



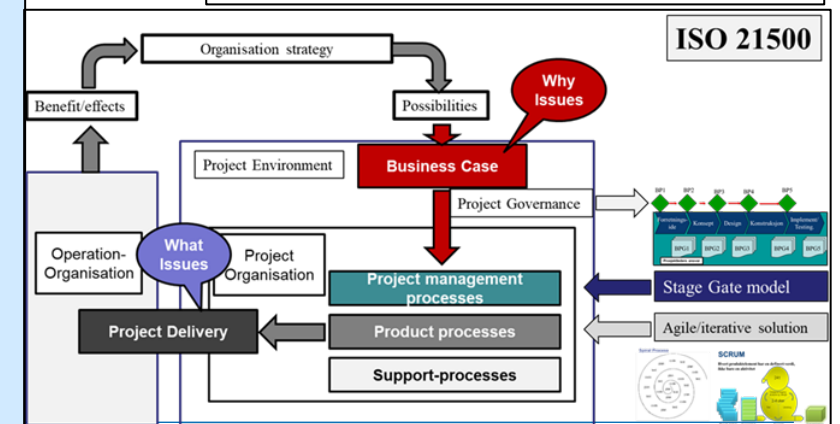
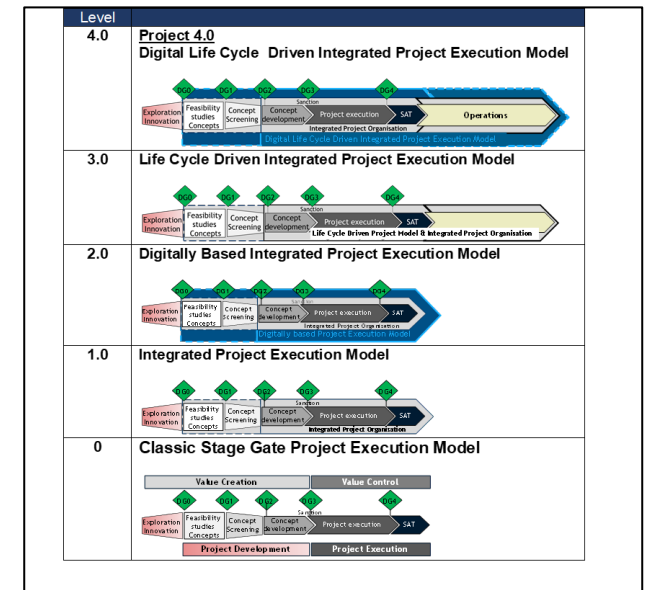
Noen høydepunkter fra FOU-prosjektene Energi - olje, gass og fornybart



Bakgrunn, historikk og tidslinje

Hovedelementer:

1. Forstudierapport februar 2020
2. Valg av to FOU-prosjektområder
3. Forprosjekt høsten 2021
 - a) Internasjonal spørreundersøkelse blant EMME studenter
 - b) Innledende spørreundersøkelse blant sponsorene
4. Analyse av spørreundersøkelsene vinter og vår 2022
5. Litteratursøk innen digitalisering og betydning av Industri 4.0 på prosjekt-ledelse og gjennomføring våren 2022 og høst 2022
6. Practitioners' report desember 2022
7. Neste steg: Empiriske data og analyse på prioriterte områder vår 2023
 - a) Generisk
 - b) Prosjektspesifikke data fra avsluttede og pågående prosjekter



1. Forstudierapport februar 2020

Bedre beslutninger og betydning av digitalisering i prosjektgjennomføring

En innledende kartlegging

ISO 21500

- Prosjektledelsesprosesser
- Arbeidsprosesser
- Støtteprosesser

Hovedfunn:

- Betydelig grad av digitalisering i arbeidsprosessene både for fysiske prosjekter og IKT
- Noe mer begrenset grad på støtteprosesser
- Mindre grad i prosjektledelsesprosessene
 - En del på strukturelle prosesser
 - Lite knyttet til ledelse, organisering, roller
- Industri 4.0 ikke synlig
- Veldig begrenset innen omorganiseringsprosjekter

Hypotese:

- Behov for nærmere studier av betydning av digitalisering og Industri 4.0
- Prioritet på prosjektledelse organisering & roller



Forsknings- og utviklingsarbeid knyttet til prosjekter innen olje & gass

Forslag til FOU-prosjekter

Prosjekt # 1:

Integrated Business and Project Value Optimization in a life cycle perspective - Project 4.0 - A performance driven and fully digitalised integrated project execution model

Prosjekt # 2:

Impact of digitalisation on project management processes and decision making in Project Development and Execution

Har vært til høring hos Equinor, AkerBP, Gassco samt hatt egne møter for gjennomgang. Lansert for bransjen 1. juni 2021

Formål med FOU-prosjekter i Prosjekt Norge regi for olje og gass

- Bidra til videreutvikling av prosjektledelse og prosjektbasert ledelse innen olje og gass
- De akademiske medlemsinstitusjonene kan fokusere på forskningstemaer som det ikke er anledning og tid til å belyse hos den enkelte partnerbedrift
- Være brobygger fra forskningsfronten og inn mot anvendelse i virksomhetene
- Vurdere relevansen av «State of Art» i andre bransjer for prosjekter i olje og gass

Forsknings- og utviklingsarbeid knyttet til prosjekter innen olje & gass

Valgte FOU-prosjekt

Prosjekt # 1:

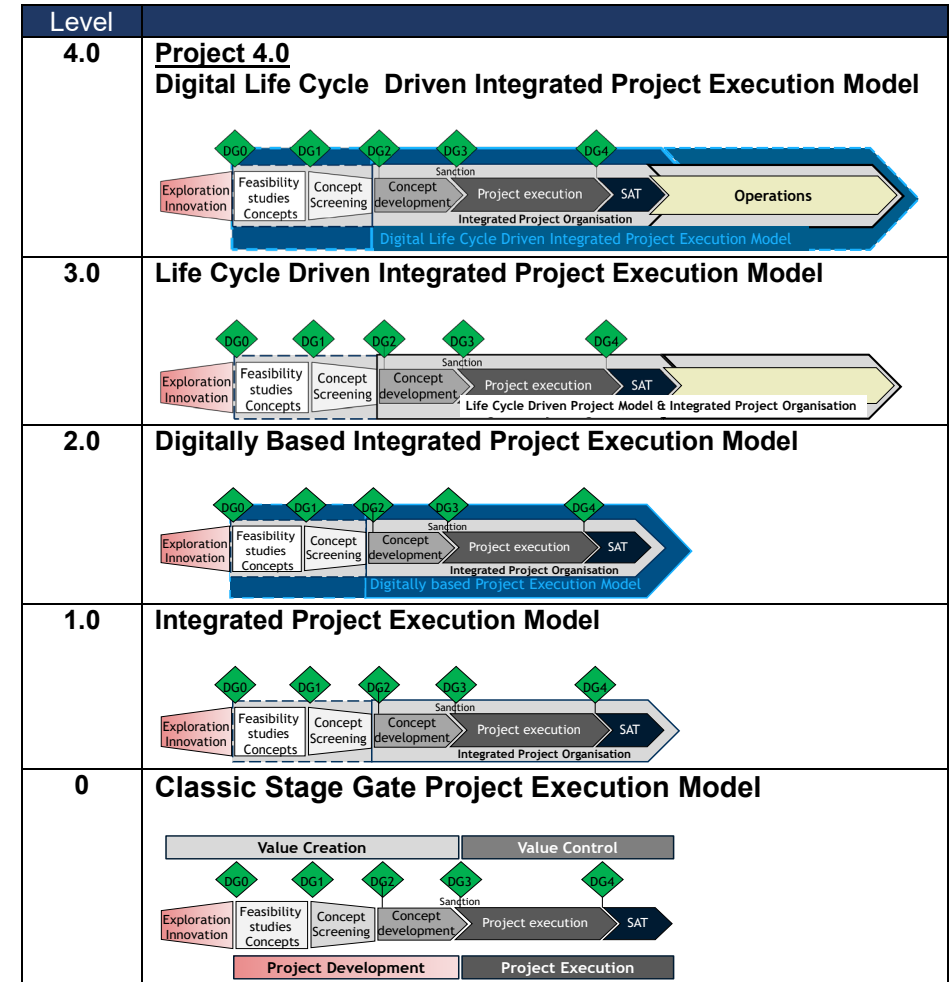
Integrated Business and Project Value Optimization in a life cycle perspective - Project 4.0 - A performance driven and fully digitalised integrated project execution model

Har vært til høring hos Equinor, AkerBP, Gassco samt hatt egne møter for gjennomgang.

Justert og oppgradert.

Lansert for bransjen 1. juni 2021

Sendt separat invitasjon til en gruppe av leverandører



Forsknings- og utviklingsarbeid knyttet til prosjekter innen olje & gass

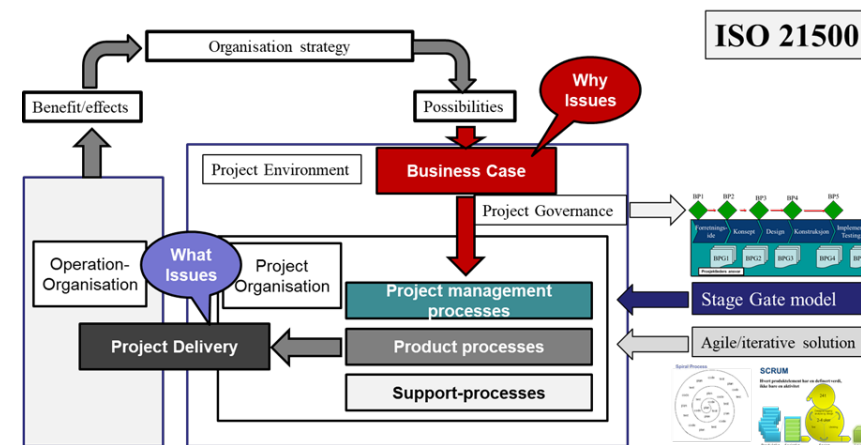
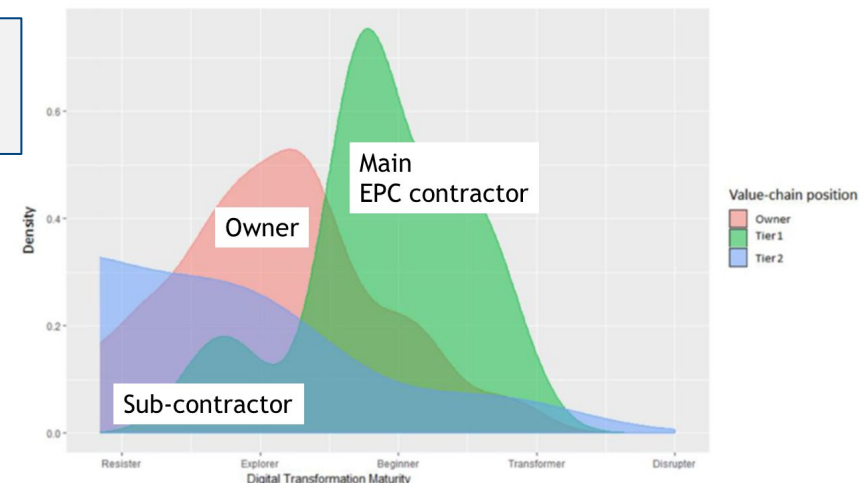
Valgt FOU-prosjekt forts.

Prosjekt # 2:

Impact of digitalisation on project management processes and decision making in Project Development and Execution

Har vært til høring hos Equinor, AkerBP, Gassco samt hatt egne møter for gjennomgang.
Justert etter innspill fra AkerBP, Equinor og Gassco
Lansert for bransjen 1. juni 2021
Egne brev til leverandører

Digital Modenhet



Støtte til FOU-forslag med egen OED formulering

- Offisiell versjon av FOU-forslagene er utarbeidet med innspill fra AkerBP, Equinor, Gassco.
- Invitasjonsbrev er sendt med FOU-forslagene som vedlegg til følgende:
 - Operatørene AkerBP, Lundin, Equinor og Gassco
 - Andre operatører er identifisert og kontaktes før sommeren
 - Leverandører til olje og gass-selskapene på Norsk Sokkel
- Forslagene er også sendt OED og gjennomgått der.
- OED lagde en egen “godkjent” tekst den 1. juni 2021, som følger, og er inkludert i invitasjonen:

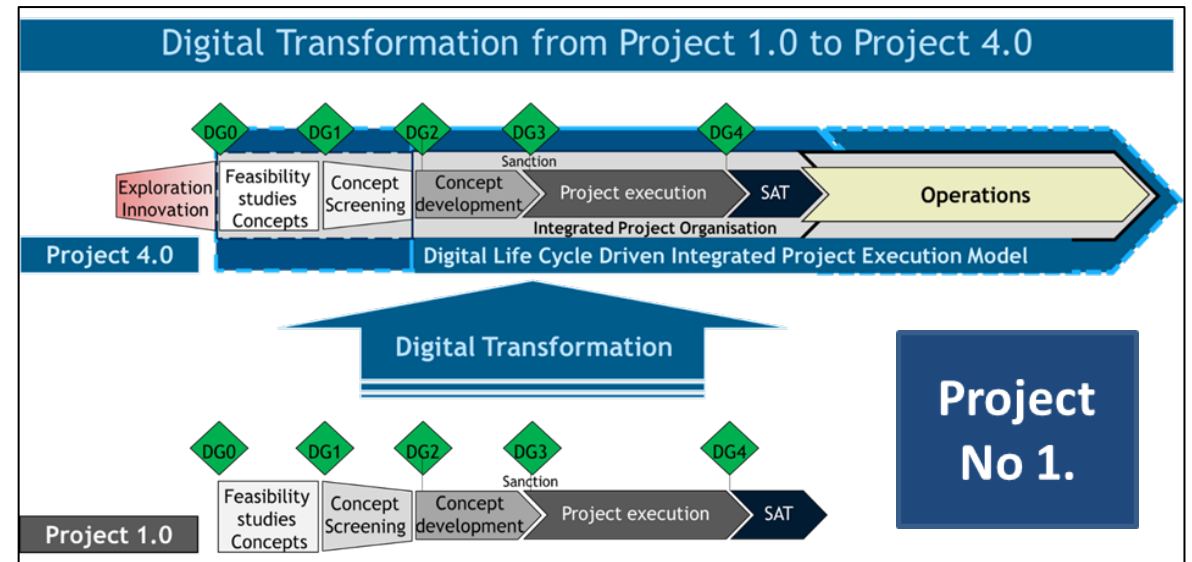
"Prosjektforslagene er drøftet faglig med operatørselskaper og Olje- og energidepartementet (OED) er orientert.

OED er opptatt av optimal ressursforvaltning på norsk sokkel, og er positiv til utvikling av forbedrede prosjektgjennomføringsmodeller med inkludering av digitale teknologier som kan sikre god og faglig forsvarlig prosjektgjennomføring."

Fra Prosjekt 1.0 til Prosjekt 4.0

Viktige elementer:

- Fra prosjektperiode til livssyklus perspektiv??? Realistisk?
 - Fra Prosjekt 1.0
 - Til Prosjekt 4.0
- Adoptere hoved-karakteristika av Industri 4.0 inn i prosjekthverdagen
 - Industriell standardisering
- Fra produktfokus til prestasjonsbaserte egenskaper og kontrakt-relasjoner
- Governance i lys av AI, ML, AR, IOT



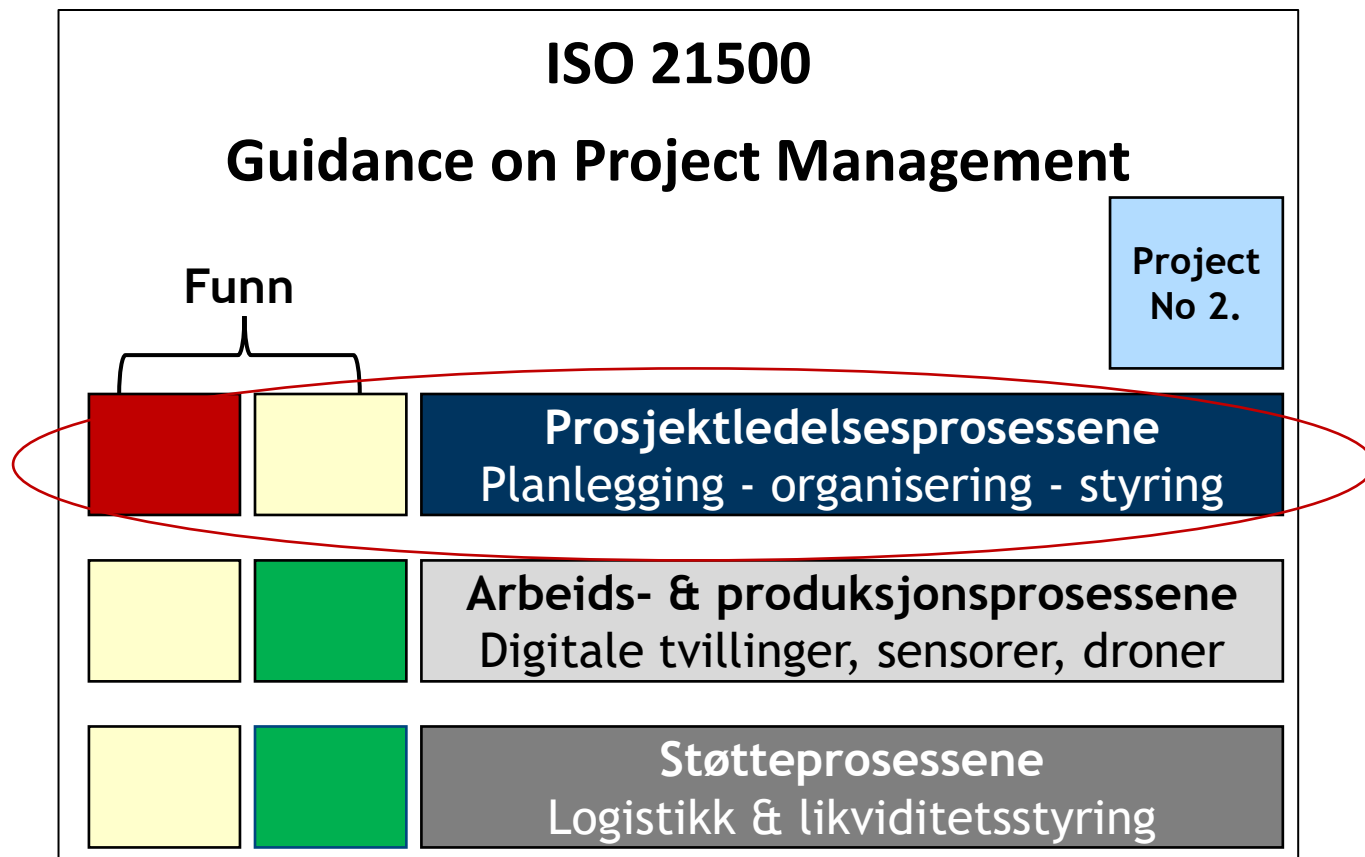
Virkninger av Prosjekt 4.0:

- Prosjektgjennomføringsmodeller og styringsprosesser
- Beslutninger og beslutningsprosesser
- Organiseringsdesign samt roller i og rundt prosjektet
- Kompetanse-profil
 - Data Analytics integrert

Spørreundersøkelse om digitalisering i prosjekter

Kartlegging og spørreundersøkelse om digitalisering og digital modenhet i prosjekter

- Norske operatørselskaper har deltatt i en kartlegging og spørreundersøkelse rundt digitalisering og Industri 4.0
- Spørreundersøkelsene er også utført blant tidligere kandidater på det internasjonale energi-masterstudiet på BI.



Digital Maturity in EPC environments

Partners assessed in EPC contracts

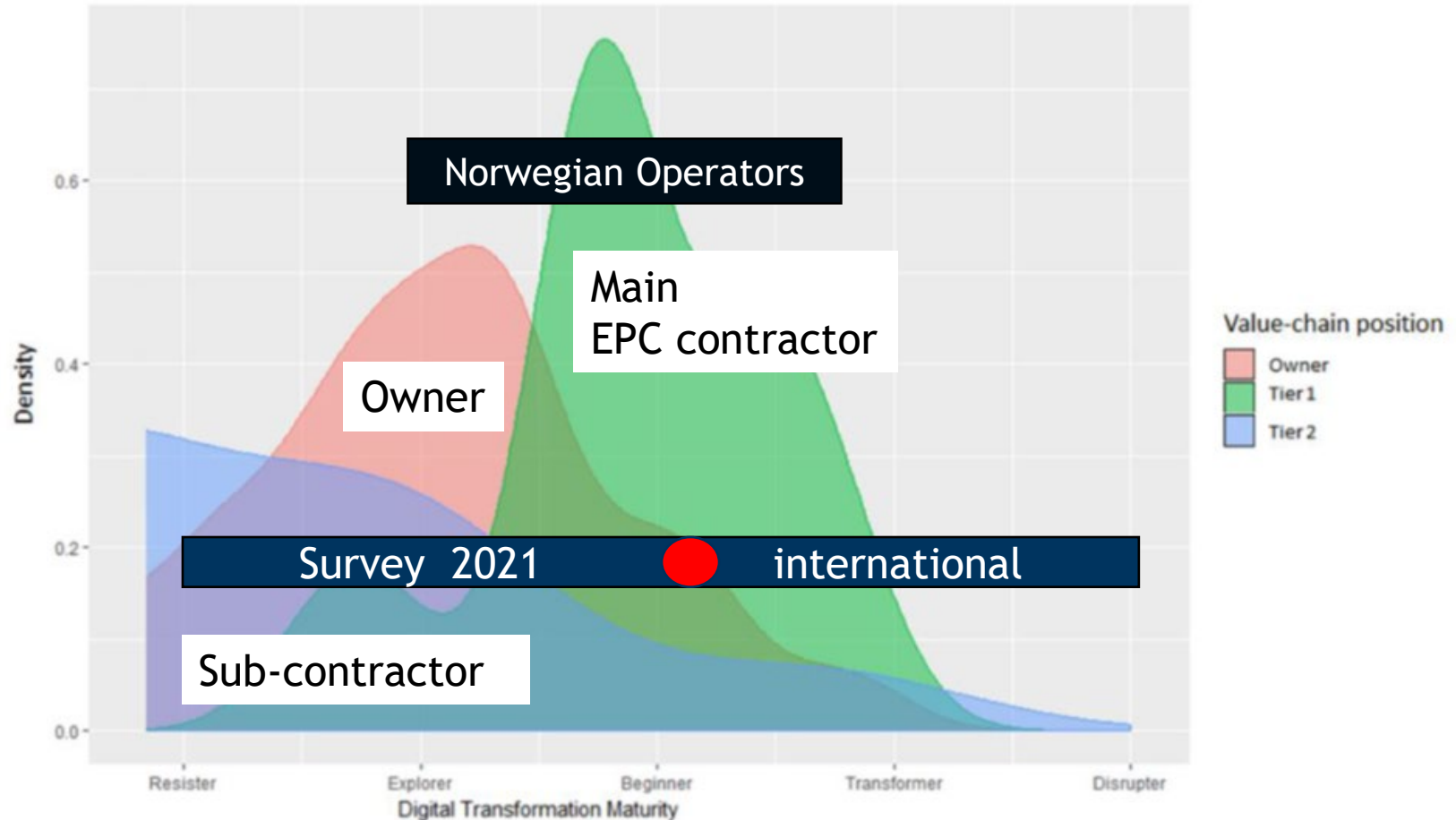
- Owner (red profile)
- Main EPC contractor (green)
- Sub contractor (blue)

IDC made a survey on behalf of Siemens AG

Categories of digital maturity

1. Resistor
2. Explorer
3. Beginner
4. Transformer
5. Disrupter

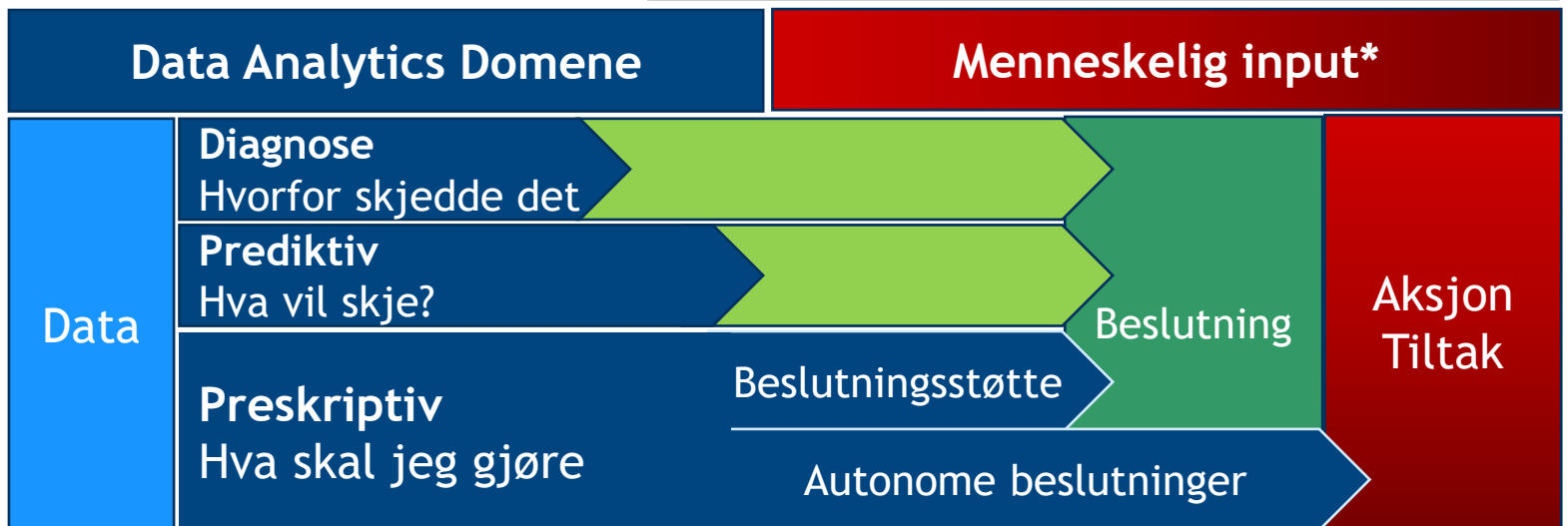
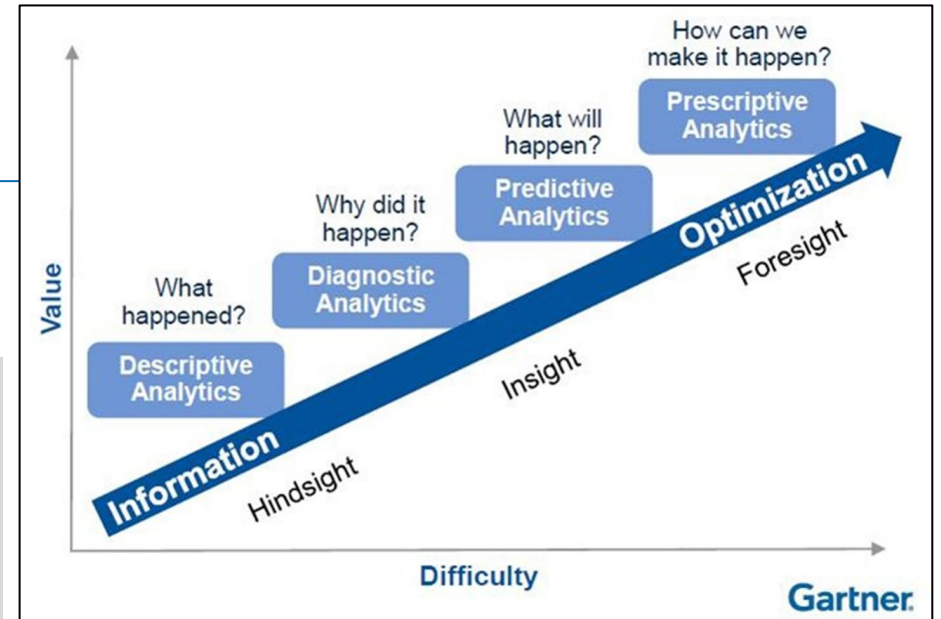
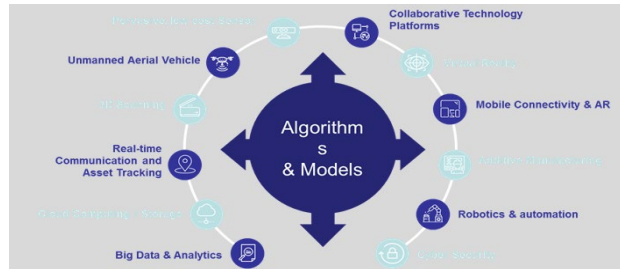
Source; (Bigliani & Verselino 2018)



Data Analytics og beslutninger

Viktige sammenhenger

- Big data
- Kontekstualisering av data
- Sanntids-analyser med
 - AI
 - Dyp maskinlæring
 - IOT
 - AR
- Beslutningskriterier
- Prognoser; prediktiv & preskriptiv
- *Taus kunnskap**?



Beslutninger i prosjekter og betydning/bruk av digitale verktøy

Operasjonelle beslutninger

Prosjektledelsesprosesser

- Planlegging
- Styring og gjennomføring
 - Risk
 - Kost & plan
 - Stakeholders
- Ressursstyring

Produktprosessene

- Produktutviklingen; produktkvalitet
- Avvikshåndtering

Strategiske «One Off» beslutninger

Prosjektledelsesprosessene

- Valg av prosjekt og prioritering i en portefølje
- Konseptvalg
- Prosjektstrategi
- Prosjektstart
- **DG- beslutning og passering**
- Prosjekt-terminering

Produktprosessene

- «Fit for purpose» ved store avvik

Autonome beslutninger mulig?

Autonome beslutninger mulig?
I disse fall beslutningsstøtte?

Roller og nødvendig fokus på digitalisering

Prosjekteier;

- Forstå betydning av digitalisering i rolle som prosjekteier og ivaretagelse av Governance i prosjektene (eierstyring)
- forstå betydning av digitalisering og bruk av digitale verktøy til en virksomhets-strategisk vurdering og prioritering av prosjekter i porteføljen, samt
- Forstå betydning av digitalisering som mer faktabasert beslutningsstøtte for konseptvalg

Prosjektleder;

- bruk av egenskapene til digitale verktøy og metoder i planlegging og styring av prosjektene, inklusive
- implementering og realisering av vedtatte prosjektstrategier

Inkludere Data Analytics-kompetanseressurser som primær støtte inn mot resultatansvarlige linjeledere i prosjektene.

Øvrige linjeledere i prosjektene, delprosjektledere etc. må få trening og opplæring

- i forståelse av nytte og
- faktisk iverksettelse og bruk.

Avsluttende punkter fra den innledende kartleggingen

- Digitalisering og digitale verktøy er tatt i bruk i vesentlig grad for produktprosessene innen fysiske prosjekter og IKT
- Stor variasjon i bruk av bruk av digitalisering i prosjektledelsesprosessene, fra helt marginalt til betydelig
- Digitaliserte beslutningsprosesser gir et paradigme-skifte med hensyn på både tempo, mer omfattende databaser, bruk av AI, maskinlæring & AR og høynet kvalitet på beslutninger
 - Fra magefølelse
 - Til evidensbaserte beslutninger
- Operasjonelle repetitive beslutninger kan i en viss grad gjøres autonome gjennom bruk av AI og selvlærende maskinlæring
- Strategiske beslutninger som er «One-Off» vil ikke i samme grad egne seg for autonome beslutninger, men beslutningsgrunnlaget styrkes med digitale modeller og verktøy
- Den innledende kartleggingen gir et godt grunnlag for analyse og evaluering av potensial og forventede fremtidige effekter. Analysene er i gang basert på dels kartlegging, dels litteratursøk

Digital Maturity Road Map AS IS 2022

Digital Categorisation

- **Green colour:** Digitalisation through a range of digital tools is to a significant extent actually in operation, although to a varying degree
- **Yellow colour:** Questionable/ beginner stage of application of digital tools and approaches
- **Red colour:** Resistor or not yet applied, any digital enablers

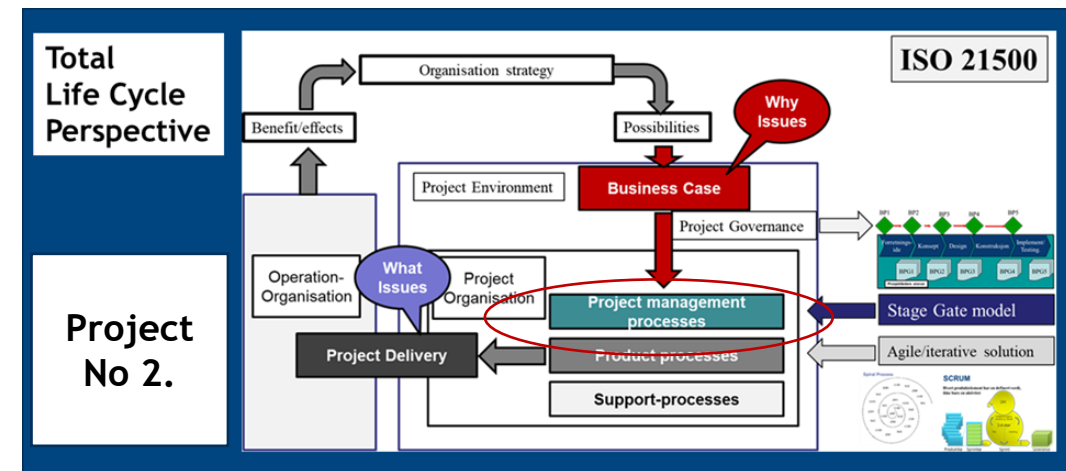
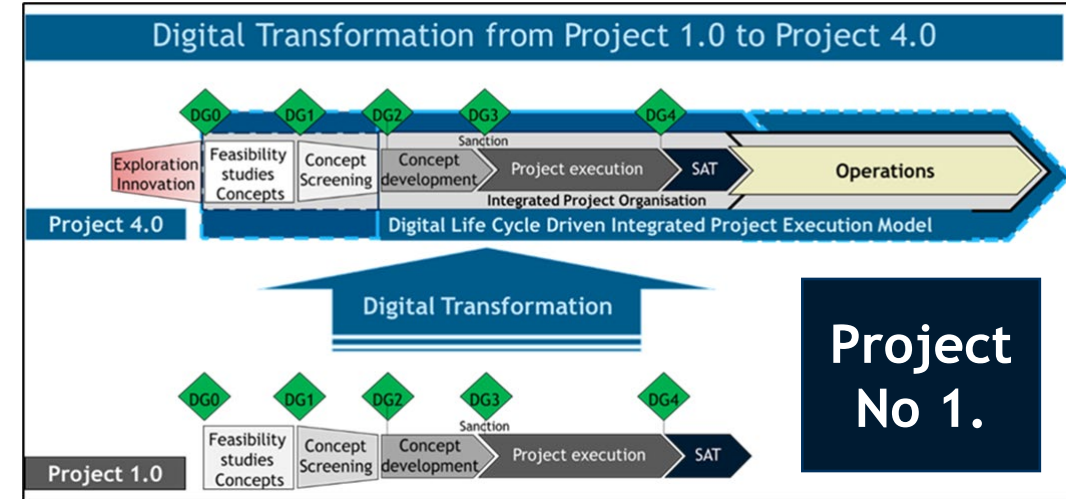
En relevant visualisering som hjelp til prioritering?

BI

Processes	Management Processes							Solutions & Work Processes		Support processes
	Governance	Decision making	Planning	Budget & Control	Uncertainty	Org. Design & roles	Stakeholders	Solution	Work Processes	Supply Chain
Stages										
Exploration & Reservoir D&W	Proven reserves						License partners	3D AI driven simulations	Iterational processes	Procurement services
							License partners	AI driven configuration	Iterational processes	Procurement services
DG0										
Field Development & Business Planning & Appraisal	Integrated configuration & solution						License partners Society Suppliers Gov. agencies	Integrated vaule optimization	Iterational processes	Integrated supply chain and field development
DG 1										
Feasibility & Concept	Selection Criteria & screening	Concept selection						Business case alternatives	Digital twin on iterational processes	Contract strategies Procurement strategies
DG 2										
FEED	Consent PUD							Maturation of concept	Digital twin & iterational processes	Maturation of contract strategies & company supply items
DG 3										
Design & Execution							License partners Contractors suppliers	AFE Design	Sequential processes use of Digital twin	Category management & logistics
Construction							Licence partners Main contractors Suppliers	As built	Optimized erection & assembly solution Digital twin	Logistics and supply chain
Commissioning	Consent for operation	Decision start operations					Licence partners Contractors	FAT & SAT	Use of digital twin	Interface & compatibility assessments
DG 4										
Operations	Governance as operator Governance in licence Committee	Decisions on Tie Back Decisions on upgrades		Life Cycle cost control Remote Control	Condition Monitoring		Service contractors	High reliability & regularity solutions Upgrades for efficiency & regularity improvements Tie back solutions	Utilisation of digital twins Condition monitoring Remote control	Just in Time supplies Strategic supplies Bulk supplies Statnadrisation improvements on supplies

Practitioners Report»

- Project No. 1.
- **A performance driven and fully digitalized integrated project execution model & adaption/utilization of Industry 4.0**
- Project No 2.
- **Impact of digitalisation on project management processes and decision-making in Project development and execution**
- ***The focus areas for both projects are related to the impact of AI on project management and the management processes with associated decision making, project organising and project execution models, not on the technical work processes as such.***



«Practitioners Report»

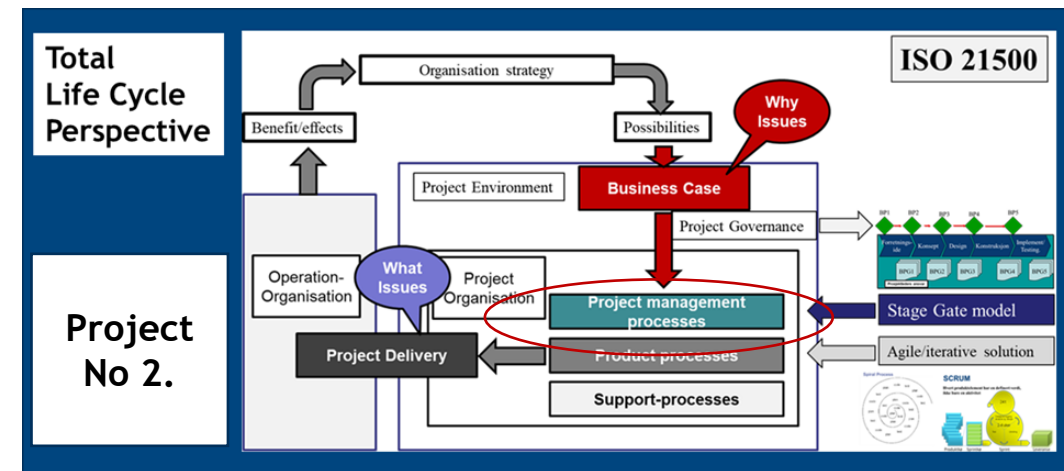
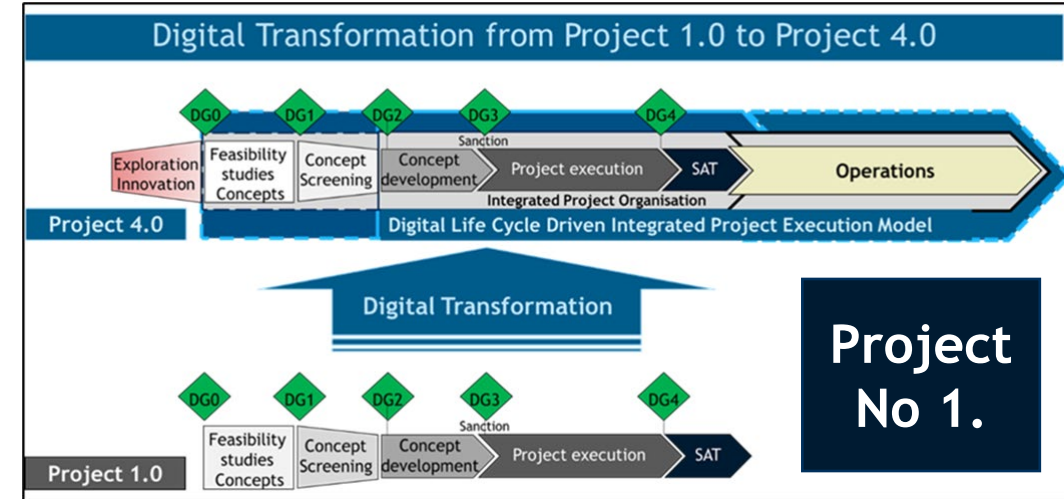
- **Scope of Work**

- **Project 1.**

1. Enable I4.0 Framework to achieve inter-operability in project execution models in the industry
2. Learning & Competence
3. Organisation design & digital Impact on roles

- **Project 2.**

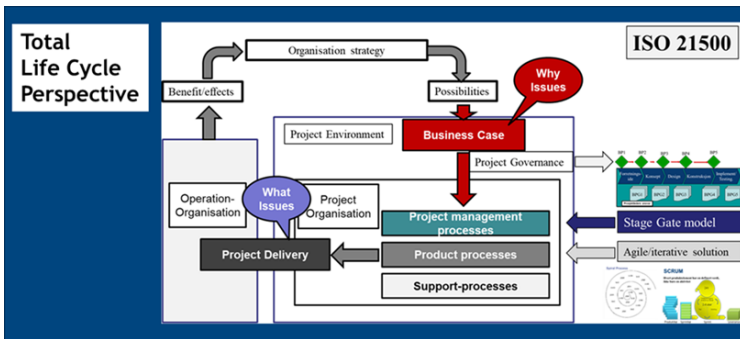
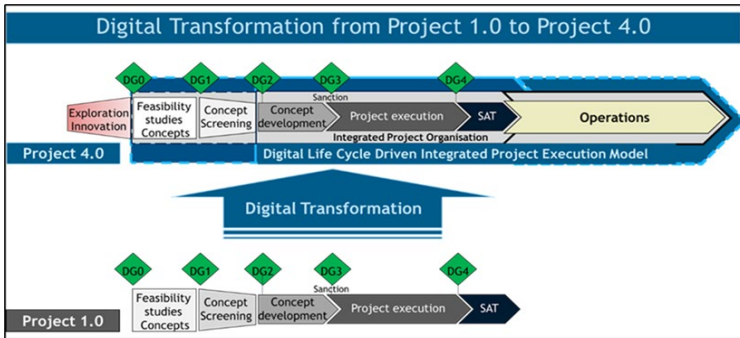
1. Governance in energy projects based on Industry 4.0 framework
2. Decision Gates
3. Organisation design & project management processes
 - Cultural & relational processes
 - Structural processes



Practitioners' Report

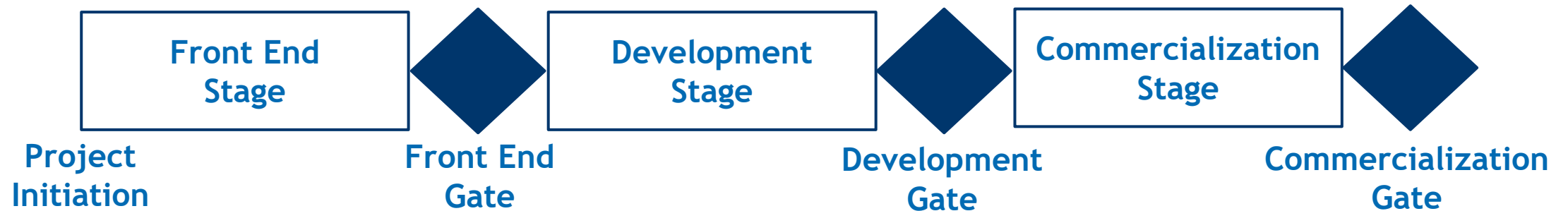
- Practitioners' Report main content presented in meeting 25. November:
- **Part 1: Preface**
- **Part 2: Summary Highlights in the R&D projects extracted from the scientific chapters**
- **Part 3: Scientific chapters**
 1. **Project Execution Models in Industry 4.0**, Kim Oorschot, Norwegian Business School BI
 2. **Governance in Energy Projects Based on the Industry 4.0 Framework**, Ralf Muller, Norwegian Business School BI
 3. **Focus on Data exchange & Sharing**, Alfons Marrewijk, Norwegian Business School BI
 4. **How to organise Energy Projects in Industry 4.0**, Anne Live Vaagaasar, Norwegian Business School BI
 5. **Organisational consequences of digitalisation, data sharing & streaming**, Ole Jonny Klakegg & Eilif Hjelseth, Norwegian Institute of Science & Technology NTNU
 6. **Next Generation Digital Twins – Challenges & Potentials**, David Cameron, SIRIUS Centre for Research- Based Innovation, Department of Informatics, University of Oslo

Road Map on Project Scope & Scientific Chapters



Scientific Chapter	SCh No 1	SCh No 2	SCh No 3	SCh No 4	SCh No 5	SCh No 6
	Oorschot	Muller	Marrewijk	Vaagaasar	Klakegg & Hjelseth	Cameron
Project No 1						
WS 1.1 Enable I4.0 & interoperability	X	X	X		X	X
WS 1,2 Learning & competence	X	X		X		
WS 1.3 Organisational design		X	X	X	X	
Project No 2						
WS 2.1 Governance & I4.0 framework	X	X		X	X	
WS 2.2 Decision Gate considerations	X		X		X	X
WS 2.3 Organisational design & digital impact		X		X		

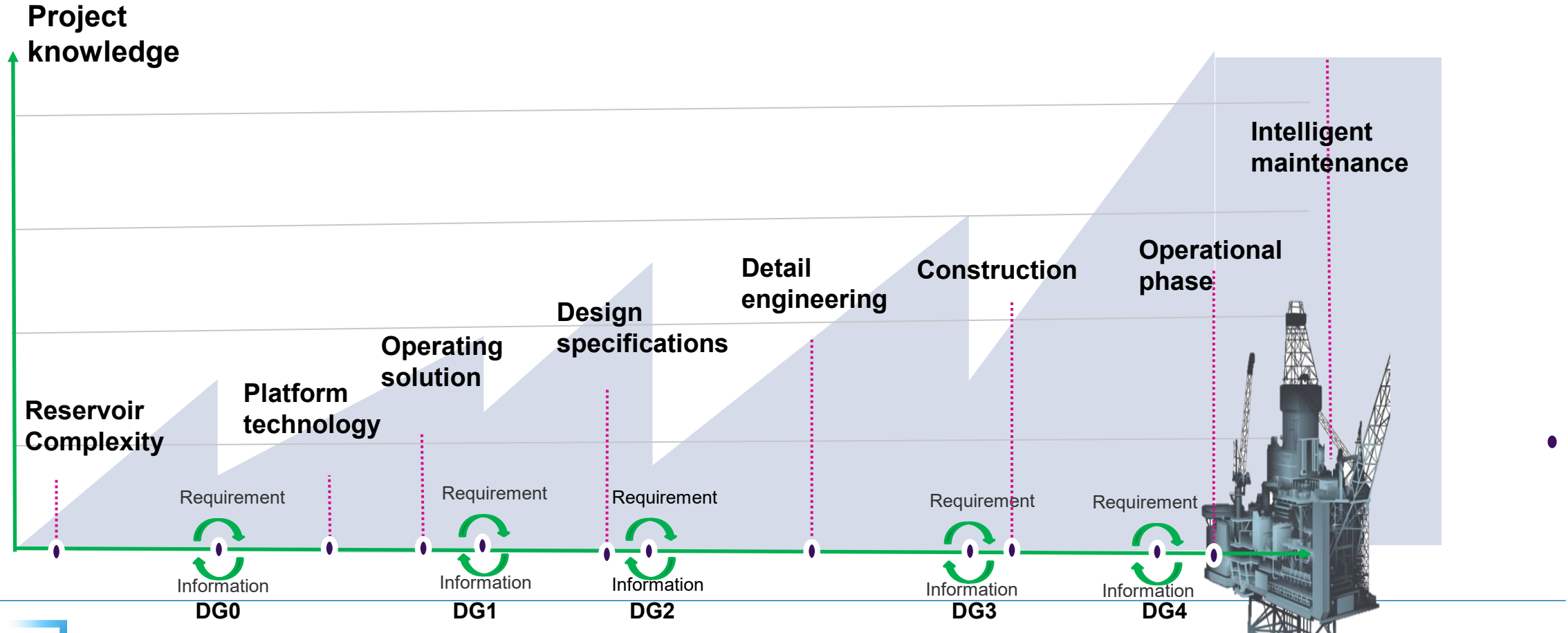
Where is project knowledge created in Industry 4.0?



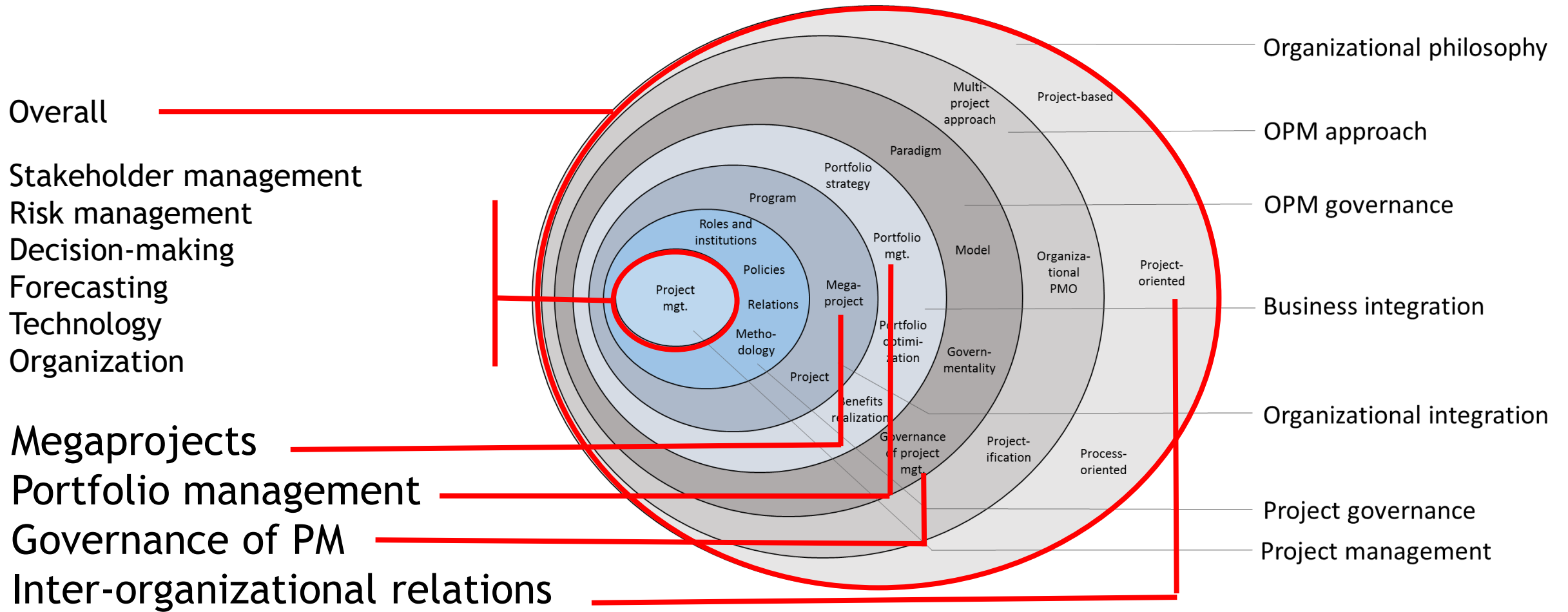
Data can be measured about what is going on **NOW** within a stage
(rigidness, standardization, digitalization, silo's)

But knowledge needs to be generated about what this data means for the **FUTURE** of the project to support decision-making
(sensemaking, integration, flexibility)

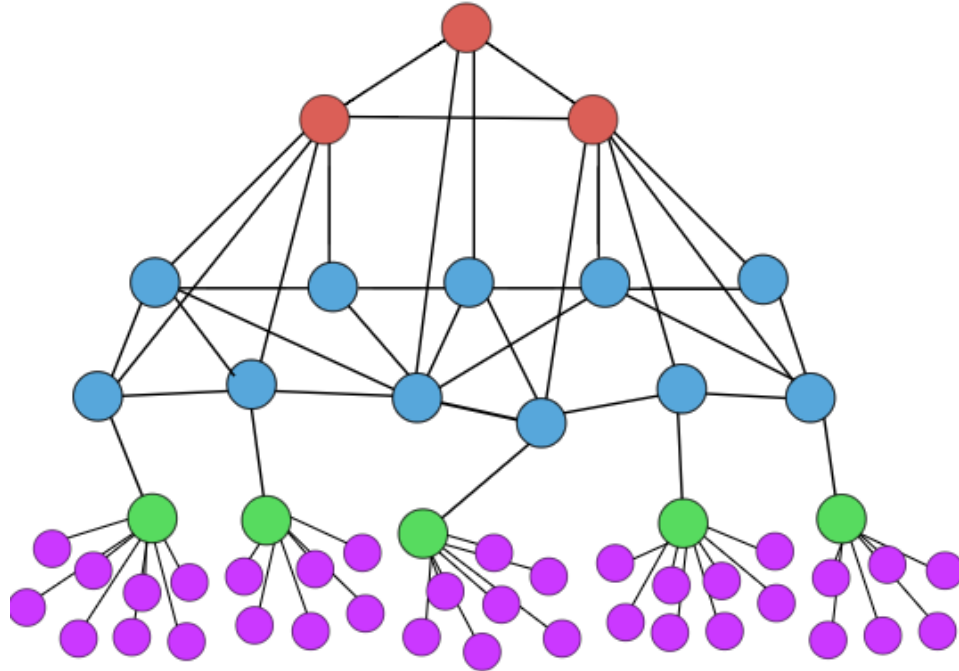
Information loss along life cycle causes rework, and a loss of knowledge of why the plant is as it is.



Mapping to intra-organizational governance of projects



Governance of inter-organizational networks for projects



Metagovernance				
Meta-exchange <i>Project types</i>	Meta-organization <i>Organizations</i>	Meta-heterarchy <i>Network structures</i>	Meta-solidarity <i>Ways to collaborate</i>	Balancing of modes <i>Priority of dimensions</i>

Governance of networks				
Structuring <i>Authoritative to democratic structure</i>	Forming <i>Orchestrated, emergent or hybrid formation</i>	Accountabilities <i>Transparency in roles and answerabilities, escalation procedures</i>	Responsibilities <i>Working in compliance with accepted professional standards</i>	Modes of collaboration <i>Interfaces between networks</i>

Network governance				
Type I governance <i>Hierarchical part of project's organizational structure</i>	Type II governance <i>Networked part of project's organizational structure</i>	Clubs	Agencies	Boards

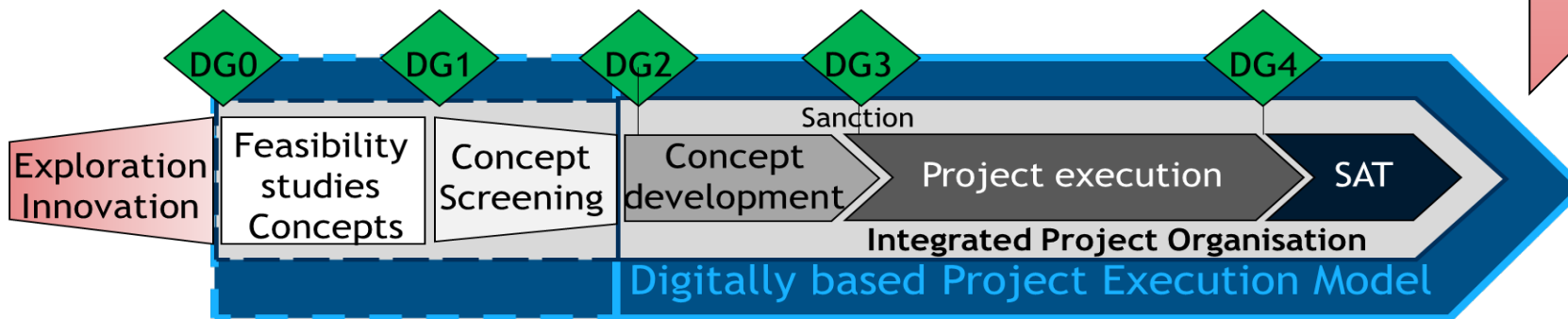
Of particular interest for field development projects with several stakeholder inside and outside the organisation.

- Partners, licence committee, main contractors, etc

Automation themes

- Automated reporting - likely?
- Automated decision making - differentiate

Interesting for
US

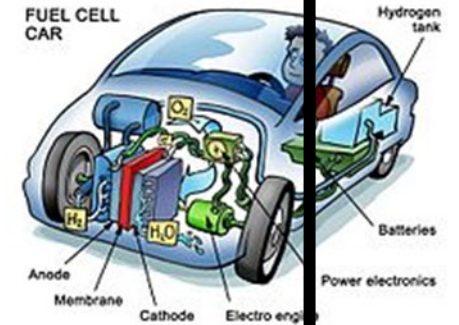


Automation themes (automobile ind.)

- Level 0: No Automation (e.g. cruise control)
- Level 1: Assisted Driving Automation (e.g. adaptive capabilities)
- Level 2: Partial Automation (e.g. self parking)
- Level 3: Conditional Automation limited automation driving functionality under certain conditions)
- Level 4: High Automation (full automation driving technology functionality in most conditions)
- Level 5: Full Automation (require no involvement of humans)

Driver must
intervene when
needed

Driver
accountable



Suggested way forward

Context: Stage Gates/Reviews

Automated reporting

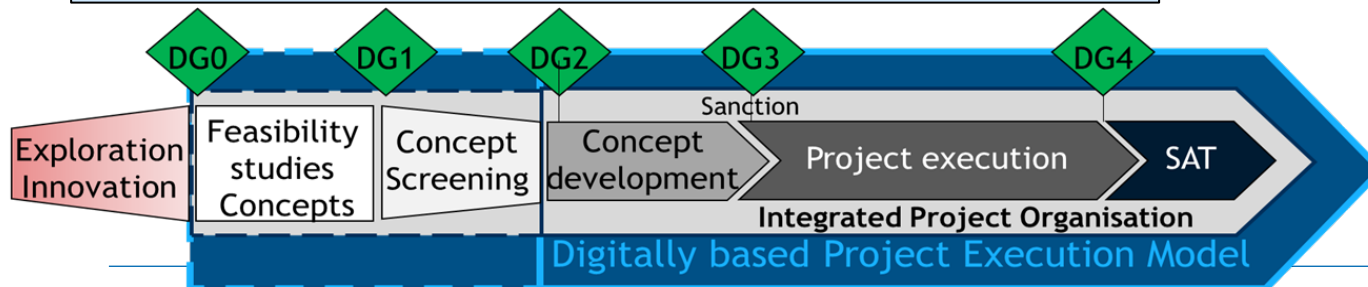
- Mapping of current measures against needed measures
- Identification of relevant data in the system
- Building a prototype

Decision automation

- Categorizing decisions by severity (impact on business, ethics, HR etc.)
- Defining type/level of control for each decision category

Develop ethics policy for automated decision-making

- Develop principles
- Identify thresholds and actions
- Develop implementation guide



Decision making in projects

Operational decisions

Project management processes

- Planning
- Management & execution, control & forecasts
- Resource management
- Interface management

Work processes

- Product development
- Non conformance & deviations

Strategic «one off» decision making

Project management processes

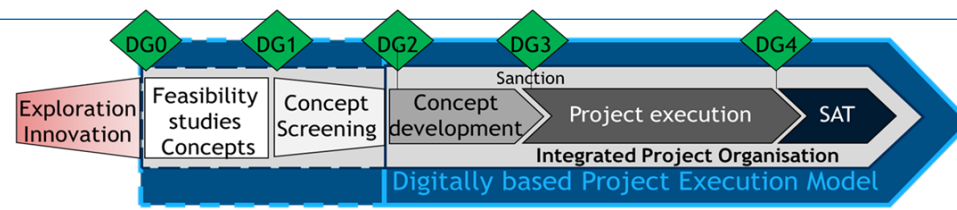
- Prioritisation and selection of projects in a portfolio
- **Concept selection**
- **DG Approval & sanction**
- Project kick off
- Project-termination

Work processes

- «Fit for purpose» at gross deviations

Autonomous decisions possible?

Autonomous decisions at all possible, or at best being better decision support facts?



Roles and the impact of digitalisation

Asset/Project Owner & Gate Keeper/Asset Owner Rep.;

- Fully understand the impact of digitalisation in the role as project owner and managing Governance in the projects
- Understand the importance of digitalisation and use of digital tools in an enterprise strategic context and prioritization of projects in the project portfolio, plus
- Fully recognise the importance of digitalisation as enabler for achievement of evidence based and datadriven decision support for concept selection

Project Leader;

- Maximum utilisation of the features of digital tools and methodologies in managing and leading the project, from planning through execution and control to delivery and handover to the client or user
- Implement and realise the approved and selected project strategies

Include Data Analytics-competences as primary support for accountable managers in the projects

Line managers(part project managers etc.) in the projects must be sufficiently trained in the

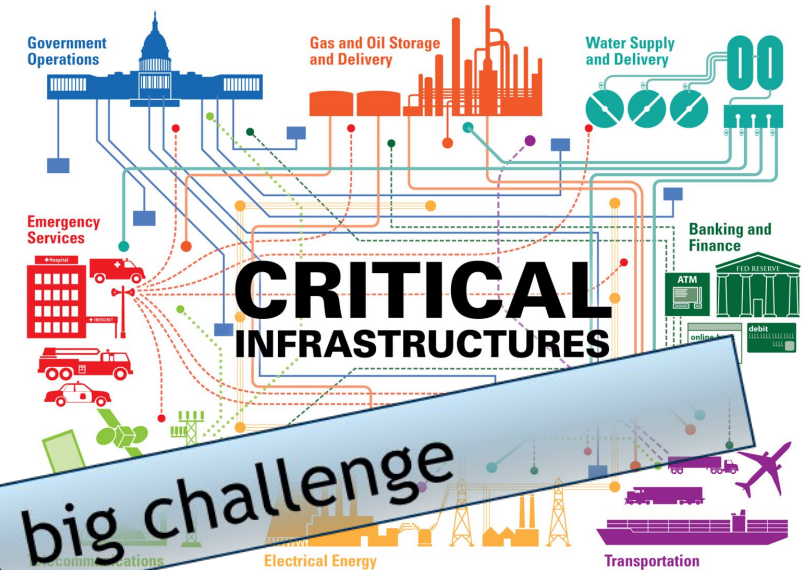
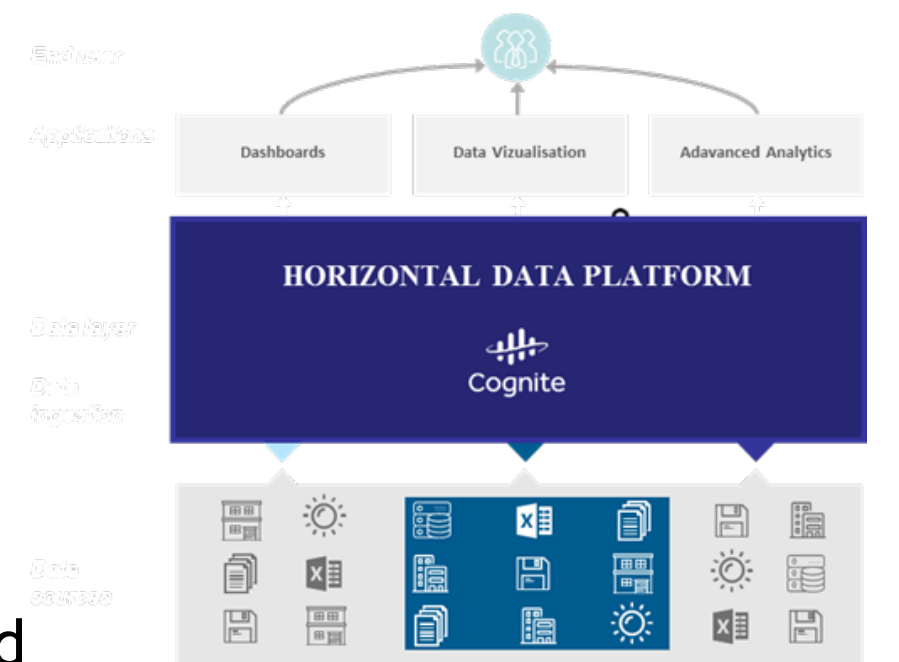
- The understanding & utilisation of digital analytics, as well as for
- Handover and use of the delivery



Open data sharing; an issue and realistic?

Key elements

- Data sharing is important for open organizing to streamline project practices and processes
- Data sharing facilitate interorganizational collaboration to meet project demands with significant cost and time reduction (Berkowitz and Dumez, 2016)
- The general assumption is that open data will offer solutions and lead to innovations
- Little insight into *how* data sharing is practiced, enabled and constrained in project settings (Janssen et al., 2012)
- **Commercial barriers?**

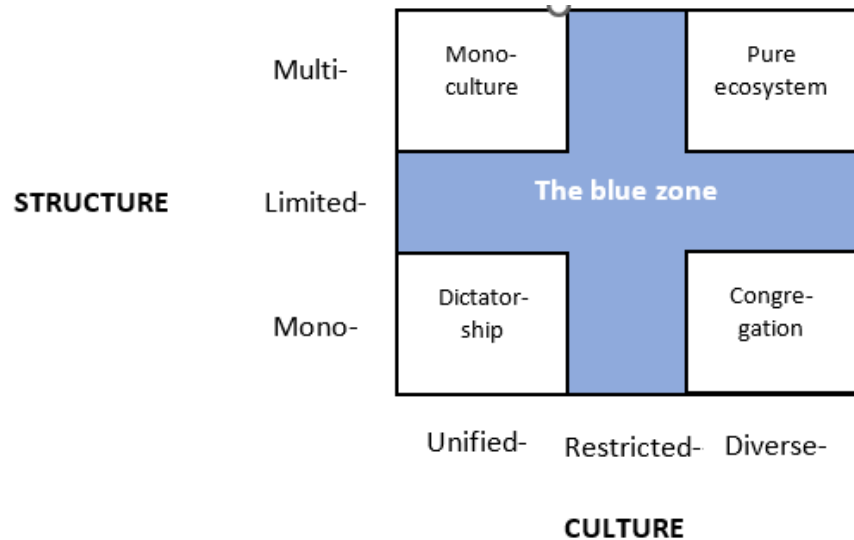


Data Sharing; a big challenge

Organizational consequences across organisations

Structure & culture dimensions

- Most permanent organizations will probably be found somewhere in the blue area of figure 2 – limited (limiting?) structure and restricted (restricting?) culture.



*Figure 2 The blue zone
- where most organizations find themselves.*

- Floating in the blue zone can be regarded as an opportunistic approach for the organization. Further studies intent to clarify pros and cons being in the blue zone, versus the more defined positions in each corner. The opportunistic approach can be seen as a more dynamic approach, where development moves more around instead of aiming towards defined positions and directions of development.

Connected value networks – koblete verdinettverk

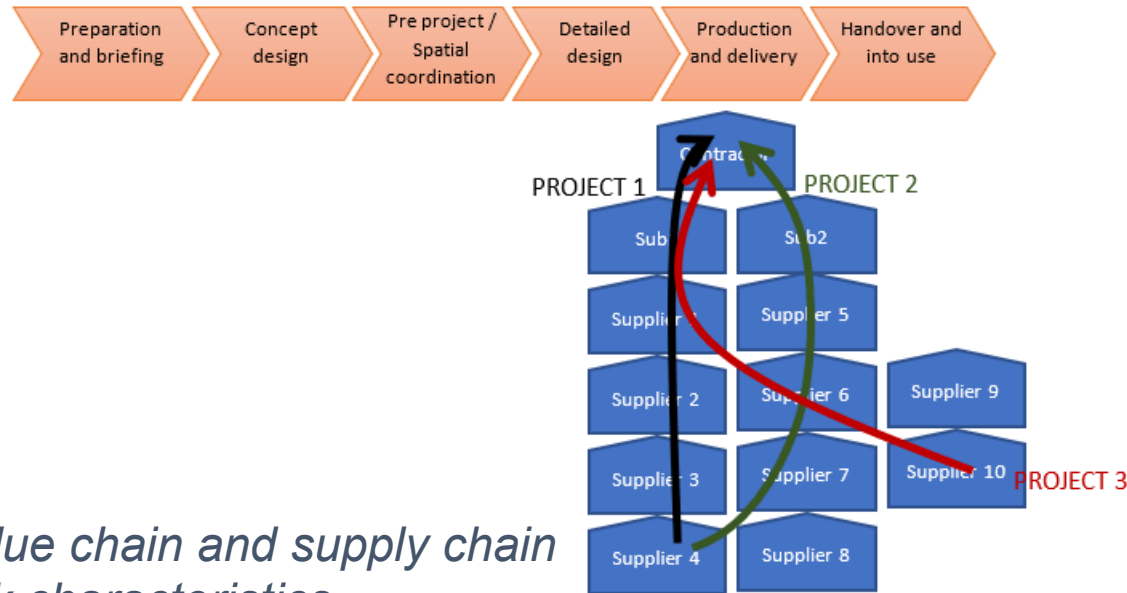


Figure 4 Value chain and supply chain with network characteristics.

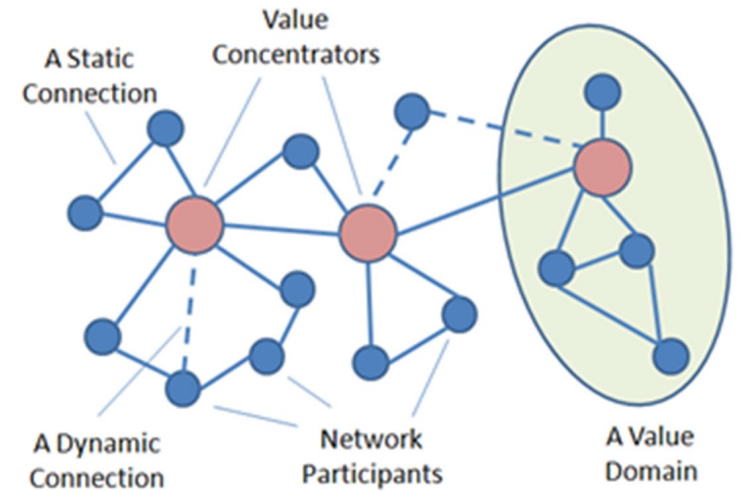


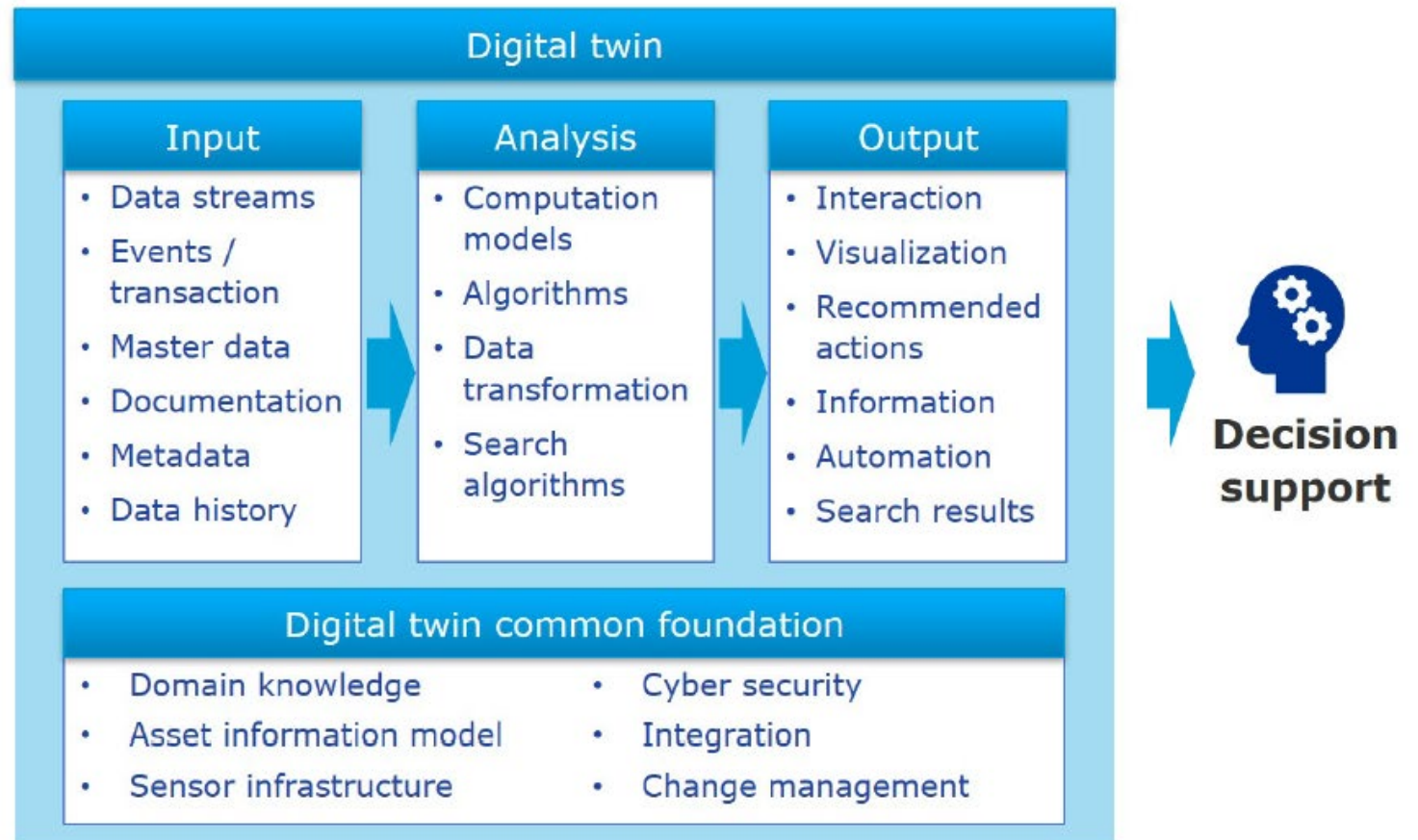
Figure: A Digital Business Network

- The new type of flexible logic where you have supply chains with network characteristics. This represents a huge difference from a traditional fixed supply chain. For each project, the owner can choose a different (sub-) supplier to make sure the best available competence and technology for the project at hand.

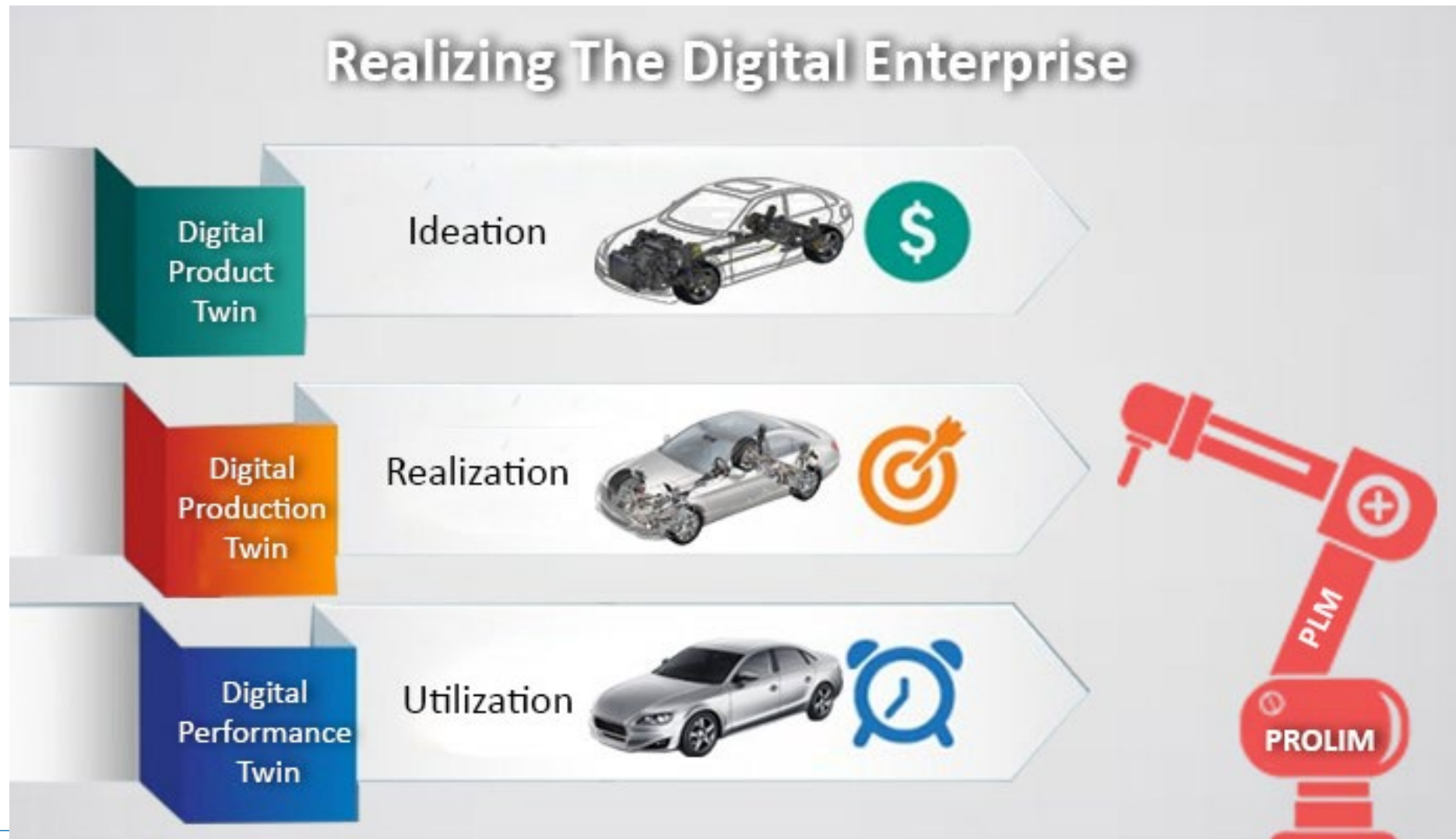
The Elements of a Digital Twin - Process perspective

BIM & Digital Twins

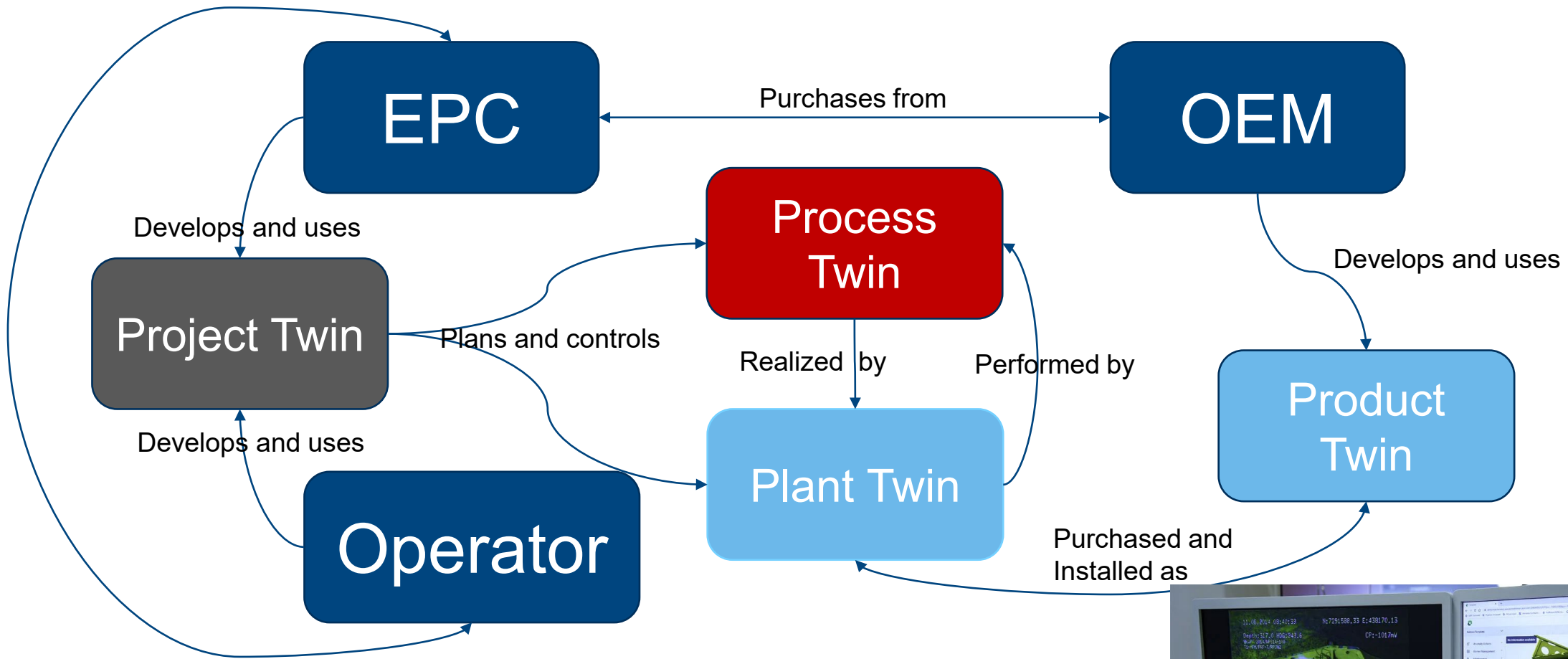
- Assessment across industry segments
- Share experience
- Features
- Application



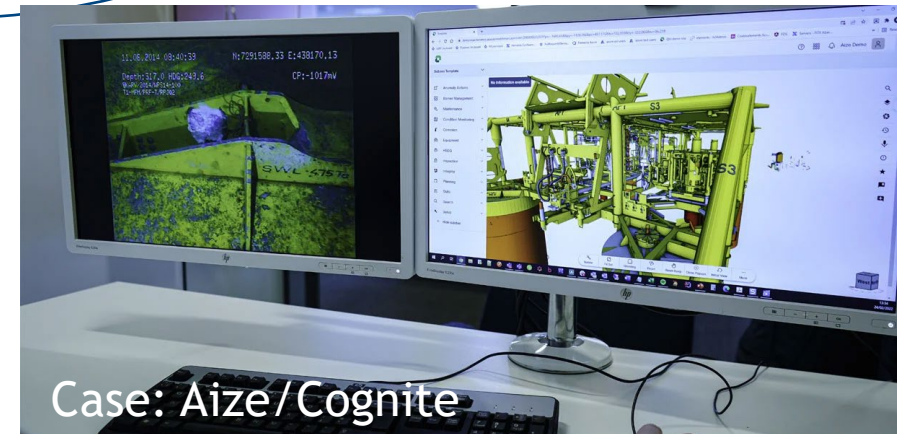
The digital twin in different stages in product development



Interacting Digital Twins



Digital Twins:
Primarily applied on Work processes, not on
Organizing and roles plus overall system level



Next Generation: Dynamic life cycle based Digital Twin

Key Features for a Life Cycle based Digital Twin

- Fast Time to Value (Real time)
- Data driven approach
- User centric focus
- Scalability; from one to many sites
- Subject matter experts
- Applicability across Asset Life
- Applicability across disciplines

The listed desired features:

- Life cycle driven solutions
- To be reflected in project execution
 - Reflected in work processes
 - **Reflected in management processes**
 - From reactive to predictive performance

WHAT IF YOU COULD TEST THE SCENARIOS BEFORE TAKING ACTION?

KONGSBERG

The infographic is a dark blue rectangle with white text and icons. It features a grid of icons in the bottom right corner. The text is arranged in two rows of four items each. Each item consists of an icon, a short title, and a descriptive sentence.

- HYBRID ML COMBINES SIMULATORS, PHYSICAL AND DATA-DRIVEN MODELS**: Icon of a brain with circuitry.
- THAT ALLOWS YOU TO TEST DIFFERENT HYPOTHETICAL SCENARIOS**: Icon of an offshore oil rig.
- PREDICT THEIR IMPACT**: Icon of a telescope on a tripod.
- COMPARE OPTIONS**: Icon of two people silhouettes.
- MAKE ACCURATE DECISIONS**: Icon of three interlocking gears.
- IMPROVE PERFORMANCE AND PRODUCTIVITY**: Icon of a bar chart with an upward arrow.
- SAVE ENERGY AND INCREASE SAFETY**: Icon of a globe.

Veien videre på FOU-prosjektene

Topic No.	Headline
1	<p>Collaborative Project execution delivery model with strong integrated collaboration with the supply chain including:</p> <ul style="list-style-type: none"> • Integration, roles, organization & learning • Degree of standardization and implementing I4.0 characteristics
2	<p>Interface with Norwegian Authority requirements concerning project delivery on NCS</p>
3	<p>ESG: ESG for E&P project delivery (ESG: Environment, Society and Governance) The impact of AI</p>
4	<p>Contract Model</p> <p>Impact of different delivery models & contract strategies on project execution performance and risk exposure/variability all through to DG4. Cross reference to Task No 1. (AkerBP)</p> <p>Assessment of different contract models across industry segments (Aker BP)</p>
5	<p>E&P Company BMS</p>
6	<p>BIM & Digital Twins – exchange across industries, Equinor – lead sponsor</p> <ul style="list-style-type: none"> • Of interest also for AkerBP, Gassco, Vår Energi, Siemens & Aibel
7	<p>Schedule driven Fast Track Project Execution Models</p>
8	<p>Data sharing -</p>