CONCEPTS OF PROJECT PLANNING & CONTROL

• DESIGNING TO REDUCE CONSTRUCTION COSTS:
  – All the following terms could be used unchangeably to explain the role of Professional Construction Manager in design stage.
    • Level of influence
    • Percent of effective control
    • Possible cost savings
    • Ability to control
    • Degree of effectiveness
  – Typically engineering & design fees < 10% of total construction costs
  – Construction costs are < of operation and maintenance costs
Level of Influence on Project Costs

- Figure 10-1 illustrates essential features of the level-of-influence concept.
- The lower portion simplifies the life of a project to a three-activity bar chart consisting of
  - (1) engineering and design,
  - (2) procurement and construction, and
  - (3) utilization or operation.
- The upper portion plots two main curves. The curve ascending to the right-hand ordinate tracks cumulative project expenditure.
- The curve descending from the left-hand ordinate shows the decreasing level of influence. The bar chart and both curves are plotted against the same horizontal bsciss project time.
FIGURE 10-1
Level of influence on project costs. (From Boyd C. Paulson, Jr., “Designing to Reduce Costs,” Journal of the Construction Division, ASCE, vol. 102, no. CO4, December
• **To build or not to build?**
  – On the first day, management has a 100 percent level of influence in determining future expenditures. Paraphrased simply, the question is: To build or not to build? A decision of not to build requires no expenditure at all for the project.

• **What to build?**
  – A decision to build requires more decision making, but initially at a very broad level. For example, shall a new power plant use conventional or co-generation (co-gen) technology? If co-gen, how many units and how big? As engineering and design continue, decisions become more detailed, but the implications are no less significant.
  – As these decisions evolve and commitments are made, the remaining level of influence on what the project costs will ultimately become drops precipitously.
The PCM has further to influence on the design standards to be more effective and uses Standard sizes, takes build ability of works into account and the replacement of parts and consider future operation and maintenance

**Costs to whom:**

Many problems associated with the level-of-influence concept result from cost sub-optimization inherent in the contractual structure for a project.

The Cost concerned for:

- Owner
- Designer
- Contractor
- Client

The point here is that contractual structures can be adjusted to minimize the consequences of sub-optimization of the type described above. The first prerequisite, however, is an understanding of some of the economic forces involved.
Costs to Whom?

Many problems associated with the level-of-influence concept result from cost suboptimization inherent in the contractual structure for a project. As a hypothetical example assume that an owner desiring a new ore-processing facility has obtained a fixed-fee contract with an engineering firm and plans to let a competitively bid construction contract once designs are complete. Assume also that the engineer has designed several similar plants in the past, and has thus negotiated his fee, say $800,000 including 20 percent ($160,000) profit and general overhead, on the assumption that much of the design can be adapted from earlier drawings.

Two of the required drawings describe the electrical instrumentation and controls for a crushing and grinding circuit. Since it is similar to one done before, the engineering budget provided for it as follows:

\[
80 \text{ design-hours} \times \$60/\text{design-hour} = \$4800
\]

However, assume that these drawings represent $640,000 worth of equipment, materials, and field construction labor.
When the electrical engineer was about 60 percent complete on these drawings, he got into a discussion with a vendor who described a new system for this application that, through the use of solid-state technology, could save approximately 20 percent of the costs of purchasing and installing a conventional facility, or $128,000 in this case. The vendor had the facts to back up his numbers.

After this discussion, the electrical engineer went to his supervisor to suggest that this change be incorporated. His supervisor denied the request with the following reasoning:

Costs to date for adapting conventional design:

\[
60 \text{ percent of } \$4800 = \ \$2,880
\]

Estimate for revised design using new technology:

\[
200 \text{ design-hours } \times \$60/\text{design-hour} = \ \$12,000
\]

\[
\text{subtotal} \ \$14,880
\]

Initial estimate for drawings E-247 and I-186 \(\$4,800\)

Design cost overrun \(\$10,080\)
The fact that this potential 210 percent overrun on these two drawings represented over 6 percent of the profit and overhead for the whole job was but one problem. It might have been negotiated as a change with the owner.

However, the design as a whole was already two months behind schedule, and the client was thought to be in no mood to even hear of, let alone approve, such a change at this time, or so rationalized the supervisor to the electrical engineer. Also, he argued, “This new technology is not well proven yet.

Stick with conventional designs that we know will work”
Contractual Implications

- Two important conclusions can be drawn from the level-of-influence concept.
- First, owing to the tremendous impact that design decisions have on construction and operation costs, contractual arrangements should be drawn to assure that construction and operations thinking is strongly injected in the conceptual, preliminary, and detail design processes.
- Second, efforts to sub-optimize design costs alone, for example by requiring competitive bidding for professional engineering and architectural services, can have disastrous consequences for the owner’s budget when construction and utilization costs are considered.
• Contractual structures can be adjusted:
• 1. Injecting construction knowledge
  – Major examples include professional construction management and also design-construct or turnkey contracts. The name alone is not enough (Architect or civil engineer could work as PCM). What is important is knowing how to package separate construction contracts along recognized trade and jurisdictional boundaries, as well as accurate knowledge for estimating time and costs for the different operations, are essential. Few design consultants really have these capabilities.
  – PCM is supposedly better than Design-construct. However, no one contractual arrangement is best for all situations.
2. Competitive bidding for professional services is not recommended. The assumption that one can save money by choosing an architect/engineer solely on the basis of lowest design fee is false economy of the worst sort.
PROJECT PLANNING AND CONTROL:
Analogy: A trip in a car

- No plan vs. too detailed plan.
  - Flexibility to respond
  - Human judgment
  - Turn to advantage
  - Provision for forecasting

- A project should have a budget; its designs should be on paper; it should have a schedule which in turn forecasts the requirements for resources of labor, equipment, and materials; but it also needs a dynamic and responsive feedback-control system to cope with the operations underway.
Objectives of Project Information system

General objectives for an information system for planning and control of construction projects may be stated as follows:

1. To provide an organized and efficient means of measuring, collecting, verifying, and quantifying data reflecting the progress and status of operations on the project with respect to schedule, cost, resources, procurement, and quality.

2. To provide standards against which to measure or compare progress and status. Examples of standard include CPM schedules, control budgets, procurement schedules, quality control specifications, and construction working drawings.

3. To provide an organized, accurate, and efficient means of converting the data from the operations into information. The information system should be realistic and should recognize (a) the means of processing the information (e.g., manual versus computer), (b) the skills available, and (c) the value of the information compared with the cost of obtaining it.
4. To report the correct and necessary information in a form which can best be interpreted by management, and at a level of detail most appropriate for the individual managers or supervisors who will be using it in keeping with the principles of management by exception.

5. To identify and isolate the most important and critical information for a given situation, and to get it to the correct managers and supervisors, that is, those in a position to make best use of it.

6. To deliver the information to them in time for consideration and decision making so that, if necessary, corrective action may be taken on those operations that generated the data in the first place.
Project Planning and Control: A Model

The flowchart in Figure 10-2 models the operations, flow of information, and decision-making processes characteristic of a feedback control system appropriate for a medium to large sized engineering construction project.

It has been designed to reflect the objectives stated in the preceding section.

Feedback: The goal remains to provide feedback to decision makers in min. time for max. impact in controlling operations. This is one of the MAJOR difficulties of the industry.
FIGURE 10-2
Flow chart of project control system. (From Boyd C. Paulson, Jr., "Concepts of Project Planning and Control," Journal of the Construction Division, ASCE, vol. 102, no. CO1, March 1976, p. 71.)
Status and progress

• Numerous measures can be taken to determine the progress:
  – **Quantities of work** units in place can be physically surveyed and compared with those shown on the drawings.
  – Elapsed *time* can be compared with the estimated activity or project durations.
  – committed or expended can be compared with the estimated budget
  – *Resource usage* can be plotted versus expected requirements for labor, materials, and equipment
• Each of these measures has its advantages and disadvantages.

• For example, field measurements may be more accurate than judgment estimates of percentage complete, but it is expensive to use a surveying crew to obtain these data.

• Judgment, in turn, can reflect qualitative factors, not evident in the quantities themselves. Each of the aforementioned measures tells something different about the project.

• All of them are necessary to gain a full understanding of the status and progress of the operations.
Nonlinear relationships

• In applying such measures, it is important to recognize nonlinear relationships among them.

• For example, there may be a nonlinear relationship between quantities in place and elapsed time.

• Also there is a nonlinear relationship between time and spent cost on material.

• Also expenditure of labor resources over time could be nonlinear when considering the learning curve.
Learning curve

- When comparing the expenditure of labor resources over time, one can also often recognize nonlinear "learning-curve" effects.
- Learning curves relate time, resources consumed, and quantities produced.
- Their basic principle is that skill and productivity in performing tasks improve with experience and practice.
- The nonlinear implications of learning curves are different for planning, or estimating, than they are for control.
Source of Data

- Data reflecting status and progress come from numerous sources.
- The formal information system, sources include labor and equipment time cards, purchase orders, invoices, field quantity reports, quality control reports, and so forth.
- In all cases, accuracy, timeliness, and completeness are important.
- Human considerations are particularly essential at this point if good management information is to be produced.
Information Processing

• In concept, information processing systems take progress and status data, compare them against reference standards such as budgets or schedules, and convert the results to information needed by the managers and supervisors on the project.

As stated in the objectives, the level of detail, the variety, and the frequency of reports to be produced should be appropriate to the people who will use them, should be feasible for the means of processing the information (manual or computer), should recognize the skills available, and should realistically assess the value of the information compared with the cost of obtaining it. Finally, the system should be fast, efficient, and accurate.
Reporting

Reporting can take many forms, ranging from conversations and telephone calls through tabular presentations of cost information and graphical presentations on bar charts, cumulative progress (“S”) curves and CPM diagrams, to up-to-the-minute reports from computers transmitted via microwave or satellite telecommunication links to sophisticated microcomputers in the field and by E-mails.

If the reporting is to be effective for control purposes, basic principles should guide each of these.
Reporting

• Complete report should have five main components:
  • 1 *Estimates* either total, to-date, or this period, that provide a reference standard against which to compare actual or forecast results
  • 2 *Actuals* what has already happened, either this period' or to-date
  • 3 *Forecasts* based on the best knowledge at hand, what is expected to happen to the project and its elements in the future
  • 4 *Variances* how far actual and forecast results differ from those which were planned or estimated
  • 5 *Reasons* of unexpected circumstances that accounting for the actual and forecast behavior of the project and its operations. and especially that explain significant variance control' the plan.
Selectivity and sub-reporting:
The report to be prepared should go to the purpose directly based on selective information needed. The project manager have no much time to search for information. 

**Variances: relative (%) and absolute**. Use variances to show which operations are relatively more in need of attention than others.

**Management by exception**: exception reports focus management attention directly to operation most in need of control.

**Forecasting and trending**: report must look to future as well as document the past. This helps manager to forecast problems

**Corrective Action**

- To do nothing except update (valid alternative)
- We do not have a HOLY plan.
PM has more information than the Planner had originally
- Significant deviation
- Understand the reasons behind the symptoms