PROJECT PRODUCTION INSTITUTE

Introduction to Project Production Management

03 December 2019

Welcome

Safety Briefing

Agenda

Topic	Process	When
Welcome, Session Context & Purpose	Present with Q&A for clarification	8:30 – 9:00
Three Eras of Project Delivery	Present with Q&A for clarification	9:00 – 9:30
Production System Dynamics	Simulate & Debrief	9:30 – 10:30
Break	Take	10:30 – 10:45
Production System Dynamics (Cont.)	Simulate & Debrief	10:45 – 12:00
Lunch	Take	12:00 – 1:00
How Leading Organizations are Benefiting	Present with Q&A for clarification	1:00 – 2:30
Break	Take	2:30 – 2:45
How Leading Organizations are Benefiting (Cont.)	Present with Q&A for clarification	2:45 – 4:30
Wrap Up	Key Takeaways, Plus Delta Analysis	4:30 – 5:00

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Case Problem

Read Case Problem and answer questions

Be ready to report out

Case Problem Debrief

Construction matters for the world economy

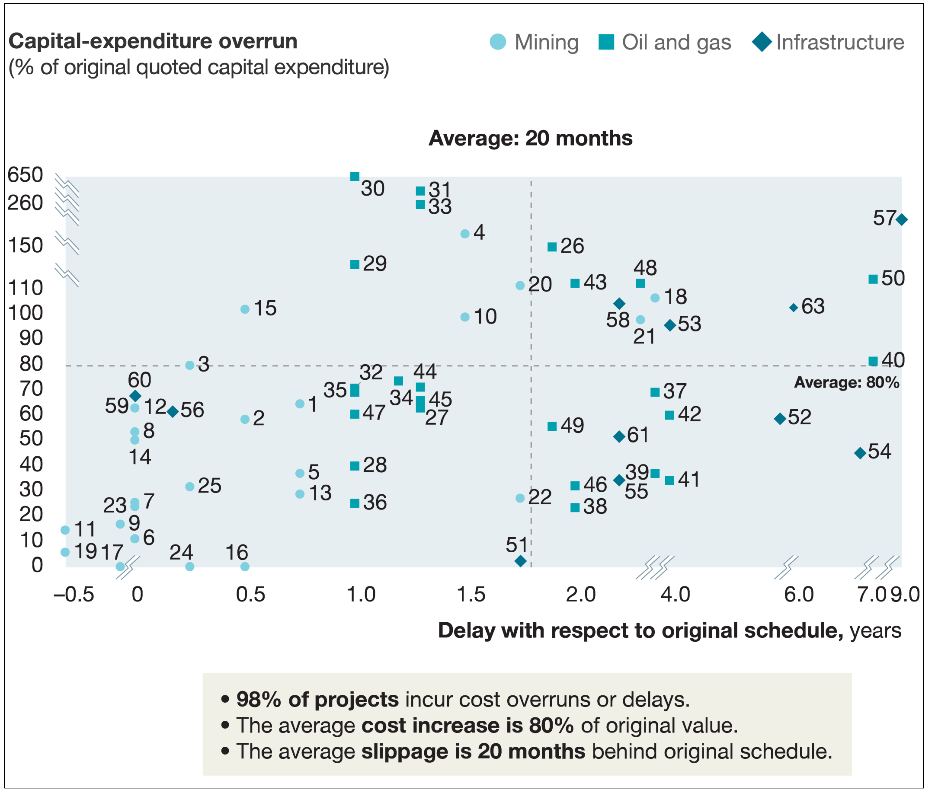
... but has a long record of poor productivity

Construction-related spending accounts for **13%** of the world's GDP

...but the sector's annual productivity growth has only increased **1%** over the past **20 years**

$1.6 trillion **of additional value added** could be created through higher productivity, meeting **half the world's infrastructure need**

McKinsey Global Institute (2017) Reinventing Construction: A Route to Higher Productivity



McKinsey & Company (2013)

Mega-project > 1$B

98% of mega-projects incur cost overruns or delays

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Special Report $68-billion California bullet train project likely to overshoot budget and deadline targets

Ralph Vartabedian • Contact Reporter

OCTOBER 24, 2015, 1:40 PM

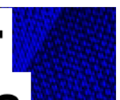
Forbes / Investing

The Little Black Bo

APR 1, 2014 @ 08:35 AM 1,631 VIEWS

Costly Delays In Bringing Up Kashagan Weighing On Oil Companies' Returns

Leaky Locks May Further Delay $5.3 Billion Panama Canal Widening



by Michael D McDonald

October 30, 2015 – 4:00 AM PDT

Last updated: July 17, 2015 8:53 am

South Korean shipbuilders shaken by loss fears

MassDOT: South Coast Rail Plan Now $1.2B Over Original Budget

2016-06-27

Boston Herald (MA)

(LEAD) Daewoo Shipbuilding dips to 7-year low on loss woes

Apple fires Campus 2 contractors as 'spaceship' faces delays, spiraling costs

By AppleInsider Staff
Wednesday, June 10, 2015, 06:45 am PT (09:45 am ET)

THE WALL STREET JOURNAL.
U.S. EDITION

Pre-Fab Nuclear Plants Prove Just as Expensive
Bv Rebecca Smith

Rail recovery plan likely to miss deadline; could project hit $11 billion?

By Gina Mangieri
Published: June 23, 2016, 5:55 pm | Updated: June 23, 2016, 8:14 pm

News / Transportation / I-4 Makeover

Interstate 4 builder's claim: 8-month delay and $100 million over budget

How Berlin's Futuristic Airport Became a $6 Billion Embarrassment

Inside Germany's profligate (Greek-like!) fiasco called Berlin Brandenburg

July 23, 2015

by Joshua Hammer

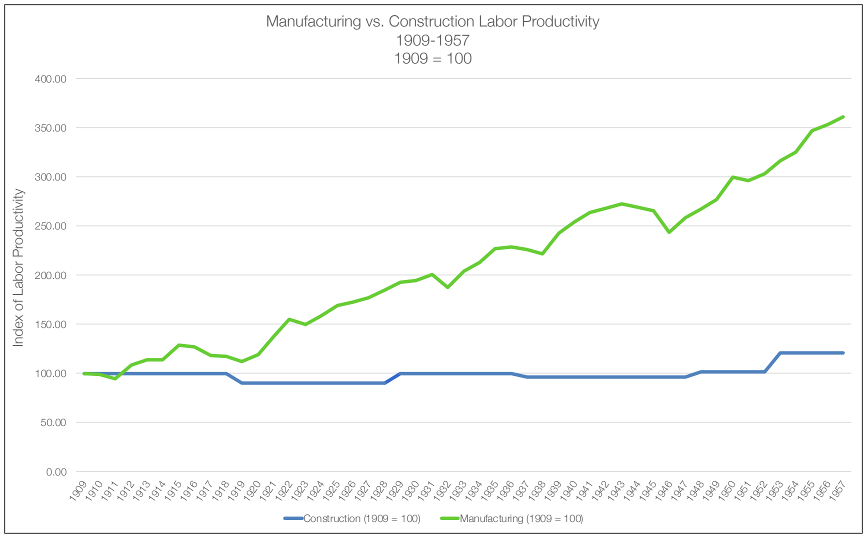
For owners, poor project performance results in loss of revenue, loss of market share, unnecessary use of cash and ultimately reduced shareholder value

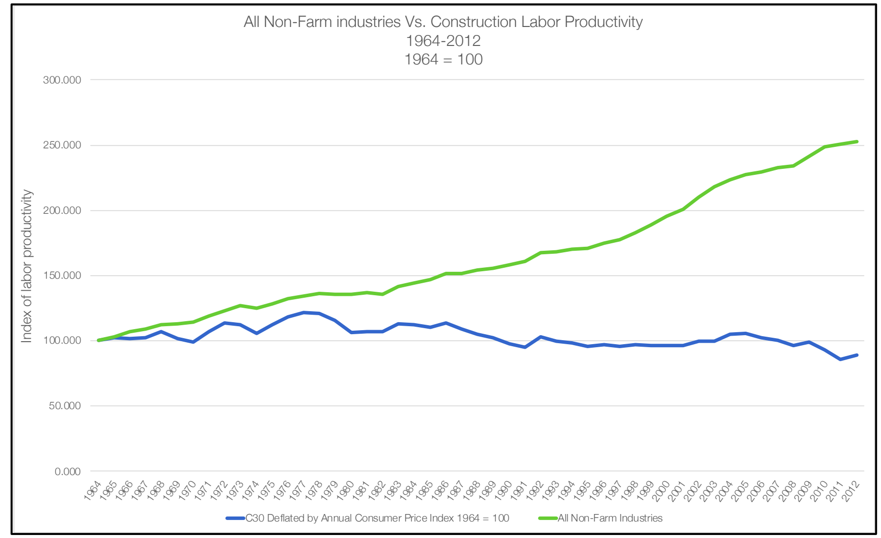
For contractors and suppliers, cost and schedule overruns result in lost opportunity, lost profit and shareholder value, and reputational harm

For investors and underwriters, this loss of value translates directly to less viable and less economic projects which translates into higher risk, lower investment opportunities and reduced growth

Probability of failing is far greater than that of succeeding

How did we get here?





"Productivity Trends in the United States" (1909 = 100)

Paul Teicholz, Stanford University

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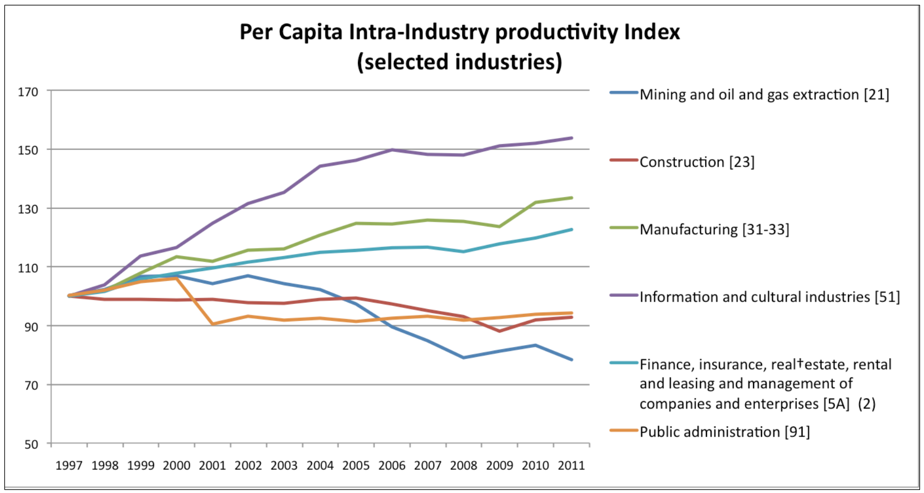
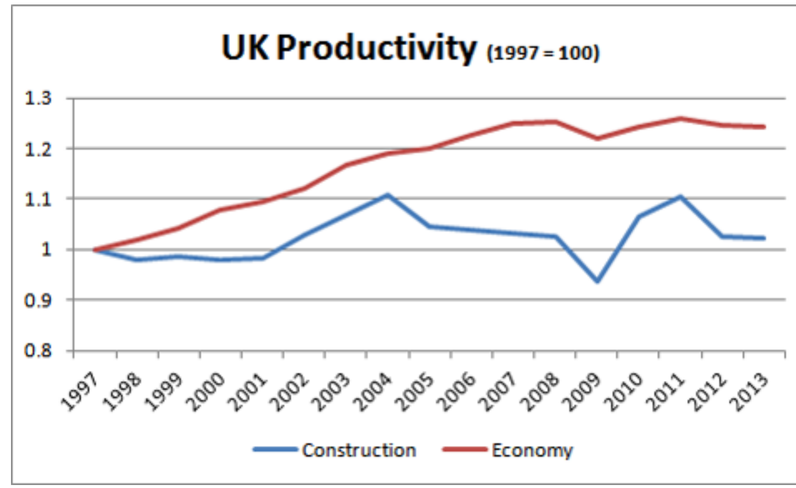


Canadian Organization for Economic Cooperation and Growth



UK Office for National Statistics

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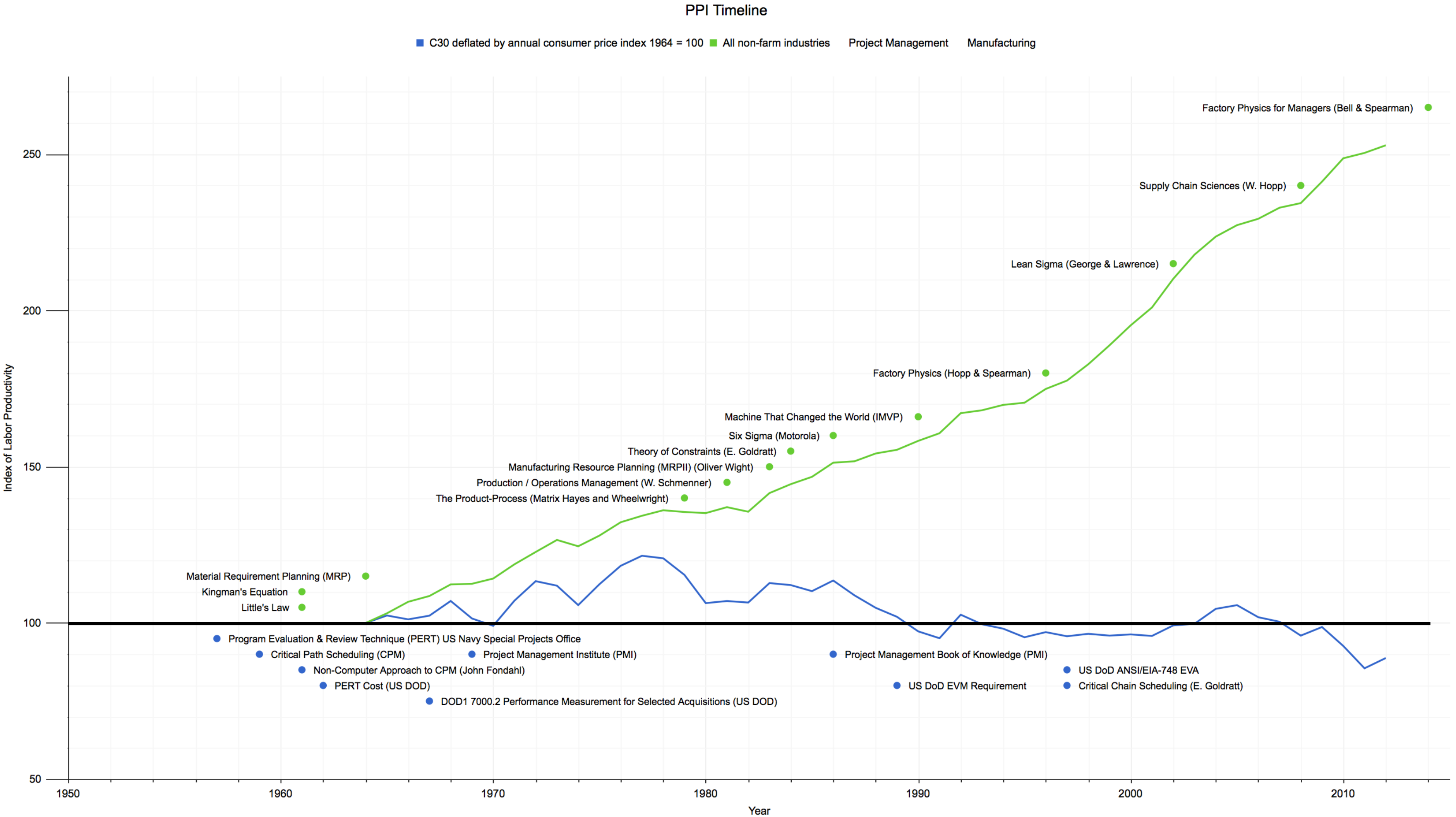
Project Production Institute

The Project Production Institute increases industry awareness and facilitates a shift in thinking in support of the application of Project Production Management theory and methodologies to major capital projects

PPI funds research and disseminates knowledge about the application of operations management and systems theory to the delivery of complex and critical projects



Productivity Data Source: P. Teicholz

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ERA-1 PRODUCTIVITY 1900 - 1950	ERA-2 PREDICTABILITY 1950 –	ERA-3 PROFITABILITY 2000 –
CLASSICAL MANAGEMENT How to get more out of workers?	PROJECT MANAGEMENT How to predict project outcomes through measurement/compliance?	PROJECT PRODUCTION MANAGEMENT How to achieve business objectives with minimal use of resources?
Scientific Management: (Babbage, Taylor, Gilbreths, Hauer, Gantt): Increase productivity through focus on the worker – How to get more out of workers Behavioral Approach: (Follet, Owen, Rothlisberger & Disckson): How to motivate the workers through connecting inborn needs with business objectives (Hawthorne Study, Theory X & Theory Y and Maslow) Administrative Management: (Fayol, Weber & Chandler): How to scale the organization (GM, Standard Oil and Sears)	Quantitative Approach: Linear Programming: Kantorovich & Dantzig, CPM: (Kelley – DuPont & Walker - Remington Rand UNIVAC), PERT: (Malcolm & Roseboom – Booz Allen & Fazar – USN), US DoD 7000.2, C/SCSC – McNamara (SECDEF), Monte Carlo in PERT: (Van Slyke – Rand Corp), Earned Value Management (EVM) Legal Action: Attorneys, Delay / Acceleration Claims, Eichleay Formula, Claims Consultants, Primavera Claim Digger, Data Analytics / Big Data Analysis Construction Management: Divest Construction Equipment, Shift Risk to Specialty Contractors, Leverage Outsourcing Movement,	Project added to Product/Process Matrix (Schmenner) Operations Science / Factory Physics (Hopp & Spearman) Project Production Management (PPI)
Bureaucracy Resulting from Functions Batch Production / Inventory & WIP Build-up	Lack of transparency Limited accountability and control Excessive use of resources	Enhanced control of time to market Reduced Cost, Duration and use of Cash Less Bureaucracy (indirect cost)
Localized optimization Industrial action	Cost and schedule overruns, claims and unnecessary stress	Reliable project outcomes More collaborative / less stressful environment

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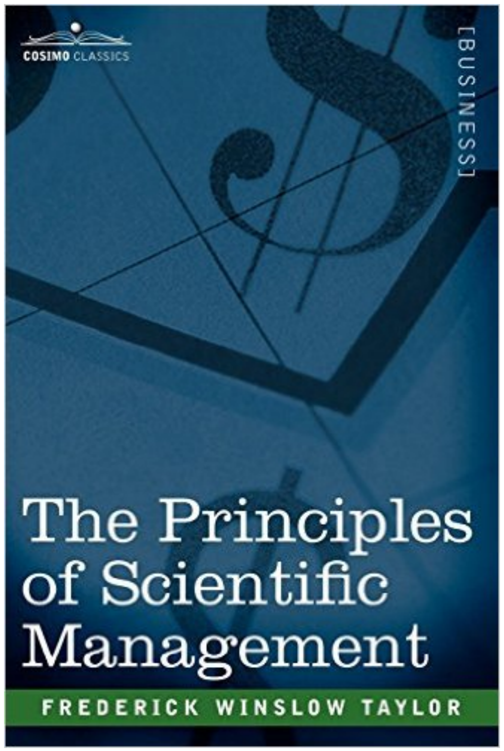
Era 1 - Productivity

Taylor’s Scientific Management



Separation of planning from doing

Time study

Advent of 8 functional foremen

Piece work based compensation

Gantt or bar chart

Scientific Management for Construction

MODERN MANAGEMENT
APPLIED TO
CONSTRUCTION

BY
DANIEL J. HAUER
CONSTRUCTION ECONOMIST; CONSULTING ENGINEER.

FIRST EDITION

McGRAW-HILL BOOK COMPANY, INC.
239 WEST 39TH STREET. NEW YORK

LONDON: HILL PUBLISHING CO., LTD.
6 & 8 BOUVERIE ST., E. C.
1918

In mechanical lines much has been done to try out this new leadership—to adopt scientific management and establish new standards for a greater efficiency in manufacturing.

It has been thought that these principles, so successfully applied in the manufacturing field, are not applicable to engineering and architectural construction. This idea, however, has been proven erroneous by the successful work of those pioneers in the contracting field.

The author's experience as a construction economist covering the past decade has taught him that scientific management is applicable to construction—he has applied and is applying the principles of such management with a fair degree of success.

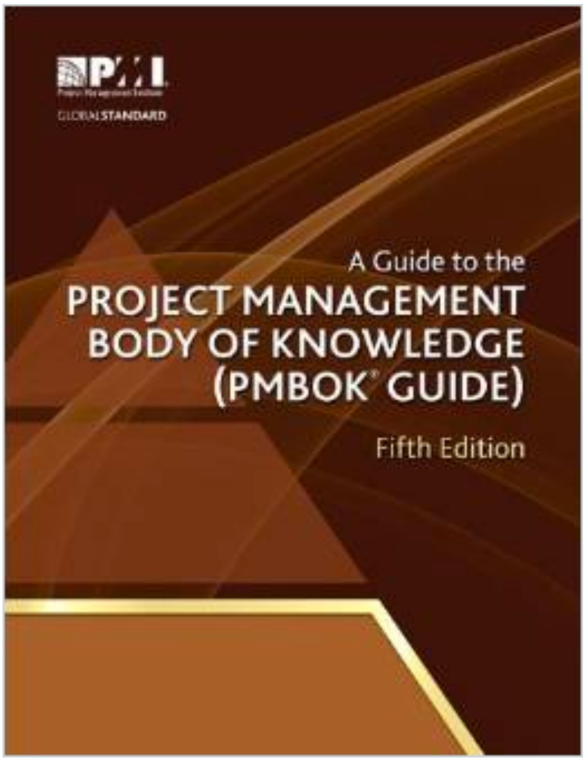
This treatise is the result of the author's experience. It is offered to the profession with the hope that engineers and contractors can build up and strengthen their organizations for greater efficiency, making possible the earning of larger profits.

DANIEL J. HAUER.

April, 1918.

Era 2 – Predictability

Functional activities developed in the 1960's



Project management, then, is the application of knowledge, skills and techniques to execute projects effectively and efficiently. It's a strategic competency for organizations, enabling them to tie project results to business goals — and thus, better compete in their markets.

It has always been practiced informally, but began to emerge as a distinct profession in the mid-20th century. PMI's *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* identifies its recurring elements:

Project management *processes* fall into five groups:

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing

Project management *knowledge* draws on ten areas:

Integration	Scope	Time
Cost	Quality	Procurement
Human resources	Communications	Risk management
Stakeholder management		

Evolution of the Project Management "Iron Triangle"

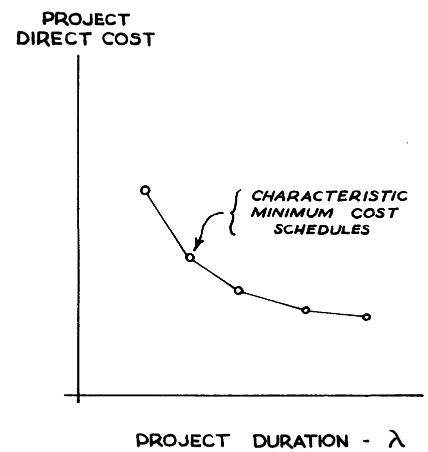
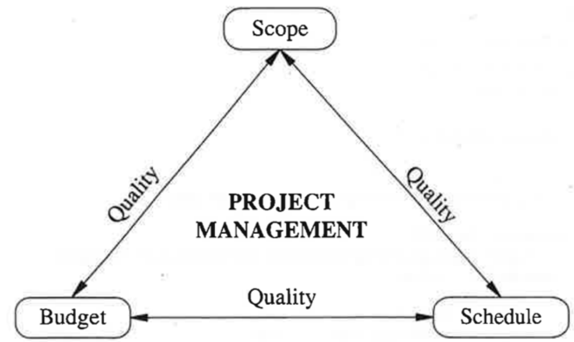


Fig. 3—Typical project cost curve.

Garold D. Oberlender, Ph.D., P.E.
Professor of Civil Engineering
Oklahoma State University



"Pick any two" [edit]

You are given the options of *Fast*, *Good*, and *Cheap*, and told to pick any two. Here *Fast* refers to the time required to deliver the product, *Good* is the quality of the final product, and *Cheap* refers to the total cost of designing and building the product. This triangle reflects the fact that the three properties of a project are interrelated, and it is not possible to optimize all three – one will always suffer. In other words you have three options:

- Design something quickly and to a high standard, but then it will not be cheap.
- Design something quickly and cheaply, but it will not be of high quality.
- Design something with high quality and cheaply, but it will take a relatively long time.

STR Model [edit]

The *STR model* is a mathematical model which views the "triangle model" as a graphic abstraction of the relationship:

$$\text{Scope} = \text{Time} \times \text{Resources}$$

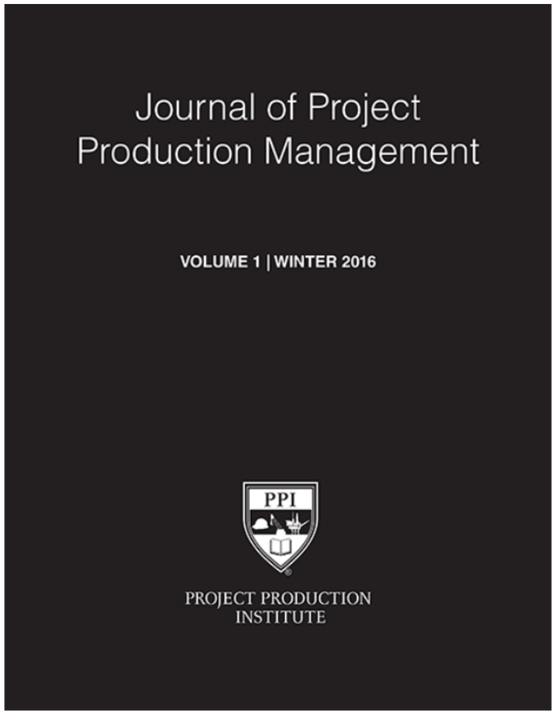
Scope refers to complexity (which can also mean quality). Resources includes humans (workers), financial, and physical. Note that these values are not considered unbounded. For instance, if one baker can make a loaf of bread in an hour, that doesn't mean ten bakers could make a loaf in six minutes.

“Advanced Work Packaging provides two primary benefits 1) improved productivity and 2) increased predictability”

CII Implementation Resource 272-2, Version 3.1 Volume I

Era 3 - Profitability

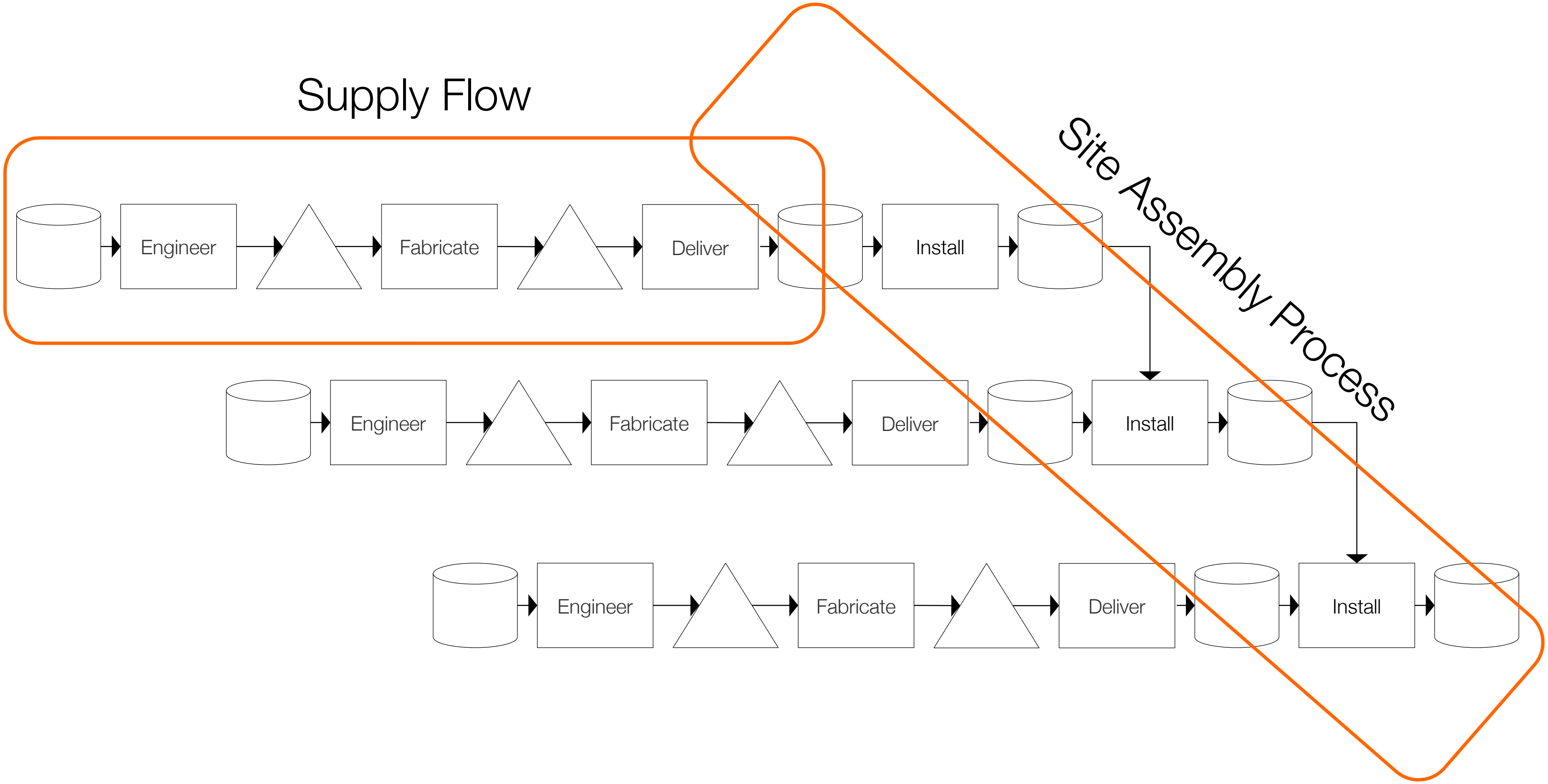
Project Production Management

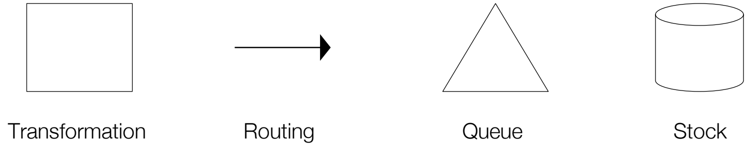


Project as Production System

5 Levers

Operations Science





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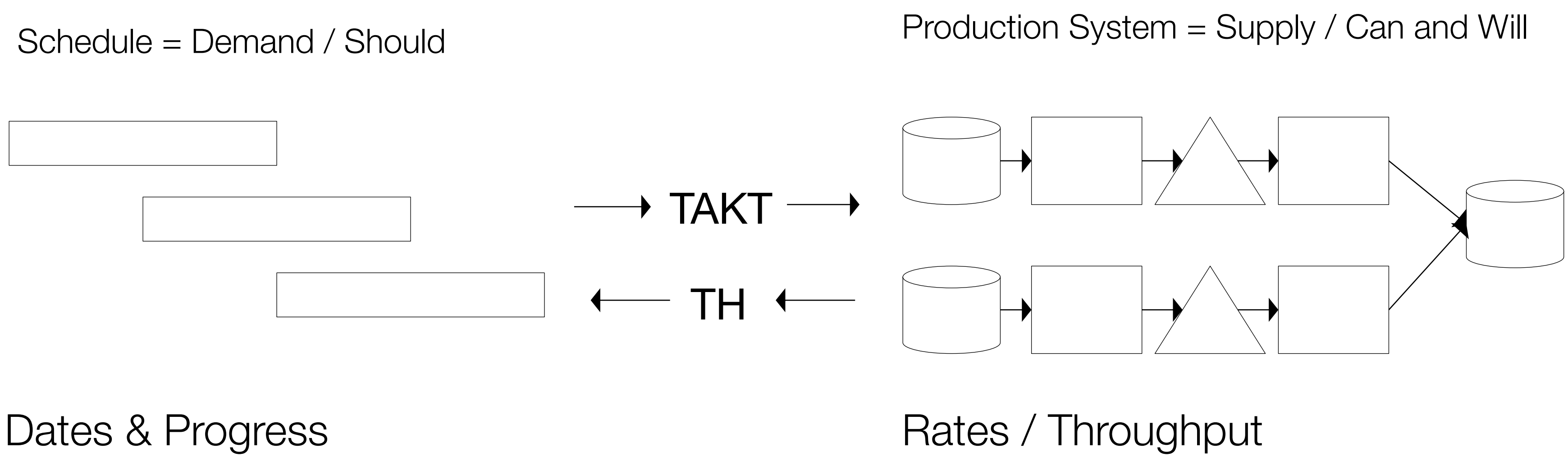
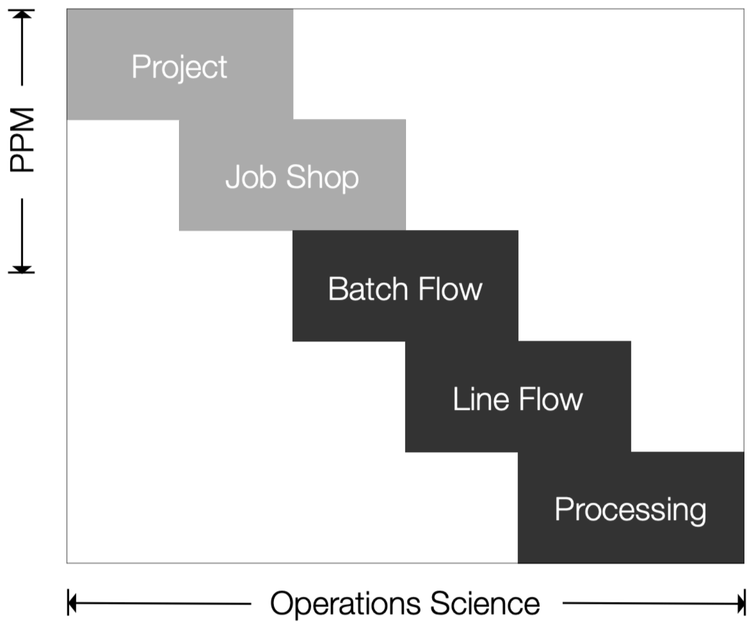
Production Rates Drive Milestone Dates



PPM Focuses on Production Rates (not dates)

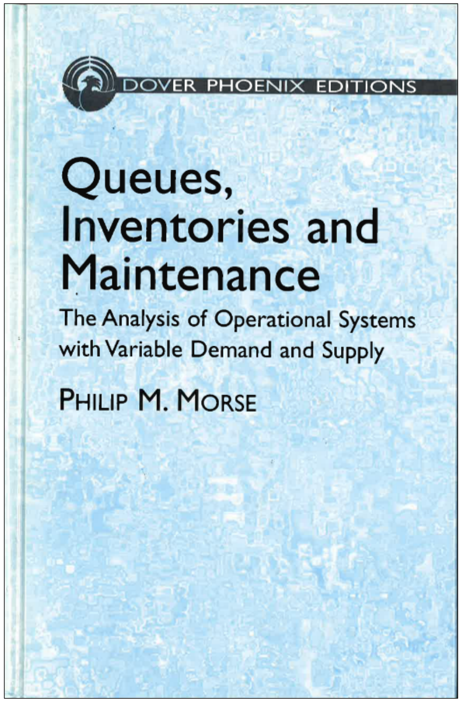


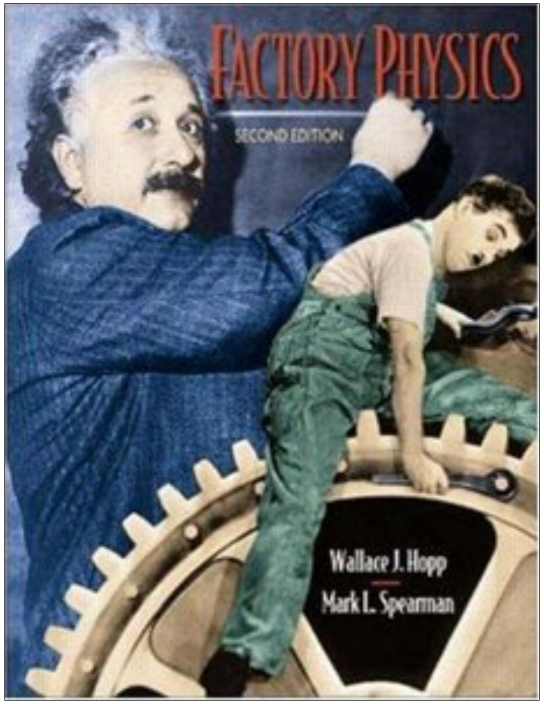
Operations Science is the basis for understanding and influencing all and any type of production system behavior

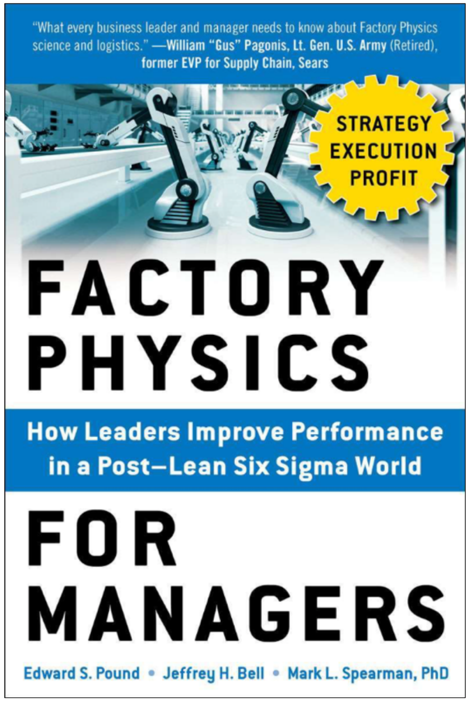
Project Production Management (PPM) focuses on project, job shop and batch flow production systems

Operations Science to better understand and influence project outcomes

Well established field of engineering and management science


DOVER PHOENIX EDITIONS
Queues, Inventories and Maintenance
The Analysis of Operational Systems with Variable Demand and Supply
PHILIP M. MORSE


FACTORY PHYSICS
SECOND EDITION
Wallace J. Hopp
Mark L. Spearman


"What every business leader and manager needs to know about Factory Physics science and logistics." —William "Gus" Pagonis, Lt. Gen. U.S. Army (Retired), former EVP for Supply Chain, Sears
STRATEGY
EXECUTION
PROFIT
FACTORY PHYSICS
How Leaders Improve Performance in a Post–Lean Six Sigma World
FOR MANAGERS
Edward S. Pound • Jeffrey H. Bell • Mark L. Spearman, PhD

PROJECT MANAGEMENT

Cost, Time & Cash = Scope & Quality + Schedule + Resource Use

PRODUCTION MANAGEMENT

Cost, Time & Cash = Product Design + Process Design + Capacity + Inventory + Variability

1.2 What is a Project?

A project is a temporary endeavor undertaken to create a unique product, service, or result. Project Management Institute (2012-09-01).

1.5.1.1 Operations Management

Operations management is a subject area that is outside the scope of formal project management as described in this standard.

Operations management is an area of management concerned with ongoing production of goods and/or services. It involves ensuring that business operations continue efficiently by using the optimum resources needed and meeting customer demands. It is concerned with managing processes that transform inputs (e.g., materials, components, energy, and labor) into outputs (e.g., products, goods, and/or services).

A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fifth Edition (ENGLISH) (Kindle Locations 601-602). Project Management Institute. Kindle Edition.

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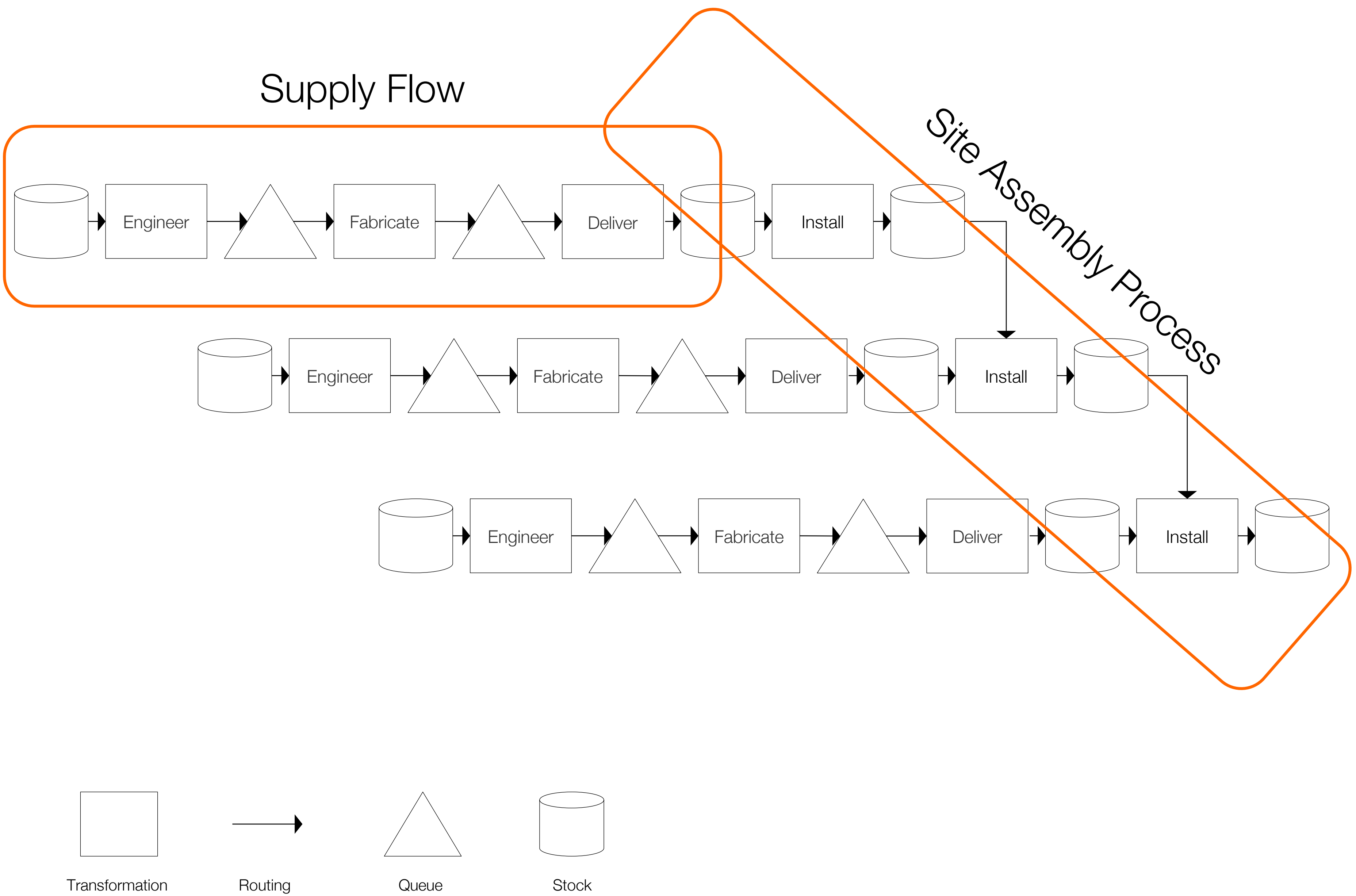

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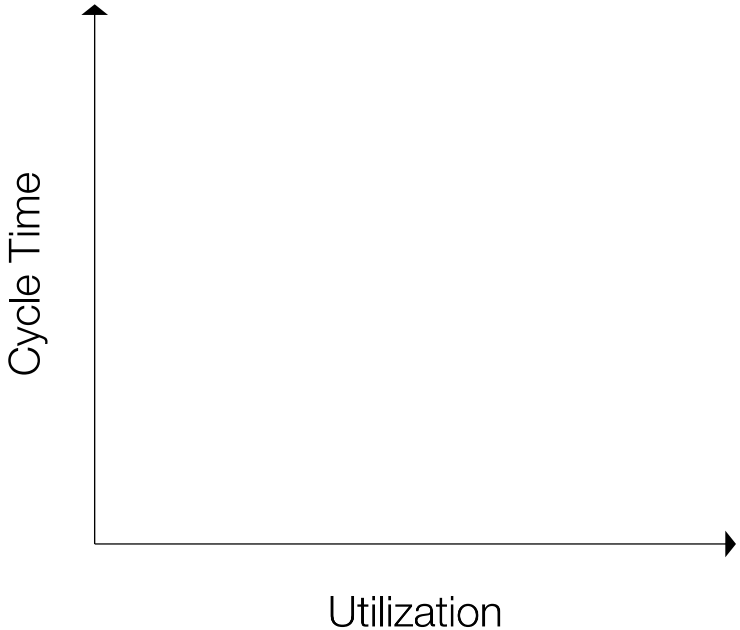
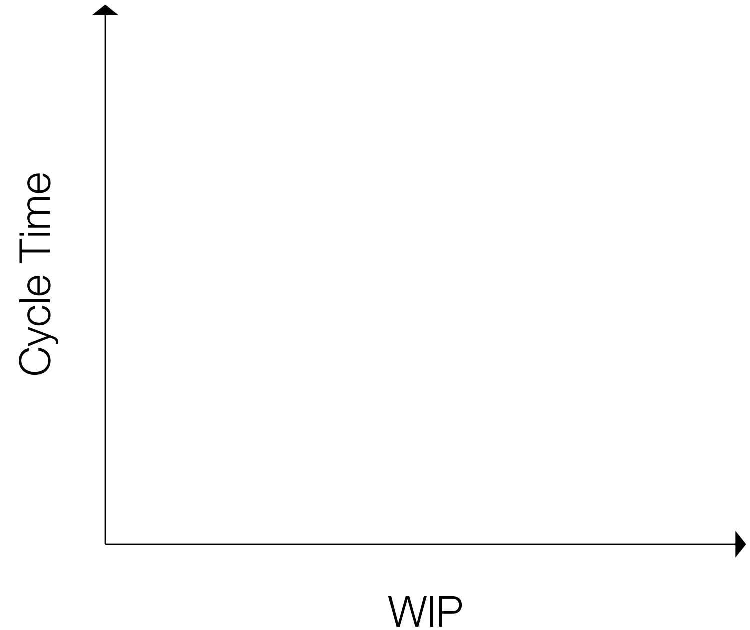

Cycle Time
Utilization

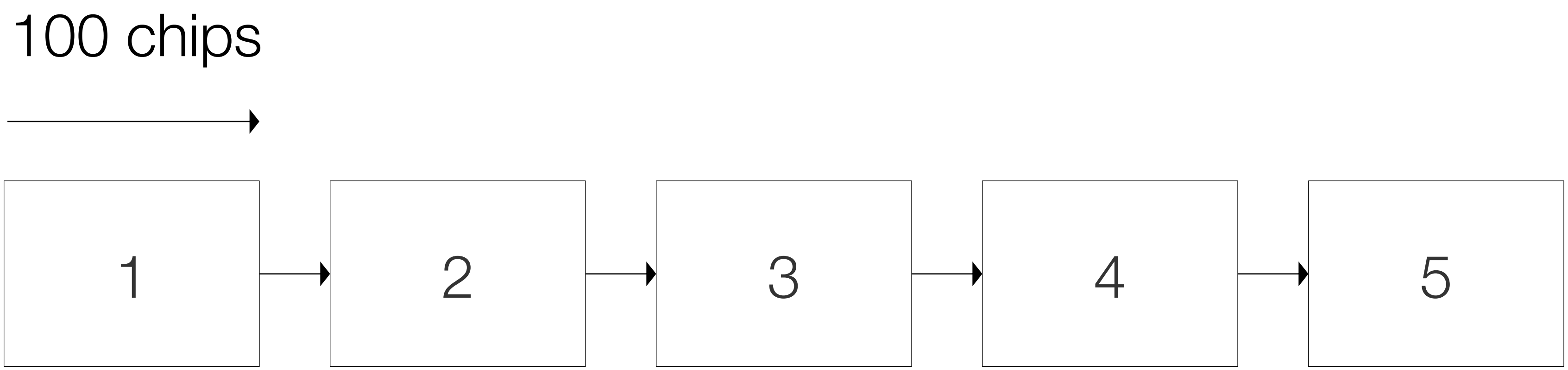

Cycle Time
WIP

Production System Variability Simulation

Form groups of 5 people

Each person performs a step in a process (linear sequence)

100 chips and 1 die are distributed to each group


100 chips
1
2
3
4
5

Dice	Number of Rolls			
	Position 1	Position 5	Total	Average

Debrief

What are your overall observations?

Was any step the bottleneck (working at or close to 100%)?

Did you observe stocks between each step?

Was everyone able to pass what they rolled? If not, why?

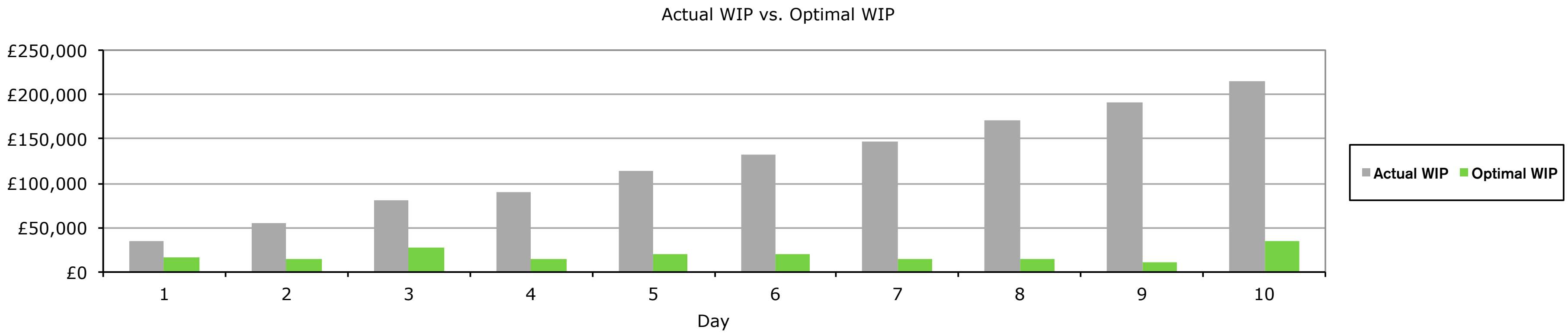
Did the players waiting for stocks increase or decrease process time?

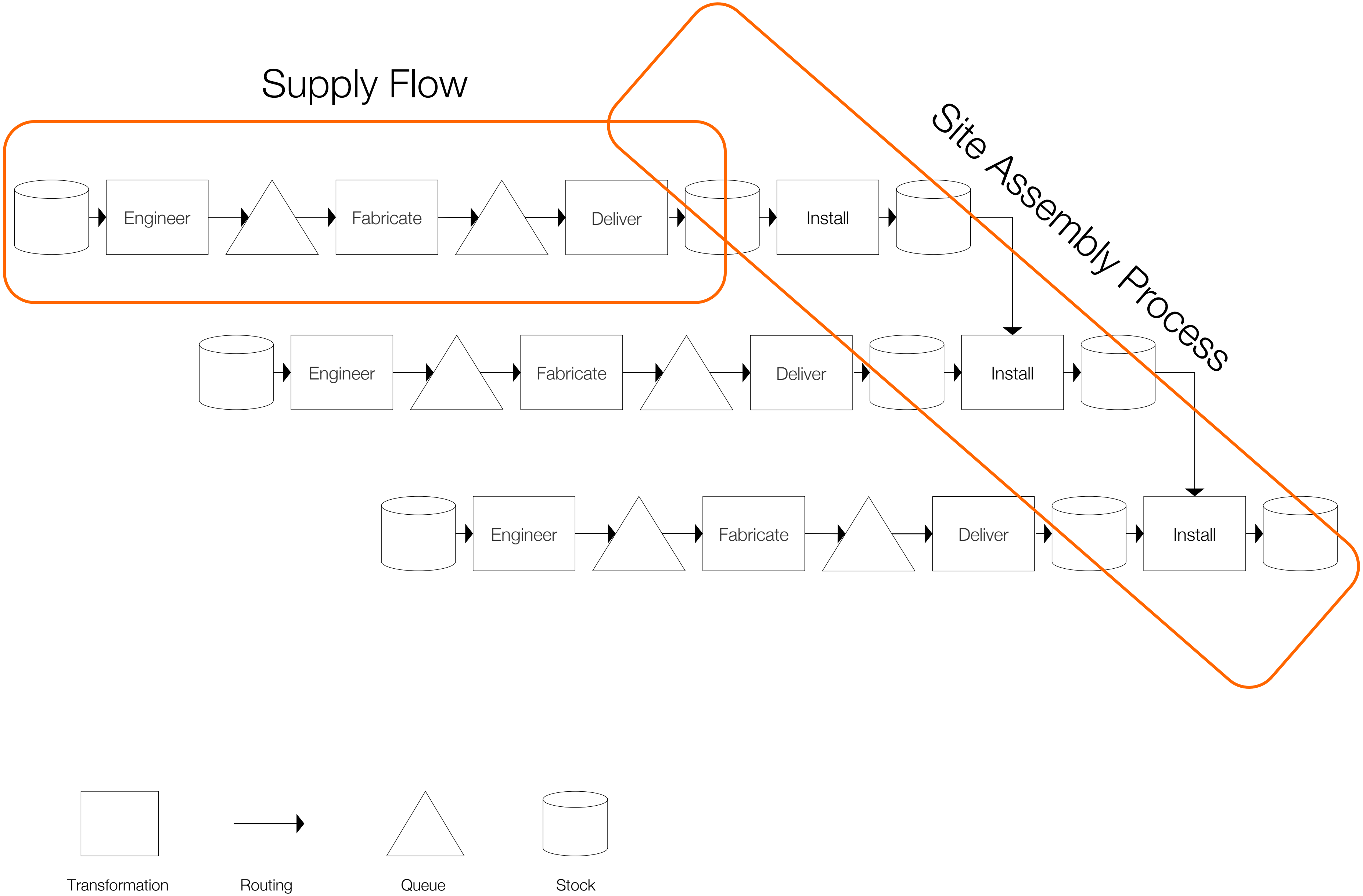
What can be done to improve performance?

Parameter	Production			Cost		
	Max	Fab	Site	Fab/Day	Site/Day	Rehandling/Unit
Planned	20	12	10	£41,760	£16,600	£800
Min PPC		90%	25%			
Max PPC		90%	75%			

Planned Final Cost:	**£14,590,000**
Actual Cost (Variation & Unreliability):	**£18,421,000**
Total Additional Cost:	**£3,831,000**

Totals		Inputs	





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Re-sequencing

New technology

Material defects

New techniques

Material delays

Equipment failures

Longer completion times

Weather delays

Ground conditions

Expedited permits

More favorable locations

Rework

Can variability be fully eliminated?

Should variability be fully eliminated?

Variability can be beneficial or detrimental

Beneficial Variability

Re-sequencing

New technology

New techniques

Expedited permits

More favorable locations

Detrimental Variability

Material delays

Equipment failures

Rework

Longer completion times

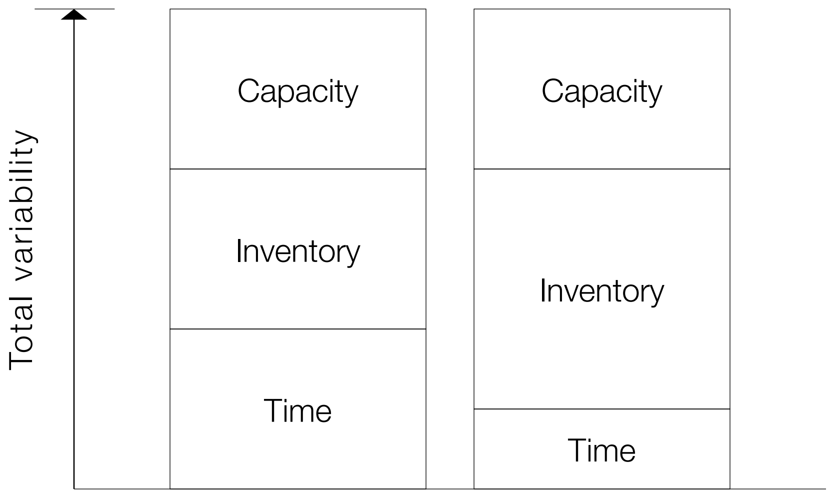
Weather delays

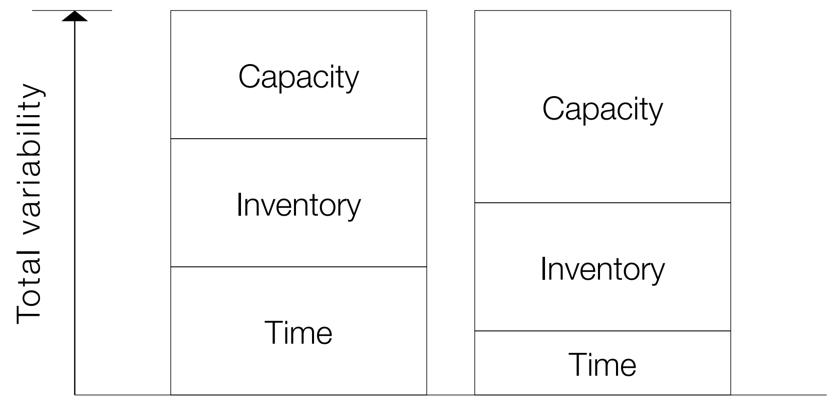
Ground conditions

Material defects

Regardless of the type, variability will always degrade system performance

Where there is variability, there will be loss of capacity, time or some combination thereof


Total variability
Capacity
Inventory
Time
Capacity
Inventory
Time

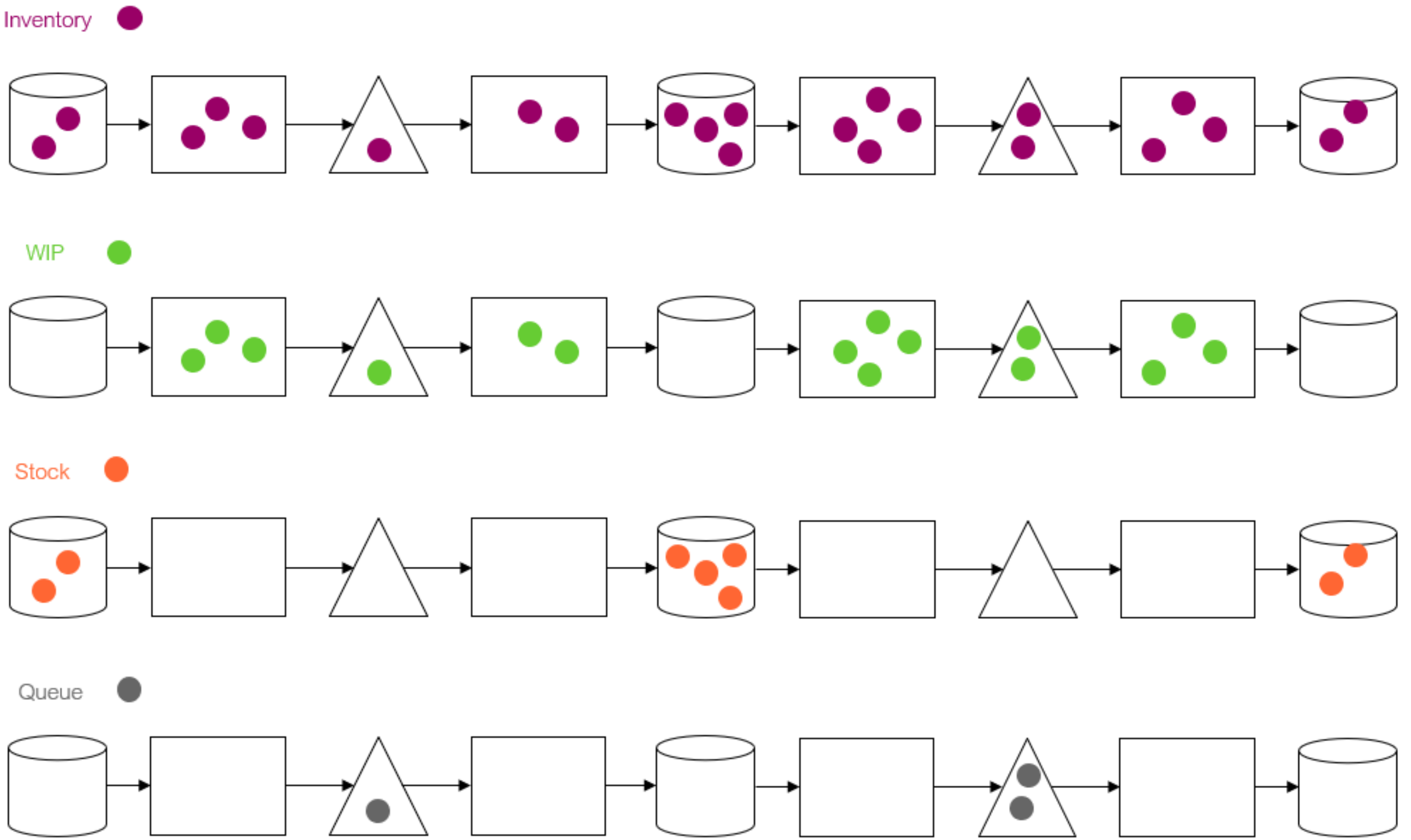

Total variability
Capacity
Inventory
Time
Capacity
Inventory
Time

Variability and inventory are a blind spot or gap that significantly increase project cost and schedule duration

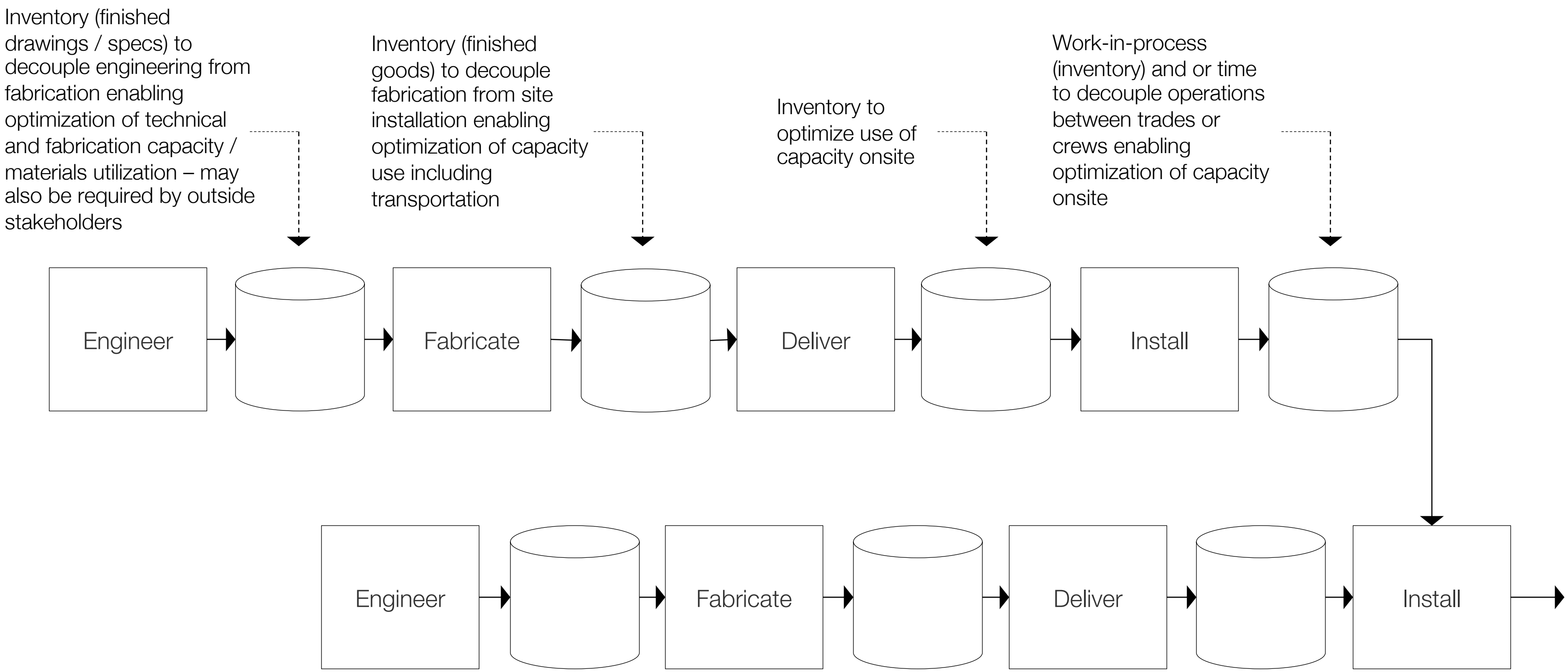
Is there an implicit amount of variability in our time-cost trade-off curve that we take for granted?

Variability is the root and inventory is its flower

Inventory is visible time


Inventory
WIP
Stock
Queue

Inventory = WIP + Stock



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Cost of Inventory

Time to amass

Handle (equipment and labor)

Hold (laydown, warehousing, etc.)

Preserve

Out of sequence work

Rework

Obsolescence (due to design change)

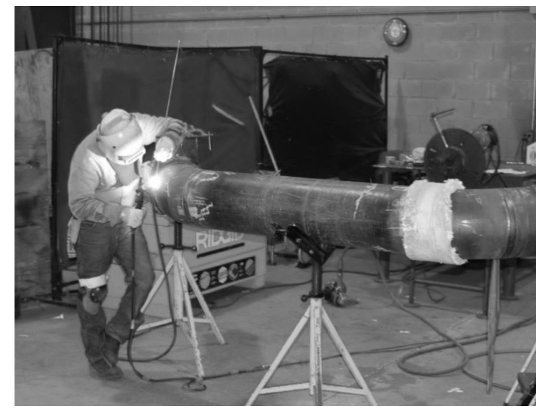
Degradation

Theft

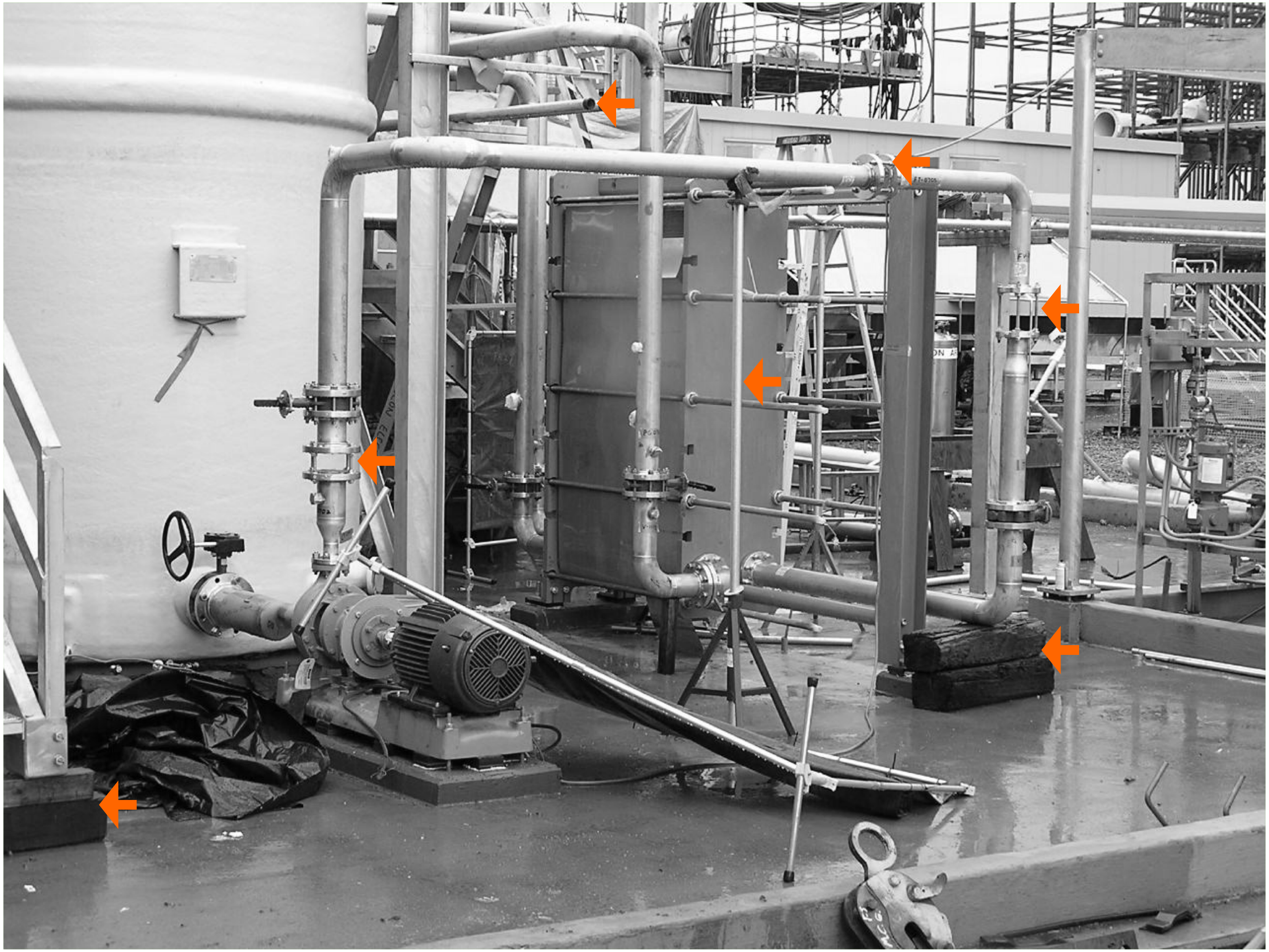
Unnecessary cash tied-up

…….

Inventory: Anything waiting to be worked or being worked

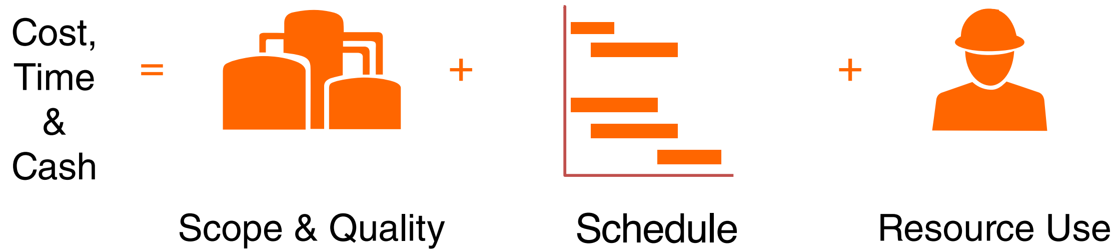


Physical or Informational

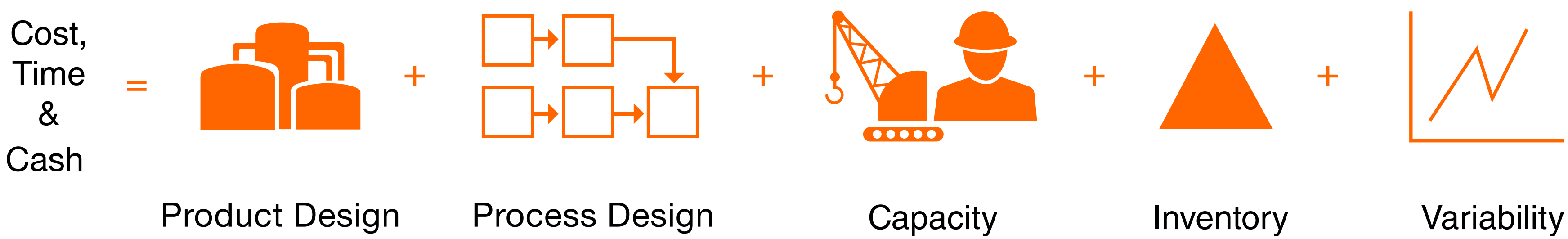


“Gap” in the current approach results in unnecessary cost, time and use of cash

PROJECT MANAGEMENT



PRODUCTION MANAGEMENT



Fundamental Relationships

Little's Law:

$$WIP = TH \times CT$$

Cycle Time Formula:

$$CT = RPT + BT + MT + QT + SDT + WTMT + PTB$$

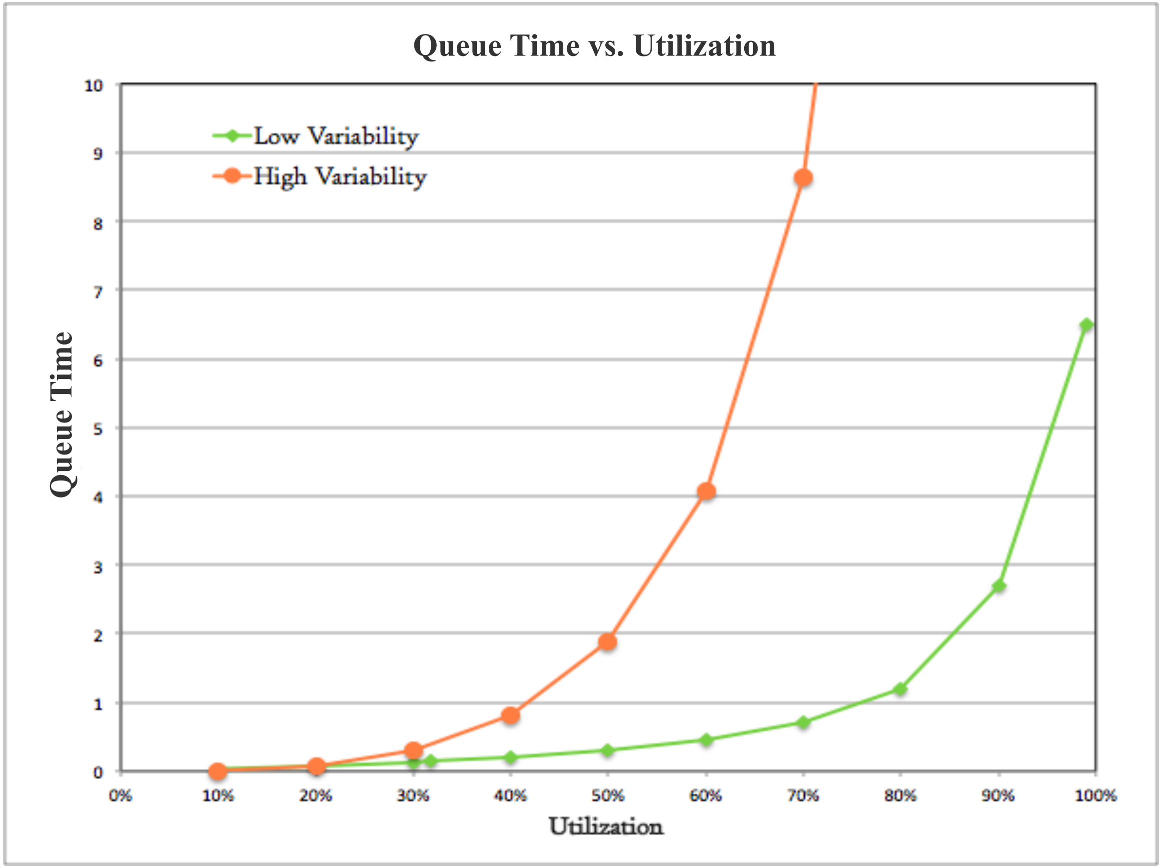
RPT = PT + ST + DT

BT = (Waiting for Batch) + (Waiting in Batch)

VUT Equation:

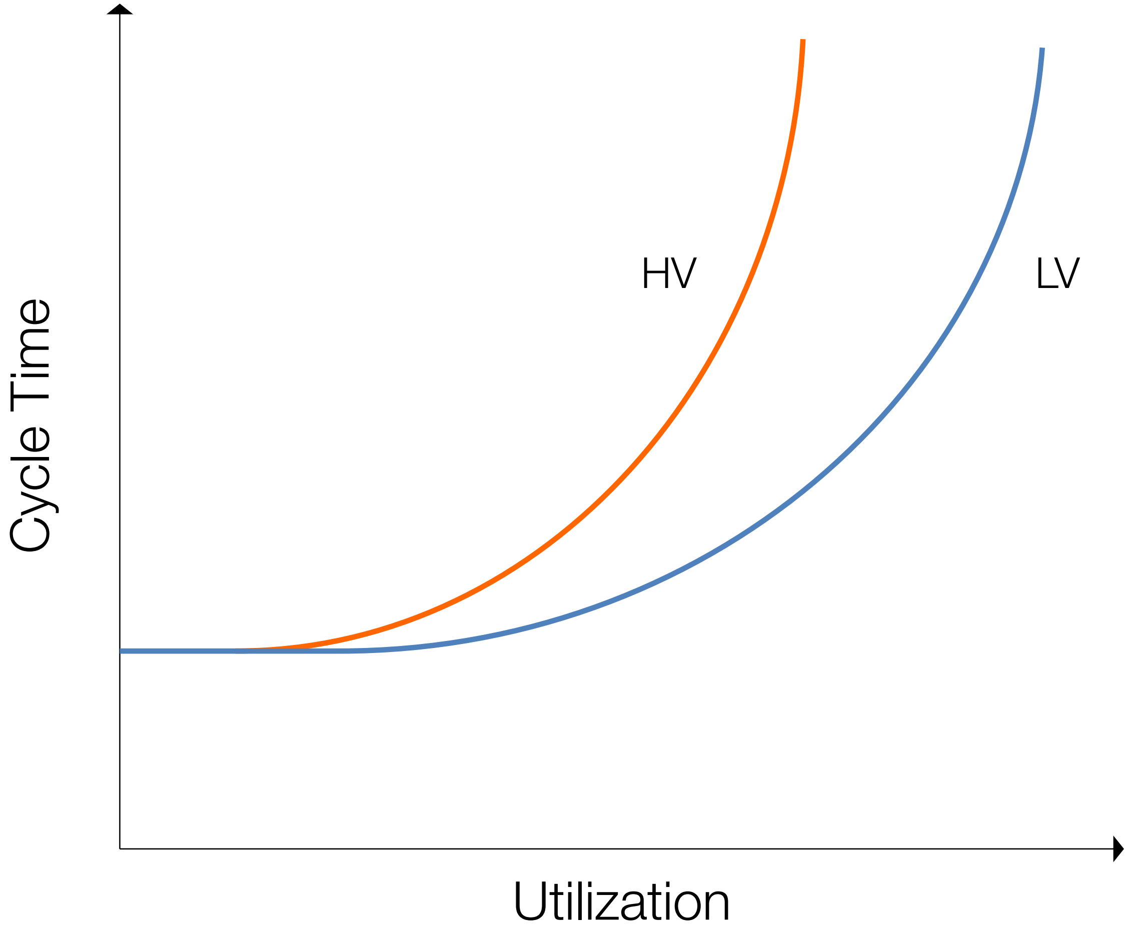
$$\mathrm{CT}_q \approx V \times U \times t$$

$$\approx \left(\frac{c_a^2 + c_e^2}{2}\right)\left(\frac{u}{1-u}\right)t_e$$



$$\mathrm{CT}_q \approx V \times U \times t$$

$$\approx \left(\frac{c_a^2 + c_e^2}{2}\right)\left(\frac{u}{1-u}\right)t_e$$


HV
LV
Cycle Time
Utilization

Agenda

Topic	Process	When
Welcome, Session Context & Purpose	Present with Q&A for clarification	8:30 – 9:00
Three Eras of Project Delivery	Present with Q&A for clarification	9:00 – 9:30
Production System Dynamics	Simulate & Debrief	9:30 – 10:30
Break	Take	10:30 – 10:45
Production System Dynamics (Cont.)	Simulate & Debrief	10:45 – 12:00
Lunch	Take	12:00 – 1:00
How Leading Organizations are Benefiting	Present with Q&A for clarification	1:00 – 2:30
Break	Take	2:30 – 2:45
How Leading Organizations are Benefiting (Cont.)	Present with Q&A for clarification	2:45 – 4:30
Wrap Up	Key Takeaways, Plus Delta Analysis	4:30 – 5:00

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PROJECT PRODUCTION INSTITUTE

Form a group of six people

Objective – build an airplane using components that move through the different workstations simulating a production line

Legos are used as parts for the airplane

Instructions will be given as to how to build the airplanes (the production system design)

Instructions

Phase	Description
1	Batch flow & push
2	Single piece flow & pull

Phase	Description	Policies	Control Protocol	Measurements
1	Batch flow & push	Batch size = 5 Workers not allowed to repair defects Stop at 6 min.	Push	Time 1st Good Airplane Total number of good airplanes Total number of airplanes to be reworked Total number of airplanes not completed

Debrief – Phase 1

What are the problems you experience during this phase?

What improvements would you propose to solve these problems? Why?

What do you think about your individual performance? Explain

Phase	Description	Policies	Control Protocol	Measurements
2	Single piece flow & pull	Batch size = 1 Workers allowed to repair defects Stop at 6 min. Workers can only have one component in front of them and only one component in the queue	Pull	Time 1st Good Airplane Total number of good airplanes Total number of airplanes reworked Total number of airplanes not completed

Debrief – Phase 2

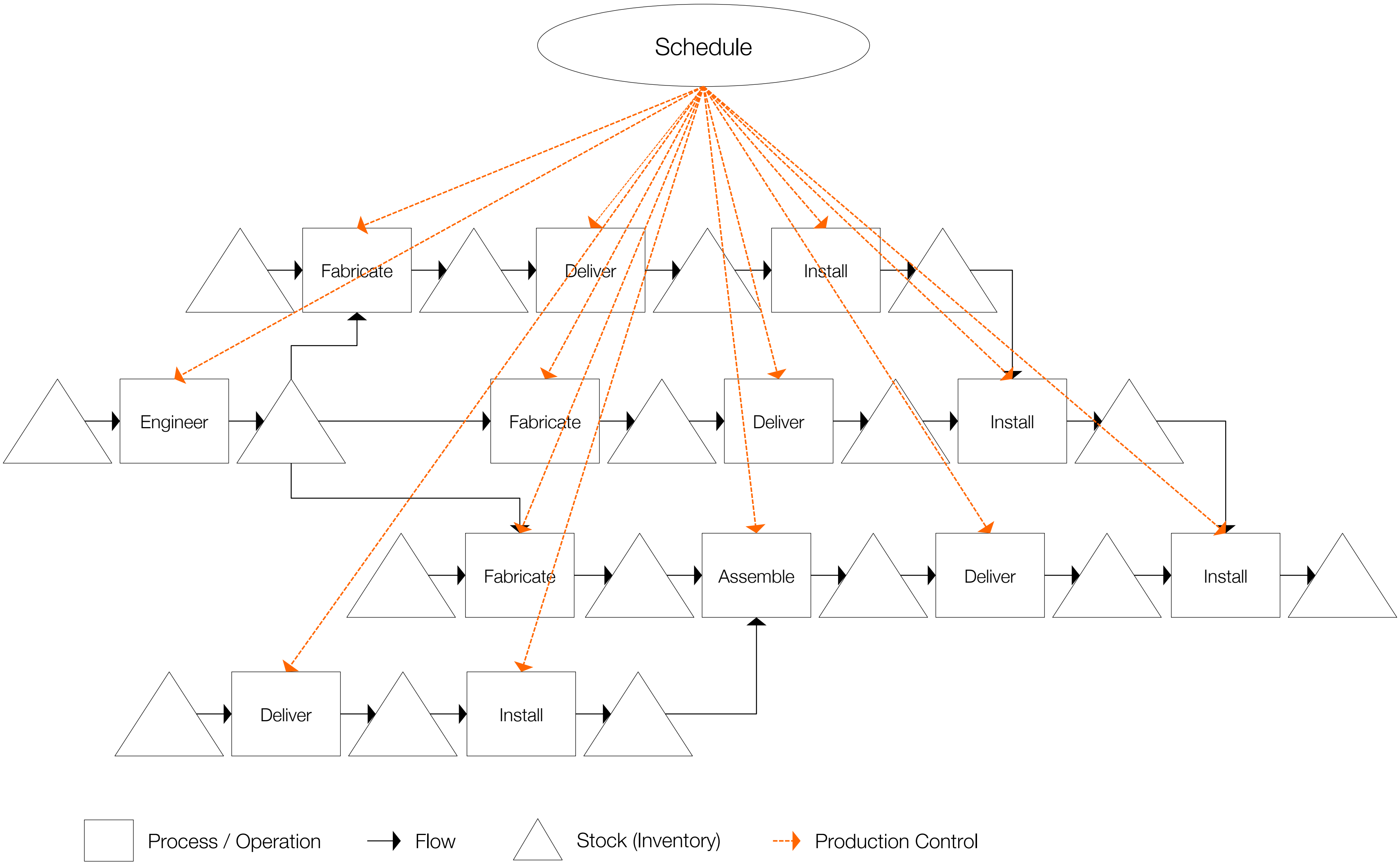
What did you learn about the effect of a pull system combined with smaller batch sizing?

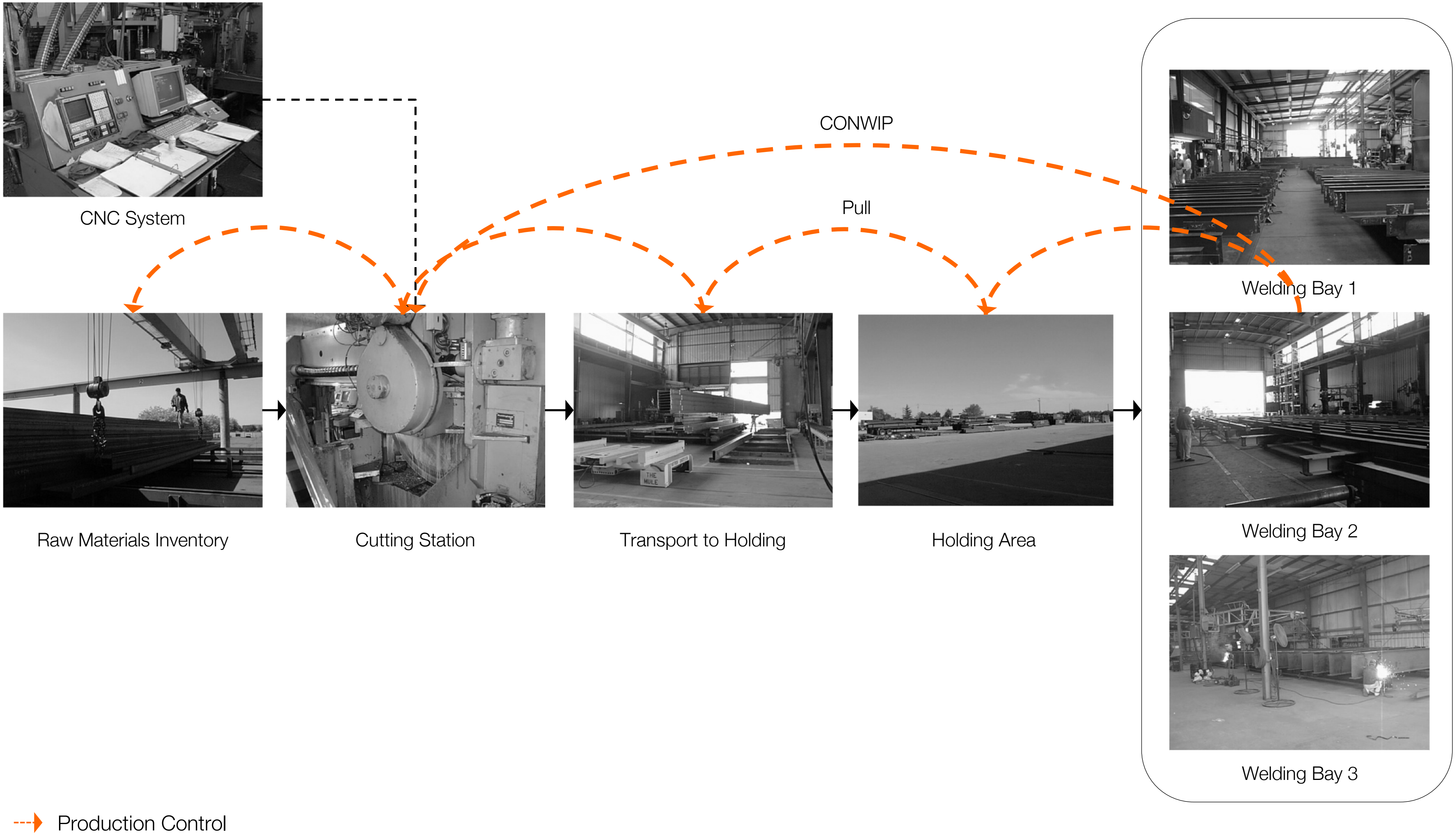
What do you think about your individual performance this time? How that this performance compare with the performance of the production system?

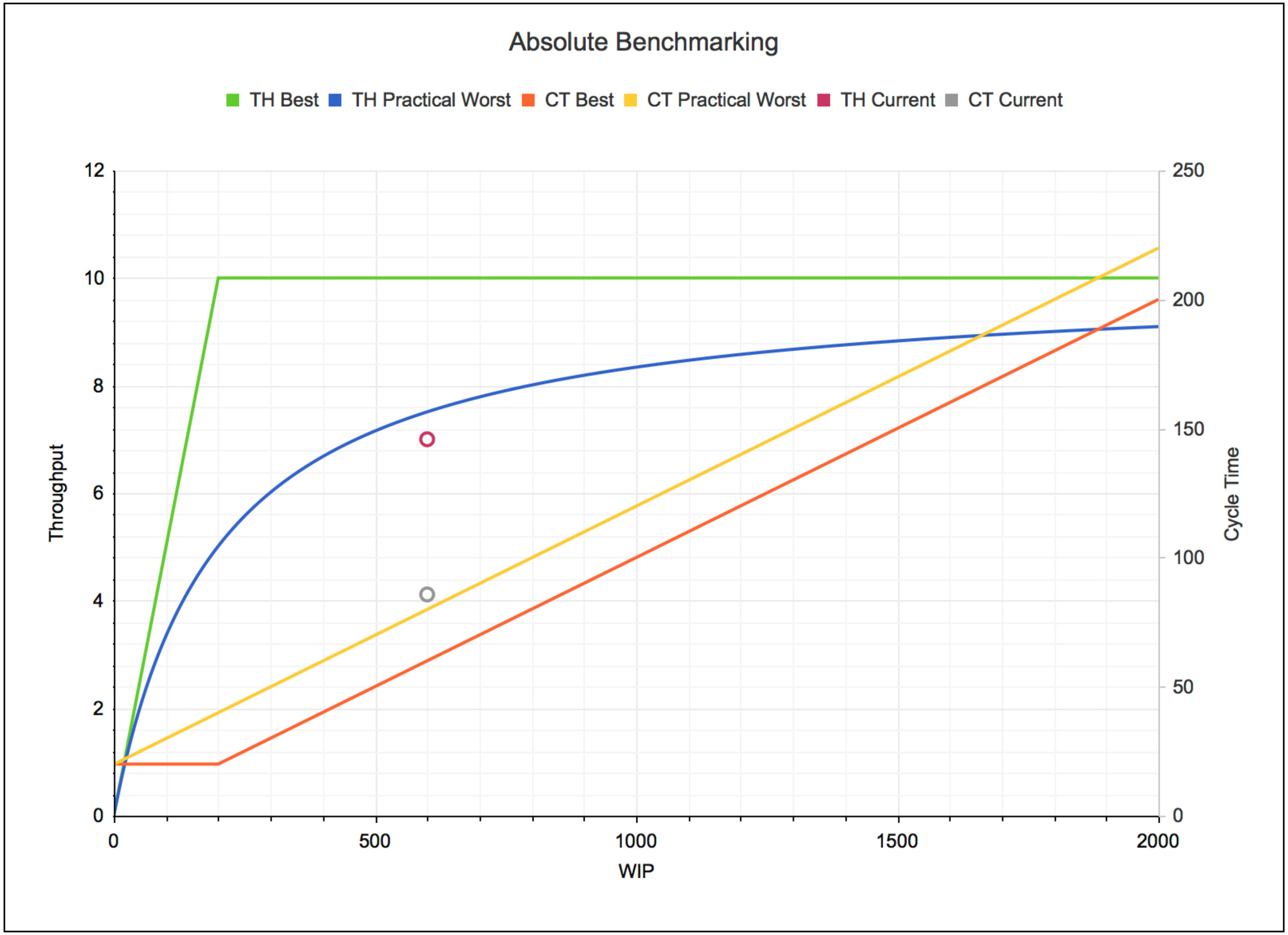
What problems did you experience during this phase?

What further improvements can be made? What are the constraints for these improvements?

Phase	Total number of good airplanes (throughput)	Time required to build the first good airplane (cycle time)	Total number of airplanes to be reworked	Total number of airplanes (not completed) in all workstations (WIP)
1				
2				


Schedule
Fabricate
Deliver
Install
Engineer
Fabricate
Deliver
Install
Fabricate
Assemble
Deliver
Install
Deliver
Install
Process / Operation
Flow
Stock (Inventory)
Production Control


CNC System
CONWIP
Pull
Raw Materials Inventory
Cutting Station
Transport to Holding
Holding Area
Welding Bay 1
Welding Bay 2
Welding Bay 3
Production Control



Absolute Benchmarking
TH Best
TH Practical Worst
CT Best
CT Practical Worst
TH Current
CT Current
Throughput
Cycle Time
WIP
0
500
1000
1500
2000
0
2
4
6
8
10
12
0
50
100
150
200
250



Unnecessary use of inventory increases cost, time and risk of EH&S incidents and results in operability issues due to the time and capacity it takes to amass, handle and hold the inventory, not to mention potential obsolescence

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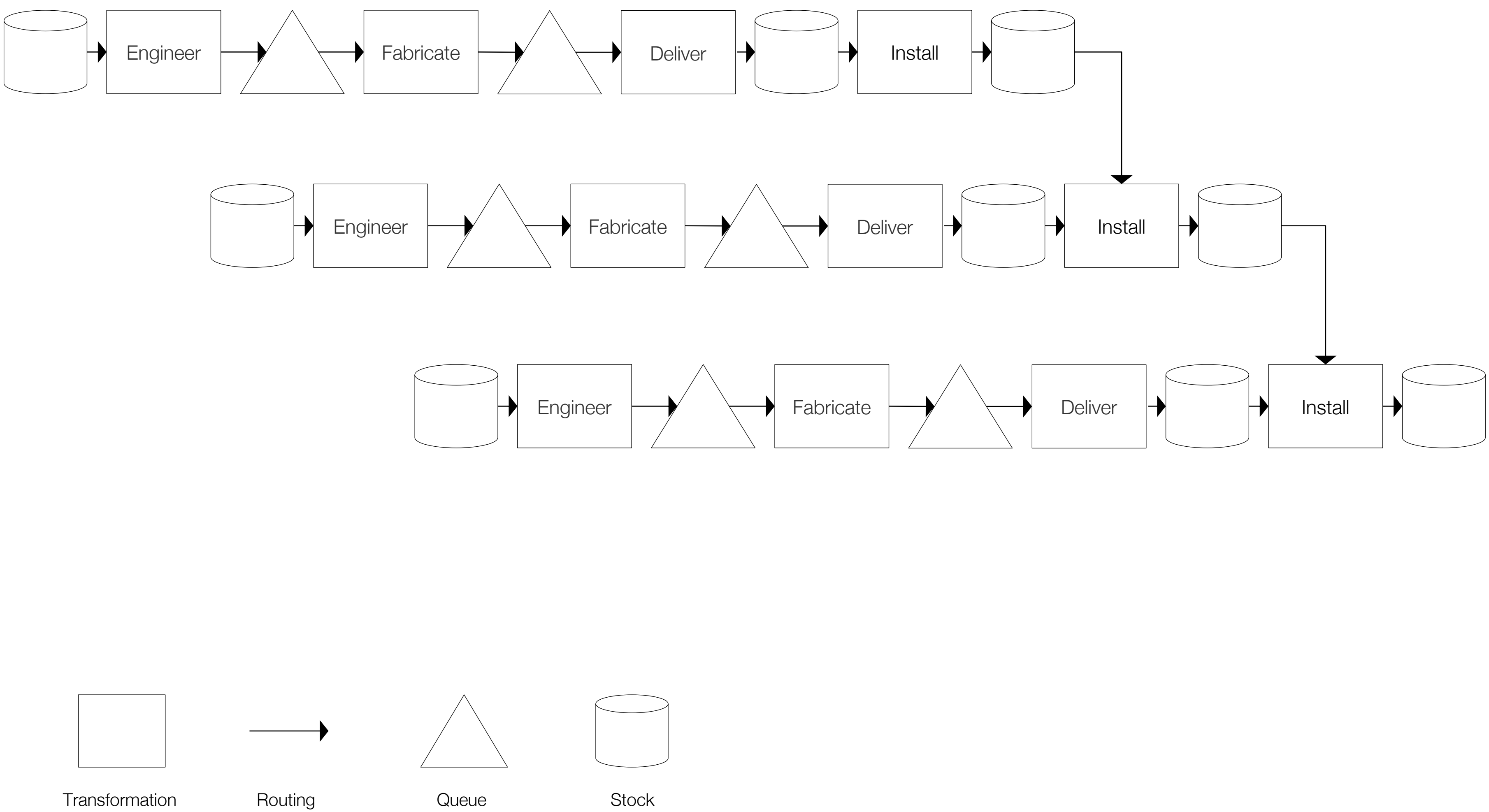
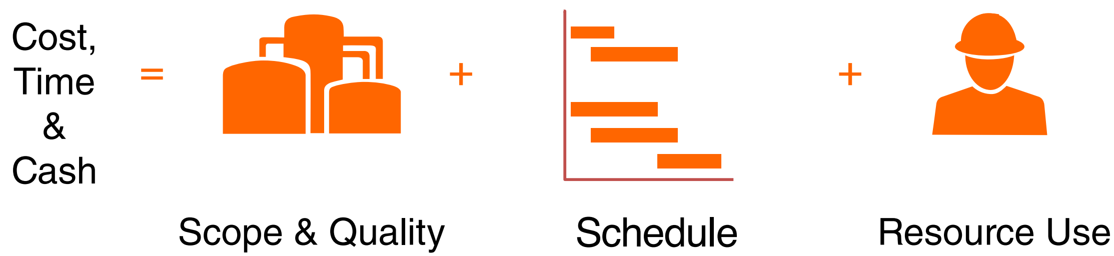
Production System Optimization

Project Production Control

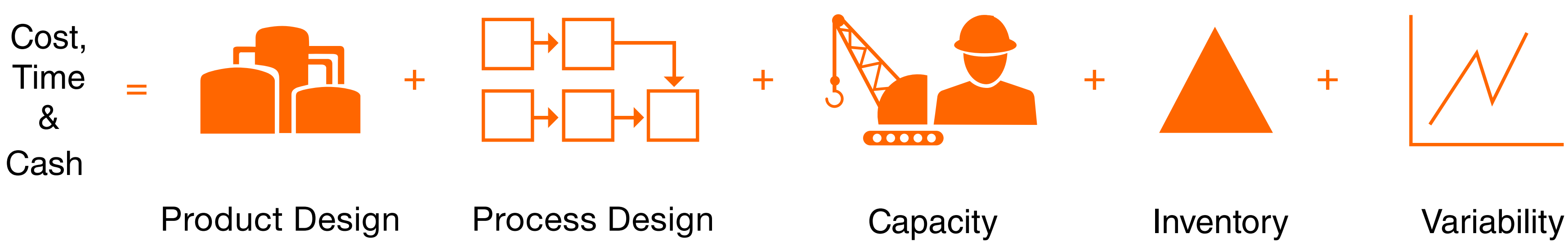
Computer-Aided Production Engineering


Engineer
Fabricate
Deliver
Install
Engineer
Fabricate
Deliver
Install
Engineer
Fabricate
Deliver
Install
Transformation
Routing
Queue
Stock

PROJECT MANAGEMENT



PRODUCTION MANAGEMENT



PROJECT PRODUCTION INSTITUTE

Production System Optimization

Identify and remove any unnecessary use of resources (capacity, inventory and time)

PSO can be used to Optimize:

Core Production Systems & Distribution Networks

Engineering Processes & Offices

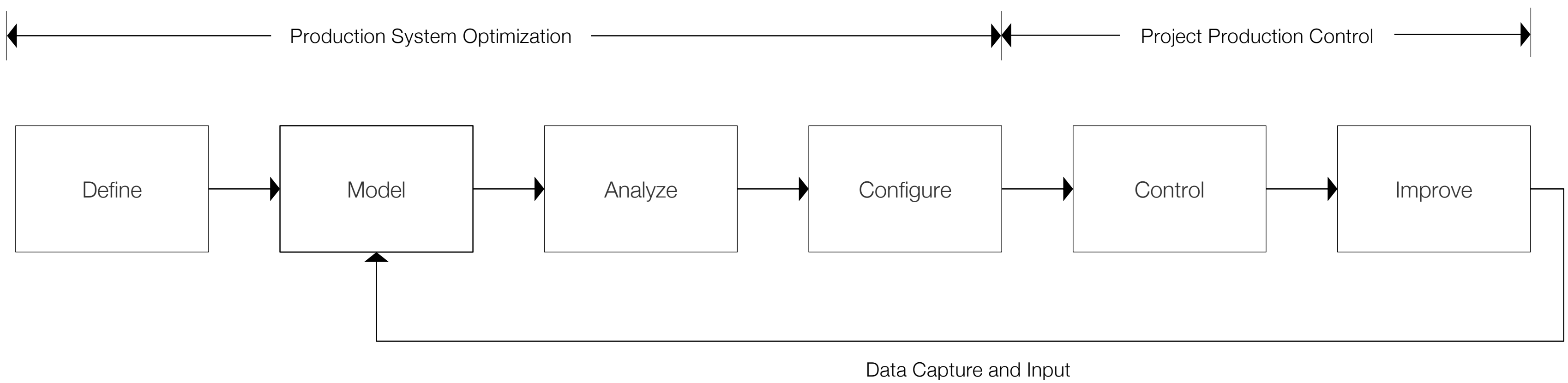
Fabrication / Manufacture Processes & Facilities

Logistics Routings & Flows

Site Construction

Project Value Stream

Some Combination of the Above



Production System Optimization
Project Production Control
Define
Model
Analyze
Configure
Control
Improve
Data Capture and Input

PILING PRODUCTION SYSTEM

PROJECT	TOTAL	DRIVEN	CUT	CROPPED	WIP (Cropped – Driven)	
A	27,589	22,711	7,605	11,599	11,112	49%
B	6,135	1,046	61	0	1,046	100%

PROJECT PRODUCTION INSTITUTE

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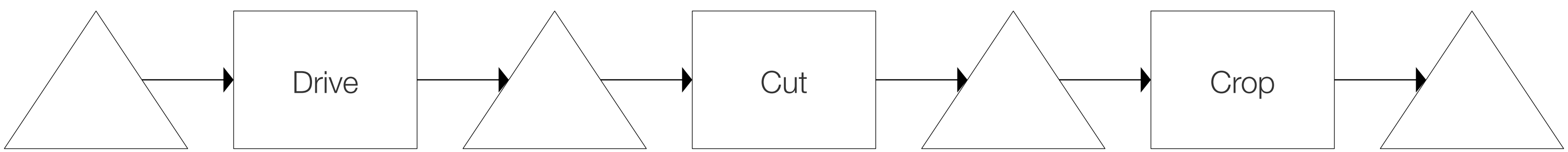
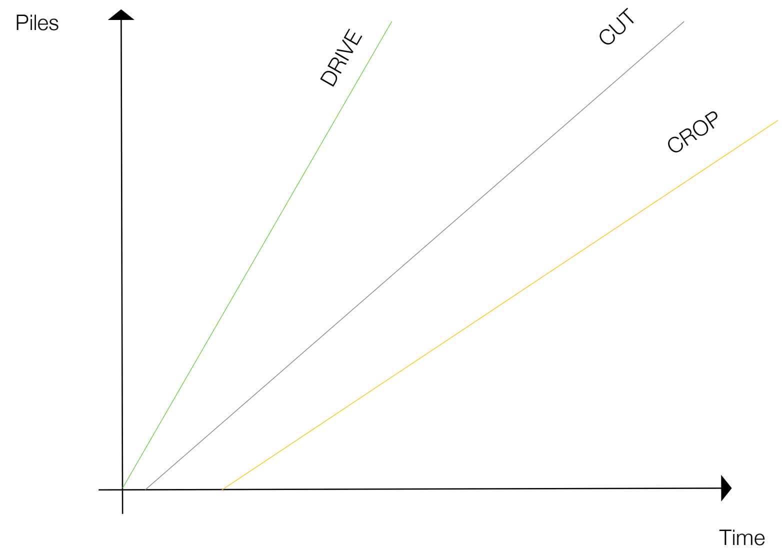
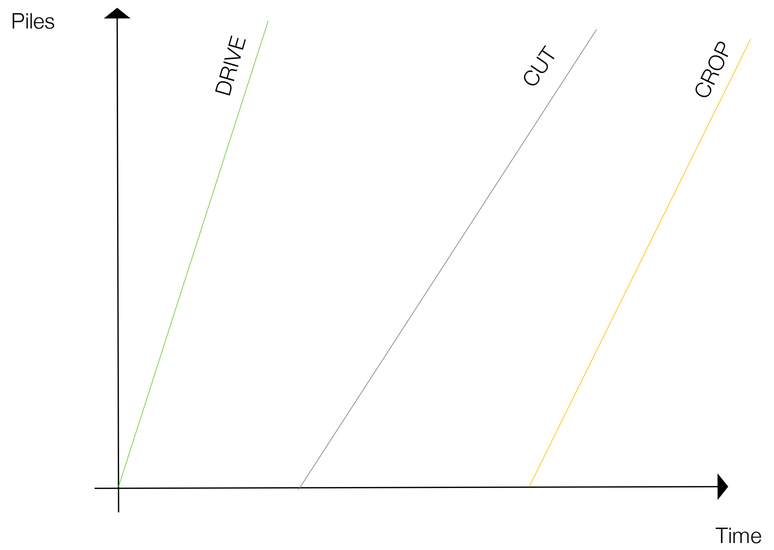
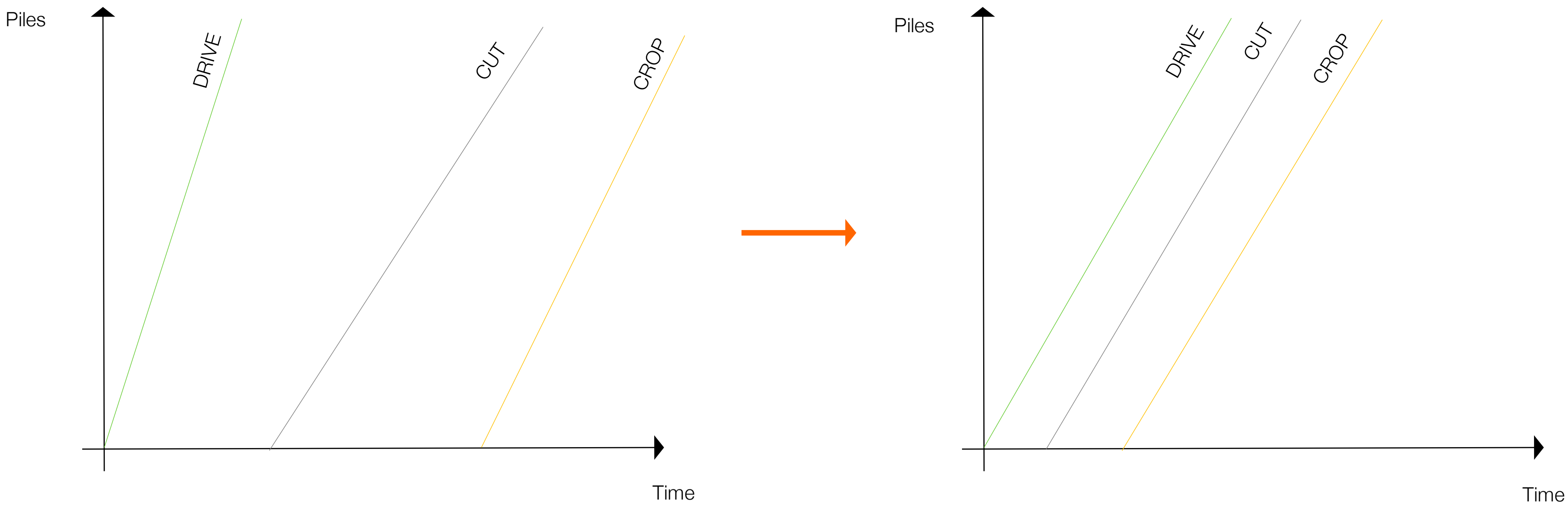
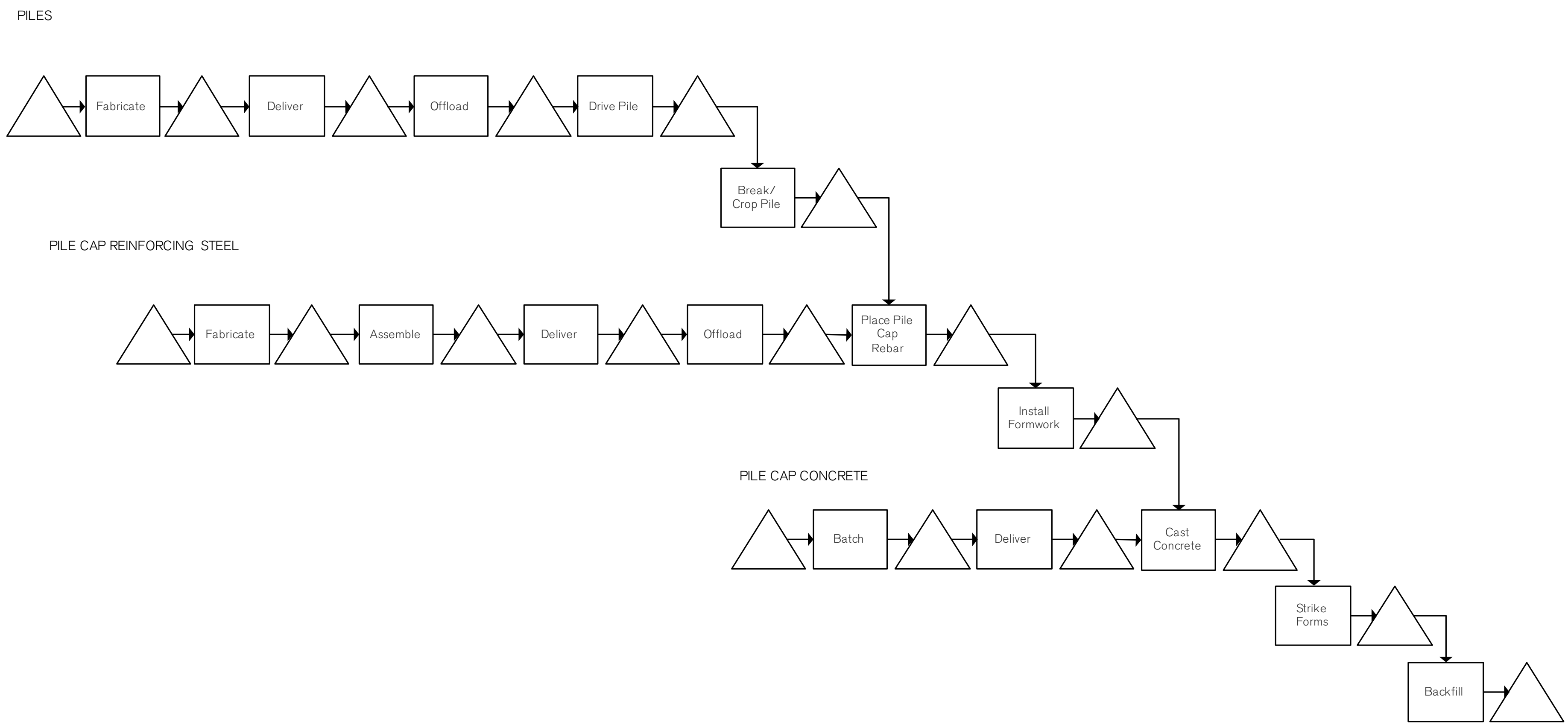


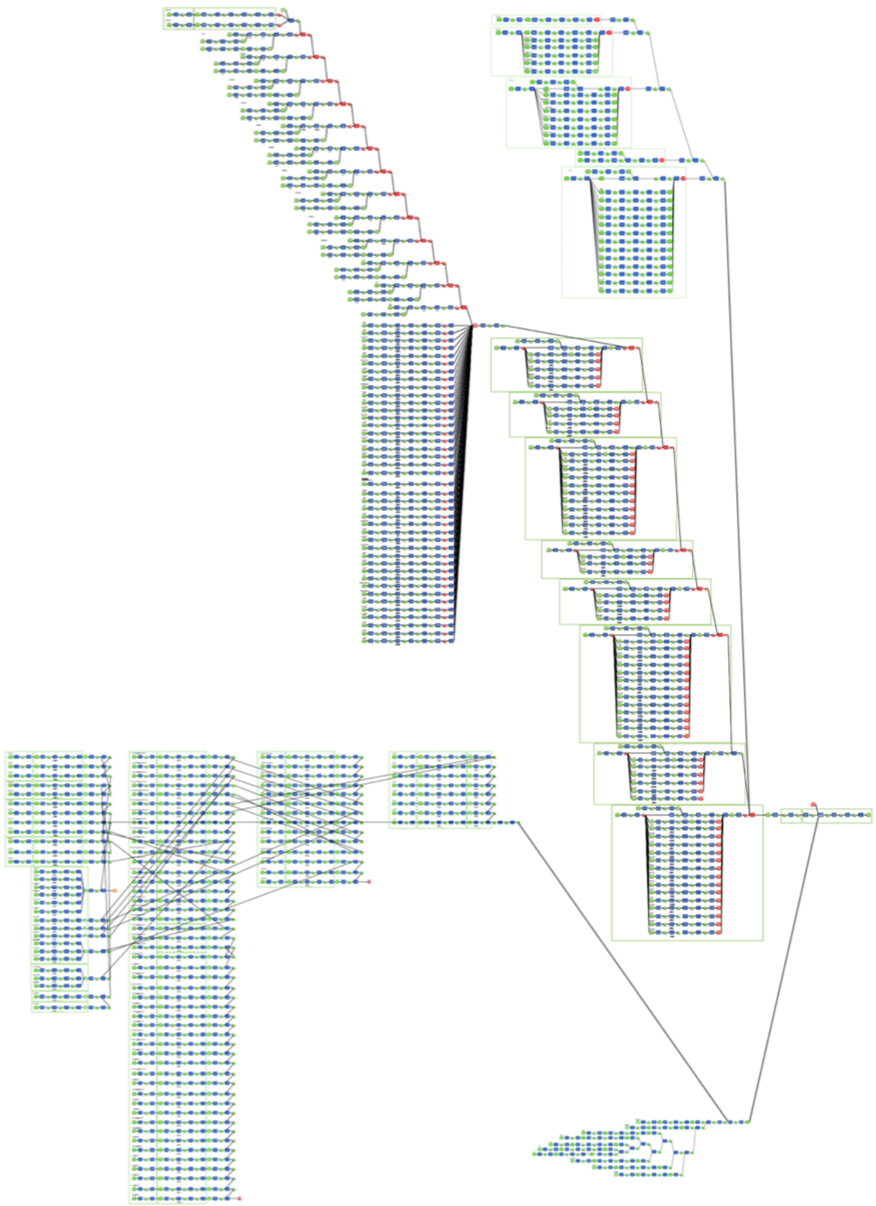

Piles
DRIVE
CUT
CROP
Time


Piles
DRIVE
CUT
CROP
Time


Piles
DRIVE
CUT
CROP
Time
Piles
DRIVE
CUT
CROP
Time



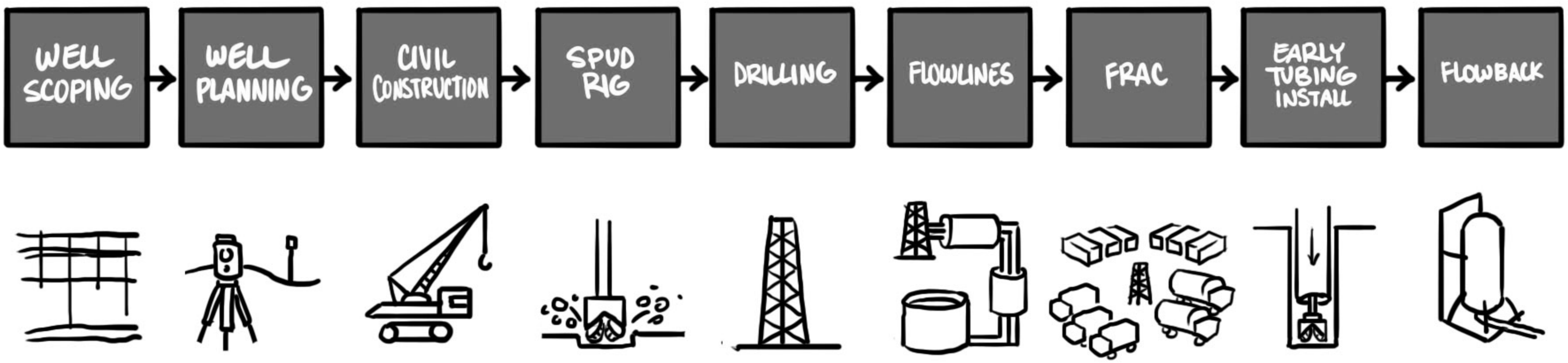
PROJECT PRODUCTION INSTITUTE

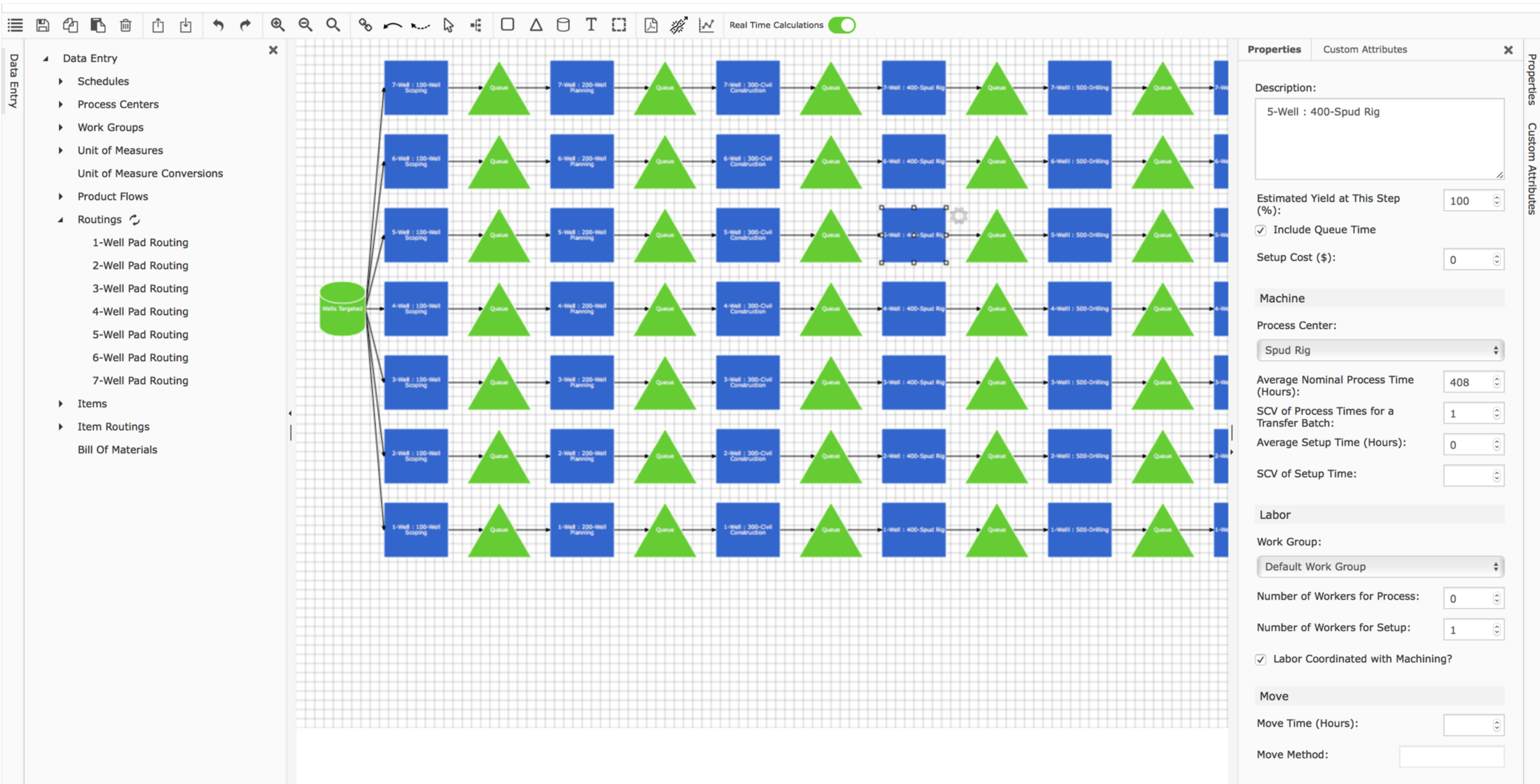


Long lead times

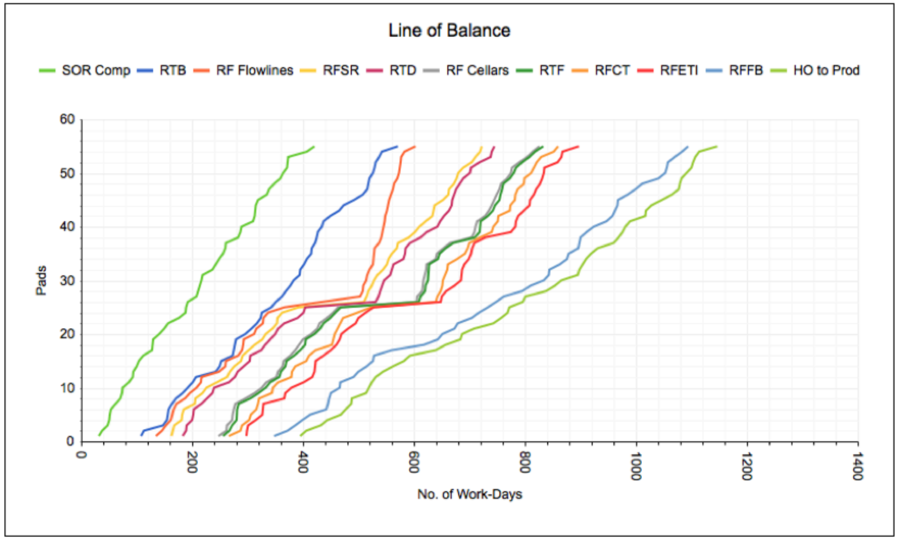
Convergence of flows

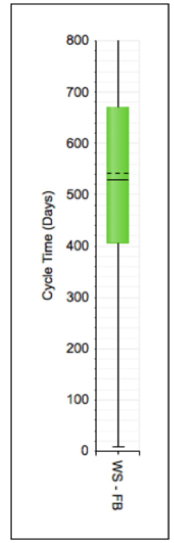
Asynchronous arrivals

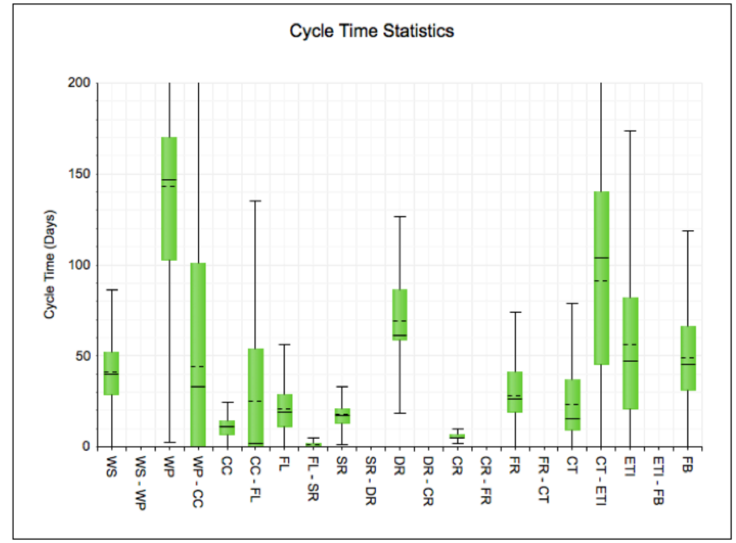

WELL SCOPING
WELL PLANNING
CIVIL CONSTRUCTION
SPUD RIG
DRILLING
FLOWLINES
FRAC
EARLY TUBING INSTALL
FLOWBACK

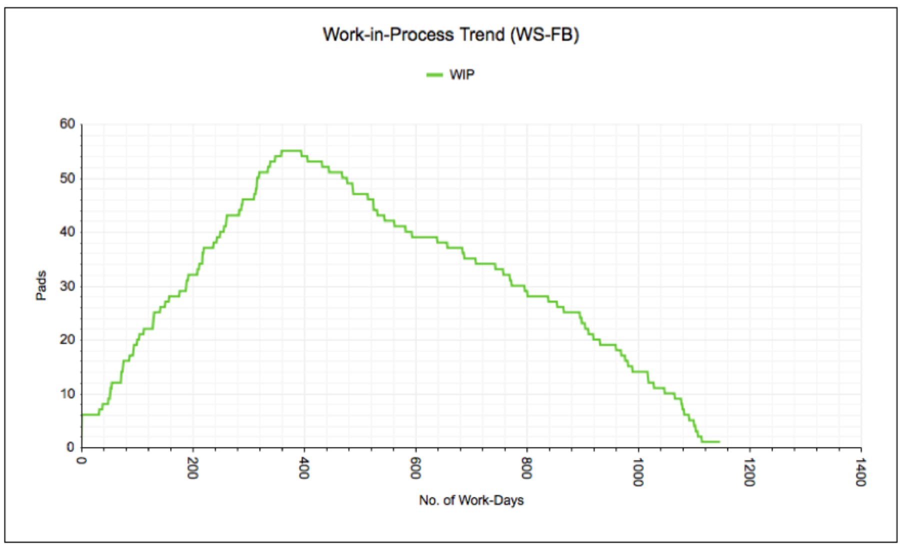


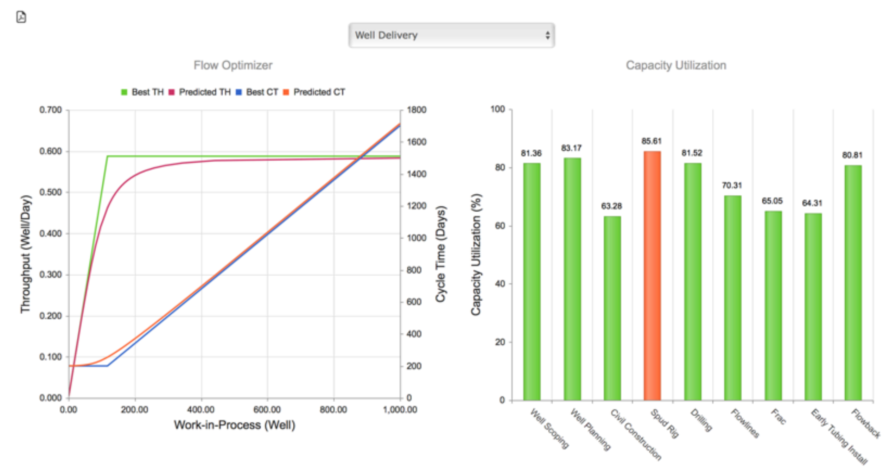
PROJECT PRODUCTION INSTITUTE


Line of Balance
SOR Comp RTB RF Flowlines RFSR RTD RF Cellars RTF RFCT RFETI RFFB HO to Prod
Pads
No. of Work-Days


Cycle Time (Days)
WS - FB

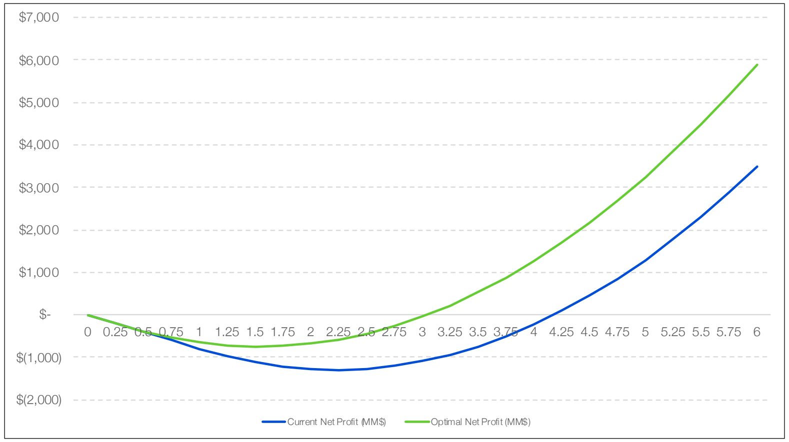

Cycle Time Statistics
Cycle Time (Days)
WS
WS - WP
WP
WP - CC
CC
CC - FL
FL
FL - SR
SR
SR - DR
DR
DR - CR
CR
CR - FR
FR
FR - CT
CT
CT - ETI
ETI
ETI - FB
FB


Work-in-Process Trend (WS-FB)
WIP
Pads
No. of Work-Days

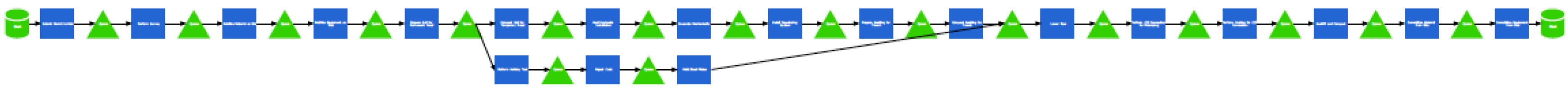

Well Delivery
Flow Optimizer
Best TH Predicted TH Best CT Predicted CT
Throughput (Well/Day)
Cycle Time (Days)
Work-in-Process (Well)
Capacity Utilization
Capacity Utilization (%)
81.36
83.17
63.28
85.61
81.52
70.31
65.05
64.31
80.81
Well Scoping
Well Planning
Civil Construction
Spud Rig
Drilling
Flowlines
Frac
Early Tubing Install
Flowback

Potential Benefit

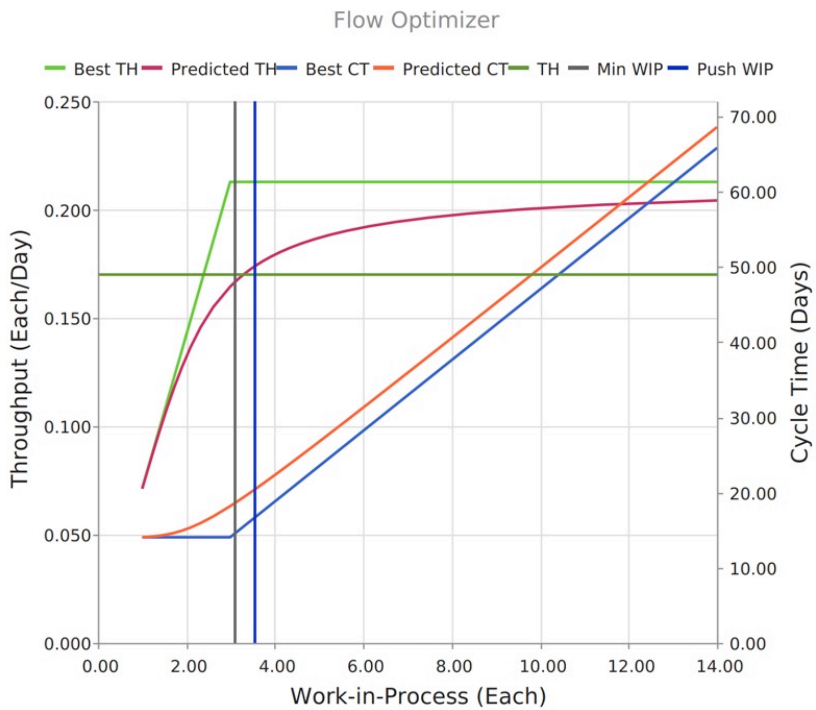
PERFORMANCE MEASURE	CURRENT	OPTIMAL	DIFF
Wells Per Year	177.29	177.29	--
Production Cost per Day	$2,189,322	$1,776,363	-18.9%
Production Cost per Year	$799,102,577	$648,372,386	-18.9%
Cycle Time (days)	372.82	126.43	-66.1%
WIP (Wells)	181.08	61.41	-66.1%
WIP ($)	$213,317,821	$72,337,099	-66.1%
Cost Per Year	$831,100,250	$659,222,951	-20.7%
Cost Per Well	$4,687,914	$3,718,421	-20.7%
Months until first well	12	4	-66.1%
Wells Produced After 3 Years	350.77	470.45	34.1%
Production After 3 Years (boe)	37,998,043	68,349,940	79.9%
Profit After 3 Years	$1,308,399,264	$2,353,516,257	79.9%

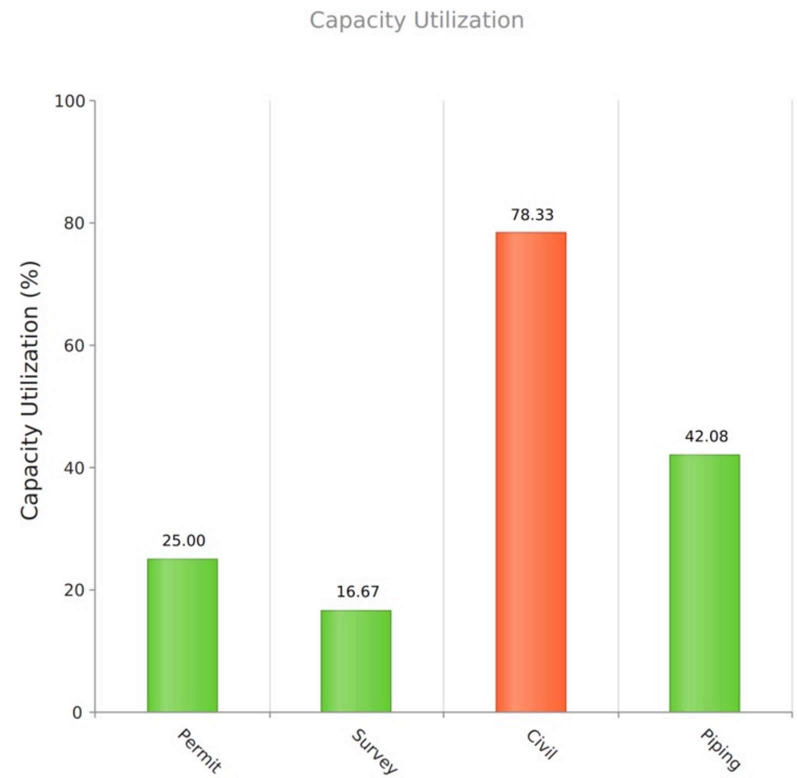


PIPELINE CROSSINGS



Pipeline





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Project Production Control

Ensure production system behaves in accordance with objectives (i.e., effective allocation of resources, management of variability)

NOT Project Controls

Project Controls

Report and forecast progress

Accounting

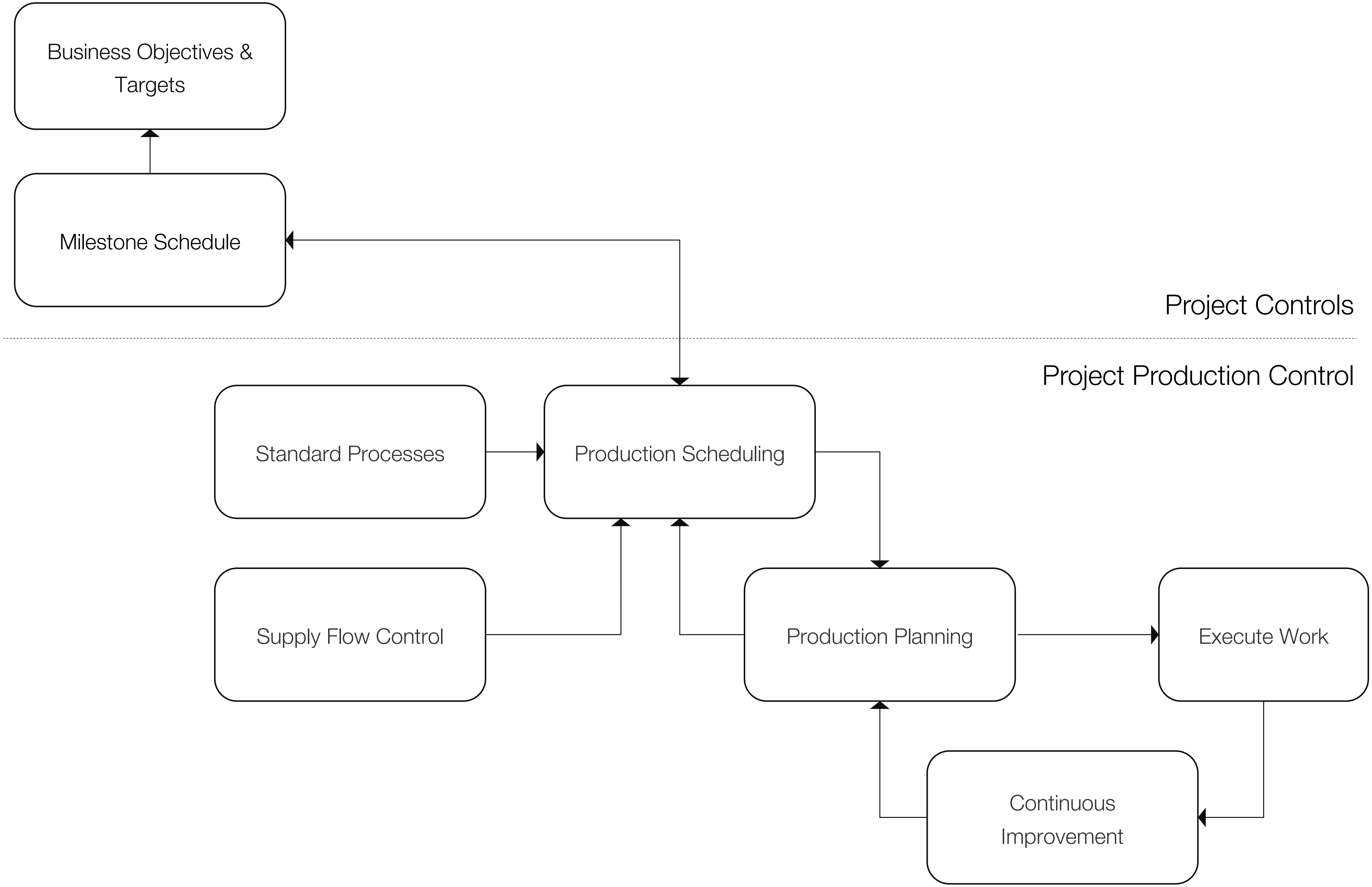
Project Production Control

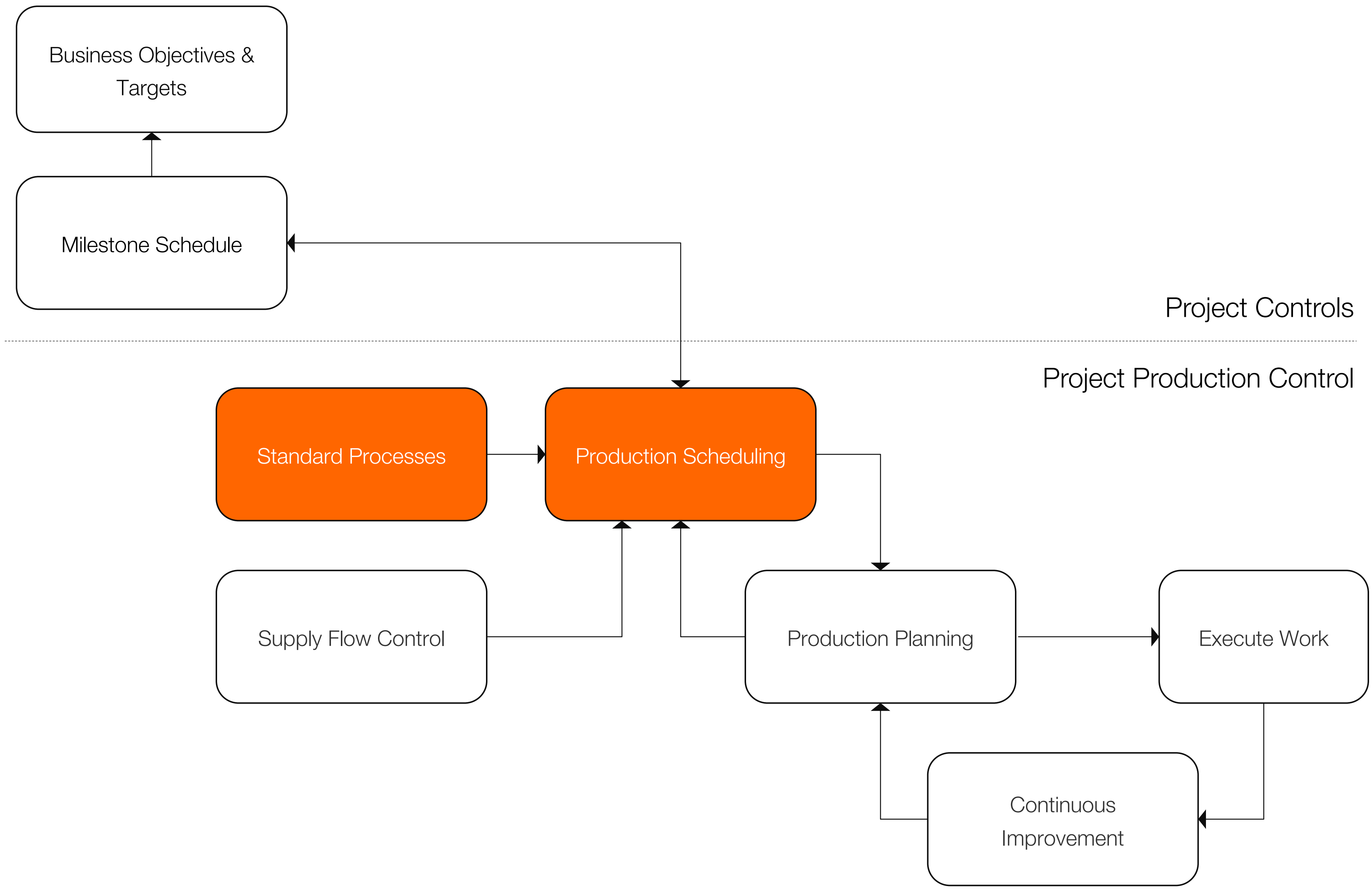
Plan, control and improve work

Operations Science

“…The word ‘controls’ is not the plural of the word ‘control’ … the two words have different meanings altogether. The synonyms for controls are ‘measurements’ and ‘information’. The synonym for control is direction … Controls deal with facts, that is with events of the past. Control deals with expectations, that is, with the future”

Peter Drucker


Business Objectives &
Targets
Milestone Schedule
Project Controls
Project Production Control
Standard Processes
Production Scheduling
Supply Flow Control
Production Planning
Execute Work
Continuous
Improvement

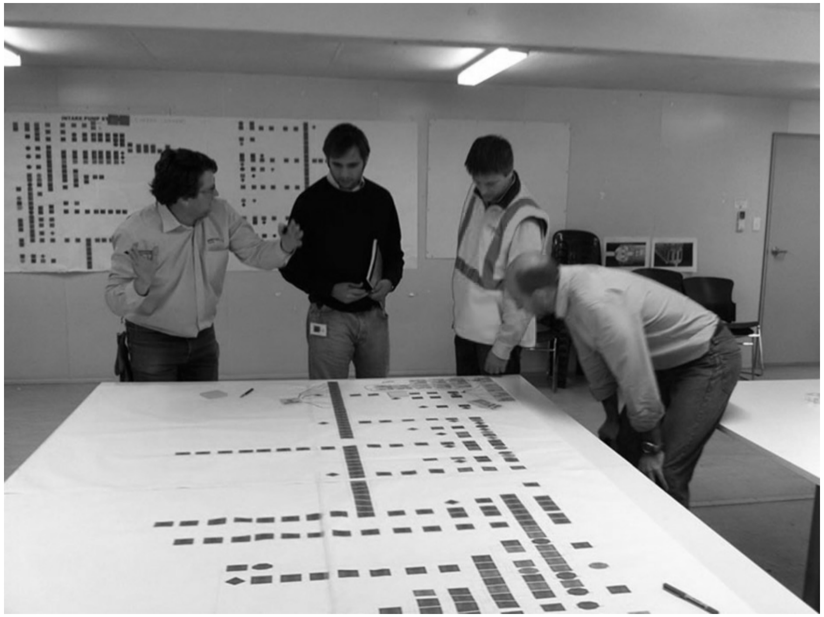

Business Objectives & Targets
Milestone Schedule
Project Controls
Project Production Control
Standard Processes
Production Scheduling
Supply Flow Control
Production Planning
Execute Work
Continuous Improvement

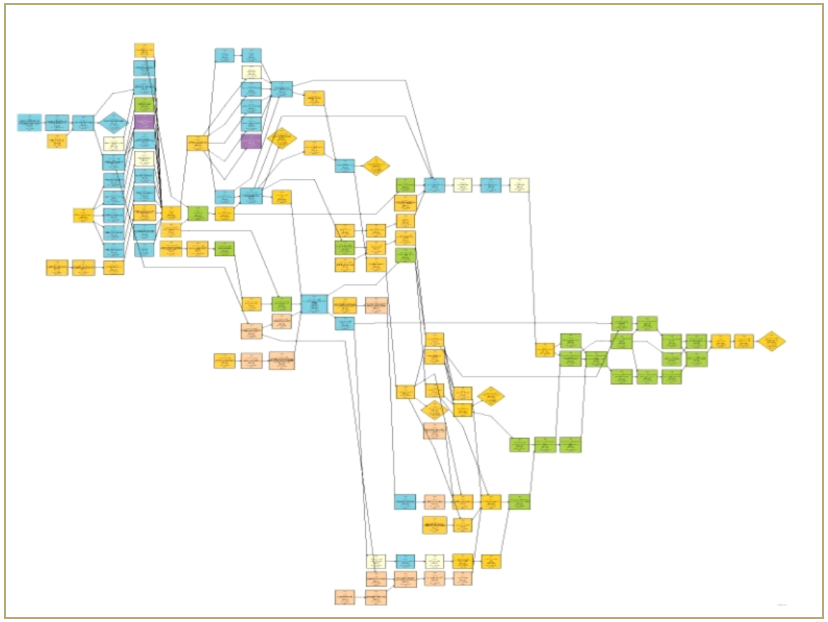
STANDARD PROCESSES

Buildable and repeatable sequence of work that combines all physical work and any type of support work

Unit of Production + Standard Work Sequence

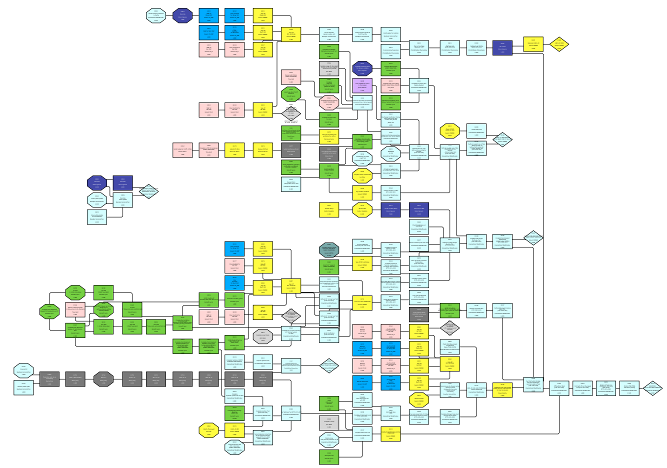
Standard Product vs. Standard Process





PRODUCTION SCHEDULING

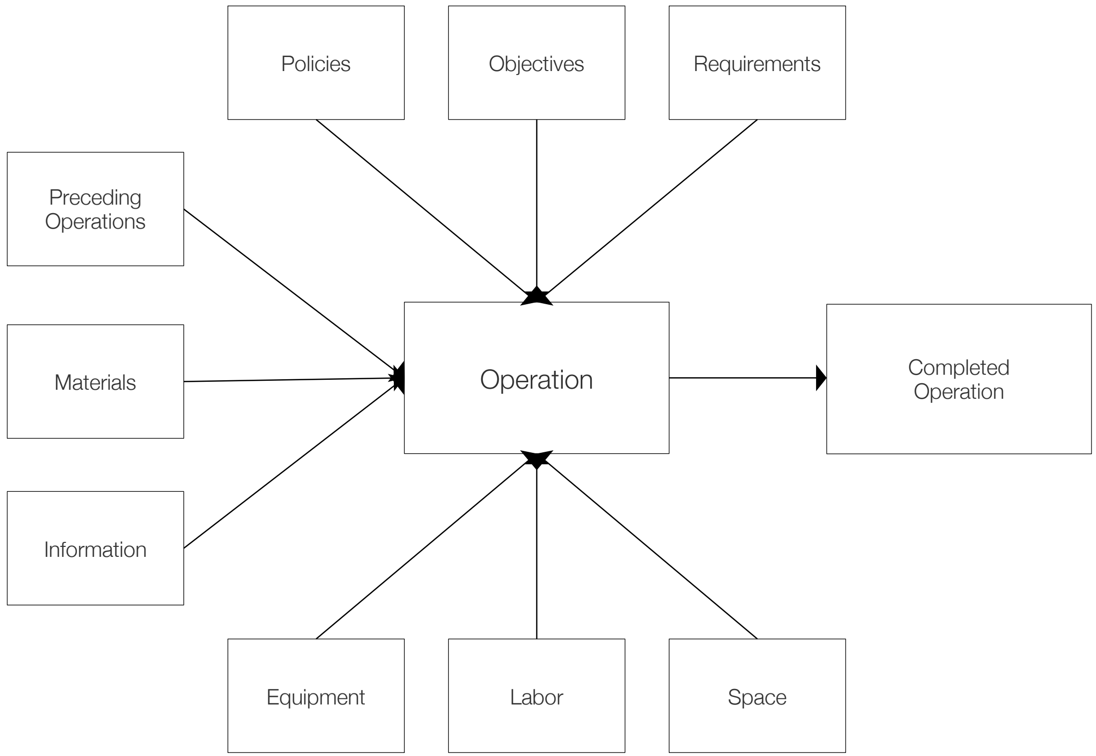
A Production Schedule is the optimal combination of standard processes and one-off processes including production constraints required to meet a production milestone by the LRM date



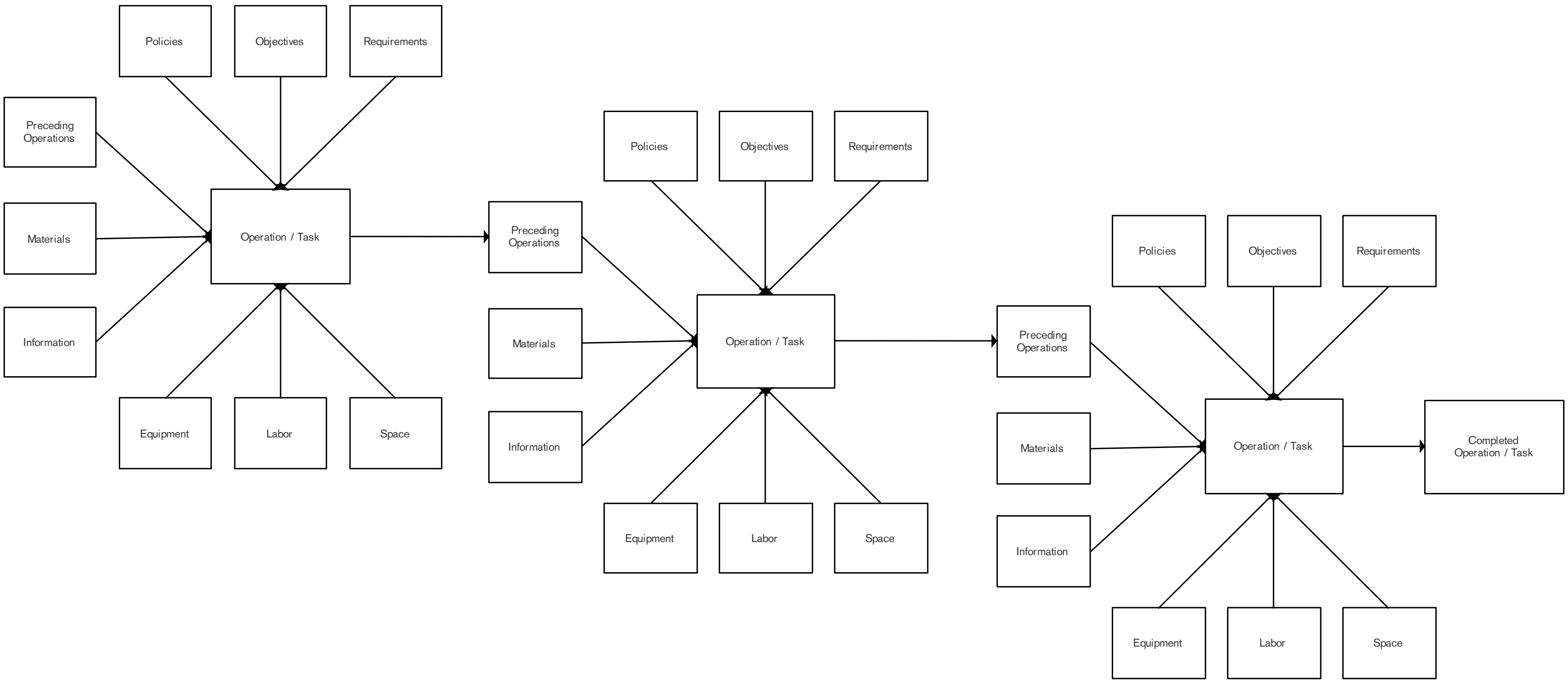
Production Scheduling Session

Integrated Production Schedule

Production Schedules are developed collaboratively with involvement of all required disciplines and by those directly responsible for the work

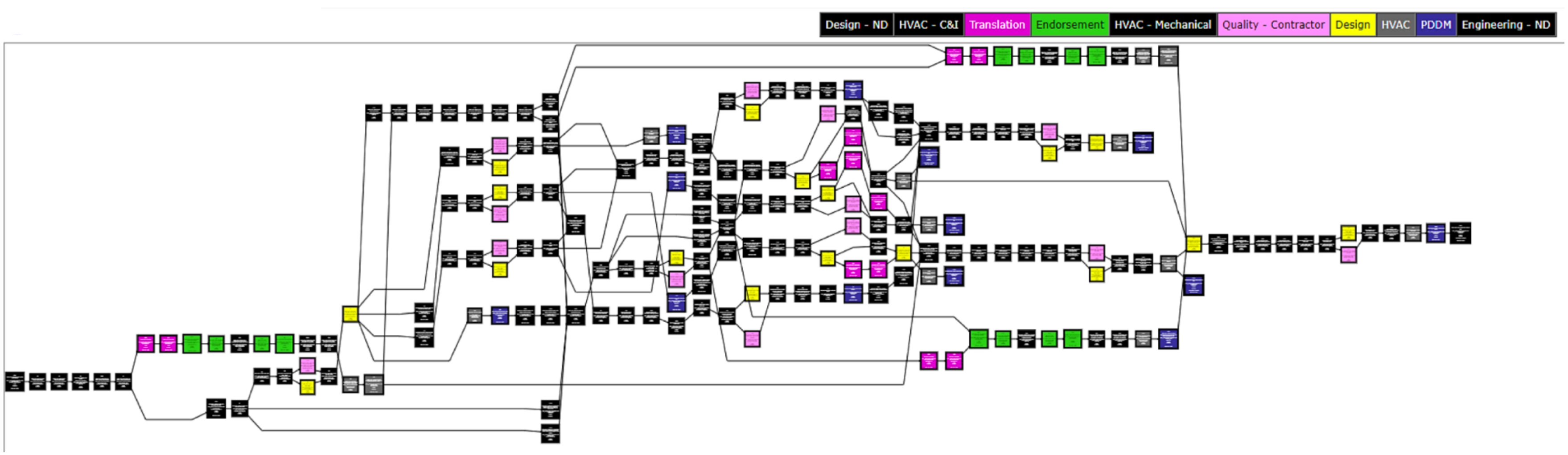


Can an operation be performed as planned?

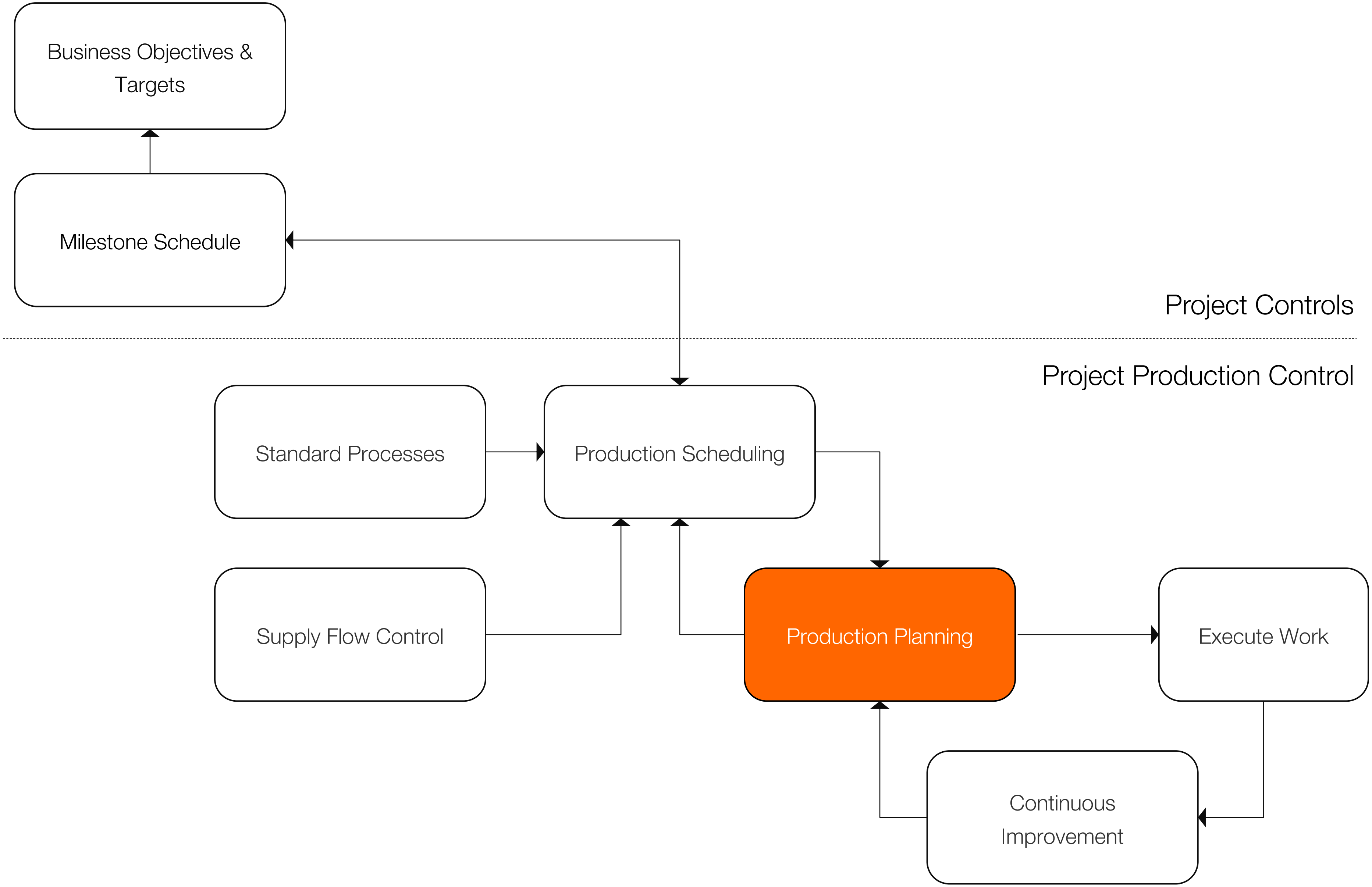


Do we understand interdependencies and constraints in order to minimize variability?

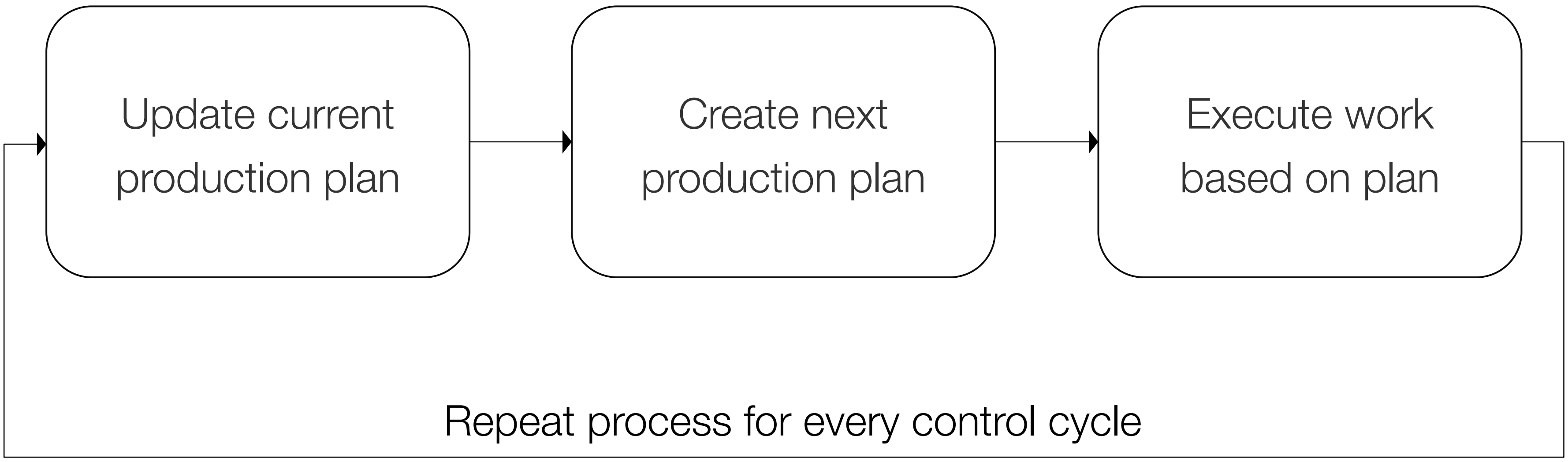
Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
PLC data available (FB-area)	Wiring PLC vendor data into SPI (ND)	Assign template (ND)	Generate layout, perform self-check, do the checking and issue for FB/HO review (ND)	FB/HO to do the review and send back to ND (FB-area)	Incorporate FB/HO review. Comments if any and send final copy to PDDM for issue (ND)	Issue on POL (ND-area and PDDM)



PROJECT PRODUCTION INSTITUTE



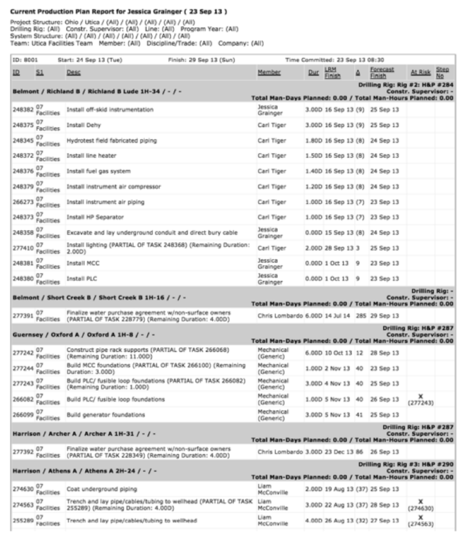
PROJECT PRODUCTION INSTITUTE


Update current production plan
Create next production plan
Execute work based on plan
Repeat process for every control cycle

Type of Work	Process	Recommended Control Cycle
Knowledge	Design / Engineering	Weekly
	Support Processes (e.g., Procurement)	
Craft	Fabrication & Assembly	Daily / Shift
	Construction & Commissioning	
	Turnaround / Routine Maintenance	

Daily Production Planning

Daily Production Plan



Current Production Plan Report for Jessica Grainger (23 Sep 13)

Project Structure: Ohio / Utica / (All) / (All) / (All) / (All) / (All)
Drilling Rig: (All) Constr. Supervisor: (All) Line: (All) Program Year: (All)
System Structure: (All) / (All) / (All) / (All) / (All) / (All) / (All)
Team: Utica Facilities Team Member: (All) Discipline/Trade: (All) Company: (All)

ID: 8001 Start: 24 Sep 13 (Tue) Finish: 29 Sep 13 (Sun) Time Committed: 23 Sep 13 08:30

ID	S1	Desc	Member	Dur	LRM Finish	Δ	Forecast Finish	At Risk	Step No
Belmont / Richland B / Richland B Lude 1H-34 / - / -							**Drilling Rig: Rig #2: H&P #284 Constr. Supervisor: - Total Man-Days Planned: 0.00 / Total Man-Hours Planned: 0.00**		
248382	07 Facilities	Install off-skid instrumentation	Jessica Grainger	3.00D	16 Sep 13	(9)	25 Sep 13		
248375	07 Facilities	Install Dehy	Carl Tiger	3.00D	16 Sep 13	(9)	25 Sep 13		
248345	07 Facilities	Hydrotest field fabricated piping	Carl Tiger	1.80D	16 Sep 13	(8)	24 Sep 13		
248372	07 Facilities	Install line heater	Carl Tiger	1.50D	16 Sep 13	(8)	24 Sep 13		
248376	07 Facilities	Install fuel gas system	Carl Tiger	1.40D	16 Sep 13	(8)	24 Sep 13		
248379	07 Facilities	Install instrument air compressor	Carl Tiger	1.20D	16 Sep 13	(8)	24 Sep 13		
266273	07 Facilities	Install instrument air piping	Carl Tiger	1.00D	16 Sep 13	(7)	23 Sep 13		
248373	07 Facilities	Install HP Separator	Carl Tiger	1.00D	16 Sep 13	(7)	23 Sep 13		
248358	07 Facilities	Excavate and lay underground conduit and direct bury cable	Jessica Grainger	0.00D	15 Sep 13	(8)	24 Sep 13		
277410	07 Facilities	Install lighting (PARTIAL OF TASK 248368) (Remaining Duration: 2.00D)	Carl Tiger	2.00D	28 Sep 13	3	25 Sep 13		
248381	07 Facilities	Install MCC	Jessica Grainger	0.00D	1 Oct 13	9	23 Sep 13		
248380	07 Facilities	Install PLC	Jessica Grainger	0.00D	1 Oct 13	9	23 Sep 13		
Belmont / Short Creek B / Short Creek B 1H-16 / - / -							**Drilling Rig: - Constr. Supervisor: - Total Man-Days Planned: 0.00 / Total Man-Hours Planned: 0.00**		
277391	07 Facilities	Finalize water purchase agreement w/non-surface owners (PARTIAL OF TASK 228779) (Remaining Duration: 4.00D)	Chris Lombardo	6.00D	14 Jul 14	285	29 Sep 13		
Guernsey / Oxford A / Oxford A 1H-8 / - / -							**Drilling Rig: H&P #287 Constr. Supervisor: - Total Man-Days Planned: 0.00 / Total Man-Hours Planned: 0.00**		
277242	07 Facilities	Construct pipe rack supports (PARTIAL OF TASK 266068) (Remaining Duration: 11.00D)	Mechanical (Generic)	6.00D	10 Oct 13	12	28 Sep 13		
277244	07 Facilities	Build MCC foundations (PARTIAL OF TASK 266100) (Remaining Duration: 3.00D)	Mechanical (Generic)	1.00D	2 Nov 13	40	23 Sep 13		
277243	07 Facilities	Build PLC/ fusible loop foundations (PARTIAL OF TASK 266082) (Remaining Duration: 1.00D)	Mechanical (Generic)	3.00D	4 Nov 13	40	25 Sep 13		
266082	07 Facilities	Build PLC/ fusible loop foundations	Mechanical (Generic)	1.00D	5 Nov 13	40	26 Sep 13	X (277243)	
266099	07 Facilities	Build generator foundations	Mechanical (Generic)	3.00D	5 Nov 13	41	25 Sep 13		
Harrison / Archer A / Archer A 1H-31 / - / -							**Drilling Rig: H&P #287 Constr. Supervisor: - Total Man-Days Planned: 0.00 / Total Man-Hours Planned: 0.00**		
277392	07 Facilities	Finalize water purchase agreement w/non-surface owners (PARTIAL OF TASK 228349) (Remaining Duration: 4.00D)	Chris Lombardo	3.00D	23 Dec 13	86	26 Sep 13		
Harrison / Athens A / Athens A 2H-24 / - / -							**Drilling Rig: Rig #3: H&P #290 Constr. Supervisor: - Total Man-Days Planned: 0.00 / Total Man-Hours Planned: 0.00**		
274630	07 Facilities	Coat underground piping	Liam McConville	2.00D	19 Aug 13	(37)	25 Sep 13		
274563	07 Facilities	Trench and lay pipe/cables/tubing to wellhead (PARTIAL OF TASK 255289) (Remaining Duration: 4.00D)	Liam McConville	3.00D	22 Aug 13	(37)	28 Sep 13	X (274630)	
255289	07 Facilities	Trench and lay pipe/cables/tubing to wellhead	Liam McConville	4.00D	26 Aug 13	(32)	27 Sep 13	X (274563)	

Execute Work

Daily Production Planning Cycle

Cross-discipline / functional / company team updates the status of today's work and commits tasks for tomorrow including capacity allocation and integration of field and support tasks

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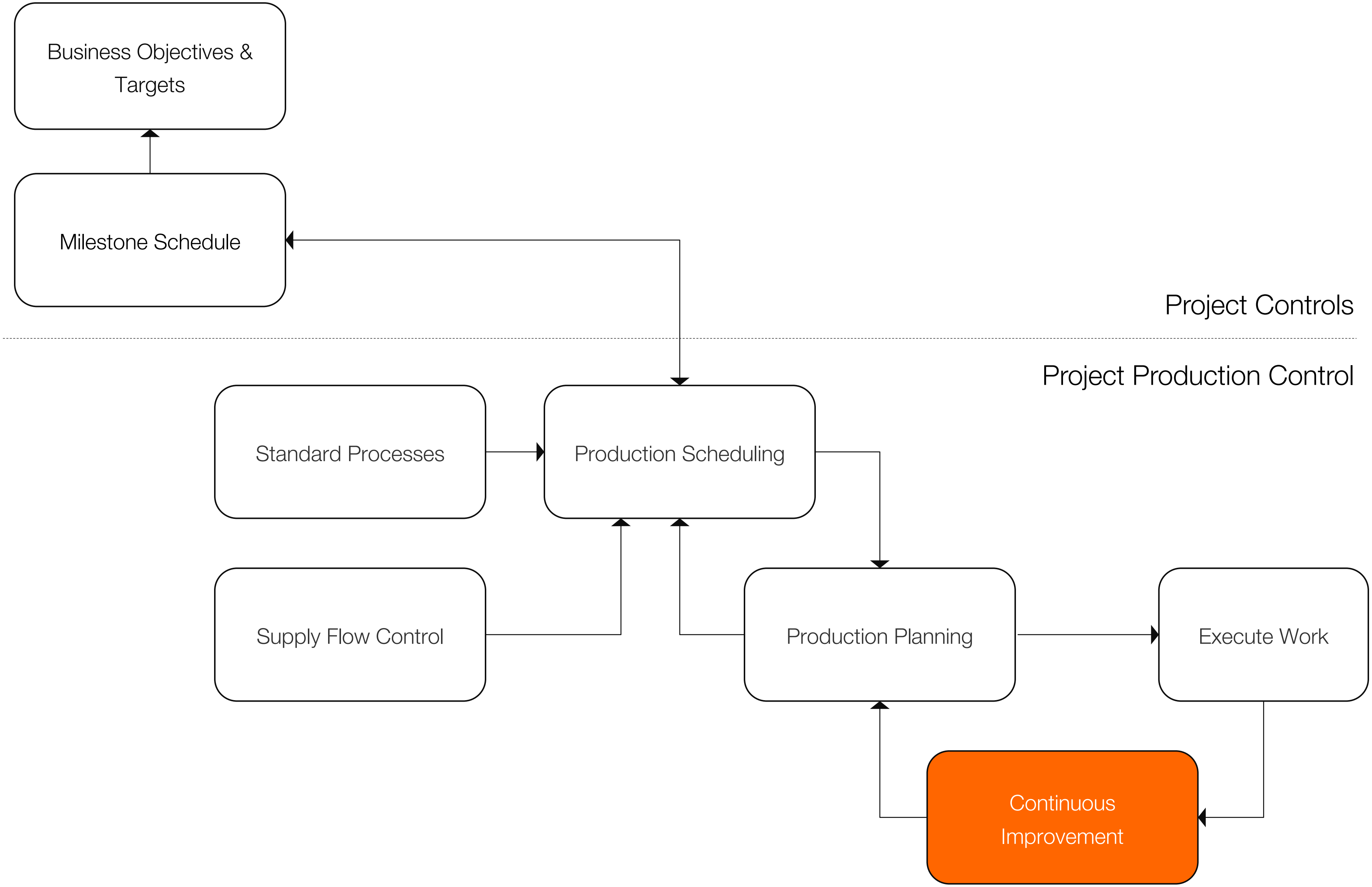

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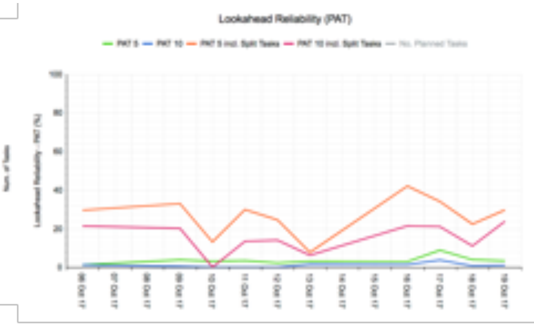

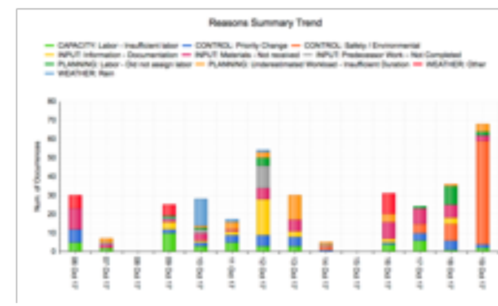

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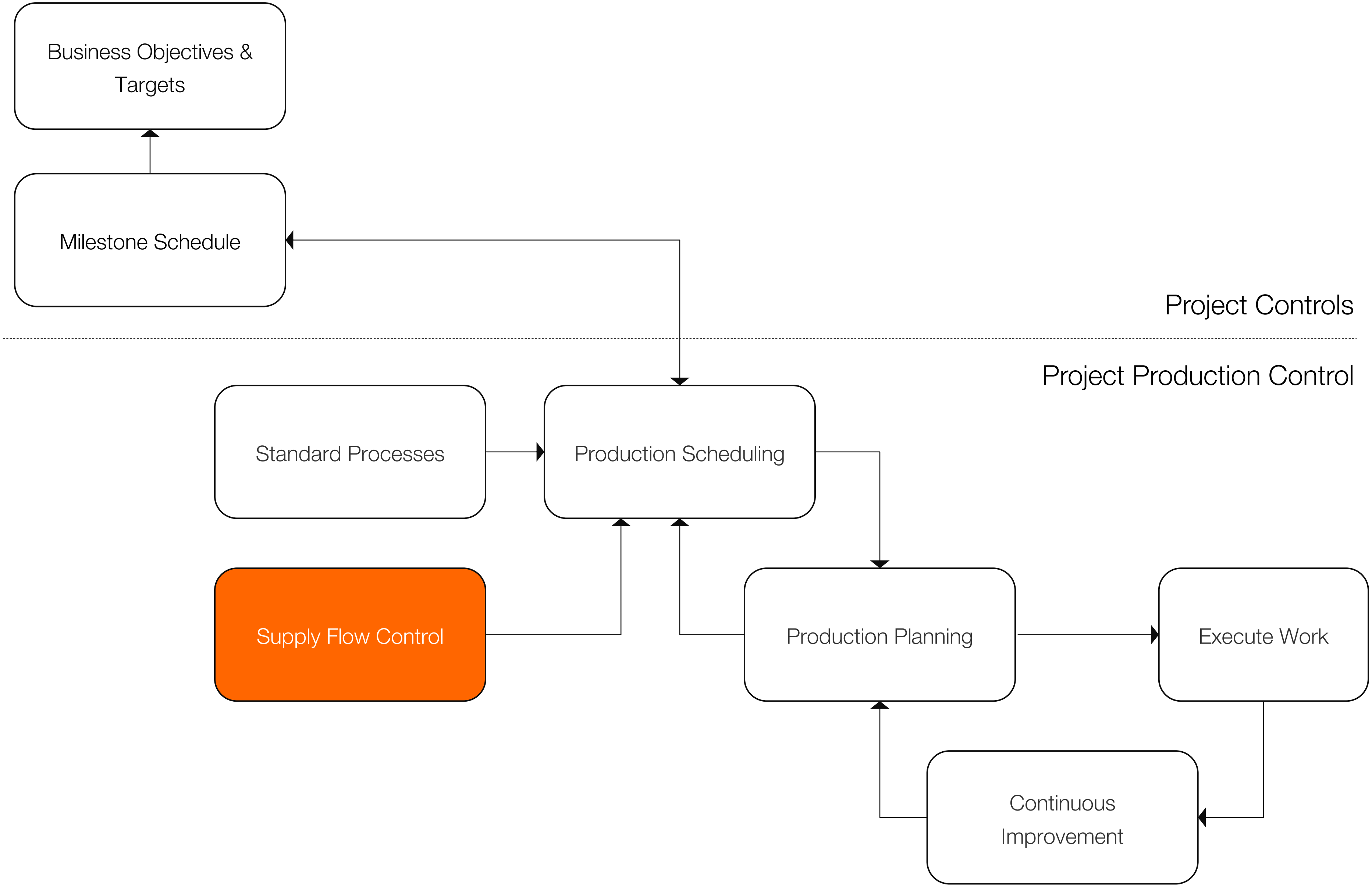
Continuous Improvement


Business Objectives & Targets
Milestone Schedule
Project Controls
Project Production Control
Standard Processes
Production Scheduling
Supply Flow Control
Production Planning
Execute Work
Continuous Improvement

How to effectively synchronize supply with demand?

Conventional Thinking - *"Better looking at it than looking for it"*

Use of large volumes of inventory as the means to synchronize

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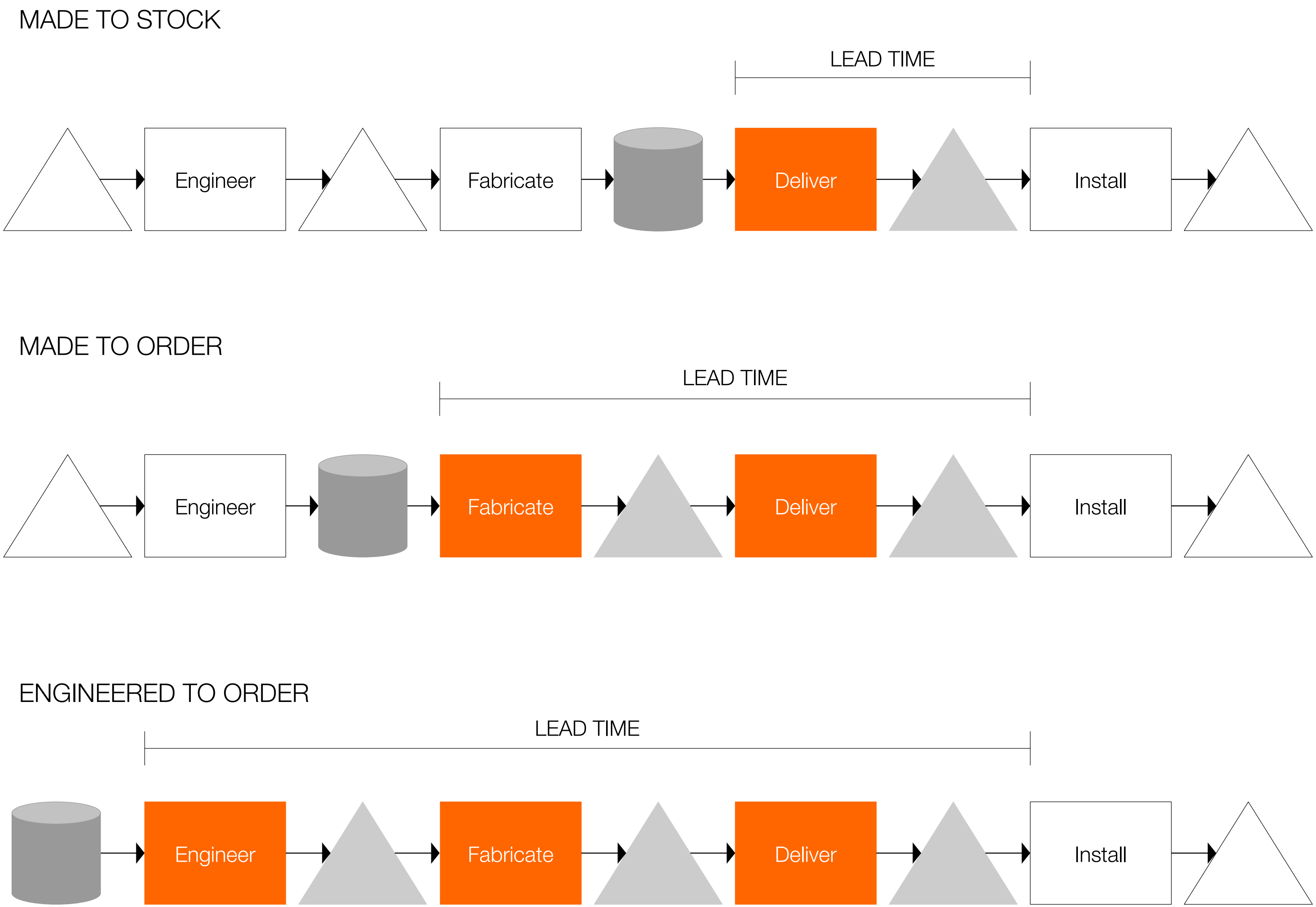
Types of Supply

Made to Stock

Made to Order

Engineered to Order



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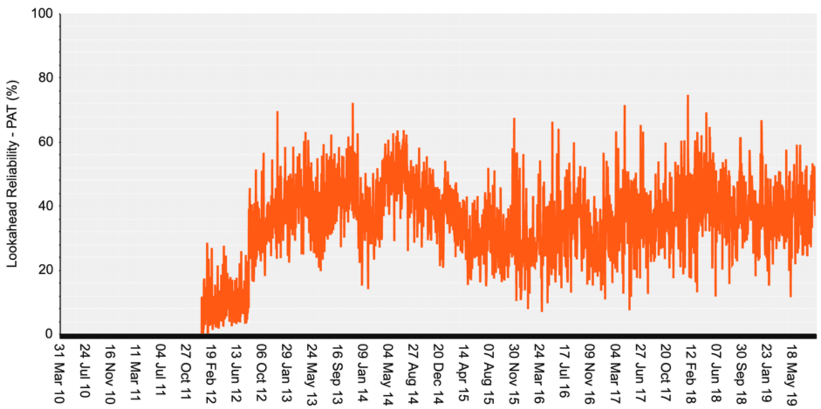
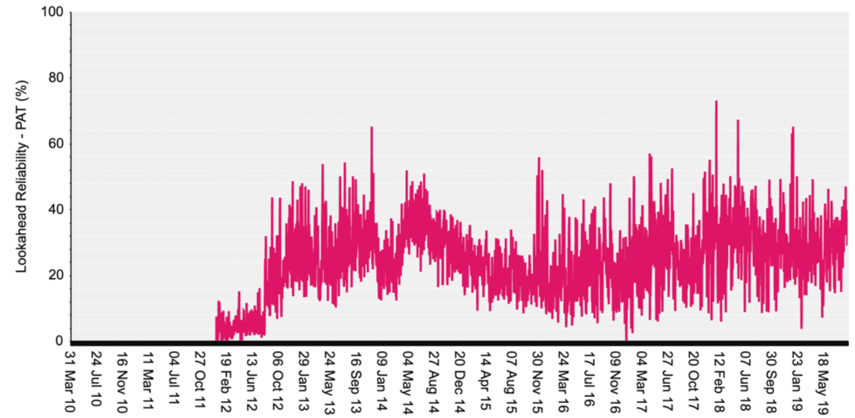
17% - 35%



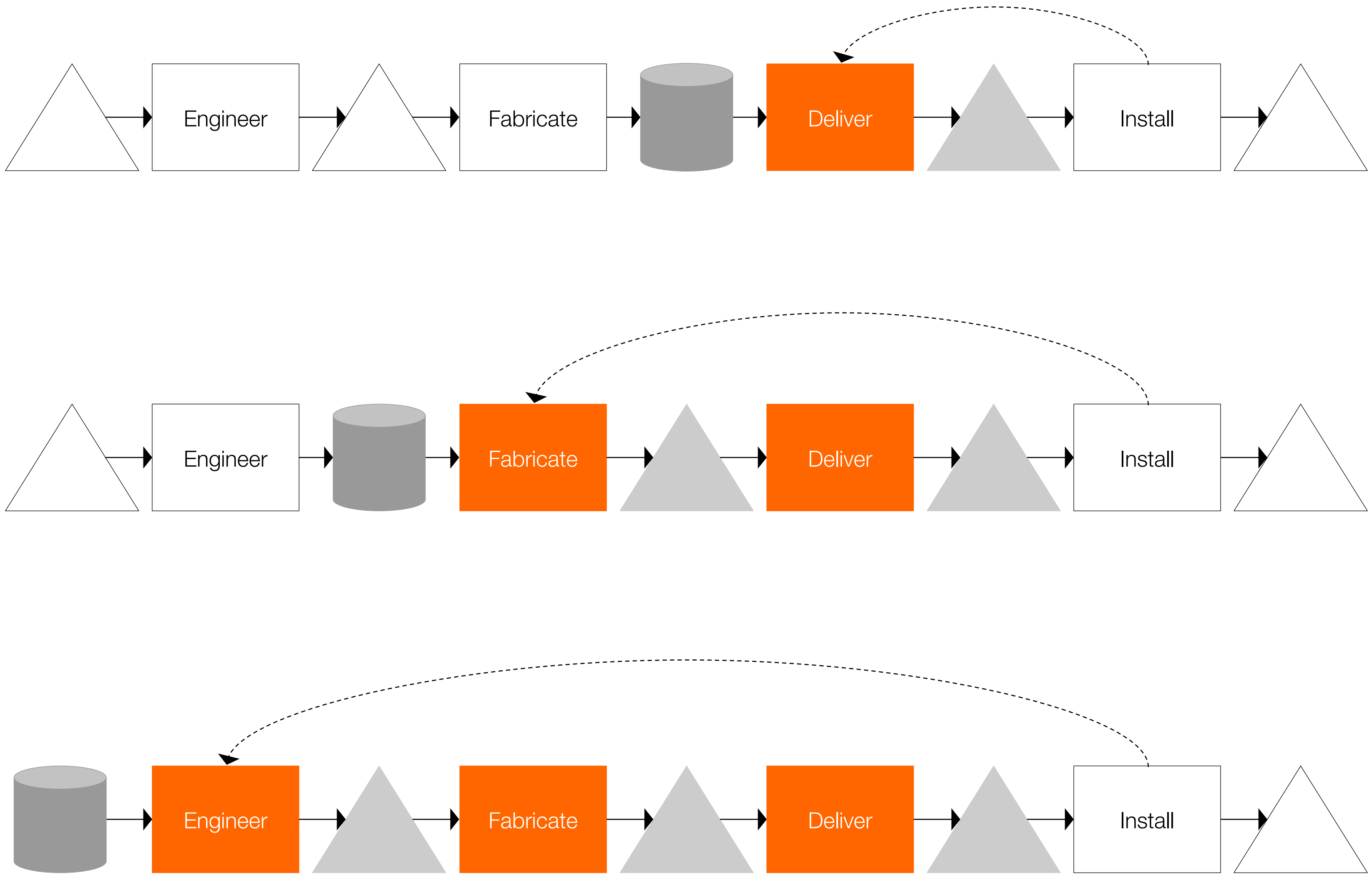
5 days

7% - 24%



10 days

Lookahead Reliability



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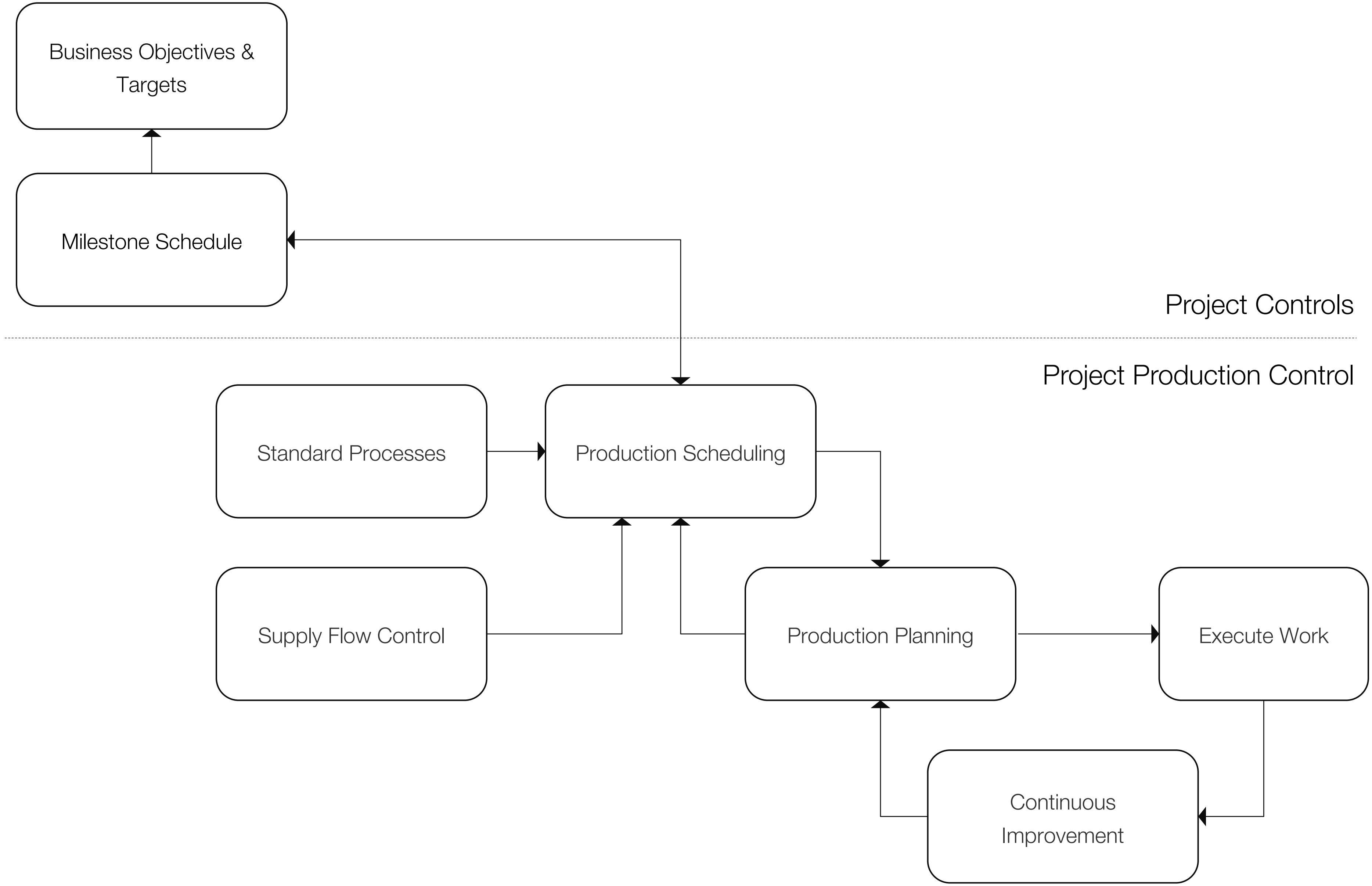

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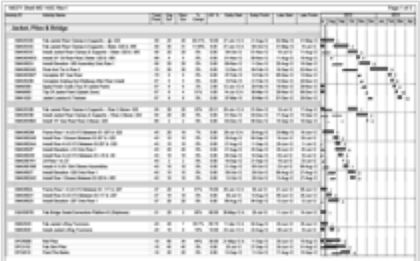
PROJECT PRODUCTION CONTROL FOR FABRICATION



Project Controls

Project Production Control

Production Scheduling
(Use of Standard Processes)

Performance Indicators

Production Planning

Work Execution

Production Plan

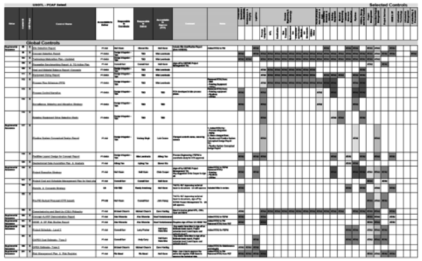
Production Planning

Execute Work

Production Planning Cycle

Shared Fabrication Capacity- "You are not the only customer"

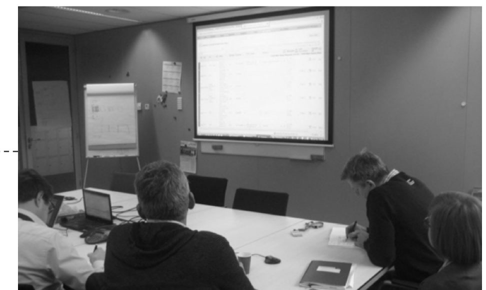
PROJECT PRODUCTION CONTROL FOR ENGINEERING



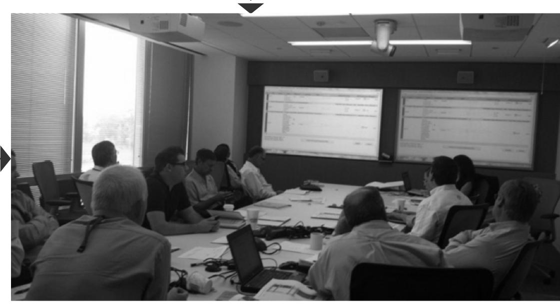
PROJECT CONTROLS

PROJECT PRODUCTION CONTROL

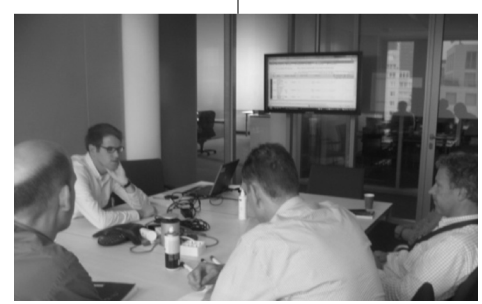
Production Scheduling
(Use of Standard Processes)



Performance Indicators



Production Planning

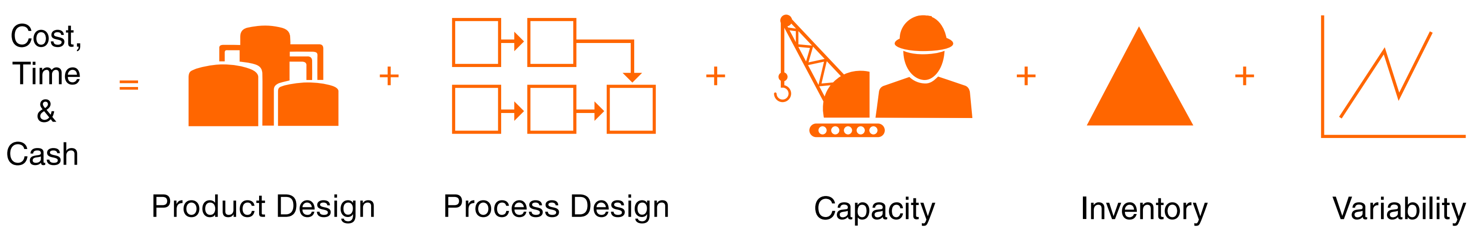


Work Execution

Computer-Aided Production Engineering

Reduce cost and time through effective design of standard operations and processes (standard work)

Fabrication, logistics and construction / commissioning operations



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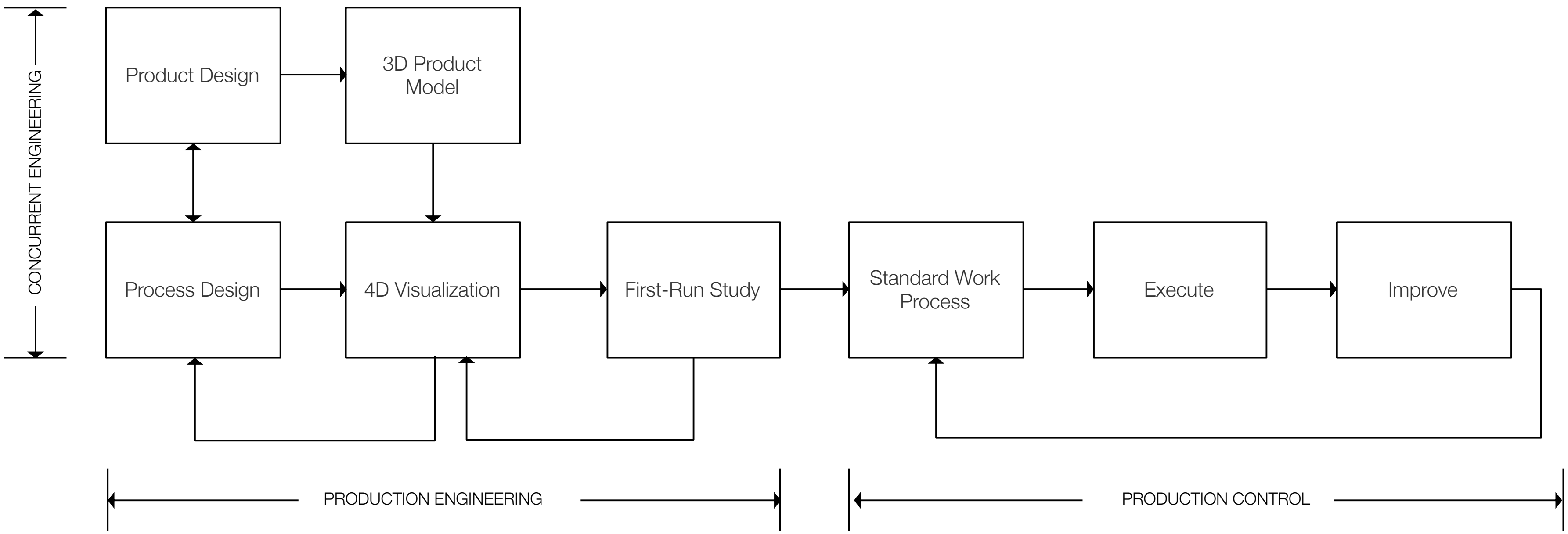
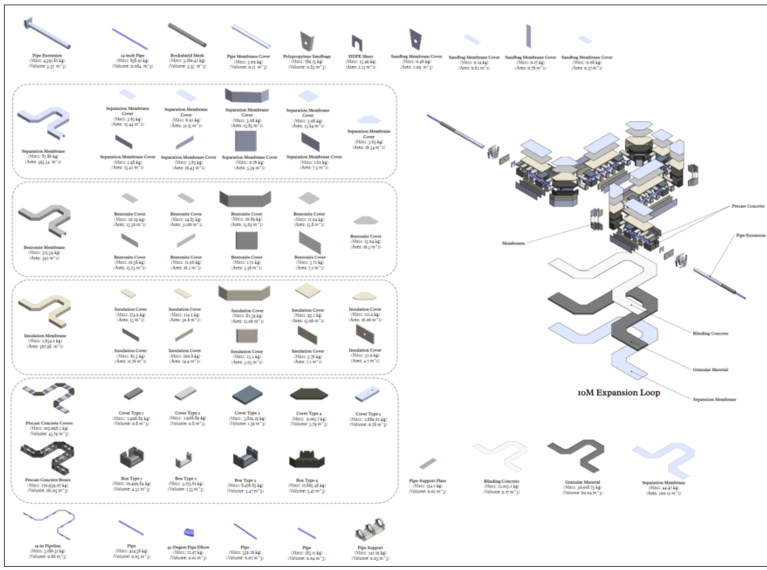
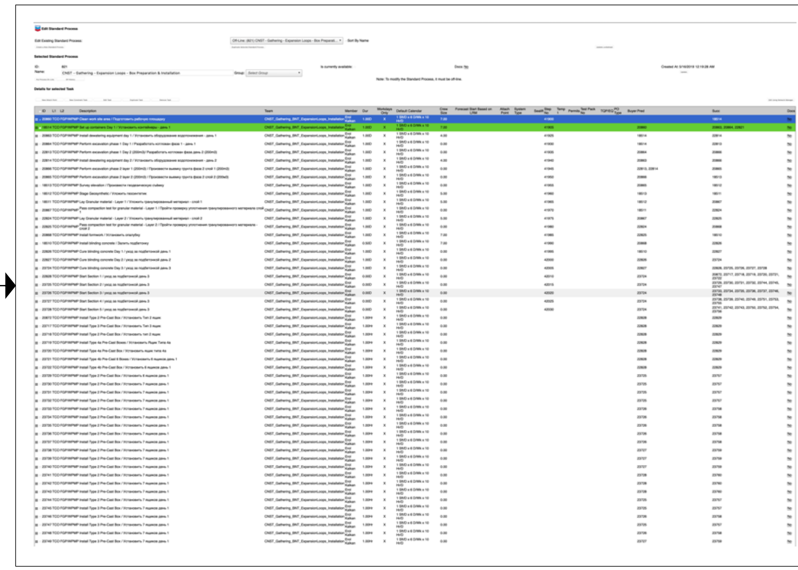

CONCURRENT ENGINEERING
Product Design
3D Product Model
Process Design
4D Visualization
First-Run Study
Standard Work Process
Execute
Improve
PRODUCTION ENGINEERING
PRODUCTION CONTROL

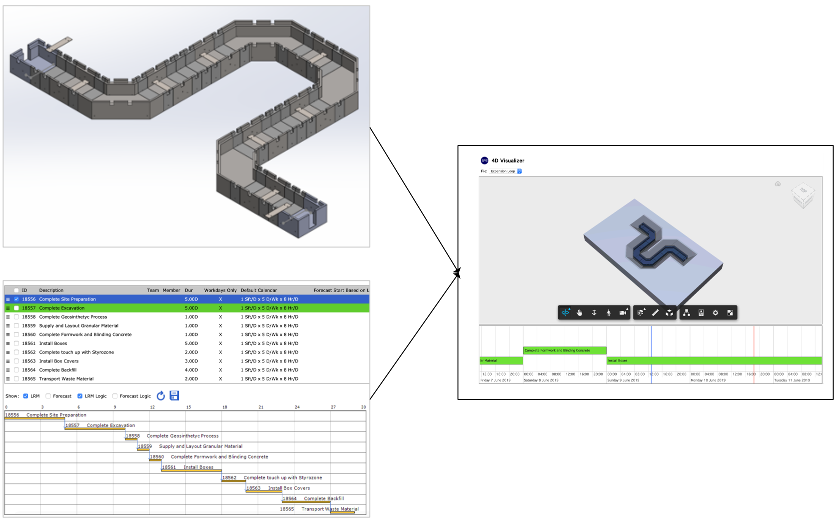


Bill of Material (BOM)

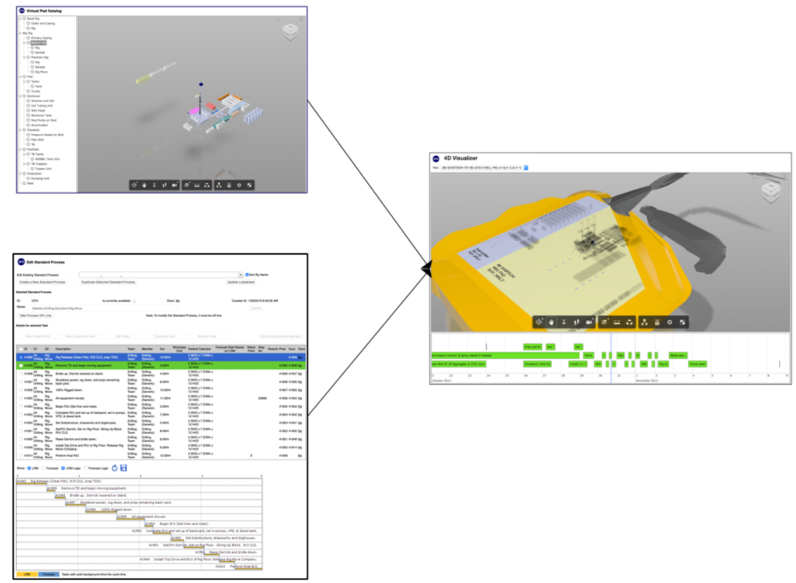


Bill of Process (BOP)

4D Visualizations



Construction Process



Equipment Use (Space / Time Conflict)

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Aggregated Steps	Detailed Process Steps	Tools / Equipment	# of Workers per Action	Total Minutes Per Step	Total Worker Minutes Per Step
1. Prep First Lift Site (in parallel)	Position crane	Crane	2	25	50
	Position truck	Truck	2	3	6
	Supply support equipment	Crane, Slings, hook tool, Lift Frame, Spacers, Ladder, tag lines	1	10	10
2. Load T3/T2 Truck	Load T3 box	Crane, Truck, , Lift Frame, Spacers, Ladder, tag lines	6	6.10	36.6
	Load first T2 box	Crane, Slings, hook tool, Lift Frame, Spacers, Ladder, tag lines	6	10.8	64.8
	Load second T2 box	Crane, Slings, hook tool, Lift Frame, Spacers, Ladder, tag lines	6	7.9	47.4
3. Prep Second Lift Site (in parallel)	Position crane	Crane	2	22.6	45.2
	Position truck	Truck	2	3	6
4. Load T1 Truck	Load T1 box	Crane, Truck, Lift Frame	6	16.3	97.8
5. Transport Boxes	Transport to site	Truck	Varies Depending on Distance from Yard		
			TOTAL	104.7	363.8

Install T1 box

Install first T2 box with dowel

Place dowel

Install second T2 box

Install T3 box

Continue with Box Installation

$1.83bn desalination plant project – 100 GL annual capacity

Two separable portions, 50% capacity each

First Water – 10% capacity

Works commenced as planned – April 2009

Design and procurement quickly fell behind due to magnitude and complexity

As design and equipment became available the active number of work fronts increased rapidly

Schedule performance began to suffer

Results

MILESTONE EVENT	PROGRAM DATE	ACTUAL DATE	VARIANCE
SP-1 Practical Completion	03 Aug 12	19 July 12	15 days
SP-1 Project Handover	12 Sep 12	28 Aug 12	15 days
SP-2 Practical Completion	12 Nov 12	25 Oct 12	18 days
SP-2 Project Handover	22 Dec 12	04 Dec 12	18 days

Refinery Project – PPM Results (1 of 2)

Operation	Pre-Implementation	Unit	Estimated Production Rate	Hours Above Estimate	Potential Additional Hours	Post-Implementation
Concrete Placing	9.28	Hrs/m3	2.00	+7.28	41,986	1.76
Reinforcement Fixing	17.00	Hrs/ton	12.50	+4.50	10,919	12.48
Formwork Fix & Strike	5.22	Hrs/m2	4.00	+1.22	2,061	3.35

Refinery Project – PPM Results (2 of 2)

Metric	Site 1	Site 2	Site 3	Site 4
Piping	2.5 mhr/lf (~4 Avg Dia In)	4 mhr/lf (~4 Avg Dia In)	2.9 mhr/lf (~6 Avg Dia In)	3.01 mhr/lf
Steel	20.9 mhr/ton	30 mhr/ton	26.7 mhr/ton	46.5 mhr/ton
Concrete	9.2 mhr/cyd	11 mhr/cyd	10.5 mhr/cyd	24.8 mhr/cyd

*Same processing system compared for all sites

Technology Infrastructure Project – PPM Results

ITEM	BEFORE	AFTER*	NEXT CONTINUOUS IMPROVEMENT
Number of Steps	252	97	Minimize steps outside standard process and explore unknown steps
Reliability	0-38%	98%	Sustain reliability levels through control
Cycle Time (PO to Install)	65-220 days	Target 71 days Actual 49 days	Further reduce variability to reduce overall cycle time
Cost	100%	64%	Decrease time for onsite installation to further reduce cost

* Process Optimization and Production Control

Case Problem Revisited

Agenda

Topic	Process	When
Welcome, Session Context & Purpose	Present with Q&A for clarification	8:30 – 9:00
Three Eras of Project Delivery	Present with Q&A for clarification	9:00 – 9:30
Production System Dynamics	Simulate & Debrief	9:30 – 10:30
Break	Take	10:30 – 10:45
Production System Dynamics (Cont.)	Simulate & Debrief	10:45 – 12:00
Lunch	Take	12:00 – 1:00
How Leading Organizations are Benefiting	Present with Q&A for clarification	1:00 – 2:30
Break	Take	2:30 – 2:45
How Leading Organizations are Benefiting (Cont.)	Present with Q&A for clarification	2:45 – 4:30
Wrap Up	Key Takeaways, Plus Delta Analysis	4:30 – 5:00

Key Takeaways

Plus / Delta

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