Title: Engineering Management Roles and Functions For The Implementation of a PC Based Costing System

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Author(s): T. Candir, G. Causton, I. Iyigun and R. Pasaribu

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Abstract: Inexpensive PC hardware and easy to use software packages have provided the construction industry with cost competitive and powerful data control capabilities. The introduction of PC based systems in an existing company structure, however, is not accomplished without some complications and measurable impact. We study these impacts and attempt to provide some solutions for the engineering manager to better manage the change before, during, and after the implementation of a PC based computer costing system. This study was provided by actual data obtained from McDermott Construction Company of Indonesia. Other reference materials were obtained from trade journals articles dealing with the various types of impacts that can be expected during change of this type.

ENGINEERING MANAGEMENT ROLES AND FUNCTIONS FOR THE IMPLEMENTATION OF A PC BASED COSTING SYSTEM

T. Candir, G. Causton, I. Iyigun,
and R. Pasaribu

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Engineering Management Roles and Functions

For The Implementation of a PC Based Costing System

Prepared for
Dr. Kocaoglu
Engineering Management 541
Portland State University
Portland, Oregon

by
Tolga Candir
Grant Causton
Iffet Iyigun
Richard Pasaribu

EXECUTIVE SUMMARY

The introduction of inexpensive PC hardware and easy to use software packages has provided the construction industry with cost competitive and powerful data control capabilities. The introduction of PC based systems in an existing company structure, however, is not accomplished without some complications and measurable impacts. This paper studies these impacts and attempts to provide some solutions for the engineering manager to better manage the change before, during, and after the implementation of a PC based computer costing system. The study provided here was provided from actual data obtained from McDermott Construction Company of Indonesia. Other reference material was obtained from trade journals discussing the various types of impacts that can be expected during change of this type.

INTRODUCTION

All companies want to improve their effectiveness in producing accurate cost proposals. The importance of this is true for both small starter companies and large ones. Obviously, minimization of project expense will make the project more profitable. But doing this can often be an horrendous task especially if the project is large and there is a deadline involved.

For a company, the management personnel need to be able to properly estimate the cost of a job. The estimate must be both competitive and profit realizing. Too low a bid price will not allow for enough profit and too high a price may led to losing a prospective client. Moreover, the need for not only accurate cost estimates but timely ones is also true.

This project will explore the benefits and problems of implementing a relatively inexpensive PC based cost estimating system for new building construction. This report also considers the social, financial, and personnel changes that will need to occur before, during and after the transition.

This project takes the form of a case study . It compares the system that is currently in use in the company with that of the proposed system. It will examine the true cost of implementing the system. Costs in the form of social changes, personnel changes, corporate goal changes, and other humane and nonhuman changes that will need to occur.

After a brief explanation of the current estimating system an overview of the proposed computer system and related hardware will be reviewed. This paper will focus on the impacts and solutions that the engineering manager will have to consider during the implementation of this new system. It will also examine the functions and roles that will need to be performed if the system is to be successful.

The Problem

One of the major challenges facing the engineering manager in today's construction market is to provide both timely and accurate cost estimates. To produce fast estimates of the project will allow the construction company to bid on more jobs at a higher competition level. To provide accurate estimates will insure that the company is both competitive and profit realizing. The effective combination of speed and accuracy gives the company the ability to explore many hypothetical deviations from the estimate and their resulting cost consequences.[1] The problem, however, is this: should the company engage in the implementation of a computer costing method to improve these areas of the estimating and biding process? Clearly, there are factors to weight in both areas. Moreover, if a company does decide to commit to such a project what can its engineering managers do to ensure a smooth transition that will maximize the current corporate resources and yet minimize the negative impacts on the organization.

General Approach of Study

The approach of the study will be to divide the implementation into four major groups: 1) Material Take-off Group (MTO), 2) Estimating Department, 3) Planning and Scheduling Department, and 4) Production Department. These four main areas incur the greatest impact in the organization. The collected data was taken from a now existing computer costing system that was installed in a marine construction company in Indonesia. The company, McDermott Indonesia Fabrication Yard was in the process of implementing this system during the employment of a fellow group member. This class member was an engineer for the software engineering department that was responsible for the development and subsequent support of the software required to make the new system simple and therefore easy to use and yet effective so that it would improve company project bidding and estimating processes. Support information of the topic was provided by various trade journals as related to change in industry and its impacts on the organizational structure. Measurements of the impacts are also made to determine if the system's installation and usage was actually beneficial to the company's ability to be more productive and competitive in the bidding and estimating process. To gain some insight into the current costing and estimating system it will now be briefly explained.

Explanation of Current System

The purpose of the MTO Group is to get the bid drawings from the Reproduction Department and assign a task number or subfunction number to each drawing. After which a list of the materials is developed from each of the drawings called the MTO form. Then entry of the MTO data into Dbase III program is performed. After entry of MTO data reports are generated and sorted by Bills of Material (BOM), subfunction, drawing number, and location. These reports are submitted to the Estimating, Planning and Scheduling, and Production Departments.

The Estimating Department studies the material reports by subfunctions then estimates the man hours required to do each of the tasks. The estimator decides qualitatively the unit man hour according to his own experience. Two persons are needed to estimate in order to countercheck one another. If too much of a gap arises between the two estimates, there is either a decision made or an average of the two is taken. This function is performed manually on a standardized form called the Chart of Account. This report is then submitted to the Bid Proposal Department and upper management.

The Planning and Scheduling Department studies the Material Reports that are sorted by subfunction. After getting the Chart of Account from the Estimating Department they split the man hours manually in terms of manpower discipline. For example, fitters, welders, operators, riggers, painters, mechanics, and electricians are all separately accounted for. Then the Critical Path Network is set up. The Network is then input into a HP-2000 mini-computer using Artemis 6000 software. Use the inputted network information to produce S-curve, bar chart schedules, manpower histograms, and critical path information. This information is then submitted to Bid Proposal and Production Departments, and upper management.

The Planning Department uses the material reports sorted by drawing, subfunction, and BOM to "source" the materials. Source the material means to determine whether the materials will come

from inventory, client, or will need to be purchased. For the material that needs to be purchased purchase orders will need to be manually created and submitted to the Purchasing Department for processing.

Explanation of New System

Material Control System is a PC based module developed for the fabrication facilities in Batam, Indonesia. This system is in response to the need to provide customized, fast and easy-to-use PC based system which can be operated by the personnel themselves. This module will provide communication through integrated links with Material Takeoff Group, Estimating Department, and Production Department. Through these groups, information will be transferred to the Planning & Scheduling, Bid Proposal, Purchasing departments, as well as to upper management.

Major features of the Material Control System are as follows:

- User-friendly: The bottom of each screen details actions available to the user. It has the ability to move from one screen to another with a single keystroke. Also to move from one line of a record to another or delete the line record or insert a new record. It can also move from one field to another within a line record. Easy editing of each field is also possible.

- Minimizes input time: It has the capabilities to duplicate line items, all materials on a particular task sheet (subfunction)/drawing. The user can also copy all data from one project onto another or combine several projects into one. This means that several people can work on a single project and later combine the different pieces into one. Also one can use an already existing similar takeoff information and adjust it to generate a totally new material takeoff. This is especially true when converting from bid stage to Approved For Construction(AFC) stage.

- Generates Various Reports: More than 20 reports can be generated to provide different views of the input data. There is also a means to convert a takeoff in English units into Metric units and vice versa. The system can provide reports with the weight for each material, drawing, and subfunction.
- Error Checking: The system can ensure that no material or grade/specification is entered which does not exist in the master catalogs. The system has three master catalogs to define materials, grades/specifications and subfunctions. Also it ensures that the units are not mixed or information is incorrectly entered in the takeoff stage.
- Additional Features: The Material Control System has the ability to take off NET versus GROSS dimensions, to take off client supplied materials and produce requisition orders (for purchase orders), and material demand forms for the in-house material order. It keeps track of the traffics of materials e.g. delivery dates, quantity received, quantity issued to shops/yards, and quantity fabricated and/or installed.

The Material Control System has three hierarchical levels. (see Figure 1). The first level is the Project level. Here, the project information is defined. For example, the project number, client name, project description, are clarified and assigned. Each project has material takeoff indexes. The material takeoff indexes, the second level, show how the project is broken into its component parts. They can be divided either by drawing or by subfunction (task number) or by any combination of both. The third

level shows where the takeoff of the individual materials occurs. So for each item in the material takeoff index the corresponding material information is available.

Below is the hierarchy diagram of the Material Control System.

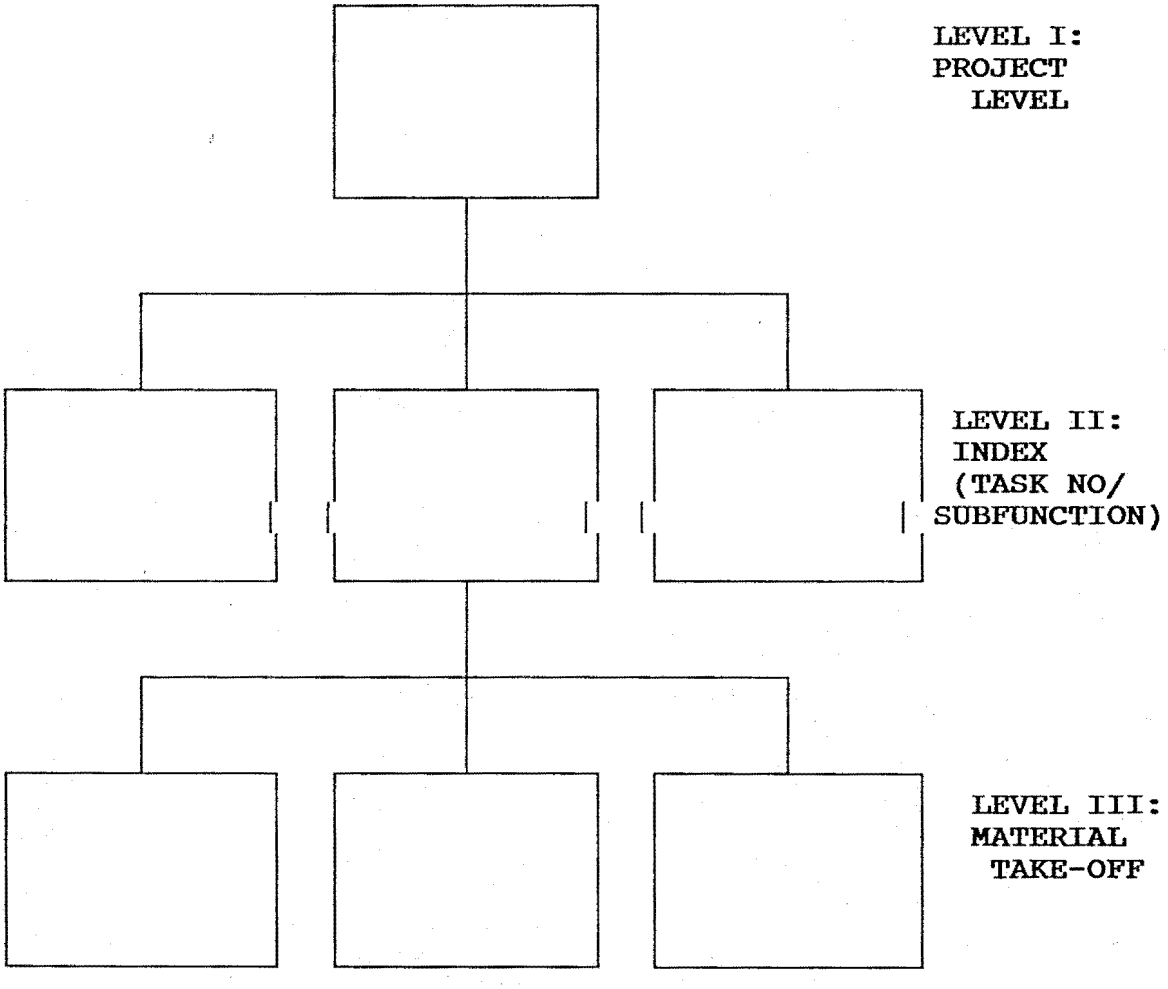

Figure 1.

The Material Control System is the critical component that links various departments together. The system feeds data into Production Department that produces the bill of materials (BOM), it sources each item in the BOM to determine whether it is to be supplied from in-house inventories, client's supply, or from outside purchases. Generating material requisitions for the purchase order, field transfer forms for in-house material, and client supply list are also created. The tracking of receipts of materials from vendors or clients is also performed. The system transfers data into the Estimating Department using MTO data as a basis. For example, fields are added to generate weld volumes and other criteria against which standard base unit man-hours are supplied to generate man-hour estimates. Material availability data and manpower man-hour breakdown are input to the Planning & Scheduling Department so that schedules can be constrained to material and manpower availabilities.

Below is the structure chart showing the connections between the Material Control System and other departments. Figure 2.

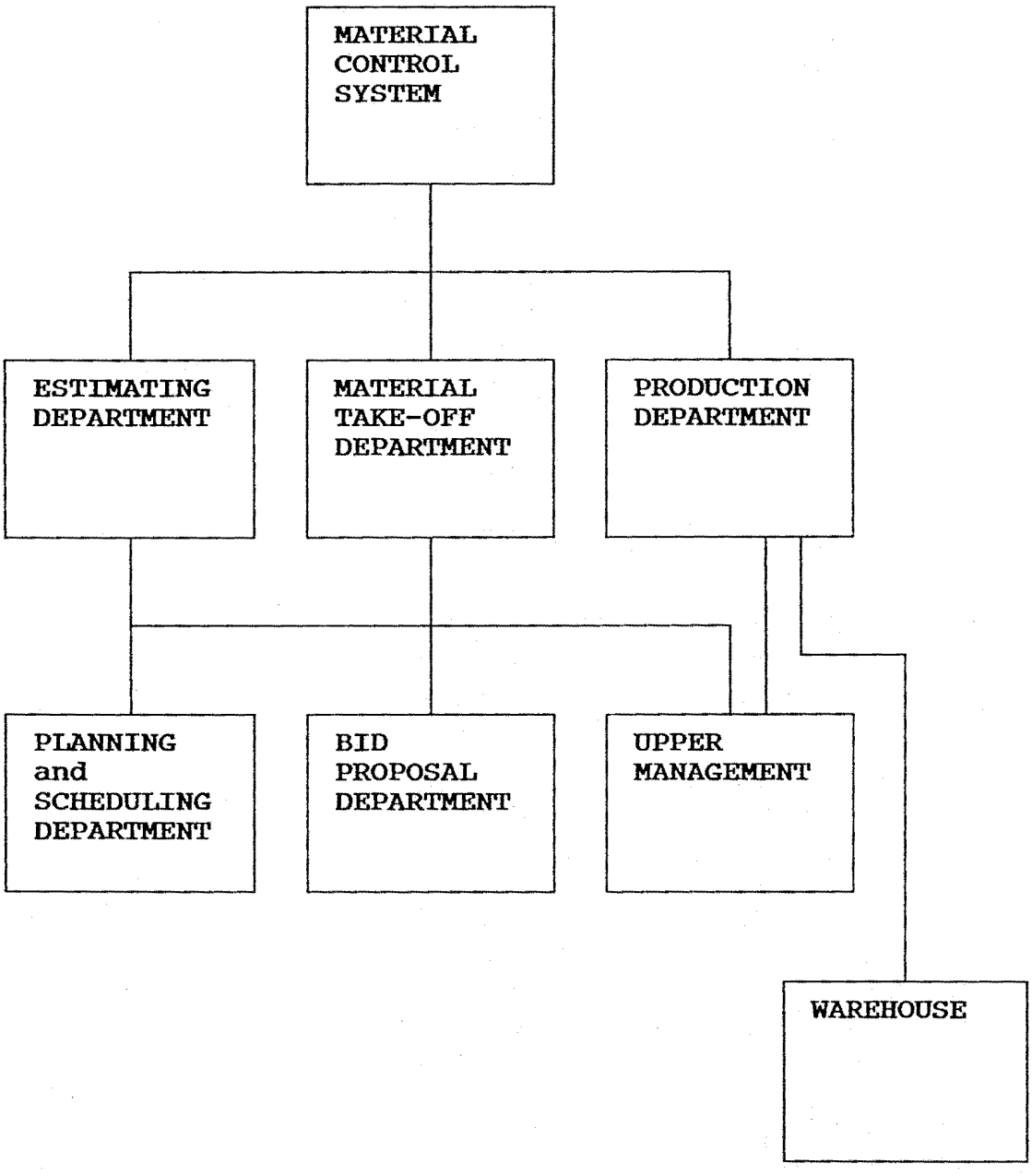
MATERIAL CONTROL SYSTEM
ESTIMATING DEPARTMENT
MATERIAL TAKE-OFF DEPARTMENT
PRODUCTION DEPARTMENT
PLANNING and SCHEDULING DEPARTMENT
BID PROPOSAL DEPARTMENT
UPPER MANAGEMENT
WAREHOUSE

Figure 2

MEASUREMENTS AND COLLECTED DATA

The purpose of this section is to provide quantitative measurements that compare the current system in use and the proposed new system. The sources of the measurements are based on the experience of the person who was involved in this project during the evolution from the old system through the implementation of the new system. Although no official company documentation was prepared for this project, this is an accurate assessment of the available data of the implementation process. The data was obtained and compiled based on interaction with the user on a one-to-one basis as the project progressed.

The measurements are in units of time and vary depending on the nature of the task performed. The measurement units are man-day, hours, and minutes. If the measurement is not in units of time a figure will be given. Effects on equipment and changes in personnel will be measured in dollars. If the measurement between the old and new systems is the same, no figure will be given; instead the word "same" will be given. To indicate change the following index will be used to indicate the magnitude of the impact.

Magnitude Index

+	-- means moderate increase in the performance
++	-- means a high increase in the performance
0	-- means no increase or decrease in the performance
-	-- means a decrease in the performance
--	-- means a high decrease in the performance

To standardize the measurement an example project is chosen. The project chosen is to fabricate a deck structure of a production platform with the following specifications: a total of 500 short-tons in weight, about 50,000 man-hours to build are estimated, 1000 records of materials are required, and a six month fabrication period is projected.

The following measurements are presented by the job task or activity, old system measurement, new system measurement, and scale of the change as related to each of the four main groups affected

by the new system. Please see the following pages for the summary of collected data and related information.

Collected Data

Group	Old System	New System	Chg
MTO Group			
1) Get bid drawings from Production Department	same	same	0
2) Assign task numbers	same	same	0
3) Retrieve materials from drawings and record on the standardized form	same	same	0
4)Input material records into PC	10 hours	8 hours	+
5) Generate reports, bills of materials, subfunctions, drawings	3 hours	1 hour	+
6) Number reports generated	10	20	++

Collected Data

Estimating Department	Old System	New System	Chg
1) Study the MTO reports and familiarization with drawings, designs, and specifications	same	same	0
2) Estimate man-hours	4-man-days	1-man-day	++
3) Minimum number of persons to estimate project	2 persons	1 person	+
4) Calculate weld volumes produce and submit the reports to others.	2-man-days	2 hours	++
5) Calculate weights per drawing, subfunction and location. Produce and submit the reports to Design Department and upper management	2-man-days	2 hours	++
6) Generate and submit reports to other departments: Bid Proposal and upper management	same	same	0
7) Amount of downtime due to software application	0	1 hour	-
8) Is the system user-friendly?	no	yes	+

Collected Data

Production Department	Old System	New System	Chg
1) Study the MTO reports and familiarization with drawings, design, and specifications	same	same	0
2) Source the material (client, PO, or in-house supplier)	10-man-days	5-man-days	++
3) Generate requisitions for vendor purchase orders, client supply list, and in-house material requisition	2-man-days	2 hours	++
4) Record the material delivery dates	same	same	0
5) Order or issue materials from ware-house to the work site	same	same	0
6) Control the materials already received, issued, fabricated, and installed	same	same	0
7) Generate reports for the status of the materials described on point 6	2 hours	10 minutes	++
8) Produce weekly progress reports and submit to Planning and Scheduling Department and upper management	1 hour	5 minutes	++
9) Amount of downtime due to software application	0	3 hours	-

Collected Data

General	Old System	New System	Chg
1) Cost of equipment (PS's, peripherals and software)	$ 0.0	$ 200,000	--
2) Hours of training for every engineer	0	20 hours	--
3) Extra cost for Software Development Department	0	$ 35,000/year	--
4) Number of similar projects an engineer can perform	3 projects	5 projects	++
5) Maintenance of system	minor	2 times/month	-

EVALUATION OF DATA

The current system was programmed in dBase III (in 1984) and the new system was programmed in Turbo Pascal version 4.0 (in 1989). Turbo Pascal version 4.0 has faster speed in accessing data. In general, generating reports is faster by using the new system. It has capability to find and search record quickly in a huge datafile and indexfile. The master file has up to 20,000 records, which makes slower for the old system to access and produce the reports.

The new system has "standard base unit man-hour" master file which was set up through consensus by several experts in man-hours estimation, while the old system depends on the manual method and at least two persons are needed to countercheck each other. The "standard base unit man-hour" master file provides unit weight for each material so that the weight calculation can be generated automatically. By contrast, the old system uses manual method, extracting the unit weight and totalling the weights.

The new system helps users to prepare and produce standardized forms for vendors, clients, and warehouse. Once the data are prepared in the system, only a single keystroke is needed to

generate the print-outs, while in the old system, users have to fill in the forms manually. The status of materials (i.e., when the material will be delivered by vendor, how many that have already arrived, how many already sent to the yard/shops, and how many already fabricated and/or installed) can be provided and printed-out at any time by simply keying some keys. By contrast, in the old system, user have to prepare the status of materials manually. Users can automatically generate weekly progress report since the information have already been fed through status of materials prepared earlier. In contrast, the current system users have to prepare manually which tales at least an hour.

Since the new system was implemented,(it has been one year in use) it still needs maintenance, such as corrections on bugs and errors, responses to users' requests for modifications and changes, and optimization for more efficient operation. The new system is not yet a error-free module and still gives disruptions to users. The disruptions often discouraged users to use the new system. Besides the software perspective, maintenance on the hardware is becoming a necessity. So far no trained or expert personnel on hardware has been assigned for this task. Vendor is always called for help that creates down time for coming and fixing it. This disrupts the streamline of the work.

Money has been spent for as much as $200,000 for PCs, software, peripherals, and accessories. However, twenty new PCs with the average configuration of COMPAQ 386/20 110-MB HD can be used at the same time for other implementations i.e., computer-aided design, project scheduling, spread-sheets, and word processors. Also extra cost center for the new department i.e., Software Development, is to be spent every year for as large as $35,000. The Software Development Department is to perform the 'software life-cycle' which is to define, implement, and maintain software modules required by users within the company. This department is also to serve the company in providing modules for other departments for example Quality Control, Costing/Accounting, personnel, and others, as well as in training the relevant users.

After one year implementation of the new system, most engineers are very comfortable with the system, and their performance has increased. He has been given responsibilities with more projects. From his acknowledgement, the new system helps him managing the projects, and moreover, he has become very familiar with the use of computers, minis and PCs. Two other engineers have been using the system, but not for all projects they handle. Some projects have already been set up using the old system. Some other engineers once had started to use the system, but after quite some time they quit due to disruptions from module errors. The rest of the engineers are either busy with on-going projects or are not interested in the system with various reasons: for example, uneasy to start a change, feel comfortable with current system, or very unfamiliar with PCs.

There are some key benefits that were realized by the implementation of the Materials Control System in this company. The two departments that benefitted most from these changes were the Estimating and Production Departments. The reduction of time to estimate man-hours by 75%, from 4 man-days to 1 man-day, is a dramatic benefit for the company. The elimination of one person from the currently required two people to estimate the project represents a yearly salary savings that could be applied to offset the costs incurred by the implementation of the new system. Along with estimate time reductions, there are savings in the calculation of weld volumes, weights per drawing and subfunction and report preparation in the Estimating Department. Conversely, although the amount of down time experienced in this was several hours, this time is expected to decrease as the 'bugs' are removed from system further reducing the down time only to include the maintenance of the system. This maintenance would, however, be performed after hours to lessen the impact on the daily usage of the system.

In the Production Department there were also some noteworthy changes. The reduction of the time to 'source' the materials was reduced by 50%, from 10 man-days to 5 man-days. The projections of this figure over multiple projects would save the company thousands

of dollars. The improvement in performance of the engineer to handle tasks from 3 projects to 5 projects is a dramatic benefit for the company. The company can expand its capacity in managing more projects, and in the future, in absorbing more projects and thus increasing revenue.

IMPACTS AND SOLUTIONS

During the implementation of any new system there will always be some sort of impact on the organization. By organization it is meant both the human and nonhuman subsystems. The impacts can either be positive or negative. If positive, the organization must find ways to benefit the most from the situation. If the impact is negative, solutions that will minimize the undesired results must be found. According to Settles' and Mize's findings the effective implementation of change requires an ability to integrate many diverse elements into one smoothly functioning system. The engineering manager has the responsibility for facility planning, material handling and storage systems, quality control systems, manufacturing systems design, production planning and control, human performance measurement, information systems, incentive systems, methods and procedures, and human factors in the work place.[2]

In particular, the implementation of a new cost estimating system into this marine construction company will create impacts on personnel, productivity, management, and the entire organizational structure. In analyzing the case, all the impacts will be stated, then the solutions and ways of utilizing these impacts will be discussed.

Initially, due to some important reasons, some employees will resist the social changes that occur during the implementation of the new system. Reasons for resistance include fear of the change itself and an individuals job security for example. It should also be noted that resistance is usually created because of certain "blind spots" and attitudes which staff specialists have as a result of their preoccupation with the technical aspects of new ideas. Paul Lawrence suggests in his article on dealing with resistance that "local pride" may also be an obstacle to change. "Local pride" is the idea that the organization is unique or special in some positive way leading to the belief that alterations in the organization would decrease this uniqueness.[3] Furthermore, resistance is the most common type of impact that is seen during

the transition period. According to Kirkham's study the problems of this period are as follows: low stability, perceived high levels of inconsistency in the working environment, high emotional stress, undirected energy, desire for tight control and broad visibility of what is happening, clinging to past behavior patterns and longing for "the good old days" and increased conflict and misunderstanding.[4] Also, it will be observed that older people tend to resist more than the younger ones.

There will be a need for new personnel to run the new system. The increase in personnel will cause increased costs, such as training expenses and increase in salaries. The kinds of personnel needed are data entry staff to input historical data into the new system and computer development personnel in the form of software program development and hardware development. As a result of this personnel increase there may be some current employee lay offs.

The Estimating and Evaluation department has to be created to operate the new system successfully. New departments also need personnel who will be recruited either from the inside or outside. If they are hired from the outside, it means additional cost. If they are transferring from other departments, they will need to be trained to obtain the understanding of the new system.

Training for the entire company on the new system will need to be implemented in order to make the transition more successful. This will result in both cost increases and time consumption at the expense of employee working hours.

Skilled technical persons will be needed to create the master file database for the MTO group. So training the skilled company people and hiring necessary outsiders are essential to manage this function. While the hiring of new staff may seem simple enough, it can have problems also. For example, conflict may be especially acute if the innovation involves establishing new job positions. It has been discussed that there are several factors producing resistance when an innovation is implemented on a unilateral basis by top management. Resistance increases during the implementation of an innovation for many reasons. For example, because of the

mistrust and condemnation of the subordinates implied by the new program, the inhibition of questions and fears, the subordinates wished to express before they were "sold", the feelings of being manipulated by the fact that the changes were kept a secret.[5]

If managers would concern themselves with these problems and encourage their staff to respect the knowledge of workers and to give up their preoccupations with technical change, they could help create common purpose and understanding in work situations where there is often anxiety and logrolling.[6]

The ongoing system maintenance of the new software system will be needed periodically. This means an additional fixed expense for the company. Besides, as the company's needs change, improvements in the software, such as technical updates, database addition and improvements, and technical improvements will need to be made. This also results in extra cost.

Productivity will increase with the efficient use of the new system. By better control of the information generated by the database system, all persons at all levels of the company can obtain information easily. Inputting records, generating reports, drawings and bills, estimating man hours, calculation of the necessary amounts, sourcing the material, and generating requisitions can be done much more faster. So the project schedules will be produced in a shorter time. (by using the on line scheduling methods) Better use of resources, including people, facilities, equipment, information, time, budget and materials will cause a productivity increase. Productivity increase means producing more projects, more efficiently, in a shorter time frame. In turn, it causes a profit increase for the company as the earnings from projects increases and overhead costs decreases. There is one important point in the productivity case which can be stated as follows: during the transition period there may be a decrease in productivity due to the newness of the system. When a system is new, it will be difficult to use it efficiently as the operators are not familiar with the system.

Using the database system will increase the accuracy in

estimating time, cost, material usage and personnel needs of a project. To have a project finished within specified limits (time, cost, state-of-the-art, quality, etc) will satisfy the customer best.

Management can review the projects more easily with faster information transfer. They can control the ongoing projects better. Also with the accuracy created by database they can rely on the work done by the subordinates without any fear.

Some of the managers may also resist the change. According to Kirkham this resistance depends on many factors: logistics (timing, scheduling, personnel, equipment location, environmental factors), economics (costs, budgets, fiscal policy, financial resources and philosophy), politics (influence, ego, territory, group dynamics, decision making, personality conflict).[7] These types of managers should also be treated as the other employees in overcoming the resistance.

The impacts, of the new system on the organization, which are stated above show that most of them are related to human aspect of the organization. The nonhuman side of the problem is solved by the installation of the computer system, purchasing the necessary software and doing the maintenance of the system. It results in only extra cost for the company and this cost will be offset by the profit increase due to the use of new system. The main concern then turns out to be the utilization of the new system where the most important condition is the acceptance of the new system by the personnel. If the company people accept the system and begin to use it effectively there will be less need for recruiting outsiders and also there will be less current employee lay-offs. Also hiring people from outside creates a money problem which can be considered to be solved by generation of higher profits.

To find solutions to the human side of the problem, an engineering manager must understand why people reject new ideas. Understanding this helps engineering managers convert resistance into acceptance. The full benefit of technical change is not realized until it receives wholehearted acceptance by the

organization.

Resistance to change may be open, taking the form of hostility or lack of cooperation. Resistance may also be concealed, expressing itself in seemingly unrelated counterproductive behavior such as apathy, absenteeism or decline in job performance. Success in countering resistance to change may be achieved by understanding the causes of such resistance and applying interpersonal techniques which will result in change being welcomed. Basically, five causes of resistance to change can be identified. They are highlighted as follows:

1) Threatened Self-interest

The biggest reason for resisting change is the anticipation that the personal costs of the change will be greater than the benefits. Change resulted in the creation of new engineering manager positions for coordination and liaison work, altered lines of responsibility and communication with in engineering management departments and redefined job responsibilities. Reactions to this, really reflects a concern over reassignment of job duties and responsibilities and a disruption of existing social and work relationships with the new system. Personal costs are perceived as quite high by the affected individuals. When individuals resist change due to threatened self-interest, there is a tendency to camouflage the real reasons for resistance with other reasons that the change should not be made.

2) Inaccurate perception

Resistance to change may arise as a result of the individuals' not understanding the nature and implications of a change. This may reflect a lack of information or experience with the proposed change.

3) Objective disagreement

Resistance as a result of objective disagreement arises when the goals of the employee and the organization are the same, but the individual feels the change will not lead toward those goals. Such disagreement may occur when communications have

broken down.

4) Psychological Reactance

Resistance may arise when personnel perceive that their freedom to engage in the desired behaviors has been threatened or eliminated. Psychological reactance may take the form of establishing behaviors that have been eliminated by the change. It may also be in the form of perceived increase in the desirability of the eliminated freedom. Either form may then surface in a variety of counterproductive behaviors.

5) Low Tolerance for Change

Low level of tolerance for change may reflect a particularly strong desire to avoid taking risks or personality traits such as low self-confident. The result of this is an emotional resistance to change that goes apart from logical, rational or intellectual considerations.

A number of techniques for taking advantage of resistance to change should be considered. The power of a given technique may depend on the circumstances and individuals involved.

Participation

Participative management is a powerful technique for overcoming the resistance to change. As a result of early involvement in change process, nontechnical personnel may feel a sense of ownership of the change and therefore be motivated to carry the change out. The power of this technique may be limited by certain conditions. First, individuals may feel that the effort of participating in the change is greater than the potential benefits to be derived from personally influencing the change process. The second factor is the ability of those who are asked to participate in the change to make a meaningful contribution. An additional difficulty may be encountered when the individual has the desire and the ability to contribute to the change process but the participative decision process requires more time than is available before the change needs to be introduced. Resistance to change can also be overcome by getting the people involved in the change to

participate in making the change. Participation is a felling of doing on the part of the people, and not just the mechanical act of being called into to take part in the discussion of the change.[8]

Education

The focus of education is on providing the individual with an understanding of the rationale for the change. This approach works best when the underlying problem is one of the inadequate information of a complex nature or inaccurate perception of the situation. It is important for the engineering manager to have a trusting and open relationship with those resisting the change. The educational approach will not work well in a hostile and suspicious environment.

Incentives

It is important that incentives used for this purpose be tied to the successful implementation of the intended change. Incentives are particularly useful when threatened self-interest is expected to result in resistance to change. If the resisting parties are powerful and clearly have something to lose, the use of such incentives may be the optimal course of action given the costs and benefits of the proposed change.

Gradual Introduction

Breaking down a large change into a series of minor changes that occur overtime is a powerful technique for overcoming resistance to change. This approach also allows the feasibility of the smaller change to be demonstrated before moving on to the next in the sequence of changes. Supportive behavior in the form of counselling services, training in new skills and generally considerate and understanding treatment can be an effective way of reducing resistance. It is most effective when combined with other techniques for dealing with resistance to change.

Coercion

Attempts at forcing change acceptance through coercive methods may intensify feelings of hostility and resistance and result in an increase in counterproductive behavior. Coercion involves implicitly or explicitly threatening individuals in order to force

them to accept a change. A particular danger in using this method of overcoming change resistance occurs in a matrix management situation in which the engineering manager has little power to enforce threats made.

Manipulation

Manipulation occurs when change initiators behave in a devious manner to accomplish their ends. Manipulation can be used very effectively particularly in combination with other techniques.[9]

The above are the methods that can be used in solving the resistance to change problem. It is better to use the techniques in combinations to correspond to different aspects of the problem.

New office systems will enable most users to do their work in less time. To have the effective users, one must first look to the company. Most departments have at least one highly motivated user with some technical aptitude who learns the new technology more rapidly. These people can be used to train other personnel.

In some cases an adaptive training is necessary. The most successful training programs that are existing, feature an eclectic mix of resources and procedures that can be adapted to employees' widely varying interests and skill levels. This approach has the added advantage of being able to accommodate the varying rates at which users' needs and skill levels change.[10] With a successful training program employees can become familiar and learn to use the system. When the training program is efficient, the time and cost problems are eliminated by the gains received from training.

Most organizations pay little attention to the process of change once the decision has been made to acquire a particular system. They rarely plan for decreased productivity while users learn how to use the new systems and aside from training almost never budget for such non-hardware/software costs as meetings and planning procedures. In an effective strategy, needs and goals should be identified before the technological means for fulfilling them are decided.[11]

CONCLUSION

The impacts of adding a new system on an organization should not be underestimated. It should, however, not be avoided simply for that reason. Change is good for an organization. Change can provide for growth, maturity, diversity, and sometimes strength when provided with the proper management. The managers of the organization need to be capable to anticipate and plan for the negative impacts that change can have on an organization. To be prepared a manager needs to be in touch and involved with his people at a personal level. His use of informal can one of his best tools for this. While it is easy to get encased in the technical details of the change, the good manager needs to maintain a personal degree of involvement with the people of his organization. Provide the atmosphere to let them help him do his job by encouraging communication from lower levels to himself. Not just complaint sessions but interactive decision making and change making meaningful communication. Granted this may be no easy task for the technical manager when faced with employees that are not willing to make the change that are being required of them. It is at this time when the capable technical manager can be the most useful and beneficial to the organization by providing the individual guidance for an employee that may who is having difficulty with the change. The manager should make the conversation a two-way exchange of ideas that is both critical of the issues and sensitive to the persons involved. There are too many organizations that rule with an iron fist. It has also been seen that this type of management often is exemplified by a high turnover rate with in the company and dissention between the management and staff. The management of technical change in an organization can be exciting if the participants look at it with all the facts available to them. It is the mangers responsibility to set the stage and successfully guide the team through this change.