Engineering, Procurement and Construction (EPC) Projects

Opportunities for Improvements through automation

Presented by Robert N. Fox
Summary

• Clarify distinctions between EPC and AEC
• State EPC Challenges
• Review EPC Principal Functions
• CAD Evolution in the past quarter century
• Case Study of an EPC “Mega-Project”
• Opportunities
• Q&A
Contrasting EPC and AEC

• ‘C’ component is the principal target for both
• EPC – explicit emphasis on ‘P’ component
• EPC – relatively minor ‘A’ component
• AEC – relatively minor ‘E’ component

EPC Engineering Disciplines:
- Process
- Mechanical
- Geo-technical
- Civil-Civil
- Civil-Structural
- Plant Layout
- Piping
- Electrical
- Instrumentation and Controls

AEC Engineering Disciplines:
- Architectural
- Mechanical (HVAC & Plumbing)
- Geo-technical
- Civil-Civil
- Civil-Structural
- Electrical & Telecomm
EPC Challenges

- Execute EPC “mega-projects” within budget and on schedule
- Minimize construction delays due to lagging information, material or equipment.
- Track progress and maintain contingency plans to stay on schedule.
- Document project progress in terms of installed quantities.
The Challenge

• Intelligently apply IT/CAD to the EPC environment.
• Overcome conservative mind-set of builders.
• Push progression of 2D to 3D, 4D and even 5D.
• Apply IT/CAD tools to the advantage of constructors and their clients. Better productivity leads to better gross margins.
Coordinating EPC Functions

**ENGINEERING:**
- Budgeted Deliverables
- 3D Model w/ attribute data
- Parsed MTO
- Quantity Estimate & Tracking

**PROJECT CONTROLS:**
- Schedule
- Code of Accounts
- Definitive Cost Estimate
- MTO Parsing Criteria

**CONSTRUCTION:**
- Parsed MTO
- Work Scope Packaging
- Resource Management
- Progress Tracking

**PROCUREMENT:**
- Parsed MTO
- ROS Dates
- Prioritization
- Mat’l Receipt/Release

**COORDINATION**
EPC Engineering Sequence

- Studies
- OM Cost Estimate
- NTP

Basic Engineering
- Criteria & Specs.
- MTO Estimate

Purchase Requisitions
- Calculations
- Detailed Engineering
- Definitive Estimate

Issue "Engineering "Deliverables" to Construction

- RFI’s and FCD’s
- Produce “As-Built”
- Project Close-Out
Procurement Sequence

• Develop Bidders Lists
• Purchase Order Pro-Forma
• Contracts Pro-Forma
• Transportation and Logistics

• Specifications (Eng.)
• Quantities (Eng.)
• Solicit/Evaluate Bids
• Award P.O. / Contract

• Shop Inspections
• Track Status
• Expedite per ROS Dates

• Transport & Receive
  • Warehouse
  • Maintain
  • Release to Construction
Construction Sequence

Note: Construction is supported by Field Engineering
Inter-Functional Coordination

**PROJECT CONTROLS**
- CPM Schedule
- Budget
- Code of Accounts
- Trends

**ENGINEERING**
- Specifications
- Quantities
- Material Requisitions
- Design Drawings
- Lift Plans

**PROCUREMENT**
- Purchase Orders
- Contracts
- Traffic and Logistics
- Shop Inspection
- Expediting
- Receiving/Releasing

**CONSTRUCTION**
- Constructability
- Construction Planning
- Temporary Facilities
- Resource-Planning

Must devise a data exchange key
Slice and Dice the Project

PHYSICAL BREAKDOWN:

• Project
  • Facility
    • Sub-Facility
      • Commodity Type
        • Tag Items or Bulk Materials

TEMPORAL BREAKDOWN:

• Milestone Schedule
  • Level 3 CPM Schedule
    • Level 4 Detailed Schedule
      • Level 5 Work Packaging by work front

SEQUENTIAL BREAKDOWN:

1. Detailed Engineering
2. Materials Specification AND Quantification
3. Procurement
4. Construction
5. Commissioning and Start-Up
Project Controls Sequence

- Milestone Schedule
- Code of Accounts
- Cost Estimate
- Budget Definition and Tracking
- Level 3 CPM Schedule (aka P3)
- Trend Program
- Contingency Tracking
- Schedule Optimization
## Cycle of Each “Widget”

<table>
<thead>
<tr>
<th>ACTIONS</th>
<th>BY WHO</th>
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<tbody>
<tr>
<td>SPECIFY &amp; DESIGN</td>
<td>Engineering</td>
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<tr>
<td>APPROVE &amp; ISSUE</td>
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</tr>
<tr>
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<tr>
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<td>Procurement</td>
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<td>Construction</td>
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<td>ERECT / INSTAL</td>
<td>Construction</td>
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<tr>
<td>INSPECT / ACCEPT</td>
<td>Field Engineering</td>
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</tbody>
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**Challenge:** How to enable rapid identification and reliable tracking of each widget as it is controlled by the various functional entities.
Levels of Modelling

• 2D Drawings and Sketches (E)
• 3D CAD Model with data attribute links (E)
• 4D Construction Simulation Model (EC)
  – 4Dc – Construction Planning & Sequencing
  – 4Dr – Resource Management (and Lift Plans)
  – 4Ds – Construction Status
• 5D Cost Tracking Model (EPC)
  – 5Dm: material costs
  – 5Dr: resource costs
2D Drawings and Sketches

- Traditional format
- Inter-drawing design coordination subject to error
- Change management requires rigorous document control process.
- 2D CAD used for nearly 30 years aids in drawing format consistency as well as storage and management of drawing files.
“Intelligent” 3D CAD Model

- Used for EPC over the past 20+ years (3DM, PDS, PDMS, Smart-Plant, Plant-Space)
- Requires changes to traditional work processes
- Component attribute data is the “intelligence”
- Clash Checking
- Automatic Drawing Creation
- Material Take-Off Reports
- Data Consistency Reports
4D Construction Simulation Model

- Links 3D model components with P3 schedule
- Assigns temporal dimension to each “widget” in the 3D model
- Facilitates Construction Operations:
  - Construction Sequencing
  - Resource Management Planning
  - Constructability Assessment
  - Lift Plan Verification
  - Visualization
EPC Proceduralized Coordination

• Materials Management is the key
  – Parse project in 3D Space as well as by material commodity types.
  – Derive a matrix of spacial sub-divisions crossed with commodity types to define a series of tags. Call it the Work Execution Package (WEP).
  – Construction planners help define spacial entities.
  – Each material item is assigned a tag that ties it to the matrix.
  – Each WEP tag is embedded into a scheduled activity.
5D Cost Tracking Model

• Material Cost Model
• Resource Distribution Model
• Expended Cost Tracking Model
• . . . Others yet to be defined
A Case Study EPC Project

Copper Concentrator Plant located in Central Chile ($2.5B)
Case Study Parameters

- Two sites connected by a 57 km. pipeline
- 8,000,000 cubic meters of earth-works
- 400,000 cubic meters of structural concrete
- 18 tons of structural steel
- 1,200+ Equipment tag items
- 120,000 meters of piping (1,700 line nos.)
- Plant capacity: 110,000 tons per day
Grinding Circuit & Slurry Discharge
Grinding Circuit & Slurry Discharge
Large, 24-Hour Concrete Pour at 10,500 foot elevation
Flotation Circuit & Moly Plant
Flotation Circuit