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A Case Study on Parallel Engineering, New Trend in Oil & Gas Industry

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Abstract—*Parallel engineering is a third generation project execution philosophy, and this execution philosophy has become very popular and successful in oil and gas industry. In this execution process, several engineering disciplines work concurrently to execute a particular project. In project management field, this phenomenon is called "First tracking".*

With the increasing trend of competitive engineering services, it has become a necessity to execute a project with a schedule constrain, and parallel engineering provides the solution. As First tracking brings many challenges, Parallel engineering is not an exception, and the main challenge it brings is "rework". Hence proper engineering planning and effective communication are essential.

The main objective of this paper is to demonstrate a case study of how successfully a critical structure was executed through parallel engineering execution philosophy, and to provide a comparative study of total time taken to complete the task with that would be taken if standard execution philosophy is followed.

Keywords*: Parallel engineering, concurrent engineering, schedule compression, first tracking, project execution.*

1. INTRODUCTION

In today's competitive market, to achieve project milestones in a shorter period of time, to meet the client's demand or to avoid schedule overrun, the project management team may have to reduce a project schedule, and that is termed as **"schedule compression"**. It is a technique used in project management to shorten an already developed schedule to bring schedule back on track or as a preventive measure for anticipated schedule overrun. This might be done to meet an updated delivery date, a new opportunity or schedule delay. It's done without changing the scope of the program. Schedule compression techniques include, but are not limited to:

1. **Crashing**: A technique used to shorten the schedule duration for the least incremental cost by adding resources. Examples of crashing include i) approving overtime, ii) bringing in additional resources, iii) paying to expedite delivery to activities on the critical path etc.

Crashing works only for activities on the critical path where additional resources will shorten the activity's duration. Crashing does not always produce a viable alternative and may result in increased risk and cost overrun.

1. **Fast tracking**: A schedule compression technique in which activities or phases normally done in sequence/series are performed in parallel for at least a portion of their duration. Fast tracking is defined as compressing the project schedule by overlapping activities that would normally be done in sequence, such as Design and Construction. Fast Tracking to overlap schedules has an impact on Project Predictability in terms of achieving planned objectives (time, cost and quality).

An example is constructing the foundation for a building before completing all of the architectural drawings or casting of foundations of a pipe rack before completion of isometric drawings of plant design and piping. Fast tracking may result in rework and increased risk. Fast tracking only works if activities can be overlapped to shorten the project duration.

Now a days among all of these techniques, fast tracking as a project delivery system has been widely implemented in Construction Industry which is called "**Parallel Engineering"** or **"Concurrent Engineering"**. The approach can require work to be performed without complete detailed information. Some of the factors that encourage Fast Tracking are financial considerations, Project Complexity, Political Conditions and Market Conditions. The accelerating of projects due to the present market scenario has created a large demand on shortening the project duration. This increases the uncertainties and can result in changes, rework and extra costs as the successor activities must start with incomplete data. A decision whether a specific degree of overlapping is desirable or not can be made on the basis of trade-off between its positive and negative impacts.

2. BRIEF COMPARISON OF PROJECT EXECUTION METHODS

The process of engineering work to produce the required deliverables depends not only on the functional disciplines but also on their engineering functions. Engineering in EPC project is the task of translating a set of functional requirement into a full set of drawings and specifications depicting every detail of a facility.

Engineering involves various disciplines which include:

- Process
- Civil and Structure
- Mechanical
- Piping
- Electrical
- Instrumentation

The strategy is dependent on Engineering and procurement providing their deliverables to meet the path of construction which is very much controlled by the engineering design management system.

Concurrent engineering or parallel engineering is a relatively new design management system which replaces the traditional sequential design flow or 'Waterfall Model'. The difference between these two methods is that the 'Waterfall' method moves in a linear direction by starting with client requirements and sequentially moving forward to design, implementation, construction, procurement, commissioning and operation. In this design system, a design team would not look backwards or forwards from the step it is on to fix possible problems. In the case that something does go wrong, the design usually must be scrapped or heavily changed. On the other hand, the iterative design process is more cyclic in that, all aspects of the life cycle of the procured item or product are taken into account, allowing for a more evolutionary approach to design. The difference between the two design processes can be seen as follows:

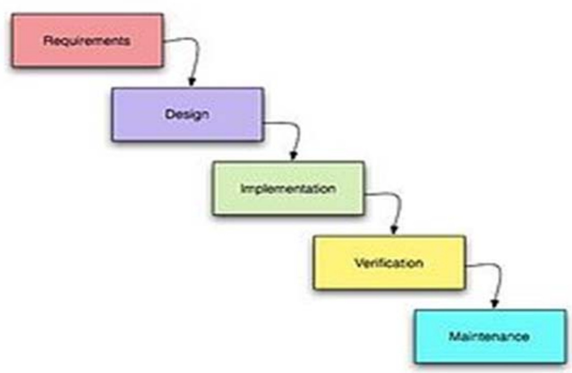

Fig. 2.1: Traditional Sequential Development Design Method.

Hence it is seen that in a fast track project, there is a considerable overlapping the various phases of the project considered. Fast tracking of a schedule comes with a series of problems related to both cost and quality. The dangers of exponential cost overruns during fast tracking are very real due to the challenges tied to managing a larger team and the potential for unforeseen inefficiencies. Quality may also be affected by the rapid ramp-up of the project team's size and significant amount of rework. The predictability of fast track projects plays a very important role in their success.

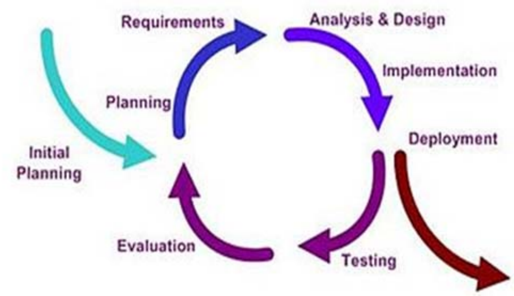

Fig. 2.2: Iterative Development Method in concurrent engineering

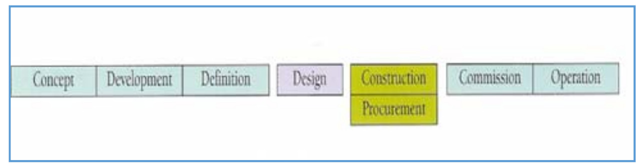

Fig. 2.3: Normal Project managed by sequential design method.

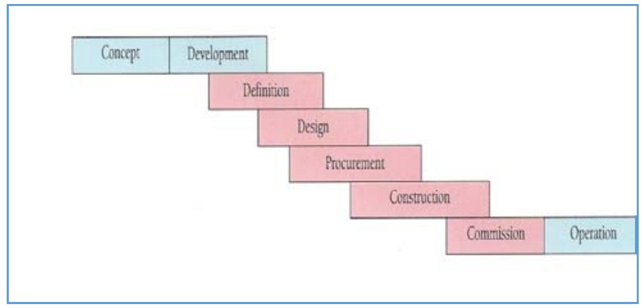

Fig. 2.4: Fast tracking project managed by concurrent/parallel engineering design method.

3. REAL WORLD PROJECT EXECUTION BY PARALLEL ENGINEERING: A CASE STUDY WITH PIPE RACK.

Parallel engineering technique is widely used in Oil and Gas industry. The ideal work process which is based on sequential engineering cannot be followed in almost any of the projects because of schedule constrain. In case of parallel engineering, structural engineering work progresses with other disciplines concurrently.

Refer Fig. 3.1 for typical timeline for various disciplines following the parallel engineering method.

As illustrated in the figure, other upstream discipline's design works are not yet matured by the time structural steel drawings are issued for construction. So receiving request of late changes is unavoidable. From Fig. 3.2, it is understandable that as per sequential engineering, each discipline activities need to be finished before going into next stage of engineering activities carried out by another disciplines. It takes longer time to complete the project, causing delay in construction & commissioning.

For the study, a 100 m long Flare pipe rack which has been executed with help of parallel engineering in one of our current projects is considered. Fig. 3.3 shows an isometric view of the rack. All engineering departments such as process, instrumentation, electrical, piping, structural engineering are involved. But Process engineering is performed initially and then others engineering disciplines are involved. So process engineering is not considered in the study. Table 3.1 shows the time required for each department to complete its part.

Table 3.1 Required time for each department

Departments	Days
Piping Engineering	40
Instrumentation Engineering	20
Electrical Engineering	20
Structural Engineering	40

For a traditional sequential design method, the total project time taken for the pipe rack is 120 days. If parallel engineering is used, the activities are done concurrently. So activities overlap, and ultimately total time taken into the project is reduced. Fig. 3.5 shows how activities from all departments overlap. Form that figure, it is shown that total time is taken 60 days. In this practice, some reworks are expected after finalizing engineering from other departments. It is not a major issue if proper engineering practice, expert judgment, and continuous and effective communication are used. In that case, total 20 days were taken for the rework. Hence total time is 80 days, showing that schedule can be compressed almost by 33% if parallel engineering technique is used.

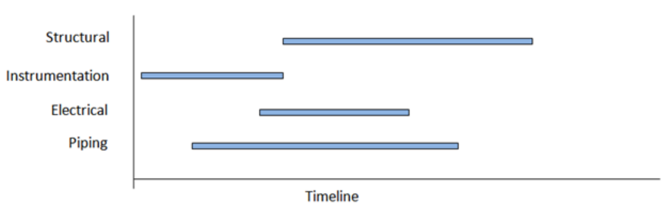

Fig. 3.1 engineering timeline for various disciplines following parallel engineering design method.

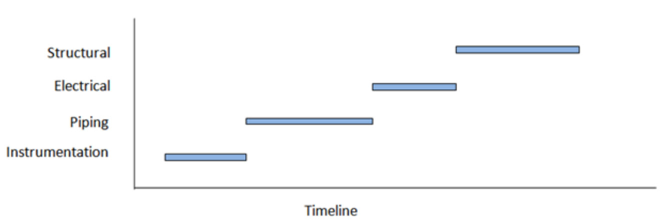

Fig. 3.2 engineering timeline for various disciplines following traditional sequential engineering method.

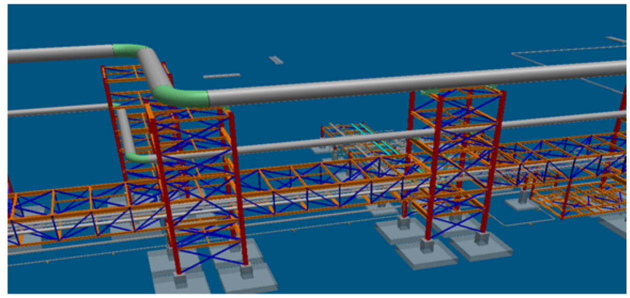

Fig. 3.2: Elevation view of flare pipe rack.

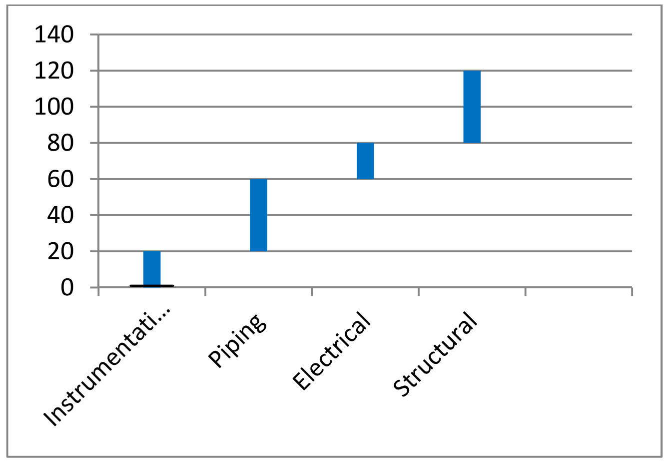

Fig. 3.4: Time taken (days) in sequential engineering practice.

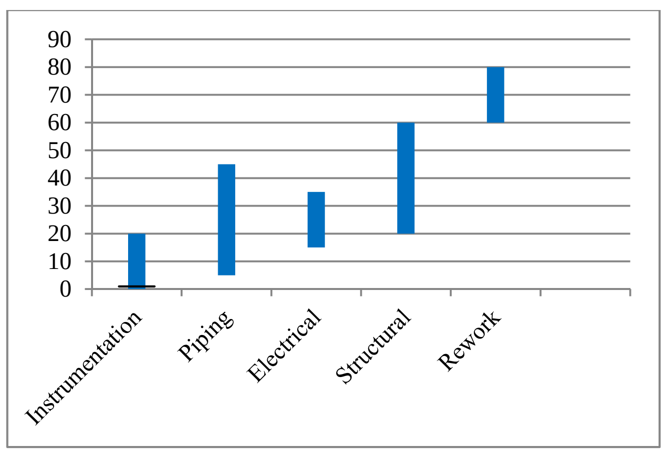

Fig. 3.5 time taken (Days) in parallel engineering practice.

4. CONCLUSION

Project execution process in oil and gas industry is going through a rapid change as every project is subjected to schedule constrain. Parallel engineering technique provides a solution. With the help of parallel engineering, projects can be executed successfully while fulfilling all constrains. But proper engineering practice, expert judgment, and continuous and effective communication are required to minimize reworks.

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