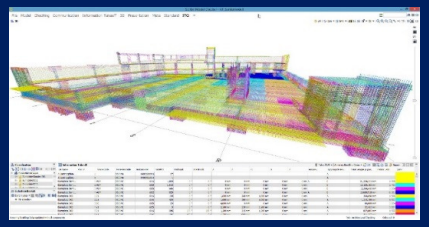
SKANSKA

Virtual Design and Construction in Skanska Norway



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Today's agenda

13:30	Welcome
13:40	VDC at Skanska *Roar Fosse, Skanska Norway*
14:00	Creating High Performance Buildings with VDC *Martin Fischer, CIFE/Stanford University*
14:30	Break
14:40	VDC in production *Henning Habberstad, Skanska*
15:00	Status of Norway's first IPD Project *Ingvald Grindheim, Tønsberg Project*
15:15	Q&A with speakers

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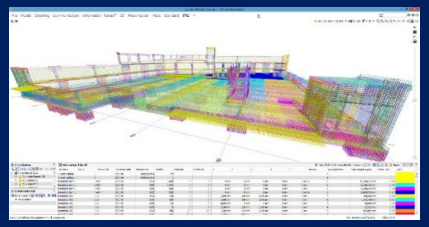
Virtual Design and Construction in Skanska Norway



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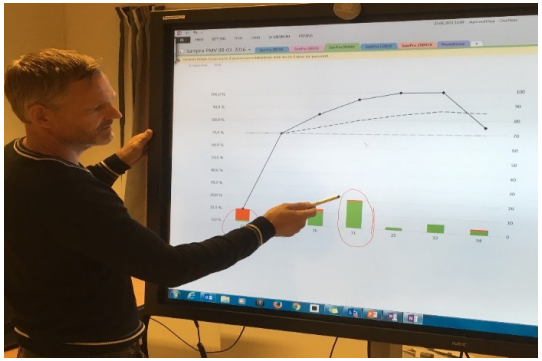
What is our ability to…

…do things correctly the first time and as efficiently as possible?

…measure performance to see trends and challenges in time to fix them?

…support efficient work methods with appropriate technology?



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Virtual Design and Construction (VDC)

Framework for designing, planning and executing construction projects using modern methods and tools.

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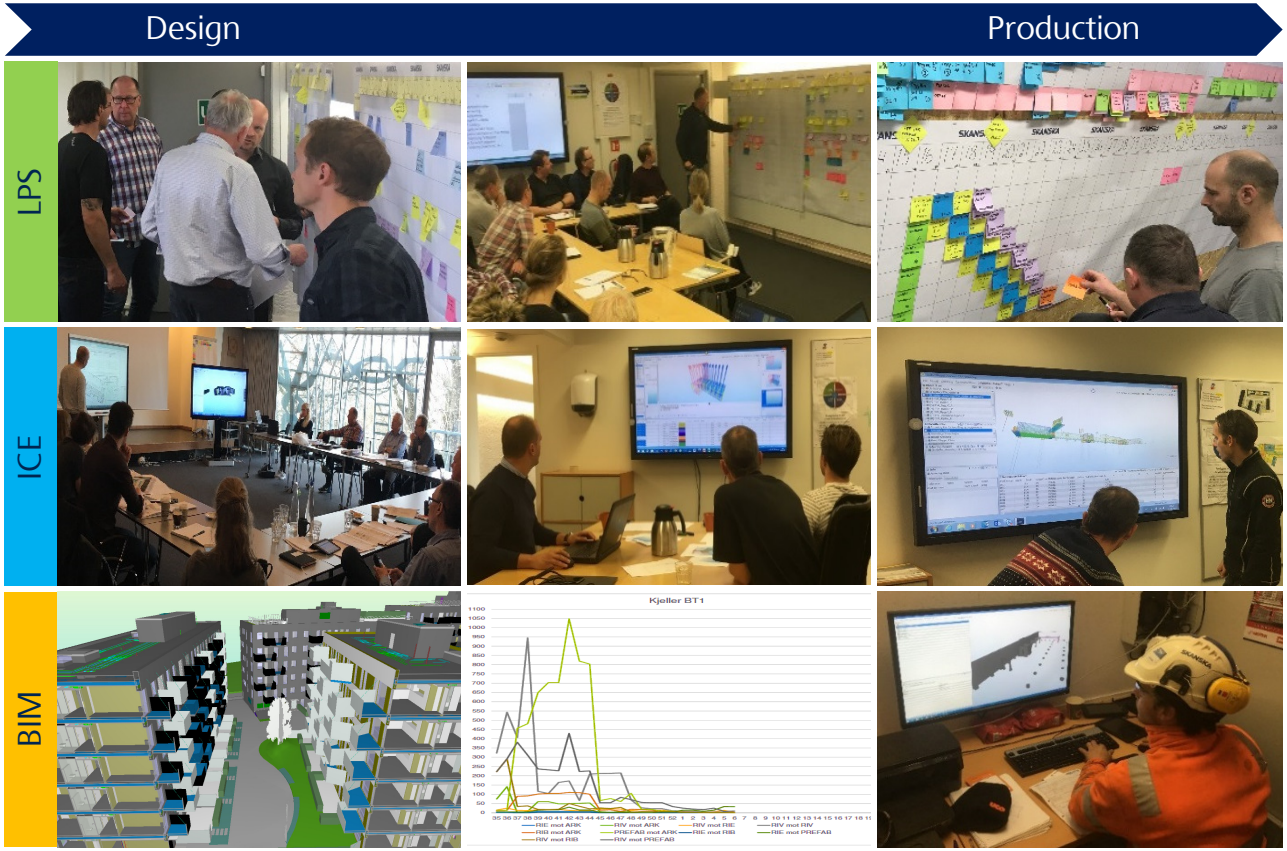
VDC integrates modern practices



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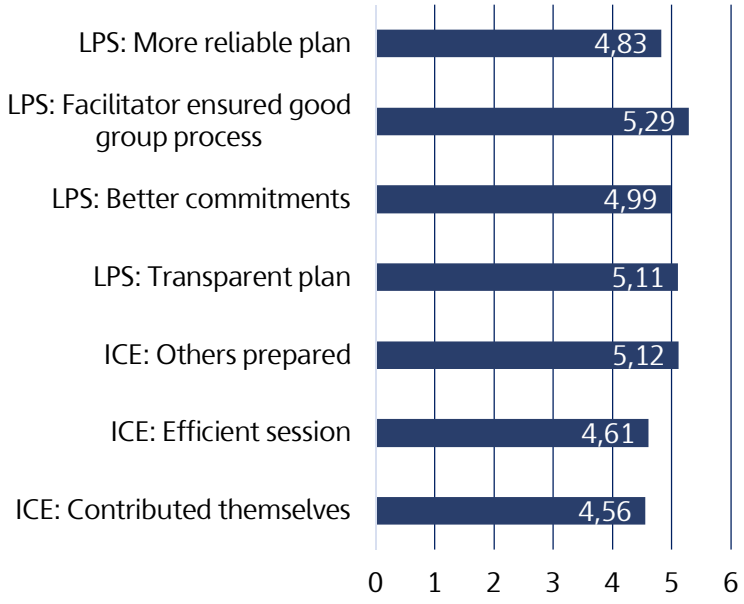
Footprint and benefits of VDC



Pull-plannings
Production: 19
Design: 36

Plan checks
Production: 27
Design: 41

ICE
Sessions: 57
Trained facilitators: 5

Big Rooms
On site: 10
Touch screens: 18

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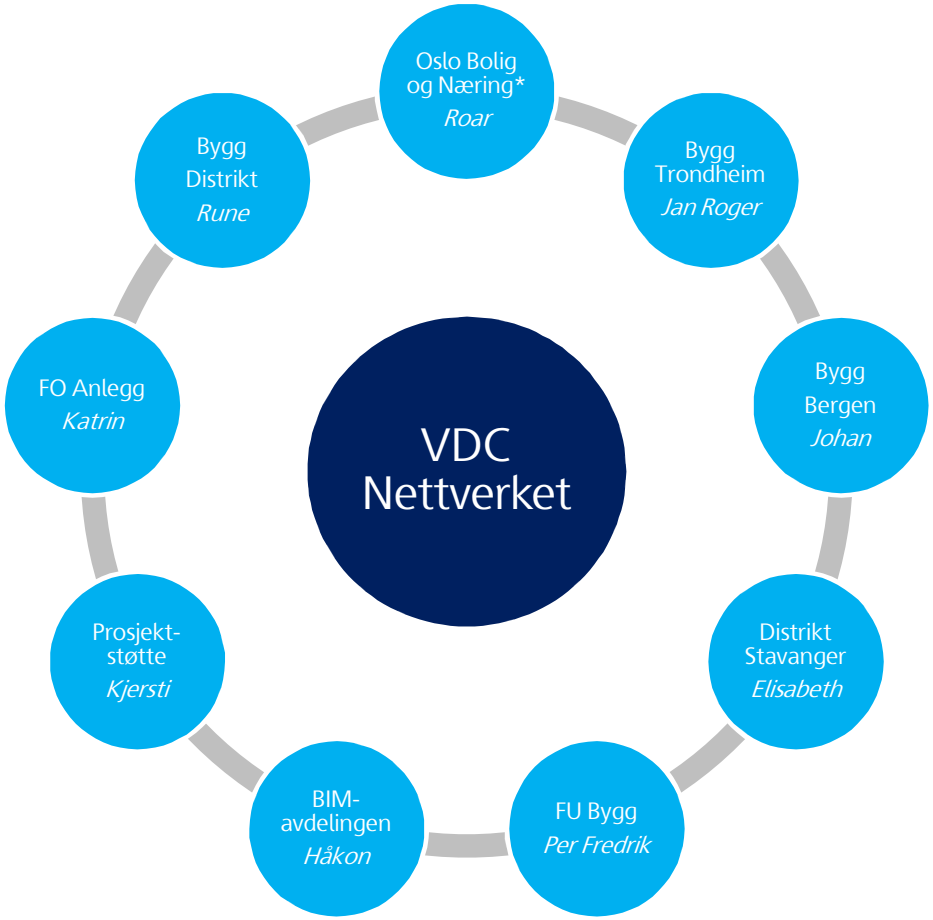
VDC Network



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CIFE/Stanford VDC Certificate Program

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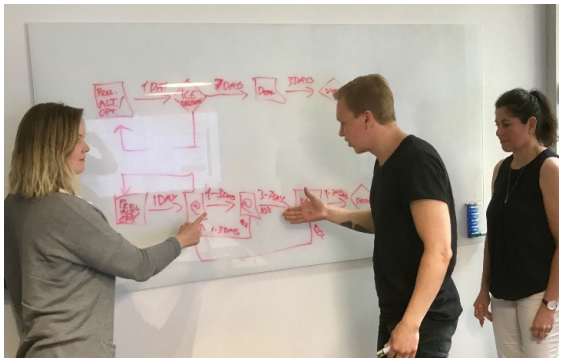
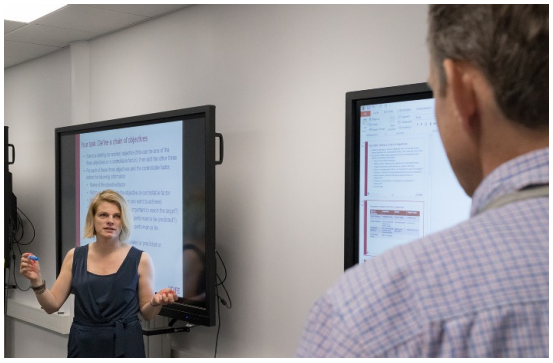
CIFE/Stanford VDC Certificate Program





Creating High-Performing Buildings with VDC

MARTIN FISCHER

PROFESSOR, CIVIL & ENVIRONMENTAL ENGINEERING, STANFORD UNIVERSITY

DIRECTOR, CENTER FOR INTEGRATED FACILITY ENGINEERING (CIFE)

CIFE

- 100% funded by industry
  - Building owners
  - Design and construction companies
  - Software and hardware vendors
- 1988-2000 BIM
- 2000-2010 VDC
- 2010+ Optimize Facility

Vision –
A future I would like to make happen

Every workhour
builds the right product
safely and productively

Definition of Vision by Robert Burgelman, GSB, Stanford

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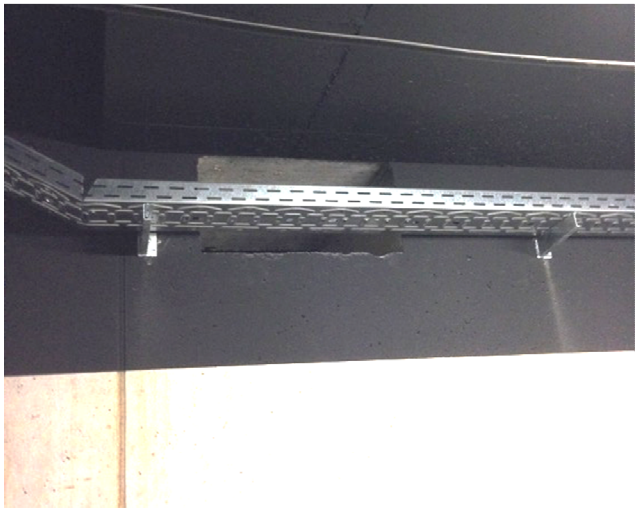
We still produce too much rework …



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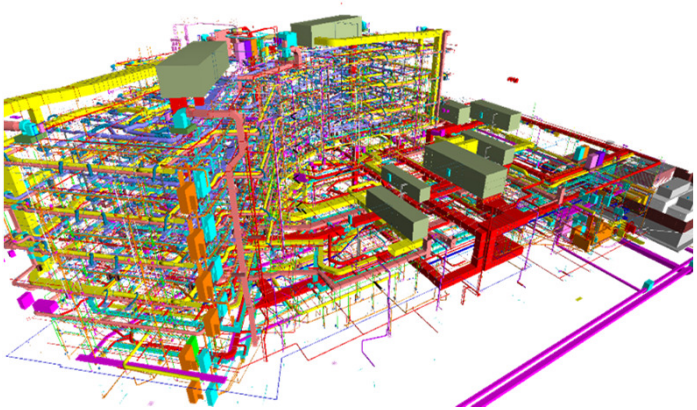
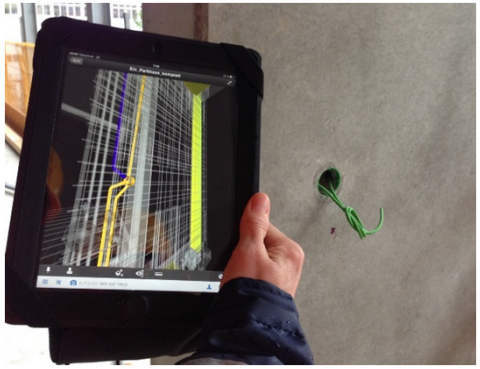
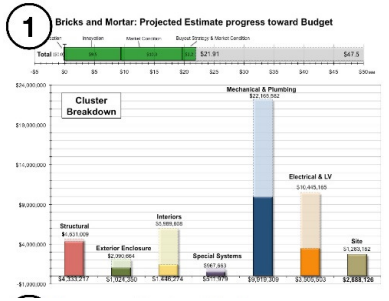
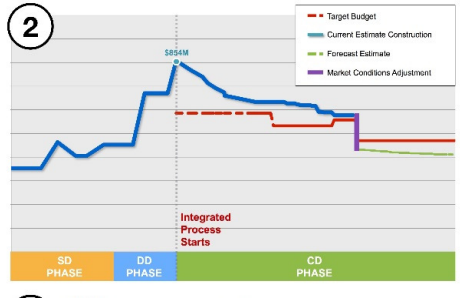
We see many new practices









Pictures courtesy DPR and Max Bögl

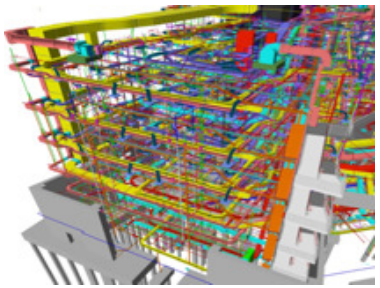
VDC method gave the client everything he wanted

Open whole scope of hospital on budget and 30% earlier than typical

Highly reliable construction

Confirm constructability of detailed design

Combine everyone's detailed design



Everyone works with the same plan

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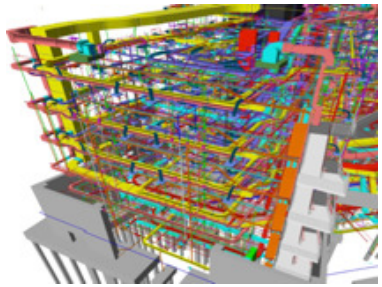
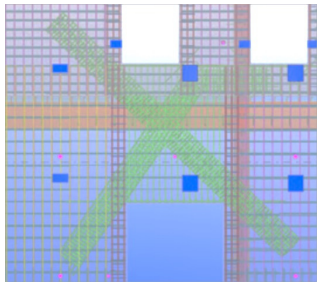
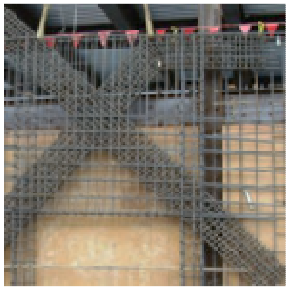
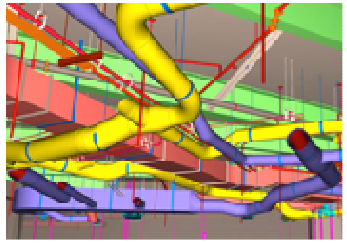
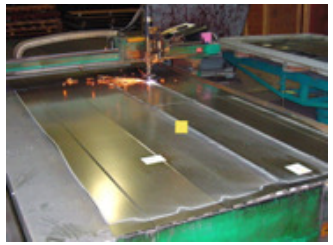
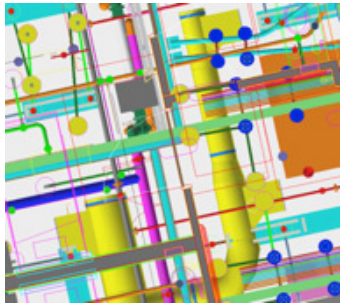
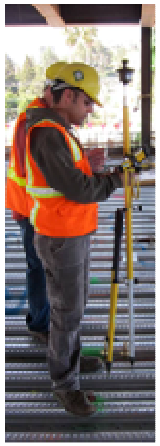
Illustrations of good VDC practice



Courtesy DPR

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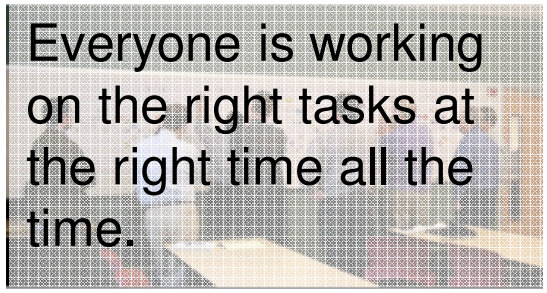
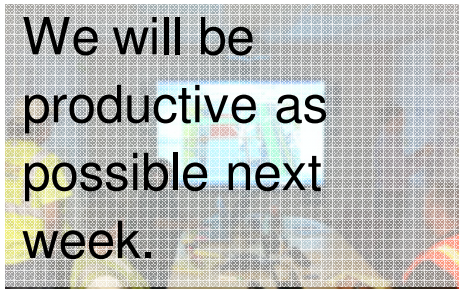
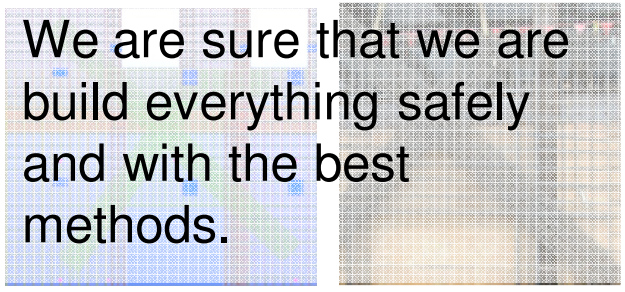
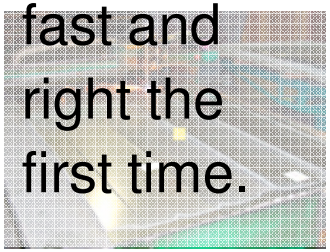
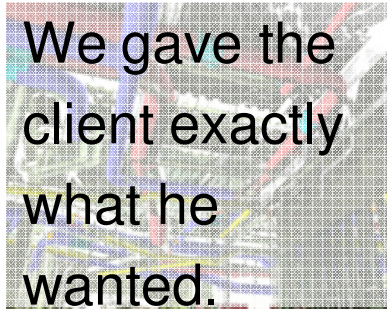
Impact of good VDC practice











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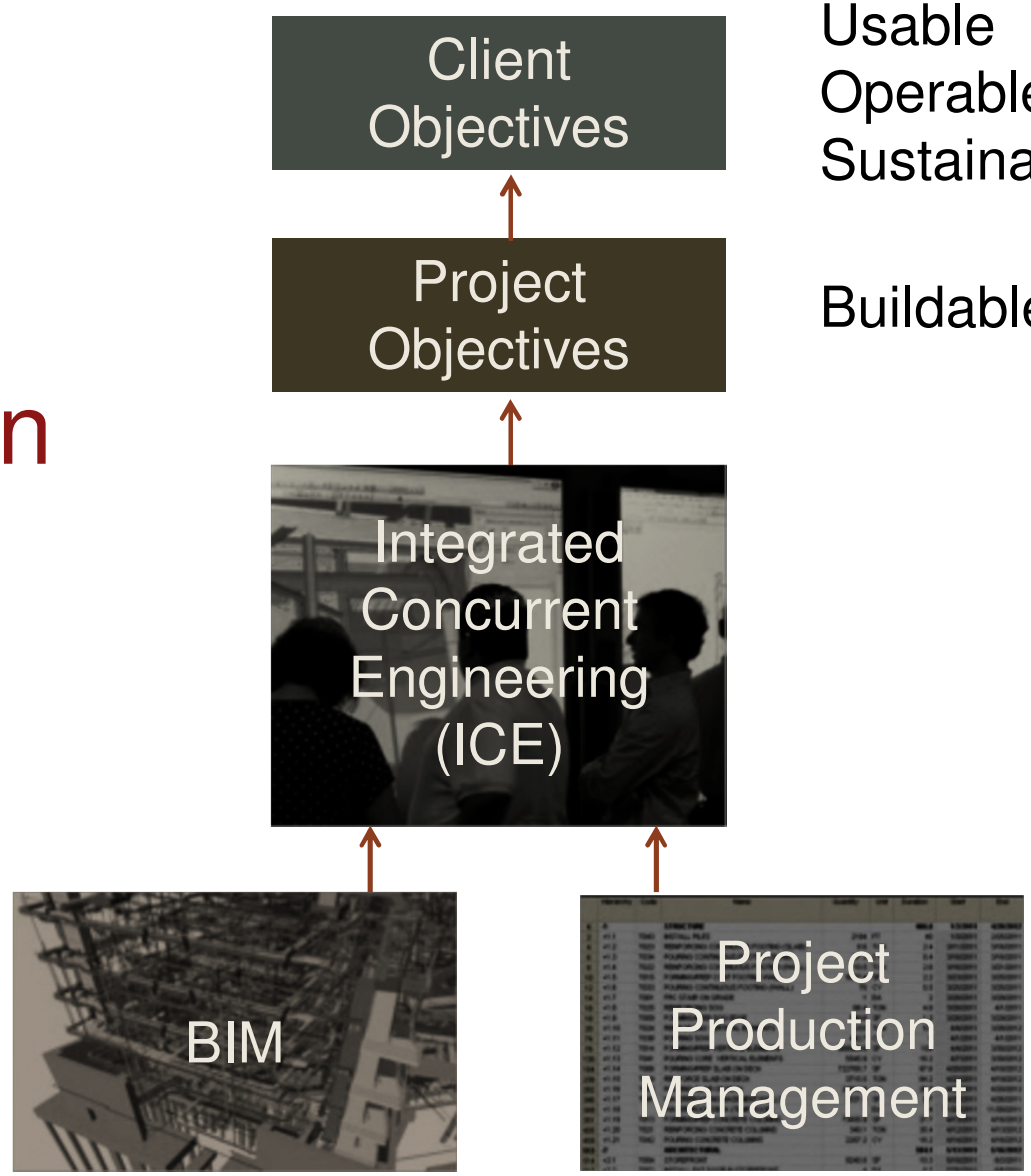
VDC
Virtual Design and Construction



Usable
Operable
Sustainable

Buildable

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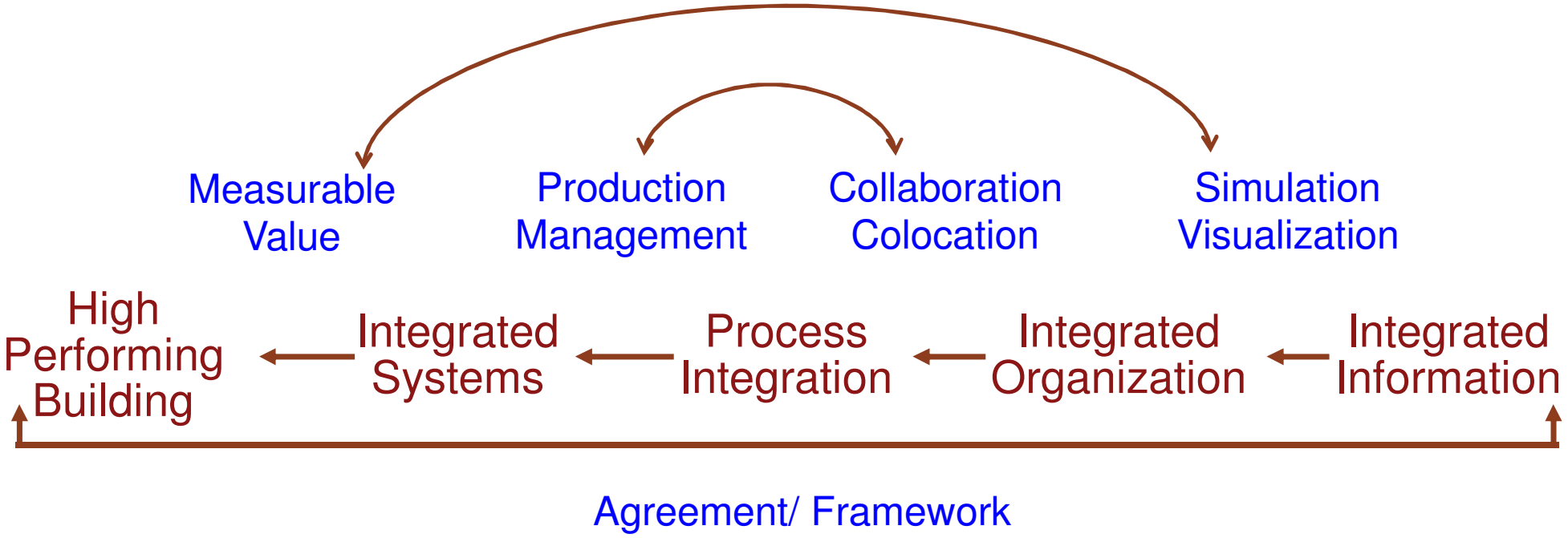
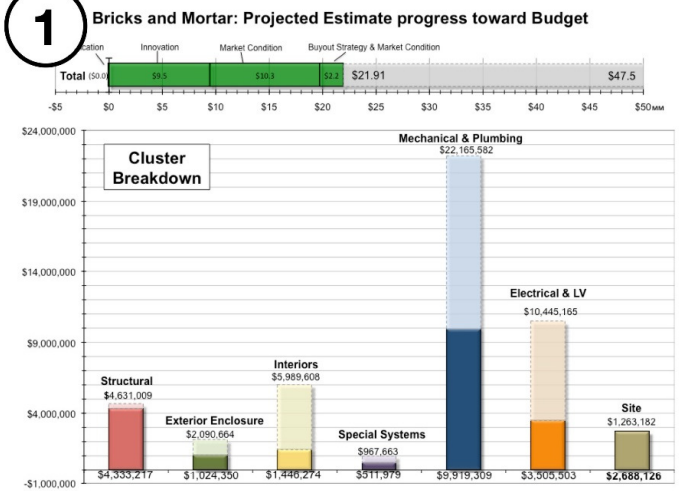
The Simple Framework for IPD



MEASURABLE VALUE

1



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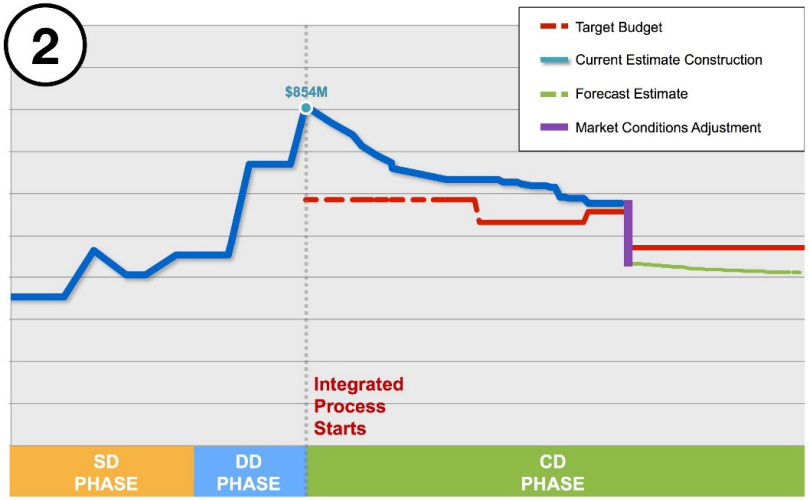

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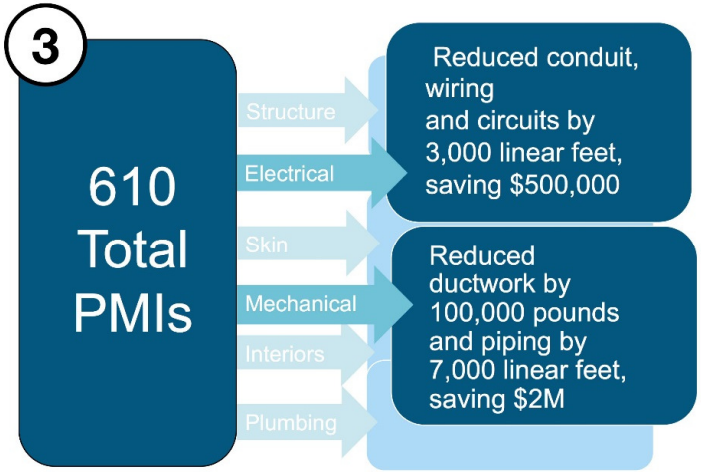

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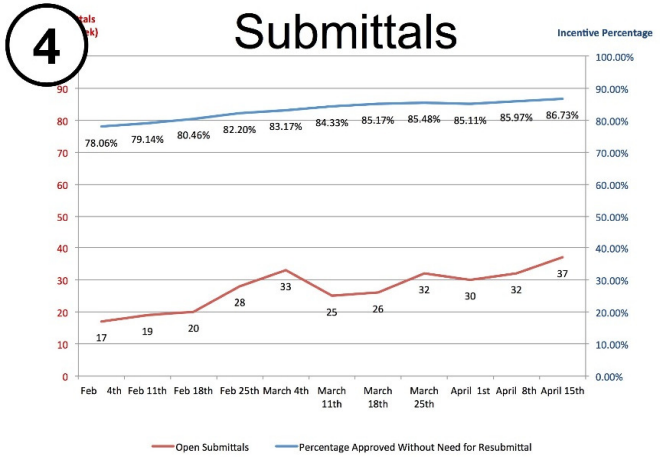
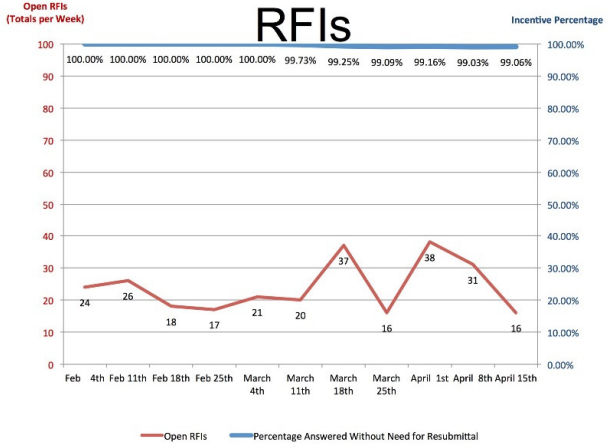


5



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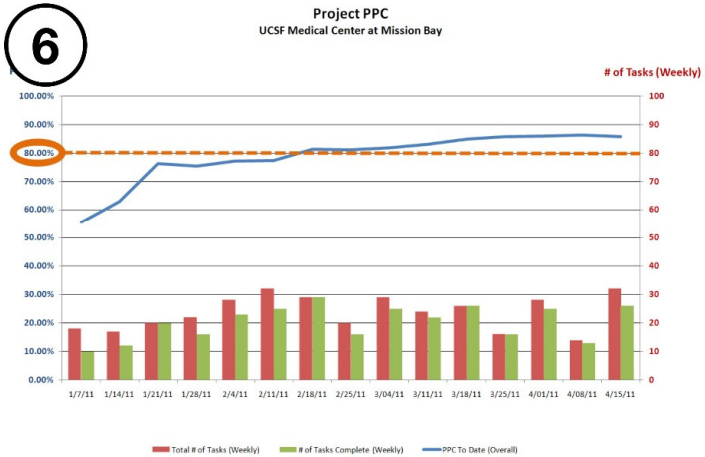
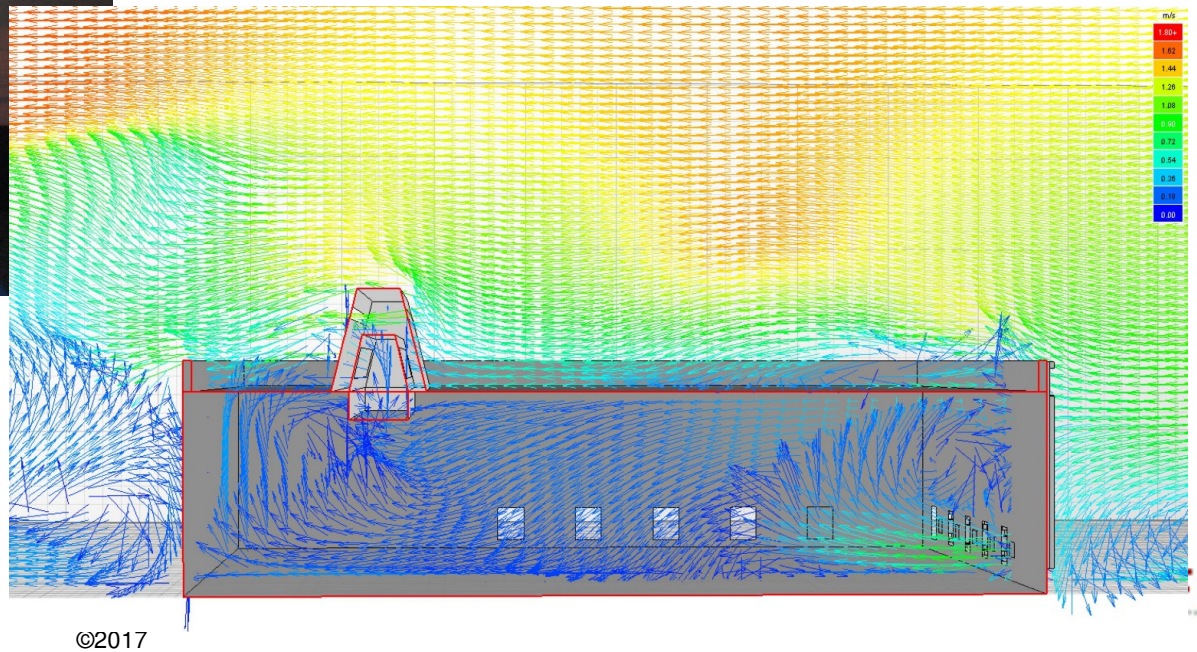
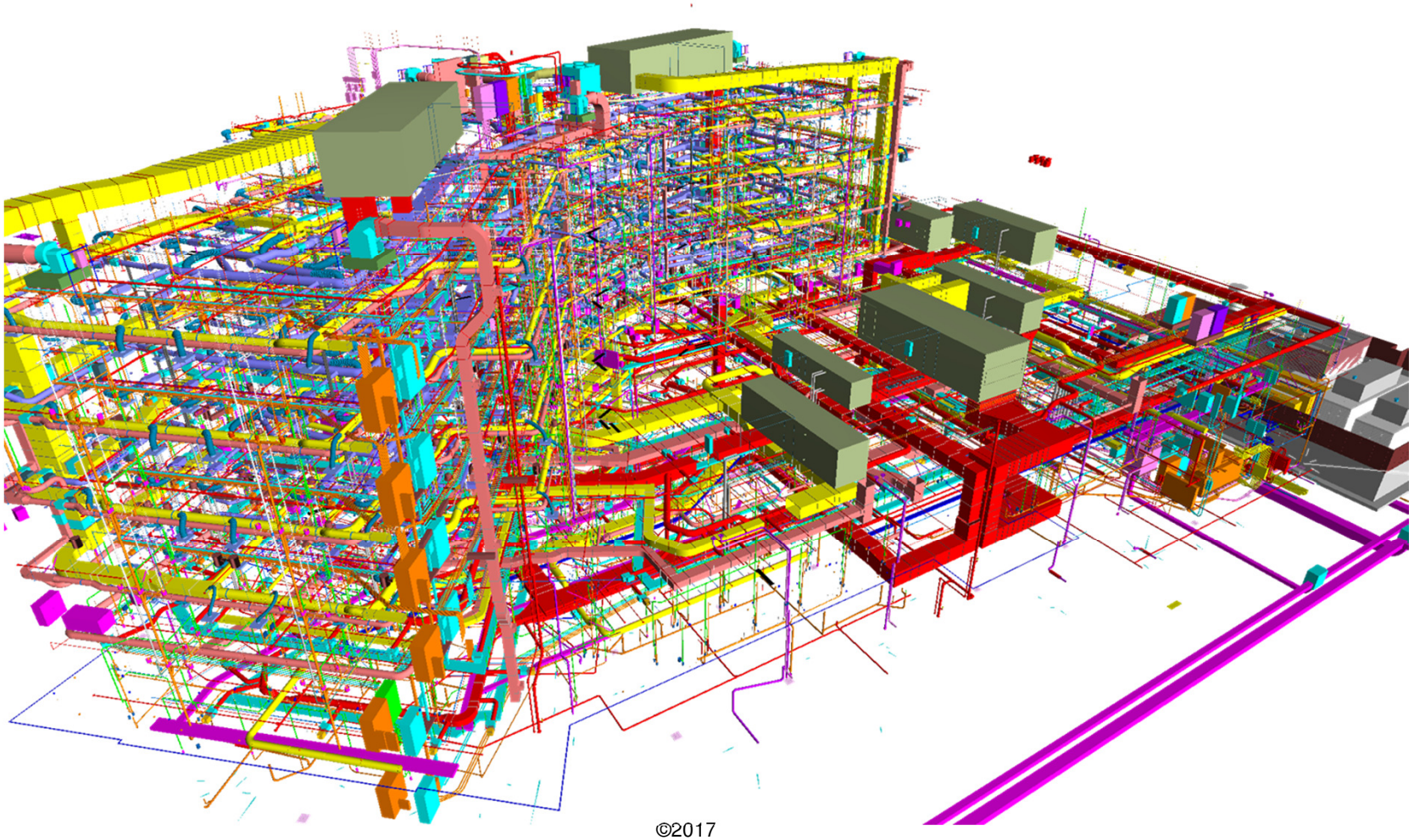


VISUALIZATON | SIMULATION



INTEGRATED INFORMATION



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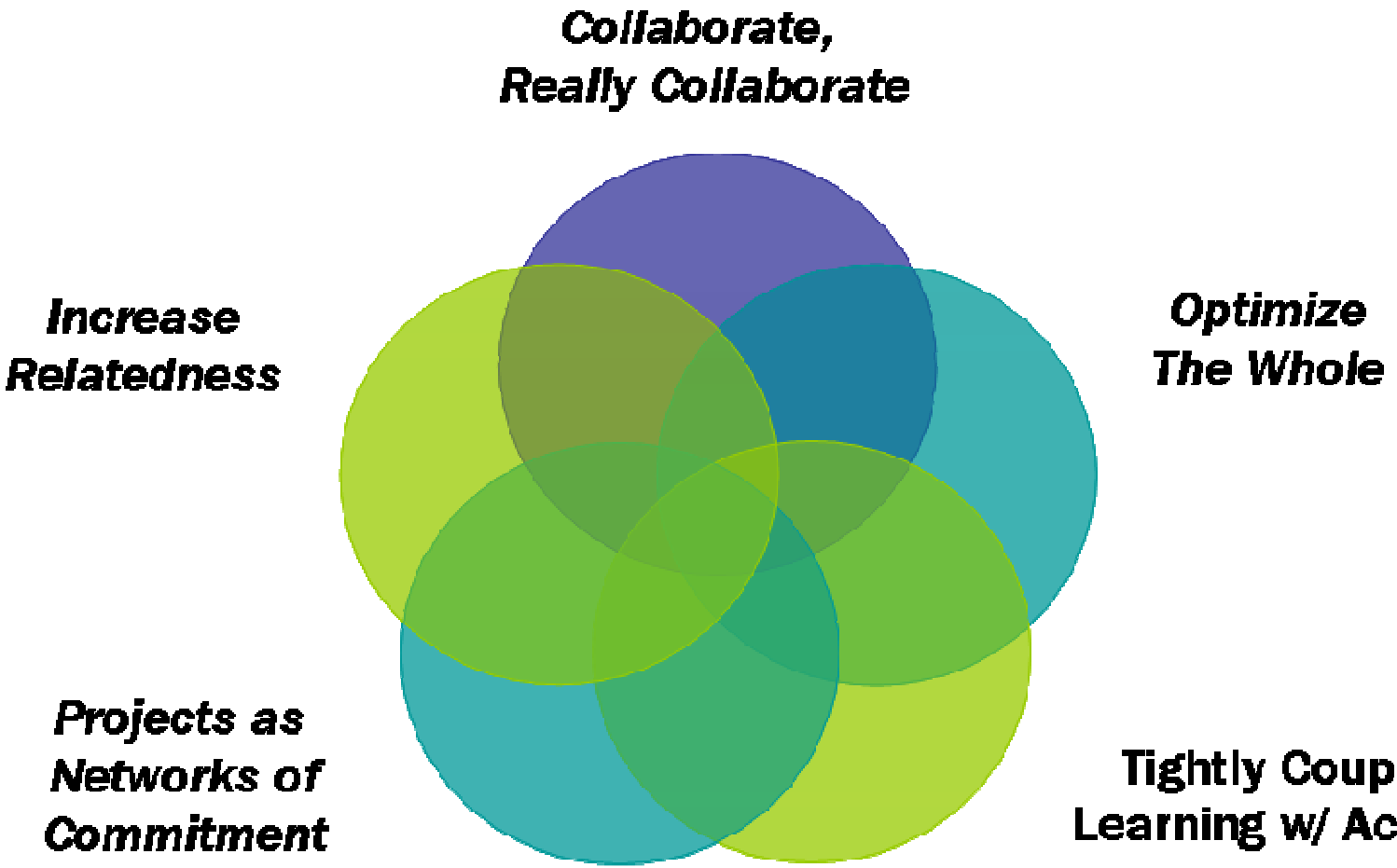
INTEGRATED ORGANIZATION



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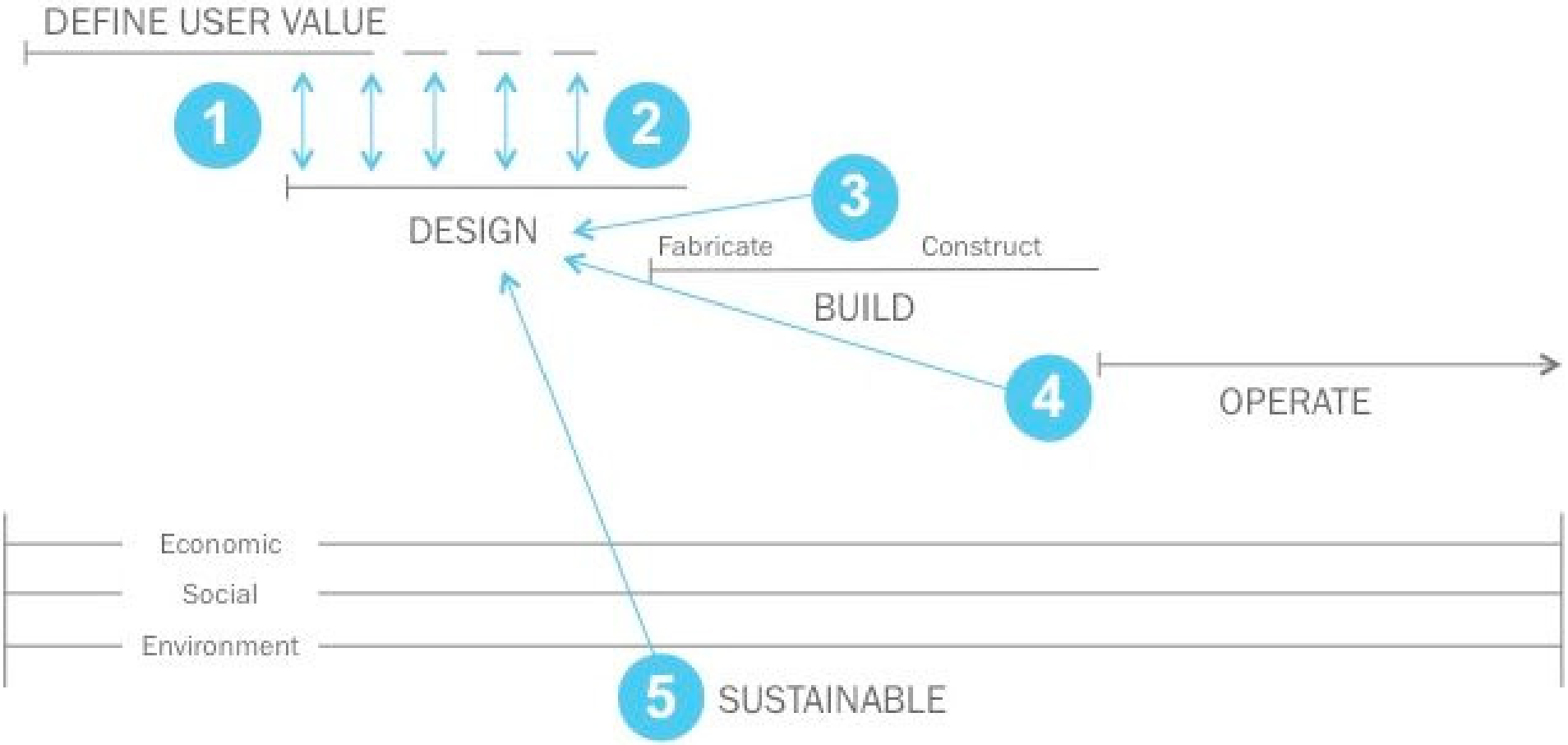
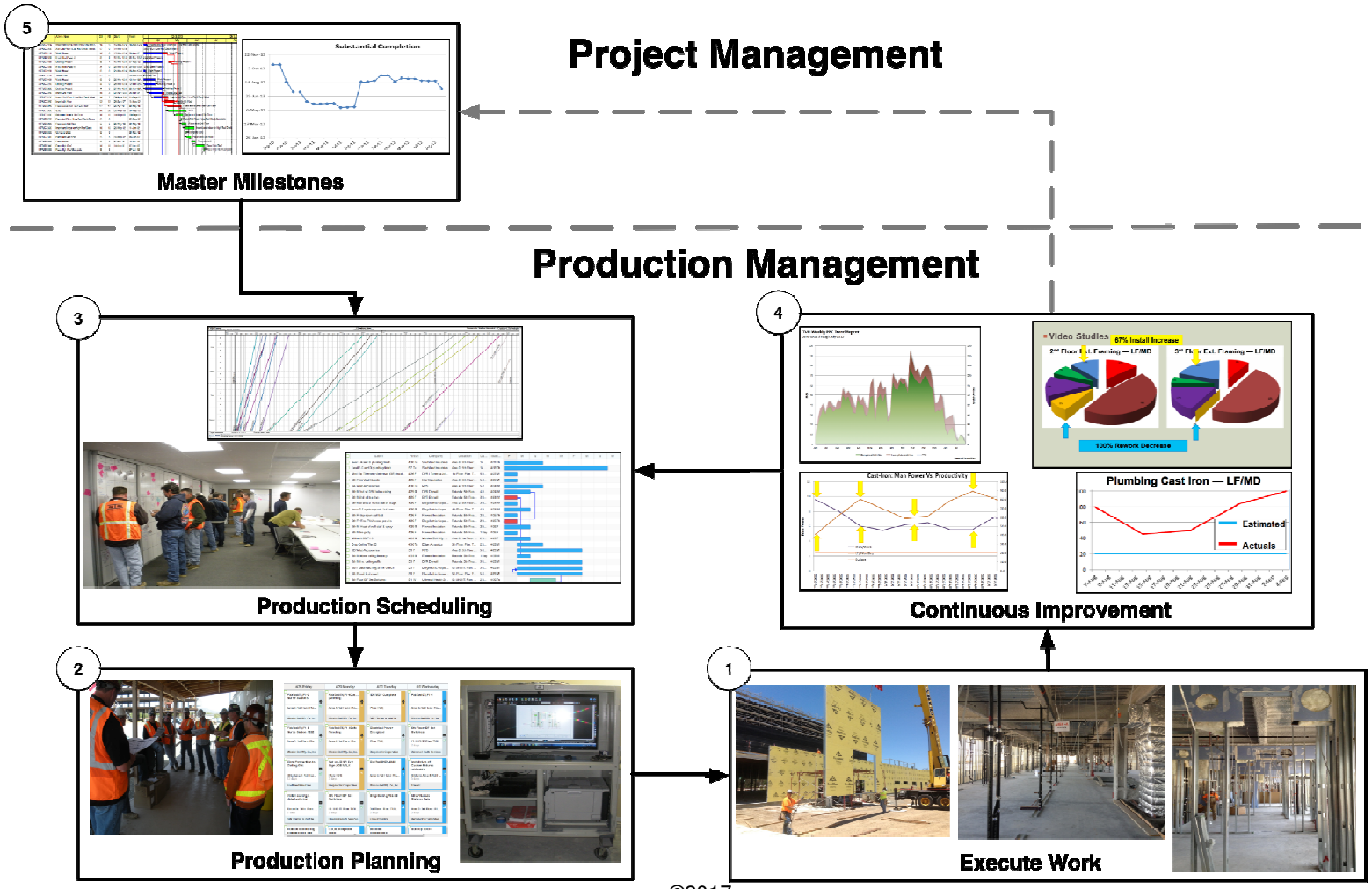
PROCESS INTEGRATION



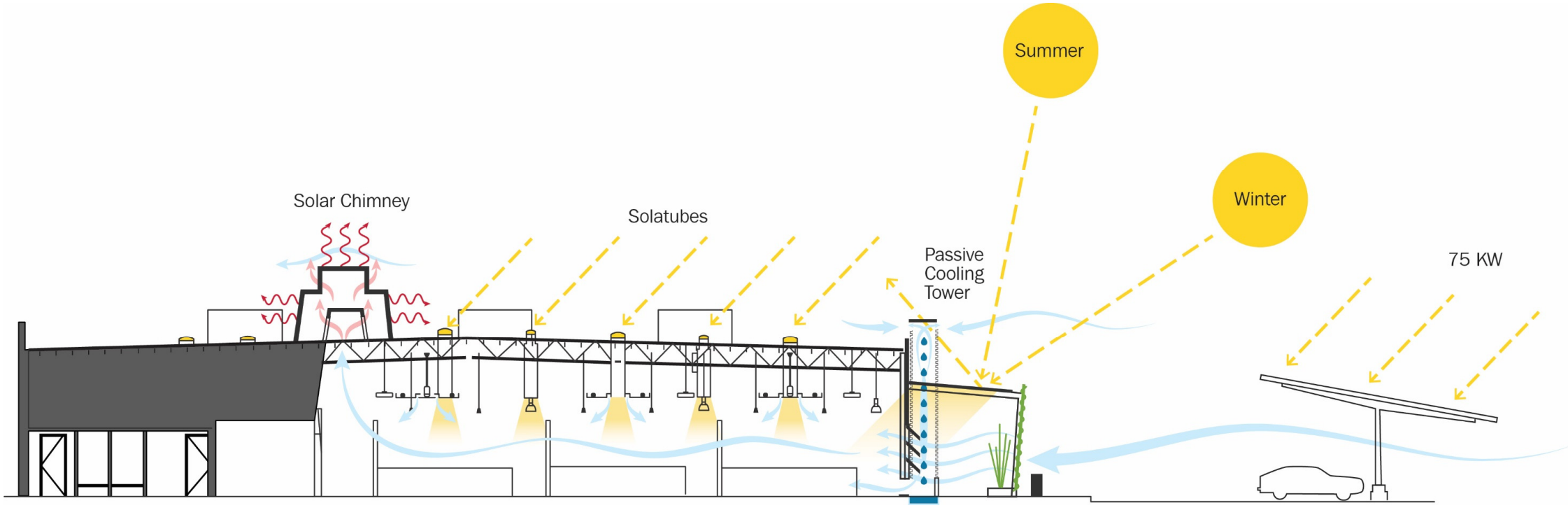
COLLABORATION | CO-LOCATION

PRODUCTION MANAGEMENT

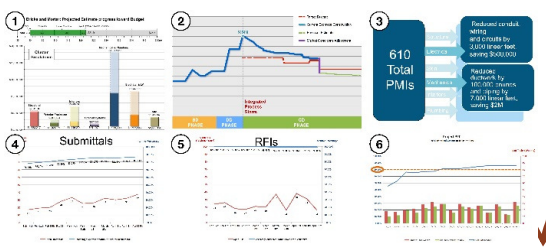


INTEGRATED SYSTEMS

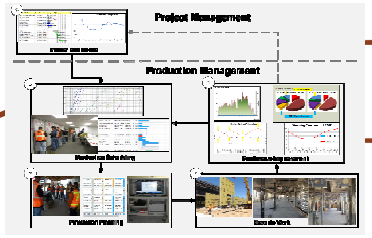
Physics 101: what teams must produce and deliver



The Simple Framework for IPD

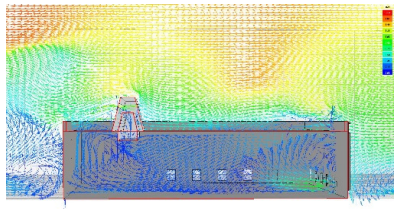


Measurable Value



Production Management

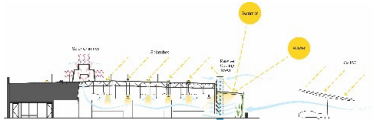
Collaboration Colocation



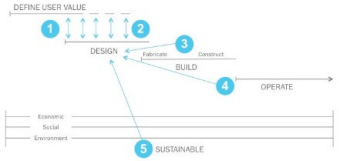
Simulation Visualization

High Performing Building

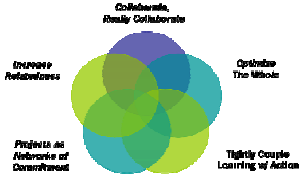
Integrated Systems



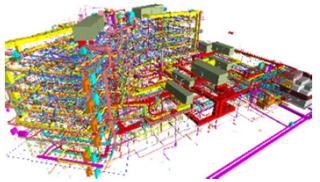
Process Integration



Integrated Organization



Integrated Information



Agreement/ Framework

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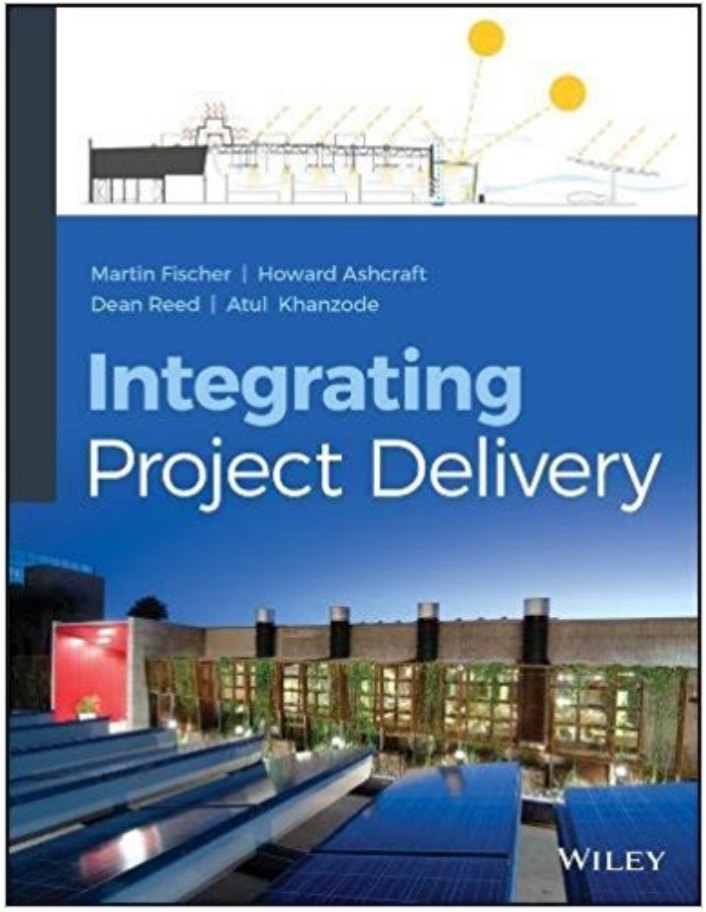
~~Integrated~~ Integrating Project Delivery



Combines

- many practitioners' experiences with integrated practices compiled by DPR,
- Howard Ashcraft's experience with IPD contracts, and
- almost 30 years of CIFE research

into

- a book that describes how projects should be done.

PROJECTS	EXAMPLES	FIGURES	FEATURES
50	123	189	33

CIFE

Key technology and management developments

Mobile

- from just-in-case to just-the-right information

Cloud

- anytime (push and pull bi-directional, ”unlimited”)

Parallelization

- fast

Location / dimensional measurement

- accuracy, dimensional control, off-site / on-site

Machine learning

- experience and data

Robotics, additive manufacturing

- virtual ←→ real, safety, environmental impact

Internet of Things (IoT)

- virtual ←→ real

Virtual Environments

- test

Collaboration

- concurrent knowledge

Lean

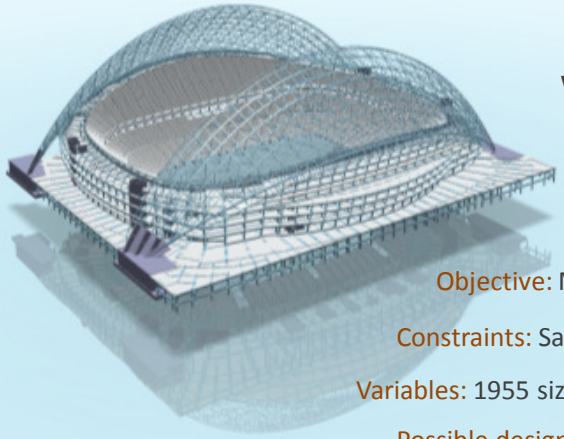
- lower uncertainty, lower risk, customer, pull, purpose → value

The combination of these developments creates significant opportunities for dramatic change.

CIFE

Reducing the Cost of Steel Structures Using Computational Design Optimization

Work by Forest Flager in Collaboration with Arup and John Haymaker



Design Problem

Objective: Minimize steel weight

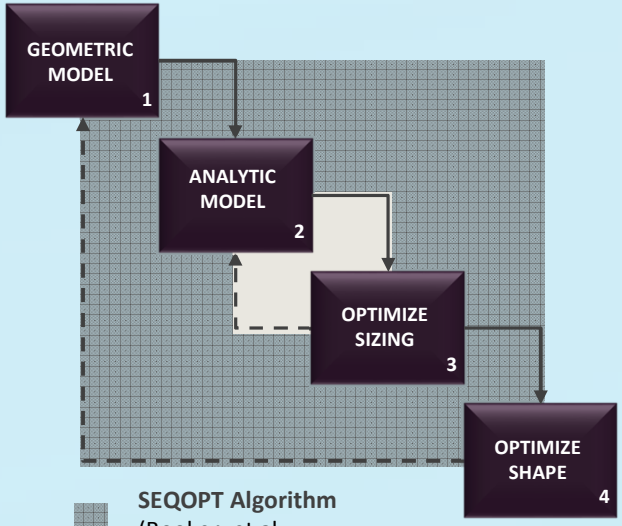
Constraints: Safety and serviceability

Variables: 1955 size and shape variables

Possible design alternatives: ~ 10^{2435}

BiOPT METHOD

http://cife.stanford.edu/sites/default/files/TR202.pdf



SEQOPT Algorithm (Booker, et al. 1999)

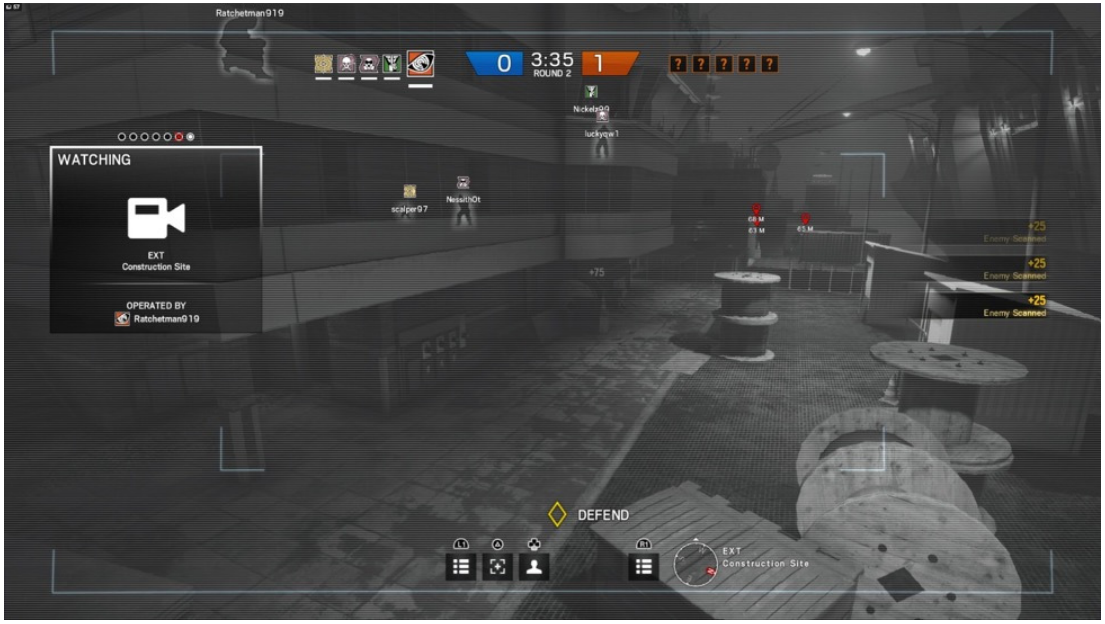
FCD Sizing Algorithm
http://cife.stanford.edu/sites/default/files/TR201_0.pdf

Case Study Results

	conventional design method	FCD (128 cpu) design method
PROCESS		
Design cycle time	4 hrs	3 sec
Alternatives evaluated	39	12,800
Total design time	216 hrs	151 hrs
PRODUCT		
Total steel weight	2,728 met t	2,292 met t
Est. cost saving (USD)	-	$4 M (-19%)

- Orders of magnitude reduction in design cycle time
- Evaluation of a greater number of design alternatives
- Improved product quality

CIFE



Interact in a virtual environment

Screenshots courtesy
Brandon Fischer

- Rapidly understand target, team, roles, progress, obstacles, challenges
- Frequent communication, feedback

DN Dagens Næringsliv

Oslo Børs: 11:55
Indeks: 711,62
+0,22%

På Skanska er grensene mellom virkelighet og fiksjon litt sløret. Bak f.v Fredrik Antonsen, Henning Habberstad, Peder Bogsti. Foran f.v: Rekrutteringssjef Christian Scheen og direktør i Skanska teknikk Rune Stene. Foto: Mikaela Berg.

Talent Spillteknologi

Nå tar Skanska inn gamere

Byggebransjen søker etter folk med spillbakgrunn. Slik skal de holde tritt med den teknologiske utviklingen.

Dagens Perspektiv

LOGG INN BLI ABONNENT UKEAVISEN LEDELSE

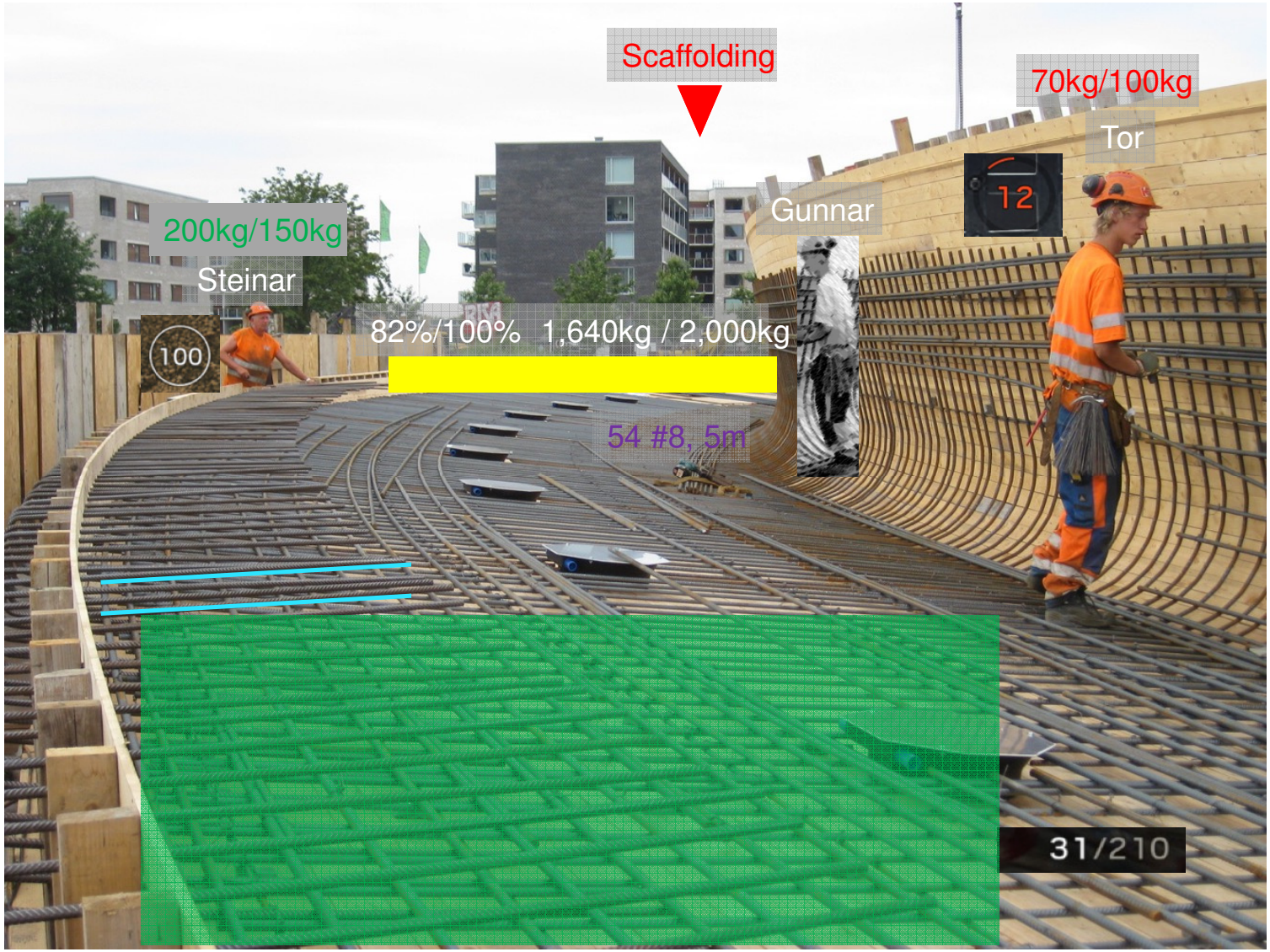
LEDELSE SAMFUNNSSTYRING NYSKAPING ARBEIDSLIV EKSISTENS SYNSPUNKT

En stillingsutlysning trakk et tjuetalls interesserte til gaming-kveld hos byggentreprenøren Skanska. Foto: Aurora Hannisdal.

ARBEIDSLIV
NYSKAPING

Rekruttering | Spiller seg til stilling

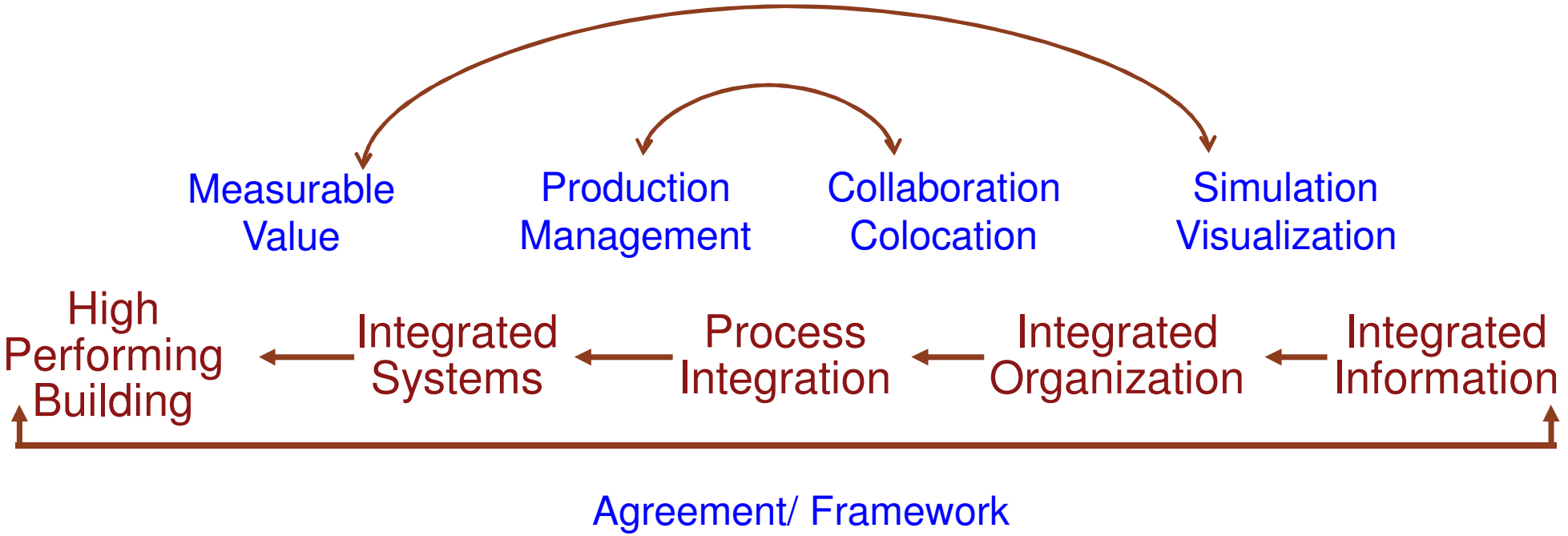
Når bygg- og anleggsbransjen skal hente inn ny IKT-kompetanse, må de lete i helt nye miljøer.


Scaffolding
70kg/100kg
Tor
12
Gunnar
200kg/150kg
Steinar
100
82%/100% 1,640kg / 2,000kg
54 #8, 5m
31/210

Every workhour
builds the right product
safely and productively

CIFE

Creating the right building safely and productively



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BIM and VDC, the way to production

Henning Habberstad, Skanska Teknikk - BIM

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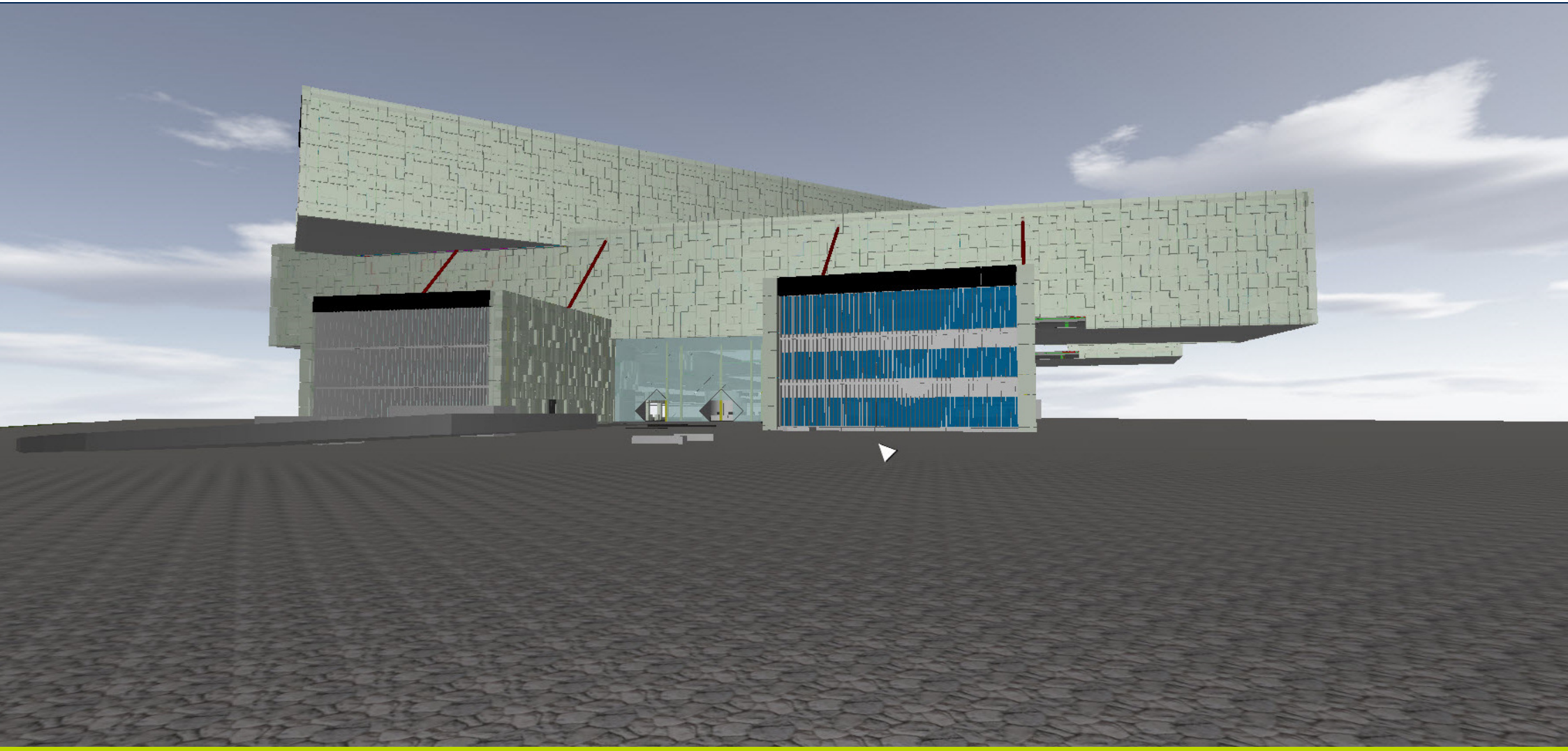

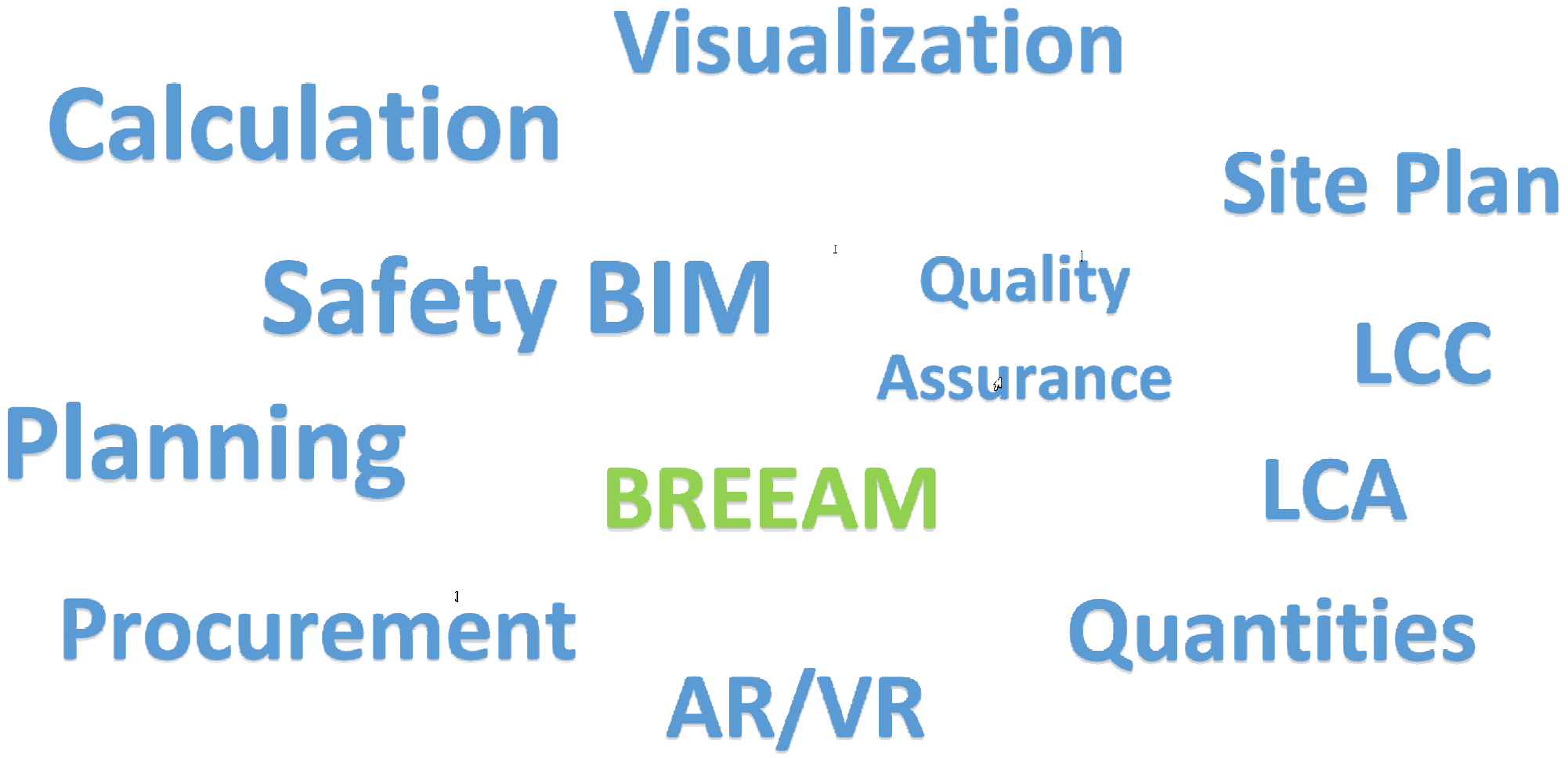
Visualization
Calculation
Site Plan
Safety BIM
Quality
Assurance
LCC
Planning
BREEAM
LCA
Procurement
Quantities
AR/VR

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Digital inspection form

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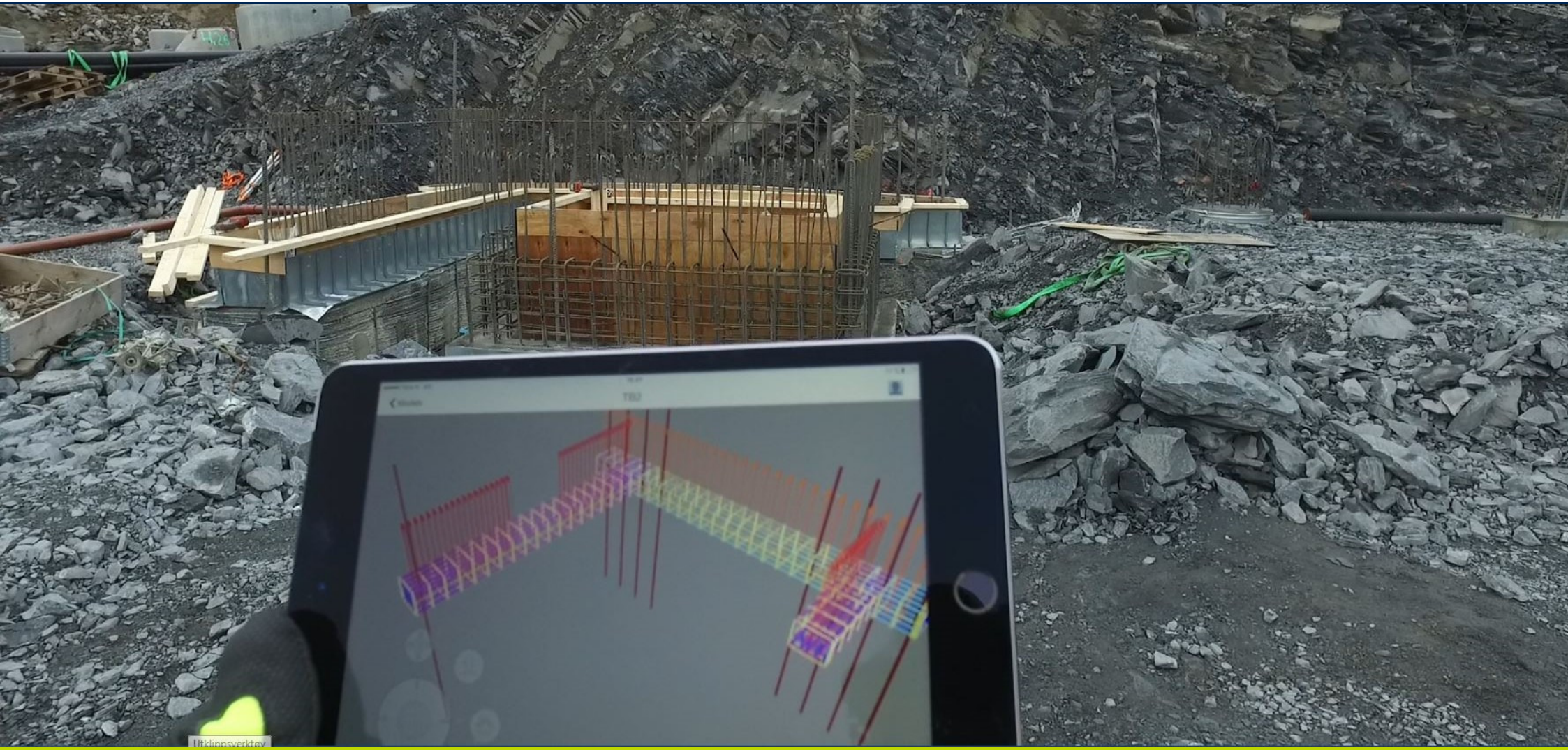

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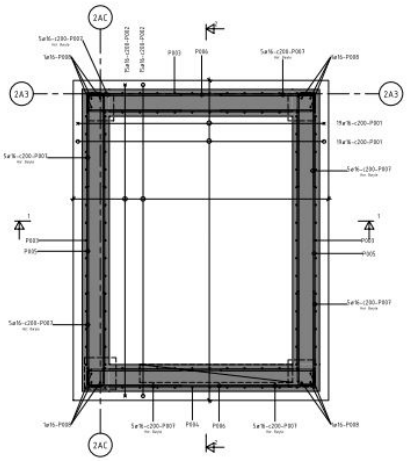
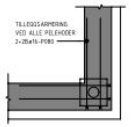
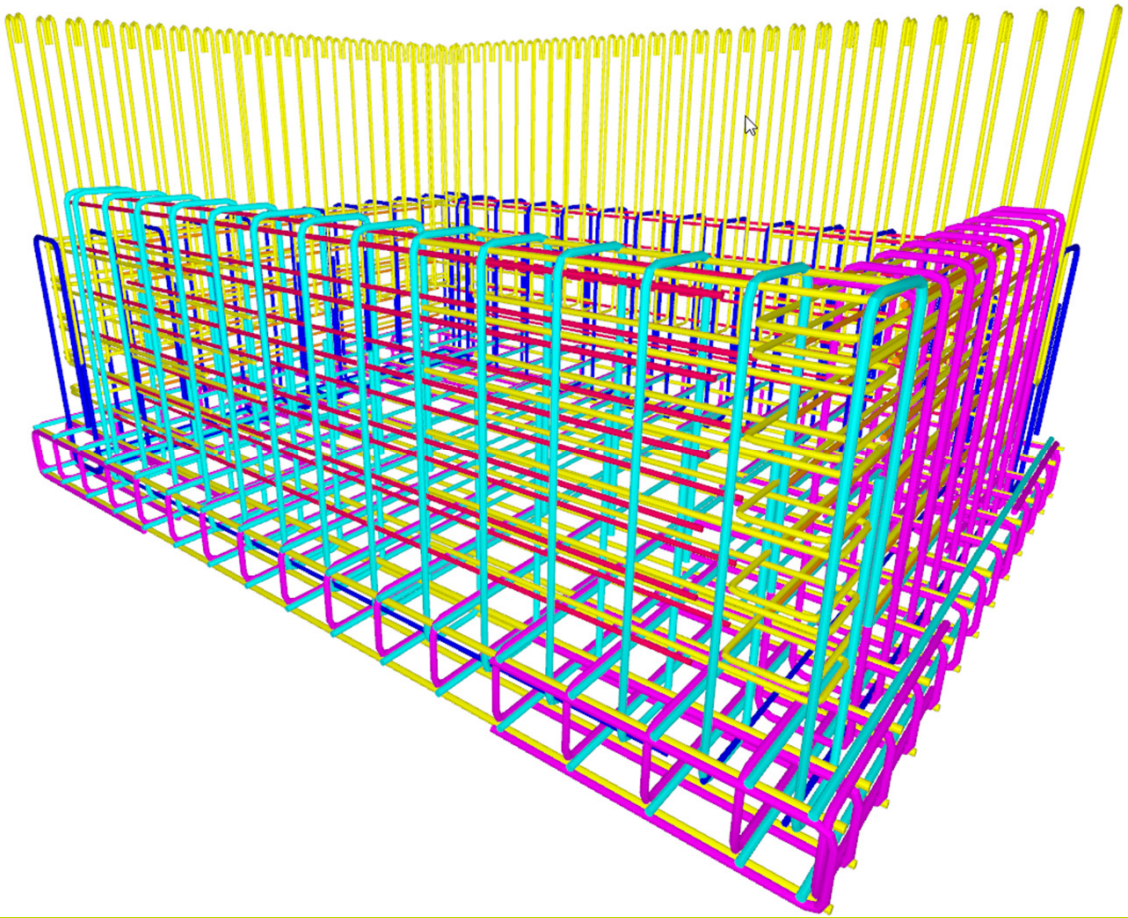
Digitalization in Skanska

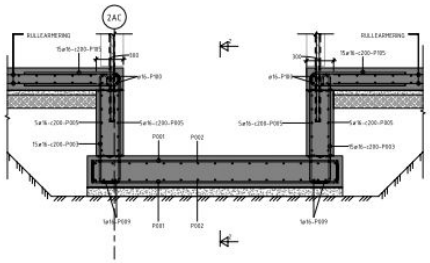


Heisgrube A - Armering
1 : 20

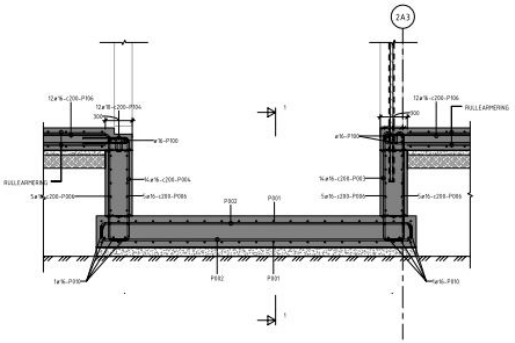


Heisgrube A - Prinsippsnitt tilleggsarmering pelehoder
1 : 20





1 Heisgrube A - Snitt 1 - Armering
1 : 20



2 Heisgrube A - Snitt 2 - Armering
1 : 20

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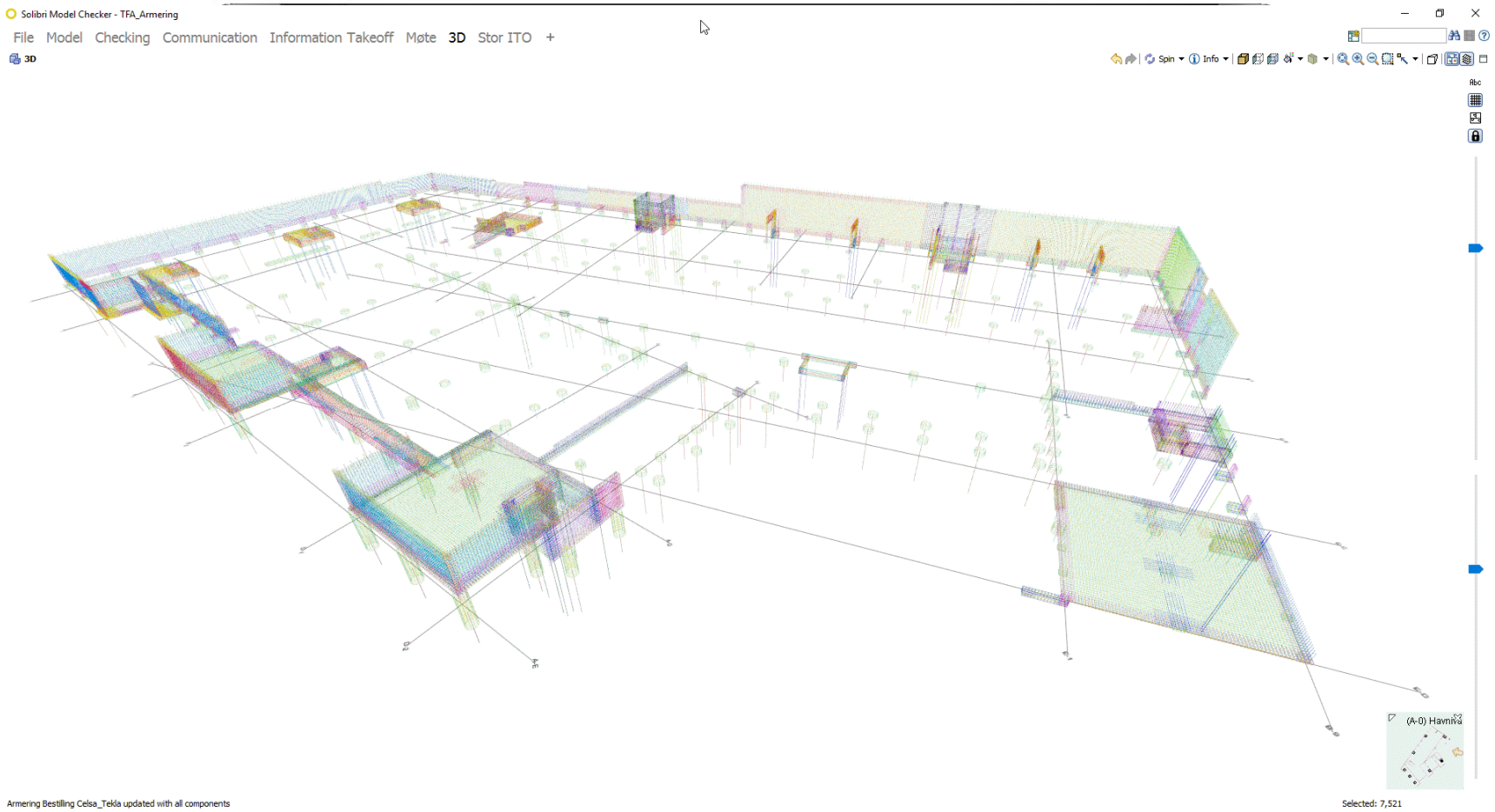

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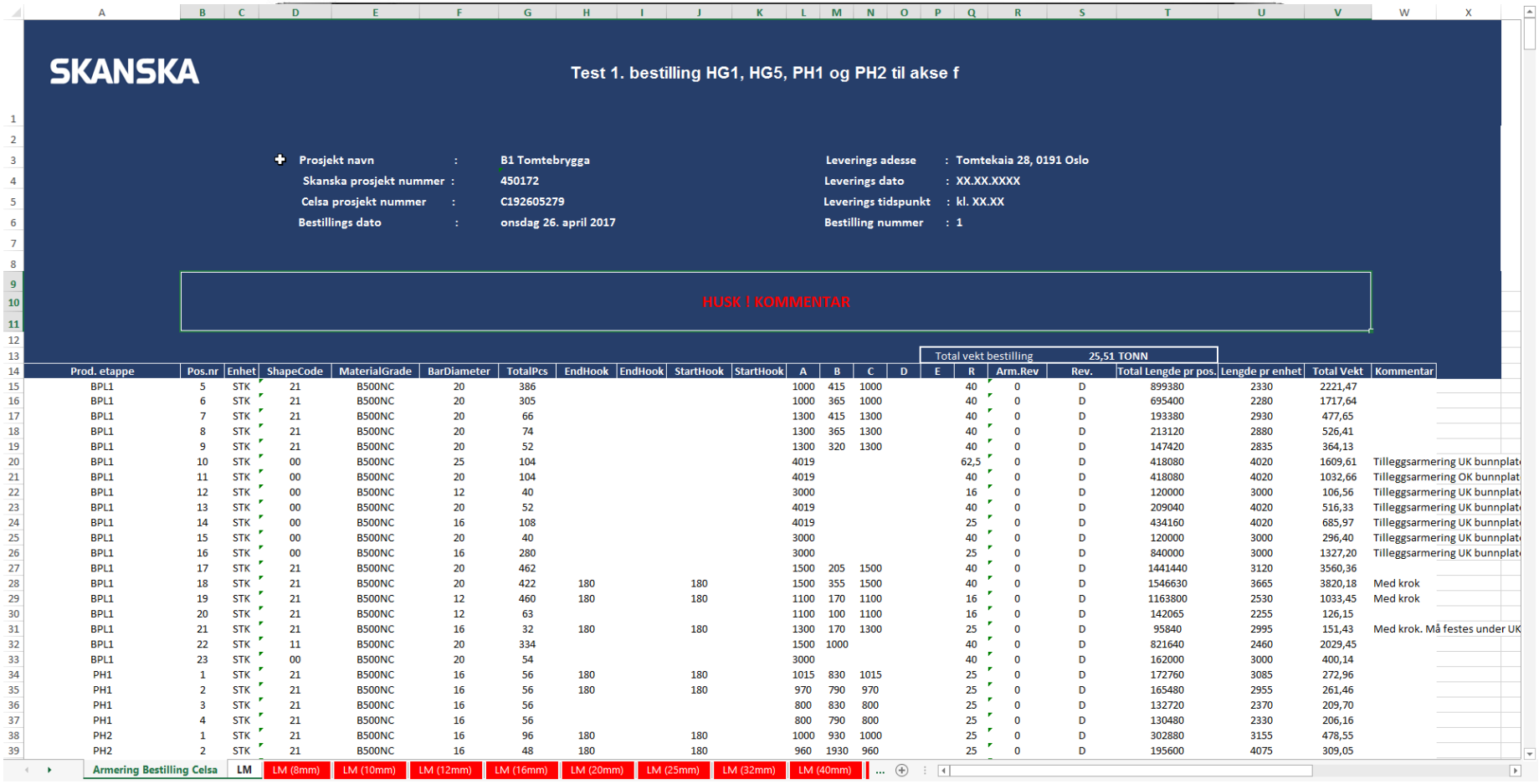

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Test 1. bestilling HG1, HG5, PH1 og PH2 til akse f

Prosjekt navn	: B1 Tomtebrygga	Leverings adresse	: Tomtekaia 28, 0191 Oslo
Skanska prosjekt nummer	: 450172	Leverings dato	: XX.XX.XXXX
Celsa prosjekt nummer	: C192605279	Leverings tidspunkt	: kl. XX.XX
Bestillings dato	: onsdag 26. april 2017	Bestilling nummer	: 1

HUSK ! KOMMENTAR

Total vekt bestilling 25,51 TONN

Prod. etappe	Pos.nr	Enhet	ShapeCode	MaterialGrade	BarDiameter	TotalPcs	EndHook	EndHook	StartHook	StartHook	A	B	C	D	E	R	Arm.Rev	Rev.	Total Lengde pr pos.	Lengde pr enhet	Total Vekt	Kommentar
BPL1	5	STK	21	B500NC	20	386					1000	415	1000			40	0	D	899380	2330	2221,47	
BPL1	6	STK	21	B500NC	20	305					1000	365	1000			40	0	D	695400	2280	1717,64	
BPL1	7	STK	21	B500NC	20	66					1300	415	1300			40	0	D	193380	2930	477,65	
BPL1	8	STK	21	B500NC	20	74					1300	365	1300			40	0	D	213120	2880	526,41	
BPL1	9	STK	21	B500NC	20	52					1300	320	1300			40	0	D	147420	2835	364,13	
BPL1	10	STK	00	B500NC	25	104					4019					62,5	0	D	418080	4020	1609,61	Tilleggsarmering UK bunnplat
BPL1	11	STK	00	B500NC	20	104					4019					40	0	D	418080	4020	1032,66	Tilleggsarmering OK bunnplat
BPL1	12	STK	00	B500NC	12	40					3000					16	0	D	120000	3000	106,56	Tilleggsarmering UK bunnplat
BPL1	13	STK	00	B500NC	20	52					4019					40	0	D	209040	4020	516,33	Tilleggsarmering UK bunnplat
BPL1	14	STK	00	B500NC	16	108					4019					25	0	D	434160	4020	685,97	Tilleggsarmering UK bunnplat
BPL1	15	STK	00	B500NC	20	40					3000					40	0	D	120000	3000	296,40	Tilleggsarmering UK bunnplat
BPL1	16	STK	00	B500NC	16	280					3000					25	0	D	840000	3000	1327,20	Tilleggsarmering UK bunnplat
BPL1	17	STK	21	B500NC	20	462					1500	205	1500			40	0	D	1441440	3120	3560,36	
BPL1	18	STK	21	B500NC	20	422	180		180		1500	355	1500			40	0	D	1546630	3665	3820,18	Med krok
BPL1	19	STK	21	B500NC	12	460	180		180		1100	170	1100			16	0	D	1163800	2530	1033,45	Med krok
BPL1	20	STK	21	B500NC	12	63					1100	100	1100			16	0	D	142065	2255	126,15	
BPL1	21	STK	21	B500NC	16	32	180		180		1300	170	1300			25	0	D	95840	2995	151,43	Med krok. Må festes under UK
BPL1	22	STK	11	B500NC	20	334					1500	1000				40	0	D	821640	2460	2029,45	
BPL1	23	STK	00	B500NC	20	54					3000					40	0	D	162000	3000	400,14	
PH1	1	STK	21	B500NC	16	56	180		180		1015	830	1015			25	0	D	172760	3085	272,96	
PH1	2	STK	21	B500NC	16	56	180		180		970	790	970			25	0	D	165480	2955	261,46	
PH1	3	STK	21	B500NC	16	56					800	830	800			25	0	D	132720	2370	209,70	
PH1	4	STK	21	B500NC	16	56					800	790	800			25	0	D	130480	2330	206,16	
PH2	1	STK	21	B500NC	16	96	180		180		1000	930	1000			25	0	D	302880	3155	478,55	
PH2	2	STK	21	B500NC	16	48	180		180		960	1930	960			25	0	D	195600	4075	309,05	

Armering Bestilling Celsa | LM | LM (8mm) | LM (10mm) | LM (12mm) | LM (16mm) | LM (20mm) | LM (25mm) | LM (32mm) | LM (40mm) | ...

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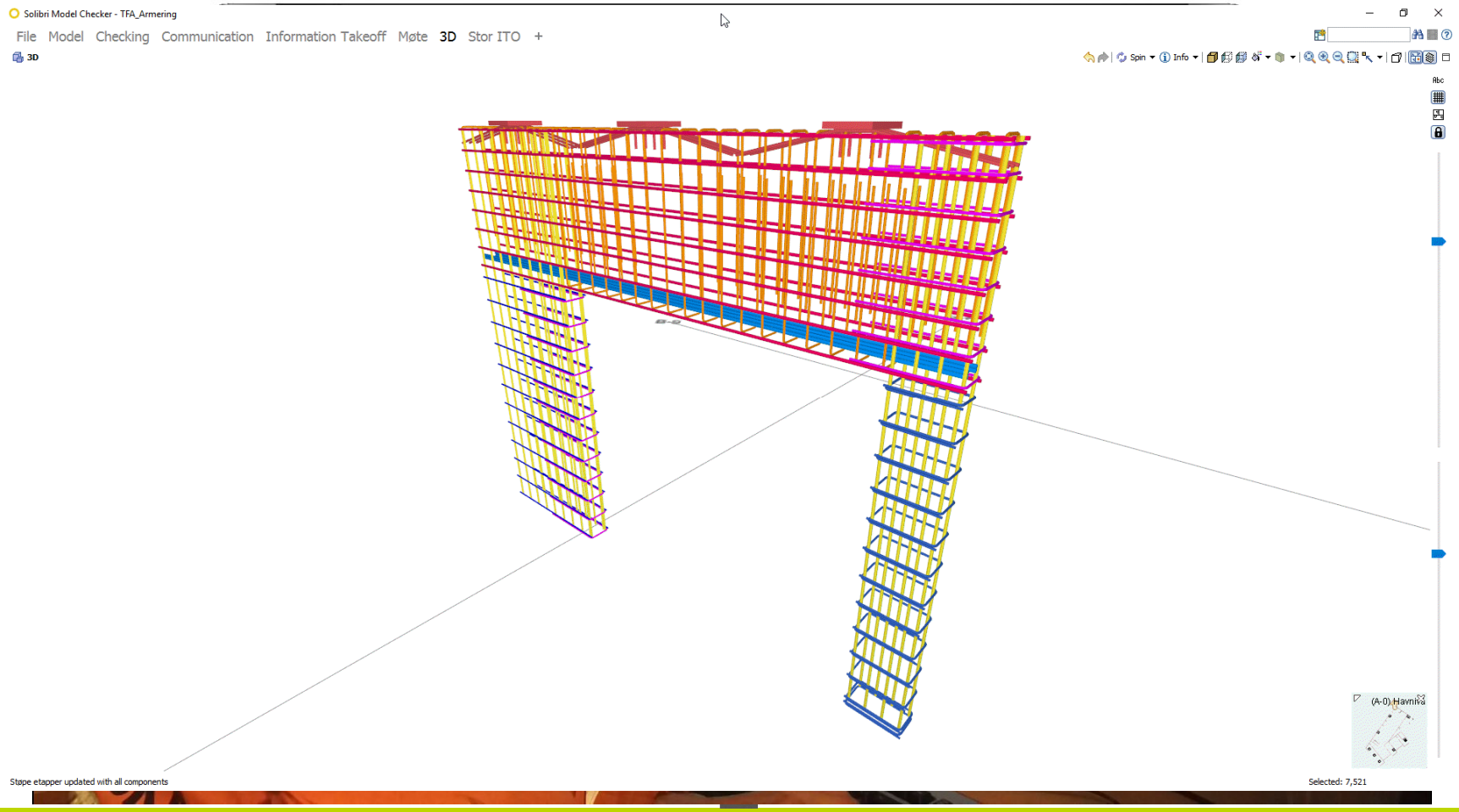
Digitalization in Skanska



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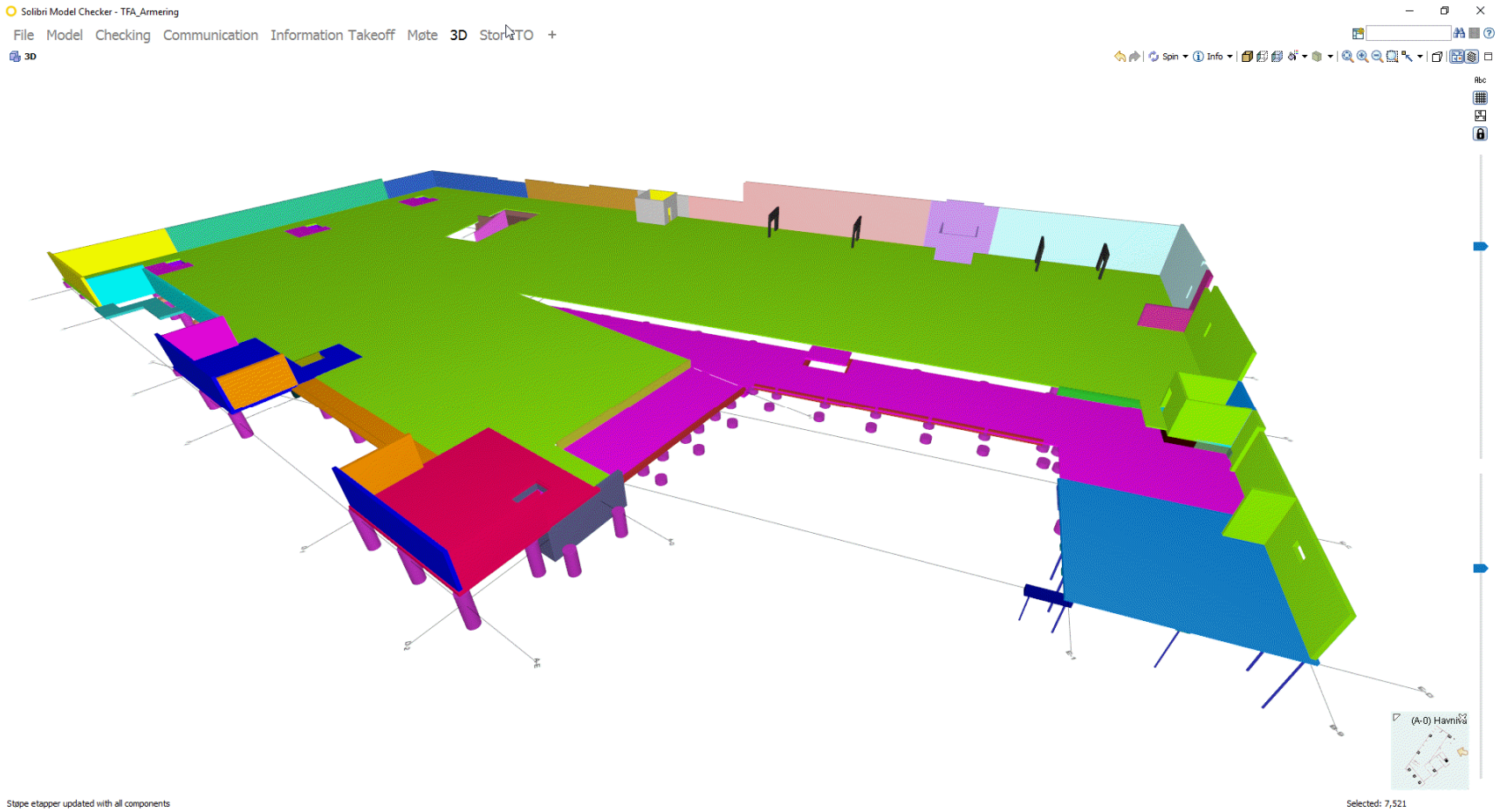

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Tønsbergprosjektet

Presentasjon 14.06.17

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The Tønsberg Project

Tønsbergprosjektet

Project owner:
Sykehuset i Vestfold HF (Vestfold Hospital Trust)

Scope:
- Total ca 45.000 m2
  - Psychiatric building - 12.000 m2 – Finished in 2019
  - Somatic building - 33.000 m2 – Finished in 2021
- Ca 2,7 Billion NOK
- Project period : 2015 - 2021

Project goals:
- Zero injuries – no workplace crime
- Zero building defects
- 10% lower cost than comparable projects
- Built 50 % faster than comparable traditional projects (above ground)
- Use of openBIM (6D +)
- Industrialized building process

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Tønsbergprosjektet

Contract Strategi
IPD

Tønsbergprosjektet

Sykehuset i Vestfold

The Tønsberg Project – An IPD project

Tønsbergprosjektet

Integrated Project Delivery (IPD) Principles:

- Mutual Respect and Trust
- Mutual Benefit and Reward
- Collaborative Innovation and Decision making
- Early Involvement of Key Participants
- Early Goal Definition
- Intensified Planning
- Open Communication
- Appropriate Technology
- Organization and Leadership

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IPD Strategies

- Early contribution of expertise (Early Involvement of Key Participants)
- BIM - virtual rehearsal of construction and ongoing constructability reviews
- Lean Construction Processes
- Co-location
- Champion/ Facilitator (Leadership by All)
- Pre-existing relationship between parties
- Key Participants Bound Together as Equals (Multi-party Agreement)
- Budget & create team for design intensive work
- Shared Financial Risk and Reward Based on Project Outcome
- Liability Waivers between Key Participants
- Fiscal Transparency between Key Participants

Tønsbergprosjektet

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How did you end up here?

Tønsbergprosjektet

Award Criterion
«Key Personnel's Qualifications» - 40%

- ✓ Design Team Leader
- ✓ Discipline Leader Architect
- ✓ Discipline Leader Electro
- ✓ Discipline Leader HVAC
- ✓ Leader Technical integration and completion
- ✓ Leader Design for manufacturing
- ✓ OpenBIM manager/coordinator
- ✓ Discipline Leader Construction

- ✓ Collaboration including Integrated Project Delivery (IPD), cooperation with the design and build contractor and the Contracting Entity and Co-localization
- ✓ Use of BIM - particularly open BIM
- ✓ Lean construction
- ✓ Breeam
- ✓ Projects with industrial implementation, such as use of modules and prefabricated solutions

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How did you end up here?

Tønsbergprosjektet

Award Criterion
«Key Personnel's Qualifications» – 40%

- ✓ Project Director/Manager
- ✓ Project Manager psychiatric building
- ✓ Lead Planner
- ✓ Lead Design and engineering
- ✓ Lead Industrialization
- ✓ Lead Production
- ✓ Lead Electro
- ✓ Lead HVAC

- ✓ Collaboration including Integrated Project Delivery (IPD), cooperation with the Design and Engineering Team, and Co-localization
- ✓ Complex and large projects
- ✓ Lean Construction
- ✓ Projects with industrialized implementation, such as use of modules and prefabricated solutions
- ✓ Use of BIM/open BIM – including 4D and 5D
- ✓ BREEAM

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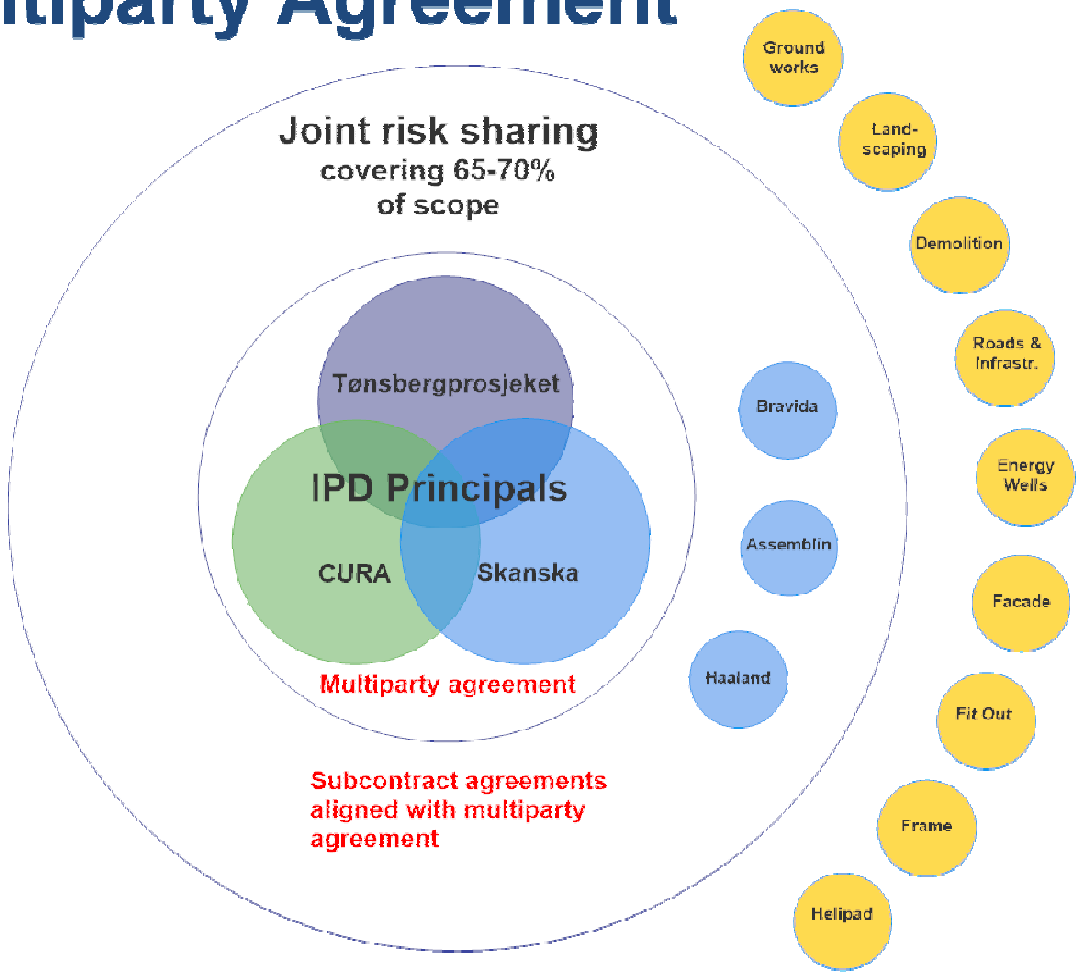
Multiparty Agreement



Tønsbergprosjektet

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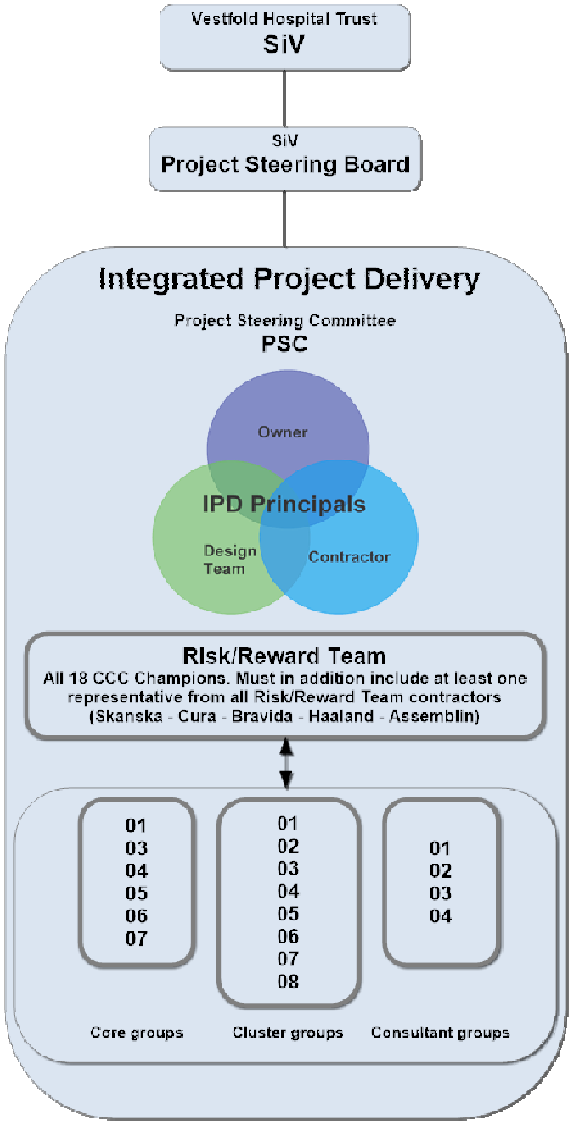

Definition: Risk Reward Team consists of representatives from all parties, each of whom have placed their respective profit at risk and are eligible to a defined share in the ICL (Incentive Compensation Layer), supplemented by all Core, Cluster and Consultant (CCC) groups Champions.

Tønsbergprosjektet

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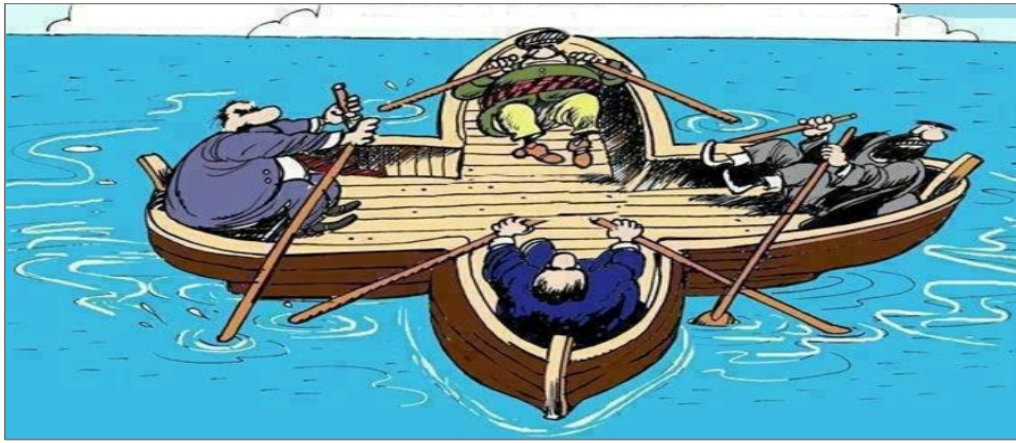
IPD so far…

- Early Involvement of Key Participants
- Appropriate Technology
- Early Goal Definition
- Mutual Benefit and Reward



- Mutual Respect and Trust
- Open Communication

- Organization and Leaders
- Collaborative Innovation and Decision making
- Intensified Planning

Tønsbergprosjektet

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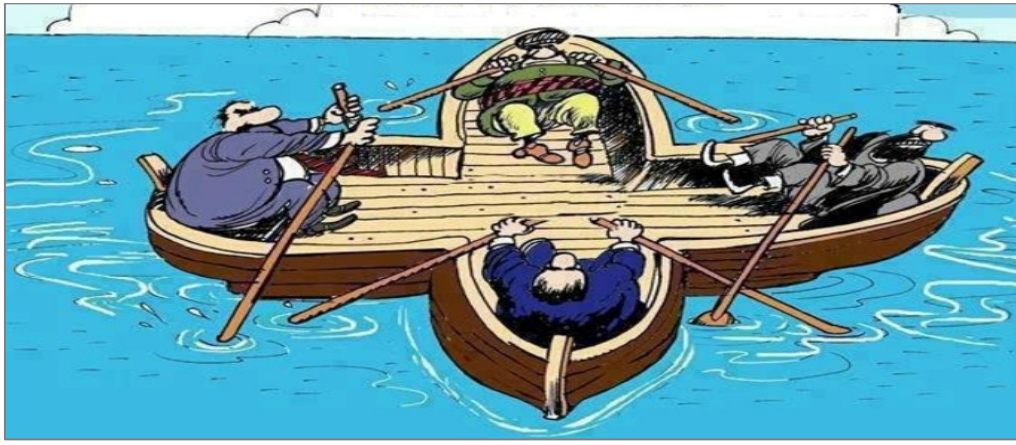
IPD so far…

- Co-location
- IPD Contract
- Last Planner
- ICE
- Target Value Design

- Onboarding
- Training
- Decision making
- Reporting
- KPI



Tønsbergprosjektet

Arbeidsprosesser
Samhandling
Lean

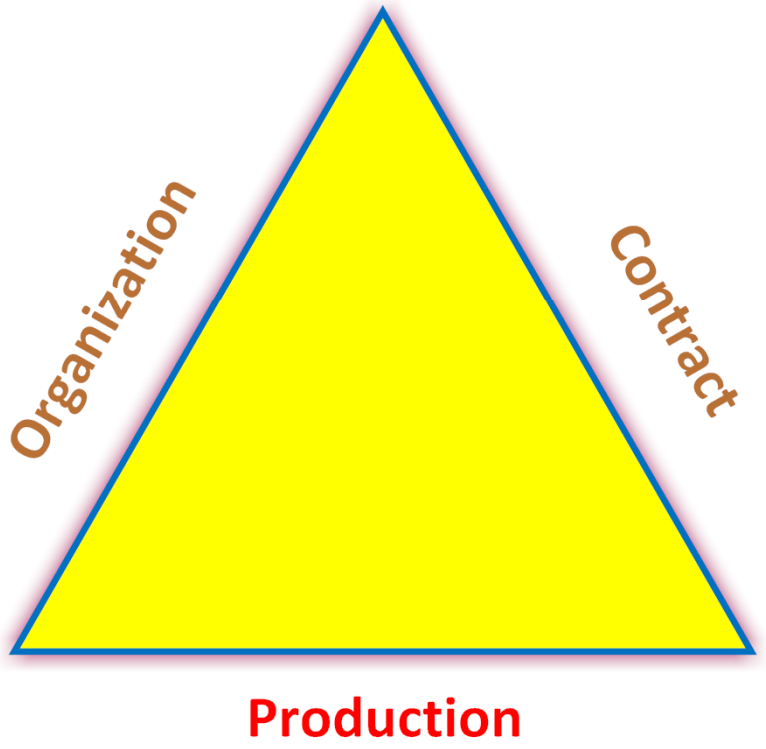
Tønsbergprosjektet

Sykehuset i Vestfold

Tønsbergprosjektet

The Lean Construction Triangle

(L. Koskela, Grimstad February 2016)



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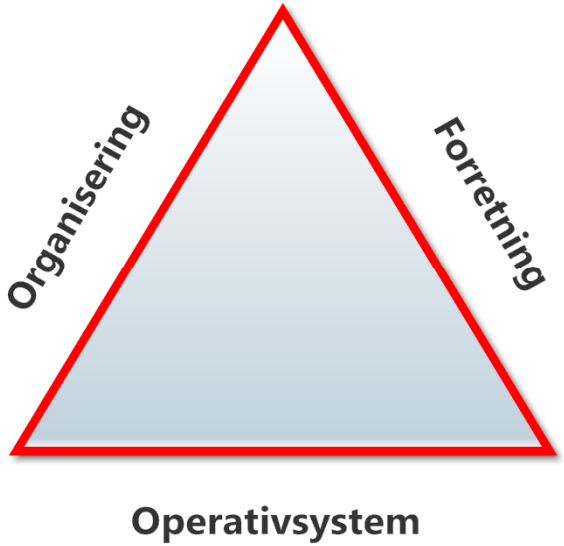
Tradisjonell prosjektleveranse

Silostruktur
Vertikal kommunikasjon
Isolerte beslutninger
Vertikal oppfølging



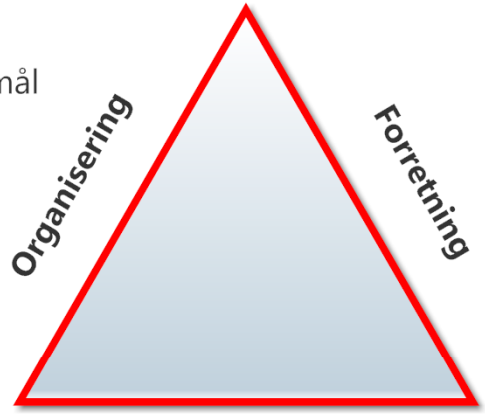
Single party kontrakter
Utvelgelse etter laveste pris
Individuelle KPI-er
Sub-optimalisering

Push-planlegging
Kostnadsbasert (ikke verdibasert) styring
Ikke samstemt teknologi
Ikke **virkelig** samhandling

Fra Thomsen et al., 2009

Integrert prosjektleveranse (IPD)

Tverrfaglig struktur
Felles oppgaveforståelse/mål
Åpen beslutningsprosess
Gjennomsiktig oppfølging
Big Room samlokalisering



Multiparty kontrakter
Utvelgelse av beste deltaker
Felles smerte og gevinst
Felles KPI-er

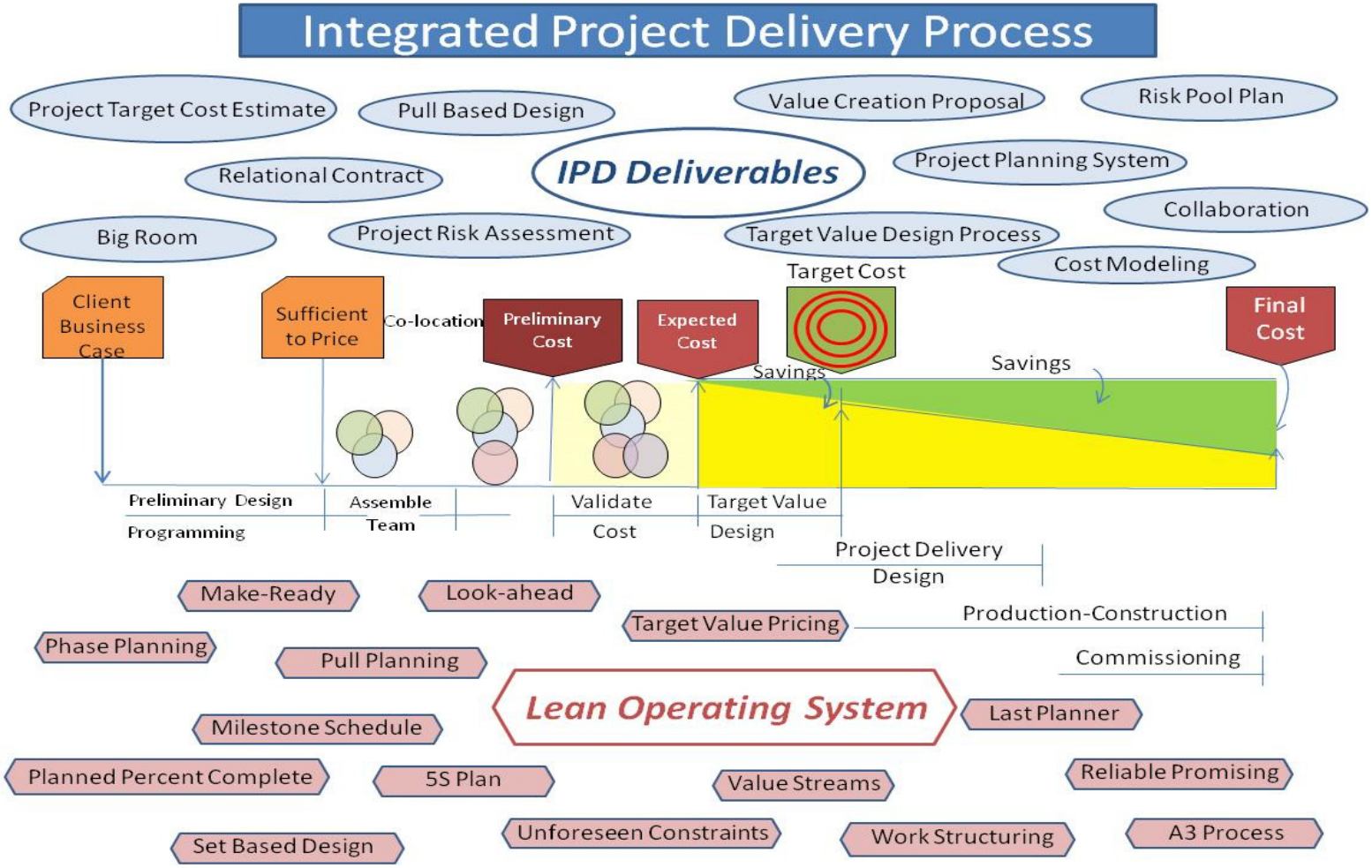
BIM
Target Value Design
- A3
- Choosing By Advantages
- Set Based Design

Last Planner/PPC
Value Stream Mapping
Look-ahead/pull-planlegging
Fra kontroll av hva som er gjort til å få ting til å skje

Fra Thomsen et al., 2009

Tønsbergprosjektet

Integrated Project Delivery Process



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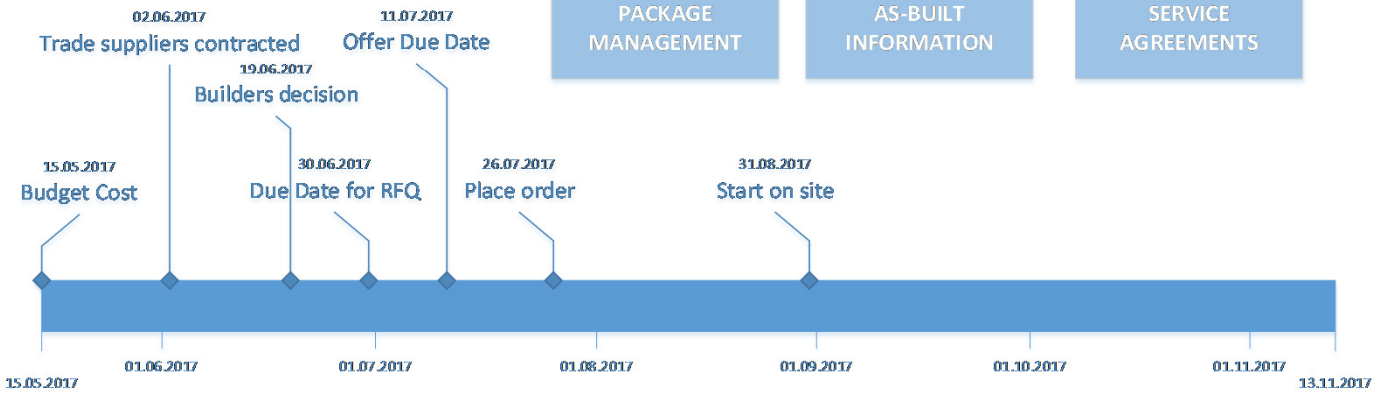
Tønsbergprosjektet

Tønsbergprosjektet

DESIGN	PROCUREMENT	PRODUCTION	CONSTRUCTION	COMMISSIONING	HAND OVER
PRE DESIGN	SCHEMATIC DESIGN	DESIGN DEVELOPMENT	CONSTRUCTION DOCUMENTS		
PACKAGE LIST	COST PLAN	PROCUREMENT SCHEDULE			
		PACKAGE MANAGEMENT	AS-BUILT INFORMATION	SERVICE AGREEMENTS	



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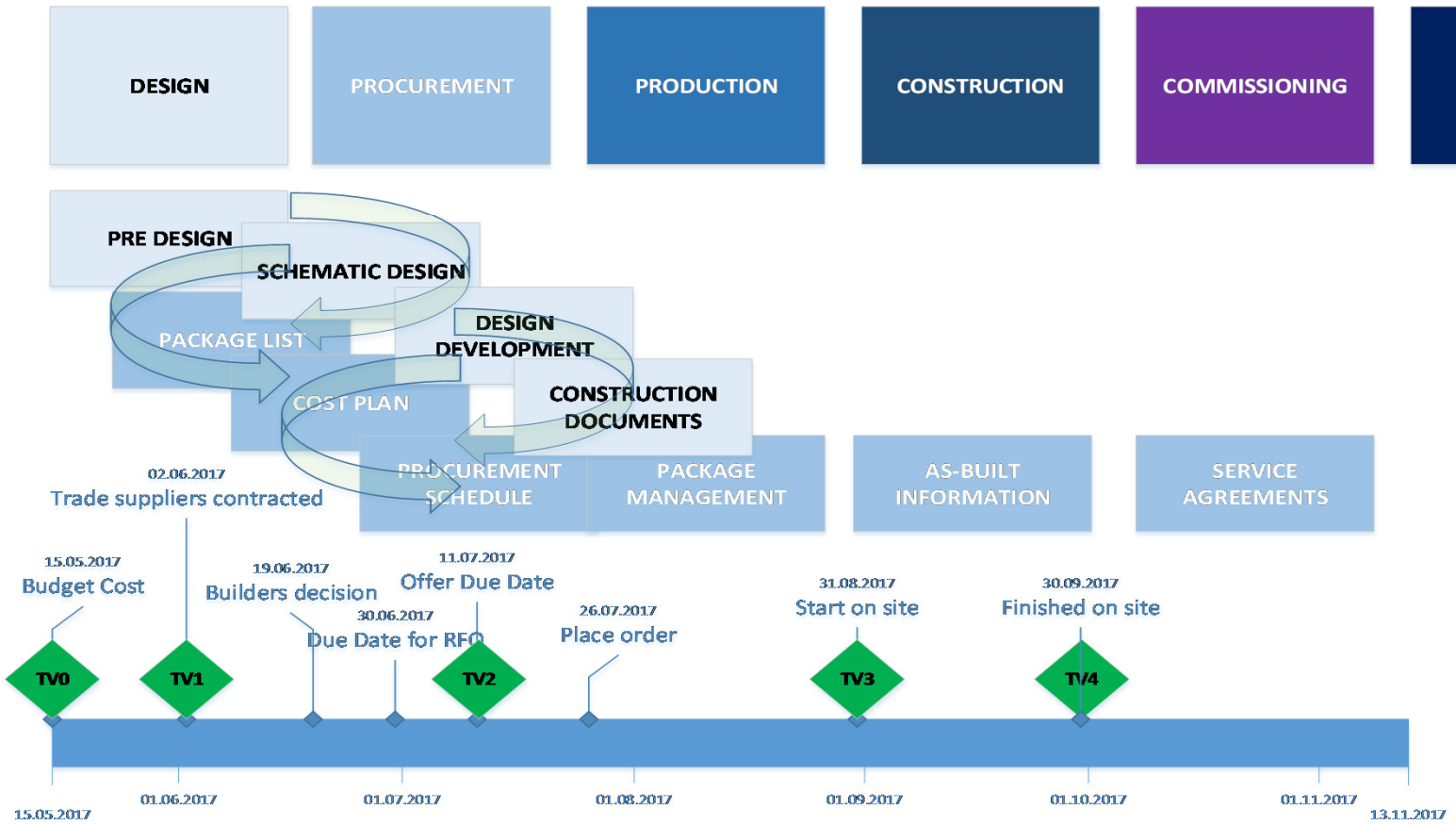
Tønsbergprosjektet

Tønsbergprosjektet



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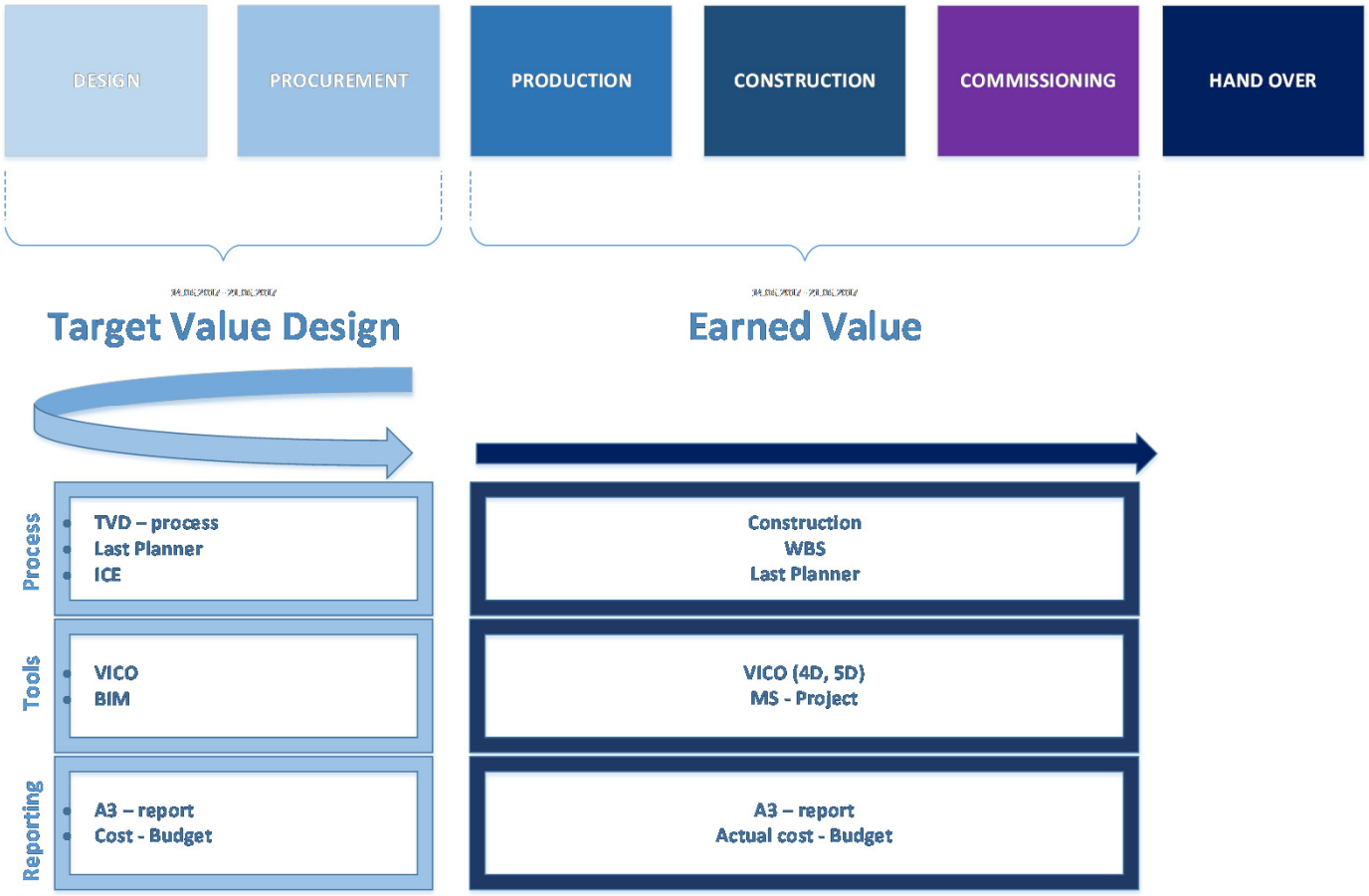
Tønsbergprosjektet

Tønsbergprosjektet



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Tønsbergprosjektet

bergprosjektet

WBS IPD

- Engineering
- Rig & Operation
- Somatic
- Psychiatric
- Site

WBS TVD

- Enabling & Site Works
- Substructure
- Frame
- Envelope
- MEP
- Fit Out

Procurement packages Psychiatric

- Groundworks
- Substructure work
- Frame
- Facade
- Roof
- MEP
- Fitout

Procurement packages Fitout Psychiatric

- Bathroom pods
- Ironmongery
- Dry limed pertitions
- Doors
- Door installation
- Steel doors
- Door automation
- Kitchens
- Suspended ceilings
- Fixtures and fittings
- Floor finishes
- Decorations
- Arch. Metal works
- Wall protection
- Levelling screed
- Mastic
- Core drilling

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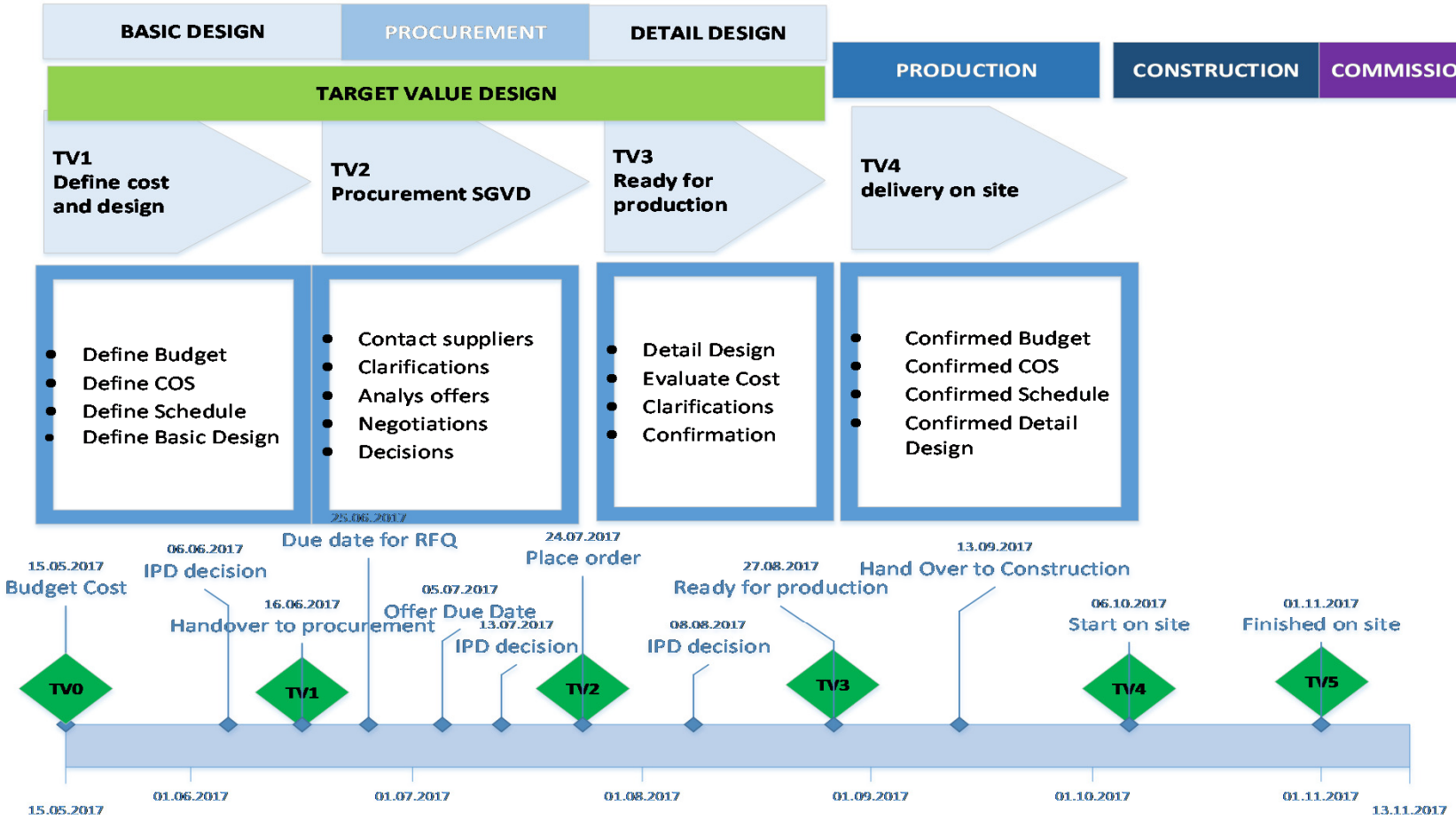

Tønsbergprosjektet

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