# Engineering, Procurement and Construction (EPC) Projects

## Opportunities for Improvements through automation

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# 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

**COORDINATION**

**PROCUREMENT:**

- Parsed MTO
- ROS Dates
- Prioritization
- Mat'l Receipt/Release

**CONSTRUCTION:**

- Parsed MTO
- Work Scope Packaging
- Resource Management
- Progress Tracking

# 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

- General Const. Plan
- Site Layout Plan
- Temporary Facilities

- Geo-Tech
- Mass Earth-Works
- Structural Concrete
- Structural Steel

- Equipment (mech. & elec.)
- Piping
- Raceway
- Instrumentation & Controls

- System Turn-over
- Start-Up & Commissioning
- Performance Run
- Turn-Over to end-user

Note: Construction is supported by Field Engineering

# Inter-Functional Coordination

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

Must devise a data exchange key

**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

# 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”

| ACTIONS | BY WHO |
|---|---|
| SPECIFY & DESIGN | Engineering |
| APPROVE & ISSUE | Engineering |
| PROCURE | Procurement |
| FABRICATE,  TEST | Fabricator / Supplier |
| INSPECT & SHOP RELEASE | Procurement |
| EXPEDITE / SHIP / RECEIVE | Procurement |
| WAREHOUSE / RELEASE | Procurement |
| WITHDRAW and STAGE | Construction |
| ERECT / INSTAL | Construction |
| INSPECT  / ACCEPT | Field Engineering |

**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

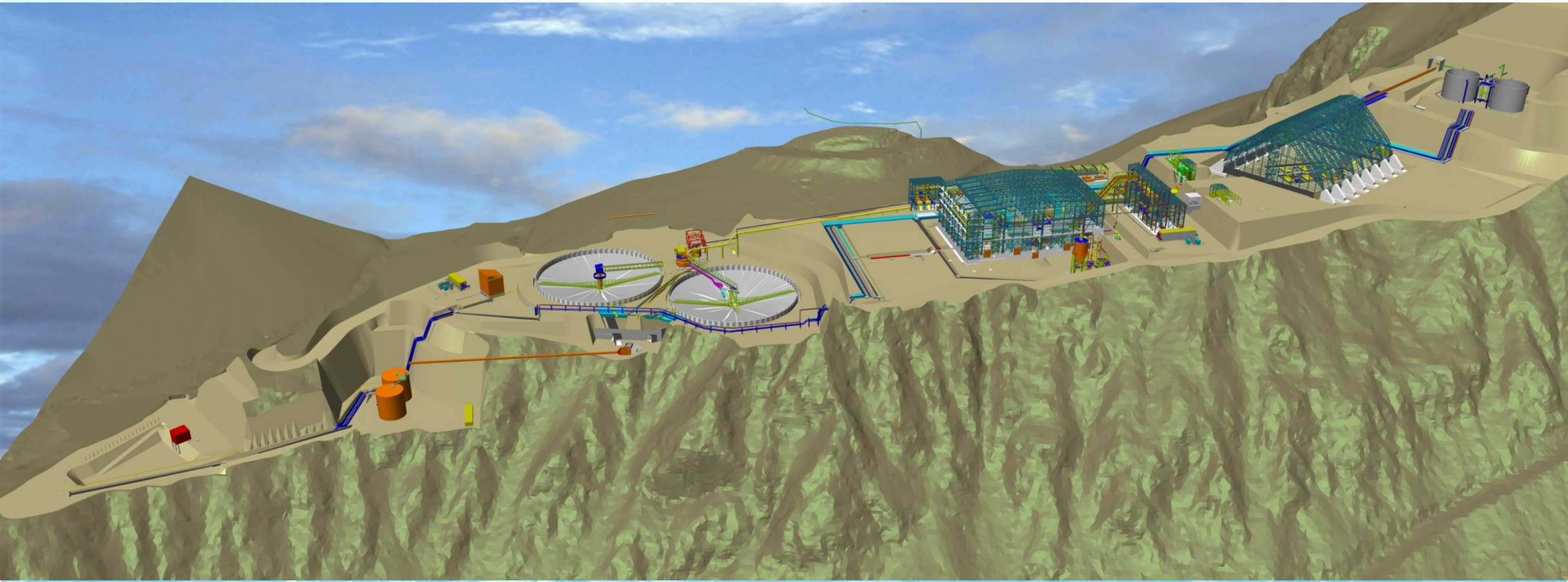
# A Case Study EPC Project

## 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

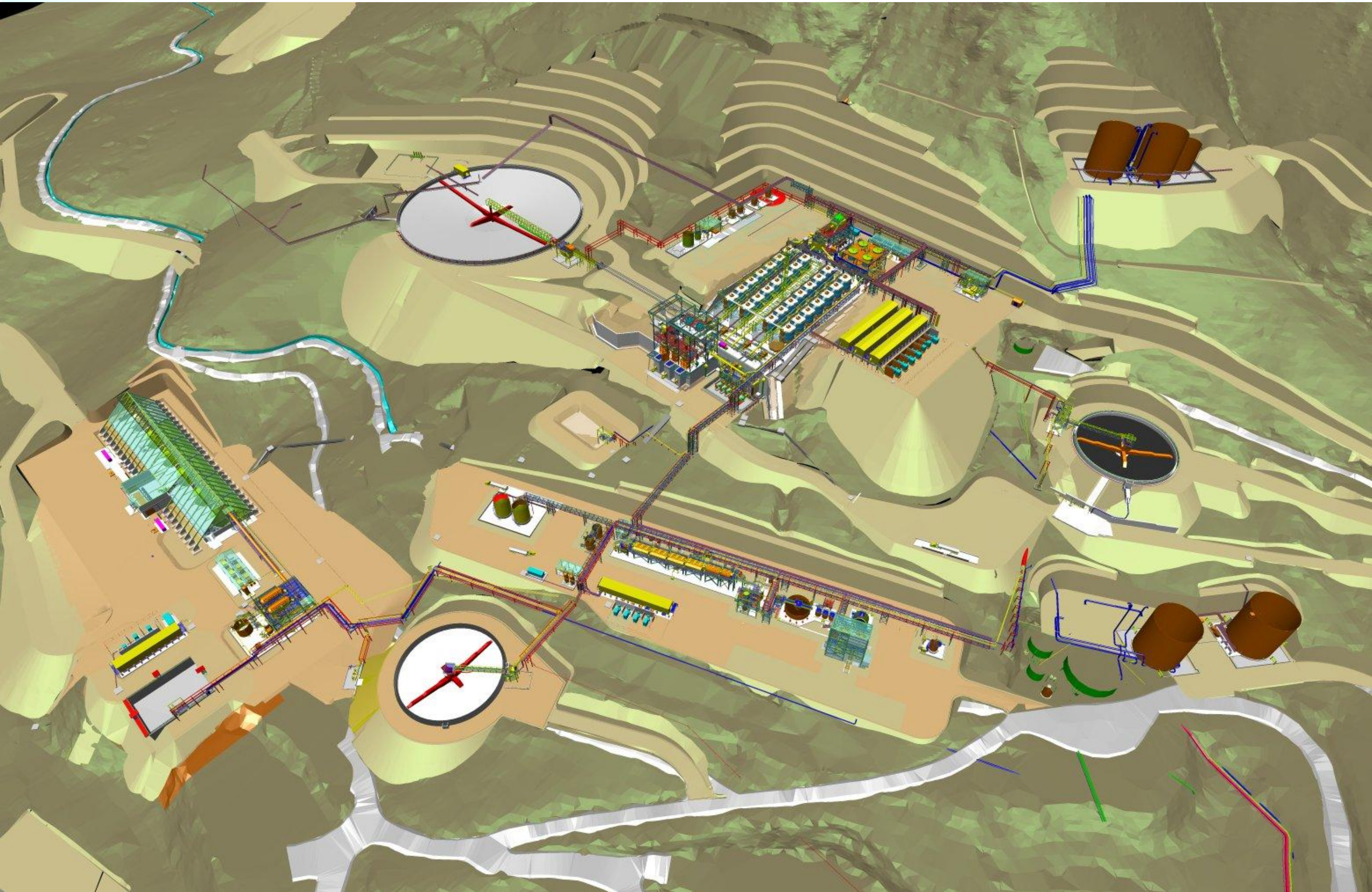
# Grinding Circuit & Slurry Discharge



# Grinding Circuit & Slurry Discharge

# Large, 24-Hour Concrete Pour at 10,500 foot elevation

# Flotation Circuit & Moly Plant




Flotation Circuit


Q & A