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CONSTRUCTION COST ESTIMATING IN PROJECT MANAGEMENT

BY

KALPIT N. PATEL

THESIS SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL  
OF THE NEW JERSEY INSTITUTE OF TECHNOLOGY IN PARTIAL  
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MASTER OF SCIENCE IN CIVIL ENGINEERING 1990

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IN PROJECT MANAGEMENT

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ABSTRACT

Title of Thesis: Construction Cost Estimating In  
Project Management.

Kalpiti N. Patel, MASTER OF SCIENCE IN CIVIL ENGINEERING,  
1990.

Thesis Directed By: Professor Harold M. Tepper.

The primary objective of Cost Estimating is to support the timely generation of bid or alternative estimates. Cost Estimating also supports management analysis of estimate accuracy, reasonableness and project risk through the generation of summary reports and analysis. Estimates also provide a base of information during construction for such items as scope changes to the contract, variations in costs of the project cost, total project cost, feedback for scheduling etc.

Construction cost estimating is the process of identifying and compiling the many items of cost that will enter into a construction project. This is a procedure that requires very detailed study of the project during the different construction stages, combined with an intimate knowledge of the availability, characteristics and cost of materials, equipment & labor.

Construction cost estimates becomes useful for different activities during the construction of the project such as:

- (i) Procurement - the selection and purchase of materials, equipment & labor for individual work items during construction of the project.
- (ii) Change orders during construction due to alterations in the original contract, delays in the construction due to unavoidable reasons or any other problems occurring between the Owner and Contractor. Estimating is used to determine the increase or decrease in the amount of the original contract or involve no change.
- (iii) Back charges - charges for materials, equipment & labor or other costs furnished to the Contractor by the Owner, to the Contractor by the Architect / Engineer, or to a Sub-contractor / Vendor by the Contractor due to defective/incomplete or unsatisfactory work during construction. This requires the preparation of an estimated cost of the back charge work so that the Owner or Contractor can have information regarding the dollar amount of back charges.
- (iv) Use of Construction cost estimating becomes helpful in determining the financial position of the project by determining the total cost of work items completed to date, the cost of work required to complete and projected final costs so that one can determine whether there will be a project underrun or overrun.

Also it becomes useful to determine the payment to be made to the Contractor by the Owner for the executed work so that, he has sufficient information concerning the cashflow for the entire project. This also provides relative information to scheduling systems for manpower, planning and resource evaluation.

Estimating also plays an important role in providing information for the cost control of the project. Estimating and cost control are the two most important tasks a Contractor performs to develop equipment & labor production rates for each and every work item of the project during construction and for the selection of labor and equipment. Also estimating becomes useful to keep the cost of an on-going project within the established budget.



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## ACKNOWLEDGEMENT

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Kalpiti N. Patel

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CHAPTER I  
INTRODUCTION

Estimating and the construction industry have always been closely related. With a few notable exceptions, those proposing to construct for themselves or for others have found it necessary to estimate the cost of the project to be undertaken.

An Estimate is an opinion or judgement, of the probable cost for performing certain work under specific conditions. In order to calculate this projection there first must exist some accurate cost data to be utilized as a base cost component on which to apply the variables involved in a specific project so that the forecast for anticipated costs of future work will be accurate within a reasonable tolerance.<sup>1</sup>

It must be acknowledged that an estimate is not an exact science. However, it still must possess sufficient factual data that it can stand the challenge of proof of each element contained in the estimate.<sup>2</sup>

Cost estimating is the analytical process of determining the costs of materials, labor and other components necessary to accomplish project work. In practical terms, cost estimating also depends on the experience and common sense of the Estimator.<sup>3</sup>

The objective of this paper is to develop the procedure for different activities involved in Construction Cost

Estimation at various stages of Construction Project. The activities are Change order, Back charges, Financial Status report, Payment requisition, Puch List and Stored Material Analysis. All these activities play an important role in the preparation of Cost-Estimate at various stages, of Construction.

In the procedures of Cost Estimation, role of different Personnel such as Owner, Architect / Engineer, Contractor, Sub-Contractor, Project Manager and Estimators have been defined for different stages of the activities involved during construction of the project.

(i) Purchasing: The procedure involved in this activity is to obtain the approval for purchasing different items such as labor, materials, and equipment at initial stage or during construction of the project by submitting estimate by Contractor to Owner, so that the Contractor can do further planning and Scheduling of the individual work items for which purchasing is required.

(ii) Change Order: The procedure involved in this activity is to obtain the final approval of the cost proposal prepared by Architect / Engineer due to changes in the work at initial stage or during construction of the project as per Owner's directive, which is to be verified and signed by the Contractor. So that the Contractor can issue Change Orders to appropriate Sub-contractors and Vendors with adjusted contract amount and time required for completion.

(iii) Back charges: The procedure involved in this activity is to determine the changes in the contract amount and time for completion due to Unsatisfactory / Defective / Incomplete etc. work by the Contractor and his Sub-contractors, so that the Owner can accept back charge change order amount which would be recovered from their next bill.

(iv) Financial Status Report: The procedure involved in this activity is to prepare up-to-date financial status report for the actual work completed by the Contractor, so that the Owner can have enough information on monthly financial status of the project. Also it becomes helpful in determining the projected final cost of the project, which can be used to compare with the cost of original estimate to know the total-to-date savings or losses.

(v) Payment Requisition: The procedure involved in this activity is to prepare a requisition for payment for the work completed satisfactorily per Owner's specifications. In this activity, Contractor's Project Manager prepares requisition for progress payment for the actual work done by them which includes project cost break downs, forecasted schedules of progress payments and preparation of periodic pay estimates which has to be verified by Architect / Engineer and approved by Owner.

(vi) Punch List: The procedure involved in this activity is to determine the total cost of the work items which have not been completed by the Contractor or which have not been approved by the Owner for unsatisfactory work



performed by the Contractor. The final punch list prepared by Architect / Engineer is to be verified by the Contractor and approved by the Owner. This approved final amount of punch list is retained by the Owner until the final satisfactory completion of the project.

(vii) Stored Material Analysis: The procedure involved in this activity is to prepare the estimates of the stored materials for different work items (by Contractor and Architect / Engineer) which are used, yet to be used or stored. This information becomes helpful for the further planning and scheduling of the materials in advance.

In general, the fundamental nature of the project management requires estimates of future activity times, cost and resources. The process of estimating involves making a prediction or forecast of predefined events and/or occurrences weighted and influenced by subjective and objective information. Planning techniques are available so that estimates can be developed relating to schedules, resources, budgets, cash-flow, and performance standards.<sup>4</sup>

CHAPTER II  
PROCUREMENT

The purchasing environment is assigned the major task of simultaneously selecting the Sub-contractors and principal Vendors who can perform the work or supply the materials and equipment required by the contract documents and who have appropriate levels of skill and resources to become a member of the project construction team. The selection criteria between price and performance are frequently in conflict; thus the purchasing function needs the input and expertise of several other work environments in order to effectively address its responsibilities. The major functional guideline for purchasing is to buy from Sub-contractors and principal Vendors a full scope of work or materials in strict accordance with the Plans and Specifications.

Purchasing uses as its major control criteria:

- 1) The operation of plan and schedule for the project, usually prepared by the project management staff.
- 2) The purchasing budget, which may be established by the project management staff or by the business management staff.<sup>5</sup>

The budget for the purchase of different items such as materials, equipment & labor etc., must be decided prior to choosing Sub-contractors / Vendors for the individual work items for the project so that the budgeting criteria becomes an in-

tegral part of the bid strategy. Purchasing must maintain a very close primary working relationship with several other work environments. It is especially concerned with the legal implication of agreements. Terms and conditions of contracts and purchase orders are its crucial considerations. The responsibilities of purchasing include the resolution of cost, schedule, conditions of the work, and terms and conditions of the sub-contract and purchase documents.

Purchasing must maintain a primary working relationship with estimating and draw upon estimating's knowledge when the contract documents may not fairly or completely describe the scope of the work. Some purchasing is frequently performed directly by project management personnel. Other purchasing is performed with the approval of a Purchasing Agent or separate purchasing department. Whatever the company's organization, the relationships are especially sensitive.

Since purchasing establishes many of the controlling guidelines for finance control and accounting especially in dealing with accounts payable, the relationship between purchasing and finance must be especially close. The best written sub-contracts and purchase orders will not eliminate the potential for disagreements in the field environment concerning the several responsibilities of the Sub-contractors and Vendors.<sup>6</sup>

Similarly, contract administration must rely heavily on communications from purchasing in order to resolve questions or disagreements concerning the scope of the work, especially

inclusions and exclusions, which result in claims, charges, and back charges.

The purchasing environment is a service function charged with the distribution of technical data and pricing requirements to the Sub-contractor and Vendor marketplace. It is responsible for the collection and verification of competitive and comparative prices for the components of the project and in analyzing the data. It is also responsible for negotiating sub-contracts, purchase orders and schedule. Some project management is usually operative between purchasing and the business management environment when purchase orders and sub-contracts cannot be let within the limitations of the established budget and schedule. The purchasing function must be carried out efficiently in order to maintain budget control of a project and it must be accomplished expeditiously so that materials, goods and services will be available at the job site when these are required for field construction.

The difficulties encountered with purchasing occur when sub-contracts and purchase orders are not clearly written in the context of the contract between the Contractor and Owner. The purchasing environment involves a high degree of discipline and organization. It deals with highly technical issues of legal consequence. These tend to be formally and efficiently handled when external legal counsel is used.<sup>7</sup>

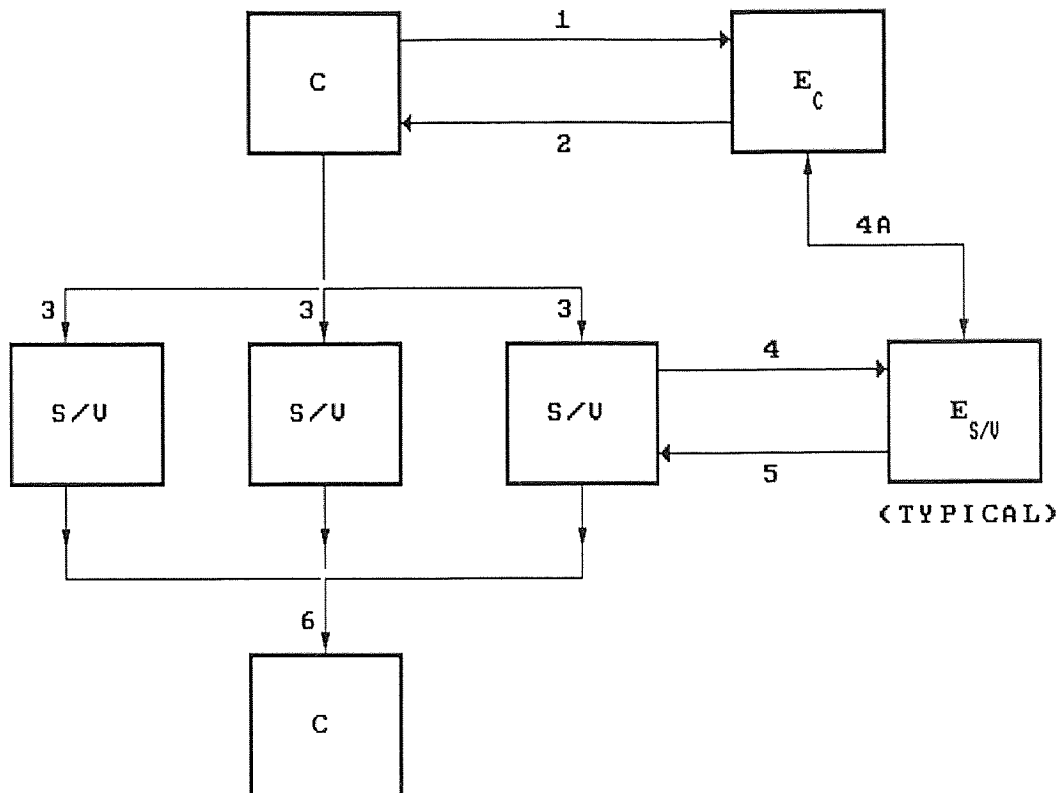
## 2.1 Estimating Procedure

Flowchart # 1 on page 8-A graphically outlines the Estimating activities involved in the preparation of purchasing criteria and requirements. A description of these activities is as follows:

- Activity 1: Contractor, prior to conducting the purchasing, asks his Estimator to review the estimate for different items estimated for the construction project.
- Activity 2: Estimator, by reviewing the estimated cost of the project, prepares estimate for individual work items as per Contractor's needs.
- Activity 3: At the same time as Activity # 1 is undertaken Contractor asks his Sub-contractors / Vendors to review their estimated costs of the project to determine the cost for the individual work items for which selection is to be done.
- Activity 4: Sub-contractors / Vendors ask their Estimators to prepare estimates as per Contractor requirements.
- Activity 4a: Sometimes before Activity # 5 takes place the Sub-contractor's Estimator keeps in touch with the Contractor's Estimator to collect required information regarding the project in order to prepare the estimate. Similarly sometimes, as per Contractor's requirements, his Estimator provides information to the Sub-contractor's Estimators as and when required.

## LEGEND

E = ESTIMATOR  
 C = CONTRACTOR  
 S/U = SUB-CONTRACTOR / UENDOR  
 E<sub>C</sub> = CONTRACTOR'S ESTIMATOR  
 E<sub>S/U</sub> = SUB-CONTRACTOR'S / UENDOR'S ESTIMATORS



PURCHASING

FLOWCHART NO. 1

Activity 5: Sub-contractor / Vendor Estimators prepare estimates per their requirements for the individual work items and return same to Sub-contractors / Vendors.

Activity 6: Sub-contractors / Vendors submit their detailed estimates for the different work items to the Contractor. Contractor reviews the estimates submitted by Sub-contractors / Vendors and prepares final list for the purchasing task using Sub-contractors / Vendors prices and his own estimate, for the further planning and scheduling of the construction activities.

## 2.2 Purchasing Objectives

There are four major factors to be considered in Estimating during the purchasing phase of a construction project:

- 1) Price
- 2) Quality
- 3) Delivery schedule
- 4) Vendor / Sub-contractor responsibility

Price is of prime importance. But when a lower purchase price is offset by losses due to delays, additional expediting costs, and questionable quality, they can usually result in a higher final cost. Hence while estimating during purchasing, price variances must be taken into account. A Contractor makes a profit only on complete work, and it is only when buying contributes to the final job project that it contributes to earnings.

Quality is controlled by the Specifications, and the Owner can expect only what he has specified and is willing to pay for. Sometimes Specifications will call for inferior materials but set standards which, if met, would require materials of top grade. The Estimator must watch for such inconsistencies per the Owner's directives for the purchasing.

Looking at the different estimates submitted by Sub-contractors / Vendors, Owner / Contractor selects the lowest responsible estimate, per the specifications and requirements which control quality of the work.

Delivery schedules can sometimes become the controlling factor in determining a purchase. During construction the preparation of estimates to select the required materials, equipment & labor, which need to be used for the project, delivery time, delivery ahead of schedule plays an important role which may result into loss if any of the above runs out of control or schedule. Also while purchasing losses due to spoilage or theft or disruptions in cash forecasting should be considered.

Vendor's responsibility is a term that has a number of meanings, and all of them are important. It is directly related to the supplier's ability to provide goods of uniform quality, make accurate deliveries, keep precise delivery schedules, and still sell at a price which meets comparable competition. Therefore, the Vendor's financial stability can be an important factor to consider when selecting a supplier.



Before estimating the purchasing needs for individual work items, it is of prime importance to collect the information of valid responsible Sub-contractors / Vendors / Suppliers, i.e., is he financially strong, well experienced, capable to perform work, etc,. Estimates which are prepared considering all of the above criteria for the selection should not create variations in the final cost of the completed work items.

Materials, equipment and supplies are often purchased on the basis of the estimate prepared for each specific project, regardless of the size of the Contractor's business. The estimate is a quantity survey or "take-off" from the plans or, as often happens on very small jobs, it may be based on the Estimator's own experience.

### 2.3 Sub-Contracting

There are few, if any, construction projects on which some part of the work is not performed by a Sub-contractor. Sometimes on larger projects, the larger Sub-contractors will sub-contract portions of their work. This practice results in several "tiers" of Sub-contractors. The Owner holds the Contractor responsible for the entire project, even though some parts of it may be done by firms of which neither the Owner nor Contractor has ever heard. In the same way, the Contractor holds the first tier Sub-contractors responsible for their portion of the work.

The first step in choosing a Sub-contractor is a decision by the Contractor as to just what work is to be sub-contracted. Because the extent and scope of the work may vary according to which Sub-contractor is chosen, it may be necessary to select the Sub-contractor at the same time the scope of the work is determined.

During the construction of the project, as discussed earlier in Sub-contractor's responsibility, it is the Contractor's responsibility to review the estimate submitted by Sub-contractors / Suppliers / Vendors, and select valid responsible Sub-contractors / Vendors / Suppliers who are financially capable, technically sound, well experienced, and capable of performing the work. This process of selection will become very expensive if a mistake in judgement in selecting a Sub-contractor / Vendor / Supplier is performed.

CHAPTER III  
CHANGE ORDERS

A Change Order is a formal document that alters some portion of the original contract between the Owner and Contractor. It can increase the amount of the original contract, decrease it or involve no change.

Change Orders cannot be avoided on a construction project but they can be either profitable for the Contractor or can cause losses if they get out of control.<sup>8</sup> Change Orders create both problems and opportunities for the Contractor. When there are too many of them, they slow down the project and increase unit costs. Also, when Change Orders cause delay in completing the project it is necessary to obtain a time extension. On the other hand, they offer opportunities to negotiate changes to the original contract price which can prove quite profitable. The best procedure is to take advantage of the opportunities and avoid as many changes as possible.

There are two types of costs relative to a Change Order. Normally the major costs of a Change Order, are direct costs, consisting of labor, materials, equipment, supplies and sub-contracted costs. Direct costs are defined as "the cost that can be identified with a particular part or segment of a project." There also are indirect costs. They fall in two categories: job overhead and home office overhead costs.

Job overhead costs consist of office staff, car radios, typewriters, job trailers, job utilities, field staff, taxes, insurance, bonds and other similar items. Home office overhead costs are similar to job overhead but are normally expended off the job site. Indirect costs are "those costs that cannot be attributed to a single item or unit of construction work."

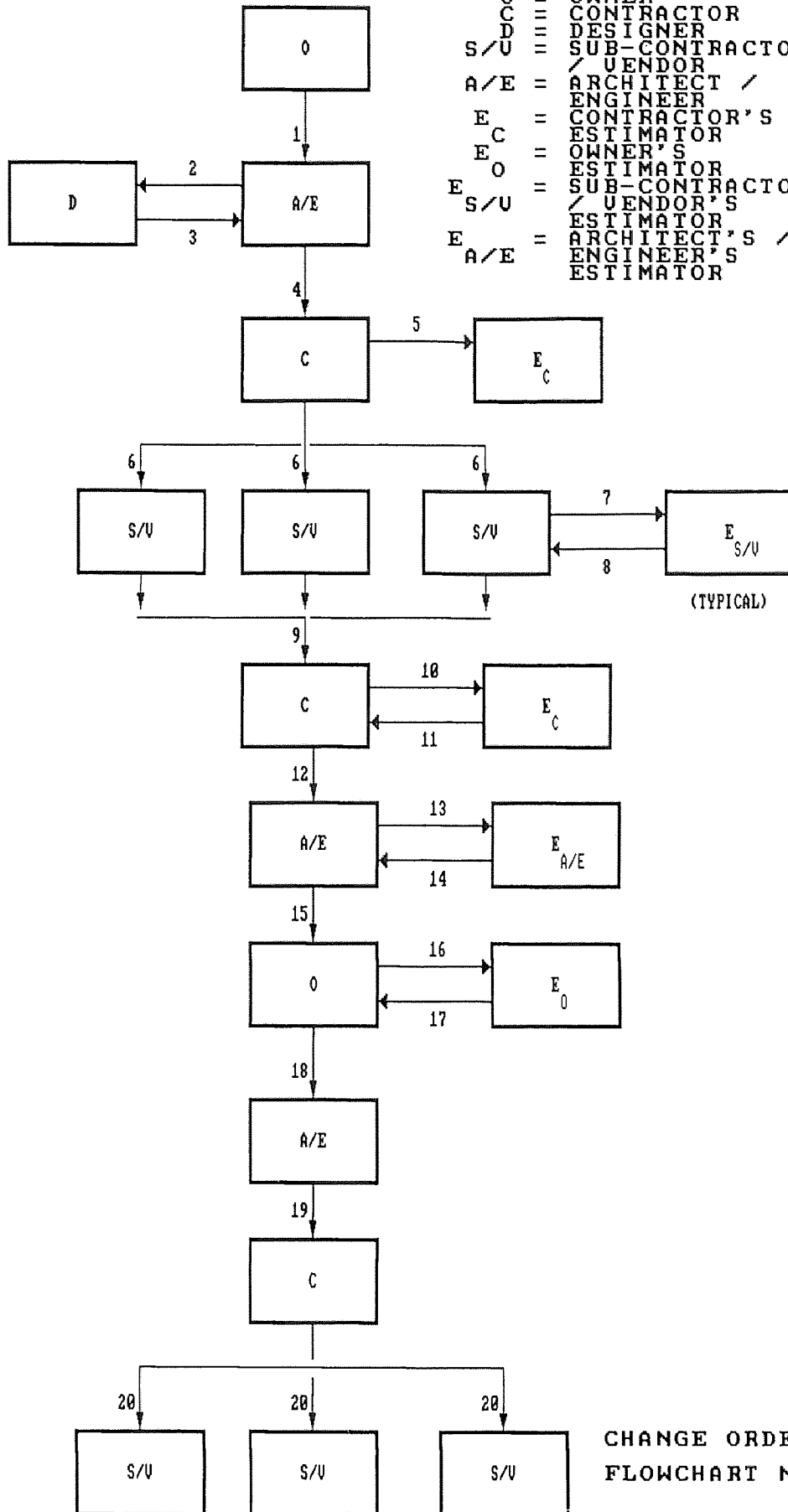
### 3.1 Estimating Procedure

Flowchart # 2 on page 14-A graphically outlines the Estimating activities involved in the preparation of an Owner to Contractor Change Order. A description of these activities is as follows:

- Activity 1. Proposed change during construction, as requested by Owner for various reasons not initiated by the Contractor, is forwarded to the Architect / Engineer to make changes in the contract documents per requirements.
- Activity 2. Architect / Engineer prepares outline and data concerning the proposed change and forwards same to design personnel to prepare proper documents.
- Activity 3. Design personnel prepare documents for changes per outline given by Architect / Engineer and sends same to Architect / Engineer.
- Activity 4. Architect / Engineer forwards required documents with request for a cost proposal and impact on time for the proposed changes to Contractor.

LEGEND

- O = OWNER
- C = CONTRACTOR
- D = DESIGNER
- S/U = SUB-CONTRACTOR
- / U = VENDOR
- A/E = ARCHITECT / ENGINEER
- E C = CONTRACTOR'S ESTIMATOR
- E O = OWNER'S ESTIMATOR
- E S/U = SUB-CONTRACTOR'S ESTIMATOR
- / U = VENDOR'S ESTIMATOR
- E A/E = ARCHITECT'S / ENGINEER'S ESTIMATOR



- Activity 5. Contractor sends proposed changes and documents (as prepared by Architect / Engineer) to Estimator for preparation of quantity survey, cost estimate and impact on the time for the completion.
- Activity 6. At the same time as Activity # 5 is undertaken Contractor forwards proposed changes to Sub-contractors / Vendors to prepare their cost estimate of the changes in work.
- Activity 7. Sub-contractor sends proposed changes and documents to their own Estimators for preparation of quantity survey, cost estimate and time impact.
- Activity 8. Sub-contractor / Vendor's Estimator forwards cost estimate to Sub-contractor / Vendor.
- Activity 9. Sub-contractors / Vendors submit their proposals covering the requested changes to Contractor.
- Activity 10. Contractor submits Sub-contractor / Vendor's proposal to Estimator for review of estimates submitted by each Sub-contractor / Vendor. Estimator prepares quantity surveys, individual line item cost estimates and a complete summary of estimate for the proposed change using a combinations of Sub-contractor / Vendor prices, material prices and own cost estimates.
- Activity 11. Estimator sends summary of estimate to Contractor.
- Activity 12. This summary of estimate for the proposed change is forwarded by Contractor to Architect /

Engineer for review and approval.

Activity 13. Architect / Engineer forwards Contractor's proposal and summary of estimate to his own Estimator for comparison with his own summary of estimate.

Activity 14. Architect / Engineer's Estimator returns Contractor's summary of estimate with recommendation for required changes to Architect / Engineer, if needed, or indicates approval of Contractor proposed cost estimate.

Activity 15. Architect / Engineer reviews the summary of estimate submitted by Contractor and compares it with Owner's acceptance criteria. Architect / Engineer forwards the summary of estimate to Owner for approval.

Activity 16. Owner sends Contractor proposal and summary of estimate as required by Architect / Engineer to his own Estimator for final check.

Activity 17. Estimator compares Contractor proposal and summary of estimate submitted by Architect / Engineer with Owner's criteria and returns same to Owner.

Activity 18. Upon Owner acceptance approval is issued to Architect / Engineer for preparation of Change Order.

Activity 19. Architect / Engineer prepares Change Order form per Owner's requirements and issues executed Change Order to Contractor.

Activity 20. Upon receipt of executed Change Order, Contractor adjusts the original contract amount and time for

completion. Contractor then issues Change Orders to the appropriate Sub-contractors and Vendors. Necessary action is then taken by the Contractor to complete the Change Order.

### 3.2 Owner / Contractor Change Order Format

There are many formats by which a Change Order proposal can be submitted. Some are outlined in the Contract, others maybe indicated in the specifications and some are designated by the Owner or Architect / Engineer. If it is in the contract there is little choice but to use that format. If the format is not outlined, one of the following types is commonly used:<sup>9</sup>

- 1) Lump sum
- 2) Crew type
- 3) Detailed cost proposal

#### 1) Lump sum:

This format is a proposal describing the Change Order and offering to perform it for a lump sum price. There is no breakdown of costs or summary of estimate included. Why not a detailed proposal instead of a lump sum? Because, the more detail provided the Owner and Architect / Engineer, the more fault that can be found.

#### 2) Crew type:

This format is a semi-detailed cost estimate with direct costs, indirect costs, total hourly costs and also crew hourly costs which describe the Change Order and offer to perform it for a percentage of the total cost. There are two types of formats recommended to break out the direct costs



into a crew type format. Either format will work well. This type of proposal is used when the Owner or Architect / Engineer has requested a detailed proposal and when there are questions unresolved concerning the change. The crew type format lends it to the use of contingencies.

Indirect costs, profit and bond are applied as a percentage of the total direct hourly cost. The end result is a total hourly cost for this particular crew that when multiplied against so many hours equals the total crew cost for the change.

3) Detailed cost proposal:

This type of proposal which contains line item estimates and a summary of estimate is needed by the Contractor for negotiations. With this type of proposal one can know the condition of the progress of the project, by looking to the summary of estimate without referring the individual work item. This also is the type of cost proposal Owners generally desire. With this much detail, the Owner, by performing his own detailed cost estimate and analysis and using the Contractor's detailed proposal, can challenge the Contractor's detailed proposal to be on the safe side.

In this type of format each direct cost is computed and totaled. In this totaled direct cost, indirect cost, profit and bond are added as a percentage of the total direct cost to get a total cost.

### 3.3 Changes In The Prime Contract

When the Owner properly notifies the Contractor that a change is to be made, the Contractor should stop as much as possible of the work that would have to be torn out or changed if the order were actually issued. He should also notify his Sub-contractors and Vendors to take the same steps.

Under ideal circumstances, all the necessary plans relative to a change would be available to the Contractor for immediate preparation of a cost estimate and negotiation of a Change Order. It is often necessary, however, to delay this procedure until the necessary drawings and specifications showing the change are ready. Another procedure is to proceed with the work under a "Notice to Proceed" and leave negotiations of the formal Change Order amount until some later.<sup>10</sup>

When the Notice to Proceed is used, it is better, in any event, to proceed with the normal routine of preparing a Change Order and have it signed by both parties. However, if work on the change starts before the formal Change Order is issued, a Work Order should be prepared.<sup>11</sup>

When a Change Order affecting the original contract price is issued, the original project estimate should be adjusted accordingly. As a partical matter, this is rarely done more than once each week; more commonly, it is done once or twice a month.

There are two ways in which changes affecting the original contract amount, may be reflected. First, they may

be treated separately, as if each were a separate work item. Second, they may be reflected by a direct adjustment of the work items. When the changes are few, it makes little difference which method is used. When they are numerous, it may be necessary either to incorporate them into the related work items or to lump them together into "Additive Changes", "Deductive Changes or "Changes Not Affecting Initial Work Items."<sup>12</sup>

### 3.4 Changes In Sub-contracts And Purchase Orders

Contractors, and Sub-contractors (who have sublet a portion of their sub-contracts) are constantly facing the problem of determining to what extent, if any, a change in their original scope of work will affect their Sub-contractors.

Usually this determination is made when the initial summary of estimate relative to a change is prepared. But there still remains the task of following through and issuing Change Orders to the Sub-contractors.

The same follow-up needs to be carried out with respect to materials ordered from Vendors.

It is a good idea whenever practical, to put copies of the Sub-contract Change Orders and the changes to Purchase Orders to Vendors in the file folder containing the individual line item of work estimates and summary of estimate. When it is not practical, it is necessary to have some cross reference to the Change Order and Purchase Order files.

When a change is actually ordered, from Contractor to Sub-contractor, a Change Order form should be employed. If

there is any question at all regarding the Sub-contractor's or Vendor's willingness to accept the change, it would be desirable to send the notice by registered or certified mail.

CHAPTER IV  
BACK CHARGES

4.1 Owner To Contractor and Contractor To Sub-Contractor /  
Vendor Back Charges

Back charges represent charges for labor, materials, equipment, services or other costs or expenses furnished to the Contractor by the Owner or performed on the Contractor's behalf by the Owner. The same situation can occur with respect to the relationship between the Sub-contractor / Vendor and the Contractor.

If the charges are proper, a senior executive should personally authorize any back charge before it is accepted. The procedure for handling back charges, once they are properly authorized, is simple. The organization asserting the backcharge prepares a Change Order for the agreed price of the back charge. It is then accounted for as any other Change Order in the monthly requisition procedure. In making the next progress payment by the Owner to the Contractor or by the Contractor to his Sub-contractor / Vendor, the amount of the back charge Change Order is deducted.

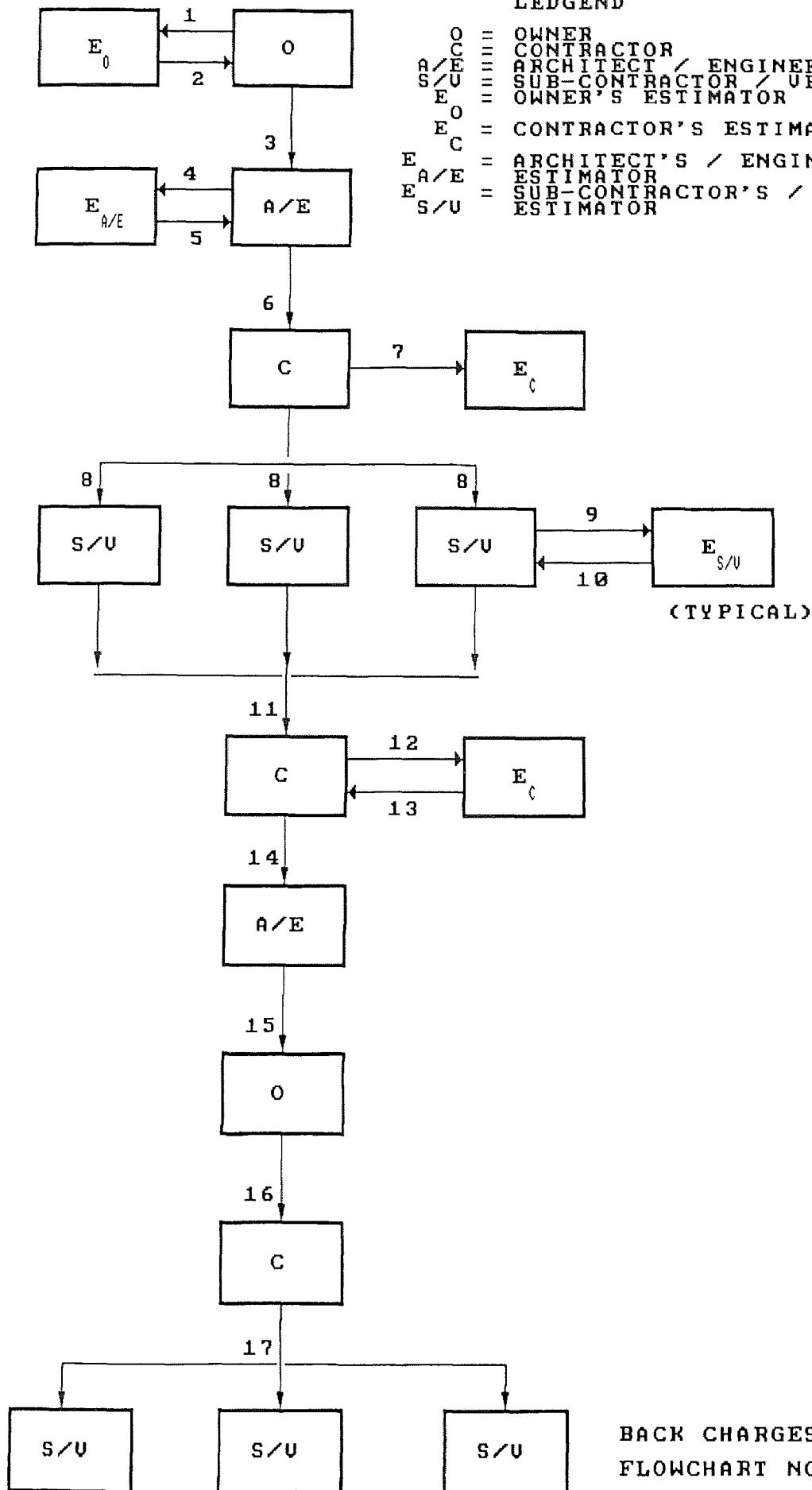
4.2 Estimating Procedure # 1

Flowchart # 3 on page 23-A graphically outlines the Estimating activities involved in the preparation of a back charge Change Order (viz, Owner to Contractor; Contractor to Sub-contractor / Vendor). A description of these activities is as follows:

- Activity 1. Owner asks his own Estimator to prepare cost estimates for the unsatisfactory / defective / incomplete, etc. work by Contractor for his knowledge.
- Activity 2. Estimator prepares the various estimates in accordance with the Owner's requirements and submits same to Owner.
- Activity 3. At the same time as Activity # 1 is undertaken Owner asks Architect / Engineer to prepare similar independent quantity surveys, line item cost analyses and a summary of estimate for the back charge.
- Activity 4. Architect / Engineer forwards proposed back charge information to his own Estimator to prepare quantity survey, line item, cost estimates and summary of estimate.
- Activity 5. Estimator prepares summary of estimate in accordance with the list of back charges and returns same to Architect / Engineer.
- Activity 6. Architect / Engineer reviews the summary of estimate prepared by his Estimator, compares it to that which was prepared by the Owner's Estimator and if appropriate prepares a back charge Change Order and forwards the Change Order to Contractor.
- Activity 7. Contractor forwards information received with backcharge Change Order and sends same to his Estimator for verification.

LEDGEND

- O = OWNER
- C = CONTRACTOR
- A/E = ARCHITECT / ENGINEER
- S/U = SUB-CONTRACTOR / UENDOR
- E/O = OWNER'S ESTIMATOR
- E/C = CONTRACTOR'S ESTIMATOR
- E/A/E = ARCHITECT'S / ENGINEER'S ESTIMATOR
- E/S/U = SUB-CONTRACTOR'S / UENDOR'S ESTIMATOR



BACK CHARGES  
FLOWCHART NO. 3

- Activity 8. At the same time as Activity # 7 is undertaken Contractor sends summary of proposed back charges to the Sub-contractors / Vendors for their verification of the cost to be back charged to them.
- Activity 9. Sub-contractors review proposed back charge cost and asks their Estimators to prepare independent quantity surveys, line item cost estimate and a summary of estimate for proposed back charges.
- Activity 10. Estimator verifies amount of proposed back charges and submits comments to Sub-contractor / Vendor.
- Activity 11. Sub-contractors / Vendors review the estimates prepared by their Estimators and forward their comments or acceptance of proposed back charges to Contractor.
- Activity 12. Contractor sends Sub-contractor / Vendor estimates or comments to his Estimator for verifications against his own's estimate.
- Activity 13. Estimator verifies amount of proposed back charge and submits comment to Contractor.
- Activity 14. If Contractor is satisfied with the proposed amount of back charge Change Order he advises Architect / Engineer of acceptance by signing change order.
- Activity 15. Architect / Engineer reviews Contractor's accepted back charge Change Order, approves it and forwards to the Owner for final verification.



Activity 16. Owner reviews and signs the back charge Change Order approved by Architect / Engineer and sends final approved back charge cost to the Contractor which would be recovered from his next bill.

Activity 17. In the same way as Owner does with the Contractor, Contractor sends appropriate back charges to Sub-contractors / Vendors which would be recovered from their next bill.

#### 4.3 Estimating Procedure # 2

Flowchart # 4 on page 25-A graphically outlines the Estimating activities involved in the preparation of a back charge Change Order (viz, Architect / Engineer to Contractor).

A description of these activities is as follows:

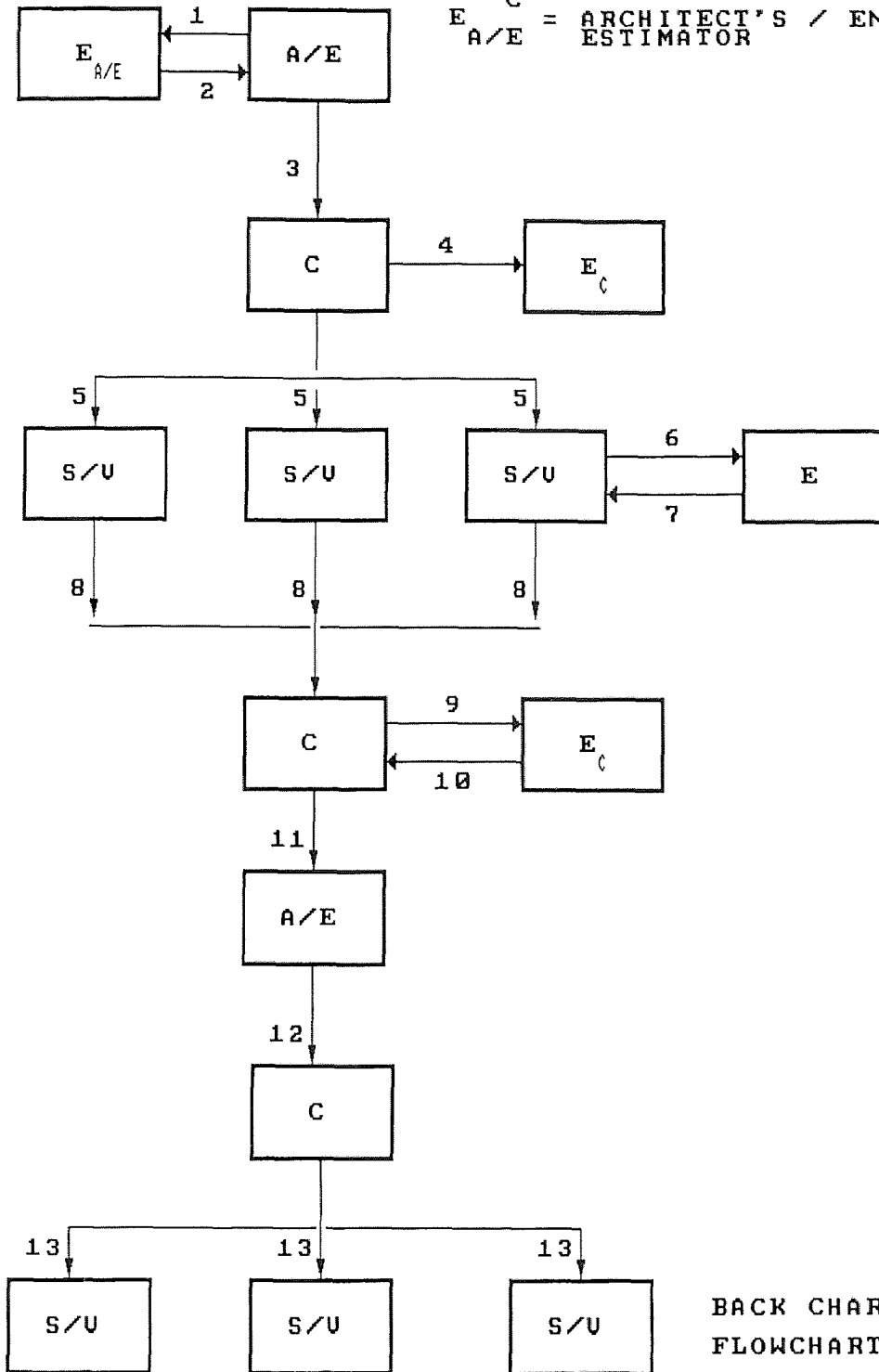
Activity 1. Architect / Engineer asks his own Estimator to prepare cost estimates for the unsatisfactory / incomplete / defective work etc. performed by Contractor before he sends final approval for the completed work to Owner for verification.

Activity 2. Estimator, as per Architect / Engineer directives, prepares summary of estimate in accordance with the list of back charges and returns same to Architect / Engineer.

Activity 3. Architect / Engineer reviews the summary of estimate prepared by his Estimator, and if the estimate is appropriate and meets his requirements, prepares a back charge Change Order and forwards the same to the Contractor.

LEGEND

C = CONTRACTOR  
 A/E = ARCHITECT / ENGINEER  
 S/U = SUB-CONTRACTOR / UENDOR  
 E = ESTIMATOR  
 E C = CONTRACTOR'S ESTIMATOR  
 E A/E = ARCHITECT'S / ENGINEER'S ESTIMATOR



BACK CHARGE  
 FLOWCHART NO. 4

- Activity 4. Contractor forwards information received with back charge Change Order and sends same to his Estimator for verification.
- Activity 5. At the same time as Activity # 7 is undertaken Contractor sends summary of proposed back charges to the Sub-contractors / Vendors for their verification of the cost to be back charged to them.
- Activity 6. Sub-contractors review proposed back charge cost and ask their Estimators to prepare independent quantity surveys, line item cost estimate and a summary of estimate for proposed back charges.
- Activity 7. Estimator verifies amount of proposed back charges and submits comments to Sub-contractor / Vendor.
- Activity 8. Sub-contractors / Vendors review the estimates prepared by their Estimators and forward their comments or acceptance of proposed back charges to Contractor.
- Activity 9. Contractor sends Sub-contractor / Vendor estimates or comments to his Estimator for verification against his own estimate.
- Activity 10. Estimator verifies amount of proposed back charge and submits comment to Contractor.
- Activity 11. If Contractor is satisfied with the proposed amount of back charge Change Order he advises

Architect / Engineer of acceptance by signing change.

Activity 12. Architect / Engineer reviews Contractor's accepted back charge Change Order and compares with his summary of estimate and if he agrees with it, approves it and forwards final approved back charges cost to the Contractor, which would be recovered from his next bill.

#### 4.4 Estimating Procedure # 3

Flowchart # 5 on page 27-A graphically outlines the Estimating activities involved in the preparation of back charge Change Order (viz, Contractor to Sub-contractors / Vendors). A description of these activities is as follows:

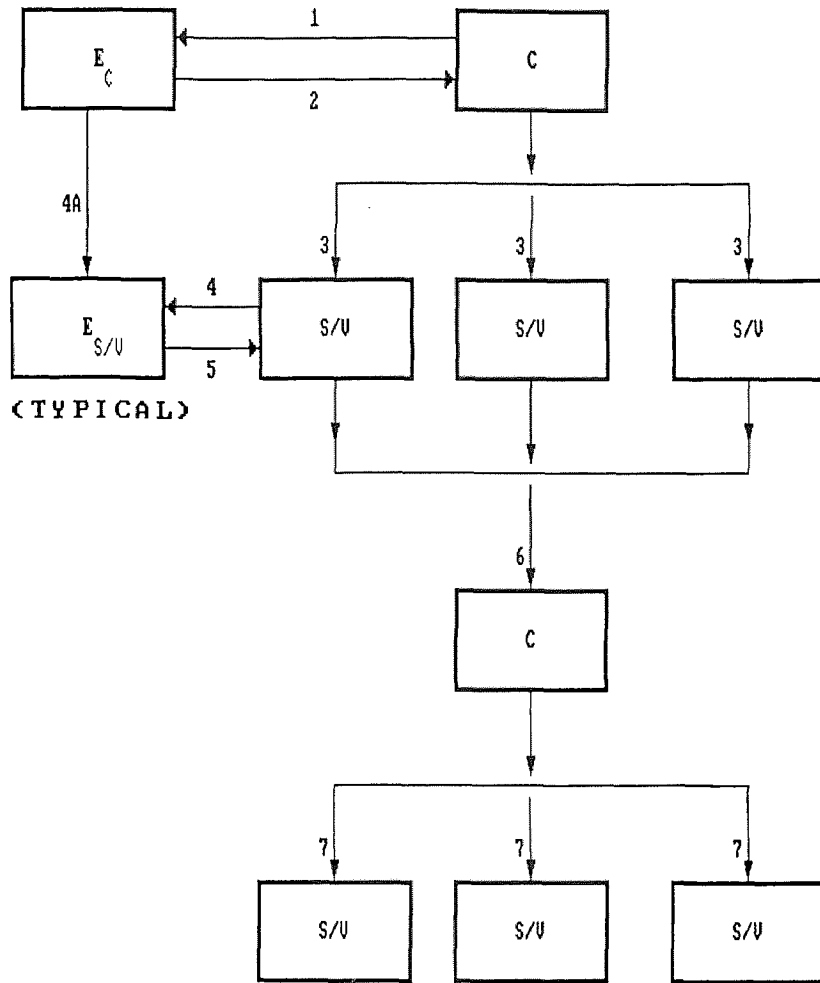
Activity 1. Contractor asks his own Estimator to prepare cost estimate for the unsatisfactory / defective / incomplete work, etc. performed by Sub-contractors / Vendors and also the work rejected by Owner for the work Sub-contracted by Contractor.

Activity 2. Estimator prepares the various estimates in accordance with Contractor's requirements and submits same to Contractor.

Activity 3. At the same time Activity # 1 is undertaken Contractor sends summary of proposed back charges to the Sub-contractors / Vendors for their verification.

LEGEND

$C$  = CONTRACTOR  
 $S/U$  = SUB-CONTRACTOR /  
 UENDOR  
 $E_C$  = CONTRACTOR'S  
 ESTIMATOR  
 $E_{S/U}$  = SUB-CONTRACTOR'S /  
 UENDOR'S ESTIMATOR



BACK CHARGE  
FLOWCHART NO. 5

- Activity 4. Sub-contractor forwards information received with back charge Change Order and sends same to his Estimator for verification.
- Activity 4a. Sometimes, before Activity # 5 takes place Estimator of Sub-contractors / Vendors keep in touch with Contractor's Estimator to collect required information regarding applied back charges to his Sub-contractors which may become useful in preparing estimates. Similarly sometimes, per Contractor's requirements, his Estimator provides information to Sub-contractors / Vendors Estimator as and when required.
- Activity 5. Estimator verifies amount of proposed back charges and submits his comments to Sub-contractor / Vendor.
- Activity 6. Sub-contractor / Vendors review the summary of estimate prepared by their Estimators and forward their comments or acceptance of proposed back charges to Contractor.
- Activity 7. Contractor reviews Sub-contractor / Vendors accepted back charge Change Order with his own estimated back charge and if agrees with the one submitted by Sub-contractor / Vendors signs it and sends final approved back charge cost to Sub-contractor / Vendors which would be recovered from their next bill.

CHAPTER V  
FINANCIAL STATUS REPORT

5.1 Monthly Up Date

Each month a Contractor should prepare a financial status report for the entire corporation. To facilitate compilation of this report it is essential that the status of each project be accurately reported.

To accomplish this, estimates for the total quantity of a completed work item are prepared, "to-date", and project savings or loss figures are obtained by subtracting its actual estimated cost (i.e. projected final cost to-date) from its original estimated cost. When a work item has been only partially accomplished, "to-date" savings or losses on that particular work item are obtained in the same way as for the completed work item. For this type of activity which has not yet been completed, the cost difference (i.e. estimate to complete) cannot be compared exactly with the total to-date estimate for saving or loss.

Hence, the monthly preparation of the progress estimate for the project affords the Project Manager the opportunity to analyze several of the essential ingredients that determine whether the project is running under or over the original estimated cost.

## 5.2 Estimating Procedure

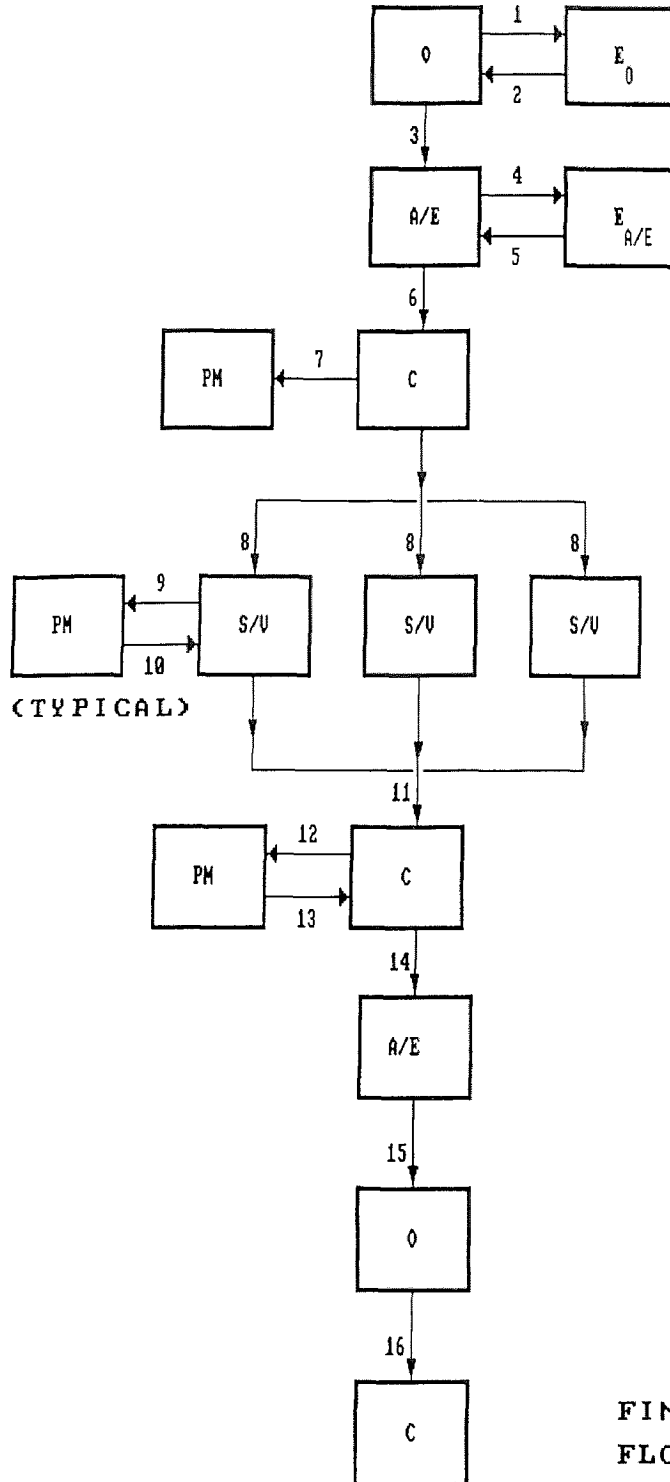
Flowchart # 6 on page 30-A graphically outlines the Estimating activities involved in the preparation of Financial status report. A description of these activities is as follows:

- Activity 1. Owner asks his own Estimator to prepare monthly project financial status report by considering the "up to-date" position of completed work preformed by Contractor.
- Activity 2. Estimator does project cost anaylsis by collecting information regarding each and every activity of the project, such as amount of work order, total to-date work completed, and amount of work to be completed. Estimator, with this information analyzes the projected final cost so that Owner can compare it with the original estimated amount to know whether the project is underrunning or overrunning, and yielding a projected savings or loss figure. This final report is submitted to Owner by the Estimator.
- Activity 3. At the same time as Activity # 1 is under taken, Owner asks Architect / Engineer to prepare a monthly project financial report to know the projected final cost of the project by which he can know whether the project is underrunning or overrunning.



LEGEND

- O = OWNER
- C = CONTRACTOR
- PM = PROJECT MANAGER
- A/E = ARCHITECT / ENGINEER
- S/U = SUB-CONTRACTOR / UENDOR
- E<sub>O</sub> = OWNER'S ESTIMATOR
- E<sub>A/E</sub> = ARCHITECT'S / ENGINEER'S ESTIMATOR



FINANCIAL STATUS REPORT  
FLOWCHART NO. 6

- Activity 4. Architect / Engineer, per Owner's directives and per the actual position of construction work gathers information regarding different work items executed by Contractor and his Sub-contractor. This information is sent to his Estimator to prepare the projected final cost of different work items.
- Activity 5. Estimator prepares summary of monthly project financial report in accordance with Architect / Engineer's requirements and returns same to him.
- Activity 6. Architect / Engineer reviews summary of the financial status report prepared by his Estimator and compares it with the one which is prepared by Owner's Estimator. If appropriate a final monthly financial status report is prepared and forwards same to the Contractor.
- Activity 7. Contractor forwards information received with the final monthly financial status report from Architect / Engineer and sends same to his Project Manager for verification.
- Activity 8. At the same time as Activity # 7 is under taken Contractor sends summary of financial status report to Sub-contractors to verify the projected final cost for individual work items and analyzes them as to applicability.
- Activity 9. Each Sub-contractor reviews the monthly financial report and asks their Project Manager to

prepare an independent estimate for the work performed by them.

- Activity 10. Project Manager verifies each and every work item completed by them and determining the projected final cost of the work so that it can be compared with the cost of original estimate to know the savings or loss for the individual work items and then forwards same to Sub-contractor.
- Activity 11. Sub-contractor reviews the cost for the monthly project status analysed by his Project Manager and forwards same with necessary comments to Contractor.
- Activity 12. Contractor sends Sub-contractor's estimated report to his Project Manager for verification against his own financial status report.
- Activity 13. Project Manager verifies the amount of projected final cost and submits same to Contractor.
- Activity 14. If the Contractor agrees with the report prepared by his Project Manager, considering the one submitted by Sub-contractor, he advises Architect / Engineer of acceptance by signing it.
- Activity 15. Architect / Engineer reviews Contractor's accepted amount of projected final cost, and if he agrees with it, forwards it to Owner for final verification.

Activity 16. Owner reviews and compares the amount of projected final cost with the original estimated amount of each and every work item so he can know the financial position of the project. If he agrees with it, he signs it and sends final approved financial status report to Contractor with necessary comments.

CHAPTER VI  
REQUISITION FOR PAYMENT

PART I. Contractor To Owner

The Project Manager normally has the over-all responsibility for the financial management of his particular project. This includes carrying out such fiscal duties as may be imposed by the construction contract and implementing appropriate monetary procedures according to the dictates of good business practice. Project financial management can involve a broad range of responsibilities.

A construction contract normally requires that the Contractors perform certain duties of a financial nature. For example, they are made responsible for certain aspects of progress payments. This can include project cost breakdowns, forecasted schedules of progress payments, preparation or approval of periodic pay estimates, and documentation required for final payment. Construction contracts prescribe specific procedures to be followed by the Contractor with regard to payment for extra work, extensions of time, processing of Change Orders, claims and settlement of disputes.

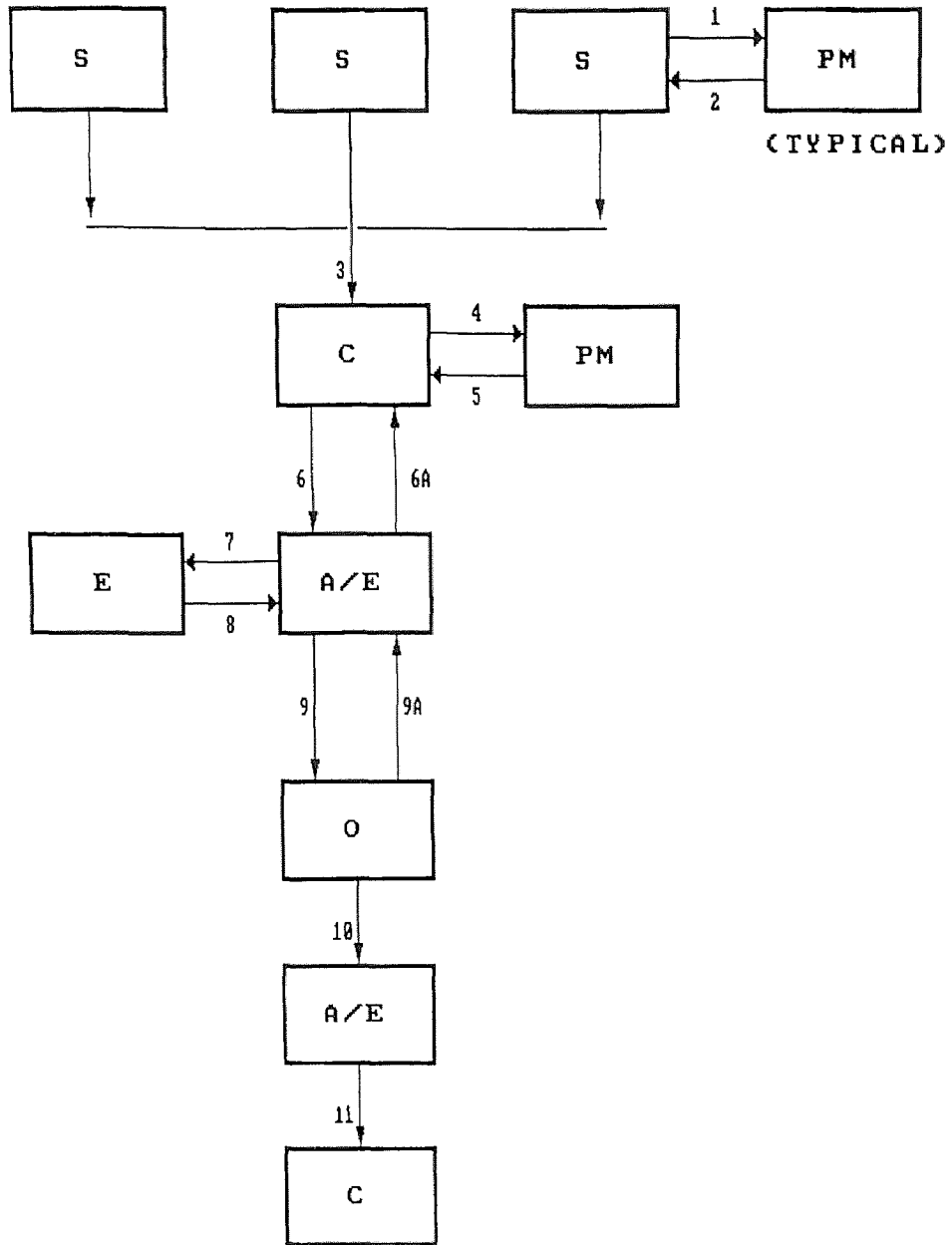
6.1 Estimating Procedure

Flowchart # 7 on page 35-A graphically outlines the Estimating activities involved in the preparation of requisition of payment to Contractor by Owner. A description of these activities is as follows:

- Activity 1. Sub-contractors ask their Project Manager to prepare a requisition for payment for the work completed satisfactorily as per Contractor's requirements and after approval by Architect / Engineer.
- Activity 2. Project Manager prepares estimate of actual work completed by Sub-contractors for the requisition.
- Activity 3. Sub-contractors submit invoices covering the completed work to Contractor so he can prepare an invoice for payment.
- Activity 4. Contractor reviews the invoices submitted by Sub-contractors and ask his Project Manager to prepare requisition for payment by considering the amount of work done by his own forces and the invoices submitted by the Sub-contractors in terms of a suitable percentage.
- Activity 5. Project Manager prepares payment request as per Contractor's requirement and returns same to the Contractor.
- Activity 6. Contractor reviews the payment request prepared by his Project Manager and forwards it to Architect / Engineer.
- Activity 6A. Architect / Engineer reviews Contractors payment request, compares with his own estimate and if not in agreement with it, returns it to Contractor with required changes.

LEGEND

- O = OWNER
- C = CONTRACTOR
- E = ESTIMATOR
- S = SUB-CONTRACTOR
- A/E = ARCHITECT / ENGINEER
- PM = PROJECT MANAGER



PAYMENT TO CONTRACTOR BY OWNER  
FLOWCHART NO. 7

- Activity 4. Contractor reviews the payment request returned by Architect / Engineer with required changes and asks his Project Manager to prepare revised requisition for payment, if he agrees with the required changes suggested by Architect / Engineer.
- Activity 5. Project Manager prepares revised payment request as per Contractor's requirement and returns same to the Contractor.
- Activity 6. Contractor reviews the revised payment request prepared by his Project Manager and forwards it to Architect / Engineer.
- Activity 7. Architect / Engineer reviews the payment request made by Contractor and ask his Estimator to prepare a requisition for payment for the work performed by Contractor.
- Activity 8. Architect / Engineer's Estimator prepares payment review and submits it to Architect / Engineer.
- Activity 9. Architect / Engineer again reviews the revised payment request submitted by Contractor, per his requirements, and if he agrees with it, approves the payment request and forwards same to Owner for final approval.
- Activity 9A. If the Owner does not agree with Architect / Engineer approval of the payment request, he returns payment request to Architect / Engineer



with required changes. Hence, Activity # 4 (with Owner's required changes), Activity # 5, # 6, and # 9 take place again.

Activity 10. Owner reviews the revised net amount of the payment request, approves same and returns it to the Architect / Engineer for transmission to the Contractor.

Activity 11. Architect / Engineer sends approval copy of payment request to Contractor.

## 6.2 Progress Payment

Construction contracts typically provide that the Owner shall make partial payments of the contract amount each month to the Contractor as the work progresses. In any event, a payment request is prepared periodically that covers the cost of the work accomplished since the last payment to the Contractor was made by the Owner. This is typically accomplished in practice by determining the total value of work done to date and then subtracting the sum of the previous progress payments made by the Owner.

The total value of work done to date is obtained in different ways, depending on the type of contract. Under lump sum contracts, progress is customarily measured in terms of estimated percentages of completion of major job components. The payment schedule for a lump sum contract also can be computed on the basis of a bar chart. An approximate total cost is established for each work item identified in the bar chart.

The quantities of work done on unit price contracts are determined by actual field measurement of the work items put into place. When a unit price contract is involved, the payment schedule depends entirely upon the quantity of each work item completed during each month.

In either type of contract, materials stored on site are customarily taken into account as well as any prefabrication or preassembly work that the Contractor may have done at some location other than the job site.

### 6.3 Payment Requests For Lump Sum Contracts

Pay requests for a lump sum contracts usually are prepared by the Contractor. These requests include all sub-contracted work, as well as work performed by the Contractor's own forces. For each work classification that he does himself, the Contractor estimates the percentage completed and in place. From invoices submitted by his Sub-contractors, suitable percentage figures are entered for all sub-contracted work. To the total of completed work is added the value of all materials stored on the site, but not yet incorporated into the work. The cost of stored materials includes that of the Sub-contractors and is customarily set forth in a supporting schedule. From the total of work in place and materials stored on site is subtracted the retainage. With this information the Contractor is able to prepare estimates for payment requests for the work performed.

Although the payment request procedure for lump-sum contracts has been in general use for many years, it has one

serious defect. The project is divided for payment purposes into relatively few work classifications, most of which are extensive and often extend over appreciable portions of the construction period. This situation can make it difficult to estimate accurately the percentages completed of the various work categories.

Payment in a lump sum contract, can create a problems for the Owner. Although reviewed and throughly examined, the payment request submitted by Contractor, may cause excess payment to him for a lesser amount of work actually performed. This is called "front end loading". Hence, estimating is the most important part of the project by which the up-to-date position of the project cost can be obtained.

Actual measurement of work quantities accomplished to date is the key to accurate percentage figures. However, this can become very laborious and therefore most of the percentage are established by a visual appraisal and negotiations between the Project Manager and Architect / Engineer. Contractors want these estimates to be fair representations of the actual work achieved, but understandably, they do not want them to be too low. Hence most of their percentage estimates are apt to be on the generous side.

This circumstance continues to produce vexing problems for both the Contractor and the Architect / Engineer. However, the Architect / Engineer prepares summary of estimate per Owner's requirements by considering total amount of work preformed to-date and the invoices for the payment request

submitted by the Contractor. Also he asks the Contractor to prepare the final amount of payment request for the work performed by his Sub-contractors and his own forces. This allows the Architect / Engineer to compare the amount of pay request submitted by Contractor with his own estimate. This creates difficulties for the both parties in estimating the completion percentage of the work accurately. Yet, the Architect / Engineer, working in the best interest of his Owner, makes an honest effort to see that the payment requests are reasonably representative.

## PART II. Sub-contractors / Vendors To Contractor

### 6.4 Payment To Sub-Contractors / Vendors

When the Contractor receives monthly invoices from his Sub-contractors / Vendors, he has his own problems of verifying the requested amounts. In many instances, the Contractor does not require nor receive cost break-downs from his Sub-contractors / Vendors.<sup>13</sup> The Project Manager must expend considerable time and effort in checking the invoices. Even then, unless he happens to be experienced in each construction specialty the Project Manager usually has no real basis for accurately evaluating the progress of a Sub-contractor's work on a project. In this type of situation he may prepare an estimate of payment to be made to Sub-contractors / Vendors by his experience from past projects performed satisfactorily and by preparing the summary of estimate for the cost of the materials, equipment & labor used for the appropriate work

items.

Many prime Contractors require their Sub-contractors / Vendors to submit appropriate cost break downs for payment purposes. These cost schedules are used by the Contractor to evaluate the payment requests. One form of price break down that can be used is to have each Sub-contractor / Vendor place a price tag on every network activity in a CPM schedule with which he is involved.<sup>14</sup> Using this technique, it is not difficult for the Project Manager to check the reasonableness of the reported amounts for each activity. Once the Contractor and the Sub-contractor / Vendor have agreed that the amounts of actual work performed are due on the completion of designated activities, the analysis and verification of monthly invoices from Sub-contractors / Vendors are readily performed.

Contractors are anxious to prepare their requests for payment and transmit them to the Architect/Engineer and Owner as soon after the first of the month as possible.<sup>15</sup> With a break down of Sub-contractor / Vendor prices for each activity, the Project Managers can determine the amount due from their own evaluation of activity progress.

A common contract provision requires the Contractor to provide the Owner with an estimated schedule of monthly payments that will become due during the construction period. This information is needed by the Owner so that he can have funds available to make the necessary periodic payments to the Contractor. When a lump sum contract is involved, the payment schedule depends upon the percentage of completed work items.

While in unit price contract, the payment schedule depends entirely upon the number of each bid items that should be completed during each month. Therefore, the estimate for the payment request for the any of the above contracts submitted by the Contractor becomes helpful to the Owner in preparing periodic payment.

The payment schedule for a lump-sum project is often computed using the traditional bar chart, one that is not network based. An approximate cost is established for each bar on the chart, and this cost is distributed uniformly over the length of the bar. From this a cumulative total project cost curve is computed for the contract period. The problem with this procedure is the inaccurate way the costs of the project segments are distributed over the contract period.

Although the total cost of each major job segment can be established with reasonable accuracy, the time rates at which these expenses are incurred can involve such variation that the payment schedule derived therefore may be seriously in error. To illustrate, bar charts often have a category called Electrical or Mechanical whose bar extends from project start to finish. The total value of this work, which is usually subcontracted, is distributed uniformly over its duration. This is seldom a realistic time allocation of expense.

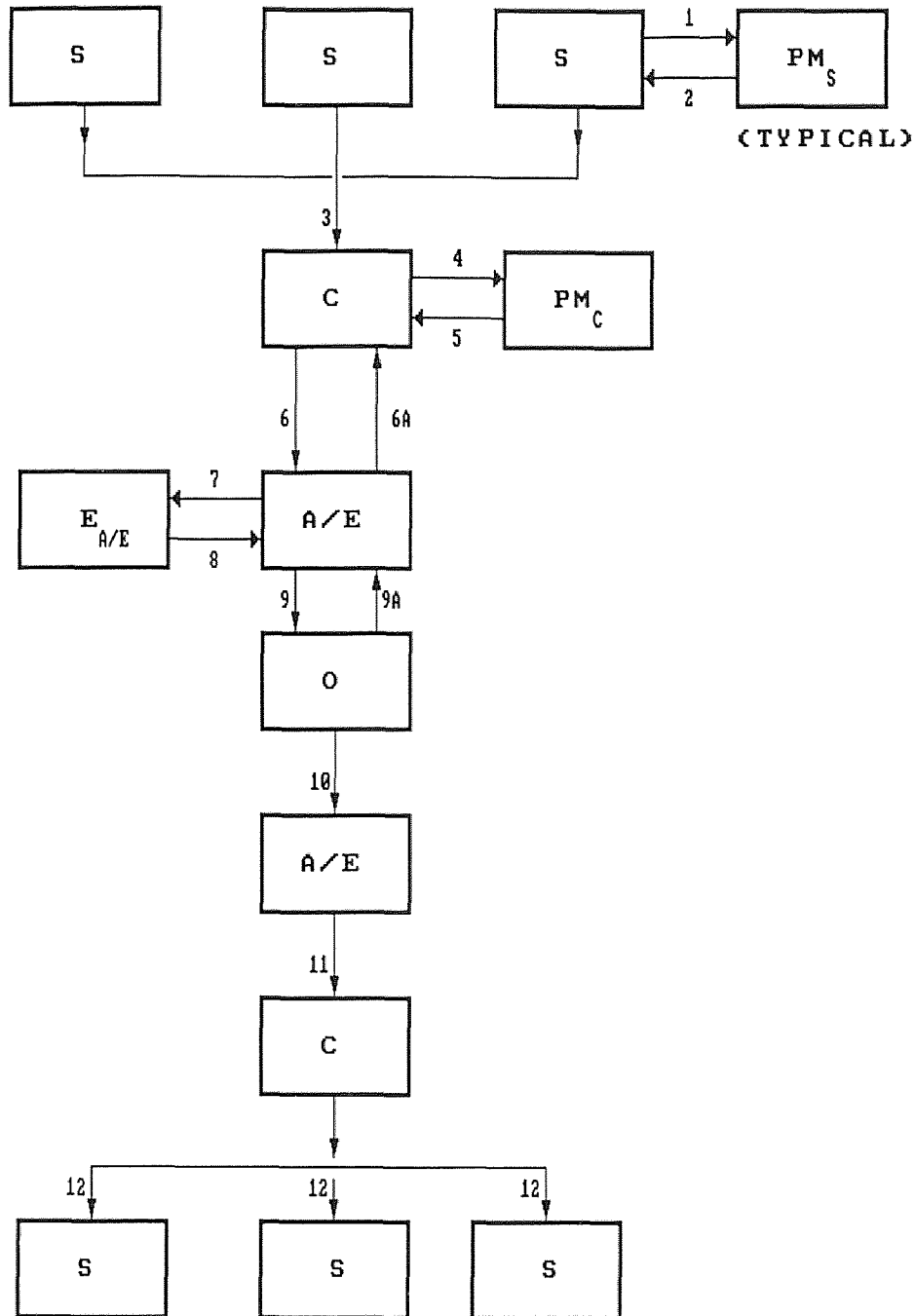
## 6.5 Estimating Procedure

Flowchart # 8 on page 43-A graphically outlines the Estimating activities involved in the preparation of requisition of payment to Sub-contractor by Contractor. A description of these activities is as follows:

- Activity 1. Sub-contractors ask their Project Manager to prepare a requisition for payment for the work completed satisfactorily per Contractor's requirements and after approval by Architect / Engineer.
- Activity 2. Project Manager prepares estimate of actual work completed by Sub-contractors for the requisition of payment.
- Activity 3. Sub-contractors submit the invoices of the completed work to Contractor from which he can prepare final invoices for the payment.
- Activity 4. Contractor reviews the invoices submitted by Sub-contractors and asks his Project Manager to prepare requisition for payment by considering the amount of work done by his own forces and the invoices submitted by the Sub-contractors in terms of a suitable percentage.
- Activity 5. Project Manager prepares payment request per Contractor's requirement and returns same to the Contractor.

LEGEND

- O = OWNER
- C = CONTRACTOR
- E = ESTIMATOR
- S = SUB-CONTRACTOR
- A/E = ARCHITECT / ENGINEER
- PM = SUB-CONTRACTOR'S PROJECT MANAGER
- E<sub>S</sub> = ARCHITECT'S / ENGINEER'S ESTIMATOR
- PM<sub>S</sub> = CONTRACTOR'S PROJECT MANAGER
- PM<sub>C</sub> = CONTRACTOR'S PROJECT MANAGER



PAYMENT TO SUB-CONTRACTOR BY CONTRACTOR  
FLOWCHART NO. 8



- Activity 6. Contractor reviews the payment request prepared by his Project Manager and forwards same to Architect / Engineer.
- Activity 6A. Architect / Engineer reviews Contractor's payment request, compares it with his own estimate and if not in agreement with it, returns it to Contractor with required changes.
- Activity 4. Contractor reviews the payment request returned by Architect / Engineer with required changes and asks his Project Manager to prepare revised requisition for payment, if he agrees with the changes suggested by Architect / Engineer.
- Activity 5. Project Manager prepares revised payment request per Contractor's requirements and returns same to Contractor.
- Activity 6. Contractor reviews the revised payment request prepared by his Project Manager and forwards same to Architect / Engineer.
- Activity 7. Architect / Engineer reviews the payment request made by Contractor and asks his Estimator to prepare requisition for payment for the work performed by Contractor.
- Activity 8. Architect / Engineer's Estimator prepares payment review and submits same to Architect / Engineer.
- Activity 9. Architect / Engineer again reviews the revised payment request submitted by Contractor per his requirements and if he agrees with it, approves

the payment request and forwards the same to Owner for final approval if the required retainage.

- Activity 9A. If the Owner does not agree with Architect / Engineer approval for the payment request, he returns payment request to Architect / Engineer with required changes. Hence, Activity # 4 (with Owner's required changes), Activity # 5, # 6, and # 9 takes place again.
- Activity 10. Owner reviews the revised net amount of the payment request, approves same and returns it to the Architect / Engineer for transmission to the Contractor.
- Activity 11. Architect / Engineer sends approval copy of payment request to Contractor.
- Activity 12. After obtaining the final approval for the payment from Owner, Contractor reviews the invoices for the payment request submitted for the payment by Sub-contractors and make payments to them with appropriate retainage.

## CHAPTER VII

PUNCH LIST ESTIMATING PROCEDURE

A list of the activities which have not been completed or which require corrective work is normally prepared and used with a certificate of substantial completion. This listing is called a Punch List. A cost estimate is prepared for this corrective / uncompleted work item by item.

Assuming that the Punch List is not extensive, two actions result. The first of these is assigning a dollar value to each item on the Punch List which becomes the basis for any holdback against the final amount due under the revised contract sum. The second is that any retainage held during the project is released and paid. The result is that the only amount withheld at substantial completion is the value of the items not yet completed or requiring correction. A substantial completion requisition is prepared along with the appropriate certificate of payment which allows the payment of the entire revised contract sum less the value of the work contained on the Punch List.

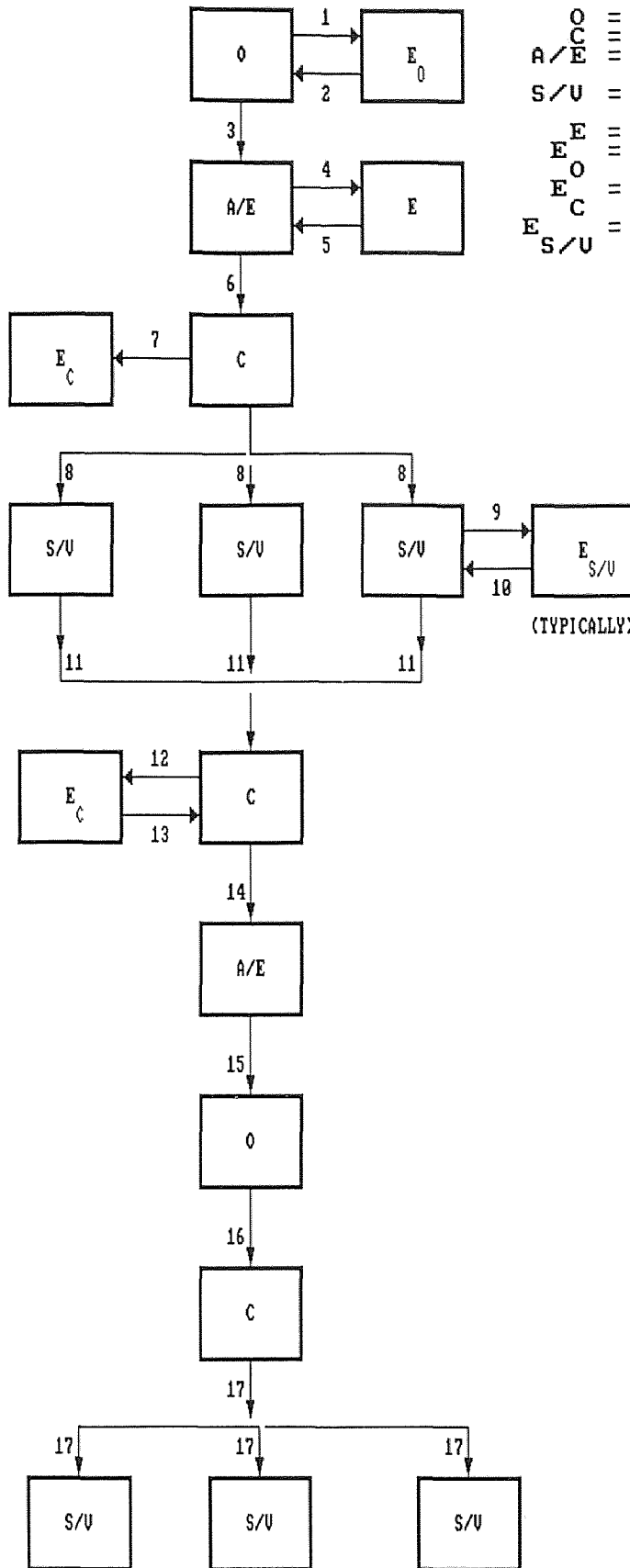
## Estimating Procedure

Flowchart # 9 on page 47-A graphically outlines the Estimating activities involved in the preparation of the Punch List. A description of these activities is as follows:

- Activity 1. Owner asks his own Estimator to prepare cost estimates for unsatisfactory / defective / incomplete work performed by Contractor for his knowledge.
- Activity 2. Estimator prepares the estimate in accordance with the requirements and submits same to Owner.
- Activity 3. At the same time as the Activity # 1 is undertaken Owner asks Architect / Engineer to prepare a summary of estimate for the work items needed to be completed, performed or corrected to achieve the final completion of the project.
- Activity 4. Architect / Engineer per Owner's directives and per actual position of construction of individual work items prepares a final Punch List and forwards same to his Estimator to prepare the final estimated cost and impact on time require to rectify the remaining work items.
- Activity 5. Estimator prepares the summary of estimate in accordance with the list of Punch List items and returns same to Architect / Engineer.
- Activity 6. Architect / Engineer reviews the summary of estimate prepared by his Estimator, and compares with the Owner's estimate and if appropriate prepares a final Punch List and forwards same to Contractor.
- Activity 7. Contractor forwards information received with the estimate for the Punch List and sends same

LEGEND

- O = OWNER
- C = CONTRACTOR
- A/E = ARCHITECT / ENGINEER
- S/U = SUB-CONTRACTOR / UENDOR
- E = ESTIMATOR
- E<sub>O</sub> = OWNER'S ESTIMATOR
- E<sub>C</sub> = CONTRACTOR'S ESTIMATOR
- E<sub>S/U</sub> = SUB-CONTRACTOR'S / UENDOR'S ESTIMATOR



- to his Estimator for verification.
- Activity 8. At the same time as Activity # 7 is under taken Contractor sends summary of appropriate proposed Punch Listed items to Sub-contractors / Vendors for their verification.
- Activity 9. Sub-contractors / Vendors review the proposed cost for the final Punch List and ask their Estimators to prepare independent quantity surveys, line item cost estimates and a summary of estimate for the proposed Punch List.
- Activity 10. Estimator verifies amount of proposed Punch List and prepares summary of estimate with necessary comments and sends same to Sub-contractors / Vendors.
- Activity 11. Sub-contractor / Vendors reviews the estimates prepared by their Estimators and forwards their comments or acceptance of proposed Punch List to Contractor.
- Activity 12. Contractor sends Sub-contractor / Vendor estimates to his Estimator for verification against his own estimate.
- Activity 13. Estimator verifies amount of Punch List and submits same to Contractor.
- Activity 14. If Contractor agrees with proposed amount of final Punch List, he advises Architect / Engineer of acceptance by signing it.
- Activity 15. Architect / Engineer reviews Contractors accep-

ted amount of final Punch List, if he agrees with it, approves it and forwards the same to Owner for final verification.

Activity 16. Owner reviews and signs the final Punch List approved by Architect / Engineer and sends same to the Contractor, with retaining amount of Punch List items from the final bill until the final completion for the project has been approved.

Activity 17. In the same way Owner relates to Contractor, Contractor sends appropriate Punch List of items to be corrected or rectified to Sub-contractors / Vendors. The amount of the Punch List items is retained by the Contractor until the final completion for the project has been approved.

CHAPTER VIII  
SCHEDULING IN PROJECT COST ESTIMATING |

Building a project on time and within budget requires accurate estimating, efficient scheduling and timely cost control. Neglecting these tasks is a risk potentially turning a profit into a loss. But profitability can be improved by coordinating them in a single project management system, which also allows the tasks to be performed more efficiently.

The key to successful coordination is defining work items or project segments that are used for all three management functions, viz: Estimating, Scheduling, Cost Control. A work item is a task that is commonly repeated in all the jobs. Work items tie together Estimating, Scheduling, and Cost Control functions. A work item for estimating becomes an activity on the Contractor's bar chart or critical path method (CPM) schedule. Later it is a cost item by which progress is measured.

#### 8.1 General Time Schedule

When a new project is being constructed, it is necessary that a general plan and operational time schedule be devised. Estimators customarily do this, although often in an informal and almost subconscious way during the take off stage. Small jobs may require little investigation in this regard, but larger projects deserve more than a cursory time study. Time is of first rate importance on all projects. One reason for



is of first rate importance on all projects. One reason for this is that most contracts impose a required completion date on the Contractor.<sup>16</sup>

Devising a general job plan and time schedule must start with a study of project requirements. This will enable an approximation to be made of the time necessary to accomplish each of major job segments. A project schedule is simply projected time table of construction operations. There are several steps involved in the devising of an efficient and workable job schedule. The following is the list of activities required for estimating the time schedule.<sup>17</sup>

1. Estimate the time required to carry out each network activity during construction.
2. Using these time estimates for remaining work items, compute the time required for overall project completion.
3. Establish the time interval within which time each activity must start and finish.
4. Identify those activities whose expedient execution is crucial to timely project completion.

## 8.2 Material Delivery Scheduling

Management controls over material are concerned with insuring that the materials and equipments, in the quantities and qualities required, are on the project when needed. The Contractor's purchase order customarily prescribes the quantity, quality, price, delivery data and mode of transportation for the materials covered.<sup>18</sup> In a reimbursable type of contract

quantity and quality of all materials delivered are verified by inspection, count and test (if necessary) as they arrive. Apart from these standard procedures, management control of job materials is directed primarily toward achieving their timely delivery. Considerable time and effort have been expended in developing an estimate of a work schedule that will satisfy time and resource limitations.

Also in a reimbursable contract, lead times for material deliveries have already been included in estimating the project schedule. This was accomplished by incorporating appropriate material restraints into the original project network. These restraints were based on the delivery terms included in the material quotations received from Vendors when the job cost was being estimated.

Immediately after the construction contract has been signed, it is necessary to fix the deadline dates by which purchase orders for the various project material must be issued to the suppliers.<sup>19</sup> This is required so that the Estimator, when he prepares estimate for individual work item, can have enough information regarding time scheduling of each work item. In the case of a Building Project, the critical path includes the preparation of drawings and delivery of many critical items. The immediate issuance of these purchase orders, the obtaining of the necessary shop drawing approvals, and the fabrication and delivery of these materials are of major importance.

### 3) Sub-contractor Scheduling

The management control of Sub-contractors centers about getting them on the job when they are needed and insuring that they accomplish their work in accordance with the estimated job schedule. There are two main considerations involved in carrying out this responsibility.

- a) Selecting the Sub-contractor by reviewing their estimates and considering the form and content of the subcontract agreement. A carefully written document with specific requirements in terms of submittals, approvals and schedule can often strengthen the Project Manager's hand in obtaining Sub-contractor compliance. The timing of the issuance of a sub-contract is not an issue because a Contractor will normally proceed with subcontract preparation immediately after the construction contract has been signed.
- b) The second consideration is ensuring that the Sub-contractors order their major materials in ample time based on estimated quantities to meet the construction schedule.

Some Contractors find it advisable to monitor their Sub-contractor's material purchases. This is sometimes accomplished by including a sub-contract requirement that the Sub-contractor submit an unpriced estimate of his purchase orders to the Contractor within ten days after receipt of the sub-contract. The Contractor, by referring to the Sub-contractor's estimates of purchasing and his own purchasing requirements, prepares summary of estimate so that he can have enough time and information to meet the construction schedule.

## CHAPTER IX

CONSTRUCTION EQUIPMENT PRODUCTIVITY COMPARATIVE ANALYSIS

Projects that are of the Highway, Heavy or Utility (HHU) category require considerable amounts of construction equipment for their accomplishment. A substantial proportion of the total cost of such projects is associated with construction equipment ownership and operation. Equipment costs, however, are highly variable with the type and size of the individual unit.

Unfortunately, the term "equipment" does not have a unique connotation in the construction industry.<sup>20</sup> In the context of HHU work common usage of the word refers to scaffolding, hoists, power shovels, paving machines, cranes and other such items used by Contractors to accomplish the work.

To estimate the expense of major equipment items as realistically as possible, early management decisions must be made concerning the equipment sizes and types required and the manner in which the necessary units will be provided to the project. A scheme sometimes used when the duration of the construction period will be about equal to the service life of the equipment is to purchase all new or renovated equipment for the project and sell it at the cessation of construction activities.

Hence, while estimating the individual work items during construction of the project, viz. excavation, pouring of concrete, erection of structural steel, etc., for which an

estimate is to be prepared as to the equipment selection whether the equipment is to be rented or leased / bought is a major issue. The following points should be considered for estimating equipment in the selection process:

- (i) Desired production rate required for the individual work items.
- (ii) Maximum productivity of equipment.
- (iii) Selecting pieces of equipment to achieve a desired production rate.
- (iv) Estimating probable production for individual work items.

In estimating the equipment for the project, where purchase / lease or rental is involved, the equipment ownership cost must be computed including such items as depreciation, interest for the borrowed or own money, insurance and the equipment, taxes, storage for the equipment, and replacement cost. Equipment operating costs must also be computed and included to determine the total estimate for the equipment cost. Operating costs include expenses such as fuel, oil, grease, maintenance and minor repairs, major repairs etc.

In addition to the equipment cost, equipment production rates are also needed for the computation of equipment expense while reviewing the estimate during construction of the project. Also the cost of labor, equipment hourly expenses and production rates to job quantities enables the Estimator to compare the total equipment expense for the project with the original estimate. "Equipment unit costs" can also be deter-

original estimate. "Equipment unit costs" can also be determined, which are equipment costs per unit of production. Equipment production rates, like those of labor are subject to considerable variation and are influenced by a host of job site conditions. In addition, some equipment production rates must be computed using specific job conditions such as haul distances, grades and rolling resistance. Estimators must consider and evaluate these factors when they are evaluating the cost of a project.

There are several sources of equipment production information. Probably the most reliable are cost accounting records from past projects. Sometimes information gathered from experienced equipment operators becomes useful in the preparation of estimates. The production rates of labor and equipment used for estimating purpose should be average figure taken over a period of time.

## CHAPTER X

ESTIMATING CLAIMS

Construction claims are becoming increasingly prevalent and expensive. Many of these claims are delay related and of the largest cost increases to both Owner and Contractors are delay costs. Estimates for the costs of delays are prepared by the Contractor and sometimes the Owner for delayed work.

In the case where the construction work is delayed because of the Owner, the Contractor prepares the estimate for the delayed work by considering increases in overhead, escalation, overtime as well as the costs of loss of efficiency due to related acceleration and out of sequence construction. At the same time the Contractor ask his Sub-contractors to submit their estimates for the damages due to delays. And finally the Contractor submits the final estimate by reviewing the Sub-contractor's estimates with his own estimates with reasonable time extensions for the project.

The same procedure is to be followed by the Owner for estimating the damages due to delays because of Contractor's delays. Sometimes Owners counterclaim for their increased costs of extended overhead and loss of income from the facility related to schedule delays. During the construction period, the Owner asks the Architect / Engineer to prepare a summary of estimate of work items for which losses occurred due to delays by Contractor. This summary of estimate is sent to the Contractor for his information, so that, the amount of delay is recovered from the final payment.

One way of reducing delay claims is to build on schedule. Another way is to closely monitor progress issuing excusable time extensions in a timely manner and carefully documenting non-excusable delays.

Determination of the responsibility for delay and subsequent calculation of reasonable damage may be more accurately accomplished if a practical scheduling procedure is utilized during the life of a construction project. Based on the accuracy of estimating the delay damages may be increased if the schedule is directly related to the progress payment procedure. The resolution of all outstanding claims between the Owner and the Contractor is a part of completion of final Punch List since items included on the Punch List maybe subject to claims. It is therefore, important to estimate all claims outstanding at the time of final completion.

#### 10.1 Schedule Visibility

While estimating the damages due to delayed work, the following conditions of the contract become helpful.<sup>21</sup>

- 1) Start dates
- 2) Finish dates (and float)
- 3) Crew sizes / Resource Requirements
- 4) Payment value
- 5) Work week hours
- 6) Work sequence

The greater amount of data available, the higher the schedule visibility, for estimating delays.



Relating payments to a schedule allows for a more accurate damage calculation. The usual procedure for allocating progress payment to the schedule activities is for the Contractor to submit, for approval, the normal contract breakdown, often 20 to 40 work categories on a building project. After approval (revised and required) and after development of the initial CPM, which activities have been defined as subparts of the contract breakdown, the estimate prepared for the payment is distributed to the schedule activities. Delivery activities receive the material amounts while construction activities receive the labor and all markup per estimated quantities. As the project proceeds, the actual start and finish dates of all activities should be logged, along with any significant changes in the resource requirements, work week or sequencing.

#### 10.2 Contract Time Extensions

In estimating time extensions for delayed work the following points are to be considered:

- I. A bar chart, along with experience, may sometimes serve to identify the critical activities which were delayed. This is especially so on simple projects. However, the more complex the project and interwoven the delays, the more a network schedule (CPM) is required to determine the amount of critical delay which should be included in a contract time extension.
- II. A time extension is a change to the contract. While most delay requests originate with the Contractor the Owner may also initiate a change involving a delay which it caused or

to recognize a force majeure delay.

III. Issuance of contract time extensions should not be delayed following the conclusion of an excusable delay since the Contractor may rightfully claim the additional costs related to constructive acceleration related to maintaining the currently scheduled project completion date.<sup>22</sup> Practically all construction claims are time related. The justification for such claims depends on Contractor's ability to demonstrate the adequacy or inadequacy of construction time available or the actual effect of a given delay or change on the job completion. In a real sense, the Contractor's original network represents the basis on which he predicts his estimate of cost and time.

## CHAPTER XI

STORED MATERIAL ANALYSIS

## 11.1 Planning And Communications

Construction materials management is generally recognized to be the integrated coordination of material take-offs, purchasing, expediting, receiving, warehousing and distribution. When these functions are not properly managed, material shortages, surpluses and cashflow problems are likely to occur. Costly labor delays result when the required quantity or quality of materials are not available when needed. Owner-Contractor, Engineer-Contractor, and Home Office-Project Site communications appear to be critical to the success of the materials management effort.

Early communication between the Owner and the Contractor are important because per the Owner's requirements for the construction, the Contractor can prepare estimates of the stored materials for the different work items which becomes helpful to the Owner in the management of stored materials.

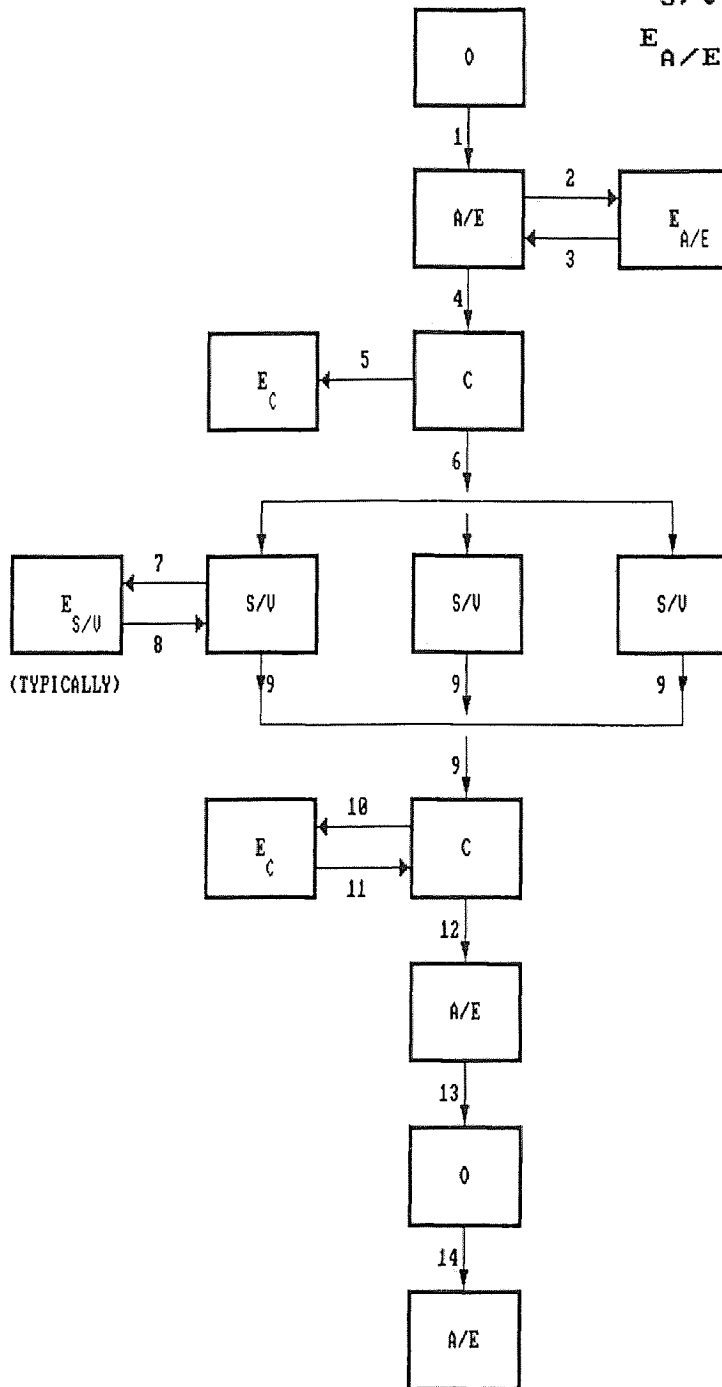
## 11.2 Estimating Procedure

Flowchart # 10 on page 62-A graphically outlines the Estimating activities involved in the preparation of stored materials analysis. A description of these activities is as follows:

- Activity 1. Owner asks his Architect / Engineer to prepare summary of stored materials analysis which includes material take-offs, purchasing, expediting and receiving required for further construction of the project and to keep up-to-date details of materials used and required to be used for the project.
- Activity 2. The Architect / Engineer, per Owner's directive and per actual position of stored materials, collects the information regarding the needs of materials for the further follow-up of the progress of the project. He asks his Estimator to prepare an estimated cost of materials which are yet to be used or stored.
- Activity 3. The Estimator per Architect / Engineer's instruction prepares a summary of estimate of total projected final cost from which the requirements of the materials can be analysed and returns same to Architect / Engineer.
- Activity 4. Architect / Engineer reviews the summary of estimate prepared by his Estimator and asks the Contractor to prepare the same which has been used and required to be used for future construction of the project. Thus, he should have enough information for the planning and the schuldung of the materials in advance.

LEGEND

- O = OWNER
- C = CONTRACTOR
- A/E = ARCHITECT / ENGINEER
- S/U = SUB-CONTRACTOR / UENDOR
- E<sub>C</sub> = CONTRACTOR'S ESTIMATOR
- E<sub>S/U</sub> = SUB-CONTRACTOR'S / UENDOR'S ESTIMATOR
- E<sub>A/E</sub> = ARCHITECT'S / ENGINEER'S ESTIMATOR



STORED MATERIALS  
FLOWCHART NO. 10

- Activity 5. Contractor forwards information received with summary of stored material analysis from Architect / Engineer to his Estimator for verification.
- Activity 6. At the same time as Activity # 5 is under taken Contractor sends summary of estimated stored materials to the Sub-contractors / Vendors for their verification.
- Activity 7. Each Sub-contractor / Vendor reviews the summary of estimated stored materials and asks his Estimator to prepare an independent estimate for the materials which has been used and required to be used for the future construction and that which is in storage and that which requires purchasing.
- Activity 8. The Estimator verifies the materials used and required for each and every work item in order to prepare an estimate of the stored materials, so that it can be compared with the cost of original estimates for the stored materials to the known the requirements of materials for individual work items.
- Activity 9. The Sub-contractor / Vendor reviews the summary of cost estimate for the stored materials as prepared by their Estimator and forwards same with necessary comments to Contractor.

- Activity 10. Contractor sends Sub-contractor / Vendor estimate reports to his Estimator for verification and to prepare final summary of estimate considering Sub-contractor / Vendor estimate and his own summary of estimate.
- Activity 11. Estimator prepares final summary of estimated stored materials and returns same to Contractor.
- Activity 12. Contractor reviews final summary of estimated stored materials prepared by his Estimator and if satisfied with same, advises Architect / Engineer by signing it.
- Activity 13. Architect / Engineer reviews the Contractor's summary of estimate of stored materials and if he agrees with it, approves it and forwards it to Owner for final verification.
- Activity 14. Owner reviews the final summary of estimate for the stored materials prepared by Contractor from which he should have enough information regarding the time scheduling of the stored materials for distribution and to establish the warehousing and material lay-down requirements for the project. He sends same to Architect / Engineer for management and administration of the stored materials.

END NOTES

- <sup>1</sup>American Association of Cost Engineers Transactions: 1987,  
page C.C.2
- <sup>2</sup>American Association of Cost Engineers Transactions: 1987,  
page 5.1 - 5.9
- <sup>3</sup>Plant Engineers: Oct. 9, 1986
- <sup>4</sup>American Association of Cost Engineers Transactions: 1987,  
page B 4.4
- <sup>5</sup>Fredrick Wm. Muller, C.C.E., "Integrated Cost And Schedule  
Control For Construction Projects," - 1986
- <sup>6</sup>Ibid.
- <sup>7</sup>Ibid.
- <sup>8</sup>Highway And Heavy Construction: Dec. 1986, page 129:38
- <sup>9</sup>Ibid.
- <sup>10</sup>Bill G. Epps, Cost Accounting for the Construction Firm, 1986
- <sup>11</sup>Ibid.
- <sup>12</sup>Ibid.
- <sup>13</sup>Richard H. Clough, Construction Project Management, 1979
- <sup>14</sup>Ibid.
- <sup>15</sup>Ibid.
- <sup>16</sup>Ibid.



<sup>17</sup>Ibid.

<sup>18</sup>Ibid.

<sup>19</sup>Ibid.

<sup>20</sup>Ibid.

<sup>21</sup>American Association of Cost Engineers Transactions: 1987,  
page H 4.1

<sup>22</sup>Ibid.

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