Facility 3D Model Value throughout Lifecycle

USPI FL3DMS Business Case Team

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Version 1.0

Facility 3D Model Lifecycle Management Gap

3D Models are typically created in the concept through design phases, then used during fabrication, construction, and mechanical completion of a physical facility

After the transition from project phase to operating of a facility, the native 3D model/data is rarely maintained and often not used to its full potential

How much economic value is lost by not using 3D Model during operations?

How much economic value is lost by not standardising 3D model development?

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Executive Summary

Background

- A facility 3D model adds significant value during optimisation of lay-outs enabling reduced wasted space and ensuring access/serviceability of systems
- A facility 3D model can support many post start up use cases such as early production planning, brownfield modifications, replication, turnarounds
  - A 2017 survey by IOGPs ISSC identified that these use cases are often not realised
- This business case development effort seeks to understand use cases for facility 3D model management and their associated value potential

Steps to develop the business case

1. Identify 3D model use cases
2. Assess savings-potential per use case
3. Calculate overall business case based on value pockets at various stages of detailed design, construction, operations, modification, or maintenance of a complex process facility

Executive Summary

Findings

- Industry standardisation of 3D model development and associated data can reduce the cost of design and construction activities
- Keeping facility 3D models As-Built over the asset lifecycle can significantly reduce Repairs/Maintenance/Brownfield engineering costs
- Operating expenses & Brownfield projects represent 2/3rd of the total cost of ownership over the asset lifecycle – 3D models can help reduce these costs
- The unrealised value of the facility 3D model is between 0.8% - 2.3% of the asset lifecycle cost (CAPEX & OPEX)
- Standardisation is a key enabler of the value pockets within the use-cases

Recommendations

- Owner-operators should specify the FL3DMS standard to contractors to realise maximum value generated from facility 3D models
- Design contractors and owner-operators should work closely together to create a quality facility 3D model that enables the many lifecycle use cases
- The supply chain partners should work together to further develop FL3DMS ensuring it can provide maximum value
- Owner-operators who want to reduce costs should consider a corporate policy of maintaining facility 3D Models As-Built for the full asset lifecycle

Why develop a 3D model business case?

An IOGP ISSC survey in 2017 of 10 owner-operators investigated current use of 3D models. Conclusions:

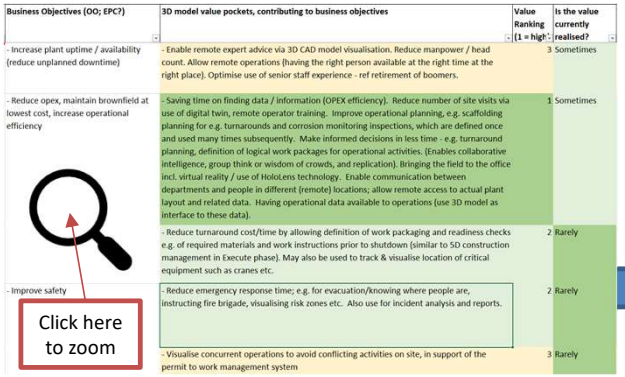
1. *3D models are created on all major capital projects to enable design and procurement. Opportunities to derive value from 3D models in subsequent projects & operations are often overlooked. Key barriers are standards and processes.*
   - ***Question: Is there a business case for keeping 3D model as-built for the asset lifecycle?***

2. *Lack of standardisation of 3D models causes integration issues, especially for packaged equipment. It also is a hindrance to other use cases such as advanced work planning and corrosion management.*
   - ***Question: What are the lifecycle use cases for 3D models?***
   - ***Question: How much economic value is lost by not realizing all lifecycle use cases?***
   - ***Question: Which uses cases are enabled by standardization of 3D models?***

The FL3DMS business case team set out to address the questions raised by the IOGP survey with the objective to identify key use cases yet to be realised to work smarter and increase the economic value of projects & assets.

How was the business case developed?

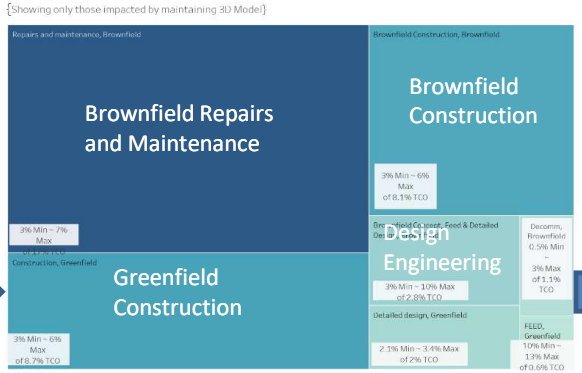
1. Identify 3D model use cases (40 in total) & standardisation opportunities



Business Objectives (OO; EPC?)	3D model value pockets, contributing to business objectives	Value Ranking (1 = high)	Is the value currently realised?
- Increase plant uptime / availability (reduce unplanned downtime)	- Enable remote expert advice via 3D CAD model visualisation. Reduce manpower / head count. Allow remote operations (having the right person available at the right time at the right place). Optimise use of senior staff experience - ref retirement of boomers.	3	Sometimes
- Reduce opex, maintain brownfield at lowest cost, increase operational efficiency	- Saving time on finding data / information (OPEX efficiency). Reduce number of site visits via use of digital twin, remote operator training. Improve operational planning, e.g. scaffolding planning for e.g. turnarounds and corrosion monitoring inspections, which are defined once and used many times subsequently. Make informed decisions in less time - e.g. turnaround planning, definition of logical work packages for operational activities. (Enables collaborative intelligence, group think or wisdom of crowds, and replication). Bringing the field to the office incl. virtual reality / use of HoloLens technology. Enable communication between departments and people in different (remote) locations; allow remote access to actual plant layout and related data. Having operational data available to operations (use 3D model as interface to these data).	1	Sometimes
	- Reduce turnaround cost/time by allowing definition of work packaging and readiness checks e.g. of required materials and work instructions prior to shutdown (similar to 5D construction management in Execute phase). May also be used to track & visualise location of critical equipment such as cranes etc.	2	Rarely
- Improve safety	- Reduce emergency response time; e.g. for evacuation/knowing where people are, instructing fire brigade, visualising risk zones etc. Also use for incident analysis and reports.	2	Rarely
	- Visualise concurrent operations to avoid conflicting activities on site, in support of the permit to work management system	3	Rarely

Click here to zoom

2. Understand the plant lifecycle cost breakdown by phase

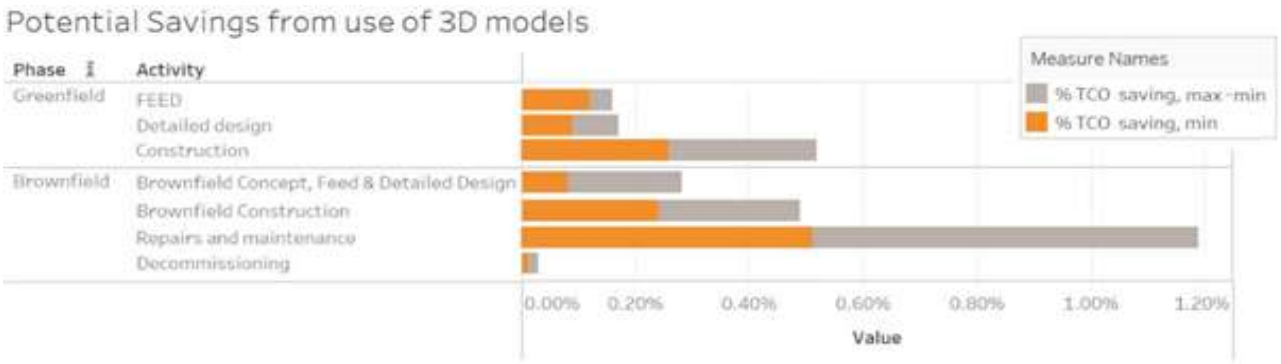


3. Identify savings-potential per use case

Use case	Phase	Min	Max
• Reuse of 3D model from FEED phase is not common practice • Standardisation status and maturity of 3D models is key to data being available when needed	FEED	0.12%	0.16%
• Automation of design, auto-routing of pipes and cables, generation of drawings and fabrication spools (requires proper integration of supporting tools), etc. • Reduced schedule and engineering manhours.	Detailed Design	0.02%	0.04%

EXAMPLE

4. Calculate 3D business case per lifecycle activity



Lifecycle Cost Breakdown of a typical facility

Cost Split as % of Total Cost of Ownership	From	To	Mean	Notes/Actions
CAPEX Lifecycle split	**25%**	**50%**	**34.8%**	Add narrative on how we got here and assumptions
- Greenfield			17.4%	e.g. different asset types and design philosophies
- CONCEPT Engineering Phase (Pre-FEED)			0.3%	
- FEED				
- Detailed Design				
- Procurement				
- Construction				
- Brownfield				
- CONCEPT Engineering Phase (Pre-FEED)				
- FEED				
- Detailed Design				
- Procurement				
- Construction				
- Decommissioning/ Abandonment				
- CONCEPT Engineering Phase (Pre-FEED)				
- FEED				
- Detailed Design				
- Procurement				
- Construction				
OPEX	**45%**	**82%**	**65.2%**	
- Variable Direct Production Costs (operators, feedstock, energy, consumables etc)			13.7%	
- Repairs and maintenance (staff, ongoing maintenance, turnarounds, inspections, spares)			17.0%	
- Fixed Charges (Depreciation, insurance, rent, financing, royalties)			23.8%	
- Asset Overhead Costs (HSE, storage, food, QC laboratories)			3.6%	
- General Expenses (Administration, Sales and Marketing, R&D)			7.2%	
Total Cost of Ownership			**100%**	

Why maintain the facility 3D model throughout lifecyle?

>80% of the total cost of ownership of a typical facility is incurred after the original project that created the model transitions to operations. Potential value derived from use of a facility 3D model **stops *before* start up** if not maintained into operational phase of the asset lifecyle.

OPEX

~65%

of cost

Results of the business case

Financial benefits – numbers

Phase/Activity		Spend Category %of TCO	Saving in activity min. %	Saving in activity max. %	% TCO saving, min	% TCO saving, max	Notes	Hypothetical average savings at an asset with CapEx of $500 Million
Greenfield	Concept engineering	0.3%	0.0%	0.0%	0.00%	0.00%	Gains already realised, e.g. layout optimisation	$ -
	FEED	0.6%	10.0%	13.0%	0.12%	0.16%	From reuse of FEED 3D model in Detailed Design, using std. catalogue	$ 350,761
	Detailed design	2.0%	2.1%	3.4%	0.09%	0.17%	From easier integration of 3D models from package vendors*	$ 280,978
	Procurement	5.7%	0.0%	0.0%	0.00%	0.00%	Gains already realised, e.g. generation of bill of material	$ -
	Construction	8.7%	3.0%	6.0%	0.26%	0.52%	From AWP with workpackages identified in 3D model	$ 1,956,522
Brownfield	Repairs and maintenance	17.0%	3.0%	7.0%	0.51%	1.19%	From ability to access virtual asset for planning, training, turnaround AWP	$ 4,239,130
	Brownfield Concept, Feed & Detailed Design	2.8%	3.0%	10.0%	0.08%	0.28%	From avoidance of laser scans and redrawing 3D model	$ 906,750
	Brownfield Procurement	5.3%	0.0%	0.0%	0.00%	0.00%	Gains already realised, e.g. generation of bill of material	$ -
	Brownfield Construction	8.1%	3.0%	6.0%	0.24%	0.49%	From AWP with workpackages identified in 3D model	$ 1,819,565
	Other operational costs	48.3%	0.0%	0.0%	0.00%	0.00%	3D model not used to manage these costs	$ -
	Decommissioning	1.13%	0.5%	3.0%	0.01%	0.03%	From avoidance of laser scans and redrawing 3D model	$ 98,913
Full life	Total unrealised value	100.0%			1.31%	2.84%	* Omits value of replication, as this requires more than 3D model standard.	$ 9,652,620

Value from standardising and using the 3D model for the asset lifecycle	1.3% - 2.8% of TCO
Cost of maintaining the 3D model for the full life of the asset	0.5% of TCO
Business case for standardising and using the 3D model for the asset lifecycle	**0.8% - 2.3% of TCO**

TCO = Total asset lifecycle cost, i.e. CAPEX + OPEX

Results of the business case

Project delivery benefits

- Makes life easier – faster integration of packages, replication
- Makes delivery more cost effective (reduced rework, better resource planning)
- Enables advanced work packaging

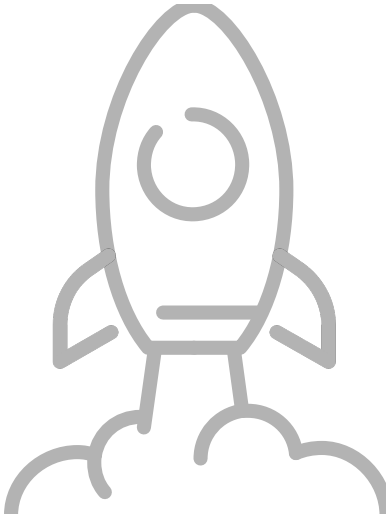
Operations benefits

- Enables remote working - reduces HSSE exposure, costs and time for repairs (unplanned downtime)
- Reduces rework – avoids laser scans and accelerates Brownfield projects
- Facilitates maintenance and integrity management – turnarounds, corrosion isometrics, cathodic protection
- Higher employee satisfaction – training time reduced, consistency, modern workforce demands digital solutions
- Foundation for digital twin integration of supporting IT systems incl. remote monitoring systems
- Economy of scale benefits from standardisation

How to maintain & keep facility 3D models As-Built

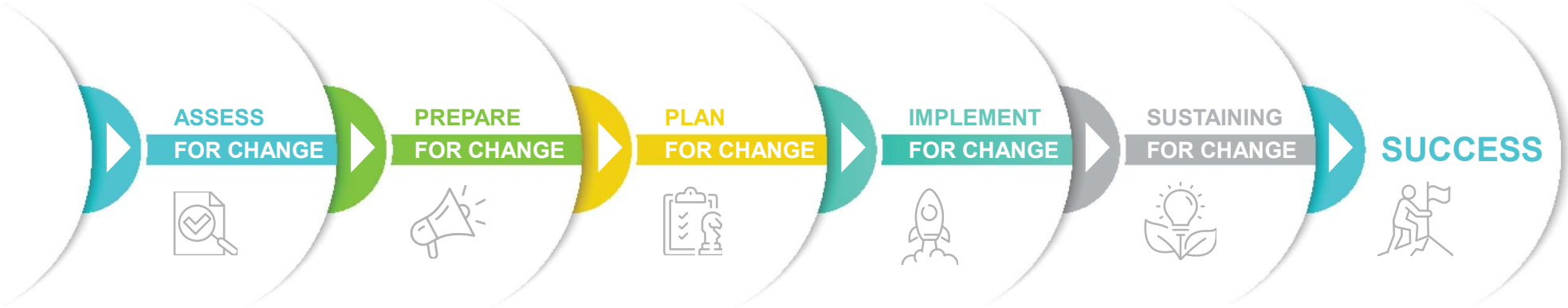
There are several options for maintaining a 3D model as-built during the asset lifecycle:

1. In-house capability to provide engineering and/or manage the MoC process
2. Have contractor(s) provide engineering and/or manage the MoC process
3. A hybrid of options 1 and 2



Change management tasks

Change management



Tasks:

- Ensure that as-built native 3D model data is contractually owned by the owner-operator
- Decide on hosting strategy (internal, (sub-)contractor, software provider)
- Allow editing of 3D model(s) to ensure it is maintained as a single source of truth (SST)
- Establish Management-of-Change procedures to keep model As-Built
- Leverage in-house resources or engineering contractor to manage change
- Provide viewing access to all stakeholders to bring additional value from 3D model usage

FL3DMS Next steps – standardisation and use

- Create commitment to adopt, improve, maintain, continue development of facility 3D model specifications
- Support our organisations to improve stewardship and maintenance of 3D models for the full asset lifecycle
- Bring additional members to USPI FL3DMS to build industry alliance for future development
- Continue to leverage other industries best practices and overcome hurdles in the digital twin space
- Keep the journey roadmap updated and clearly articulate the desired end state
- Support further collaboration and openness in relationship between Owner-Operators, EPC contractors and software providers

FL3DMS 3D Model Business case Asset Lifecycle Value Pockets

Use Cases	Business Objectives (OO; EPC?)	3D model value pockets, contributing to business objectives	Value Ranking (1 = high)	Is the value currently realised?
OPERATE (Digital Twin)	- Increase plant uptime / availability (reduce unplanned downtime)	- Enable remote expert advice via 3D CAD model visualisation. Reduce manpower / head count. Allow remote operations (having the right person available at the right time at the right place). Optimise use of senior staff experience - ref retirement of boomers.	3	Sometimes
	- Reduce opex, maintain brownfield at lowest cost, increase operational efficiency	- Saving time on finding data / information (OPEX efficiency). Reduce number of site visits via use of digital twin, remote operator training. Improve operational planning, e.g. scaffolding planning for e.g. turnarounds and corrosion monitoring inspections, which are defined once and used many times subsequently. Make informed decisions in less time - e.g. turnaround planning, definition of logical work packages for operational activities. (Enables collaborative intelligence, group think or wisdom of crowds, and replication). Bringing the field to the office incl. virtual reality / use of HoloLens technology. Enable communication between departments and people in different (remote) locations; allow remote access to actual plant layout and related data. Having operational data available to operations (use 3D model as interface to these data).	1	Sometimes
		- Reduce turnaround cost/time by allowing definition of work packaging and readiness checks e.g. of required materials and work instructions prior to shutdown (similar to 5D construction management in Execute phase). May also be used to track & visualise location of critical equipment such as cranes etc.	2	Rarely
	- Improve safety	- Reduce emergency response time; e.g. for evacuation/knowing where people are, instructing fire brigade, visualising risk zones etc. Also use for incident analysis and reports.	2	Rarely
		- Visualise concurrent operations to avoid conflicting activities on site, in support of the permit to work management system	3	Rarely
		- Operator training - also staff with no experience at all!	2	Sometimes
		- Demonstrate regulatory compliance based on actual information. E.g. knowing operational service, corrosion and design data for an pipe	3	Rarely
	- Reduce Brownfield project CAPEX, e.g. operational engineering costs	- Execute design modifications and plant re-vamps via 3D model. Requires maintenance of the 3D model, however the benefits typically outweigh the costs, as illustrated by the number of service contractors maintaining the 3D models of OOs without this being a formal contractual requirement.	1	Sometimes

Screen shot of business case asset lifecycle value pocket worksheet

EXAMPLE

FL3DMS
LEVERAGING YOUR 3D MODEL

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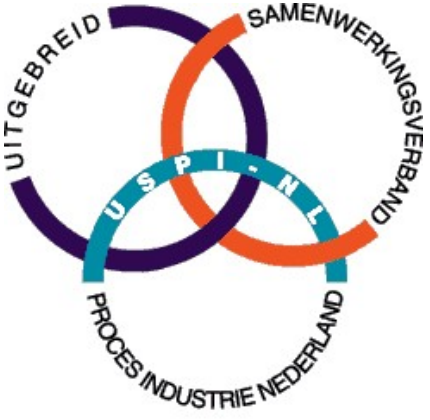
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FL3DMS
LEVERAGING YOUR 3D MODEL

Participants

Owner-Operators: Equinor, BP, ExxonMobil, Shell, Total

EPCs / Contractors: McDermott, Baker Hughes, Technip

Software Providers: AVEVA, Bentley, Hexagon, Talent Swarm

Service Providers: Digital Construction Works (DCW)

MoU Partners: IOGP-CFIHOS (JIP-36), DEXPI

Safety As A Use Case (Video)