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INCREASING PRODUCTIVITY THROUGH
METHODS IMPROVEMENT

By

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ABSTRACT

The SNAME Ship Production Committee's SP-8 Panel on Industrial Engineering's primary objective has been to increase productivity in the Shipbuilding Industry. Since the Panel's conception, it has introduced a number of Industrial Engineering techniques to improve the utilization of our two most important resources, men and machines. One can not function without the other, and only through proper management will optimum productivity be achieved.

One of the elements of good management is to encourage and pursue Methods Improvement at all levels of the organization. Due to the size of our product, we are led to believe that in order to improve, a major Methods change must occur. To some extent, this is true--such as the introduction of Group Technology, which has an effect on our entire organization. Changes like this must occur; however, we must not forget the importance of productivity improvement of each individual task, which, when combined has a tremendous impact on the total productivity picture.

The use of Industrial Engineering Techniques provides for a good, solid evaluation of tasks to boost productivity. The SP-8 Panel has sponsored a number of Methods Engineering Workshops to acquaint shipyard personnel with the techniques that are available, and how to use them. Workshop attendees have been introduced to work sampling, operations and flow process charting, operations analysis, and relationship charting. With these, an individual can systematically perform an analysis on any size task, and produce facts about the operation from which decisions can be made to improve productivity.

Substantial productivity gains can be made through the application of Industrial Engineering Techniques.

INTRODUCTION

In order to stay in business in today's 'economy we have to build and repair ships tomorrow with better productivity than we did yesterday. Substantial productivity gains can be made through the application of basic industrial engineering techniques; one of these being methods improvement.

Increasing productivity thru methods improvement is currently used extensively in many industries throughout the world, but little in U.S. Shipyards. There is a need to improve and become more competitive. Being more competitive by improving manufacturing techniques will result in more jobs, better wages, increased benefits, job security and many other advantages.

This paper discusses productivity and how to improve it, the productivity improvement attitude and the techniques used. The primary emphasis is on utilizing industrial engineering techniques to implement methods improvement.

In 1981 the SNAME Panel SP-8 on Industrial Engineering commissioned the Institute of Industrial Engineers to develop and put on a 5-day workshop to train shipyard personnel in the techniques of methods improvement with the ultimate goal of improving manufacturing productivity in the yards. The workshop material is the end result of several hundred hours of research and development by specialists in training and shipyard industrial engineers. Properly used, they can be the core (or improve your present program) of a valuable and effective program for Industrial Engineers, IE technicians, Production Engineers, Foremen, Supervisors, and Operations Managers.

Methods Improvement Awareness

What Is Productivity

Productivity may be defined as follows:

"Productivity is the ratio of output to total inputs"

Put in simpler terms, productivity, in the sense in which the word is used here, is nothing 'more than the arithmetical ratio between the amount produced and the amount of resources used in. the course of production:

- ° Land
- ° Materials
- ° Machinery
- ° Manpower
- ° Utilities

The productivity of labor, land, materials, or machines may have increased, but this bare fact does not in itself tell anything about the reasons why it has increased. An increase in the productivity of labor, for example, may be due to better planning of the work on the part of the management or to the installation of new machinery. An increase in the productivity of materials may be due to greater skill on the part of workers, to improved designs, and so on.

0 Productivity of Land

The productivity of land used for shipbuilding or repair may be said to have been increased if additional output can be met without increasing the acreage to support it. One such way to increase the productivity of land would be to

utilize storage racks rather than spread the material out on the ground. Therefore, the productivity of that land, in the storage sense, has been increased.

0 Productivity of Materials

If a skillful burner is able to cut eleven fitting saddles from a plate from which an unskillful burner can only cut ten, in the hands of the skillful burner the plate was used with 10 percent greater productivity.

0 Productivity of Machines

If in a machine shop a machine tool has been producing forty pieces per day and through the use of improved cutting tools its output in the same time is increased to fifty pieces, the productivity of that machine has been increased by 25 percent.

0 Productivity of Men

If a grit blaster has been cleaning thirty square-feet of steel per hour and an improved method of blasting has been implemented which will enable him to cover forty square-feet an hour, the productivity of that man has increased by $33\frac{1}{3}$ per cent.

In each of these examples output-or production-has also increased, and each case by exactly the same percentage as the productivity. But an increase in production does not by itself indicate an increase in productivity. If the input of resources goes up in direct proportion to the increase in output, the productivity will stay the same. And if input increases by a greater percentage than output, higher production will be being achieved at the expense of a reduction in productivity.

In short, higher productivity means that more is produced with the same expenditure of resources, i.e., at the same cost in terms of land, materials, machine-time, or labor; or alternatively that the same amount is produced at less cost in terms of land, materials, machine-time, or labor used up, thus releasing some of these resources for the production of other things.

Productivity Improvement Climate

Many people have been misled into thinking of productivity exclusively as the productivity of labor, mainly because labor productivity usually forms the basis for published statistics on the subject. Productivity should be treated as one making the best possible use of all the available resources, and attention will constantly be drawn to cases where the productivity of materials or plant is increased.

The main responsibility of raising productivity rests with management. Only management can introduce and create a favorable climate for a productivity program and obtain the cooperation and involvement of the workers which is essential for real success.

Even with good planning, steps taken to raise productivity will probably meet with resistance. This resistance can generally be reduced to a minimum if everybody concerned understands the nature of a reason for each step taken and has some say in its implementation.

Productivity Improvement Attitude

Methods improvement is largely a matter of systematic application of sound, practical common sense. One may say that it is common sense systematically applied. There are a large number of highly specialized methods improvement techniques available today. These techniques should be utilized to identify potential improvements along with common sense to determine if the proposed method improvement is practical.

The most important single asset to success with methods improvement is mental attitude. A desire to ask questions and to be "down right curious" often leads to sizable methods improvements. A healthy curiosity is sometimes far more valuable in connection with methods study than a thorough knowledge of the job. When a person has achieved a good working knowledge of the job, there may be a tendency to feel that the best methods have been attained and that additional methods improvement work is not necessary. This is not true. If the attitude that "no improvement can be made" is prevalent, nobody will try to make any improvement. Thus, the possibility of a better method may die on the spot.

A slogan used by many industrial engineers is: "With sufficient study, any method can be improved." Of course, practical limitations prevent a method from being improved to the point of perfection. From a theoretical standpoint, however, methods improvement can never be complete as long as the operation itself exists. It is better to call a methods improvement "the best method yet devised."

Techniques

Methods Engineering Discipline

Methods Engineering embraces several techniques, but in particular, method study and work measurement.

Method study is the systematic recording and critical examination of existing and proposed ways of doing work, a means of developing and applying easier and more effective ways of doing things, and reducing costs.

Work measurement is the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance.

Method study and work measurement are, therefore, closely linked. Method study is concerned with the reduction of work content of a job or operation, while work measurement is mostly concerned with the investigation, identification and reduction of ineffective time.

Work measurement, as the name suggests, provides management with a means of measuring the time taken in the performance OR an operation or series of operations in such a way that ineffective time is identified and can be separated from effective time. In this way its existence, nature and extent become known where previously they were concealed within the total. Once the existence of ineffective time has been revealed and the reasons for it tracked down, steps can usually be taken to reduce it.

Work measurement has another role to play. Not only can it reveal the existence of ineffective time; it can also be used to set standard time for carrying out the work, so that, if any ineffective time does creep in later, it will immediately be shown up as an excess over the standard time and will thus be brought to the attention of management.

Work measurement is more likely to show up the management itself than the poor behavior of workers. Because of this, it is apt to meet with 'far greater resistance than method study. Nevertheless, if efficient operation of a yard as a whole is being sought, the application of work measurement, properly carried out, is one of the best means of achieving it.

The objectives of method study are:

- ° The improvement- of processes and procedures,
- ° The improvement of yard, shop, and workplace layout and of the design of plant and equipment,
- ° Economy in human effort and the reduction of unnecessary fatigue and avoidable delays,
- ° Improvement in the use of materials, machines and manpower,
- ° The development of a better physical working environment,
- ° The assurance that an operation is properly staffed.

There are a number of method study techniques suitable for tackling problems on all scales from the layout of a complete shipyard to the smallest movement of workers on a repetitive job. In every case, however, the method of procedure is basically the same and must be carefully followed. There are no short cuts.

Basic Procedure

When a problem is examined there should be a definite and orderly sequence of analysis. The basic procedure for conducting any methods study is as follows:

- SELECT the work to be studied, define the problem,
- RECORD all the 'relevant facts about the present method by direct observation, involve those who will be affected,
- EXAMINE those facts critically and in ordered sequence, using the techniques best suited to the purpose,
- DEVELOP the most practical, economic and effective solution or improved method having due regard to all factors,
- DEFINE the new method so that it can always be identified,
- SELL the change to assure a smooth transition to the new method,
- INSTALL that method as standard practice,
- MAINTAIN that standard practice by regular routine checks or through the use of a Labor Reporting System.

These are the eight essential stages in the application of method study: none can be excluded. Strict adherence to their sequence, as well as to their content, is-essential for the success of the project.

Do not be deceived by the simplicity of the basic procedure into thinking that method study is easy and therefore unimportant. On the contrary, method study may on occasion be very complex and difficult.

Selecting Work to be Studied

When considering whether a method study investigation of a particular job should be carried out, certain factors should be kept in mind. These are:

- Economic considerations
- Technical considerations
- Human or psychological factors

1. Economic Considerations will be important at all stages. It is obviously a waste of time to start or to continue a long investigation if the economic importance of the job is small, or if it is one which is not expected to run for long. The first questions must always be: "Will it pay to begin a method study of this job?", and: "Will it pay to continue this study?"

Obvious early choices are:

- "Bottlenecks" which are holding up production operations,
- Movement of material over long distances between shops, or operations involving a great deal of manpower or where there is repeated handling of material,
- Operations involving repetitive work using a great deal of labor and liable to run for a long time.

2. Technical Considerations will normally be obvious. The most important point is to make sure that adequate technical knowledge is available with which to carry out the study, and that the proposed solution will work. Examples are:
 - (a) The use of pre-construction primer versus raw steel in the construction process might bring increased productivity of facilities and labor, but there may be technical reasons why a change should not be made. This calls for advice of specialists in welding, burning, coatings, etc.
 - (b) A machine tool constituting a bottleneck in production is known to be running at a speed below that at which the high-speed cutting tools will operate effectively. Can it be speeded up, or is the machine itself not robust enough to take the faster cut? This is a problem for the machine-tool expert.
3. Human or Psychological Factors are among the most important factors to be taken into consideration, since mental and emotional reactions to investigation and changes of method have to be anticipated. If it appears that the study of a particular job appears to be leading to a great deal of unrest or ill feeling, leave it alone for the time being, however promising it may be from the economic point of view. If other jobs are tackled successfully and can be seen by all to benefit the people working on them, opinions will change and it will be possible, in time, to go back to the original choice.

Involving the people affected almost always helps the improvement process.

It is important to set clearly-defined limits to the scope of the investigation. Method study investigations often reveal scope for even greater savings and there is a strong temptation to go beyond the immediate objective. The original objectives should be adhered to; and any jobs shown up as offering scope for big improvements through method study should be noted and tackled separately.

Record and Analyze the Method

After selecting the work to be studied, record all the facts relating to the existing method. The success of the whole procedure depends on the accuracy with which the facts are recorded, because they will provide the basis of both the critical examination and the development of the improved method. It is therefore essential that the record be clear and concise.

The usual way of recording facts is to write them down. Unfortunately, this method is not suited to the recording of the complicated processes which are so common in shipbuilding. This is particularly so when an exact record is required of every minute detail of a process or operation. To describe everything exactly that is done in even a very simple job would probably result in several pages of closely written script, which would require careful study before anyone reading it could be quite sure that he had grasped all the details.

To overcome this difficulty other techniques or "tools" of recording have been developed, so that detailed information may be recorded precisely and at the same time in standard form, in order that it may be readily understood by all.

The most commonly used of these recording techniques are charts and diagrams. There are several different types of standard charts available, each with its own special purpose.

Operation Analysis

Operation Analysis is a systematic procedure used to study all the factors which could affect the method of performing an operation economically. Through this analysis, the present best available method of performing each necessary step of an operation is determined and improved if possible.

The Operations Analysis Form was designed to act as a guide to systematically analyze operations. The first page of the six page form is shown as Fig. 1. It directs the analysis through the key factors and ensures that none are over looked. The primary factors which should be reviewed in every operation are:

1. Purpose of operation
2. Part design
3. Material
4. Material handling
5. Inspection requirements
6. Process analysis
7. Design of work

SHIPYARD OPERATION ANALYSIS FORM

Page 1 of 6

OPERATION _____
 PART NAME _____ PART NO. _____
 ANALYZED BY _____

DATE _____
 DWC. NO. _____
 HULL NO. _____

ACTION	ANALYSIS CONSIDERATIONS	DESCRIPTION
	Is the operation necessary?	1. PURPOSE OF OPERATION
	Can operation be eliminated by improving previous operations?	
	Can one or more operations be combined?	
	Can operations be changed to simplify succeeding operations?	
	Are the intended results accomplished?	
	Does your competitor have a better way?	
	Can the part be purchased at a lower cost?	
	Are inefficient operations tolerated just because they run smoothly and predictably?	
	If the operation has been added to correct a following difficulty, is it possible that the corrective operation is more costly than the difficulty itself?	
	Are all parts necessary?	2. PART DESIGN (Indicate possible improvements)
	Can standard parts be used or converted to do the job?	
	Can one part be redesigned to function for two?	
	Does design permit the most economical means of Manufacturing?	
	Is "excess" material minimized?	
	Do you have good relations with engineering and the sold loft to effect improvements and correct mistake?	
	Can scrap be reduced?	3. MATERIAL
	Can part be made from scrap?	A. PRESENT MATERIAL
	Can parts be nested to reduce scrap?	
	Would material change reduce manufacturing costs?	
	Can less expensive material be used?	
	Is material always available before job is scheduled to start?	

Fig. 1 OPERATIONS ANALYSIS FORM

8. Workplace layout, machine, and tools
9. Working conditions
10. Methods comparison chart

Process Charts

"A process chart is a schematic or tabular representation of the sequence of all relevant actions or events - operations, transportation, inspection, delays, storages - occurring during a process or procedure." The intent of the process chart is to provide a graphic representation of a process so that present and proposed methods could visually be compared in chart form.

The flow process chart tracks five activities: operations, transportation, inspection, delays and storage. This chart can be used to analyze the sequence of operations as a part goes through and tasks that a person performs. A typical flow process chart is shown in Fig. 2.

The operation process chart only addresses the introduction of material into the production cycle, and the sequence of operations and inspections subsequently performed on it. This chart is an excellent way to quickly learn what goes on and provides a superior way to explain a before (proposed improvement) and after situation to management. A sample process chart is shown in Fig. 3.

The five activities have been assigned standard symbols so that process charts would be universally understandable.

SUBJECT _____ DATE _____

CHART BEGINS _____

CHART ENDS _____

[illegible]

-733-

OPERATION PROCESS CHART

PRESENT METHOD

SUBJECT CHARTED Panel Assembly DRAWING NO. A2-496
 DATE CHARTED 5-15-85 CHARTED BY J. Ruecker

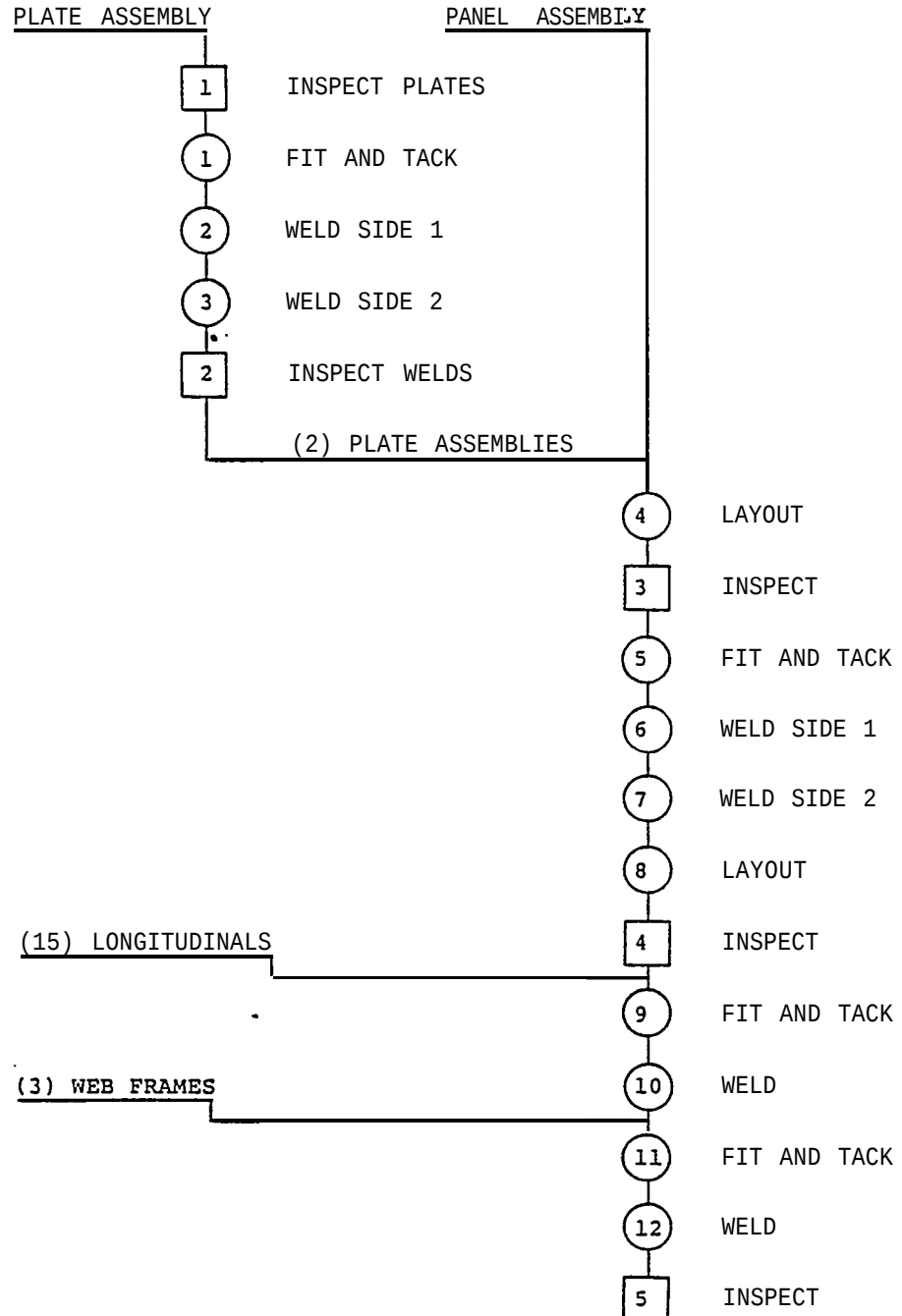


FIG. 3 TYPICAL OPERATION PROCESS CHART

Activities Defined:



Operation. An operation occurs when an object is intentionally changed in any of its physical or chemical characteristics, is assembled or disassembled from another object, or is arranged or prepared for another operation, transportation, inspection, or storage. An operation also occurs when information is given or received or when planning or calculating takes place. (Symbol: Circle)



Transportation. A transportation occurs when an object is moved or a person moves from one location to another, except when such movement is part of the operation or is caused by the operator at the work station. (Symbol: Arrow)



Inspection. An inspection occurs when an object is examined for identification or is verified for quality or quantity in any of its characteristics. (Symbol: Square)



Delay. A delay occurs when an object or person waits for the next planned action. (Symbol: D)



Storage. A storage occurs when an object is kept and protected against unauthorized removal. (Symbol: Inverted Triangle)

Measure the Time of an Operation

"Work measurement is the application of systematic techniques to determine the work content of a defined task and the

corresponding time required for its completion by a qualified worker". There are a number of techniques such as estimates, historical data, stop watch time studies, predetermined times, standard data and work sampling.

Estimates - is the least accurate of the techniques. Usually developed from gut feel with occasional use of factual data.

Historical Data - requires good record keeping in order to have any value. If proper record keeping is in place this techniques is valid. However, it tends to cover over poor methods, and locks in inefficient operations.

Stop Watch Time Studies - commonly used technique to establish operational time values. It is as accurate as the observer is trained in the technique. It's short coming is the observers ability to make judgement calls to correct for operator skill and effort levels.

Predetermined Times System (PTS) - are usually very structured and detailed to maintain accuracy. Their application may be time-consuming depending on the level of accuracy required, and the length of time the task takes. A number of systems are used today, each one has a specific application, primarily dependent on level of accuracy required. The systems include MTM, MOST, MEK, UAS, Work Factor, etc.

Work Sampling - is an inexpensive means of getting a fairly accurate measure of machine downtime, manpower utilization, crane wait, setup time, etc. in a shipyard. Work sampling is based upon the laws of probability. A random sample from a large group tends to have the same pattern of distribution as the large group. The sample size is determined by the accuracy required and the occurrence of the task. Charts and nomographs are typically used to establish the size of the sample.

Standard Data - is a higher level of predetermined time systems. It takes the small time blocks of PTS and are combined into larger blocks of times for typical products for faster application. This is achieved by using time formulas, curves, nomographs, and charts.

Examine the Facts

Methods improvement can only be accomplished with an open mind. Do not take any method for granted, no matter how long it has been done one way or how good the present method seems. Remember there is always a better way.

The technique of work simplification, more than anything, relies on good common sense and a few logical steps. First, establish a job or function you want to improve. Look for jobs that have many delays, bottlenecks, poorly maintained machines, excessive set up time, etc.

Second, break down the job so it can be effectively analyzed. It is much easier to analyze a job when it is broken down into small elements so attention can be paid to one element at a time.

A number of tools and techniques can be used to break down a job. One very good tool is the "questioning" attitude.

"Why" is the most important question and should be asked first and then applied in turn to each of the other questions: What, Where, When, who, and How as follows:

Where should it be done?

Change sequence?

Why should it be done there?

Combine?

When should it be done?

Change sequence?

Why should it be done then?

Combine?

Who should do it?

Eliminate?

Why should he do it?

Change sequence?

How should it be done?

New process?

Why should it be done that way?

Change method?

Ask these questions so that the answer may lead to eliminating, combining, rearranging, and/or simplifying some of the activities.

Listen for comments from the workers and foremen. "Bitches", complaints, suggestions often have the gem of an idea for you to build on - and provide built-in involvement later on. This information will mostly be opinion and the facts will have to be sorted out in order to be meaningful data.

Develop the Improved Method

After the method to be studied has been selected, the gathering of facts on the current practices begins. This is the very first

step in developing the improved 'method. You must first know how the operation is currently being performed before good solid suggestions for improvement can be made. The collection of facts will provide the data that, once analyzed, will provide the clues for improvement. During this' phase, suggestions on how to improve the operation should be solicited from the people performing and supervising the operation. The more views received on how the operation can be improved, the better the chances of success with the final proposed method. The person actually performing the work will usually have the most valuable input for improving an operation. He also can make the new method work or not work.

After the analysis has been completed and the optimum solution has been picked, develop a brief report describing the improved method. Keep it short with a minimum amount of detail. You can always go back to your files to answer detailed questions, that is, if you have done your homework. The report should start with a description of the current operation that is being considered for change. Then a description of the' proposed changes and the benefits of making such a change. Include a Comparison Chart of present versus proposed.

Selling the Improvement

Resistance to change is a major impediment to methods improvement activities 'in most organizations. As irrational as such resistance may seem at times, it does serve the purpose of testing new ideas so that they will not be accepted and implemented prematurely. Once you understand the individual and organizational obstacles

that inhibit change, you will be able to develop your creativity more fully and "sell" your ideas more successfully.

Methods improvement implementation requires cooperative effort. But many people get so ego-involved with their ideas that their suggestions for a modification are automatically opposed as unnecessary tampering. As a result, they fail to elicit the participation and cooperation of associates during the development and implementation stages.

Presenting a new idea is in many ways one of the most crucial aspects of the methods improvement process. Here are some ways to improve your chance of success:

1. Presenting to a group? Try to sell it (or better still, try to involve them) before the meeting to one or more members. They'll appreciate your advance confidence and, possibly, rally to your side if the going gets rough during the presentation.
2. Give background. Before actually presenting the idea, give a short history of the problem which led you to investigate the area and how you proceeded to solve the problem and created the new idea.
3. Show them you've thought it out. Demonstrate by your conversation that this idea isn't the first one you've dreamed up. You've thought the problem out and made various approaches and refinements until you're satisfied that you have something worthwhile. You must be prepared to prove that you've thought it through. Charts and diagrams may help here.

4. Don't knock the status quo. Your audience may have been intimately involved in getting things running the way they do now, so don't be hypercritical of "things-as-they-are". Instead, talk about the better times ahead - if the proposed idea is accepted.
5. Go slowly. The presentation of new material should be delivered no faster than it can be understood and absorbed. Clear language is absolutely necessary.
6. Emphasize the money angle, where appropriate. When selling an idea to top management, remember that a strong dollars and cents case must be made.
7. Sum up. At the end of your presentation, sum up the outstanding points, the anticipated advantages of the idea, the need that exists or can be created for the idea, and why you think the idea should be adopted.
8. Put it in writing. Not everyone is capable of following an oral presentation, so stack the odds in your favor by leaving copies of a clear, well written report with your listeners.

Implementation

The ground work for implementing an improvement project actually starts with selecting the work to be studied. What you do and how you do it from that point to the time you are going to make the change will determine the success of implementation. If you have:

- 0 Involved everyone concerned,
- 0 Listened to their ideas,

- ① Taken the time to completely understand the current method,
- ① Conducted a thorough analysis,
- ① Come up with a genuine cost-effective improvement,
- ① Sold the idea and answered all questions.

Then you will have all the detail and support required. If not, be ready for a rough implementation period.

In most cases when introducing a new method, the worker will require retraining. In the training the most important thing will be to develop a habit of doing the job the correct way. Habit is a valuable aid in increased productivity as it reduces the need for conscious thought. Good habits can be formed just as easily as bad ones.

Maintaining the New Method

It is important that, when a method is installed, it should be maintained in its specified form, and that workers should not be allowed to slip back into 'old methods,' or introduce elements not allowed for, unless there is very good reason for doing so.

Action by the implementor is necessary to maintain the application of the new method because human nature being what it is, workers and foremen will tend to allow a drift away from the method laid down, if there is no check. If it is found that an improvement can be made in the method (and there are very few methods which cannot be improved in time, often by the operator himself), this should be officially incorporated: a new specification drawn up.

One of the most universally used techniques to insure adherence to approved methods is by use of a Labor Standards Reporting System.

Conclusion:

There is a greater need today than ever to increase productivity in the U.S. shipbuilding industry. Everyone must do their part in order to meet this goal. The techniques present will aid in uncovering areas for improvement and help establish a new improved method. The success of this approach relies on good common sense. No matter what a chart or formula tells you, if it does not make sense, it more than likely will not work or be short lived.

The application of industrial engineering techniques can be applied yard-wide. However, success will come faster if they are applied in an area you are responsible for rather than pointing out to the other guy how his area can be improved.

The application of industrial engineering techniques, group technology, just in time, etc. can not be considered to be panaceas in themselves. Production improvements will come through the application of portions of those techniques which make the most sense.

Remember; Question the current way of doing business, use good common sense in introducing change and there will be a better tomorrow.

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