
22																
23																
24																

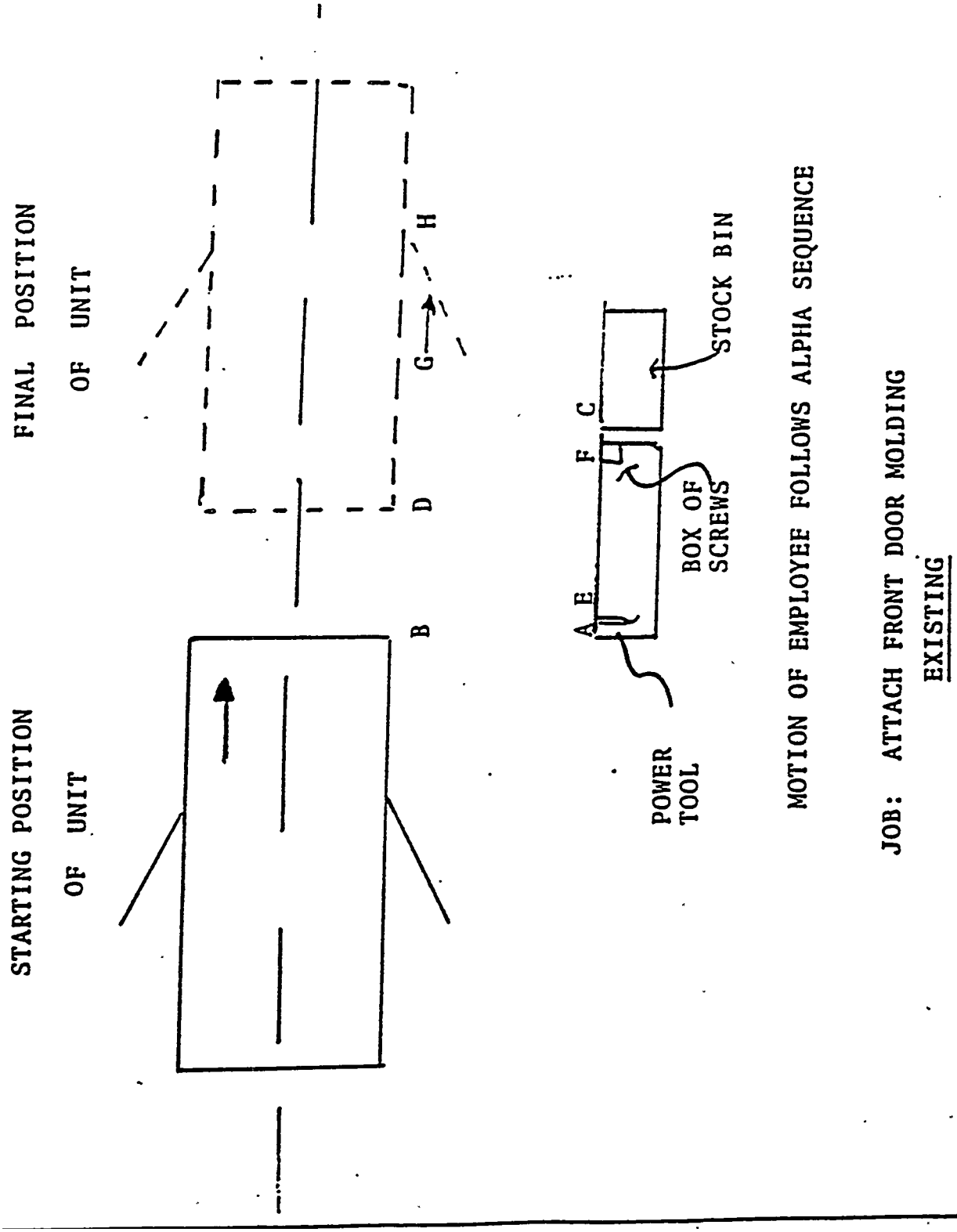
Diagram begins: _____

Diagram ends: _____

Diagram follows: (.)Man, or ( )Material; _____

Prepared by: _____ Date: _____

(REMEMBER! Follow the same item you followed on the Flow Chart.)



FLOW CHART

NO. 3
PAGE 1 OF 1

SUMMARY

	PRESENT NO.	PRESENT TIME	PROPOSED NO.	PROPOSED TIME	DIFFERENCE NO.	DIFFERENCE TIME
○ OPERATIONS	10	.62	9	.59	-1	.03
⇨ TRANSPORTATIONS	7	.24	3	.13	-4	.11
□ INSPECTIONS						
D DELAYS						
▽ STORAGES						
DISTANCE TRAVELED	47 FT.		26 FT.		21 FT.	

JOB Attach Front Door Molding

☒ MAN OR ☐ MATERIAL

CHART BEGINS Walk to IBM

CHART ENDS Release Power Tool

CHARTED BY RHH DATE 11/17/82

	DETAILS OF (PRESENT / PROPOSED) METHOD	OPERATION	TRANSPORT	INSPECTION	DELAY	STORAGE	DISTANCE IN FEET	QUANTITY	TIME	POSSIBILITIES: ELIMINATE	COMBINE	CHANGE: SEQUENCE	PLACE	PERSON	IMPROVE	NOTES
1	Walk to IBM	○	⇨				12		.06							
2	Read IBM	○							.04							
3	Walk to Stock Bin	○	⇨				8		.04							
4	Pick Up Molding	○							.08							
5	Walk to Unit	○	⇨				6		.03							
6	Snap on Molding	○							.15							
7	Pick Up P. Tool from Hook	○	⇨						.03							Relocate power tool to hook on rail
8	Open Door	○							.03							
9	Attach Screw at Front	○							.10							Screw from apron pocket
10	Attach Screw at Rear	○							.10							Screw from apron pocket
11	Close Door	○							.03							
12	Replace P. Tool on Hook	○	⇨						.03							Do while moving to start point
13		○														
14		○														
15	TOTAL	○	⇨				26		.72							
16		○														
17		○														
18		○														
19		○														
20		○														
21		○														
22		○														
23		○														
24		○														
		○														

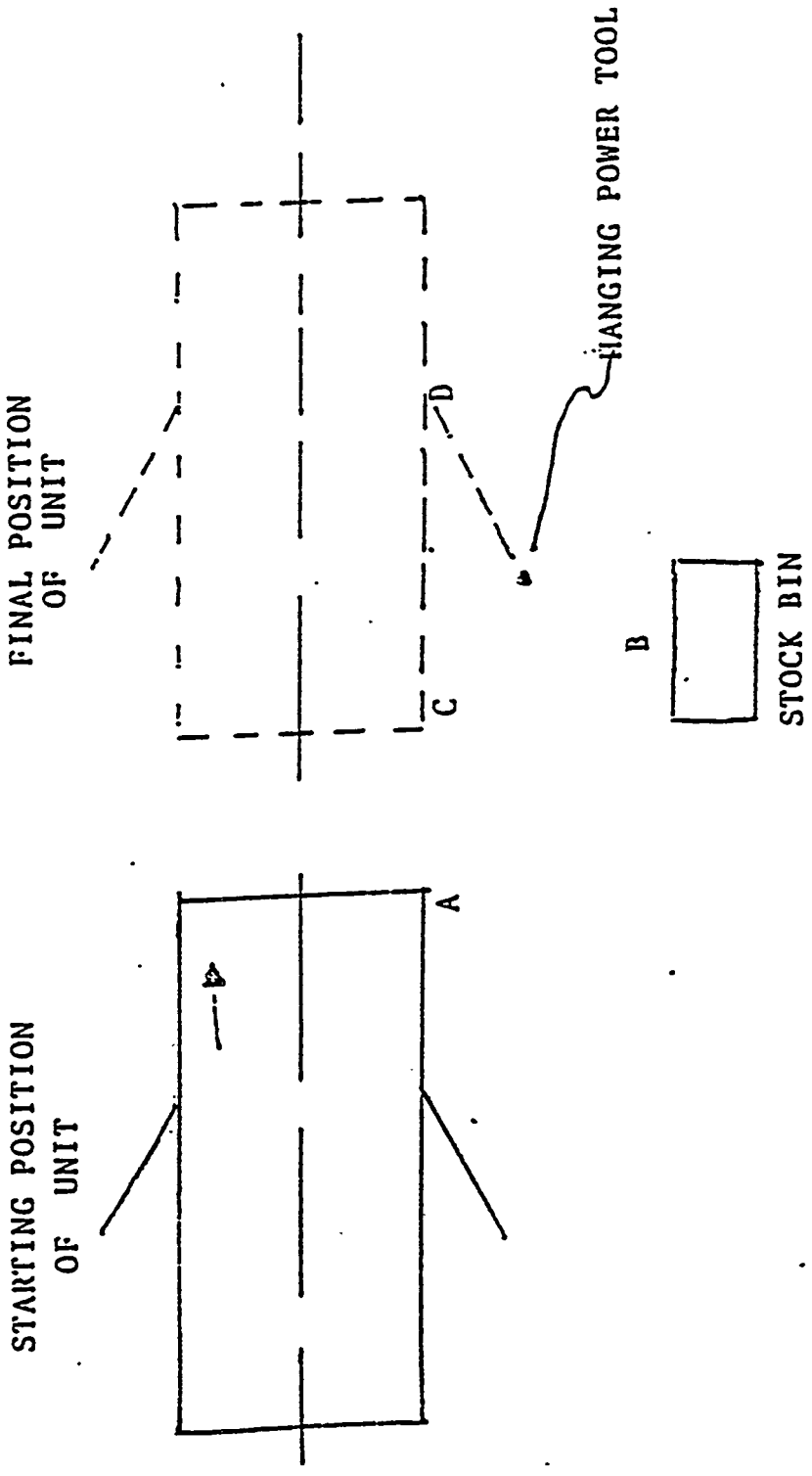
Diagram begins: _____

Diagram ends: _____

Diagram follows: ( )Man, or ( )Material; _____

Prepared by: _____ Date: _____

(REMEMBER! Follow the same item you followed on the Flow Chart.)



MOTION OF EMPLOYEE FOLLOWS ALPHA SEQUENCE

JOB: ATTACH FRONT DOOR MOLDING

PROPOSED

BASIC PRINCIPLES
OF
INDUSTRIAL ENGINEERING

-- -- --

In three Parts:

Part I What is Industrial Engineering

Part II Operational Questions for Industrial Engineers

Part III Communicating your Ideas

-- -- --

Prepared especially for

SNAME PANEL SP-8 ON INDUSTRIAL ENGINEERING

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

By

STANDARDS, INTERNATIONAL INC.

Chicago, Illinois

-- -- --

PART II

OPERATIONAL QUESTIONS FOR INDUSTRIAL ENGINEERS
(OR RECOGNIZING THAT A PROBLEM EXISTS)

-- -- --

TABLE OF CONTENTS

SECTION I

RECOGNIZING A PROBLEM EXISTS

PATTERN FOR APPROACHING PROBLEMS

The systematic pattern of approaching problems, generated through creative thinking, is an extremely valuable tool for anyone concerned with work problems.

Problems should be rather obvious. When we are exposed to something that needs repair, sometimes we fail to take action. Obviously, if enough engineers react in the same manner, the problems will grow and expand into an ugly monster.

A practical procedure is to look for problems while they are still insignificant and easy to deal with. Problems do exist, even if they are not recognized. Usually, a problem properly recognized and identified is nearly solved. Identifying the various factors involved is a reliable method of determining where improvements can be made. It can determine how much effort is needed in developing a new method, and how it can be used effectively.

A general review of the operation should be taken. Its like reading a book for the first time. You read the title on the cover and then open the book to find out the reason for the title.

What are some of the “reasons" or "indicators" that a problem exists?

- Does the work force start late and quit early?
- Is there faulty reporting of production?
- Do workers "pick" the jobs they want to do?
- If there is a performance report, does it reflect unusual performance percentages?
- Is there only minimum process identification?
- Is there only minimal methods identification?
- Are new jobs historically estimated?
- Are schedules frequently missed?
- Is the same work being measured over and over?
- Are there lots of requests for schedule adjustments ?
- Is support labor ignored?

Naturally, there could be many more questions, and like those above, not necessarily in order of importance.

Let's review the indicators question by question.

DOES THE WORKFORCE START LATE AND QUIT EARLY?

If the answer is no, don't pursue it any further. A yes answer will require further investigation.

Idle workers or missing workers at the start or end of a shift are important keys to successfully analyzing this question. Why is the worker idle? Is he waiting for material to be delivered? Waiting for instructions? Waiting for another worker? Waiting for the quit whistle? Where is the worker? Where is his supervisor? Are other workers waiting for this worker?

By searching for-reliable answers to these questions, the general question of start late/auit early can be answered. Recommendations for problems involved with this indicator can be developed by industrial engineering in its support role of managing the work force. Recommendations might take the form of preparation of the workplace before the start of the shift. A study for balancing the work tasks or a review of violations of company policy might be necessary. Assistance by industrial engineering is endless.

IS THERE FAULTY REPORTING OF PRODUCTION?

In most companies, workers are required to clock-in when they start a job. They must report what they are going to do. They are required to clock-out when they have finished the job, in order to report the work they have completed. Without this in-put it is difficult to effectively schedule and control the manufacturing of a product. It is also very difficult to determine the work-force required to produce that product.

Industrial engineering can work with supervision, staff, and management in getting the answers for questions like: Did the worker complete the work reported? Did the worker report the correct percentage of the work pack that was completed? Did the worker report any scrap or rework? Did someone else report for him? Is there a better way of reporting production?

DO WORKERS “PICK” THE JOBS THEY WANT TO DO?

Workers sometimes tell their supervisors they would like to do a particular job in a department because it is easier to do. If the supervisors let them do this regularly, the workers have "picked" the job. This type of favoritism can lower the morale of the department and decrease productivity of the department.

- Questions to ask: Why does this worker always have the easy jobs? Can only this worker do this job? Is the supervisor playing favorites? How can other jobs be improved? How can the jobs be changed so that the task requirements are compatible?

IF THERE IS A PERFORMANCE REPORT, DOES IT REFLECT UNUSUAL PERFORMANCE PERCENTAGES?

Performances which are unusually high or low may indicate faulty time reporting. They might also be an indication of a major change in work content since the time value or estimate was assigned.

Investigation of unusual performances should be made promptly after the work was performed, and the circumstances involved are fresh in everyone's mind.

Accurate labor reporting obviously becomes the basis for an accurate historical data base used on future job - estimates.

IS THERE ONLY MINIMUM PROCESS OR METHODS IDENTIFICATION?

Industrial Engineering is usually responsible for the "routing" of the product. Acceptable routing will contain a complete description of the work to be performed. It will list the machines, tools, speeds and feeds to be used. Inspection requirements, tolerances, material identification, standard hours, and manning requirements for performing that operation will be part of that routing.

If routing has to be brief, then industrial engineering should provide process and methods layouts only in reference to hours to complete the operation.

Questions usually asked -- How was this job studied? my can't I perform to standard? why are we running so much scrap? How come we have so many customer complaints? Has this job really been engineered? **Is "make** the part to print" the only routing? How come management disciplines me for doing poor work when they don't show me how to do it?

ARE NEW JOBS HISTORICALLY ESTIMATED?

There is an old saying, "if you have once measured a job, never measure it again. ” That's well and good if you have measured it right the first time. And the job requirements must be the same for the following times.

In many cases, companies use actual hours posted to a job completed as the estimate for a new job. Doesn't it make any’ difference that a lot of trial and error went into that last job? Wouldn’t it be better to “pre-measure" work to be performed? Wouldn't it be better to specify how that work will be done?

It is one bf the functions of industrial engineering to provide this factual data for estimating.

ARE SCHEDULES FREQUENTLY MISSED?

The cost of any product is based on the ability to manufacture a quality product to a given schedule of required man hours. Failure to adhere to this schedule will result in additional cost.

The company has some choices:

- Absorb the added cost
- Provide a lower return on investment
- Raise the price of its product
- Lose its "place" in the market

Industrial engineering can provide valuable assistance in this respect. St must make certain that manning and manufacturing requirements are accurate and attainable. This industrial engineering function is the catalyst for generating and assuring company profits.

IS THE SAME WORK BEING DONE OVER AND OVER?

.

Many industrial engineering departments find it difficult to carry out their supportive roles without increasing the size of their staffs. Unattended demand for their services will usually force this type of action. Departments in this category would supply a yes answer to the question. They probably are measuring the same work over and over.

Before undertaking any industrial engineering project, ask yourself these questions - What do we have available that would allow me to refer to, or use, in place of doing this project? If there is nothing available, document and reference your project or study so it can be used next time. Eventually you will not be measuring the same work over and over !

ARE THERE LOTS OF REQUESTS FOR SCHEDULE ADJUSTMENTS?

If there are lots of these requests, there are probably many reasons, some justifiable, for these requests. Ask these questions --

Is the schedule attainable?

Is this a means for improving departmental performance?

- Is this adjustment oil for a squeaking wheel?
- Has the load been revised since the schedule was developed?

Requests to change schedules, that will result in additional costs for ship construction or overhaul, should be thoroughly investigated by industrial engineering in response to that request.

IS SUPPORT LABOR IGNORED?

Support labor, sometimes called indirect labor, i necessary-work which does not alter the composition, tion, or construction of the vessel.

These wo’rkers are not performing operations t produce or assemble parts, and consequently are not con- trolled as effectively as much as production or di labor. .

Industrial engineering should “evaluate and reco manning requirements for these service functions. Often the "bottleneck" or "bulge in the-balloon" has been dev through ineffective use of this labor. Industrial engine should ask these questions:

- How can the worker be kept busy doing a manufacturing operation?
- Can we get rid of "make-ready" and put-away"?
- Should the workers be "serviced by supportive workers?
- Why is the worker idle at his work station?
- Is there "interference" of production wh workers are serviced?

STEPS FOR IMPROVED PRODUCTIVITY

1. dentify the problem and the factors involved.
2. Analyze the methods being used.
3. Question each step of the work.
4. Select the best solutions for solving your problem.
5. Review the problem and your analysis.
6. Summarize and select the best method.
7. Explain, train, and follow-up. Revise if necessary.

SECTION II

BENEFITS OF PROBLEM RECOGNITION

PROVIDING A FULL DAY'S WORK

A worker producing product to schedule for a scheduled period of time is providing a full day's work. If the schedule is developed properly, the worker will enjoy job satisfaction and security. The company will enjoy the benefits of improved productivity. A better, more competitive product will be produced at a lower cost.

Industrial engineering can assist in making this possible by questioning all aspects of work being performed. When complications and restrictions are removed from the productive process, work is reduced to a simple and most productive form. Donlt work harder, work smarter.

METHODS CHANGES

The first step for improved productivity is elimination of problems. After that first step, the following steps are undertaken.

Industrial engineering must analyze the methods being used to perform a job. They need to question each step of the work, to select the best solutions, and to implement the new method. It's a form of auditing, really, and the successful engineers are forever looking for ways to improve what they already have improved.

By staying abreast with what”s happening and applying their investigative techniques over and over, maintenance of schedules can be accomplished. Industrial Engineering can do this without the "creeping change" losses so common in industry today.

Just by walking through a department, industrial engineering should be able to practice mentally productivity improvement techniques. Selection of operations to be improved because of changes in labor content, material content, or machine content, should be evident. Implementation of those changes must be timely and recognizable by the supervisor and the worker.

USE OF AVAILABLE DATA

When work is analyzed by industrial engineering, the questioning of each step of the work should be followed by "I have (or don't have) data for that ". Availability should be noted by the industrial engineers for future reference.

It is important for industrial engineers to review and know what data is available to them. Data should be reference coded and easily identified. When searching for availability takes place, recognition of identical work tasks is important. Will the data be valid for this particular task?

Many engineers have charts and tables "under glass" on their desks. Each chart or table is referenced to a source providing the values.

Most .engineers today enjoy the availability of a computer in searching for data. All they really have to know is the magic number that will allow entrance to the data and the display thereof. It sure beats thumbing through file after file in companies where thousands of analyses and studies could be stored and “available.”

JOB SATISFACTION THROUGH PROBLEM RECOGNITION

In their work, industrial engineers should aim at solutions that will allow for optimal satisfaction of the needs of all employees involved. Job satisfaction along with job security certainly rate a place high on the totem pole with most workers.

Solutions to problems concerning a worker are effective when implemented through a methods change or process change. The change should be reviewed and tried by the worker. If you have done a good job, the worker will recognize the problem no longer exists. The "satisfied" worker will be your friend -- until the next problem comes along!

When a job has been made easier to do, workers will feel that it is easier for them to be productive. They will feel that they are not being asked to perform something over and above their ability and classification. They will be quick to acknowledge who contributeda to their happiness and to their will to work.

PRODUCING TO SCHEDULE

The basic function of industrial engineering is to assist in Panning and producing a product. If that product is produced to schedule, certainly industrial engineering can take pride in their contribution to that successful endeavor. This is where the action is! This is when the workers, supervisors, management, and the company appreciate the support of industrial engineering. This is how the function should be utilized:

At one time "bull of the woods" type of supervisors could "push" the product through the plant by screaming, hollering, demanding, and pounding. These shirt sleeve, hands on, "people pushers" were quite effective in their time.

But this is a new world, calling for technical and sophisticated ways of planning and producing a product. It takes a team effort in today society if a company is to be competitive in the market place. Failure to delegate authority and assign responsibility to others will only hasten the demise of the company, the community, and the country .

The United States has temporarily lost its lofty position as an industrial power. If our available technology is used properly, our country will once again be internationally competitive.

REDUCING EMERGENCIES THROUGH RECOGNITION

Emergencies in manufacturing can be reduced through the recognition of problems. The preventive medicine of early detection can put a halt to surprises.

Actually, in many cases, overtime is an excuse for failure to identify problems. It is the penalty paid for failure to react to problems that have been recognized. The need for additional hours to get the product out can usually be traced back to poor control of the available work-force, and of the inter-relationship of jobs in shipbuilding.

Even a few workers, when missing from work, will seriously strain the plans for producing to schedule.

One operation, not in sequence with others will cause adjustments to schedules because of set-up requirements, interference, and space availability. Low inventories are commonplace in shipbuilding today. The luxury of pulling additional parts out of "stock" is not a feasible way to plug a leak in the dam. Emergencies must be prevented in order for manufacturing to produce to schedule. Industrial engineering through methods analysis of tasks can be of valuable assistance in uncovering a problem that might lead to an "emergency."

PROBLEM RECOGNITION IMPROVES TEAM MORALE

If you are in tune with the "grapevine, " you will understand why team or worker's morale is up and down like a yo-yo .

Unattend'ed problems are discussed prior to work, during work, at rest periods, during lunch, and down at the tavern. Problems not addressed by management become increasingly more important to the workers. A sense of urgency and frantic demands for action soon are echoed by much of the workforce.

During this period of time, morale is at the bottom of the string. The yo-yo must be tugged at in order to get it back into the hand. Most of these problems--are so simple to solve. Procrastination in dealing with them should not be tolerated.

PROBLEM RECOGNITION WILL TEACH MANAGEMENT PLANNING

Teachers must know the needs of their students before they can schedule their training. Likewise, the needs and problems of the workforce must be attended to before planning can take place'.

We learn from our mistakes, and by remembering what course of action was necessary because of those mistakes. . This identification and retention will allow for "anticipation" of problems. This "pre-planning" of courses of action which will allow management planning to be realized as scheduled.

SECTION III
HELPING TO IDENTIFY PROBLEMS

WHERE IS THERE NEED FOR IMPROVEMENT

There are numerous reports generated by the company manufacturing functions to report performance statistics. These reports can be "tip-off" sheets for identifying problems.

SCRAP REPORTS

Industrial engineering can help the quality control department or the department responsible for the report. It can do so by investigating and reporting the problems identifiable with the production of scrap. .

The analysis should take into consideration. spoilage factors already built into the cost of the product. Industrial engineering should report their findings concerning the sources of scrap generation. If the problems can be solved, and the scrap percentage reduced, it should recommend attention to those problems. Attention should be recommended even though the scrap percentage was within acceptable limits.

REWORK REPORTS

Industrial engineering should provide studies analyzing the need for reworking or salvaging a product rather than scrapping it. Many times a replacement part can be produced cheaper than a salvaged part. Cost comparison studies can be undertaken and the data will be factual, when industrial engi-

neering validates hours expended to rework a part.

Rework hours should be thoroughly investigated. Sometimes rework is generated because of poor instruction, ineffective communication, or careless workers. The reasons should be brought out into the open, and not allowed to "hide" in the variance overhead hours.

It is at the line level of management that resistance to change may begin to become manifest. Foremen or supervisors are expected to run their departments and to direct the efforts of their workers. It would be easy for them to interpret a study of things taking place in their departments as criticism of their performance. Industrial engineering should make supervision aware of the reasons a study is being taken. Supervision will be much more cooperative when this communication takes place.

PERFORMANCE REPORTS

Performance reports can be a driving force for productivity improvement. A report will show departmental hours worked, production hours, product produced, allowed production hours, production hours earned, and hours not on production.

When industrial engineering uses this source as an indicator for recognizing problems, it should pay.particular attention to the hours not on production. These hours are usually listed under headings clarifying the reasons for the hours -- set-up, material handling, instructions, tool or machine trouble, clean up, rework, etc. It is easy to see why this category would be the start for investigative analyses and reporting.

If the report does not break down these hours, industrial engineering should recommend the change. Management must be aware of all of the labor hours expended and why they were expended.

Many times performance goals are set to correspond with budgeted hours. Sometimes if there is "money in the budget" for it, management will appear to be complacent about poor performance. Industrial engineering, nevertheless, should make available reports on the reasons for poor productivity and performance.

BOTTLENECK STATIONS

Bottlene'ck stations are not always due to capacity limitation or workload. Work sometimes “piles up" at a station because of other reasons.

A new or reassigned worker or one not familiar with the operation is at that station.

. Servicing the station is poor and the worker cannot produce to plan.

Machine or equipment is not functioning properly.

Additional labor is required because of defective material.

Additional labor is required because of a change to the work scope.

Manning requirements are not being adhered to.

There are many more reasons, but these cover the majority of reasons why a station is.the bottleneck.

Industrial engineering can bring attention to these stations by first questioning the need for work flow analysis. When was material handling last analyzed? Have ratio-delay studies been made recently? Work Sampling? By reviewing the tools used to solve problems like this, industrial engineering can recommend courses of action to "break" the bottleneck.

CUSTOMER COMPLAINTS

Satisfied customers believe, at the time of delivery, they have.paid a fair price for a quality product. They become dissatisfied customers, after the .time of delivery, if problems occur during the use of that product, which are traced back to yard workmanship.

In private life, when the decision is made to purchase something, “what you see is what you get.” You know what the price is. If you think that price is fair, you are happy. You are also happy with the "quality" of the product if it “looks” or “appears” to be a quality product.

Ship trials are another matter. Problems occur These problems are brought to the attention of the shipyard. If the yard does nothing to service those problems in the future, the customers will be dissatisfied. They might not be customers of that shipyard again.

When these complaints come in, industrial engineering can service the problems by analyzing the materials and processes used. They can recommend alternatives or substitutions in methods of manufacturing the product.

WHO PARTICIPATES IN PROBLEM SOLVING

Techniques for creative thinking are increasingly being used by companies for problem solving purposes. Several can be used for defining problems and assessing the needs of those involved.

A large number of ideas can be created. The screening and evaluation of ideas can be a long process and frequently everyone involved in the manufacturing of a product participates.

We have all heard someone say, "Come here, I want to pick your brain." It can start when supervisors tap the ideas of workers, or supply the spark to bring forth ideas. Ideas workers may have had for years but would't contribute.

Likewise, there is an up the ladder tapping of ideas taking place. Supervisors are tapped by engineers, engineers are tapped by managers, and managers are tapped by the company.

Top management comes strongly into the picture, but the line supervisor and the work crew are in the best position to generate or spark ideas. These are the people industrial engineers must motivate, and urge on, in order to realize productivity gains.

Resistance to change must be recognized by industrial engineering as being inherent in the nature of its work. By accepting this principle, industrial engineering can guide others. It can attract others into the use of its services--assistance in the planning and producing of a product.

SECTION IV

WORK SAMPLING

PROBLEM IDENTIFICATION

Success. It's a wonderful word! It's nice to be a success -- at home -- at work -- at play. Facts help us to be more successful in our activities and in our decisions.

Shipyard managers and foremen have many sources of facts -- accounting, engineering, planning and personnel. Sometimes facts need to be carefully measured, cross-checked and triple checked. It is necessary to be 99% sure. Other times you'll feel comfortable and confident with 80% confidence. Once in a while, you will settle for the "in the ball park" answer.

There is a quick and easy way to get facts. Especially if you don't have to be 100% sure. It's called “Work Sampling."

What is Work Sampling? The name "Work Sampling" describes the tool. Work sampling means: “Take a sample of the work. Get a quick look at the total . picture."

So what? What's the benefit? Taking a sample requires far less work than checking the total quantity. Taking a sample can identify problems before the job is complete. It is a way of getting an

idea of the complete picture before all the work is done .

Foremen and Engineers say that it is often a way of identifying the sources of future problems. They have found out' through Work Sampling that small problems can be corrected before they become large problems. And -- they won't become future problems! Work Sampling is a proven and practical way a . supervisor can determine what problems there are and how big the problems are. It can pay off in better service and lower costs by helping to identify unknown problems, idle time, opportunities for Work Simplification, need for training, and so on.

Work Sampling is not a new technique, and is known by several names. Work Sampling, Random Sampling and Ratio Delay all mean the same thing.

Work Sampling is based on the principle: the percentages for work observed will probably reflect the percentages for the total:

Work Sampling indicates: how much of the time people are working, and what they are doing by periodically observing them;

Samples are secured by observation, and serve as a guide to the whole job. Work Sampling has-the-following advantages over other techniques:

Taking a sample is an opportunity to catch errors before the total job is done.

Taking a sample saves time and effort for everyone.

The saving of time and effort is obviously important.

There is another important advantage. The random review involved in sampling a job gives the person doing the sampling exposure to what is going on. More than he or she would customarily acquire.

It gives an overview of work as it is performed. So that the observer gets "the big picture."

Work Sampling does not mean that complete studies of a job are unimportant. Sometimes both are necessary.

Work Sampling is a-form of Work Measurement. It may be used to study the work activity on an individual, a machine, a crew, or a combination of crews..

Sampling of work requires the gathering of a number of on-site observations. These observations need to be recorded. Next step is to analyze your results and summarize in order to demonstrate where improvement can be made.

In formal work sampling, the observations must be done in a random manner to assure an unbiased action. But let's be realistic! It would be difficult to do so in cramped work areas where there might be only one way in and out. Obviously the technique must be modified to allow for these conditions. It can still be a powerful tool for the supervisor and engineer when common sense adjustments to the technical procedures have been made.

There are several other advantages to Work Sampling:

> Special skill is not needed. Work Sampling is easily learned. ”
>
> The supervisor can be of great help to the observer. Or the supervisor can be the observer.
>
> The main requirement to do good Work Sampling is to be conscientious.

And if the observers are the supervisors:

They usually move around in the areas anyway. So observations can be tied in with regular work.

Activity observed will be understood.

Results are more believable.

Work Sampling is a technique to let you find out just how good your crew or crews are doing in relationship to planning. It can be used effectively where standards are not available for crews. Work Sampling will supply the answers in many areas -- in any area where there is a need for identifying the reasons or causes for bottlenecks or waste.

For instance, in a large operation in the East, a Work Sampling study showed that fork lift trucks were traveling unloaded 50% of the time. Action was taken to change the material flow through the shop. Fork lift truck operators would pick up and deliver raw materials to a department, and also transport in-process parts to the next department, or finished goods to the shipping department.

Work Sampling is based on the proven principle that the percentage of observations recorded for any part of work reflects the percentage of time actually spent on that part of the work. It is an easy way to obtain important facts. The different parts of work, the doing, the preparing to do, and the putting away, can be measured by sampling or observing. In doing sampling, there are rules that should be followed in order to get a true picture of what is being done:

- More than one sample is needed.
- Samples should be taken at random.
- Use random approaches and random times.
- Observations must be instantaneous

Keep in mind that sometimes we have to do things in another way to get the job done. We can't always play "according to Hoyle." Since one or just a few observations are not enough, a question appears like an illuminated light bulb -- how many samples are really needed to get the job done?

As a rule of thumb, to get a ball park figure for the amount of idle time with a degree of accuracy, at least. 100 samples are needed. As the number of samples increases, the ball park figure will be fine

tuned and the margin of error will decrease. In preparing for an' actual study we must:

Select the job.
List the elements.
Make a recording form.
Get random times.
Make the study.
Summarize the findings.

Look for idle time -- waiting for material, waiting for instruction, waiting for set-up -- whatever the cause. Idle time can be reduced through Work Sampling. Recognition of the causes or reasons for idle time will lead to cost improvements.

The mechanics of Work Sampling involve four steps that must be followed in order to complete a Work Sampling study They are

Prepare for the study,
Make the observation,"
Analyze the results,
Prepare a report for yourself
and whoever else is involved.
Include your recommendations.

Let's look at what the supervisors and engineers must know in order to do a Work Sampling study.

They must know some of the basic principles of Work Sampling. The method of recording observations and the selection of approaches to the work must be understood. Like any job, it is also helpful to know some of the common words identified with Work Sampling.

First, what is an observation? An observation is a “mini" description of what is being done and is clearly and immediately identifiable. As an example, here are some typical categories of work:

- Receiving instructions,
- Hauling material,
- Inspecting.

These categories are descriptions of work activity that are easy for everyone to understand. They are important. And if out of line, they indicate where immediate action for improvement can be taken.

The supervisors and engineers performing the observations should have a good working knowledge of the operations and of the workers performing those operations. For instance, a category of "idle could be incorrectly identified as "waiting on another group; or “waiting” for material” if the observer does not understand the operations of that department.

It is also important to know how many observations will be necessary to arrive at factual data. You must have confidence in your sampling study! You must know:

- How important is the element?
- How important is it to know exactly how often the element occurs?
- About how many observations should you make to get a good idea as to its occurrence?

BASIC "COMMON SENSE" SAMPLING

In determining the number of observations for Work Sampling, it is difficult to beat common sense. Sometimes you get the picture very early in the game!

Suppose you were sampling for an element that occurred only one time after 50 observations. This is such a low occurrence -- 2%. You might decide that 50 observations would be enough.

Suppose you took another 50. If you only had 2 tallies after the 100 observations, it would be a strong indication that this particular event will continue to occur only a small percentage of the time. If that is all you need to know, STOP. You have enough samples

Here is an easy practical way to decide how many observations you want to make to get your Work Sampling answers: .

- Make some observations:
- Recap your percentages.
- Make some more observations.
  Recap your percentages again, for the total.

If the percentage difference is small and unimportant, it is probable you have enough obserations.

STATISTICAL WORK SAMPLING

The Work Sampling Simulation Chart (Exhibit A) was used to plot the deviation from the average observed percentage the worker was spray painting. Sixty observations were made each week for three weeks, a total of one hundred and eighty observations.

At the end of each week, the highest % of activity was posted and the lowest % of the activity was posted. At the end of the first week, the high percentage was 65.4% and the low percentage was 39.6%. The mid-point or average for the week was 52.5%. The "margin of error" (deviation from the average) was 12.9%. (65.4 - 52.5) = 12.9%. (52.5 - 39.6) = 12.9%.

As the weeks' highs and lows were totaled and averaged, the margin of error decreased. By the end of one hundred and eighty observations, the cumulative high was 60.0% and the cumulative low was 45.0%. The margin of error from the mid-point (52.5%) was.7.5%. (60.0 - 52.5) = 7.5%. (52.5 - 45.0) = 7.5%.

Consequently, the confidence level of the sampling improved from ±12.9% to ±7.5% as the margin of error decreased.

TEXHIBIT A

STATISTICAL WORK SAMPLING

SPRAY PAINTING SAMPLING -
PERCENTAGE WORKER WAS SPRAY PAINTING

	1st Week		2nd Week		3rd Week	
DAY	%	CUM.	%	CUM.	%	CUM
MONDAY	65.4	65.4	58.2	61.8	56.4	60.0
TUESDAY	53.5	53.5	52.5	53.0	52.0	52.7
WEDNESDAY	52.5	52.5	51.5	52.0	54.5	52.8
THURSDAY	51.5	51.5	53.5	52.5	51.0	52.0
FRIDAY	39.6	39.6	46.8	43.2	48.6	45.0
SAMPLE TOTALS	60	60	60	120	60	180
CUMULATIVE HIGH		65.4		61.8		60.0
CUMULATIVE LOW		39.6		43.2		45.0
CUMULATIVE AVERAGES		52.5		52.5		52.5
MARGIN OF ERROR		12.9		9.3		7.5

At the end of 120 observations, the cumulative upper control limit was at 61.8% $\left(\frac{65.4 + 58.2}{2}\right)$ The lower control limit was at 43.2% $\left(\frac{39.6 + 46.8}{2}\right)$. The margin of error would be ± 9.3%.

At the end of 180 observations, the cumulative upper control . limit was at 60.0a $\left(\frac{65.4 + 58.2 + 56.4}{3}\right)$, the lower control limit was at 45.0% $\left(\frac{39.6 + 46.8 + 48.6}{3}\right)$. The margin of error would be ± 7.5%.

As YOU can see, the margin of error is decreasing. You would continue to take additional samples if that plus or minus 7.5% was not acceptable.

The workers in the department should be told that a Work Sampling study will be made. They shouldn't feel that a "spying activity" is taking place. If they are informed of the purpose of the Work Sampling study, they will not feel uncomfortable when the observers enter their department.

Someone once said that paperwork was a necessary evil ! However, standard forms for Work Sampling are not necessary. Work Sampling is a do-it yourself type of activity. The basic idea is to have a form that is easy to use. One that is convenient for the observers to use.

Before making a final decision on the Work Sampling forms you are going to use, make a few random trips. You may find some additional events you want to record.

The summary sheet should have columns for event or element categories, number of obsenations, number of tallies, and the time the observations were made. Summary sheets are necessary to recap and analyze the totals.

We had mentioned before the preparation necessary to make a Work Sampling study. The other three steps are”observe, analyze.” and report.

Once the categories have been defined and the times for observing have been picked, we are ready to make the observations. .The supervisor or engineer should be at the work place at pre-planned times, and tally what is being done at that instant. If they should miss an observation time, they should "scoot out" and grab 'it as soon as possible. The time for observing is very important in Work Sampling.

You must indicate on your observation sheet what work was being done at the time of observation. Don't wait for a category to start or finish. Be your own umpire. "Call 'em like you see 'em."

As an example, if one of your categories is "machine unattended," and at the time of observation the operator was not at the machine, tally what you see. "MACHINE UNATTENDED.11 Do so even if the operator was observed walking towards the machine. The machine was unattended at the instant of your observation.

Take different approach routes for each day of the study, if possible. If you always come by the same route, at the same time, you may get a "dog and pony show." The work or activity being performed

should not be for your benefit. Selecting the routes and the times prior to the study will not guarantee a true picture, but the odds will be in your favor.

Each day, you and the other observers making the study should get your heads together and report your findings. Make out the recap sheets for that particular day. Show the number of times each category was recorded.

Analyze your results after you've started making observations. It might be that a category thought to be important is not important at all. Or turn it around. A category not included is really important. Don't be afraid to change your categories. and start out all over, if there is a need to do so.

When you've finished the Work Sampling observations, it's time to analyze and draw conclusions. Use simple graphs and charts to help you in your analysis. Be sure to prepare a report on your findings. Identify where the percentage of occurrences in any category indicates that immediate action be taken. Problems just won't go away by themselves.

Any simple graphs and charts you used to help in your analysis can also help make your report clear for others. Usually the recap or summary sheet by itself will bring attention. When you've prepared, made the observations and analyzed the results, you can have confidence in your report.

Let's review what Work Sampling can do for you and your company.

Work Sampling is a proven and practical way a supervisor can recognize problems. The supervisor can use Work Sampling to decide the size of the problem and what to do about it. The objective of all supenisors should be the reduction of costs through better obsenation. Work Sampling observations can lead to improved safety and fewer injuries. Improved methods lead to improved productivity with less effort. Schedules are apt to be more attainable in a short period of time because of this "Shands-on" type of observation. Most important of ail, Work Sampling helps deliver a quality product at a lower cost.

The random review involved in sampling a job performed by a worker, a crew, or a group of crews will give the supervisor or engineer doing the sampling a bird’s eye view of what's going on.

Understanding the “big picture" can provide greater job satisfaction, understanding, recognition, and job security.

Identifying work that can be improved helps highlight improvement opportunities. Taking action on those opportunities helps put you and your company in a more favorable position.

Let's recap the reasons for using Work Sampling. "it is a way of getting a quick look -- with reasonable accuracy -- at the total picture.” Counting a few beans at a time requires less work than counting all the beans. A few samples can identify problems before the job is over. It is a convenient way to anticipate and prevent troubles. There are many other benefits from Work Sampling. The saving of time and effort is obviously important.

But there is another important advantage. The random review involved in sampling a job gives increased knowledge to the person doing the sampling. It gives in-depth exposure to-what is going “on! It provides a step-by-step analysis of work as it is done.

When should Work Sampling be done? The sooner the better! The many benefits for you -- from Work Sampling -- are there for your taking. It will do a job for you. It's a powerful, powerful tool! Practice Work Sampling regularly, and you will

- know your operations better.
- have greater success in recoanizing problems.
- have great success in correcting problems.

WORK SAMPLING QUESTIONS

Question! When should you start doing Work Sampling?

IMMEDIATELY -- while the principles are fresh in your memory!

IF SO, WHERE?

I. How about quality Problems?

Check the following:

(1) Defects -- Type & Frequencies?

(2) Causes -- Type & Frequencies?

LOOK FOR SOLUTIONS AT THE SAME TIME!

II. How about Productivity Problems?

Check the following:

(1) Faulty equipment?

(2) Faulty or missing tools?

(3) Poor workplace?

(4) Rework?

(5) Waiting?

(6) Idle?

(7) Away from work area?

(8) Interruptions?

(9) Poor work methods?

(10) Untrained people?

LOOK FOR CAUSES AT THE SAME TIME!

III. How about problems meeting planned schedules?

Check the following:

(1) Waiting for assemblies?

(2) Waiting for parts or supplies?

(3) Working out of sequence?

(4) Unskilled people?

(5) Faulty equipment?

(6) Interference -- crews?

(7) Interference -- weather?

(8) Plan changes?

(9) Rework?

(10) Defective Material?

(11) Faulty specifications?

AT THE SAME TIME, LOOK FOR CAUSES --

-- AND SOLUTIONS!

REFERENCE SOURCES

Lehrer, R. N., Work Simplification, Prentice-Hall, Englewood Cliffs, N. J., 1957.

Maynard, H. B.,Industrial Engineering Handbook, Third edition, McGraw-Hill, New York, N. Y., 1963.

Maynard, H. B., Industrial Engineering Handbook,First Edition, McGraw-Hill, New York, N. Y.,1956.

Morris, R. G.," The Past,Present and Future of Industrial Engineering",Industrial Engineering and Management press, Institute of Industrial Engineers, Norcross, Georgia, 1983.

Salveny, G.,Handbook of Industrial Engineering,John Wiley & Sons, New York, N. Y., 1982.

"The Critical-Path Method", American Telephone and Telegraph Company, Business Research Division, August 1963.

SECTION V

OPERATIONAL ANALYSIS

The following pages briefly describe a number of other Industrial Engineering techniques that can readily . be used to analyze the operation of a production area.

PRODUCT ANALYSIS

One of the programs for product analysis is value engineering. It is a systematic, creative approach to ensure that the essential function of a product, process, or administrative procedure is provided at a minimum over-all cost .

For emphasis, the following elements of value engineering are listed:

- It is an organized creative approach to cost reduction.
- It places emphasis on function rather than method.
- It identifies areas of excessive or unnecessary costs .
- It improves the value of the product.
- It provides the same or better performance at a lower cost.
- It reduces neither quality nor reliability.

Value engineering entails a detailed review of product designs and specifications. It places a dollar value on the costs of production and maintenance, and relates the functional value of parts and assemblies to cost.

COST COMPARISON

Industrial engineering should analyze the cost of tolerances and finishes. Overly stringent tolerances may result in unnecessary cost. Key tolerances and specifications for finishes must be analyzed. Industrial Engineering should investigate if it is possible to use less expensive manufacturing processes or materials.

Some of the questions industrial engineering should ask:

Is the finish more extreme than required by the end use?

Are tolerances specified practical and economical in view of end use?

Is the design restricted to one production method only, or is it flexible enough to lend itself to several methods?

Are all finishes and tolerances specified only to the degree necessitated by the functional use?

MACHINE AND EQUIPMENT ANALYSIS

There are many opportunities in industry today for multiple tending of machines and "cell" grouping of machines. One of the techniques for analysis of this type of activity is the Man and Machine Chart.

The Flow Process Chart is the steam shovel tool of Work Simplification. It is used in the initial stages of analysis because from its use results can be gained in a relatively short time. Other types of process charts, designed for a more detailed study of flow, should follow.

The carpenter starts his work with overall tools - the saw, the hammer, the chisel, etc. - roughing tools if you wish. He then progresses to finer tools - the plane, the scraper, the rasp, etc. Finally he puts on the finishing touches with sand paper, finish and polish, thus completing a thorough job. The Flow Process Chart is similar to his-roughing tools and the Multiple Man and Machine Activity Chart is the next finer tool.

Many of the activities of a Flow Process Chart are performed by groups of men or men and machines. The coordinated breakdown of their respective activity as a

team is represented graphically according to a time scale. This then-becomes a man and machine chart. The chart can plot the detailed activity of men and machines. It can be the detailed activity of a man operating a drill press for example. Or the gun crew of a battery firing a gun. Or several trades outfitting a ships compartment. Or just the detailed breakdown of the assignments of each man on a foot-ball play coordinated against time. All can be put on a Multiple Activity or Man and Machine Chart.

What a Man and Machine Chart Will Do

1. The M & M chart shows you graphically just how the man and his machine work together as a team..

2. The operator and the machine work inter-mittently on some types of work. That is, the machine is idle whenever the operator is loading or removing material. The worker is idle also when the machine is in operation. It is desirable to eliminate idle time for both .

3. A properly prepared M & M chart will show:
   a. Idle operator time.
   b. How long operator idle time lasts.
   c. Machine idle time.
   d. How long machine idle time lasts.
   e. Relationship of idle time to the part of the cycle during which the operator is busy.
   f. Opportunity for giving the operator more work to do during his idle time.
   g. Opportunity of shortening machine idle time.
   h. Opportunity of operating more than one machine at a time.

4. Idle operator time should be eliminated.

5. Operator idle time can be reduced by -
   a. Speeding up the machine cycle.
   b. Giving the operator more machines to run.
   c. Giving the operator other work to do during the idle time. This can be doing another operation on the same product, such as burring, packing, etc. or it is sometimes possible to give him work on a different product.

d. Rearranging the sequence of his work in respect to the machine cycle so as to obtain the best working relationship.

Remember, when the operator is idle, you are paying money for value not received.

6. It is equally important to keep the machine busy just as much as possible. When it is idle -
   a. The original cost of the machine and the rental of the floor space which it occupies is not being recovered. In many instances, an idle machine costs almost as much per hour as one in operation.
   b. Much needed production may be delayed. If a machine is idle 50% of each cycle, then two machines may be required to do work. Work which one machine could do if properly operated.

7. Machine idle time can be reduced by
   a. Shortening the amount of manual time which must be performed while the machine is idle. This may mean nothing more than shortening the motions and time to load and unload the machine.

b. Giving the operator less machines to run if he is overburdened. In most cases, it is just as bad to overload the operator as it is to let him be idle.

c. Rearranging the sequence of machine vs. "manual work so that machine idle time is at a minimum.

8. An M & M chart is not always required to get a better relationship between the Man and the Machine. However, in most cases getting a good picture on paper is very helpful. It usually reveals things which you didn't expect existed. It is possible to work out solutions with M & M charts which would be almost impossible to work out in your head. Difficult to work out even on paper by mathematics or formula.

9. Likewise, the interaction of several trades within a ships compartment, or crew members working on a common assignment can be analyzed.

MULTIPLE MAN ACTIVITY CHARTS

A multiple man activity chart is a chart of the coordinated synchronous or simultaneous activities of a work systerm of two or more persons. Each person is shown in a separate-j parallel column, indicating activity as related to the rest of the work system.

A multiple man activity chart shows graphically these activites on a common time scale. Charts showing work crews are usually called “gang charts”. Crews can be analyzed working on the same operation or sequential operations.

Although every charting technique is useful in selling and-demonstrating new methods to people, multi-man charts are more so. With the interrelated activities of several persons it is difficult to demonstrate new . methods to people without this chart.

Since the chart clarifies unavoidable delay time for each worker,it helps to improve their utilization. The work load of the crew can be balanced for effective utilization of assigned personnel.

This chart specifies the overall cycle time of a work system with multiple activities, and becomes the basis for the work scheduled. The activity to be studied is divided into work elements performed by each person. Symbols are used to show the type of activity taking place.

Operation - Hand(s) used for activities such as obtaining, positioning, moving, etc.

Transportation - Reaching to or from objects.

Delay - Idle hand(s) or waiting.

Hold - Hand holds object in fixed position in order to help the other hand's work.

Following is an example of one of the charts used. There are many different types showing multiple activity in relationship to expired time.

NO. _____
PAGE _____ O

MULTIPLE ACTIVITY CHART

SUMMARY PER _____ PIECES

	MAN		MACHINE	
	TIME	%	TIME	%
WORK				
IDLE				

OPERATION _____

_____ METHOD DATE _____

ANALYST _____ SCALE DIVISION _____

LAYOUT

PART- SKE

	ACTIVITY OF	TIME	ACTIVITY OF
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			

CRITICAL-PATH METHOD

The Critical-Path Method provides an organized and methodical way of carrying out the planning and scheduling of projects. Projects requiring coordination of a number of interrelated activities. Its general purpose is to develop the most efficient plan in terms of time and money costs . The use of CPM procedures can give greater certainty of efficient planning than the traditional methods generally used. It reduces the likelihood of omissions and lack of coordination in planning.

There are five principal procedures in CPM.

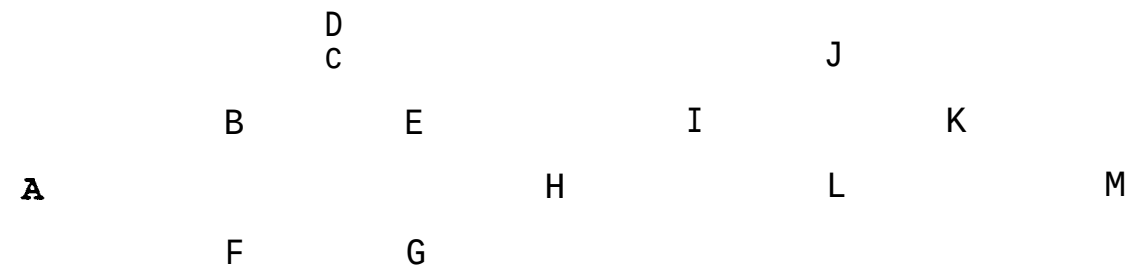
- Arrow Diagramming - by means of a diagram that shows the interrelationships in time sequence among the activities comprising the project.
- Finding the Critical Path - by adding time measurements to the time sequence shown in the arrow diagram.
- Evaluating the Resulting Program - by considering time. and cost requirements.
- Scheduling Activities - by assigning specific start and finish times for each activity.
- Reducing Project Time - by using the information developed through the previous procedures

to gain the specified reduction at the lowest additional cost.

EXAMPLE OF AN ARROW DIAGRAM

A.	Hoist Lift Truck	Worker	**#1**
B.	Remove Drain Plug	"	#2
c.	Drain Oil	"	#2
D.	Inspect Tires and Exhaust	"	#2
E.	Replace Drain Plug	"	#2
F.	Grease Underside Fittings	"	#1
G.	Check Differential & Transmission	"	#1
H.	Lower Lift Truck	"	#1
I.	Grease Upper Fittings	"	#2
J.	Oil Generator and Distributor	"	#2
K.	Check Radiator and Battery	"	#2
L.	Refill Crankcase	"	#1
M.	Return Lift Truck	"	#l

ASSEMBLED ACTIVITIES



This simple diagram illustrates the basic structural form from which all network diagraming is developed.

Planning and scheduling usually involve both extensive and intensive collaboration and coordination

Management needs can materially affect planning and scheduling a project. CPM is a vehicle well suited to facilitate necessary interchanges of information between management and planners.

CPM is mechanically similar to several other planning and scheduling techniques, particularly to PERT. CPM, however, integrates the two factors time and cost in its measurement system. PERT (Program Evaluation and Review Technique) is concerned essentially with determining most probable time.

attitude and human relations may outweigh the savings. Certainly the customer and the community will. benefit through this "team effort for productivity improvement .“

TRAINING PROGRAMS

Training is one very important part of any participational operational analysis program. The length and type of training should be tailored to meet the needs of the organization. Supervisory groups usually receive more training than either management or production groups.

Programs should include examples of operational analysis results. They should show why improvements are necessary and desirable. The impact of the human factor, a logical approach to solving work problems, and an introduction to techniques used in solving problems should be part of the programs, also.

Two important things to be learned through formal training are:

- An attitude that encourages continuous improvement.
- A step-by-step procedure for developing improved methods.

When these things are developed, the remaining problem is keeping them alive and functioning. This can be accomplished by committee activity, refresher training, and programs incorporating the operational analysis approach with regular job duties. Although training more than pays its own way through operational improvements, the improvement in

BASIC PRINCIPLES
O F
INDUSTRIAL ENGINEERING

In three Parts:

Part I	**What is Industrial Engineering**
Part II	**Operational Questions for Industrial Engineers**
Part III	**Communicating your Ideas**

Prepared especially for

SNAME PANEL SP-8 ON INDUSTRIAL ENGINEERING

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

By

STANDARDS, INTERNATIONAL INC.

"Chicago, Illinois

TPART III

COMMUNICATING YOUR IDEAS

TABLE OF CONTENTS

SECTION I

WHY IS IT IMPORTANT TO COMMUNICATE?

COMMUNICATION - HELPING WORKERS, SUPERVISORS, STAFF, MANAGEMENT, COMPANY AND COMMUNITY

The improvement of listening, or making people aware of how important listening is, can be of great value in today's industry. When employees in industry fail to hear and understand each other, that failure can result in many unsolved problems.

Building awareness of the importance of listening among employees can eliminate a large percentage of errors caused by poor oral communication. Incidents created by poor listening can cause people in industry to insist that communication should be put in writing. A memo is issued for even unimportant things. Paper work stacks higher and higher and is usually thought of as the red tape involved in communication. Many times less writing and more speaking would be advisable.

The skill of listening becomes very important when upward communication takes place. There are many routes through which management can send messages downward, but there are few routes for movement of information upward. Perhaps the easiest route would be the chain of people talking to people. The worker talks to his supevisor. The supervisor talks to someone on staff. A staff member

talks to a manager. A manager talks to the head of the company. Eventually the message reaches the top, probably distorted through errors in transmitting.

This communication chain has potential but it seldom works because of the many poor listeners involved. Only one poor listener is necessary to prevent a message from reaching the top.

People in all phases of industry need to feel free to talk to their superiors. They need to know they will be met with sympathetic understanding. But too many bosses although they announce that their doors are always open - fail to listen. Because of this failure, workers do not feel free to say what they want to say. As a result, workers withdraw from their bosses more and more. They fail to talk about important problems that should be aired. When such problems remain unaired, they often turn into unrealistic monsters that come back to torment the . boss who failed to listen.

Both the worker and supervisor benefit when the supenisor listens to one of his worker’s problems. Attending to problems through proper communication can lead to improved productivity, up and down the ladder. If a company can be competitive in the market place, the company will be able to keep its doors open.

The employees will have dollars to spend in the community. Many businesses will benefit because those involved tried a little harder to transmit and receive messages.

IDENTIFYING EXISTING PROBLEMS AND SOLUTIONS

Effective communication is in constant need by the workers and the machines and equipment they operate. Workers and machines are the front line of manufacturing, Without a two-way system of identifying problems, and attending to those problems, the forces cannot advance.

Industrial Engineering can get to the heart of many problems. They must work with the supervisors and workers in coming up with solutions to eliminate those problems. Some of the ways it can do so is

- by explaining methods and schedules,
- by reporting existing problems and recommendations to management,
- by presenting graphic material to emphasize need for improvement,
- by reporting savings through improvement projects.

Solutions to labor variance are revealed when Industrial Engineering explains to supenisors and workers the specified method and schedule for an operation. Industrial Engineering should ask the supervisors and workers what the problem is. Usually the supervisors and-workers will respend with, “We are not producing to schedule”. To find out why they are not on schedule, Industrial Engineering should suggest a review of the specified method and sche-

dule. Reviewing the operations step by step will usually provide the necessary solutions.

Industrial Engineering will sometimes be the first-reporter of existing problems. They must be careful and selective in their communication with line supervision and the workers when this happens. Industrial Engineering will now be invading the supervisor's territory. Supenision did not ask for assistance. Industrial Engineering must now review with those concerned the benefits gained through this reporting - for workers, supervisors, and management. In some cases, its supervision and the workers can be given credit for the reporting through tactful communication. Industrial Engineering must find a way to win back the respect of supervision and the workers. That respect will return once the line supervisor and worker feel they have contributed to the reporting. They will in fact ask Industrial Engineering to help them solve those problems.

When graphs are developed by Industrial Engineering to identify problems, the data source must be factual. Frequently, management is not too concerned after the first presentation of graphs. When management is confident the graphs are valid, they start to pay attention. As the days roll by, if there isn't improvement upward, their involvement is usually intense. It's amazing how that graph now becomes their own personal vehicle for showing improvement.

Industrial Engineering can gain the attention of many employees by reporting savings through implementation of improvement projects. Most of us like to see our names in print - especially if it identifies us as the contributors to the savings. There's something about the good old dollar that sparks enthusiasm. All of the contributors must be recognized when reporting improvement project savings. Those involved directly and indirectly should be given recognition. Even a little help can trigger a bigger help. Its a chain reaction called team participation.

Management is beginning to face the fact that you can't take the employee for granted. Companies are dealing with a different kind of employee. This employee is looking-for job satisfaction and meaningful work. This employee is looking for effective two-way communication. There has to be an acceptable answer for any question. This employee needs that answer.

SECTION II

WHO BENEFITS FROM COMMUNICATION?

WORKERS BENEFIT FROM COMMUNICATION

A squeaking wheel usually gets greased. Workers realize that oral communication with their supervisors is the most effective way to bring attention to their problems. Workers find it difficult to say what is really on their minds. Good supenisors and industrial engineers must search for the main idea behind their questions. When this takes place, Supenision and Industrial Engineering will provide for the workers a feeling of participating and belonging.

This feeling of participating and belonging is not easy to achieve. It takes a lot of hard work to ensure it even for a short period of time. And when you consider each supervisor has thirty to forty workers, on the average, the difficulty is compounded in many directions. Think about Industrial Engineering assisting more than one supervisor. If industrial engineers can't communicate properly at the line level, their contributions for improved productivity will be hard to identify. Their careers will justifiably be in jeopardy.

Good communication will also bring workers up to date with their concerns over events affecting their job security. When the bins are full, the workers will usually test the waters with "sales must be good?". When the bins

Tare empty the questions usually are: “will there be a lay-off?", or “when will sales pick up?". In all directions, workers are constantly weighing what is taking place in relationship, to their security and peace of mind.

Management must inform all employees of events and conditions affecting the welfare of those employees. Positive things need to be communicated. Sales are good. Customers are happy. The company plans to expand. New product has been developed. All of this information is important. All of the negative things must be communicated to ensure the workers are confident in managements ability to manage. Sales are poor. Customers are unhappy. Company will not expand. All are important. If they lose this confidence, workers will feel their security is threatened. When this happens workers become antagonistic, challenging, and nonproductive. Poor performances can be the coup de grace delivered to a struggling company.

It is easy to see why communication is the catalyst for job satisfaction. If problems affecting an employee performance are recognized, and solutions are put into motion, that employee will experience satisfaction. To satisfy is to supply fully what is desired, expected,. or needed. To satisfy is to free from doubt or anxiety. To satisfy is to give what is due to To satisfy is to answer sufficiently and convincingly, as a question or

objection. To satisfy is to fulfill the conditions or requirements of. To satisfy is to give satisfaction.

Supervisors can experience job satisfaction by satisfying the needs of workers through up front answers, easily understood. They will be quick to notice the difference this will to work makes. When they do, supervisors will be experiencing job satisfaction.

Industrial Engineering must be the catalyst for opening the door to satisfaction. It must take on the role of the arbiter, without the authority of an arbiter. It is a challenging job, but if Industrial Engineering is successful in bringing them together, suddenly there is team satisfaction. A satisfied team will be more effective in producing solutions for improved productivity. Implementation of those solutions will be much easier when the team works together to do so.

MANAGEMENT BENEFITS FROM COMMUNICATION

By communicating with Industrial Engineering and prompting it into the role of arbiter, Management will enjoy team action. Sometimes it is necessary to assure problem identification and to ensure implementation of solutions for those problems. Wars are won or lost in the trenches. In industries, it's the Workers, Line Supervision, and Industrial Engineering who are in occupancy of the trenches.

A management consultant tells a story that shows how simple yet complex the communication function is. He was called in to recommend how Management might communicate better with its work force. He suggests the President of the company join his people out in the corridor at a coffee bar. This was a break with tradition - it had never been done before.

The first attempt by the President was an abysmal failure. He didn't even know how to work the coffee machine. Employees were clustered together in little groups discussing their various concerns and glancing curiously at this man in a suit. He drank his coffee and went back into his office.

The consultant made a suggestion for the next break. "Take off your suit coat and tie and once again join the

employees". This time he got his coffee without any problem and mustered enough courage to break into the perimeter of a small gathering.

He talked about a current concern of the work force (the opening of a plant in Europe). Explanations were given for the decision to do so. He was surprised to find himself in the middle of an animated discussion about the plant.

Soon employees felt comfortable in discussing problems with him. And Management also started attending. His success opened their eyes to how beneficial this communication could be for them in solving problems.

Too many management people are reluctant to rub shoulders with the people out on the floor. Some of them never go out to the shop. Some never communicate directly. Some, for goodness sakes, never drink coffee anywhere but in a private office. Communication, when it skips a few rungs in the ladder, can sometimes be very effect-ive. When all eventually join in, Management has been added to the team as a participant in improved productivity.

THE COMPANY BENEFITS FROM COMMUNICATION

Perhaps the greatest significance of communication is that it restores badly needed balance to the management of a company. It can produce a readjustment that is needed. Because of this action, employees are provided a method of identifying what they think is important. It brings the weight of their on-line experience to bear on company decisions. When carefully fashioned and implemented with common sense, the company will benefit in many ways:

- It results in greater returns on investment.
- It allows for utilization of the skills of the work force.
- The company's position in the market place is more competitive.
- It creates a bond between workers, supervision, staff, management and community.

Companies can survive only if there are favorable returns on investment. Without investors a company does not have the necessary cash flow to conduct its business. If it isn't possible to conduct its business, a product will not be produced. If sales are not made, the monetary return from sales will not exist. Upward and downward communication strengthens the bond. between the producers of the product and the investors for producing the product. Attention to schedules and budgets for

producing a product and communicating the immediate status there of, will satisfy the needs of all concerned.

Taking advantage of the Worker's on-line experience and skills will lead to improved productivity. Solving problems is much easier when the worker's experience is tapped. When" solutions are" implemented through line supervision and the line worker, those employees are contributing to improved productivity. Performing a job day in and day out will develop skills for the worker. Anything preventing the utilization of those skills will affect productivity. The worker's will to perform will deteriorate.

If a company is not competitive in the market place it will soon be out of business. customers are looking for quality, performance, price, and availability. They usually buy the product that will satisfy those needs. Communication will keep every employee in tune with the success the company is having with the customer. Customer complaints are tip-offs for problems requiring action to correct. Customer testimonials are signals for "keep up the good work and we'll buy again".

Employees at all levels feel they are part of the. productive process when communication is effectively used upward and downward. There is a mutual respect and understanding of the job each must do to move the company forward.

.Orders are much easier to take when we know the reasons why. Orders are much easier to give when we know they are understood . This bond between workers, supervision, management, and community is strengthened when the transmitters and receivers are in harmony.

Good communication is hard to achieve. We have been communicating since that first gasp of breath. It is something, however, that not enough of us do well. What we express is sometimes the exact opposite of what we want to to express. We are never so proficient in any activity that we canst improve our skill by gaining a better understanding of it. This is especially true of communication.

SECTION Ill

HOW IS COMMUNICATION ACCOMPLISHED?

COMMUNICATION ACCOMPLISHED THROUGH AUDIO-VISUAL AIDS

Videotaping of an operation can be beneficial to Industrial Engineering. It can be used to analyze the work to be performed. It can be used to specify the best method to be used. Significant savings can be generated through repetitive viewing of the operation and by exploration of the many possibilities in selecting the method.

Videotaping of operations can benefit new industrial engineers, supervisors, staff and line workers. An employee being introduced to a job for the first time has a chance to review and learn the job prior to performing it.-

Besides methods and schedules development, audio-visual equipment is used for interplant communication, manufacturing and corporate interface, cost reduction, and feasibility studies. A picture is worth a thousand words. One division or plant can assist another by passing along a film of an improved operation. It can show how a specific solution was implemented to eliminate a problem. It is easier than transporting personnel back and forth to visit each other. Audio-visual reporting is more effective in problem solving. When it comes to documentation and maintenance of schedules, it's there for all to see in living color.

attention and your closing statement must lead the readers into taking action immediately to correct the problem. The readers must recognize it is for their benefit and the company's benefit to react favorably.

COMMUNICATION ACCOMPLISHED THROUGH WRITTEN REPORTS

Industrial Engineers spend about 30 percent of their time writing reports. It is a very important method of communication for them. They are presenting ideas, suggestions, recommendations and proposals in their supporting roles for planning and producing a product. The best and most efficient reading is based on motivation and interest. Their reports should begin with a summary of what they hope to accomplish. The opening statement should include the possible savings through implementation of the recommended solutions.

The body of the report should guide the reader step by step through the procedures necessary to implement solutions for problems. You are teaching the receiver something you have discovered during your search for solutions.

The closing statement should include specific recommendations for the specific action necessary for improvement. Directness and. completeness are most important. The recommendations should be easily understood and put into practice without further study or investigation.

Analysis reports to management addressing the need for corrective action should be factual and precise. Lengthy dialogues based on assumptions and theory shouldn't be considered. Your opening statement must gain

tion repeat or review what was said before the distraction.

We can judge the receivers' reaction by their. facial. expressions and by their questioning. This reaction is a signal for how well we are getting through. If the signal is weak, adjust the message accordingly. Repeat, rephrase, and' amplify. By judging the reactions of your audiences, you can adjust your presentation to make it easier to receive. If you can shift the odds in your favor, a receivable message will be assured.

COMMUNICATION ACCOMPLISHED THROUGH ORAL PRESENTATIONS

In oral communication there are more human senses at work than in visual. More can be communicated in one message. There is the give-and-take feature of oral communication. The listener has the opportunity to straighten matters out then and there if he doesn't understand the message. It is easy to have the listener play back the message when there is doubt it has been effectively received.

In meetings it is important to stress the reason for for the meeting. The participants should be told over and over why it is important that such-and-such be done. The importance may lie in cost-saving measures, safety, building codes, or health and welfare. Stress your ideas in your presentations and sell your ideas through repetition. We more fully grasp and remember what we hear repeatedly. Summarize your reasons for presenting your report and your audience will remember the message.

At community or organizational affairs there are usually more distractions affecting the listeners. The key to delivering a message at these gatherings is to command attention in a less formal way. Tell a joke. Acknowledge that there is a problem not conducive to good listening. When you once again have your audience's atten-

COMMUNICATION ACCOMPLISHED THROUGH LISTENING

The responsibility for effective communication does not rest solely with the speaker. Creating understanding requires at least two participants.

It is estimated that 45 percent of communication consists of listening. We retain only 25 percent of what we hear. A good listener is a candidate for career advancement because listening effectively enables us to gather data and make sound decisions. It allows us to understand and retain ideas, opinions, and experiences of others.

Earplugs are sometimes required for reduction of annoyance. Contrary to what might be expected, the use of earplugs does not always make speech less intelligible. It might be more intelligible, especially for high noise levels. At high noise levels a point is reached where additional intensity cannot be discriminated. At such levels the difference between receiving speech and the background noise cannot be discriminated. Earplugs will then bring both speech and background noise down to a point where it can be discriminated.

SECTION IV

WHAT IS IMPORTANT FOR EFFECTIVE COMMUNICATION?

HOW TO RECEIVE INFORMATION

The ability to receive information can be improved through active listening. Most of us can easily become passive listeners by not concentrating on what is being said. It is impossible to concentrate on every word spoken. Forget about your surroundings and other activities. Tune it all out and give all of your attention to the speaker. If you focus your attention on the message the speaker is sending, you will receive more information. The communicator will know you are capable of receiving additional ideas and information.

The basic problem affecting listening is caused by the fact we think faster than we talk. The average rate of speech for most Americans is around 125 words per minute. This is pretty slow for the active brain and it searches for more activity. Hundreds of words and thoughts in addition to those we hear are assembled. How a person handles this spare time is the key to good listening. People have to be taught how to use spare thinking. Good listeners usually engage in four mental activities at the same time listening is taking place. These activities tend to direct a major portion of their concentration to the message.

The listener anticipates what is going to be said and what conclusions will be rawn.

- The listener searches for validity of

evidence presented.

Over and over again what has been spoken is reviewed and summarized.

The speaker's tone of voice, expressions, and gestures are scrutinized for meanings not put into words. There is a questioning period taking place.

When people speak they want listeners to understand their ideas. Grasping ideas is where the good listener concentrates. Facts are only remembered as supporting evidence for the validity of the ideas.

To be an active listener, find an interest in what the speaker is saying. Don't tune the speaker out. Think in terms of asking yourself, “what can I learn from this message?”. Keep your mind open. Be attentive. Try to see the ideas as the speaker sees them.

The high-pressure, fast talking sales person is losing ground in the market place. Today's successful sales persons are likely to be better listeners than talkers. They listen for a customer need and try to supply it whenever the cuetomer wants it. What a good sales person says is usually guided by his listening. And so it is with successful industrial engineers. If they are listening, what they say and do will be remembered and appreciated.

Communication is a two-way process. The receivers always react. They may talk back silently. They may simply not listen. To be effective, communication must be a two-way process. When the circuit is complete, the sender is sure- the message has been received as intended.

All communication involves our bodies, sometimes profoundly. Even a pleasant chat about the weather can affect the cardiovascular system, particularly blood pressure. Blood pressure and heart rate will rise rapidly whenever people talk.

The benefits of listening are seen in the "orienting reflex", discovered by Pavlov. When a dog hears a sound or sees movement, it will stop all activity and cock its head. Another scientist, Sokolov noticed that the dog's heart rate slowed also.

A similar response occurs in people too - and it lowers blood pressure. One experiment charted human pressure during reading, staring at a blank wall, and watching fish in a tank. Blood pressure was highest when the people spoke. But it was the lowest when they simply sat and relaxed.

So how can we enjoy conversation yet keep blood pressure down? By listening more, by breathing regularly while talking, by alternating between talking and paying attention to what the other person is saying.

HOW TO TRANSMIT INFORMATION

Before any message is transmitted, you should plan the best way to get the message across. An idea must be presented. What will be the best way to present the idea? Certainly the receivers of the information must be considered-in planning the message. How is the receiver likely to misinterpret the message? What mistakes will the receiver probably make carrying out instructions, recommendations, suggestions, requests? What results do you want from this message? What is the purpose? What is the essential information necessary to present the idea? How should this information be transmitted?

In transmitting ideas for retention it is important to prepare the receivers by telling them what they are going to receive. It is important for them to know the order they are going to receive it. There are many techniques you can use to do this:

Tell them what you're going to tell them.
Tell them.
Tell them what you just told them

or

Make them dissatisfied.
Suggest a remedy.
Ask for action.
Answer questions and objections.

or

Attract attention.

Arouse interest.

Create desire.

Suggest action.

or

State your idea.

Expound on the idea.

Summarize your idea.

Allow the receiver to "play back" the idea.

Do not flood your audience with so much detail that they will miss your ideas. The success of your presentation depends on how well you impress the audience with the specific purpose of your report. Let them concentrate on your bottom line. A report does not have to be sophisticated to be effective. State your idea and purpose in easy-to-understand terms. Refrain from using words that have to be looked up in the dictionary. Your message might be misinterpreted because of meaning.

Introduce enough facts to back up your ideas but always refer back to the basic purpose of the report. Facts are difficult to receive and most receivers tune them out. They should be used primarily as evidence you have researched your idea before presenting it.

Review and summarize your idea by asizing the key points you want retained. Stay away from the facts and concentrate on presenting your idea once again. You can test how well you have done by leading the receivers into a question and answer period. Allow them to play back the idea.

The basic purpose of any communication is to get action. Action can only come through acceptance. What counts is not what people are told but what they accept. Without their acceptance the desired action will not result.

To sell your work, seek participation by all affected by your project. Employees at all levels should be brought. into the program. It is difficult for people to resist something they helped to create.

Selling can be either up or down. When selling up, Management participation in the program is essential. In selling down, get your co-workers, subordinate staff and workers involved in appraising your work. Let them be part of it. Include their suggestions for improvement. This can prevent later resistance to your project's implementation.

REMEMBER AND USE THESE LETTERS IN YOUR PRESENTATIONS:

W - WILL YOU HELP ME
WITH THIS PROJECT?

I - IF I INCLUDE YOUR
SUGGESTIONS FOR
IMPROVEMENT -

N - NOTHING IS IMPOSSIBLE!!