Session 8 Cases

- ❑ Strategic Project Control Initiatives
- ❑ Measuring Successful Technical Performance: A Cost/Schedule/Technical Control System
- ❑ Pittsburgh International Airport Midfield Terminal Energy Facility

SYNOPSIS

This case describes the implementation of a project controls philosophy to minimize the total installed cost (TIC) of a petro-chemical project in Alberta, Canada. This case also illustrates the use of the work process analysis and the obstacles of the transition from the design phase to the construction phase. The case discusses three strategic initiatives that allowed for major cost and schedule savings: early focus on planning, scheduling work packages, and the use of management tools to accelerate the transition from construction to completion.

LEARNING OBJECTIVES -“STRATEGIC PROJECT CONTROL INITIATIVES”

In discussing this case, participants should gain a better understanding of:

- the phases of a project and their interdependence
- the relation between planning and the risks faced by a project
- the challenge and methods for handling a large amount of information
- the importance of risk management

Discussion Point

- This case illustrates a project which is heavily dependent on weather and seasonal conditions. With proper planning and control processes, it is possible to deal with these circumstances.
- <u>Identify similar uncontrollable factors and characteristics which need to be taken into account when planning a project.</u>

Strategic Project Control Initiatives

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Synopsis

This case describes the implementation of a project controls philosophy to minimize the total installed cost of a petrochemical project in Alberta, Canada. This case also illustrates the use of the work process analysis and the obstacles of the transition from the design phase to the construction phase. The case discusses three strategic initiatives that allowed for major cost and schedule savings: early focus on planning, scheduling work packages, and the use of management tools to accelerate the transition from construction to completion.

Learning Objectives

The students will see how a project highly constrained by weather conditions and with a tight schedule was managed. From the questions and the class activity, the students will further understand the following key points:

- the phases of a project and their interdependence
- the relation between planning and the risks faced by a project
- the challenge and methods for handling a large amount of information
- the importance of risk management.

Discussion Questions and Possible Answers

1. The prime requirement of this project was clearly established. It was to minimize the total installed cost. The management of the project, in order to achieve this requirement and fulfill this project's objective, followed the strategy presented in Figure 1. Discuss the analogy between this strategy and the project management processes: initiating, planning, executing, controlling, and closing, listed in the *PMBOK Guide*, section 3.2, Process Groups.

   a. The strategy contains all of the five processes. They are just presented in a format which is easier for those involved with the project to understand. It could be difficult to identify a clear relationship between the elements in Figure 1 and the processes described in the *PMBOK Guide* because the figure is clearly customized for this project. However, the essence of the five processes is found in the diagram.

2. The case described a significant amount of planning as having gone into the project. How did this planning help to reduce costs?
   a. As is stated in the *PMBOK Guide* description of planning processes, section 3.3.2, the planning allowed risks to segments of the project and constraints affecting the project to be identified. Likewise, action was taken when planning tasks to account for these constraints and risks. For example, the early ordering of equipment to avoid delays and to allow work to be done by winter, as well as the identification of roadway restrictions on heavy equipment travel, were recognized and planned for. All of these travel plans were made well in advance of the project, planning which was beneficial for the project.
3. The risk and opportunity evaluation completed for this project identified several potential scheduling problems. How does this evaluation and its effect on scheduling affect cost management?
   a. Risk and opportunity evaluation recognized several potential scheduling problems, which would have led to significant delays in the project. These delays inevitably would have led to increased costs. By scheduling the project around such risks, costs can be better controlled allowing the fulfillment of the prime requirement, minimizing total installed cost, to be met.
4. The author stresses the importance of facilitating the transition between construction and completion (executing to closing the project). How did the project managers deal with this challenge?
   a. In order to close the gap between construction and completion, the project managers relied on the use of a control tool called the field progress reporting system (FPRS), when the key success factor was the ability to manage data from different databases related to manpower, progress forecasting, and work packages, therefore identifying the specific resources required for the completion of the activities.
5. Though the construction of this facility was a "cost-driven" project, cost management was not the only project management area used in the administration of the project. Mention at least two other project management areas involved in the making of this project. — ALL were involved!
   a. The knowledge areas of project management are each briefly described in section 1.3.2 of the *PMBOK Guide*. Each of these are key considerations in the successful administration of this and any other project.
6. This case describes how the natural environment affects all aspects of how the project work is done. Compare and contrast how these natural environmental risks are analogous to risks in other type of environments (i.e., public relations, political, etc.).
   a. There are similarities to all risks involved with projects, no matter their cause. Uncertainty must always be addressed and accounted for when planning a project. Some risks, such as the winter weather described in this project, can be scheduled for in order to minimize risk. Likewise, planning and care in the presentation of a politically risky project will help to minimize that project's risk.

ADDITIONAL DISCUSSION POINTS:

- This case illustrates a project which is heavily dependent on weather and seasonal conditions. With the proper planning and control processes, it is possible to deal with these circumstances. The instructor may want to have the students identify similar uncontrollable factors and characteristics which need to be taken into account when planning a project.
  a. Suggestions: Natural phenomenon, government regulations and change, market changes, public attitudes, and behavior; all of these factors share the characteristic that they are not controllable by the project managers and the company in general but one can perform sensitivity analysis in order to determine the potential effects of these risks.

Challenge to class – ALL DISCUSS

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ABSTRACT

This paper describes the implementation of a project controls philosophy to minimize the total installed cost of a world-scale petrochemical project in Alberta. Three strategic initiatives which resulted in major cost and schedule savings are discussed:

- A very early focus on planning and identifying major risks and opportunities.
- Planning/scheduling work packages based on 3-D design partitions were used to manage the design through hydrotesting cycle for piping, reducing the project critical path.
- Implementation of project management tools was directed towards accelerating the transition from construction to systems completion.

Project Background

The Prentiss II project is an Ethylene Oxide/Glycol facility that uses Union Carbide proprietary technology. Fluor Daniel provided engineering, procurement, and construction (EPC) services for this facility, located in Alberta, Canada.

The prime requirement of the project (1) was to construct the specified plant for minimum cost, i.e., a truly "cost driven" project. The project management team, therefore, adopted as its main strategy for success the minimization of "total installed cost." The emphasis from the beginning was on *total* cost impact of all major decisions.

After commencement of the project, Union Carbide decided to use a new technology, resulting in a three-month delay to the issue of detailed process design packages. As a result, the project team realized that significant changes to normal work processes would be required to recuperate the delay and still minimize the total installed cost.

All major project execution decisions were scrutinized against this criteria.

STRATEGY TO MINIMIZE TOTAL INSTALLED COST

A simplified work process for implementation of the above strategy is shown in Figure 1.

Alignment/team building sessions were held very early in the project, involving key personnel from the client and the contractor, with the whole team buying into the primary objective of minimizing total cost. These meetings continued throughout the project duration, eventually involving

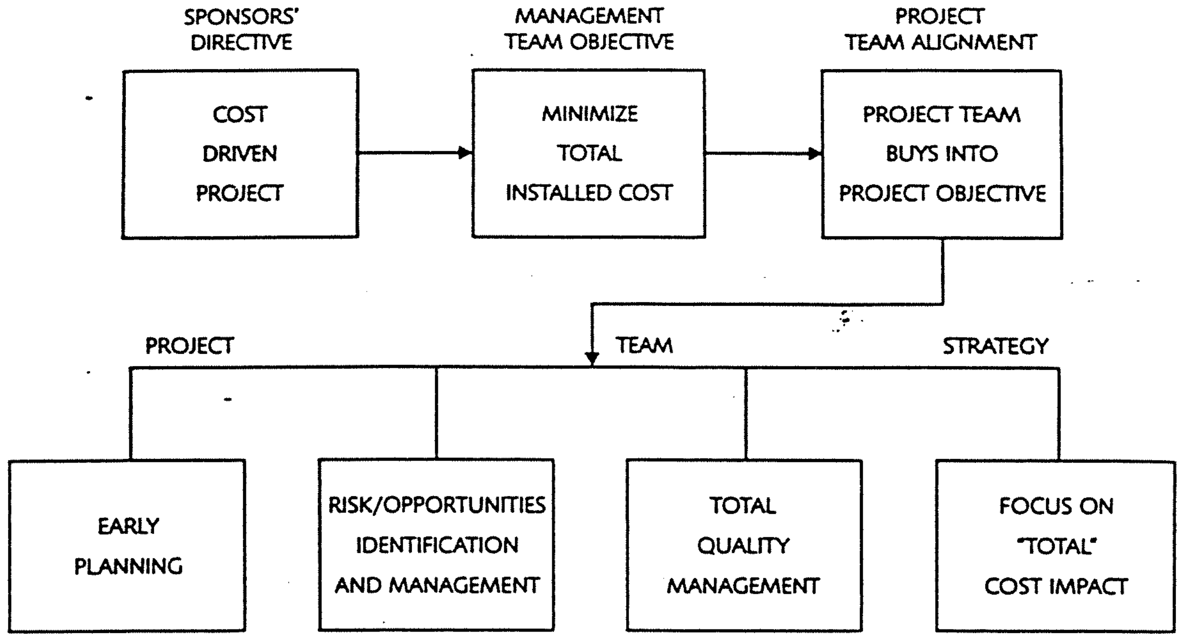

FIGURE 1 STRATEGY TO MINIMIZE TOTAL INSTALLED COST

construction management, key suppliers, subcontractors, and the construction crafts (trade unions).

A team strategy to achieve the prime requirement was formulated with emphasis on the four areas of early planning, risk and opportunity evaluation, total quality management, and focus on the reduction of total installed cost.

Early Planning

Critical equipment (long delivery) was identified and action plans for engineering and procurement were formulated to improve deliveries:

- Eight major equipment items were identified.
- Some of the heavy pieces of equipment needed to be delivered during a "transportation window" (December 1992 through February 1993) dictated by load restrictions on Canadian roads in spring.
- Other equipment had extended deliveries and needed to be ordered at a very early stage of engineering. Special efforts were made by the project team (client and contractor) to specify this equipment early, so that purchase orders could be placed in a timely manner.
- Detailed transportation plans were prepared for all critical items.

The project execution plan was developed and documented. This listed the overall execution strategies and detailed plans for project management, engineering, materials management, construction management, and project controls.

The project objective, the key driving forces, project execution risks, and strategic objectives were defined, and the project scope was documented.

Candidates for modularization and pre-assembly were identified based on previous experience and input from construction management, using brainstorming sessions and continuous evaluation of overall cost effectiveness.

The main pipe racks, the substation building, and the main analyzer building are some of the items which were modularized, with an overall cost savings of $2.5 million.

Team meetings were held in the engineering office and at the construction site to assess risks and opportunities "to go," using brainstorming techniques.

Major areas of risks and opportunities for cost savings were identified; for example:

- Due to the delay in finalization of process design, there was considerable risk that underground facilities and foundations would not be completed before "freeze up." This would have resulted in very significant cost increases. A work process to release scope defining documents in advance of the detailed process packages was developed to avoid this risk.
- As mentioned previously, there was a major risk that heavy equipment, if delayed, could not be transported to site until the following winter. Extra efforts were used in expediting and supporting the fabrication to achieve the desired delivery.
- A risk that hydrotesting was being pushed into the winter period due to the delay in process packages was identified. A number of actions was implemented to minimize the amount of hydrotesting that would have to be done under winter conditions.
- Our assessment of cost savings/avoidance achieved by managing these risks and opportunities was $3.5 million.

Total Quality Management

This subject is addressed in more detail in a previous paper (2). The main components of the quality plan relating to cost were:

- Many existing work processes were documented, analyzed, and improved for project execution, avoiding duplication and saving cost.
- Project strategic objectives (key result areas) were identified and action plans formulated to achieve success in the following areas:
  - "out of the ground" before freeze up in 1992
  - procurement of critical items (cost, delivery, quality)
  - execution of critical subcontracts (cost, schedule, quality)
  - timely receipt and approval of vendor data
  - timely completion of turnover packages.
- A value awareness plan was implemented with prompt recognition and reward for successful (Betterway) ideas. Documented cost savings/cost avoidance due to this value awareness plan reached $18 million on the project.
- An earned incentive plan for the contractor enabled cash incentives to be earned for superior performance in the areas of safety, cost, and quality. The project team's focus on cost savings and avoidances (lump sum mentality) was heightened by the fact that 25 percent of the total incentives received by the contractor were shared by the staff.

Focus on "Total Installed Cost"

Following brainstorming sessions and subsequent analysis, a written "Strategy to Minimize Total Installed Cost" was adopted, addressing key elements of engineering, procurement, and construction with specific directions to achieve the objectives. This document was widely distributed and updated regularly. Some of the elements were:

- enhancement of field productivity (each 1 percent improvement = $0.5 million savings) by ensuring availability of drawings, materials, tools, and construction equipment *before* starting work in any package
- management of overtime
- just-in-time staffing and timely destaffing
- minimization of winter work.

Key schedule targets—for example, delivery of pipe rack modules, completion of piping isometrics, and delivery of fabricated piping spools, installation of piping spools, and delivery of the modularized substation—were monitored on a weekly basis.

Alternative courses of action were evaluated on an ongoing basis, and plans were modified where necessary to achieve minimum total cost. For example, craft manpower in January and February 1994 was reduced significantly from the original plan to minimize the impact of poor productivity due to severe winter weather.

Detailed "completion and demobilization plans" were made for final stages of construction to ensure timely and cost-effective turnover of systems as well as timely demobilization of temporary facilities to maximize cost savings.

The bottom line: The net result of all the proactive strategies adopted by the project team resulted in a 10 percent cost underrun, timely completion, and high job satisfaction by all participants.

Planning and Scheduling Work Packages

The main obstacle to shortening the overall duration of a project comes from the transitions that must be made between design (which begins with process or utility systems) to construction (which is done by physical area), and back to completion, which is again by process or utility systems.

The method used to smooth the transition from design to construction on the Prentiss II project was the designation of construction planning areas called work packages (WPs). Careful thought was given to the setting of planning areas that were meaningful to both design and construction. On this project, construction WPs were set as physical areas to coincide with the boundaries of each 3-D design partition (see Figure 2). Some of the reasons that 3-D design partitions proved to be optimal WPs were:

- The size of partitions was limited to permit efficient design of piping isometrics (typically sixty to 100 isometrics).
- In construction, this meant that each partition would be manned by one piping crew or less, making it an ideal size for manpower planning.
- The monitoring paperwork was minimized by incorporating the WP number in all documentation and databases associated with an isometric or spool.
- The detailed bill of material electronically downloaded from the 3-D design system to the material control system also contained the WP number against each record.
- The pipe fabrication shop database was electronically downloaded (by special arrangement with the pipe fabricator) via modem, and the fabrication status (by WP) was obtained on a weekly basis. This was a real help in construction planning, as the latest fabrication status was available almost online.

Once the work package boundaries had been defined, specific target dates were set for the start of piping erection for each WP. These dates were set to provide firm targets for design and procurement using the following assumptions:

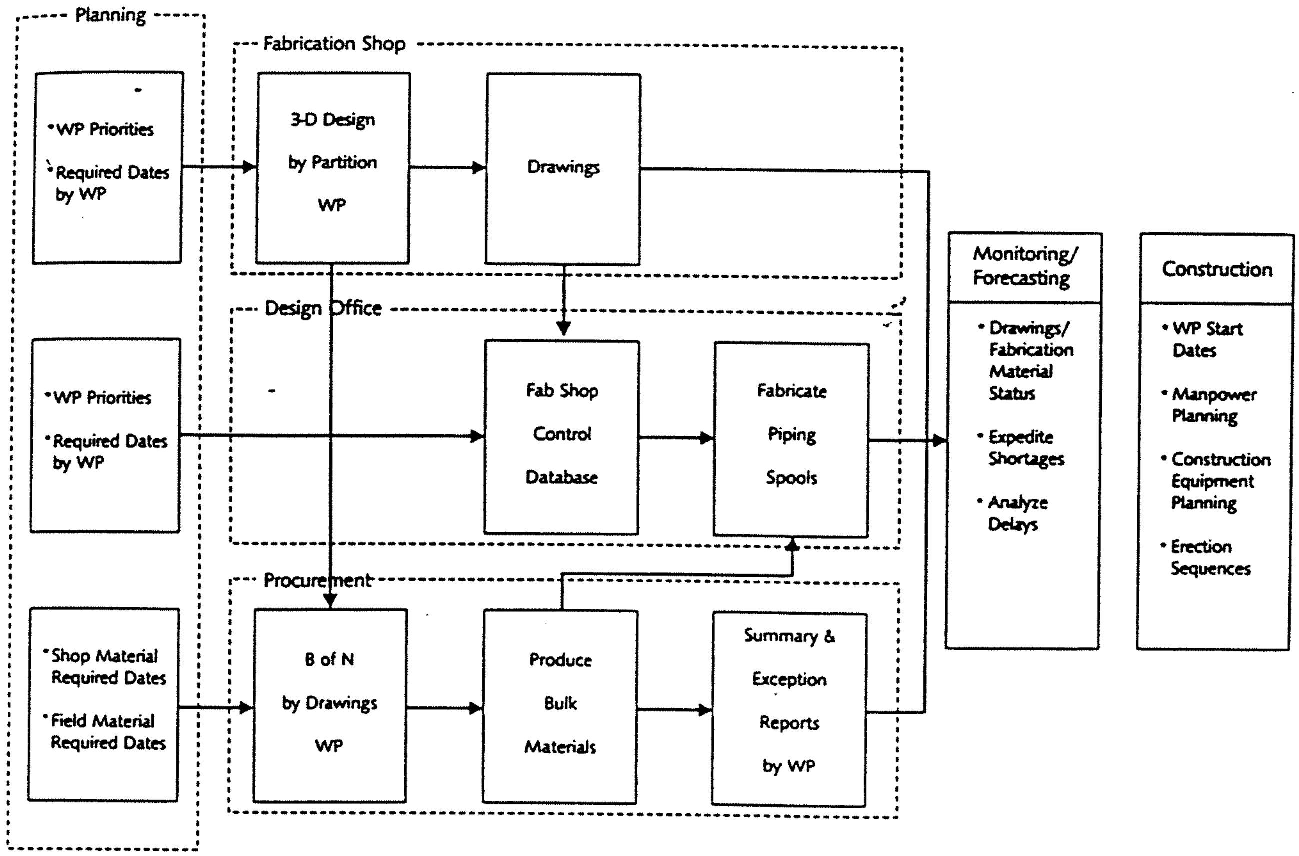

FIGURE 2 PLANNING AND SCHEDULING WORK PACKAGES (WP'S)

- To begin piping erection in a work package:
  - *All* columns must be set and plumbed, all heat exchangers set, and all pumps set and aligned.
  - *All* piping spools should have been delivered to site, together with all field destination bulk materials.
  - The pipe rack module adjacent to the WP must be placed and aligned, and any steel structures complete.
- Piping design targets for issue of *all* isometrics for a WP were set twelve weeks earlier than the construction start dates to allow for fabrication. Procurement targets were set to have *all* shop destination bulk materials delivered to the fabrication shop *at the same time*, prior to start of fabrication.

The results of this planning strategy were firm target dates for the issue of ISOs for forty-six construction work packages, the delivery of bulk materials to both shop and field, and the commencement of above-ground piping erection, which spanned an eighteen-week period.

During the monitoring phase of the plan, a weekly report was produced detailing the isometric issue status, and shop and field bulk material delivery status, and fabrication status for each WP planned and forecast dates were reported for ISO issue, material delivery, and construction start.

At site, a detailed plan was developed for each spool to be erected within each WP and progress monitored at a detailed and summary level weekly. In practice, piping erection began in a WP when 70 to 90 percent of the spools were on-site and the fabrication status indicated that the remainder were nearing completion.

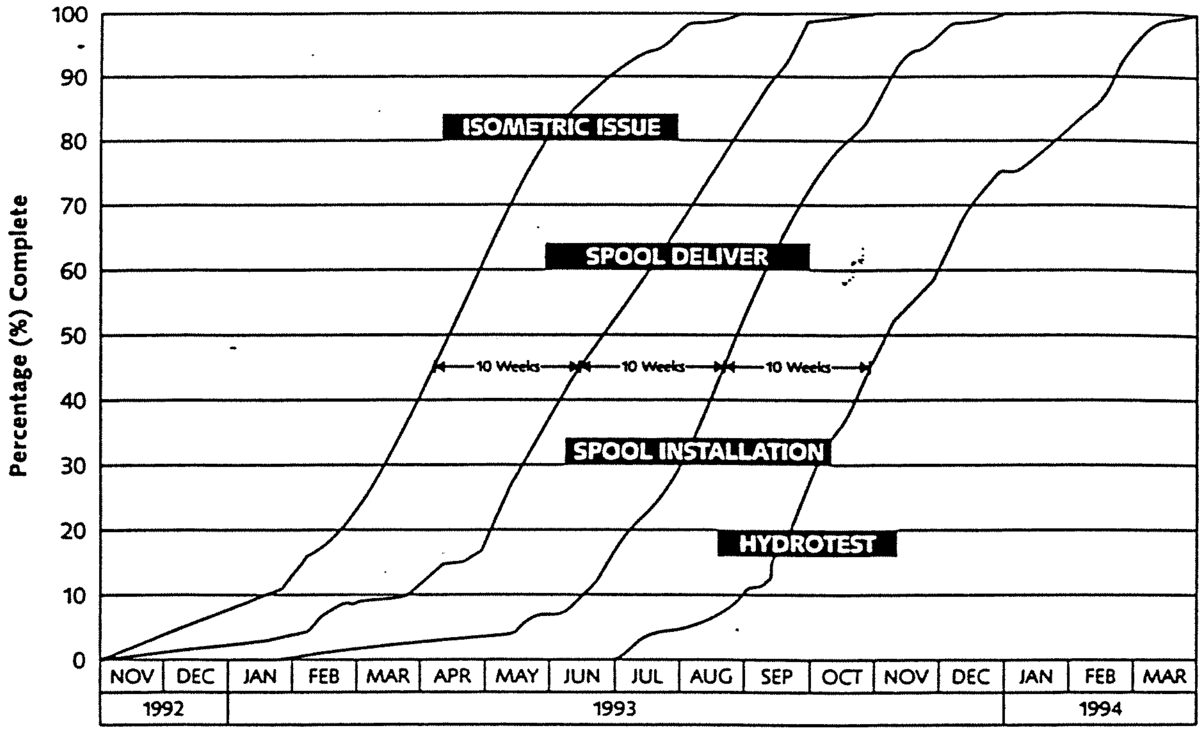

FIGURE 3 PROJECT PIPING PERFORMANCE

Benefits:

- Early in the engineering stage, the design team had clear targets for piping isometric production that were meaningful to all disciplines.
- The use of small WPs did not impose a burden of paperwork because the alignment with 3-D design partitions allowed the WP number to be associated with each element electronically.
- The effect of delays to any component of the construction plan, i.e., isometric production, design changes, bulk material deliveries, or mechanical equipment deliveries could be quickly and meaningfully assessed; corrective action could be decisively implemented.
- The most significant benefit was in day-to-day construction planning. In the early stages of construction, each area general foreman had a reliable method of directing crews to specific areas, knowing that the work could continue uninterrupted.

In cases where construction began before material was 100 percent onsite, means were available to identify pipe spools or bulk material items that were missing, and the "drop dead" date they would be required to avoid affecting productivity in the area. Spool and bulk material exceptions were identified to expediting with target dates for delivery to allow work to proceed in the WP without interruption.

- The ability to accurately plan mobilization dates and manpower requirements by WP meant that although the workforce on the Prentiss II project was increased to peak levels very rapidly, it was achieved in a well managed manner that avoided many of the productivity losses associated with rapid workforce build-up.

The total piping crew built up from seventy-five to 450 in a thirteen-week period, an average increase of twenty-nine workers per week over the period. In the same period, actual productivity averaged 5 percent higher than budgeted.

The bottom line (see Figure 3) showed the duration from isometric issue to hydrotest on the Prentiss II project consistently averaged thirty-one weeks over the life of the project. The best comparison for this is a 3-D project of comparable size that did not implement the 3-D work package planning system and achieved an average of forty-three weeks from ISO issue to hydrotest.

We feel strongly that the difference resulted in a twelve-week reduction in the overall project duration and is repeatable on other projects. This equated to a savings of approximately $1.5 million in indirect field costs on this project, and opportunities still exist for further improvement in each step of the process.

Planning Strategy for Completion Phase

The strategy used on the Prentiss II project to facilitate the transition from construction to completion phase included manpower and progress forecasting and monitoring for each turnover package (TOP). This forecast, which was based on the completion schedule, accurately reflected the specific resources required for completion of each utility and process system, set weekly targets for performance, and provided timely and accurate feedback on whether completion goals were being accomplished. This was made possible by the preparation of turnover piping and instrument flow diagrams very early in the project and identification of packages in detail.

Again, the ability to correlate data from a number of different databases was crucial to the successful implementation of this strategy. The backbone of the system was the field progress reporting system (FPRS). Briefly, the FPRS was a database that contained the budgeted workhours for all material installation or labor operations shown on "approved for construction" drawings on the project, and a milestone breakdown of the work hours. The FPRS was updated for progress of individual items every week, and formed the basis for reporting of physical progress at both detailed and summary levels.

The exercise of defining the TOPs began in the design office by entering the TOP number as a field in all applicable design databases, in much the same way that the WP was a field in these databases (see Figure 4). This included the isometric log, instrument index, and several electrical databases for wire and cable drawings. These databases were then sorted by TOP to provide the detailed listing of drawings and information required for the physical turnover package to be assembled for transmittal to the client at mechanical completion of each package. Simultaneously, this TOP data was added to the FPRS databases. Progress (percent complete) and earned and "to go" work hours could now be summarized by TOP for all construction activities specifically related to completion of the TOP.

The workhours "to go" for each craft were then spread over the remaining duration in the commissioning schedule to support the individual mechanical completion dates and manpower requirements (and percent complete forecast) for each TOP summarized by craft and area. Status against this forecast involved no additional work for the field control team other than running a different set of summary reports; i.e., progress summarized by TOP.

This technique provided construction supervision with not only a very clear road map of the manpower resources required to achieve the project completion schedule, but also weekly feedback on which TOPs were on target, and

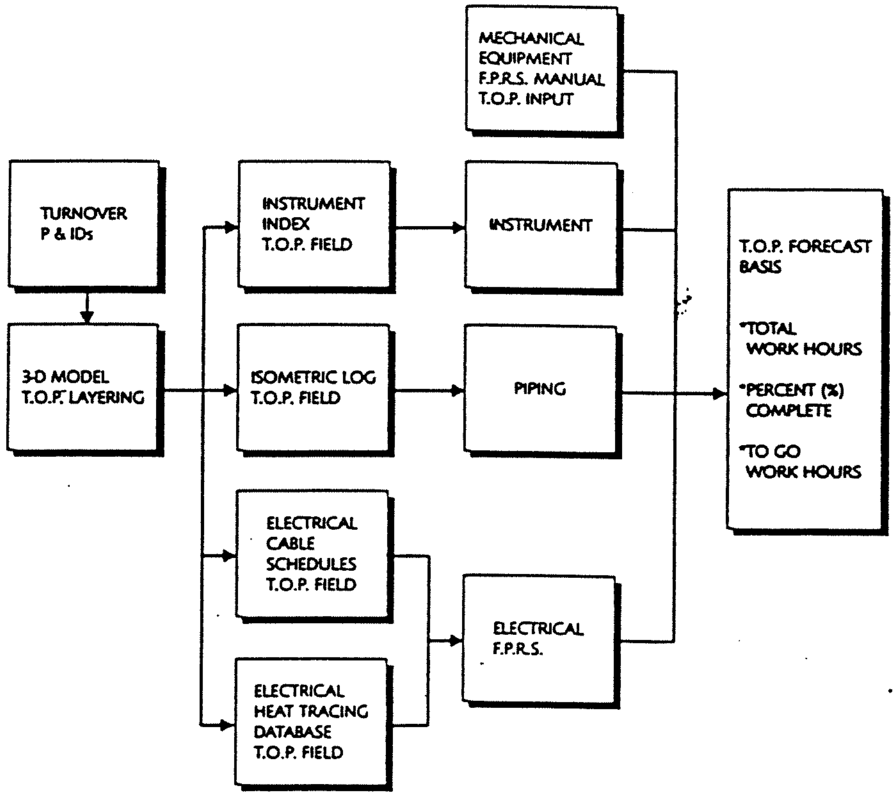

FIGURE 4 PLANNING STRATEGY FOR COMPLETION PHASE

where progress on a specific TOP was falling behind, and exactly which craft or area required additional resources.

The bottom line: A measure of the effectiveness of this strategy in easing and focusing the transition from the construction to completion phase of the project is again illustrated in Figure 3. Let us assume that the duration from spool installation, which is a construction phase activity primarily planned and executed by physical area, and hydrotesting, which is a completion phase activity planned and executed by utility and process system, represents effectiveness of shifting from one phase to the other. On the Prentiss II Project, this duration was consistently eleven weeks; the figure for a comparable project was eighteen weeks. This equates to a saving of approximately $1.1 million in indirect field costs.

CONCLUSIONS

The above strategies of minimizing total installed cost, work packaging, and completion planning benefited the Prentiss II project as follows:

- completion of the project ahead of schedule with an *overall cost savings of over 10 percent* of the total installed cost
- recuperation of the project schedule after an initial three-month delay, with no adverse cost impact
- outstanding quality and safety results.

We strongly believe the results on the Prentiss II project are repeatable and achievable on any project if similar strategies are applied. Further incremental improvements are possible through work process analysis, in particular in developing and sharing information and planning data between the design office, material fabricators and suppliers, and the construction site.

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RATEGIC PROJECT CONTROL INITIATIVES

1. The prime requirement of this project was clearly established. It was to minimize the total installed cost. The management of the project, in order to achieve this requirement and fulfill this project's objective, followed the strategy presented in Figure 1. Discuss the analogy between this strategy and the project management processes: initiating, planning, executing, controlling, and closing listed in the *PMBOK Guide*, section 3.2, Process Groups.

2. The case described a significant amount of planning as having gone into the project. How did this planning help to reduce costs?

3. The risk and opportunity evaluation completed for this project identified several potential scheduling problems. How does this evaluation and its effect on scheduling affect cost management?

4. The author stresses the importance of facilitating the transition between construction and completion (executing to closing the project). How did the project managers deal with this challenge?

5. Though the construction of this facility was "cost-driven," cost management was not the only project management area used in the administration of the project. Mention at least two other project management areas involved in the making of this project.

6. This case describes how the natural environment affects all aspects of how the project work is done. Compare and contrast how these natural environmental risks are analogous to risks in other types of environments (public relations, political, etc.).