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Balancing Design Costs in EPC Projects: In-Office Design vs. the Site Engineering Adjustments

A comparative approach between Fast Track Engineering and Finish To Start relationship among engineering stages viewed from the Contractors' perspective

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Contractors dealing with Engineering Procurement Construction (EPC) projects are often faced with balancing conceptual design costs vs. site detailed design costs as a result of adjusting the technical solutions to fit the construction concept.

These are stressful situations for the Contractor due to contract provisions that require the contractor to establish the final quantities for materials and equipment while simultaneously completing the detailed design. This is especially true for T&M (time and material) contracts. The situation is worse for open-ended contracts where the scope is not fully defined. In this case, the Contractor must establish on its own the final quantities of work and materials.

In their willingness to take the job, Contractors often ignore that the conceptual and detailed design phases must be accomplished mainly in the design office. The full package of drawings, sketches, data sheets, specifications and O&M manuals are then entrusted to the site office responsible for implementing the design prepared in the main office. There are instances when Contractors assign the conceptual design phase to the main office while starting the on-site work on a fast track basis. The site has limited information to deal with detailed engineering or construction issues, usually within the Project Engineering Office limits.

Short and always tight schedule are the main reasons for which the Contractors prefer to start working without having the full detailed design information in hand. That strategy may be satisfactory when the project is similar to past projects but when the company is dealing with a complete new challenge, then things might go wrong from the very beginning.

What are the risks?

Fast-Track construction teams may find themselves in the position to get involved in detailed design, making calculations, drawing sketches and so on in order to complete the construction phase on-time. Doing this is difficult due to the risk involved. For any risk (in the risk register) assessed as high or moderate probability, contingency plans and funds must be in place to diminish the adverse impact. The site team often struggles to stay on schedule and there may be no room in the budget for hiring or assigning an engineer to the site to perform detailed design.

The Project Manager may feel captive by both the Site Team and the Design Team and yet must deal with both the cost of designing and potential schedule delays in construction. Normally the Site Team is only charged with the responsibility of implementing the technical solutions and they have no right to alter or modify any design drawing, P&IDs', sketches and so on. But when the design documents provided by the Design Team are inadequate, the Project Manager may need to consider hiring a site design engineer to define the appropriate details for erection/installation.

This sort of arrangement is often seen in Matrix organizations where the Project Manager must either buy or negotiate with the Line Manager of a Design Department for the allocation of a design engineer for the project. Being a shared resource, however, an allocated design engineer may not be available when needed by the Project Manager.

Other cause for this additional cost triggered by the risk occurrence could be the poor definition of conceptual design or definitive detail design. If the conceptual design is not provided by the Client (whether or not assisted by a Consultant) then the Contractor is solely responsible for defining the right Scope of Work. The Project Manager and the Design Engineer may run into some disputes over the scope for conceptual vs. detail design. The Project Manager wants to get as much as possible from the conceptual phase in order to commence the site execution with a minimum risk of making mistakes and reworking, while the Design Engineer wants to provide only what is needed for the detailed design.

This conflict results in the Project Manager being captive by the conflict between the Design Engineer and the Site Engineer. Since the Design Engineer's scope might be perceived as completed, then it may become necessary to supplement the Site Team with a dedicated design engineer assigned from the office and for a limited time in order to refine the design details needed for construction purpose. The critical issue is the gap between what the Design office believes is appropriate and sufficient for proper site erection works and the real perception of the site staff when faced with the works on-site. It is a conflict between the design documents devised by the Office and the needs in the site originating from the erection teams.

If the Detailed Design is different in interpretation by the Office and for the Site, then the Project Manager is the only one capable of reconciling these two entities with the Statement of Work listed in the contractual documents. The key aspect is to try to cover as much as possible by turning the contract Statement of Work into the requirements to satisfy both needs: of the Engineering Office and of the Site staff.

The Project Manager should be aware of the fact that when she/he misses this point, then it may become necessary to return several times during the project execution to the Design Office in an attempt to refine and define what was poorly depicted within the prior design documents. Adding more resources for this important refinement, and here is especially brought to the reader's attention that

design engineers are expensive resources, shall surely increase the project budget with previously unaccounted costs.

Solutions for circumventing extras payment with the site design phase

Even in a matrix structure the Project Manager may reasonably expect sufficient design resources to be allocated for the project. Irrespective of the Client's Statement of Work, the Contractor must be able to define and refine the scope and to further break it down in Conceptual Design and Detailed Design. If the Contractor and the Project Manager are both unsure, then conditions for extra cost and project delay are likely to occur later on during the project developing.

What can and should be done:

1.) Define the erection drawings, sketches, P&IDs' etc. which are needed by Site Team for installation/erection

Usually this condition originates from the contract documents or from other adjacent papers such as technical specifications or written technical requirements. It is highly advisable prior to the project site execution, during the planning phase, both the Client and Contractor should establish a meaningful and comprehensive list of drawings and documents that require approval from the Client or its representative (such as a Consultant). The Engineering Office should follow the list, and the drawings must be therefore issued out and stamped "Approved for Site Erection" before dispatching them to the site staff.

2.) Match the SOW requirements with the scope of the in-house design department during the planning process

It is the project Manager's responsibility to break down the entire scope into a meaningful WBS as a starting point for the purpose of clarification for every project entity, including the design office. If the SOW is not accurate then discrepancies may arise between the Project Manager and design office. If the design documents package (drawings, sketches, technical data) have insufficient accuracy or details, then all these might prove themselves inoperable for the construction site. It is highly advisable that the Project Manager always scrutinize this matching data transferred from the design office to the construction staff carefully during the project meetings.

3.) Develop and maintain valuable templates as part of the historical information from similar projects in the past

As part of the lessons learned process, it is highly advisable for the Project Manager to file and document lessons, past problems and issues deriving from the project implementation in this respect. This shall constitute a valuable "lighthouse" for future projects and for project managers facing similar issues. Every organization should feel compelled

to place itself on a learning curve concept, thus reducing the time for similar actions in the future.

4.) Make the office design engineers available for surveys, walk-on, assessments

In some instances the Office Design Engineers must travel to the site for collecting missing data or information needed for design development. It is mandatory that from time to time the design engineers be required to go on-site for making their own assessment or gathering their identification of the site conditions. It is more than necessary that this *in situ* surveillance take place before the contract is concluded or, latest, at the beginning of the planning phase. This site assignment by the office design engineers is sometimes difficult to administrate in a matrix arrangement when the office engineers might serve simultaneously for two or three different projects. It is also more complicated if the design office is an independent profit-cost center. If not planned and accounted for in the beginning then additional costs are likely to be incurred on the project account.

5.) Develop a framework of design documents during contract negotiations with the Client, in order to expedite acceptance during project implementation

The Contract Administrator and the Project Manager should be equally interested in having a complete and accurate list of documents to be developed and approved during the design phase. This will lead to a less surprising situation when either the Client may ask for additional documents or when the Contractor may show up for approval with an unlisted document.

6.) Implement specific timeframes for Client review/approval in order to prevent delay of site activities, and to provide the site team with approved erection drawings on schedule.

With a lack of any limited allowable period for the documents approval, every Client tends to postpone its verdict on technical documentation or drawing approval indefinitely. The Contractor is at high-risk if the approvals arrive late, since the subsequent phases—procurement, fabrication, delivery and erection—depend upon this acceptance of deliverables. It is in the Contractor's interest to have some stops in the approval process. This shall surely rush the Client with its verdict, but should keep the Contractor on good time track with the delivery schedule.

7.) Negotiate time schedules with a predetermined period for design and engineering only, before site work begins.

It is the obligation of the Project Manager or Contract Administrator when negotiating the Contract to take into accounts the grace period that might

be extremely valuable for the design office staff. Rather than abruptly starting work in the office with limited information, and putting under pressure the site workers due to the same limited information, the Contractor had better get some "thinking" period before the start of site activity. This period of time will be used to 1.) start drafting the documents and drawings as accurately as possible and getting them through the Client's acceptance and 2.) to organize the site, mobilize progressively the workers, basically set the foot on the site.

Working within an Engineering-Procurement-Construction project environment is a classical approach for today's "turn key" construction projects. The Clients are willing to entrust to a separate entity the entire responsibility of a project, from the initiating process to the closure, retaining only in some instances the privilege of giving approvals for technical solutions or equipment to be employed during the project course.

The Contractors need to bear in mind the fact that the responsibility is balanced and shared between the parties. The Client itself has a major obligation to define preconditions for the Contractor performances. When the Client fails to accomplish its portion of the job, the Contractor may suffer serious consequences. It is therefore significant for the Contractor to try to make the Client responsible for its share from the very beginning and not to have to chase the client later after getting the green light, in order to proceed with a minimum risk.



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