CAN INDUSTRY 4.0 IMPACT PROJECT EXECUTION?

Rice Annual Forum
Amish Sabharwal, EVP Americas, AVEVA

November 14, 2017 | Version 1
Industry 4.0

1st Industrial Revolution
Steam

2nd Industrial Revolution
Assembly Line

3rd Industrial Revolution
Automation

4th Industrial Revolution
Digitalization
WHAT DOES DIGITALIZATION MEAN?

“Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities”
-Gartner
DEMOGRAPHICS

400 senior decision makers with responsibility or involvement in software purchasing decisions were interviewed in August and September 2017, split across the below sectors and countries...

Chemicals/petrochemicals - US, Singapore, Russia, Netherlands, Germany, Belgium
Pharmaceuticals - US, Ireland, UK, South Africa, France, Belgium, Switzerland, Germany
Mining – US, South Africa, Australia, Russia, Ukraine, Chile, Peru
Power generation - US, Canada, UK, Germany, Japan, China, France
Pulp and paper – US, Canada, Finland, Sweden, Brazil, Russia

Figure D1: “Within which primary sector is your organisation?”, asked to all respondents (400)
Overall, across all sectors surveyed, plant digitalisation is most likely to be seen as the number one/top priority (26%) compared to other areas of digital transformation.

**Figure 2:** Analysis showing the percentage of respondents who report that each of the above digitalisation initiatives are the number one/top priority for their organisation, asked to all respondents (400).

**Figure 3:** Analysis showing the percentage of respondents who report that plant digitalisation is the number one/top priority or a high priority for their organisation, split by sector, asked to all respondents (400).
DIGITAL TECHNOLOGIES OFFERING THE GREATEST OPPORTUNITIES TO EXPLOIT

Cloud: 27%
Intelligent information management: 20%
Robotic process automation: 10%
IoT: 10%
Advanced analytics: 8%
Drones: 6%
Sensors: 5%

Figure 25: Analysis showing the top seven most commonly reported digital technologies that offer the greatest opportunity to exploit, split by sector, asked to all respondents (400)

Cloud and intelligent information management are top priorities!
INTELLIGENT INFORMATION MANAGEMENT
PLANT OPERATIONS PERSPECTIVE

Asset Real Time Data
- Transactional data
- Real / near time feeds
- Sensor data (IoT)
- Operational technology (OT)

Operational Insight

Engineering Master Data
- Non-transactional data
- Engineered lifecycle data
- Authored in AVEVA tools
- DAaaS

Asset Master Data
- Non-transactional data
- Vendor / catalogue data
- SPIR / Procurement
- EAM Maintenance / APM
IOT IS ALL ABOUT REAL TIME OPERATIONAL INFORMATION
WHAT ABOUT ENGINEERING INFORMATION?
ENGINEERING INFORMATION

3D Models
Shop Drawings
Laser Scans
3D Models
Isometrics
P&IDs
2D
Line Lists
Instrument Index
Datasheets

1D

Status information / Maturity
Relationships / Context
THE PROBLEM?

Document Centric

EPC

HANDOVER

Owner
EPC 4.0

Drafting Table  CADD (PDMS)  Global Execution  Digital Asset
Your proposal is Innovative. Unfortunately, we won’t be able to use it because we’ve never tried something like this before.
EPC 4.0
ASK YOURSELF…

➢ Can we propagate engineering and design changes quickly and reliably across all disciplines?
➢ Can we incorporate late changes to design with minimal impact to execution?
➢ Can we quickly and reliably recalculate TIC as the design changes?
➢ Can we incorporate additional cost reduction cycles without impacting schedule?
➢ Do our projects pass over from good ideas that are too late?
➢ Can we reliably and automatically produce engineering and construction deliverables from your source tools?
➢ Do we resort to offshore “value” centers (EPC 3.0) to produce deliverables?
False confidence

Why does "business as usual" lead to additional 2.4% cost of total project budget?
TYPICAL PROJECT COST BREAKDOWN

- 40% Procurement
- 40% Construction
- 10% Engineering & Design
EXAMPLE OF EPC DATA CHALLENGE

Key to Status/Lifecycle Maturity

- Issued
- Working
- On Hold
- In Consistency
WORK PROCESS

Change of one single Temperature value

Pipe stress calcs need to be re-assessed

Pipe has now become safety critical

P&IDs need to be updated and re-issued

Different Instrument arrangement needed

Wrong piping/equipment specs to suppliers

Re-ordering

Equipment Datasheets need to be updated and re-issued

Insulation needs to be added

Spec Change

Insulation clashes

Planning is no longer valid

Wasted materials

Rework

Delays

Cost Overrun

Company reputation
ENHANCING QUALITY AND COMPLETENESS OF DESIGN DELIVERABLES

Jeyoung Woo, M.S.
The University of Texas at Austin
THE MOST PROBLEMATIC DELIVERABLES

1. FEED (Front-End Engineering Design) Validation Deliverables
2. Level 3 Baseline Schedule
3. Constructability Inputs
4. P&IDs (Piping & Instrumentation Diagrams)
5. Equipment Specifications & Data Sheets
6. Maintainability Inputs
7. Vendor Data
8. 3D Model (& Clash Detection)
9. Piping Routing and Isometrics
10. Nozzles, Ladders, and Platform for Towers/Vessels/Tanks
11. Miscellaneous Pipe Support Drawings

This information is based on the research outputs by Research Team 320 supported by the Construction Industry Institute.
The industry survey (N=36) identified 798 common defects associated with the 11 problematic deliverables. RT-320 consolidated and aggregated these common defects, developing a list of 73 significant design deliverable defects (6.63 defects per deliverable on average). Among the 73 defects, 24 percent pertain to completeness, 60 percent pertain to correctness, and 16 percent pertain to timeliness.
• **Cost of Rework** (Hwang et al. 2009)
  - 5.4% of total construction cost
  - Leading cause = Design Errors/Omissions!

### Case for Action (1/2)
- Direct Cost of Rework (2014)
  - ~ $75 billion/year
- **Cost of Rework** (Hwang et al. 2008)
  - 5.4% of total construction cost
  - Leading cause = Design Errors/Omissions!
- Average Cost of Design Errors (Lee et al. 2014)
  - 14.2% of Contract value
  - Direct + Indirect

### Pie Chart
- 40% Procurement
- 40% Construction
- 10% Miscellaneous
- Engineering & Design
AVERAGE COST OF ENGINEERING ERRORS

14.2% of contract value
Direct + Indirect

(Love et al. 2014)

This presentation is based on the research outputs by Research Team 320 supported by the Construction Industry

Procurement: 40%
Construction: 40%
Engineering & Design: 10%
Miscellaneous: 10%
### TYPICAL WBS HIERARCHY

<table>
<thead>
<tr>
<th>E</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>Procurement</td>
<td>Commissioning</td>
</tr>
<tr>
<td>Area</td>
<td>Area</td>
<td>Area</td>
</tr>
<tr>
<td>Phase (FEED)</td>
<td>Phase (Detail Design)</td>
<td>Seawater Cooling</td>
</tr>
<tr>
<td>Area</td>
<td>Area</td>
<td>Chill Water</td>
</tr>
<tr>
<td>Sub-Area (Initial Design)</td>
<td>Sub-Area (Initial Design)</td>
<td>Ballast</td>
</tr>
<tr>
<td>Tasks</td>
<td></td>
<td>System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Item P-201</td>
<td>Item V-205</td>
<td>Equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instrumentation &amp; Controls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Item P-201</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Item V-205</td>
</tr>
</tbody>
</table>

- **Tasks**: P-201, V-205
- **Phases**: FEED, Detail Design
- **Systems**: Seawater Cooling, Chill Water, Ballast
- **Items**: P-201, V-205
- **Procurement Items**: Long Lead Equipment, Project Materials, Mech Equip, Electrical Equip, Instruments, Pump PO, Vessel PO, Fabricated Items
- **Commissioning Systems**: Seawater Cooling, Chill Water, Ballast
REALITY – WBS ARE RELATIONAL
THE DATA CENTRIC PROJECT APPROACH

- Plan to manage complex Engineering Information in a relational not hierarchical way
- Go beyond technical data, captures data maturity, status and relationships
- Leverage a data authoring and storage system for Engineering Information that provides “single points of truth” for all data consumers
- Auditable/Traceable records of changes
- Generate Documents/Lists/Drawings from the data
- Allows data consumers to view data to meet their needs without creating new documents
- 24/7 information access – avoid lags in sharing discreet pieces of technical information
AFFECTED OBJECTS LOCKED DOWN

Key to Status/Lifecycle Maturity:
- Issued
- Working
- On Hold
- In Consistency
CHANGE PROPAGATED TO AFFECTED OBJECTS

Key to Status/Lifecycle Maturity:
- Issued
- Working
- On Hold
- In Consistency
ENGINEERING ITEM RE ISSUED AND ALL OTHER OBJECTS UPDATED.
Lists and Datasheets are all aligned with 3D models and schematics, ensuring quality deliverables.

Avoiding procurement errors and delays.

Avoiding rework in construction.
IMPACT OF AVEVA’S EPC 4.0 STRATEGY

- Engineering
- Concept, FEED, Detail Design
- Procurement
- Fabrication/Construction
- Advanced Work packaging
- Workface Planning
- Materials Management
- Commissioning and Startup

<table>
<thead>
<tr>
<th>Data Centric Approach Saving Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of TIC</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Engineering</td>
</tr>
<tr>
<td>Procurement</td>
</tr>
<tr>
<td>Tagged Items</td>
</tr>
<tr>
<td>Bulks</td>
</tr>
<tr>
<td>Field Contract Mgr</td>
</tr>
<tr>
<td>Fab/Constr</td>
</tr>
<tr>
<td>Fab</td>
</tr>
<tr>
<td>Constr</td>
</tr>
<tr>
<td>C&amp;SU</td>
</tr>
<tr>
<td>Owners Costs</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
AVEVA’S EPC 4.0 STRATEGY

CONSTRUCTION/PRODUCTION MANAGEMENT

MATERIAL MANAGEMENT

FABRICATION

PROCUREMENT

DESIGN

ENGINEERING

ASSET MODIFICATIONS

1D

3D

2D

Engineering Information

Standards

Documents

OPERATIONAL READINESS

ENTERPRISE ASSET MANAGEMENT

ASSET PERFORMANCE & RELIABILITY

ASSET SAFETY & COMPLIANCE

Tag: P-101

Copyright © 2015 AVEVA Solutions Limited and its subsidiaries. All rights reserved.
Digital Fleet Vision

- ENG Engineering
- E3D Everything 3D
- SMM Simulation
- P&ID Process
- AI AVEVA Instrumentation
- PE Process
- AE AVEVA Electrical

- Draw
- ISO
THE IT’S NOT JUST ABOUT TECHNOLOGY

10% Savings is enabled by technology

Enables Development of Work/Business Processes

Training

Enables Development

Technology

Processes

People
We are answering the need for efficiency from capital intensive industries.

Capital investment constraints: need to maximize utilization and efficiency of existing assets

- **Project phase 2-6 years (1/3 of project spend)**
  - Process Design
  - Plant Design
  - Build & Upgrade

- **Operations phase up to 50 years (2/3 of project spend)**
  - Operate and Maintain
  - Plant & Asset Optimization

Segmented Engineering
- Manual process
- Cost & time
- Inefficiencies

Asset Lifecycle Management Gap
- Manual process
- Data complexity
- Inefficiencies
To learn more about how AVEVA can help you execute projects more efficiently, visit http://www.aveva.com/en/Contact/

linkedin.com/company/aveva
@avevagroup

About AVEVA

AVEVA software and services enables our customers to solve the world’s most complex engineering and design challenges. Discover how we can help you redefine engineering possibilities to successfully create and manage world-class capital-intensive assets. Headquartered in Cambridge, England, AVEVA employs more than 1,600 staff in 50 offices around the world.

aveva.com