Applying Computer-Aided Production Engineering (CAPE)

PPI Annual Symposium

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Two Projects

Greenfield Project

CAPE during Construction

Focus on Pipelines

Brownfield Project

CAPE during Early Engineering

Focus on Cutovers

We will share this with you today

Why CAPE – Our drivers to innovate / look for better ways

What we mean by CAPE – What it is and what it is not

Our journey applying CAPE – Construction and Engineering

What we have learned to date

Why CAPE at TCO?

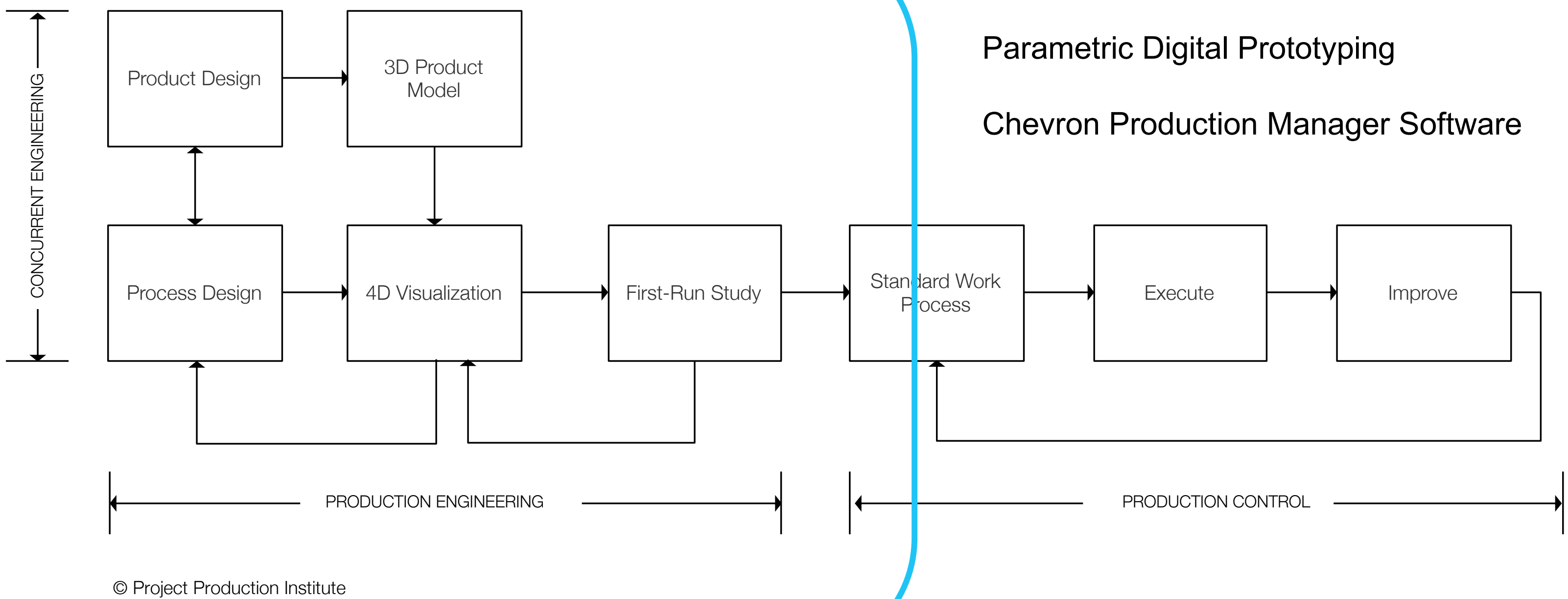
Drive Excellence in Project Performance

Be more effective at handling inherent **complexity and risks** at the execution level

Better define and design **how** we do field operations before we do them

How best to **simultaneously** design the asset and the process to build it and capture lessons learned for future applications

What are we implementing?



Key Enabling Tools

Parametric Digital Prototyping

Chevron Production Manager Software

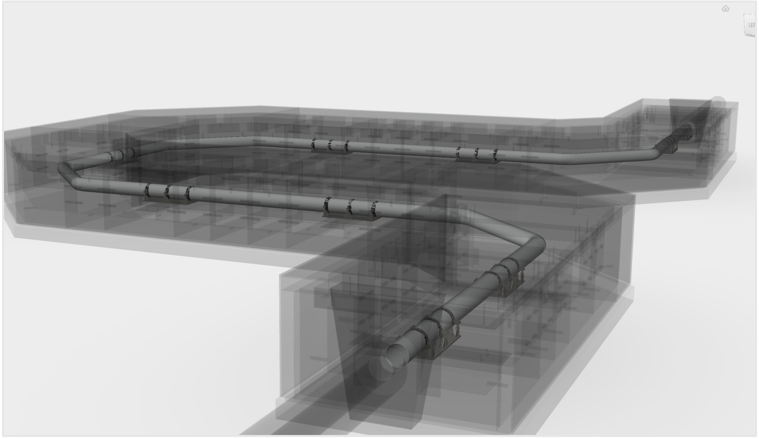
CAPE **IS:**

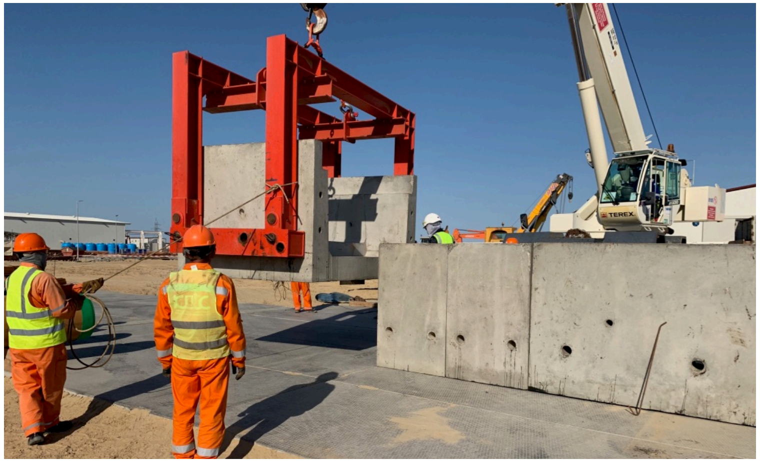
About the design and optimization of field operations that are either repetitive or one-offs (you have only once chance to get it right) during engineering or construction or both

CAPE **IS NOT:**

A constructability review that looks to identify interferences between systems

Our First CAPE Application – 93 Expansion Loops





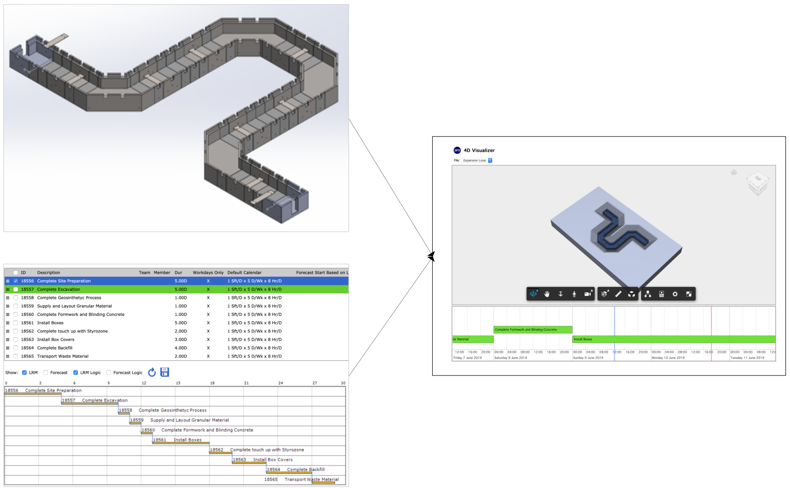
Reduced cycle time by 30%

Reduced $5 M on labor

Identified 9 design issues using the construction digital prototype

Identified 27 Fabrication / Construction improvement opportunities during First Run Studies

Visualizing & Testing the Design of the Process



Install T1 box

Install first T2 box with dowel

Place dowel

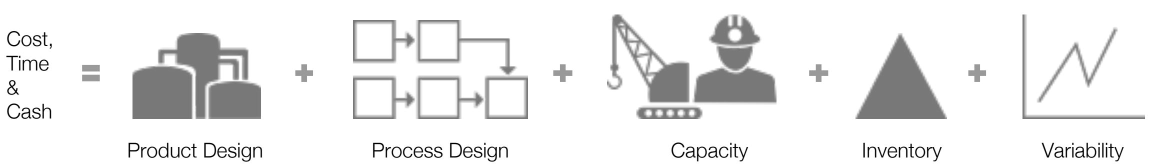
Install second T2 box

Install T3 box

Continue with Box Installation

Digitally in the Computer

Physically before doing it in the Field



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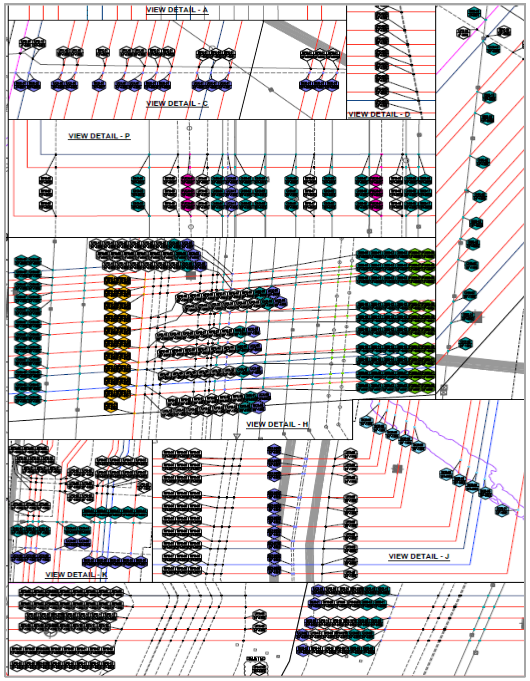
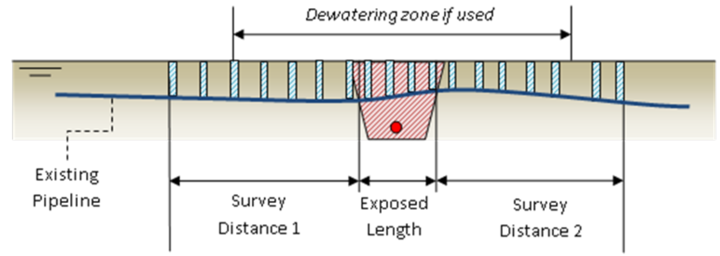
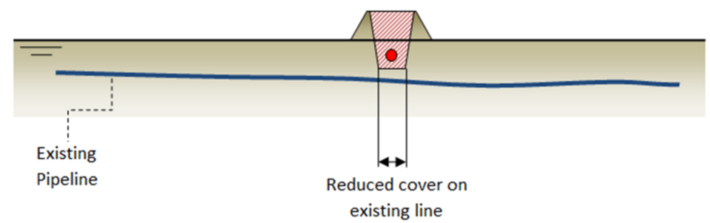
Pipeline Crossings – More than 4000

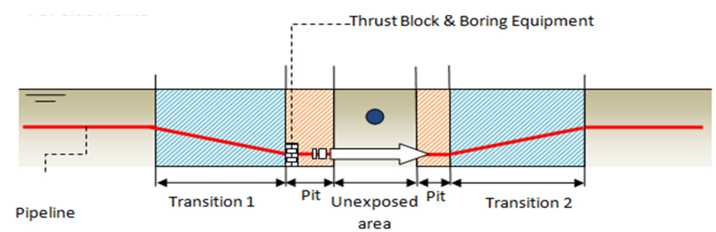




Open Cut



Above Ground



Trenchless

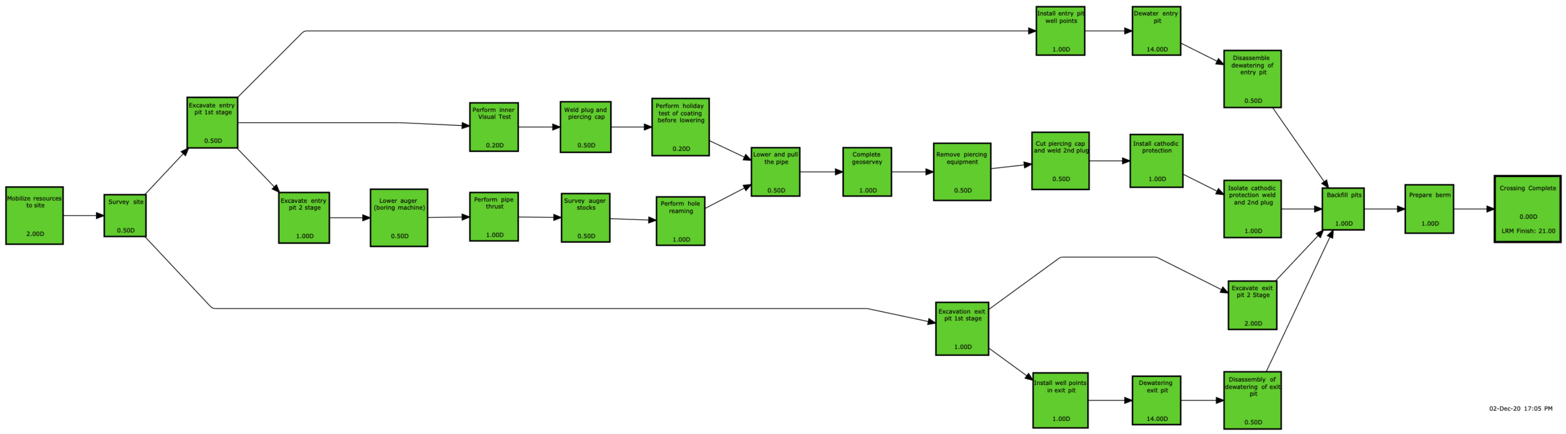
Stringent Specifications and Safety Requirements

Dynamic SIMOPS linked to Operations

Complex high concentration of multiple crossing types co-located in one area

Execution Strategy critical to align with operational shutdown schedule

Analysis of Process Design

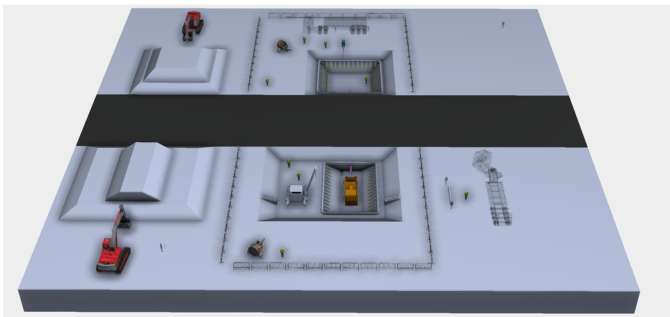


Cycle Time highly variable due to site constraints and execution method

Productivity challenged by dewatering activities and ineffective coordination and planning of shared resources

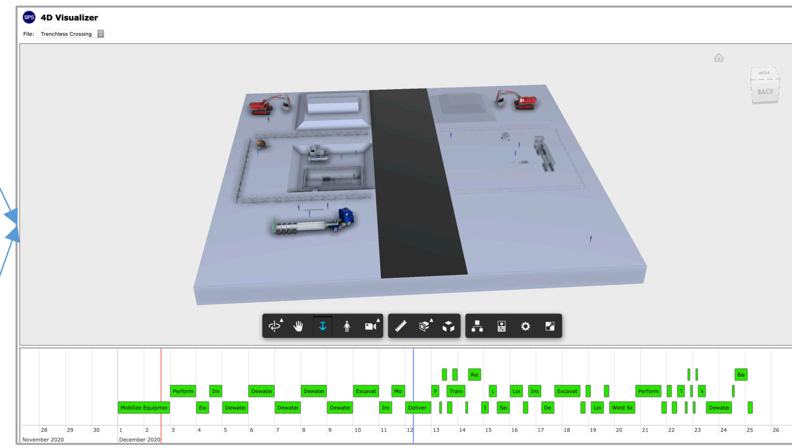
Critical Path scope to complete Pipeline scope

4D Visualization - Is the Process Design Robust / Optimal?

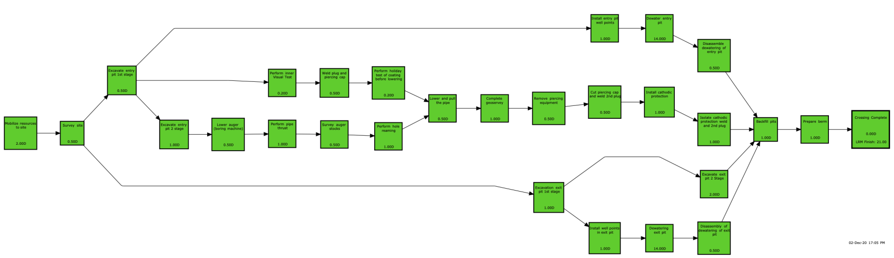


Digital Prototype

(Permanent & Temporary Components)



4D Visualization



Process Design

(Sequence, Handoffs, SIMOPS, etc.)

Executing 690V Cutovers – Applying CAPE During Engineering

~ 2044 690V hot cutovers

30 years old facility / brownfield

Site congestion / live equipment / H2S

Limited personnel onsite - schedule impacts

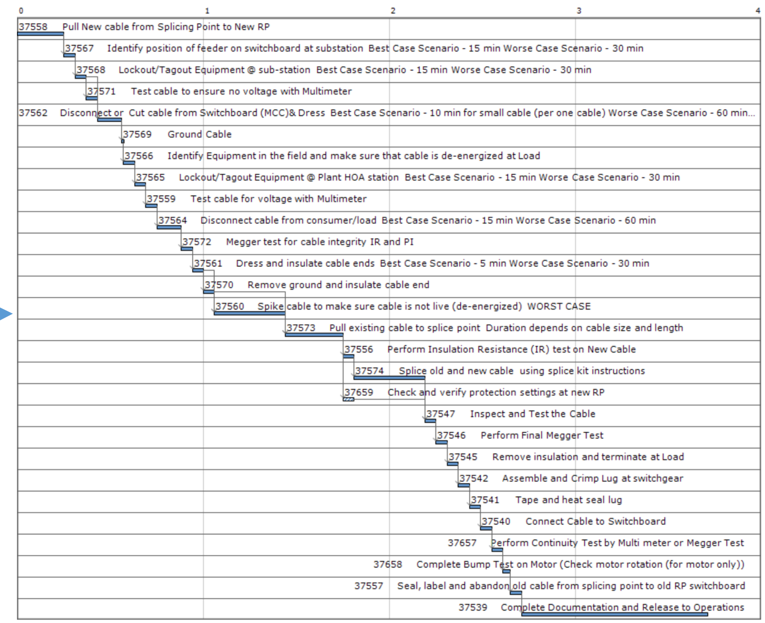
Compatibility between old and new equipment

Weather limitations

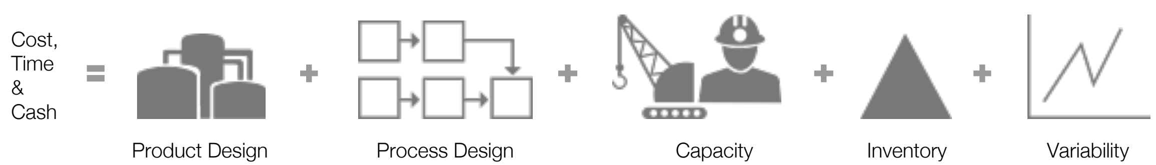
Process Design – **How** to do the work?

#	Sub. #	SWBD#, Circuit #	Cable #	Cable Size	Cable disconnect (min)	Cable pulling out of RP (min)	Cable cut, megger test (min)	Splice kit installation (min)	Final megger test (min)
1	RP-1	SWBD#1, A7-7	03-P-139	3x2.5mm2+1x2.5mm2	30	10	30	30	15
2	RP-1	SWBD#1, A10-3	08-P-106	3x2.5mm2+1x2.5mm2	30	10	30	70	15
3	RP-1	SWBD#2, A4-10	002-P-213	3x150mm2+1x150mm2	30	20	30	180	15
4	RP-1	SWBD#2, B9-4	08-P-211	3x4mm2+1x4mm2	30	10	30	50	15
5	RP-1	SWBD#3, A6-4	07-P-128	3x35mm2+1x35mm2	30	15	30	115	15
6	RP-1	SWBD#3, A4-4	07-P-144	3x70mm2+1x50mm2	30	15	30	130	15
7	RP-1	SWBD#4, B6-5	10-P-102	3x6mm2+1x6mm2	30	10	30	60	15
8	RP-1	SWBD#4, B7-3	02-P-183	3x6mm2+1x6mm2	30	10	30	60	15
9	RP-2	SWBD#1, B4-7	02-P-157	3x2.5mm2+1x2.5mm2	30	15	30	105	15
10	RP-2	SWBD#1, A8-9	04-C-103	7x2.5mm2	30	15	30	100	15
11	RP-2	SWBD#2, A8-10	05-P-228	3x2.5mm2+1x2.5mm2	30	15	30	145	15
12	RP-2	SWBD#2, B7-8	04-P-202	3x70mm2+1x50mm2	30	20	30	140	15
13	RP-2	SWBD#3, A6-2	07-P-221	3x6mm2+1x6mm2	30	20	30	110	15
14	RP-2	SWBD#3, B3-3	07-P-209	3x6mm2+1x6mm2	30	15	30	120	15
15	RP-2	SWBD#3, B6-1	07-P-150	3x2.5mm2+1x2.5mm2	30	25	30	130	15
16	RP-2	SWBD#3, A4-4	07-C-144	5x2.5mm2	30	20	30	125	15
17	RP-2	SWBD#1, B4-7	02-C-157	4x2.5mm2	30	20	30	120	15

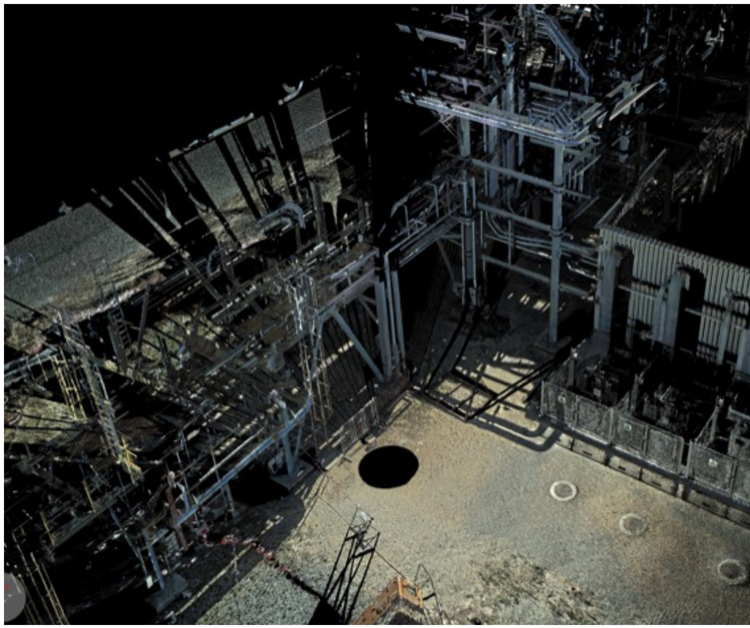
Initial Field Data



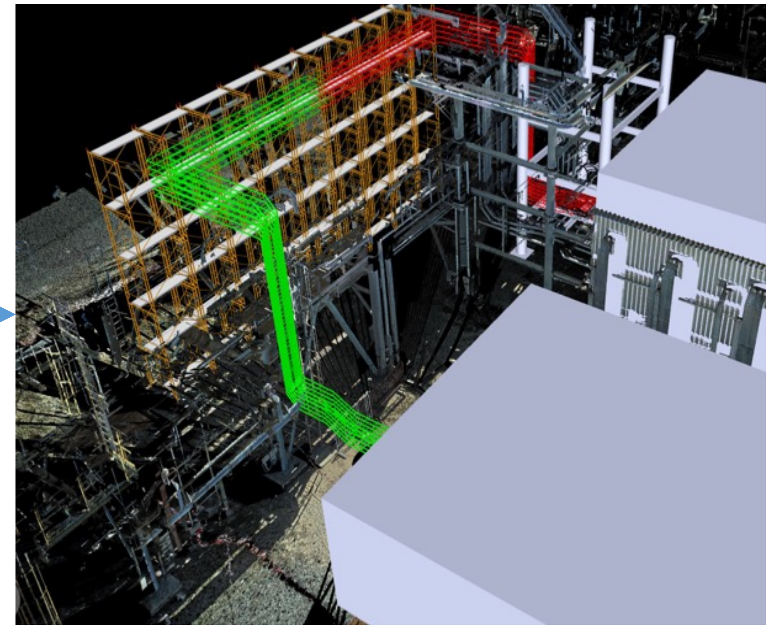
Designing the cutover field operation (**NOT a schedule**)



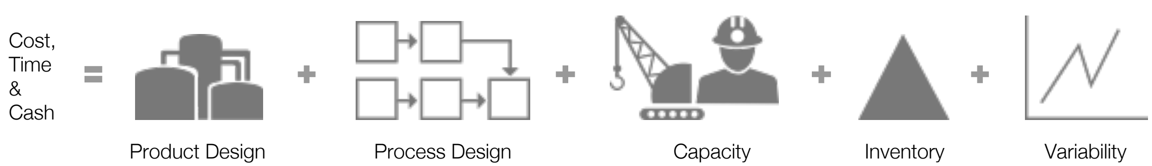
Product Design – Current Conditions & New Asset



Point Cloud – Existing Infrastructure & Conditions



Product Design – Temporary & Permanent Elements



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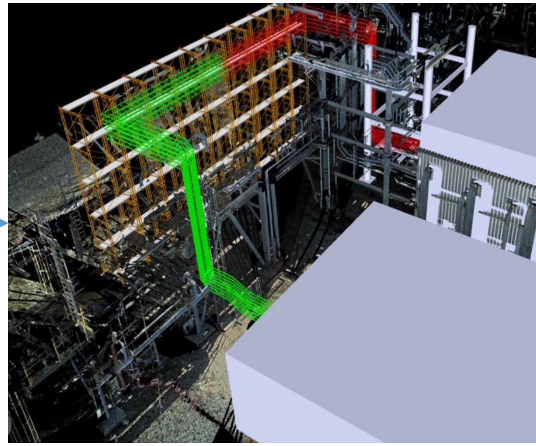
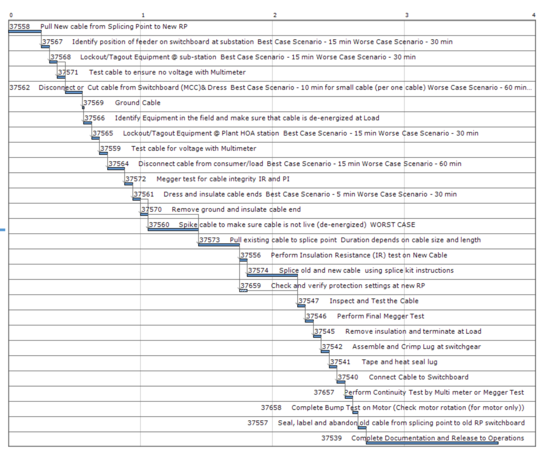
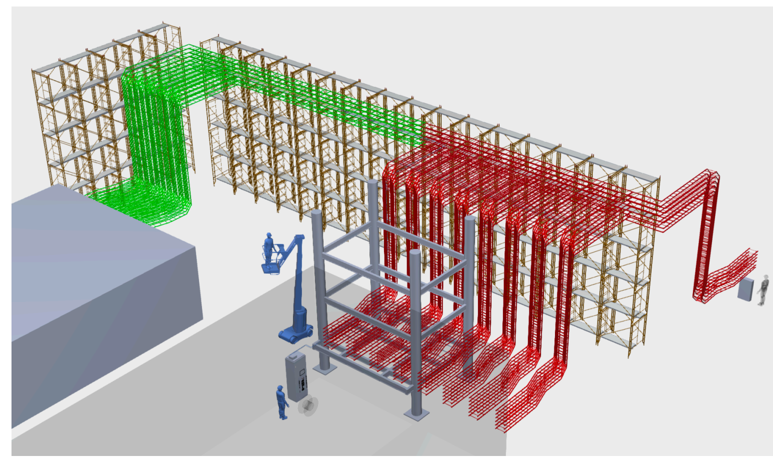
Simultaneous Process / Product Design







What We Are Learning

Enhanced understanding of constraints in the product and process design enables us to focus on the key areas and take the required actions/mitigations to improve execution cycle time, thus increasing throughput

Learnings and experience from current execution reality are now informing the digital model enabling the implementation of improvements and redesigning and testing of the future process before execution

Better understanding of the complexity of a process or workflow to inform early schedule development

Early engagement with engineering maximizes potential benefits to identify and address potential conflicts and omissions

The Implementation of CAPE forces alignment on the process from the start