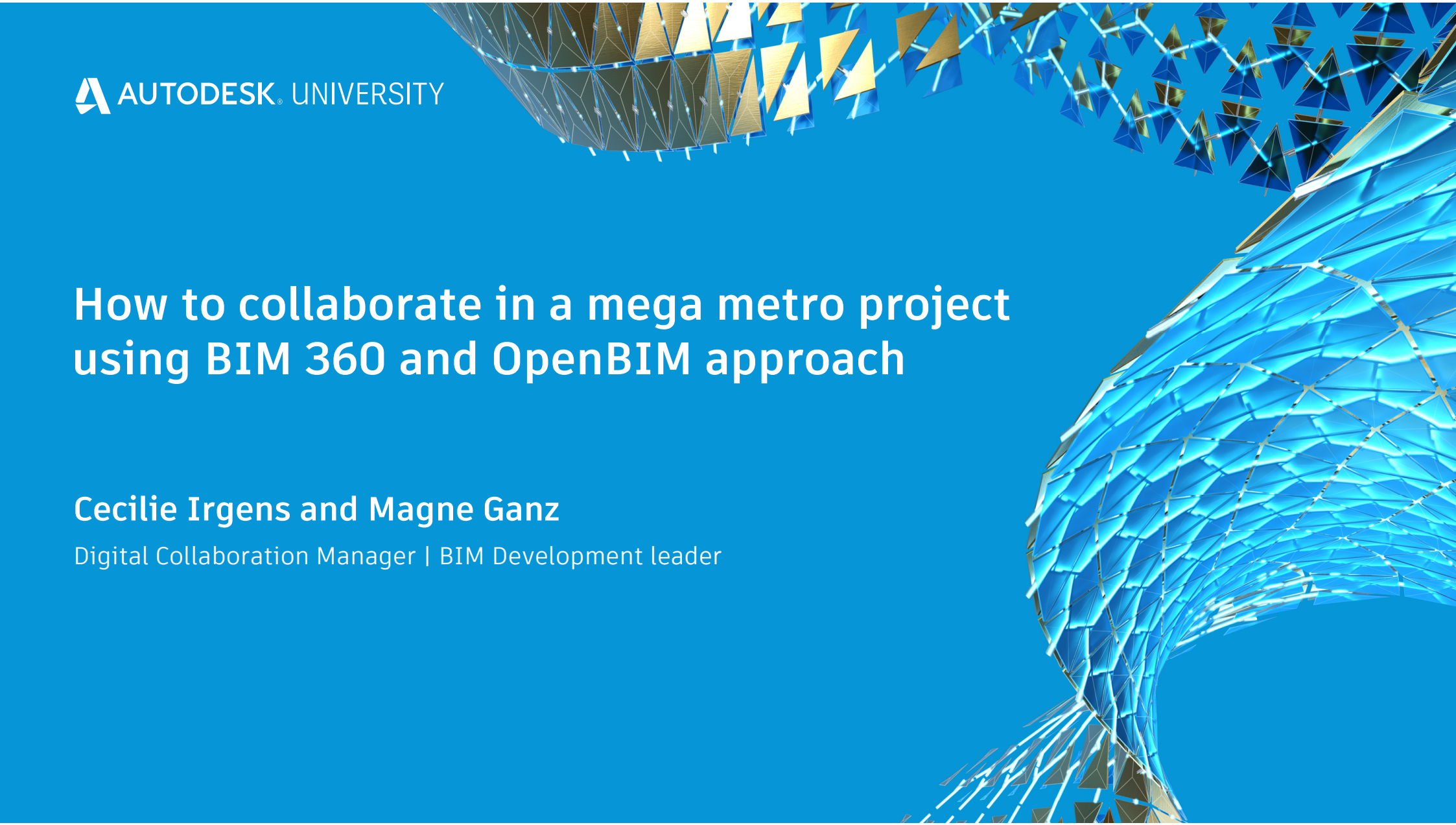
AUTODESK. UNIVERSITY

How to collaborate in a mega metro project using BIM 360 and OpenBIM approach

Cecilie Irgens and Magne Ganz

Digital Collaboration Manager | BIM Development leader



Agenda

- Project intro
- Common data environment
- BIM processes
- Applied BIM and Open BIM
- 4D and 5D
- Model based execution
- Automation
- Involve the whole organisation

About The Speaker

Cecilie Irgens | Digital Collaboration

Electrical engineer with a master degree in organization and management. First encounter with BIM in 2007. Project experience with technical know-how after 14 years in construction as an advisor in the field of electrical engineering, BIM management and software development. Loves to explore new tools and learn how to work smarter with the right methodology. Cecilie is specially focused on collaboration and what really works out there. Since January 2020 she has led the Digital Collaboration team.

COWI

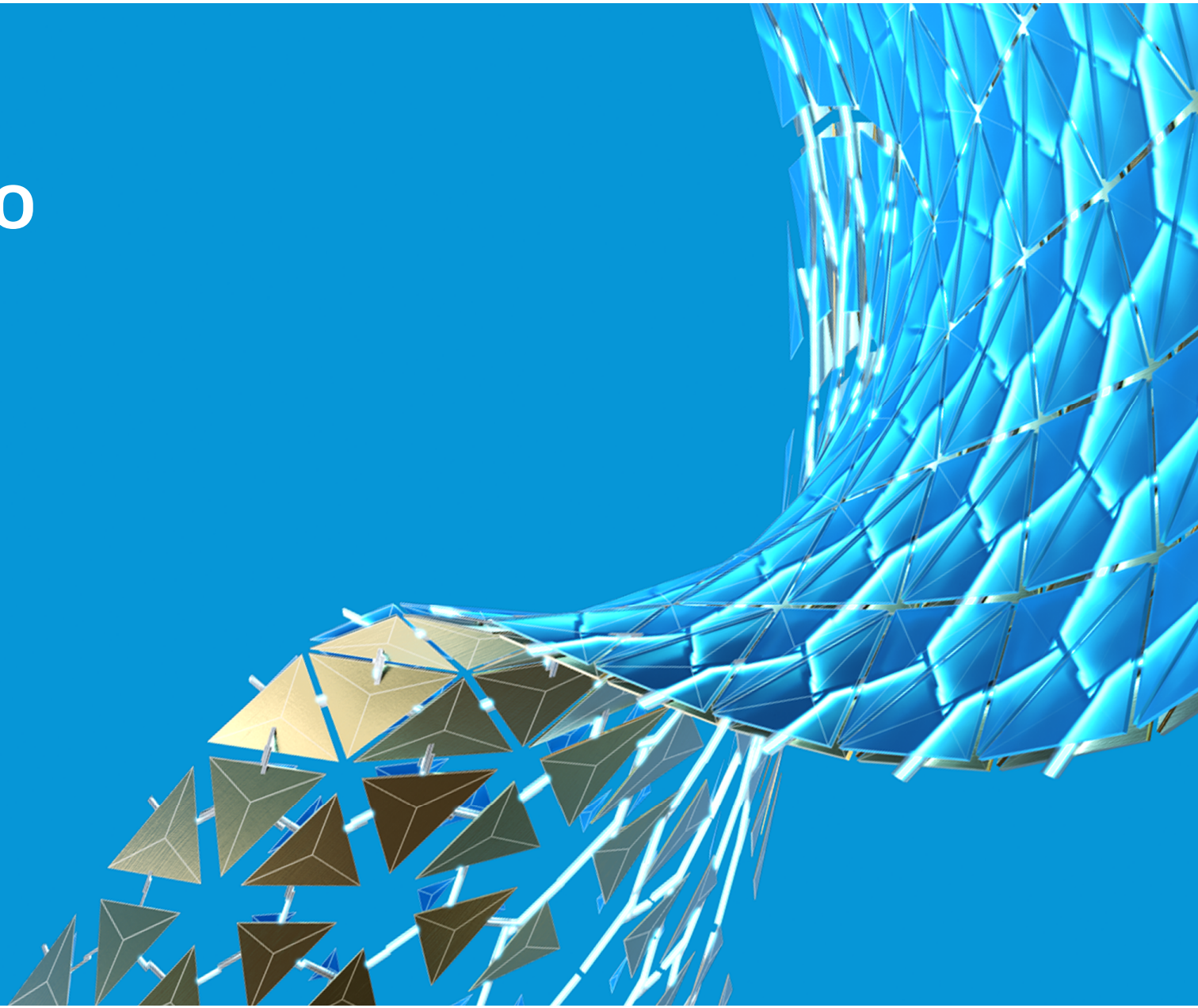
About The Speaker

Magne Ganz | BIM-Specialist

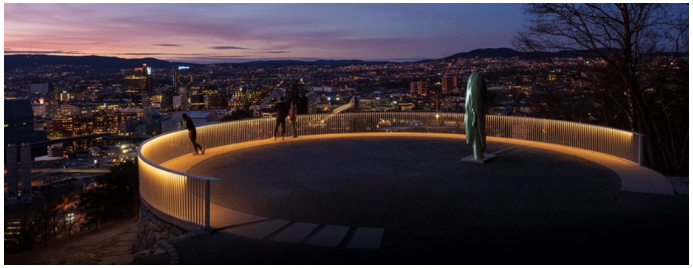
Magne has a Masters degree in Structural Engineering from 2002 and has since 2006 had a strong focus on BIM and connected technologies. Revit, Dynamo, data flow and task automation is the passion. Being in the industry for 18 years and working only with VDC and BIM the last 9 years, gives Magne the perfect background for contribution to Digital Collaboration and BIM-approach to this mega metro project.

Multiconsult

Project Intro



Welcome to Oslo, Norway



Fornebubanen - Project Intro

- New metro line
- From city center to outer suburb in 12 minutes
- 8 departures per hour
- 8000 passengers per hour vs 3000 today (bus)
- Largest metro project in Oslo in 20 years
- Project owner: Oslo municipality agency Fornebubanen

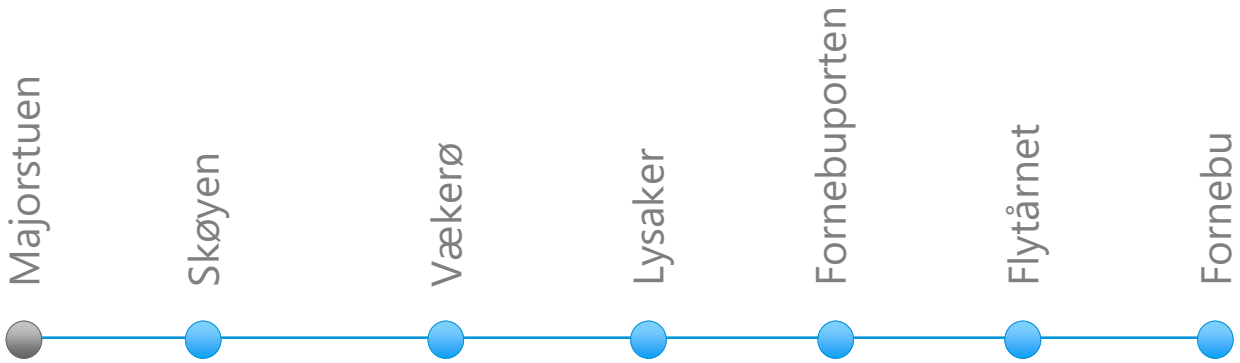
Oslo

PGF

Link to video

Project Scope

Build an 8.2 km tunnel, with 6 stations and technical infrastructure along its path



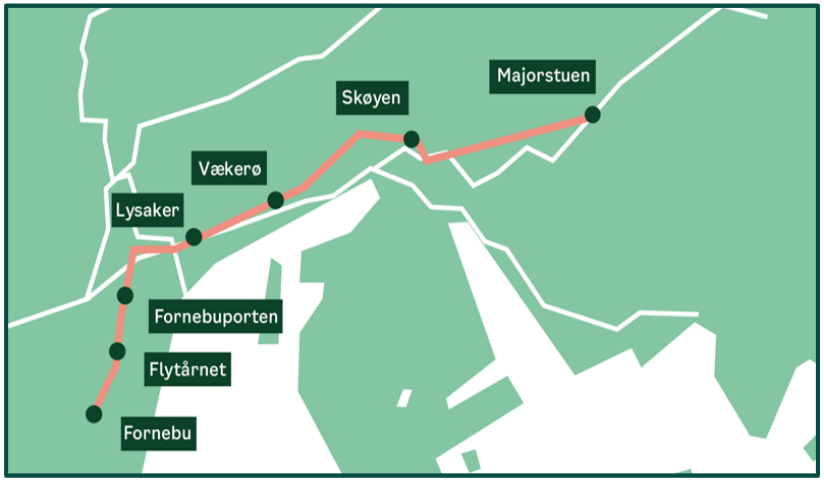
Client:
Oslo municipality agency Fornebubanen (FOB)

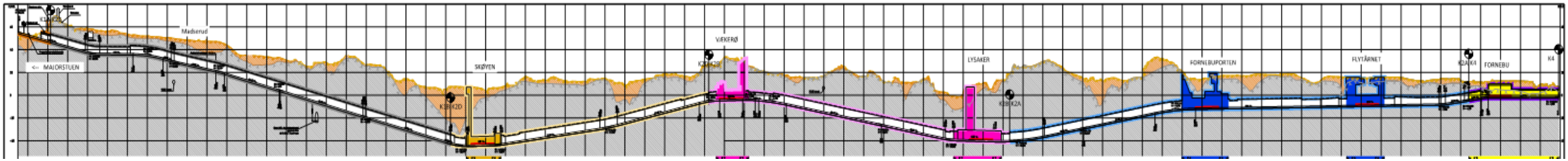
Construction period:
2020-2027

Total cost:
16,2 billion NOK / 1,8 billion USD / 1,6 billion Euro

The Tunnel

The path is not straight in any direction.



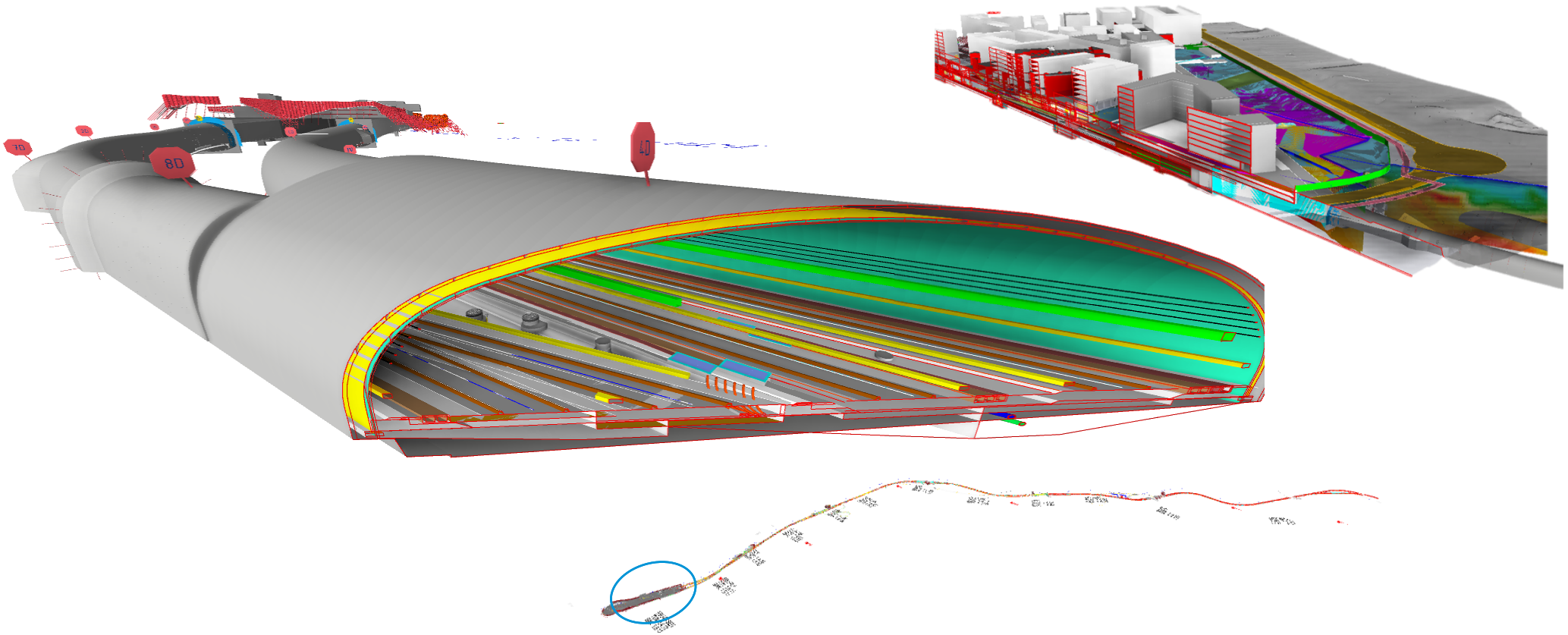


6 Stations + Operational and Maintenance Base

The stations have different expressions, varies in size, shape and function.

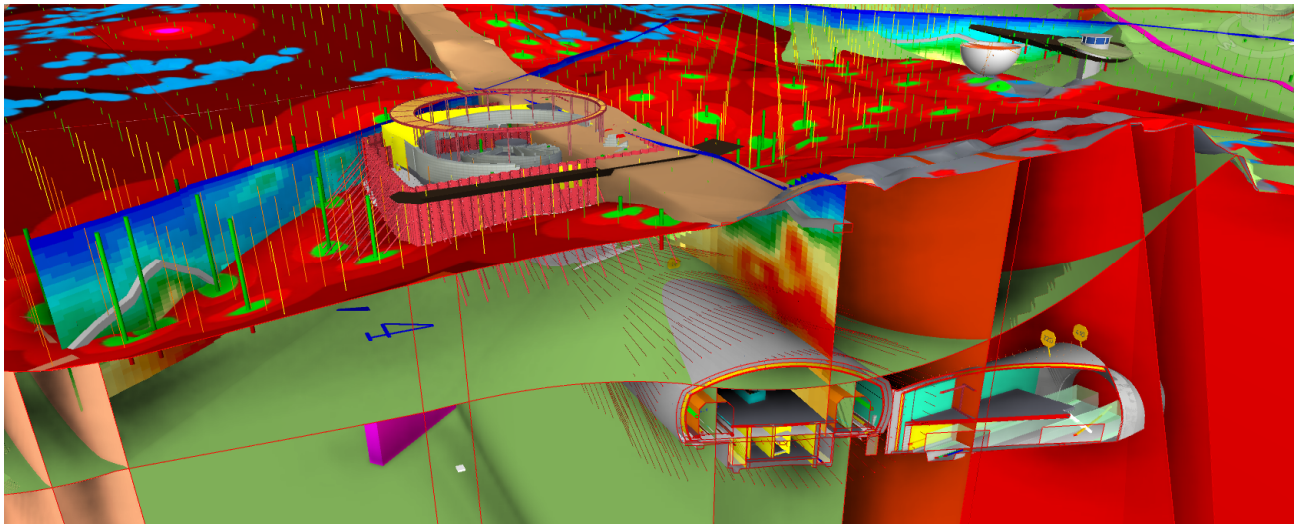
Technical Infrastructure

The new metro line has complex technical interfaces both internally and externally



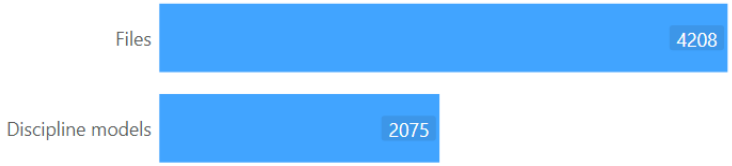
Key Challenges

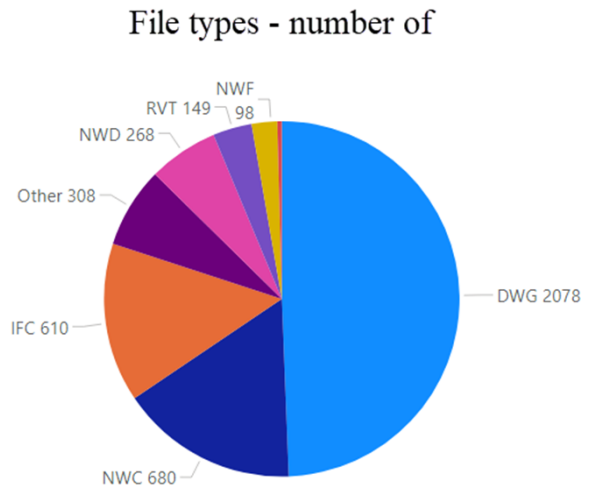
- Demanding ground conditions
- The Fornebubanen project is just one of the larger infrastructure projects to be completed over the next few years within the same area.
- Approx 2 million m³ of rock, soil and sludge is to be removed
- Complex stakeholder structure
- **The project scope is gigantic – its a mega metro project!**



Size - statistics from BIM360

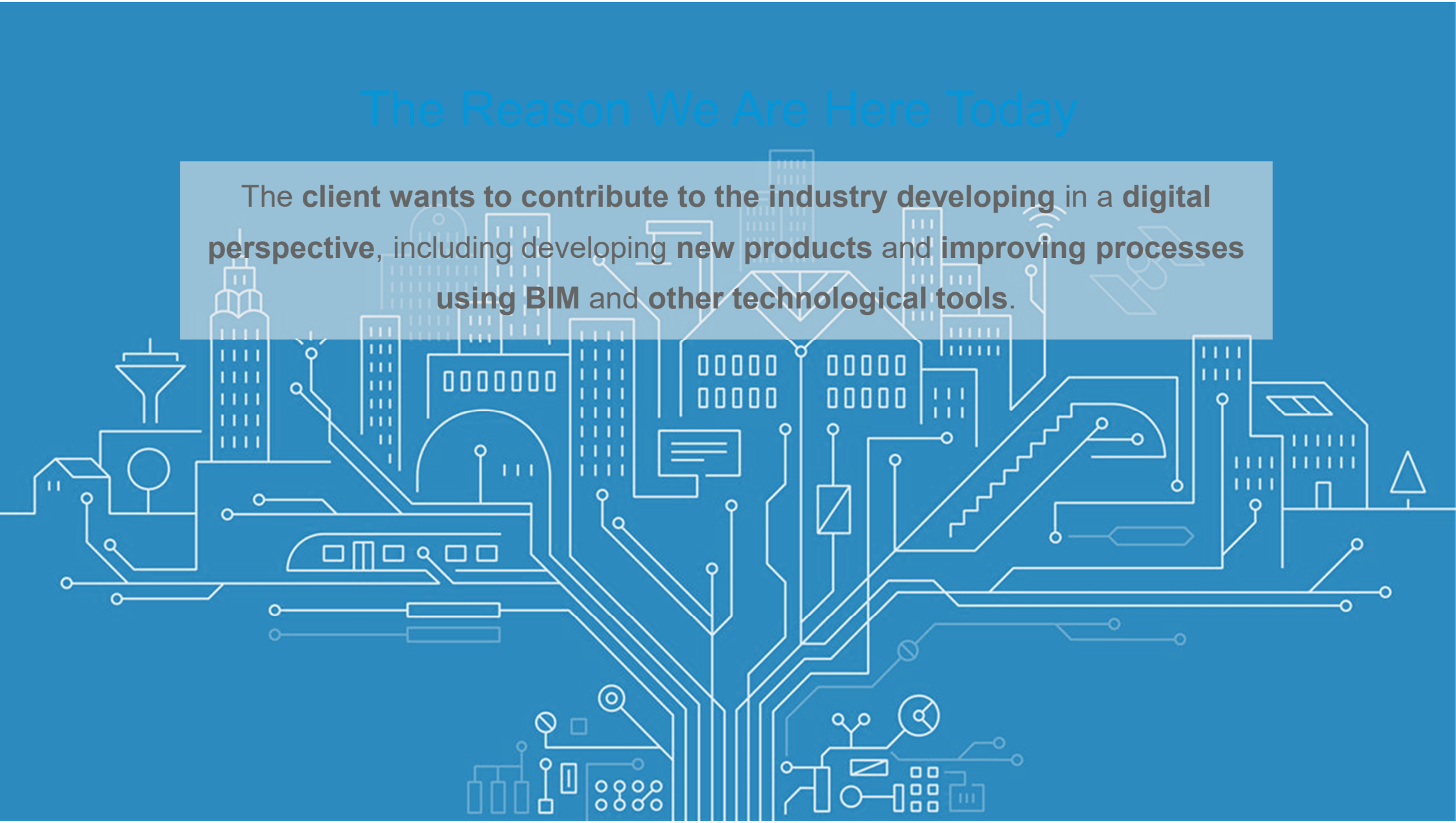
- **29 companies**
- **540 members**



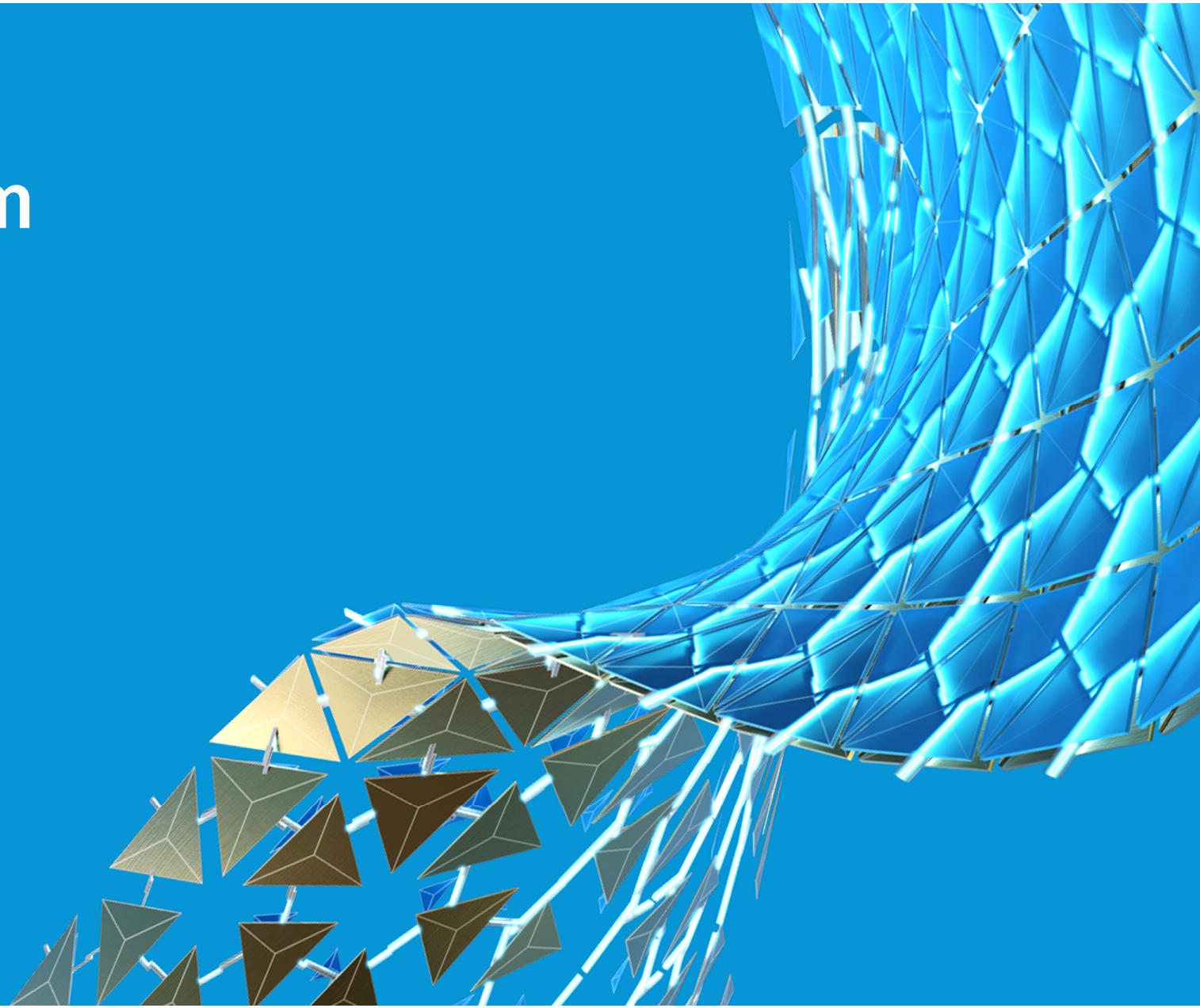


The Reason We Are Here Today

The **client wants to contribute to the industry developing** in a **digital perspective**, including developing **new products** and **improving processes using BIM** and **other technological tools**.

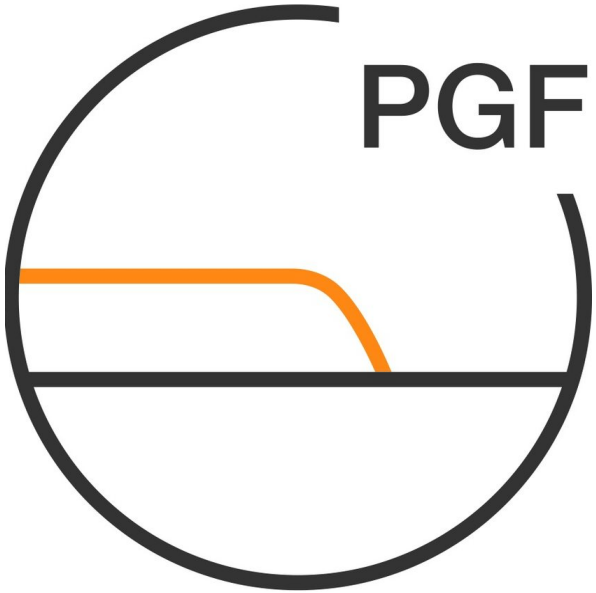


Design Team

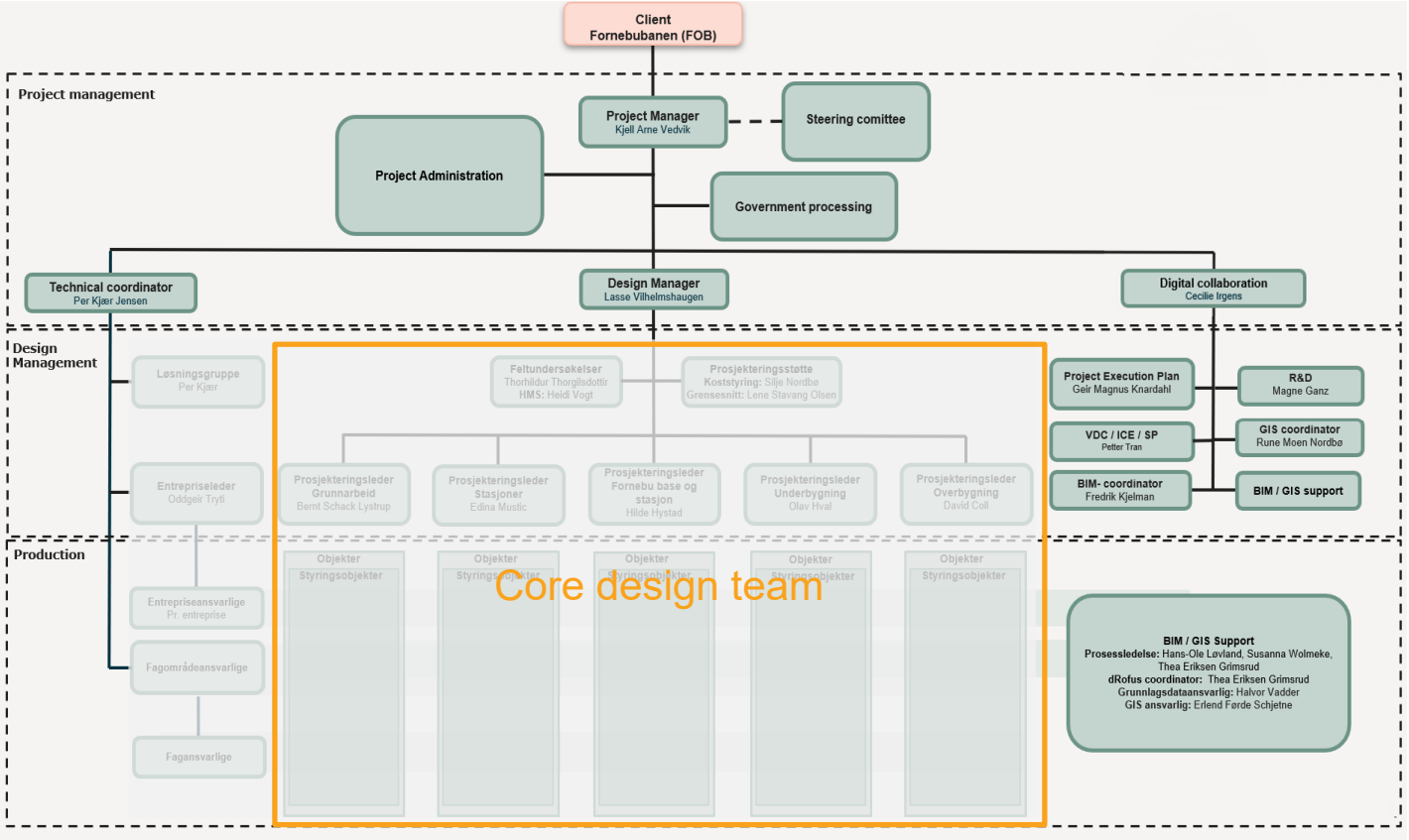


Design Team

- PG Fornebubanen (PGF)
- Joint Venture of Multiconsult and COWI
- 383 engineers, controllers and project/design managers
- 12 disciplines

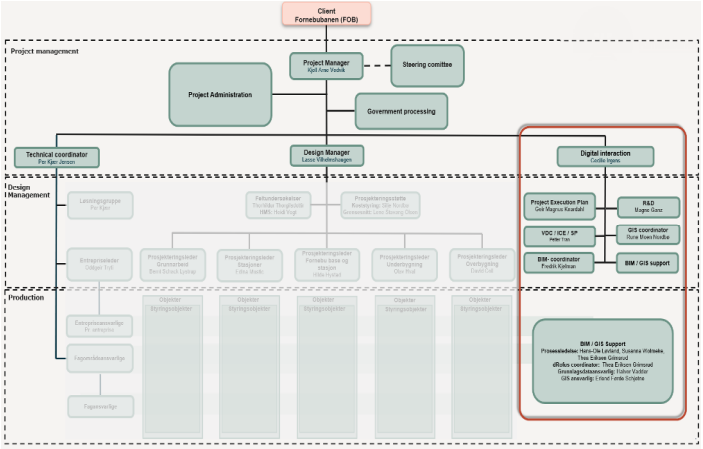


Organization and Why



- Interdisciplinary functions are embracing the core design team
- Ensure uniform methodology in the assignment
- Digital Collaboration team

Digital collaboration team



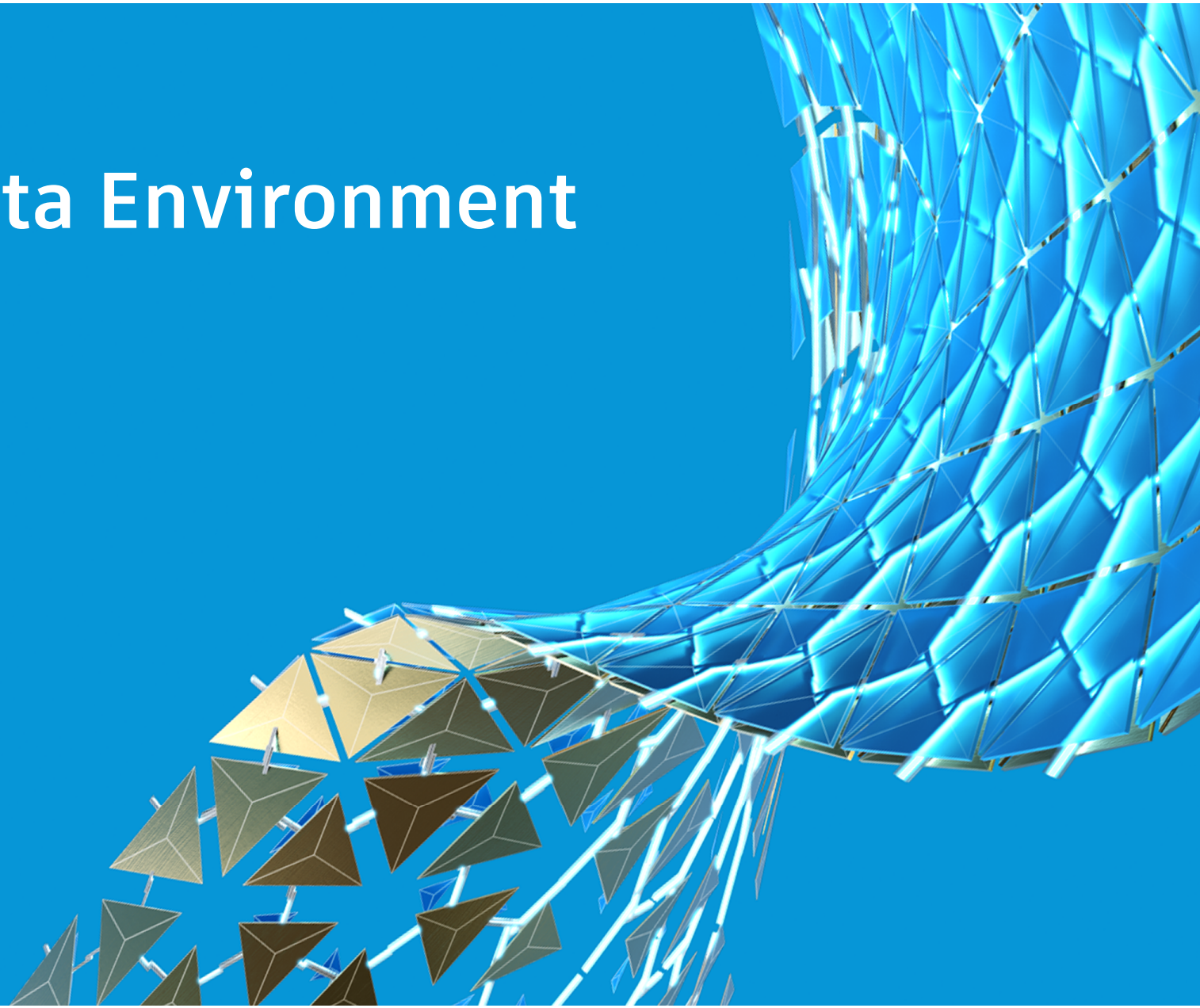
The function of the digital collaboration team is to standardize work tasks and processes, automate time thieves and implement processes and technology

The work of the digital collaboration team involves

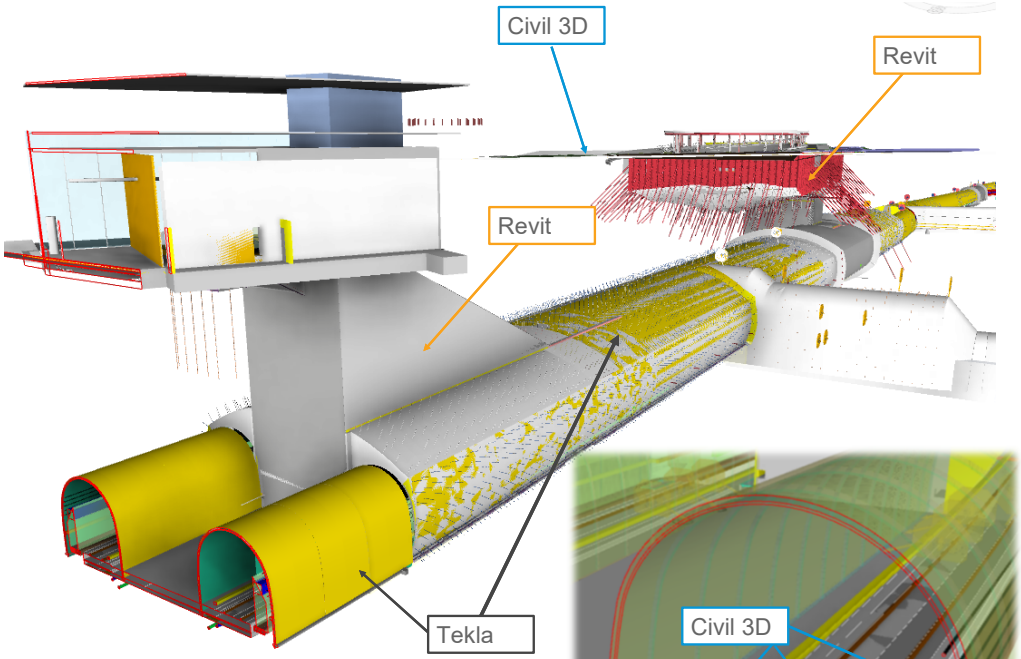
- **Develop and maintain**
  - Project Execution Plan
  - BIM Framework
  - Script, addins and apps
- **Support work and processes involving**
  - BIM
  - GIS
  - Basemaps
  - ICE
  - Cloud solutions / databases
- **Identify and lead digital innovation opportunities**
- **For all of the above, communicate and implement processes and technology**

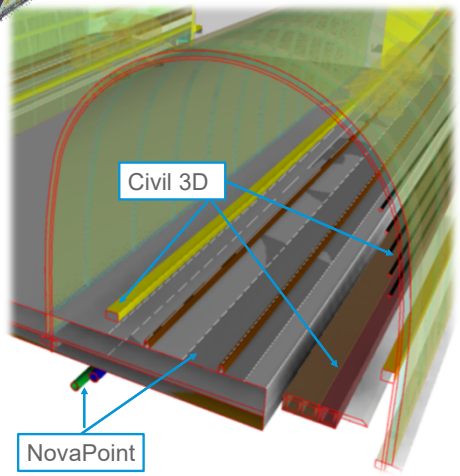
The team consists of experts in BIM, GIS, VDC/Lean, R&D, methodology and technology.

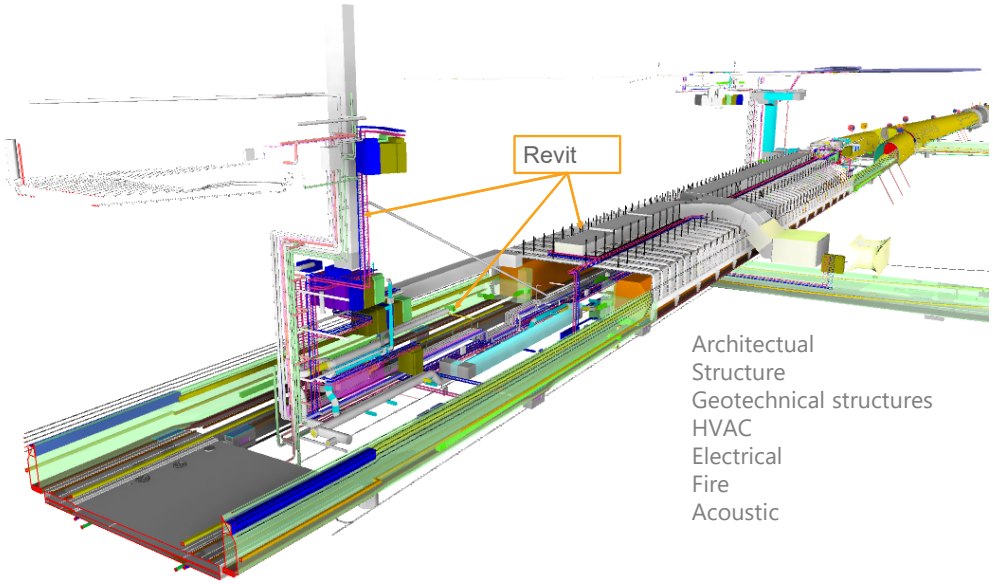
Common Data Environment



Design Software In Use

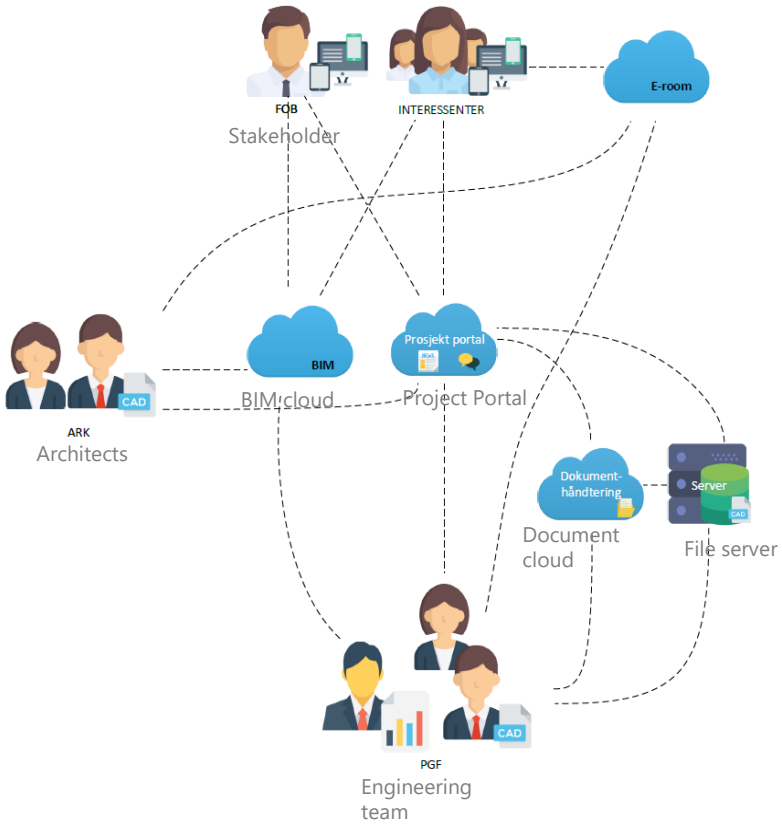




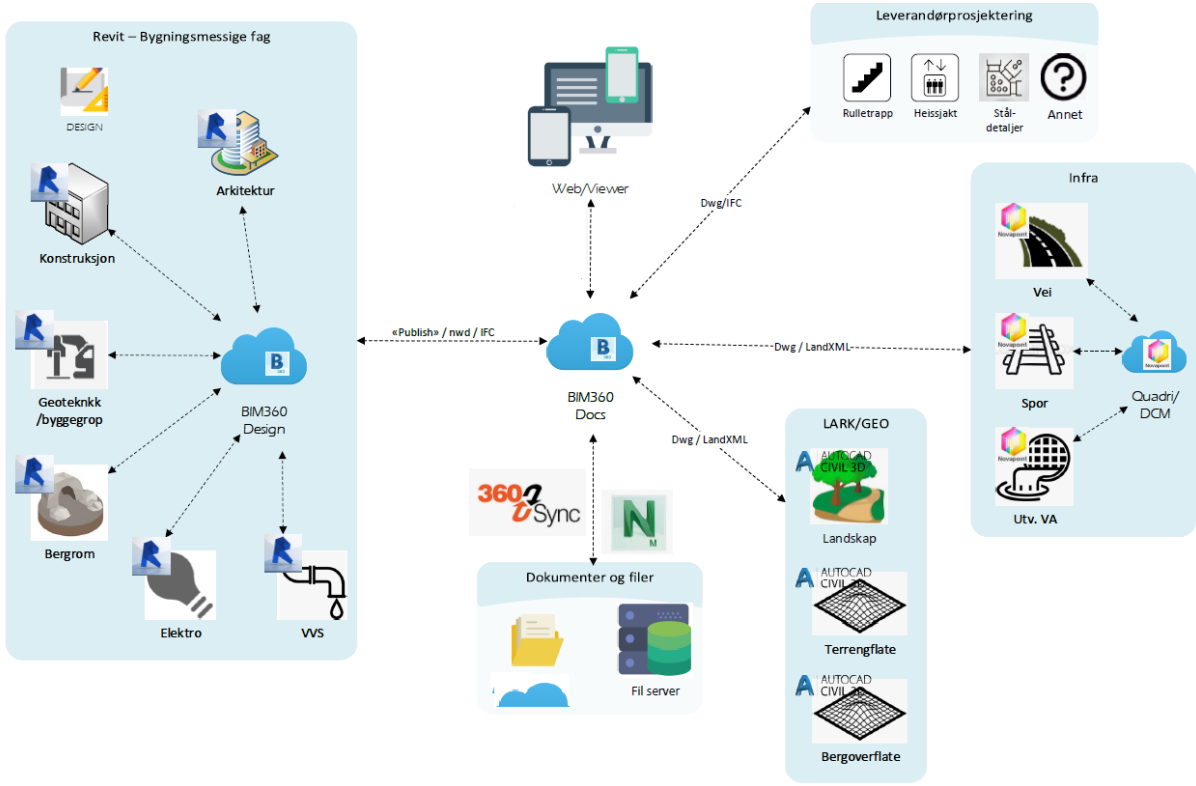


Architectual
Structure
Geotechnical structures
HVAC
Electrical
Fire
Acoustic

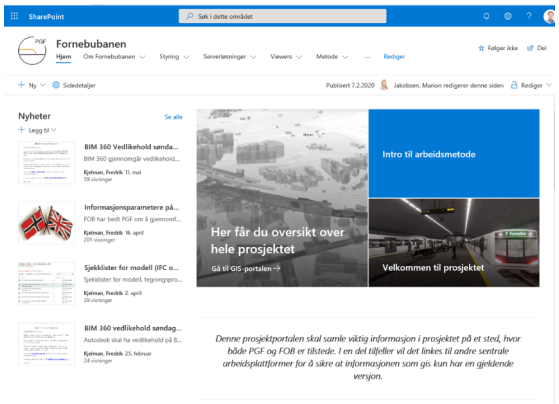
Dataflow Diagram



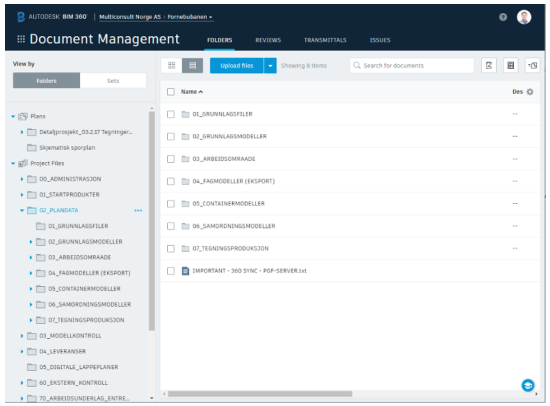
Dataflow diagram – Typical Station



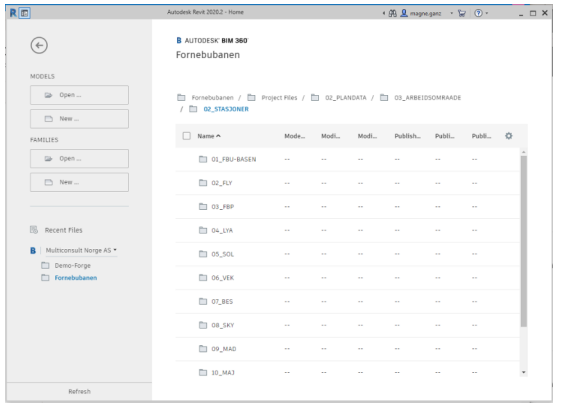
CDE – Common Data Environment



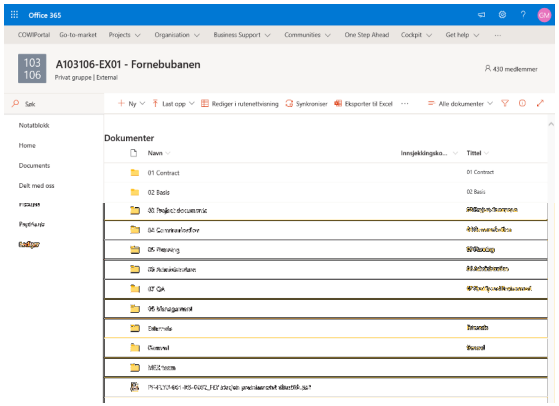
Sharepoint Information Site



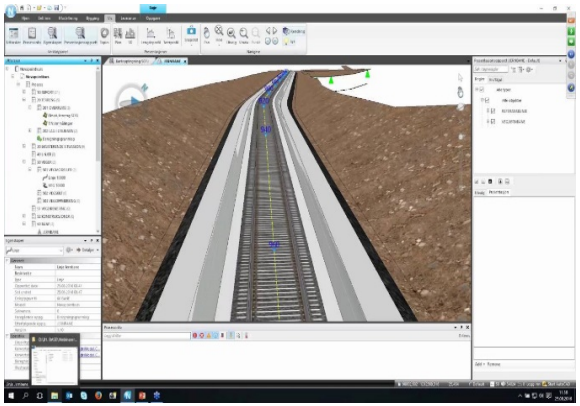
BIM 360 Docs



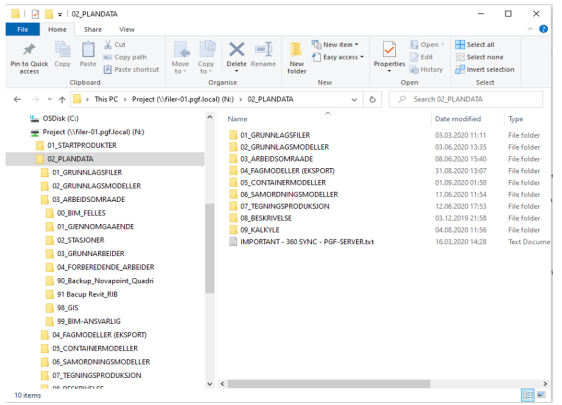
BIM 360 Design



MS Office 365



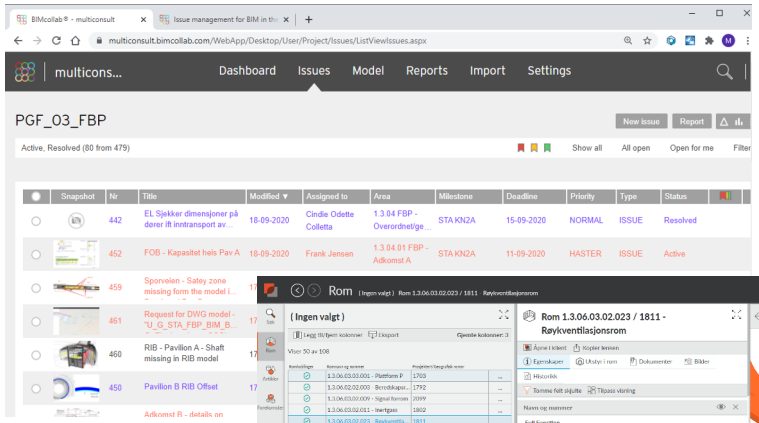
Trimble NovaPoint Quadri



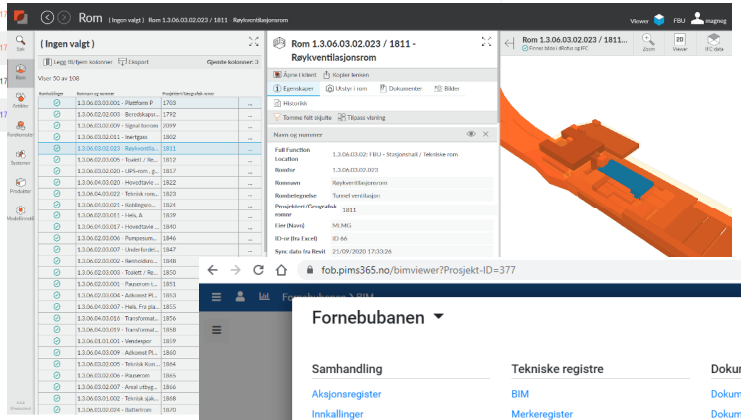
Common File Server

Additional Services

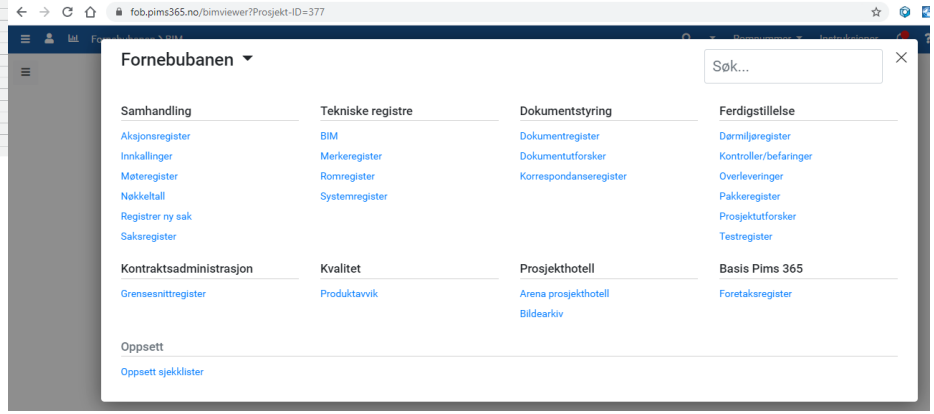
BIM Collab – BIM issue Management



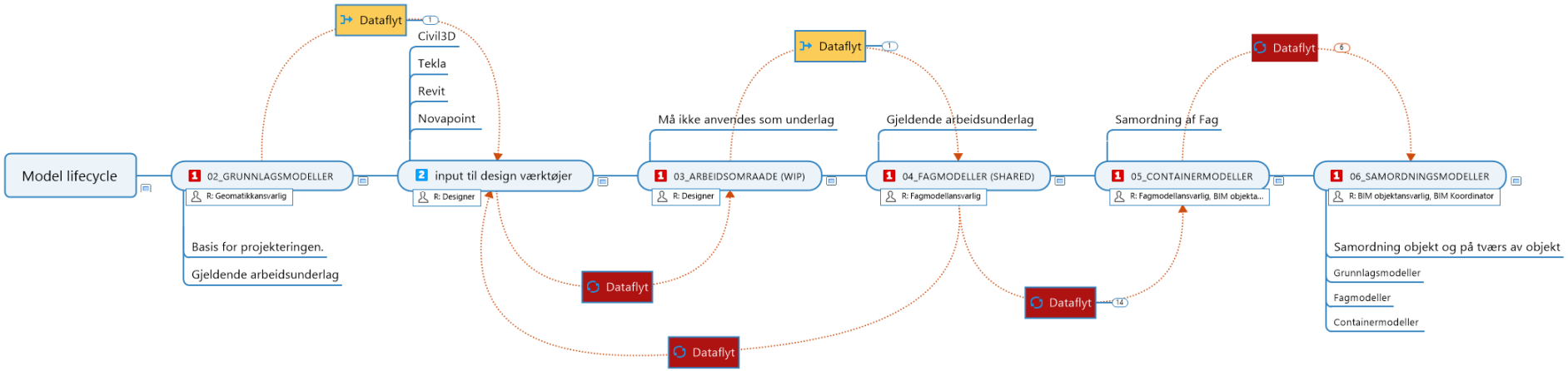
dRofus – BIM information management



PIMS – The client's construction management system

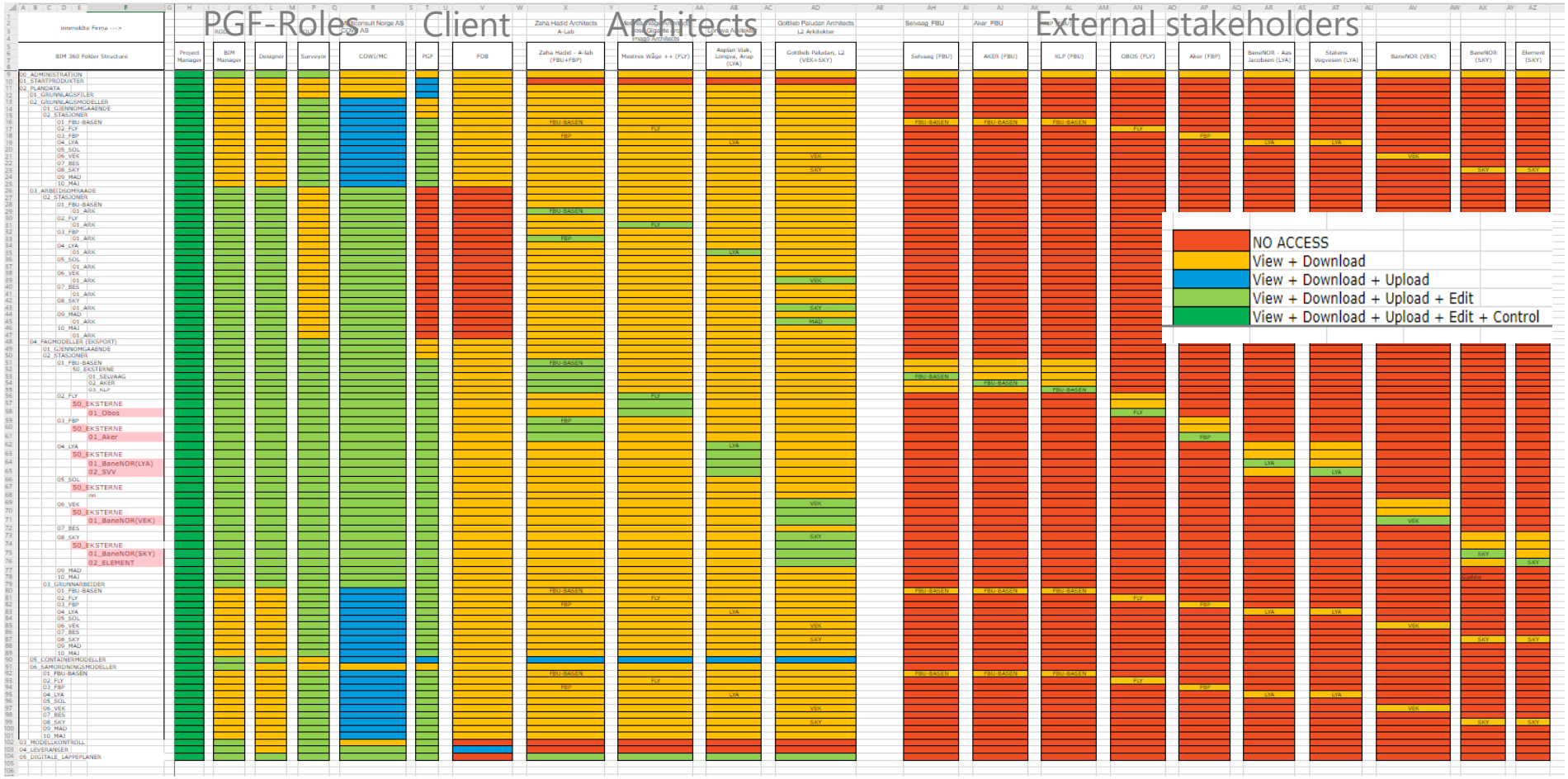


Workflow and Folder Structure

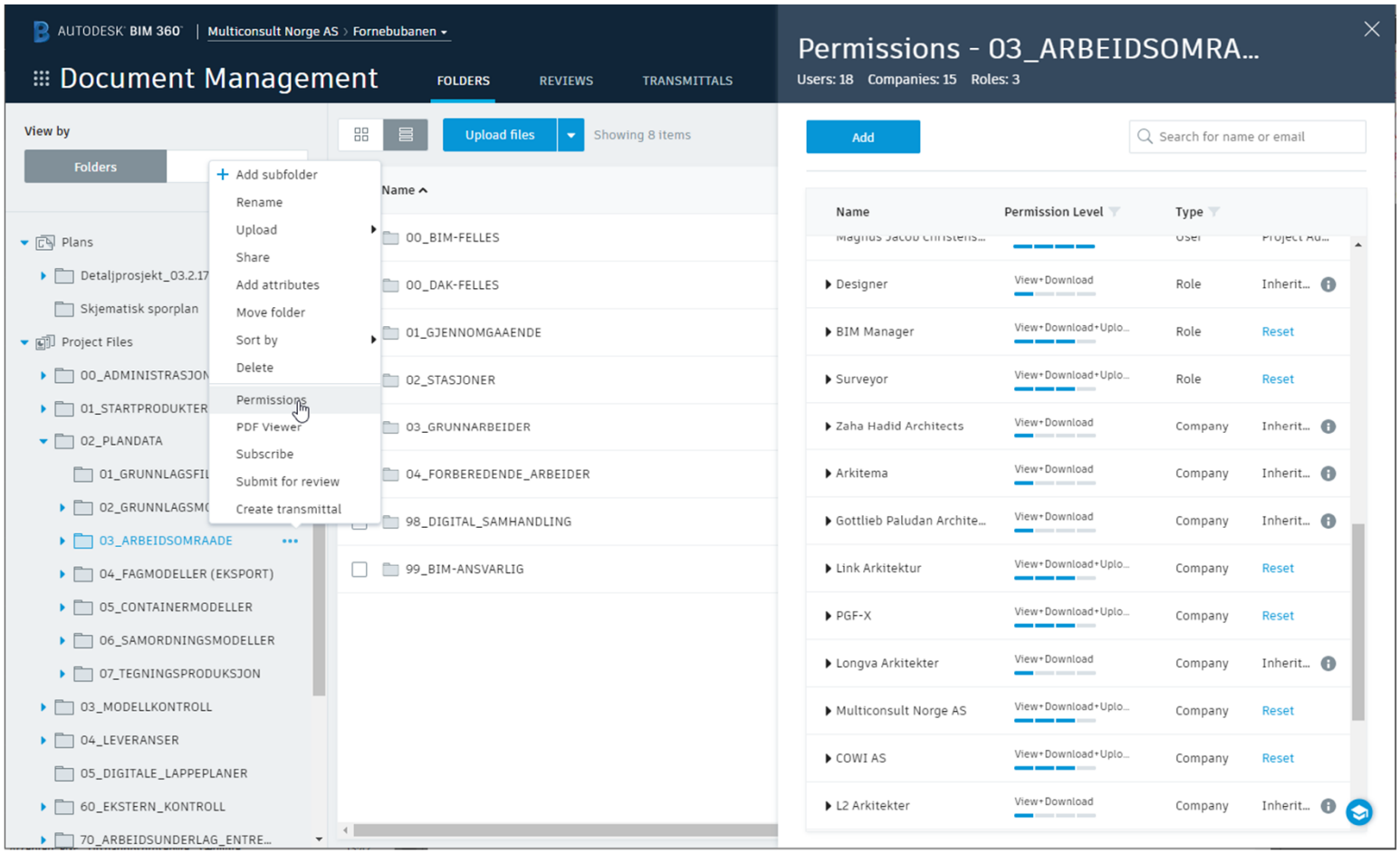


01_GRUNNLAGSFILER	**Design basis** – existing situation – reality capture – survey data
02_GRUNNLAGSMODELLER	**Design basis models** – models based on data captured
03_ARBEIDSOMRAADE	**Design models** – Work-in-progress
04_FAGMODELLER (EKSPORT)	**Design models** – deliveries – exported models (**IFC**, DWG, NWC, FBX)
05_CONTAINERMODELLER	**Container models** – collection of discipline models (a grouping - **nwd**)
06_SAMORDNINGSMODELLER	**Coordination models** – The models commonly used / viewed in meetings, at construction site etc..
07_TEGNINGSPRODUKSJON	**Drawings**

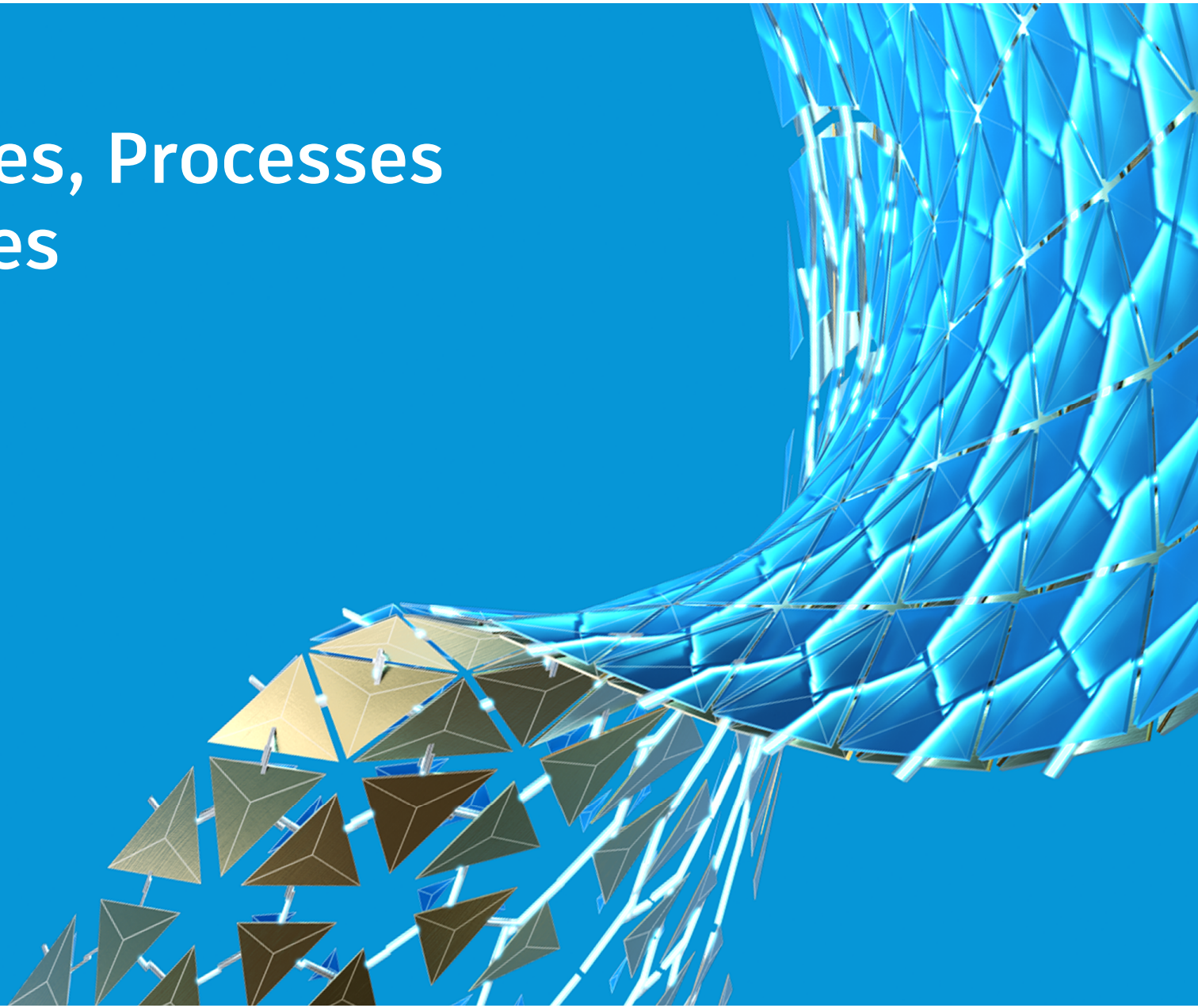
Permissions Overview



Permissions settings in BIM 360



BIM Strategies, Processes and Guidelines



BIM Framework

BIM strategy

- The goals for use of BIM and related processes
- The effect of reaching those goals

BIM Strategy

PEM

BIM execution plan

- Roles and responsibilities
- Overall guidelines and process diagrams

BEP

Digital production manual

- Specific requirements
- Software specific procedures, checklists and guides to fulfil the requirements

Strategic

Tactical

Operational

BIM Strategy Highlights

“BIM is the key information element in our collaboration”

“The use of drawings must be reduced to an absolute minimum for all phases of the project and also towards approval authorities”

“In this project, the client wants to contribute to the industry development in a digital perspective, including developing new products and improving processes using BIM and other technological tools.”

“A link between the construction schedule and the model shall be used to perform buildability analyses of the construction phase and for visual communication with stakeholders.”

“The experience of the digital project can easily be conveyed through different types of visualizations, such as. Virtual Reality (VR), Augmented Reality (AR) and gaming technology.”

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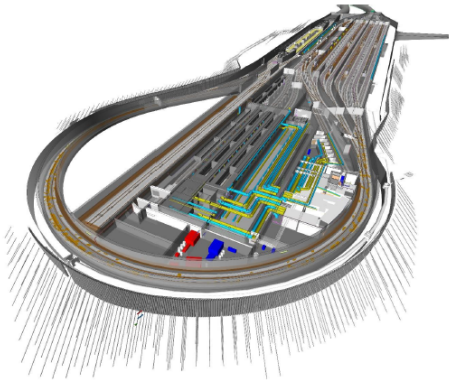
BIM strategi

Dok.nr.: FOB-170-AE-0003



Rev.	Dato	Utarbeidet av	Kontrollert av	Godkjent
05G	26.05.2020	T. Falkenberg	A. Belova	I. Krigsvoll
04G	12.12..2019	T. Falkenberg	L. C. Karlsen	H. C. Kruse
03G	12.07.2019	T. Falkenberg L. C. Karlsen C. March	I. Krigsvoll	I. Måseval

BIM Execution plan for Design

Describes in general how to achieve the goals in the BIM Strategy

- **BIM Framework**
  - BIM Strategy
  - BIM Execution plan
- **Roles and responsibility**
  - Client Organization
  - Design Team Organization
- **Way of work**
  - WBS
  - ICE
  - Last planner
- **CDE and file formats**
  - Data flow
  - Information security
  - Design tools
- **Model requirements**
  - Principles of modelbased deliveries
  - Model maturity
  - Model information
- **5D - BIM, Quantity Takeoff and Cost**
- **4D – BIM and Construction Scheduling**

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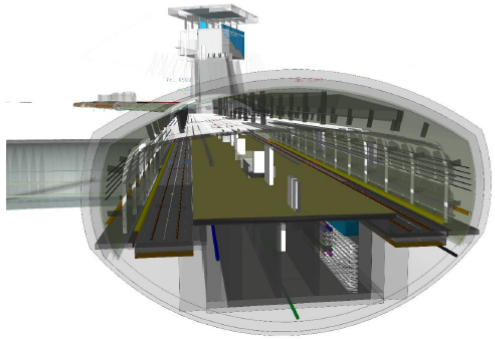
BIM gjennomføringsplan for prosjektering

Dok.nr.: FOB-170-KA-0003

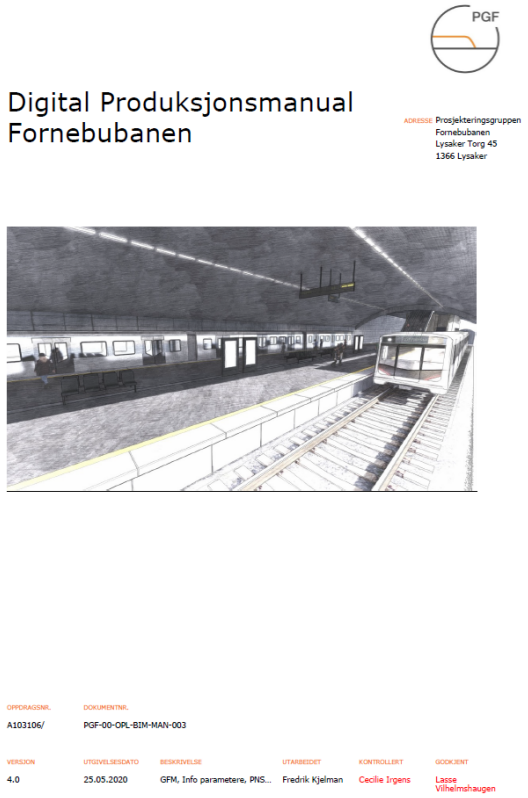


01	14.05.2020	Tore Lie Falkenberg/PGF	Hans Christian Kruse	Ingeborg Krigsvoll
Rev.	**Dato**	**Utarbeidet av**	**Kontrollert av**	**Godkjent**

Digital Production Manual

The digital production manual goes into detail of all BIM requirements. Software specific procedures are created as separate documents for each topic.

- **BIM organization**
  - BIM roles
  - BIM responsible per discipline and coordination model
- **Basis data and basis data responsible**
- **Software and software responsible**
- **Common data environment**
- **Collaboration platforms**
- **Folder structure**
- **Model naming syntax**
- **Model standards and common demands**
- **Project base points and georeferenced coordinate system for each station**
- **Leves and grids for each station**
- **Project break down structure - WBS**
- **Model communication – element status (model maturity index) and quality level**
- **Properties and property sets for exported models**
- **Drawing specific details, naming, layers, title blocks**
- **Dataflow for each sub-project**
- **Common routines**



BIM Execution Plan for Construction

Describes how BIM is utilised during construction instead of traditional drawings. It also sets demands and requirements for the Contractor regarding BIM knowledge, survey data and how to collect and deliver "as-built" data back to the design team.

- **The hierarchy of the models**
  - Models, detail models and drawings
  - Model maturity - element status
  - Model naming
  - Model information
- **Models in the tender phase**
- **Models in the construction phase**
  - Work packages
  - Delivery routines
  - Revision management
- **Contractor requirements**
  - Software and equipment
  - As-built capture
    - Laser scan
    - Survey
  - Design by supplier - requirements

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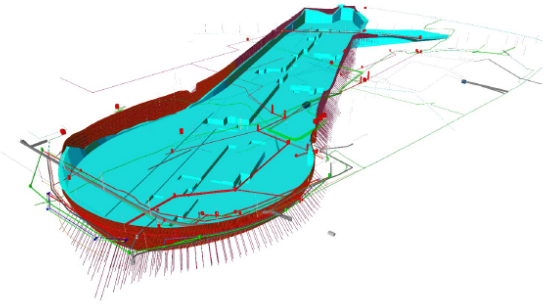
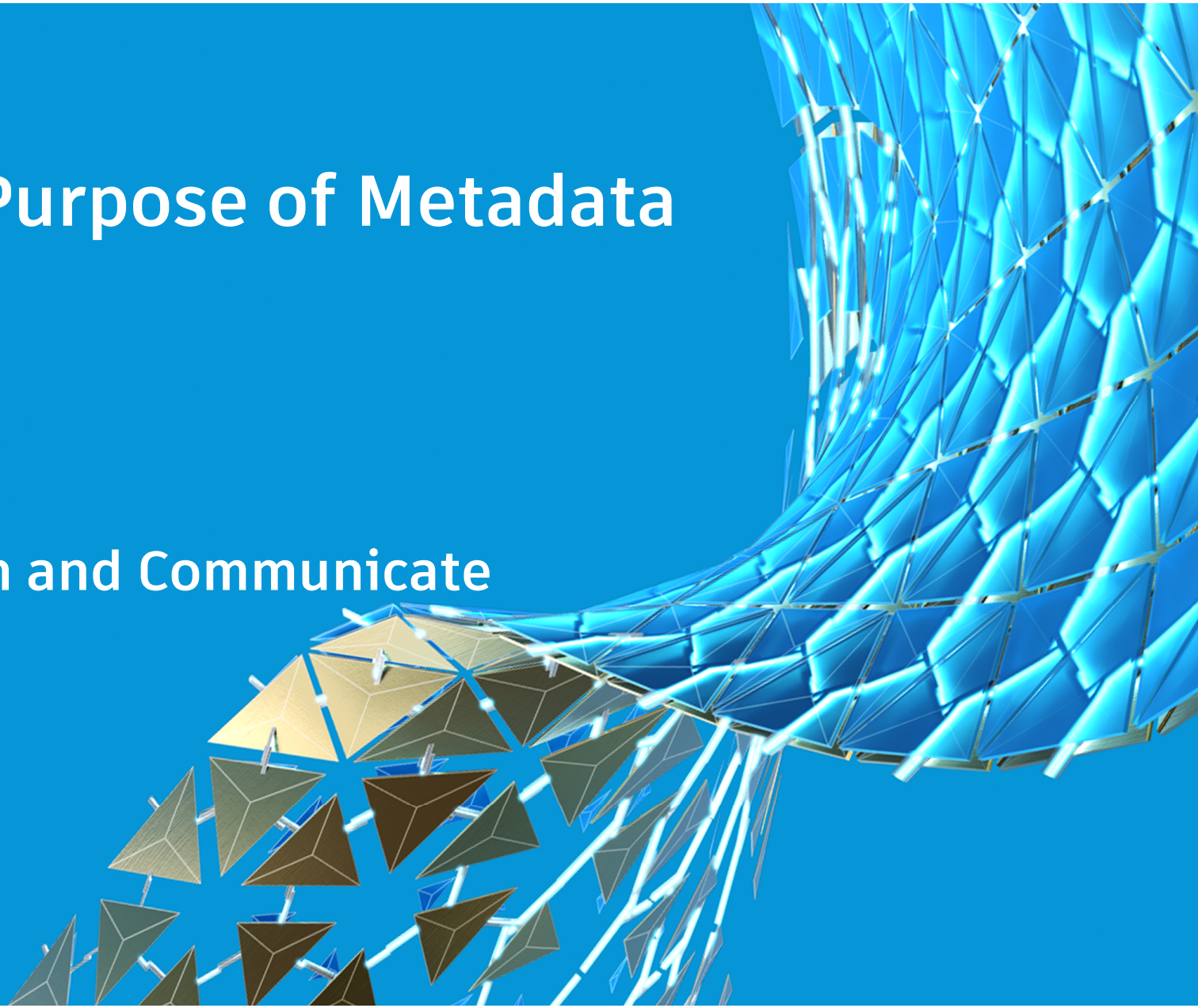
BIM-gjennomføringsplan for bygging av Fornebubanen - Grunnarbeider

Dok.nr.: PF-U-070-AD-0005
Revisjon: 03A



The Greater Purpose of Metadata

Structure, Inform and Communicate

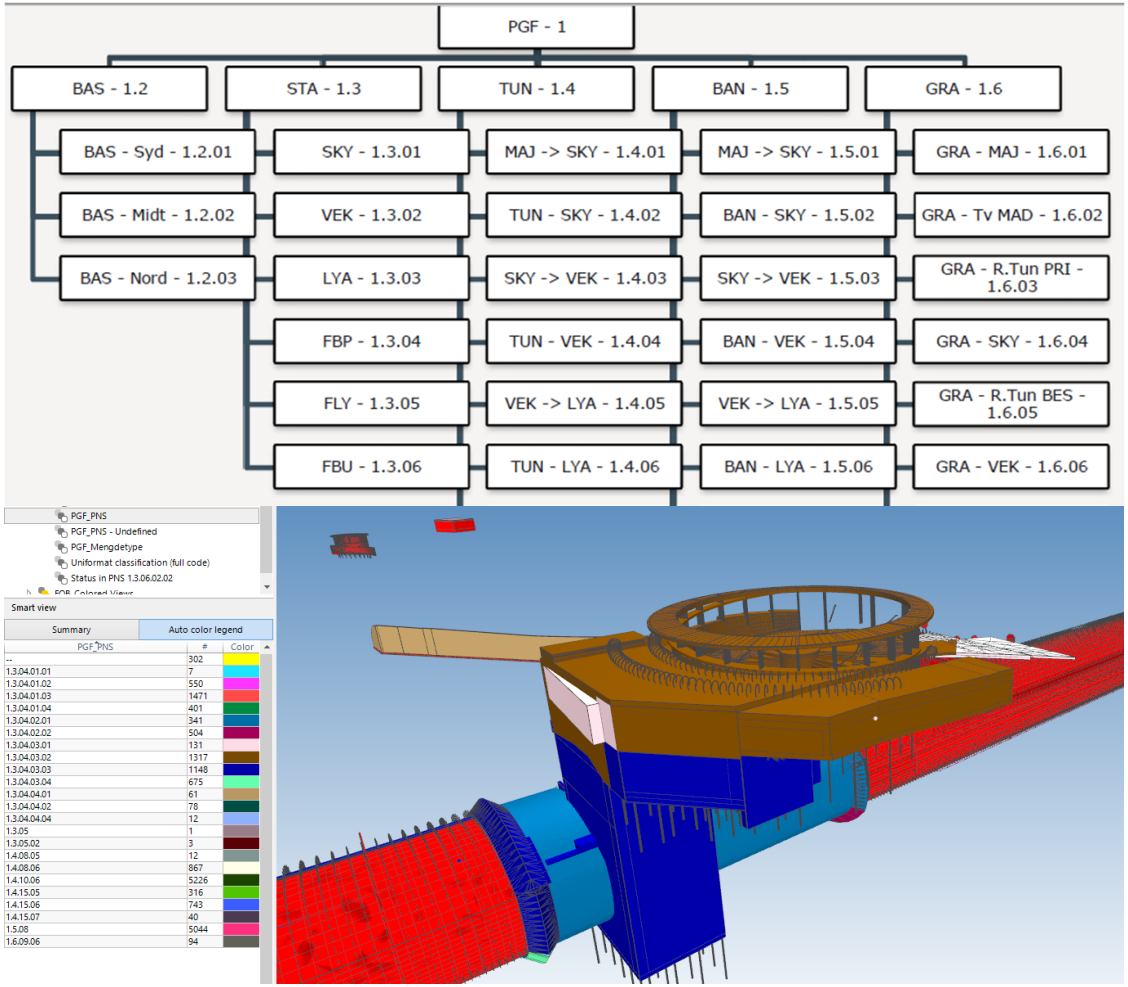


Work Breakdown Structure – WBS – “Where?”

- Q: How do you eat an elephant?
- A: Bit by bit -> WBS

- Q: Where are my model elements located?
- A: Left front foot -> WBS

Successfully implementation of WBS in BIM is when WBS is also location oriented, so the “**where is it**?” can be visualized in the BIM.



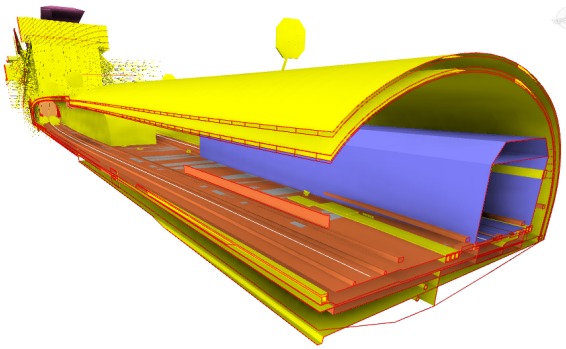
Model Element Design Status – “Are you ready?”

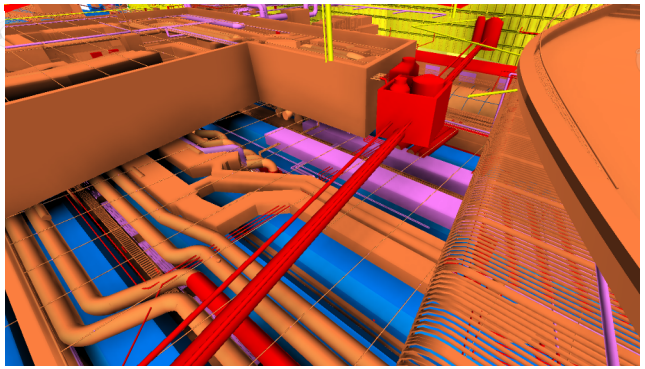
Communication of model maturity is important. It help us understand how the element can be treated.

What is reliable data and are we according to plan?
Are you ready?

- For coordination
- For tender
- For construction

In this project we use model element status to communicate “readiness”.





Status Code	Color	Definition
S0		**Identified** The model element is identified as a needed and roughly placed in the model.
S1		**Preliminary** **Geometry**: The model element is defined with preliminary position and outer geometry. **Information**: Element has correct Type Name, classification code and WBS-code. **QA**: Verified inside own discipline.
S2		**Ready for coordination** **Geometry**: The model element is defined with correct geometry and positioning for coordination purposes. **Information**: Element has correct Type Name, classification code, WBS-code and other information required for S2 as described in Digital Production Manual **QA**: Verified inside own discipline.
S3		**Freeze** **Geometry**: Issues found in coordination are corrected. Model element has final geometry and positioning. Futher detailing must be carried out without affecting other disciplines. **Information**: Element has correct Type Name, classification code, WBS-code and other information required for S3 as described in Digital Production Manual **QA**: Verified by BIM-coordinator and discipline
S4		**Ready for bidding** **Geometry**: Model element is detailed as needed for calculation by contractor. **Information**: Element has correct Type Name, classification code, WBS-code and other information required for S4 as described in Digital Production Manual. Information required for correct calculation by contractor **QA**: QA as described by procedure for BIM delivery
S5		**Ready for production** **Geometry**: Model element is detailed as needed for production by contractor. **Information**: Element has correct Type Name, classification code, WBS-code and other information required for S5 as described in Digital Production Manual. Information required for production by contractor. **QA**: QA as described by procedure for BIM delivery
S6		**As built** **Geometry**: Model element is represented as built. Verified by survey or 3D scan. **Information**: Element has information as required for operation and maintenance. **QA**: QA as described by procedure for BIM delivery

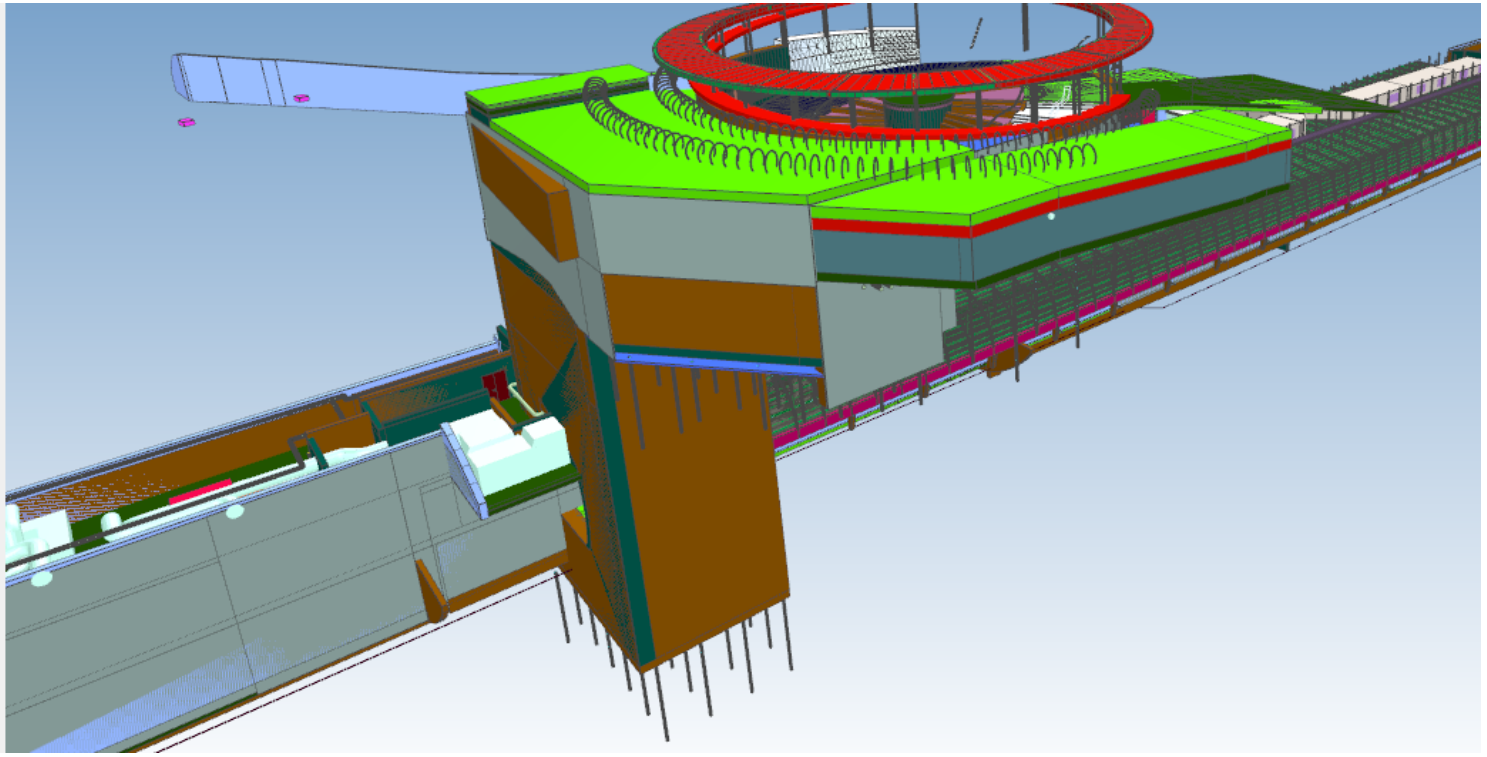
Classification – “What?”

The purpose of classification codes is to group model elements of same kind. This is so software downstream for quantity estimation, cost calculation and 4D simulation easily can sort the elements based on “**what it is**”.

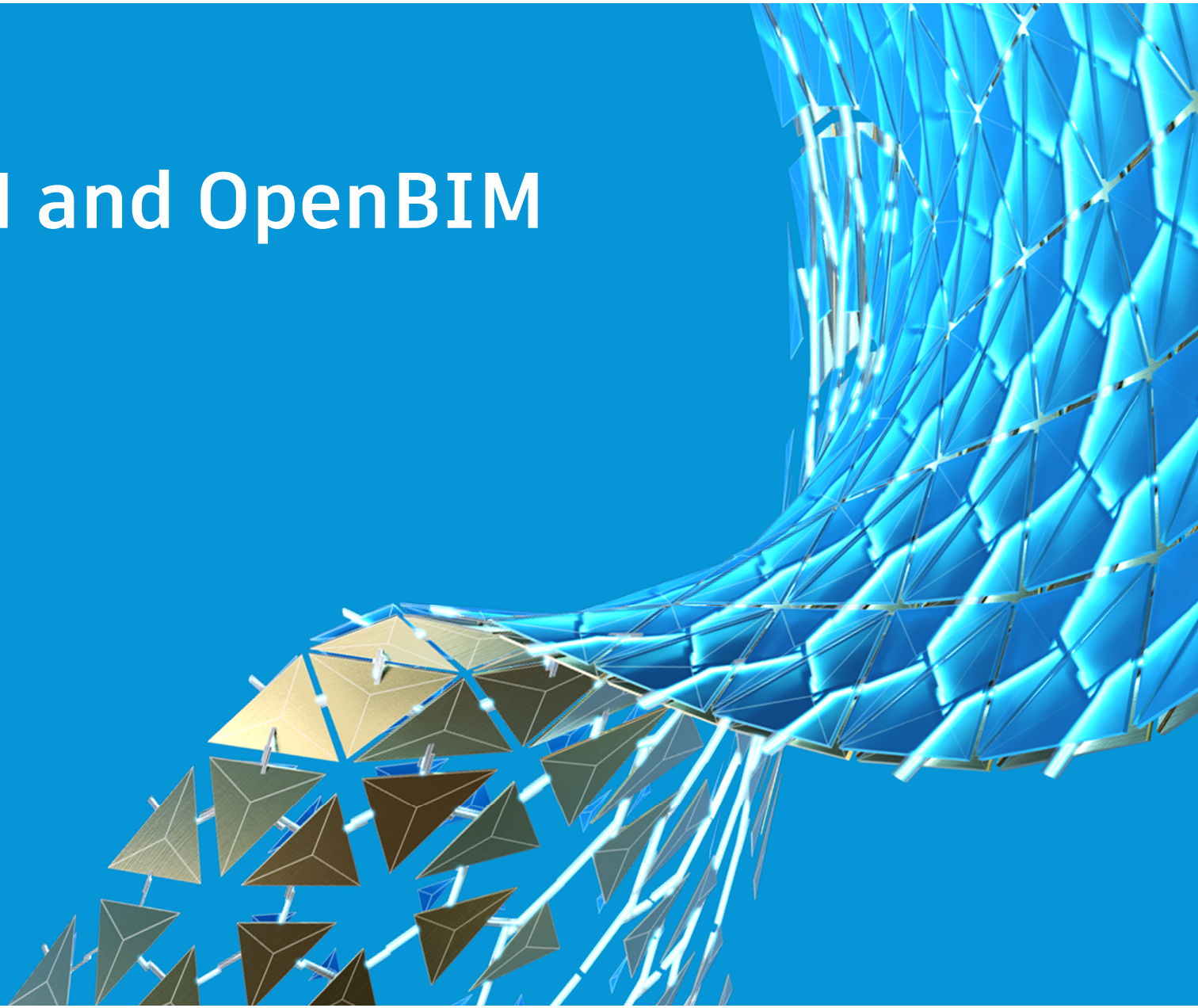
Smart view

Summary | Auto color legend

Uniformat Classification	#	Color
--	10	
215, Pelefundamentering	85	
216	2	
216, Direkte fundamentering	2	
221, Rammer	1272	
222, Søyler	99	
223, Bjelker	22	
224, Avstivende konstruksjoner	893	
231, Bærende yttervegger	268	
233, Glassfasader	14	
234, Vinduer, dører, porter	1	
2341, Dører	1	
241, Bærende innervegger	331	
242, Ikke-bærende innervegger	173	
243, Systemvegger, glassfelt	5	
2441, Dører	122	
246, Kledning og overflate	143	
25, Dekker	1	
251, Frittbærende dekker	121	
252, Gulv på grunn	37	
253, Oppforet gulv, påstøp	28	
254, Gulvsystemer	7	
256, Faste himlinger og overflatebehandling	23	
257, Systemhimlinger	1176	
261, Primærkonstruksjon	11	
267, Prefabrikkerte takelementer	24	
276, Sittebenker, stolrader, bord	11	
277, Skilt og tavler	48	
278, Utstyr og komplettering	11	
279, Andre deler av fast inventar	6	



Applied BIM and OpenBIM



Model and File Format Overview

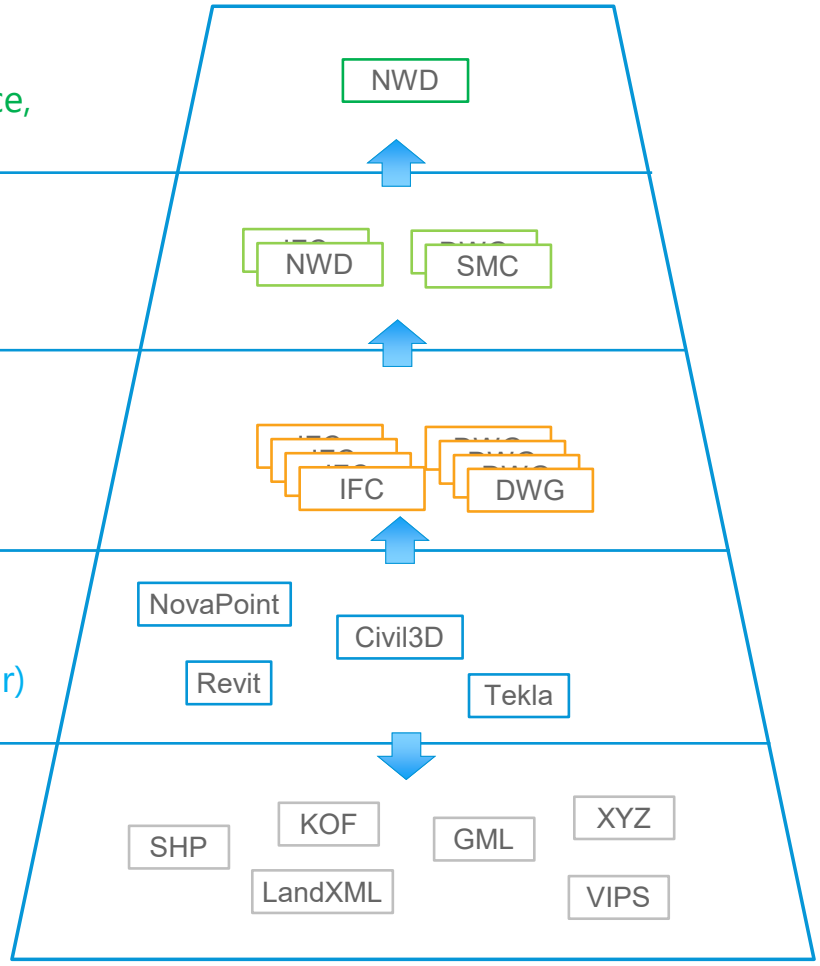
1. Coordination model
(Includes also design basis models, terrain, rock surface, existing buildings etc.)

2. Work packages / Container models
Solibri and/or NavisWorks

3. Discipline Model Deliveries

4. Design Models – Work in progress
(Not a delivery, unless needed for design by supplier)

5. Special formats – Separate export on request



Model Coordination

For everyday coordination both Navisworks and Solibri are in use. In order to have a manageable file size of coordination models, they are divided per station:

MAJ – Majorstua

SKY – Skøyen

VEK – Vækerø

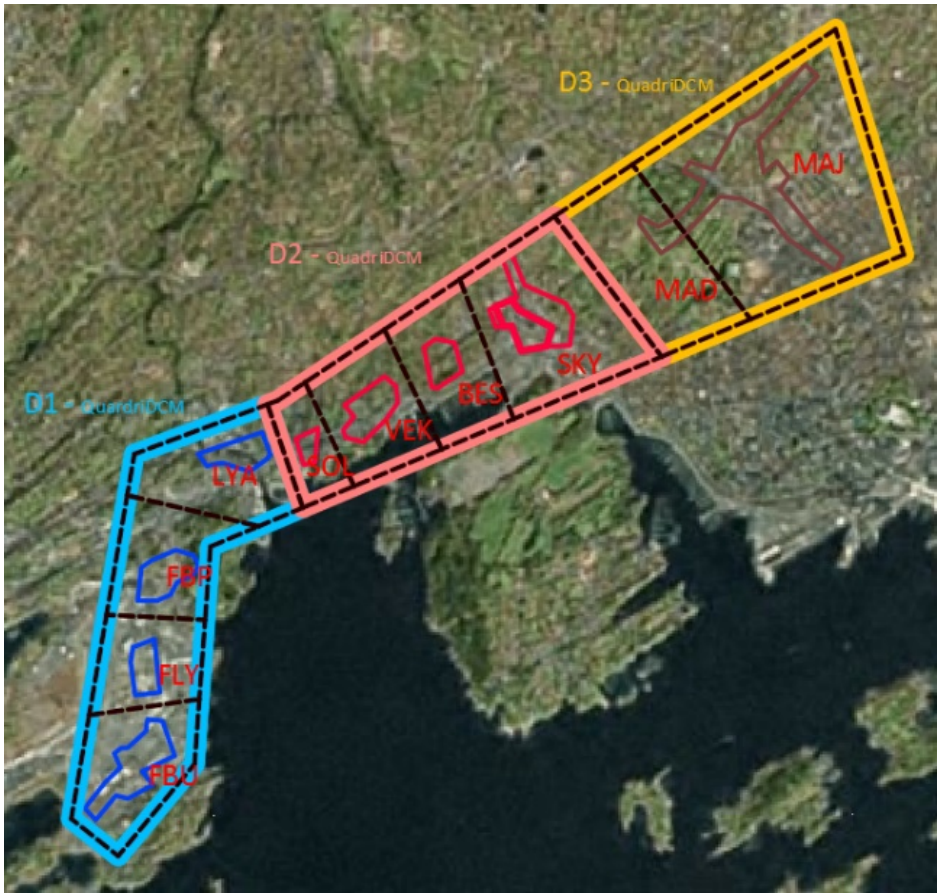
LYA – Lysaker

FBP – Fornebuporten

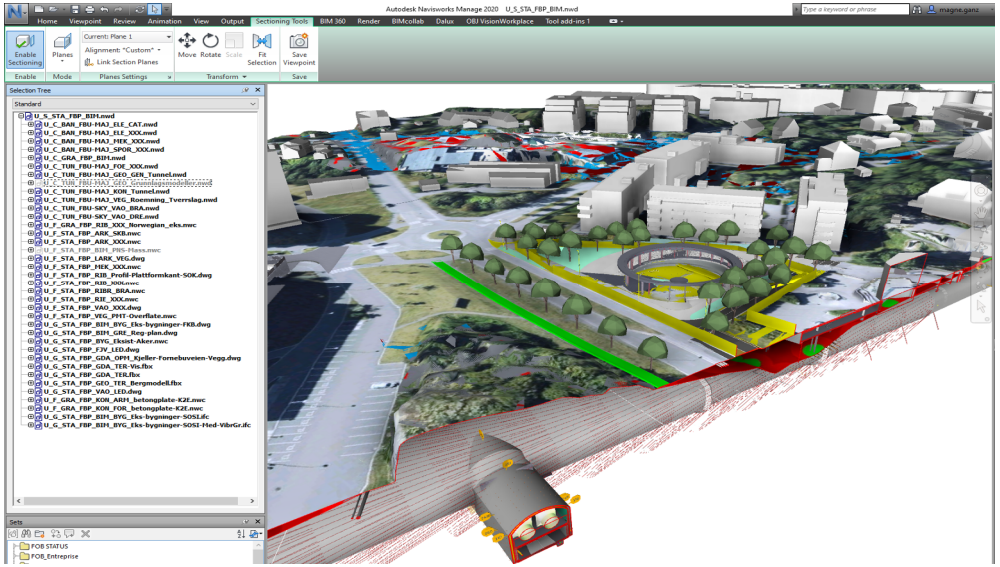
FLY – Flytårnet

FBU – Fornebu station and base

TUN-BAN – Coordination model for the whole tunnel with focus on tunnel and rail disciplines.



NavisWorks and Solibri



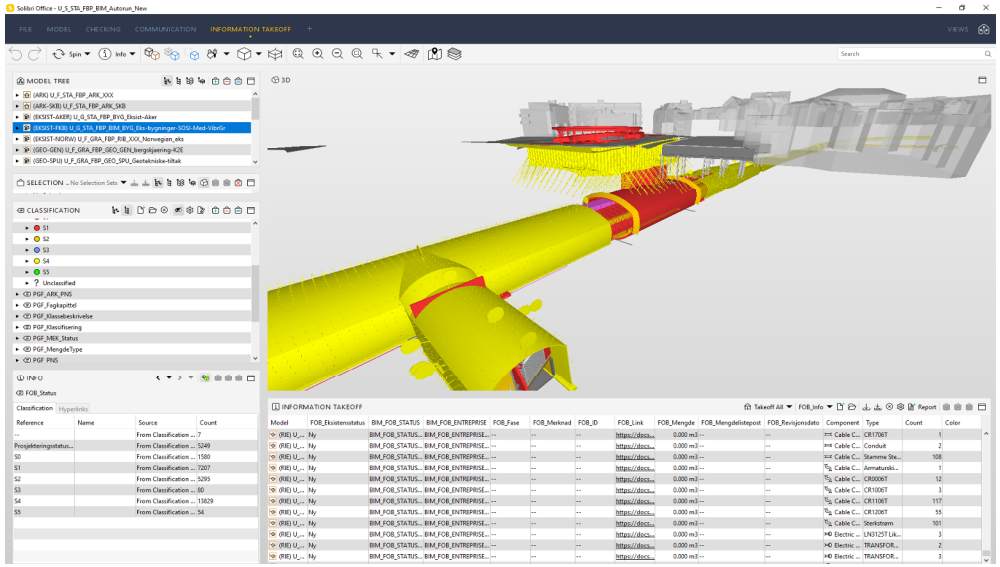
NavisWorks Manage:

Pros:

- Robust 3D Viewer for large models
- Can show textures (i.e. terrain with ortophoto)
- FileReader for most formats

Cons:

- Not ideal with OpenBIM (slow and has some errors)
- NWC export from Revit does not have User defind Psets
- Does not manage information as dynamic as Solibri
- Maintanence of appearance override and Saved views are manual



Solibri Office:

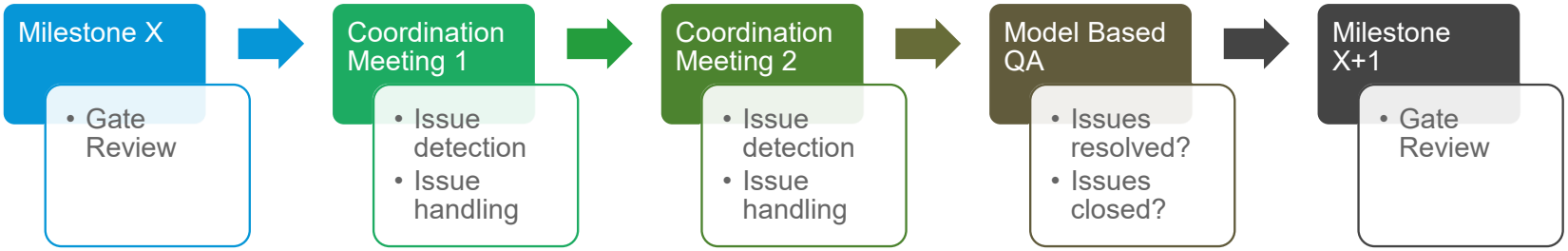
Pros:

- Reads OpenBIM (IFC) very good
- Great with information (Classifications and ITO's)
- Customizable Rules and Rulesets, not only clash detection

Cons:

- Does not read dwg and fbx
- Can not publish to web viewer

Generic Time Schedule / Workflow



Her is a generic time schedule or workflow between two milestones.

- Milestone in this project is identified as a **Quality Level**.
- Each Quality Level have specific demands to model elements of every discipline regarding status.
- Quality Level is accepted or denied through a gate review.

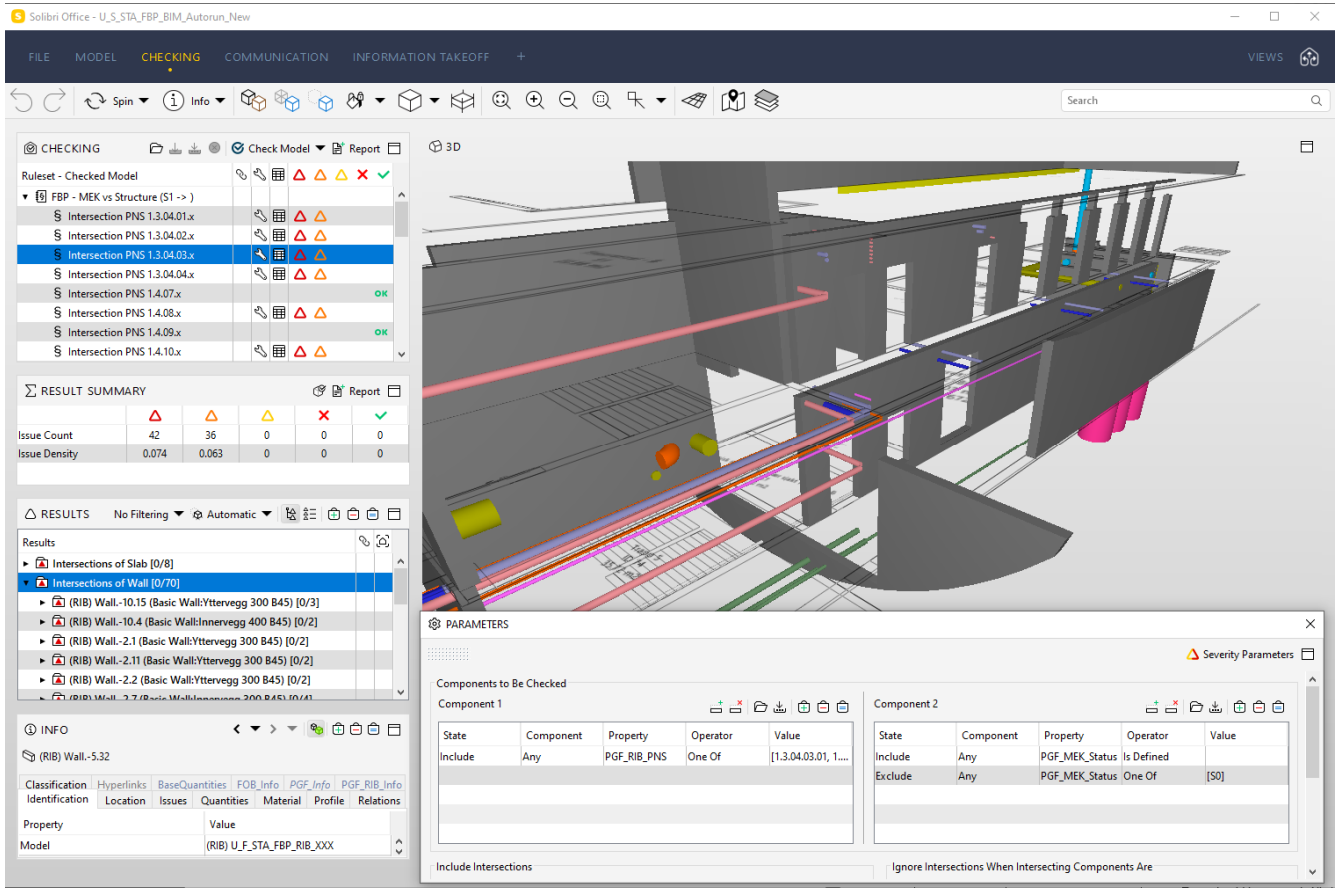
Model coordination is carried out as a continuous process with coordination meetings and issue management at steps defined by the design manager in between two milestones.

Rules and Clash Detection

In Solibri clash checking rules are customized to check:

- Discipline X vs Discipline Y
- Per WBS-location
- Only Elements with Status S2 and above.

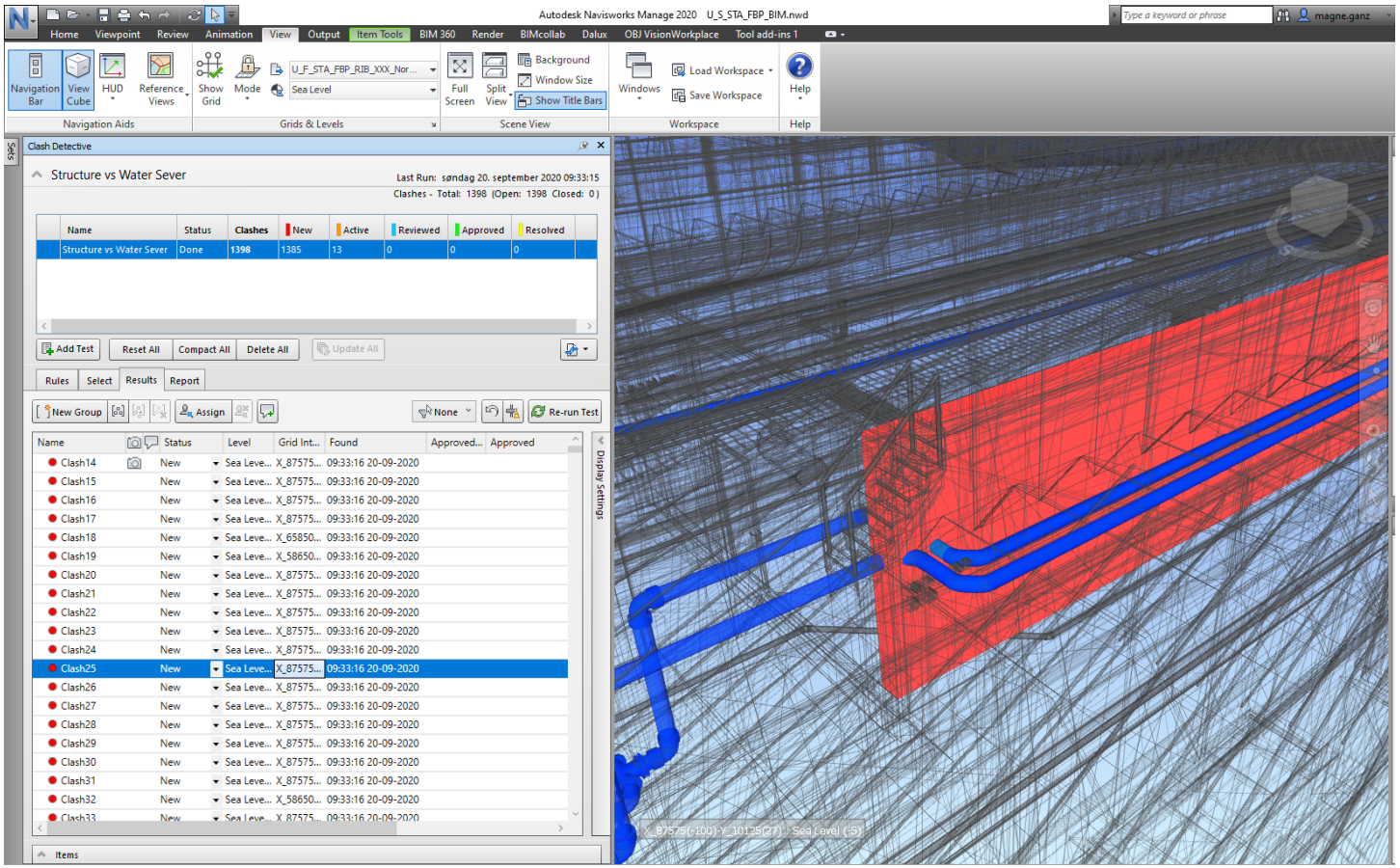
This is done through a combination of Classification Groups and Rule Parameters.



Clash Check and Visual Control

In Navisworks we can run clash check on disciplines not able to deliver IFC.

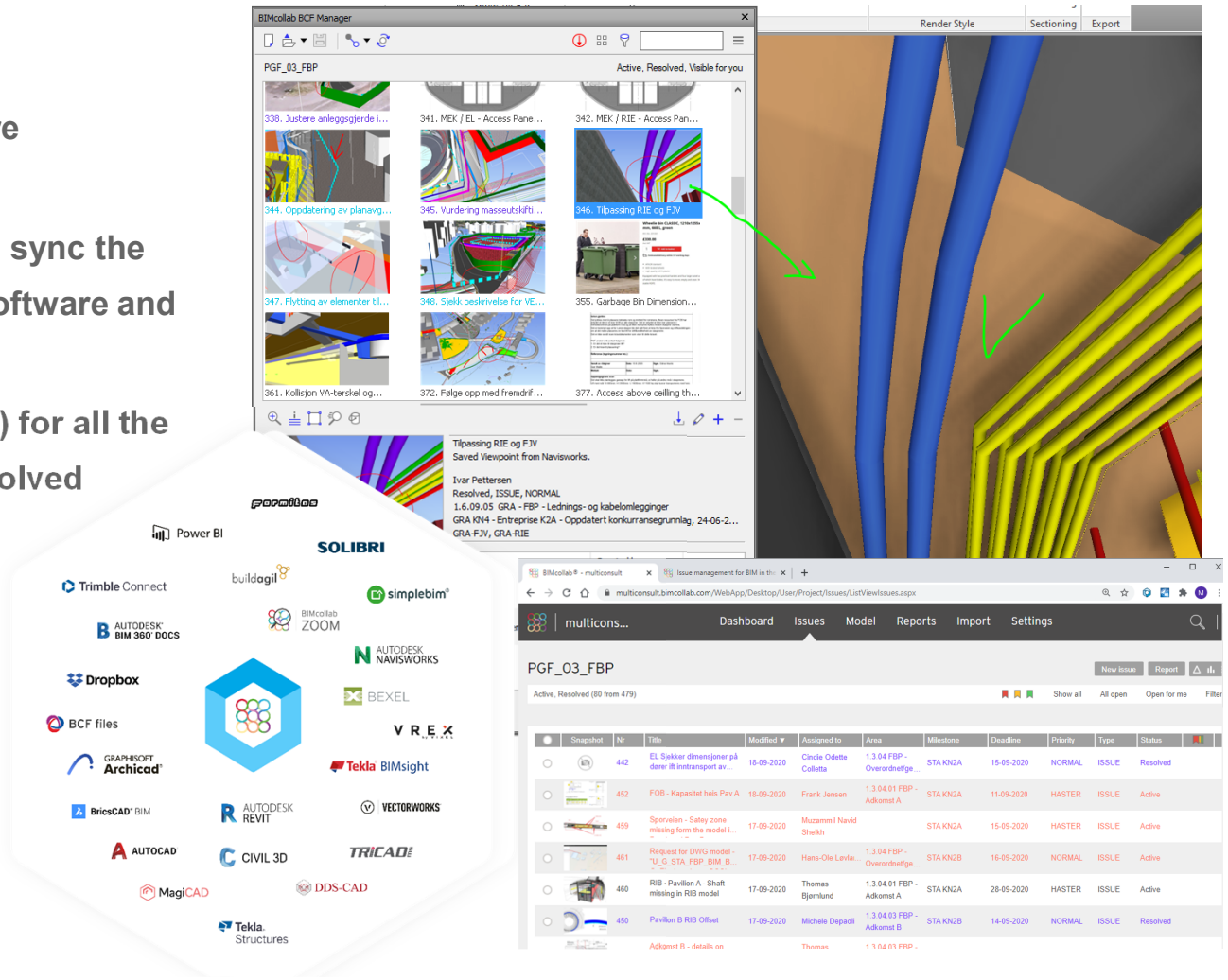
Navisworks is also the software used for visual control of the coordination models.



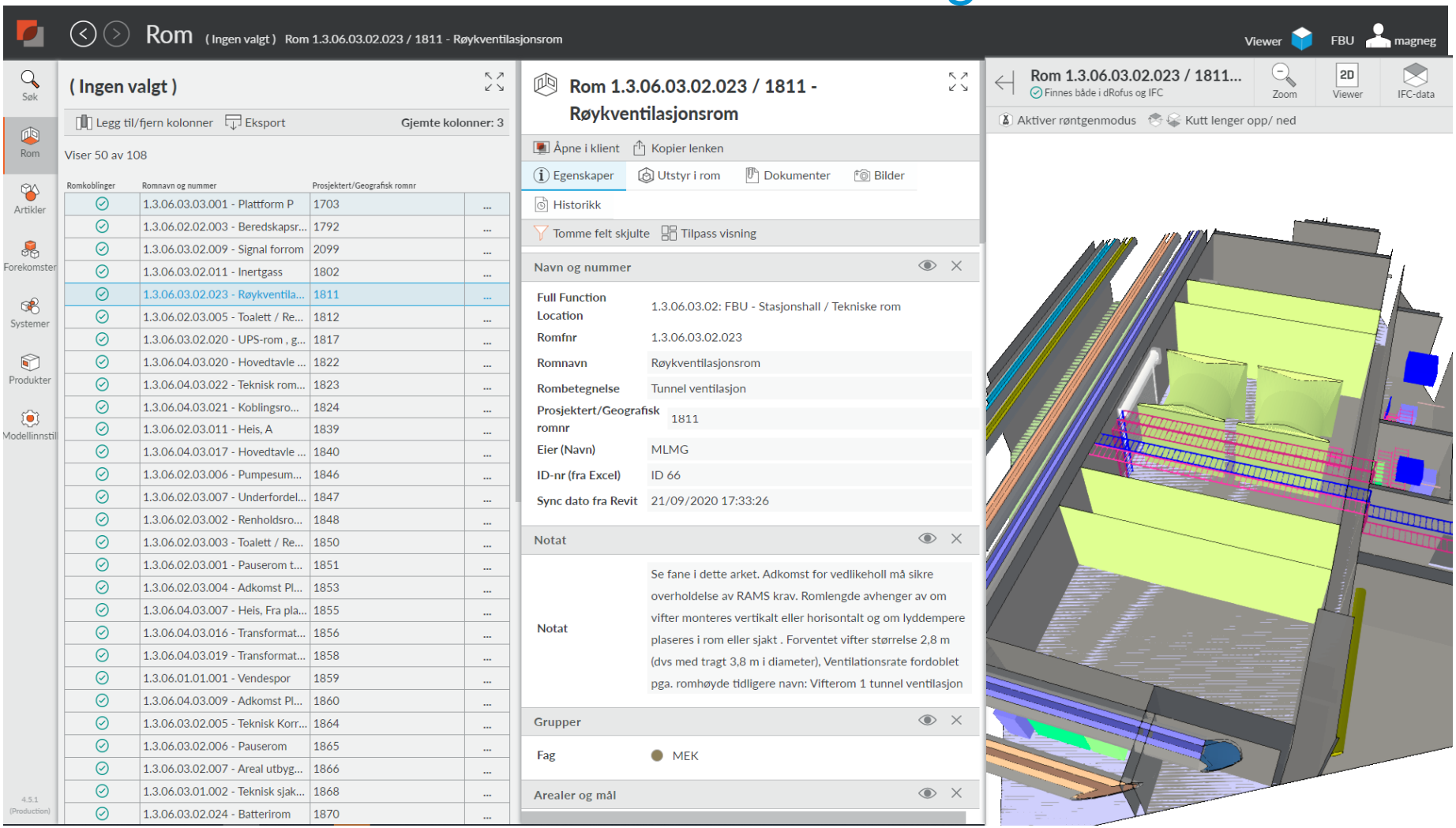
Example: Water and sewer (dwg) vs Structure (IFC)

Issue Management - BIMCollab

- Identified clashes and other issues are synchronized to BIMCollab Cloud
- The person assigned to the issue can sync the issue-information to his/her design software and fix it.
- BIMCollab have add-in (BCF Manager) for all the design and coordination software involved
- It is easy to keep track of every issue



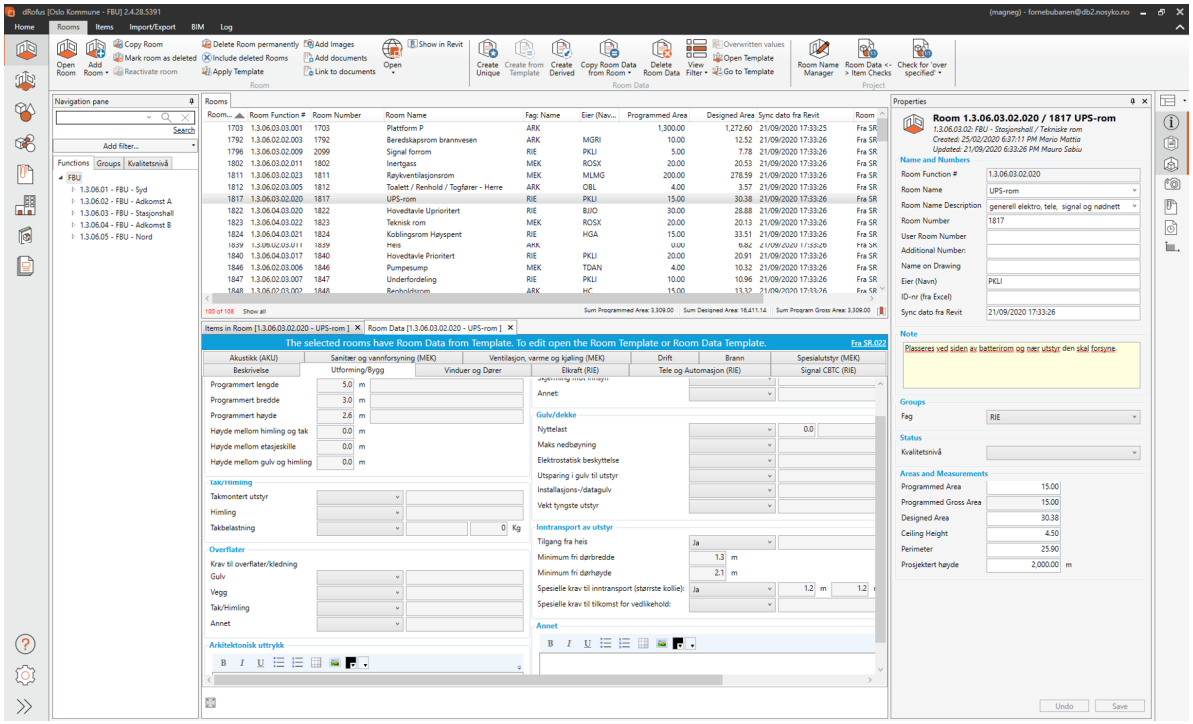
Room Data Base and Asset Management - dRofus



Room Data Base and Requirements

Requirements for all rooms in the stations are managed in a database.

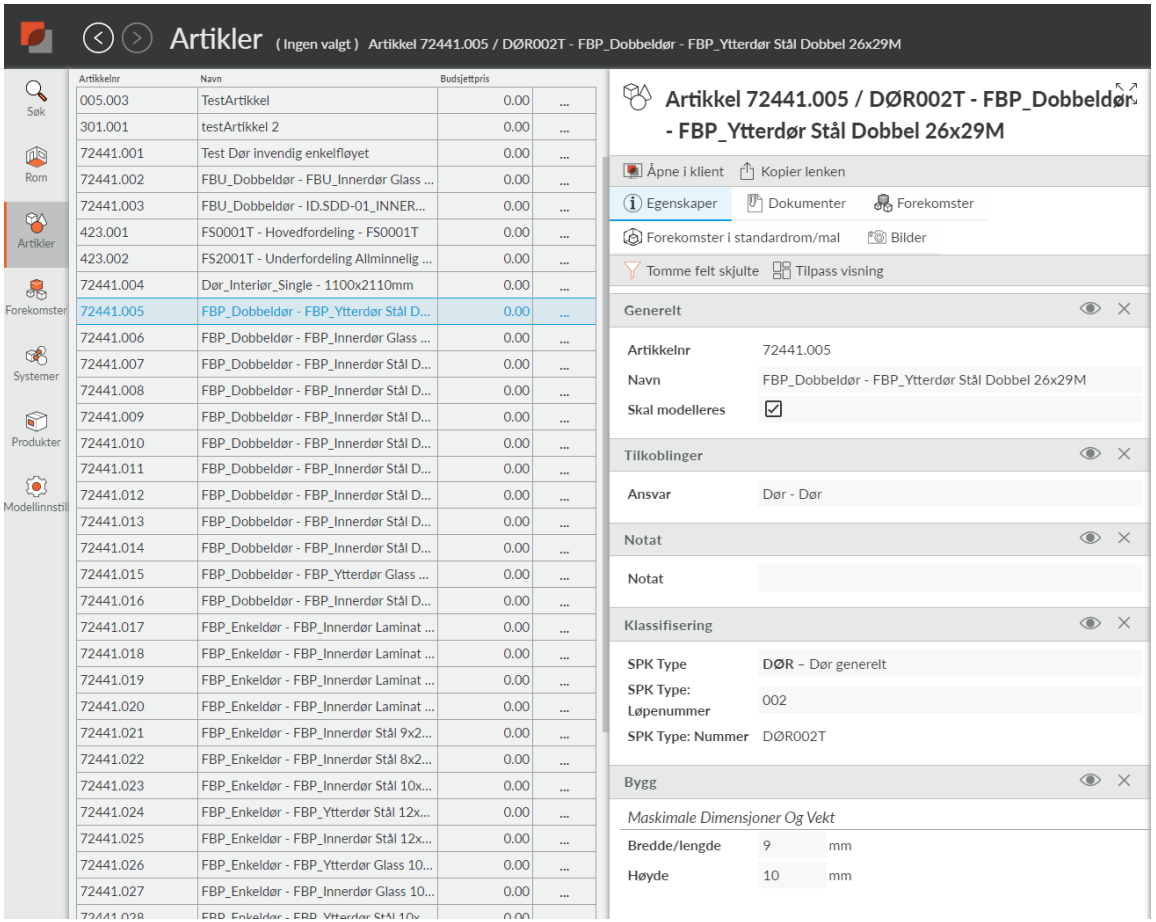
- **One database for the whole project sub-divided into projects per station**
- **Similar rooms inherit their requirements from template rooms.**
- **Key data like room-ID, Number, Name and Area are synchronized with Revit**



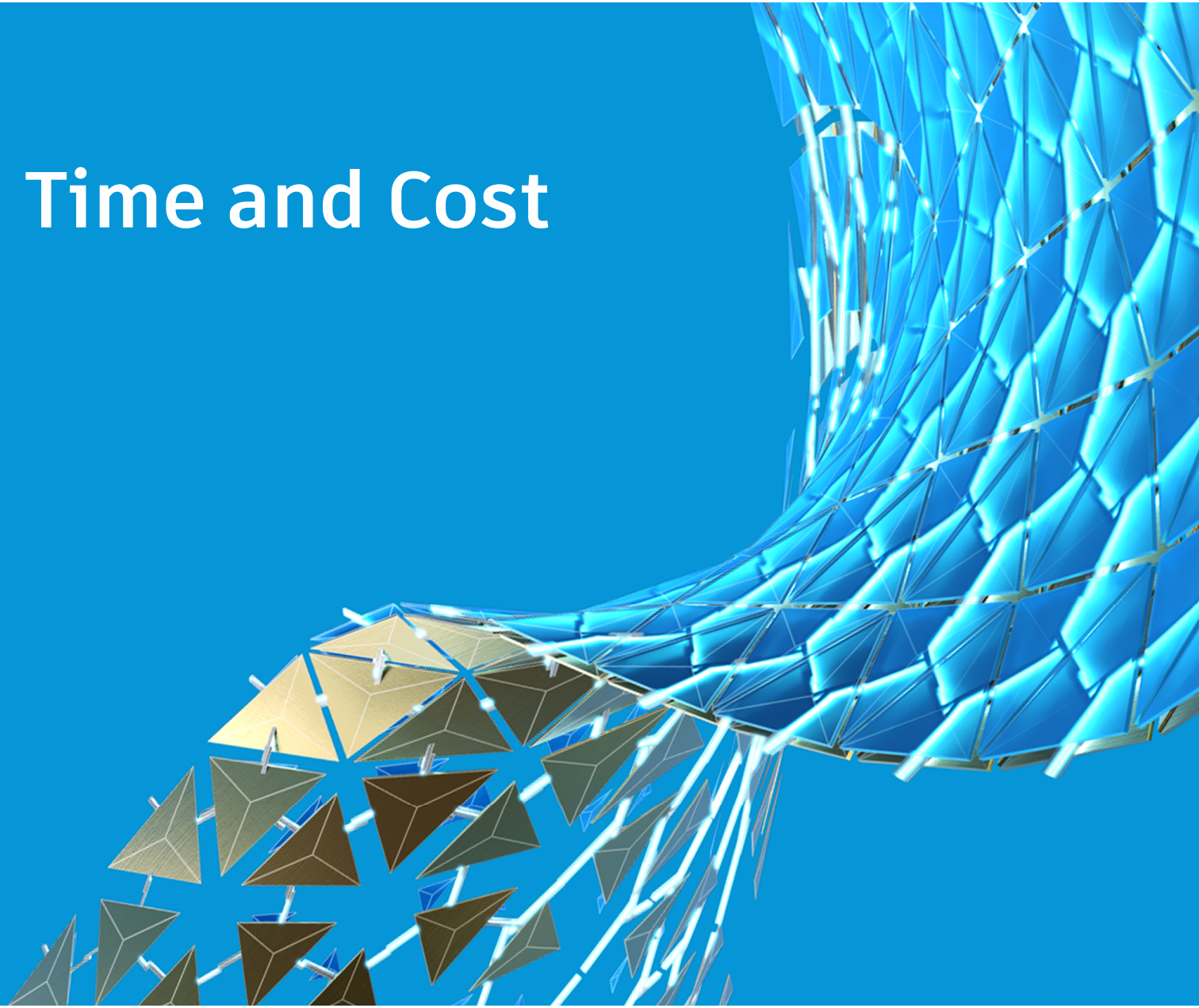
Example Asset - Doors

Asset data is synchronized between Revit and the dRofus database:

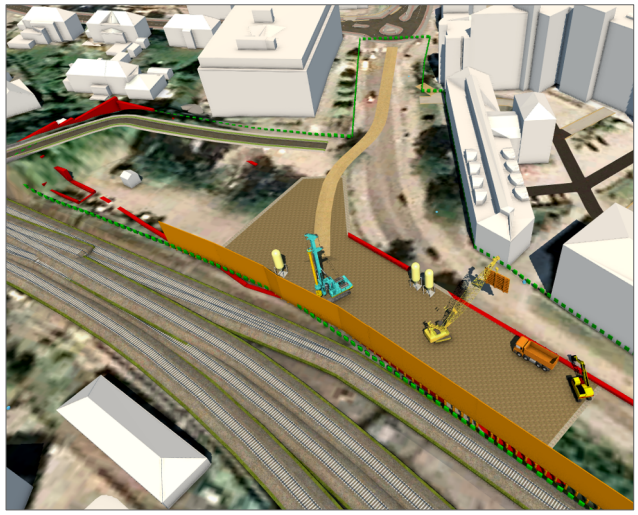
- **There are more data connected to Door (and other Items) Types / Instances, than what is manageable to handle within Revit**
- **A database where users are invited and grouped by access rights helps a great deal to:**
  - keep track of requirements,
  - standardize Items
  - collect information for Operation and Maintenance

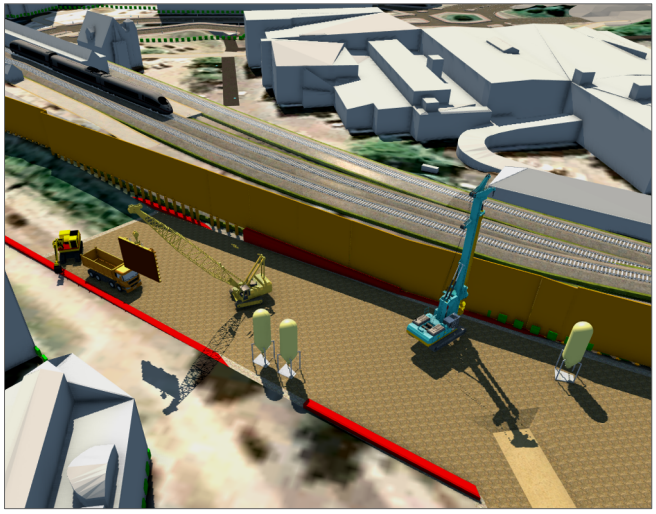


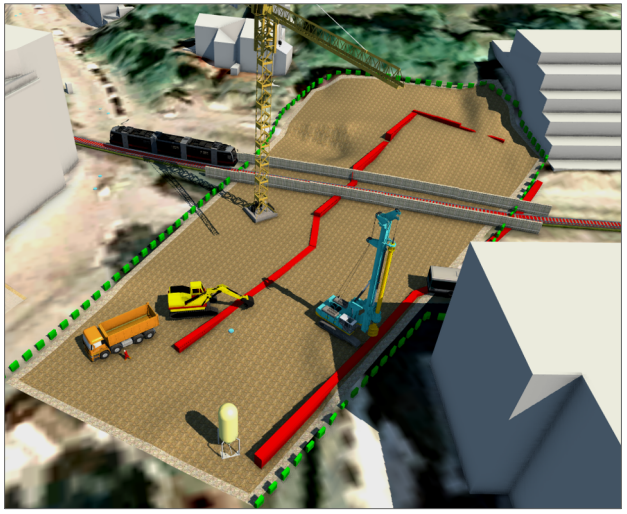
4D and 5D – Time and Cost



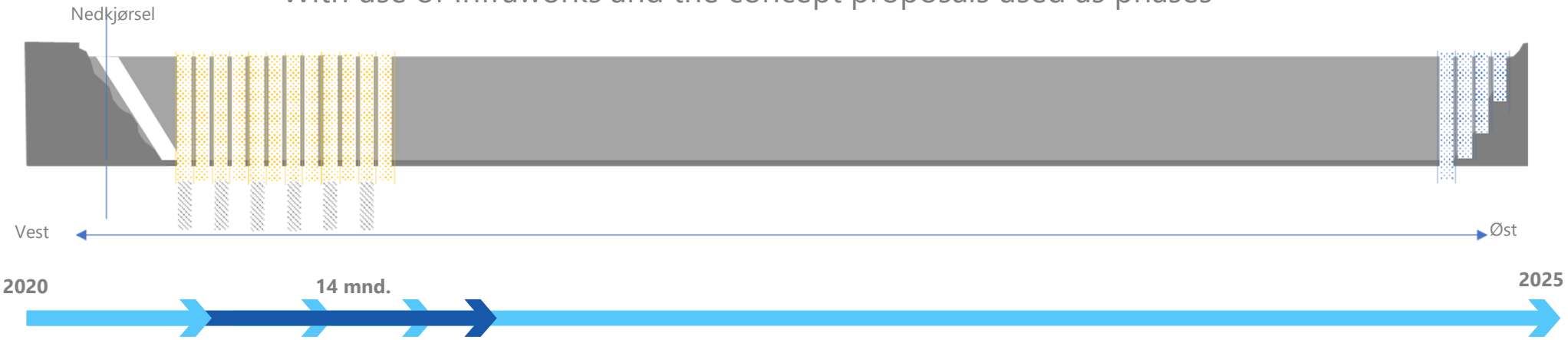
Construction Visualisation – “Semi-4D”



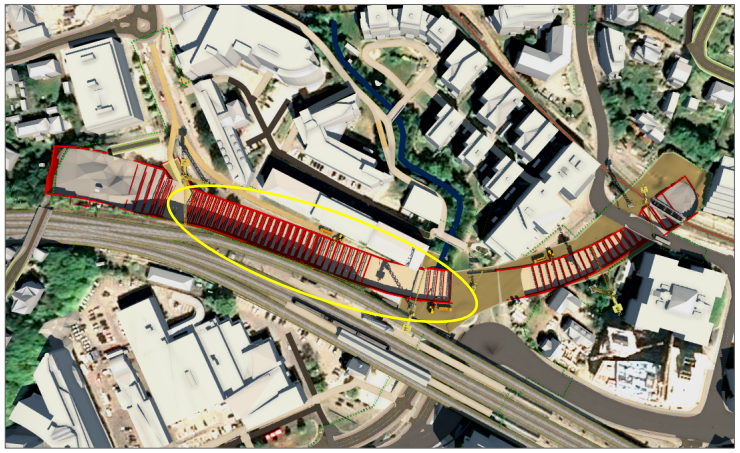


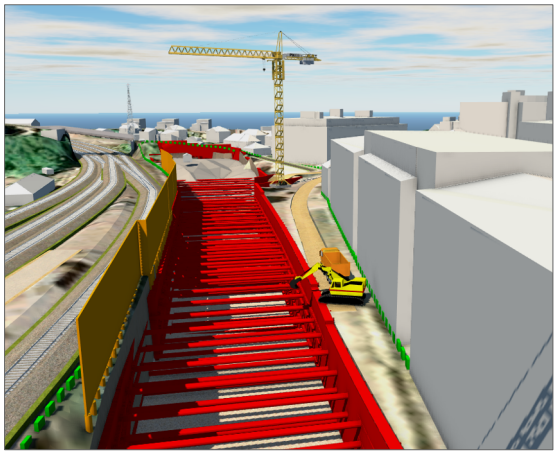


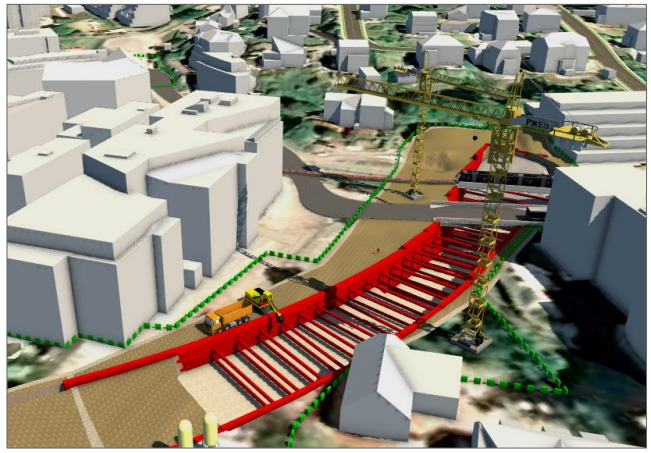
With use of Infraworks and the concept proposals used as phases



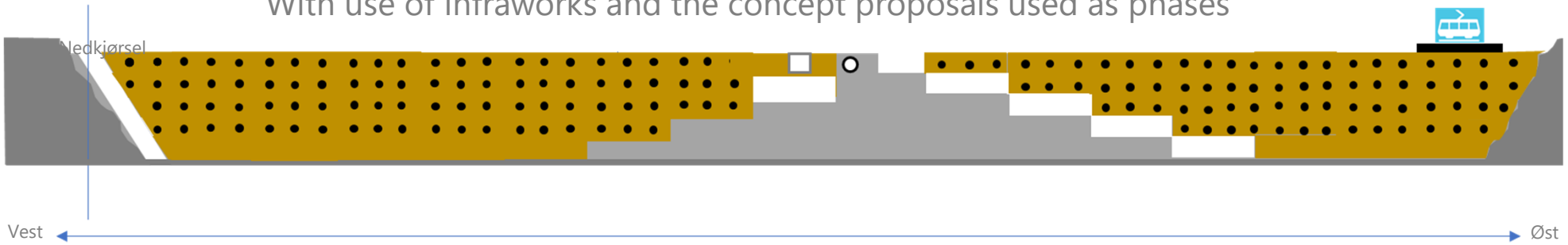
Construction visualization – “semi-4D”



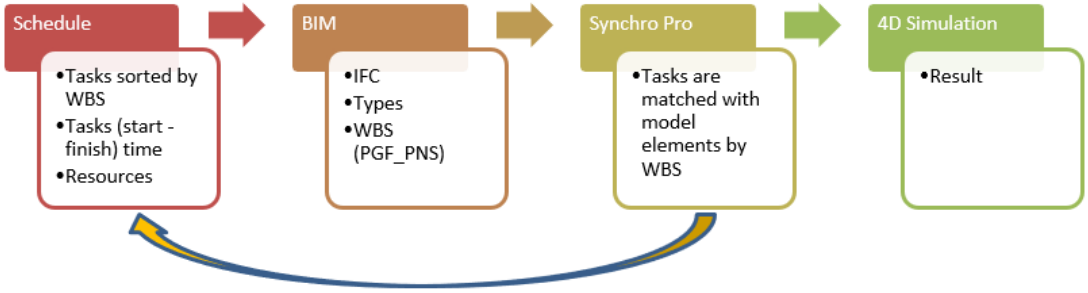




With use of Infraworks and the concept proposals used as phases

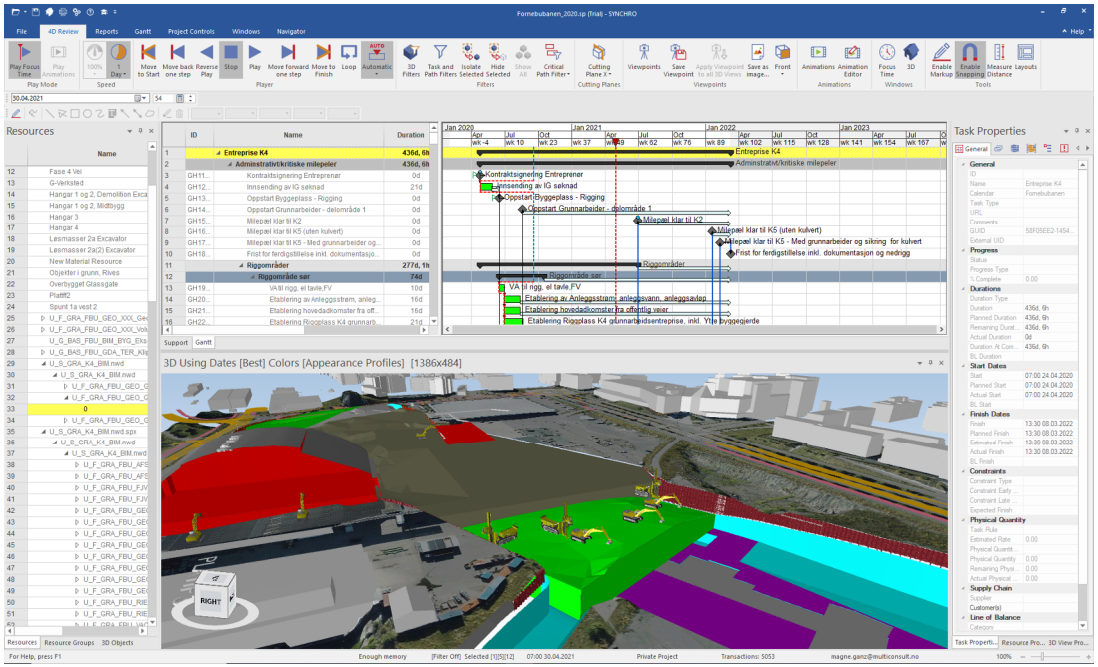


4D – Construction Simulation



Model elements with their WBS-Code are matched with tasks and processes in the schedule with their WBS-Code.

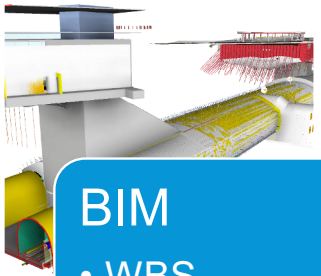
The result is a 4D simulation of the construction sequence.



4D-Video from Contract K4

MGA: Klipper inn videoer etterpå i Camtasia, så Powepointen ikke blir så stor å jobbe med.

5D – Cost calculation

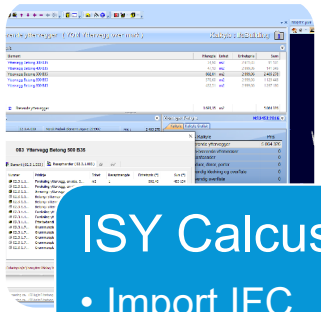


BIM

- WBS
- Classification
- Type
- Quantities

OpenBIM

- IFC
- PropertySets
- Properties
- Values

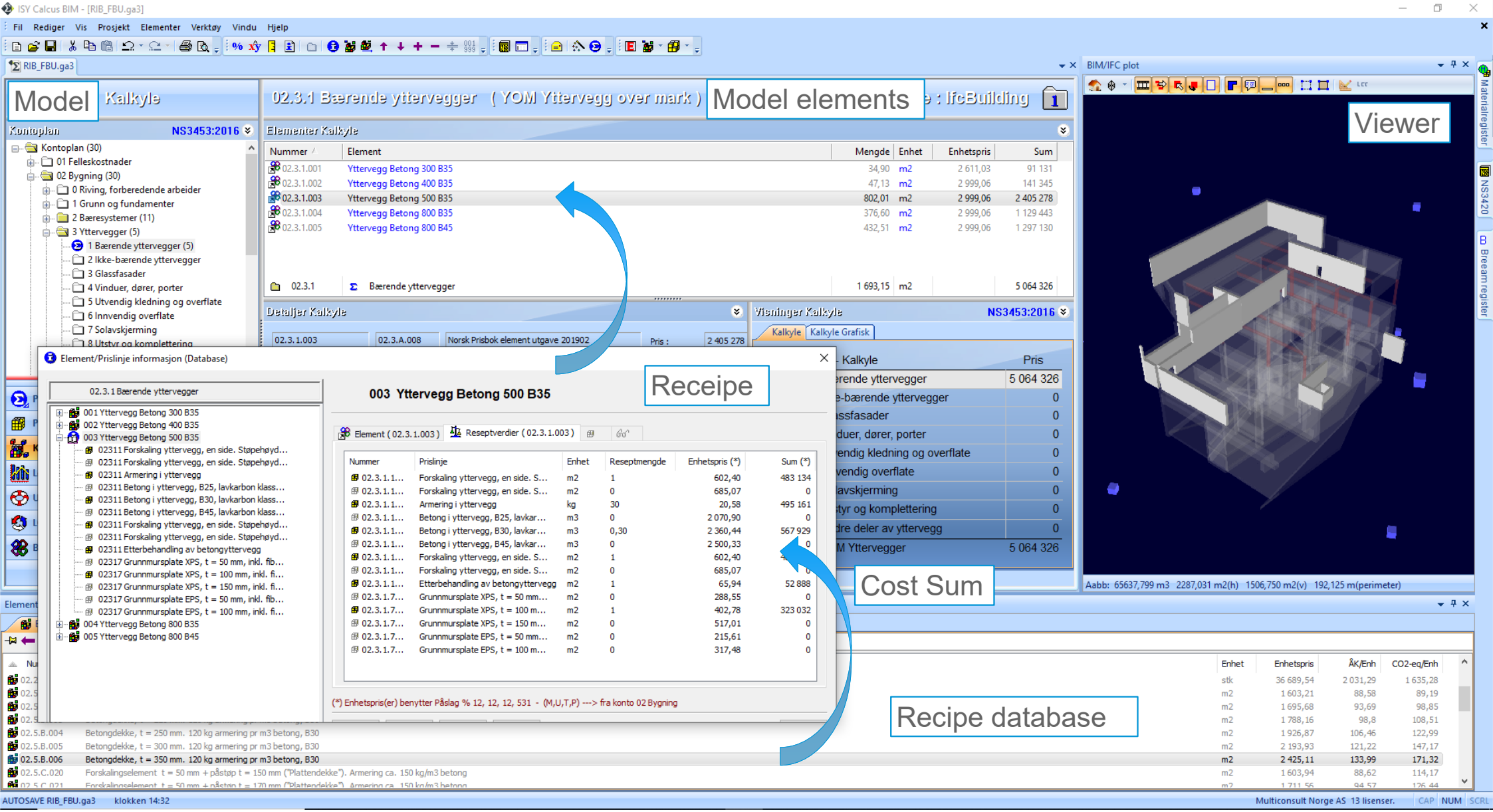


ISY Calcus

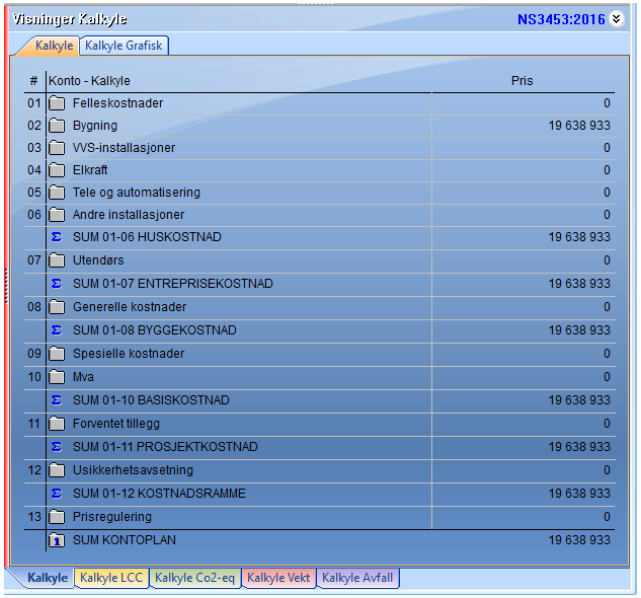
- Import IFC
- Config File
- Recipe

Results

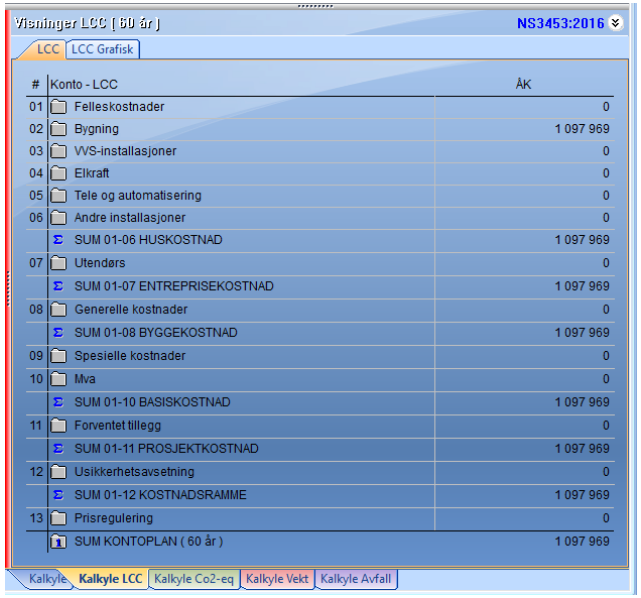
- Cost
- CO2
- LCC


Model
Kalkyle
Kontoplan
NS3453:2016
Kontoplan (30)
01 Felleskostnader
02 Bygning (30)
0 Riving, forberedende arbeider
1 Grunn og fundamenter
2 Bæresystemer (11)
3 Yttervegger (5)
1 Bærende yttervegger (5)
2 Ikke-bærende yttervegger
3 Glassfasader
4 Vinduer, dører, porter
5 Utvendig kledning og overflate
6 Innvendig overflate
7 Solavskjerming
8 Utstyr og komplettering
02.3.1 Bærende yttervegger (YOM Yttervegg over mark)
Model elements
Elementer Kalkyle
Nummer
Element
Mengde
Enhet
Enhetspris
Sum
02.3.1.001 Yttervegg Betong 300 B35 34,90 m2 2 611,03 91 131
02.3.1.002 Yttervegg Betong 400 B35 47,13 m2 2 999,06 141 345
02.3.1.003 Yttervegg Betong 500 B35 802,01 m2 2 999,06 2 405 278
02.3.1.004 Yttervegg Betong 800 B35 376,60 m2 2 999,06 1 129 443
02.3.1.005 Yttervegg Betong 800 B45 432,51 m2 2 999,06 1 297 130
02.3.1 Bærende yttervegger 1 693,15 m2 5 064 326
Detaljer Kalkyle
02.3.1.003
02.3.A.008
Norsk Prisbok element utgave 201902
Pris :
2 405 278
Visninger Kalkyle
NS3453:2016
Kalkyle
Kalkyle Grafisk
Kalkyle
Pris
rende yttervegger 5 064 326
e-bærende yttervegger 0
ssfasader 0
duer, dører, porter 0
endig kledning og overflate 0
vendig overflate 0
avskjerming 0
tyr og komplettering 0
dre deler av yttervegg 0
M Yttervegger 5 064 326
BIM/IFC plot
Viewer
Aabb: 65637,799 m3 2287,031 m2(h) 1506,750 m2(v) 192,125 m(perimeter)
Element/Prislinje informasjon (Database)
02.3.1 Bærende yttervegger
001 Yttervegg Betong 300 B35
002 Yttervegg Betong 400 B35
003 Yttervegg Betong 500 B35
02311 Forskaling yttervegg, en side. Støpehøyd...
02311 Forskaling yttervegg, en side. Støpehøyd...
02311 Armering i yttervegg
02311 Betong i yttervegg, B25, lavkarbon klass...
02311 Betong i yttervegg, B30, lavkarbon klass...
02311 Betong i yttervegg, B45, lavkarbon klass...
02311 Forskaling yttervegg, en side. Støpehøyd...
02311 Forskaling yttervegg, en side. Støpehøyd...
02311 Etterbehandling av betongyttervegg
02317 Grunnmursplate XPS, t = 50 mm, inkl. fib...
02317 Grunnmursplate XPS, t = 100 mm, inkl. fi...
02317 Grunnmursplate XPS, t = 150 mm, inkl. fi...
02317 Grunnmursplate EPS, t = 50 mm, inkl. fib...
02317 Grunnmursplate EPS, t = 100 mm, inkl. fi...
004 Yttervegg Betong 800 B35
005 Yttervegg Betong 800 B45
003 Yttervegg Betong 500 B35
Receipe
Element (02.3.1.003)
Reseptverdier (02.3.1.003)
Nummer Prislinje Enhet Reseptmengde Enhetspris (*) Sum (*)
02.3.1.1... Forskaling yttervegg, en side. S... m2 1 602,40 483 134
02.3.1.1... Forskaling yttervegg, en side. S... m2 0 685,07 0
02.3.1.1... Armering i yttervegg kg 30 20,58 495 161
02.3.1.1... Betong i yttervegg, B25, lavkar... m3 0 2 070,90 0
02.3.1.1... Betong i yttervegg, B30, lavkar... m3 0,30 2 360,44 567 929
02.3.1.1... Betong i yttervegg, B45, lavkar... m3 0 2 500,33 0
02.3.1.1... Forskaling yttervegg, en side. S... m2 1 602,40
02.3.1.1... Forskaling yttervegg, en side. S... m2 0 685,07
02.3.1.1... Etterbehandling av betongyttervegg m2 1 65,94 52 888
02.3.1.7... Grunnmursplate XPS, t = 50 mm... m2 0 288,55 0
02.3.1.7... Grunnmursplate XPS, t = 100 m... m2 1 402,78 323 032
02.3.1.7... Grunnmursplate XPS, t = 150 m... m2 0 517,01 0
02.3.1.7... Grunnmursplate EPS, t = 50 mm... m2 0 215,61 0
02.3.1.7... Grunnmursplate EPS, t = 100 m... m2 0 317,48 0
(*) Enhetspris(er) benytter Påslag % 12, 12, 12, 531 - (M,U,T,P) ---> fra konto 02 Bygning
Cost Sum
Recipe database
Enhet Enhetspris ÅK/Enh CO2-eq/Enh
stk 36 689,54 2 031,29 1 635,28
m2 1 603,21 88,58 89,19
m2 1 695,68 93,69 98,85
m2 1 788,16 98,8 108,51
m2 1 926,87 106,46 122,99
m2 2 193,93 121,22 147,17
02.5.B.004 Betongdekke, t = 250 mm. 120 kg armering pr m3 betong, B30
02.5.B.005 Betongdekke, t = 300 mm. 120 kg armering pr m3 betong, B30
02.5.B.006 Betongdekke, t = 350 mm. 120 kg armering pr m3 betong, B30 m2 2 425,11 133,99 171,32
02.5.C.020 Forskalingselement t = 50 mm + påstøp t = 150 mm ("Plattendekke"). Armering ca. 150 kg/m3 betong m2 1 603,94 88,62 114,17
Materialregister
NS3420
Breeam register
AUTOSAVE RIB_FBU.ga3 klokken 14:32
Multiconsult Norge AS 13 lisenser.

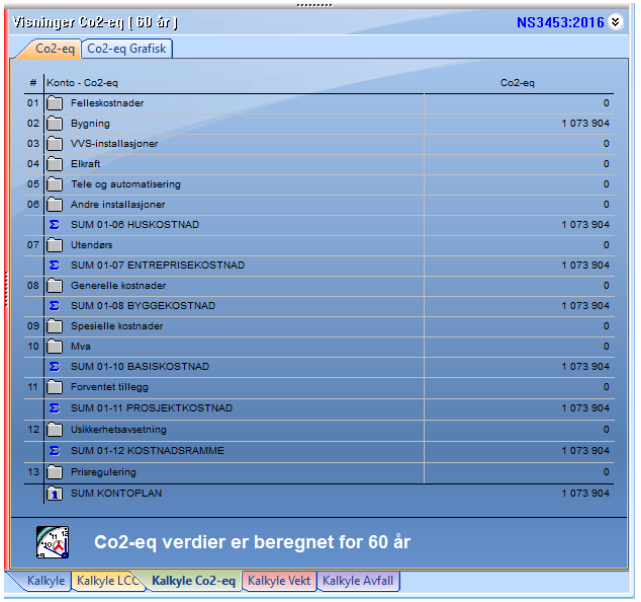
Cost, LCC and Co2 Model Based Approach



Cost Calculation

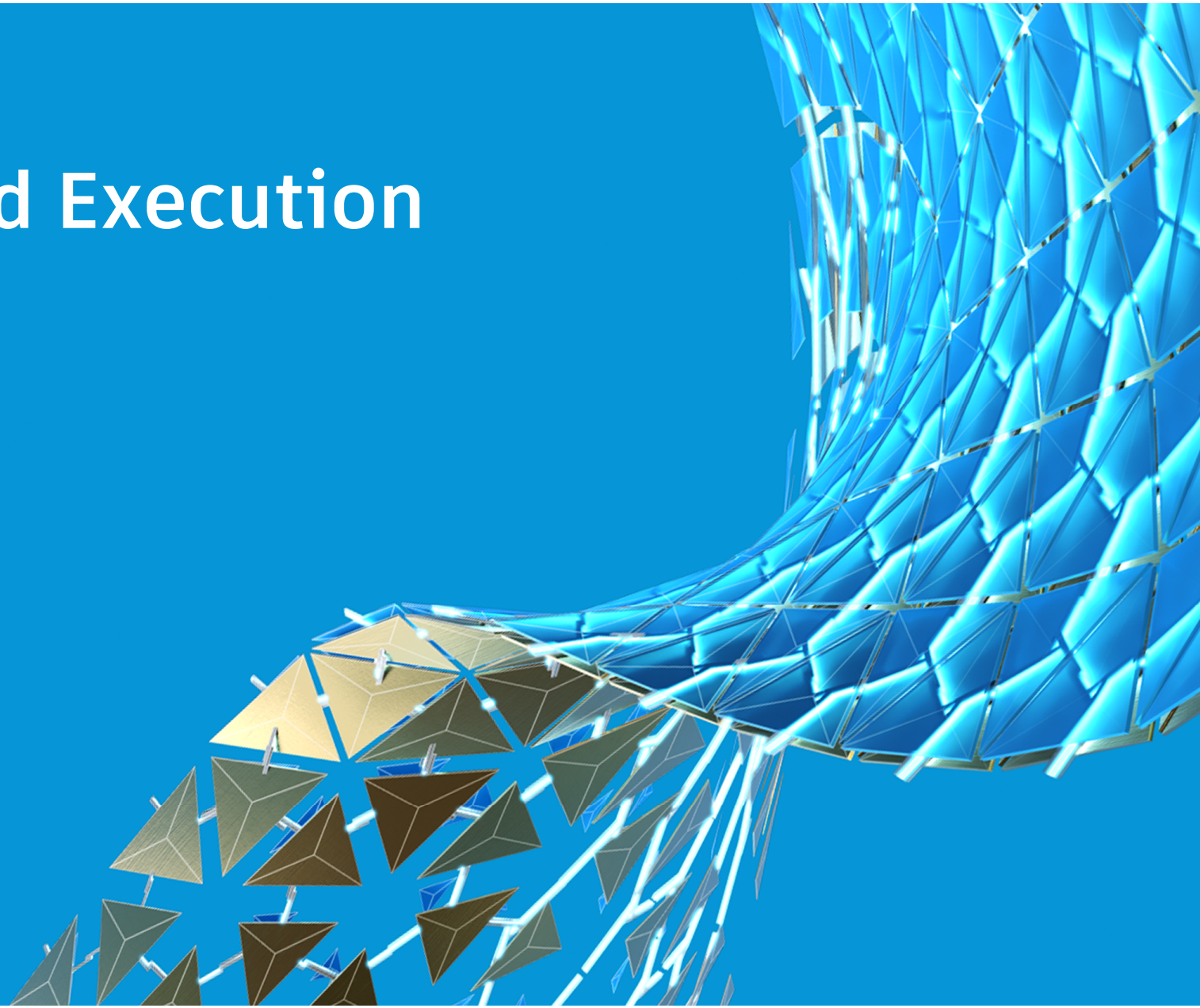


LCC Calculation



Co2-eq Calculation

Model Based Execution



Customised Models

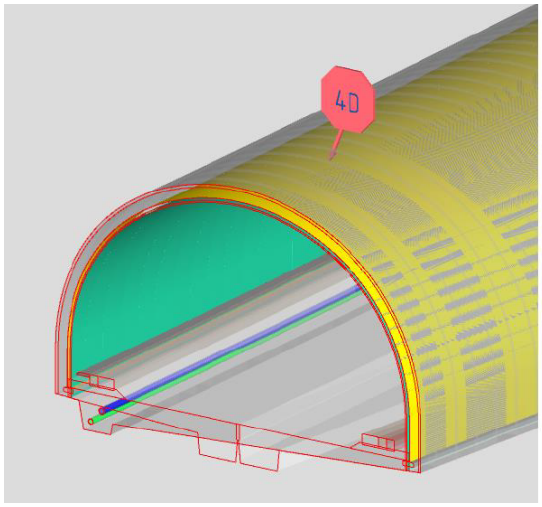
Models are customized for the task of execution:

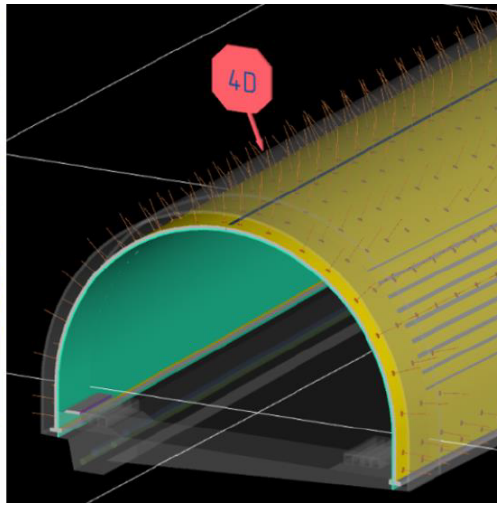
- Georeferenced discipline models (Euref 89 NTM)
- Information: Contact, WBS, Process codes, quantities and more grouped into Property Sets
- General arrangement model
- Detail section model
- Customized Coordination model per Contract with search sets and saved views

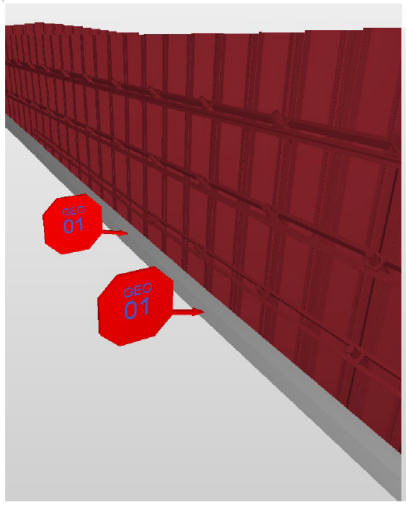
Identification | Location | Quantities | Material | Relations | Classification

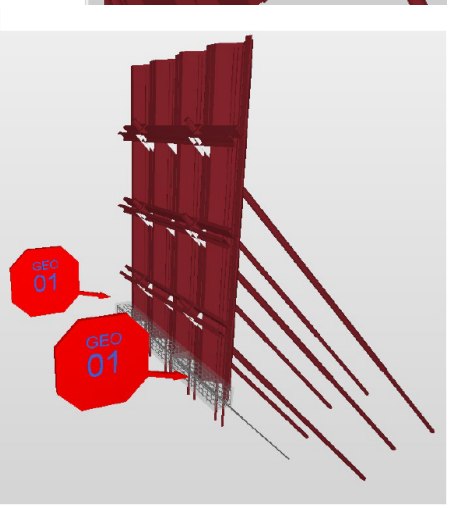
Hyperlinks | BaseQuantities | FOB_Info | FOB_Merke | PGF_GEO_Info | PGF_Info

Property	Value
FOB_Eksistensstatus	Ny
FOB_Entreprise	K4
FOB_Fase	--
FOB_ID	--
FOB_Link	--
FOB_Mengde 1 (m2)	8.30 m2
FOB_Mengde 2 (m2)	7.60 m2
FOB_Mengde 3 (m)	*0 mm*
FOB_Mengde 4 (m)	11.85 m
FOB_Mengdelistepost 1	*83.61312 Levering av stålspunt (m2)*
FOB_Mengdelistepost 2	*83.6134 Ramming av stålspunt (m2)*
FOB_Mengdelistepost 3	*83.6151 Sveising av stålspunt (m)*
FOB_Mengdelistepost 4	*83.6132 Påsveising av rør på stålspunt (m)*
FOB_Merknad	--
FOB_Revisjonsdato	--
FOB_Status	S4





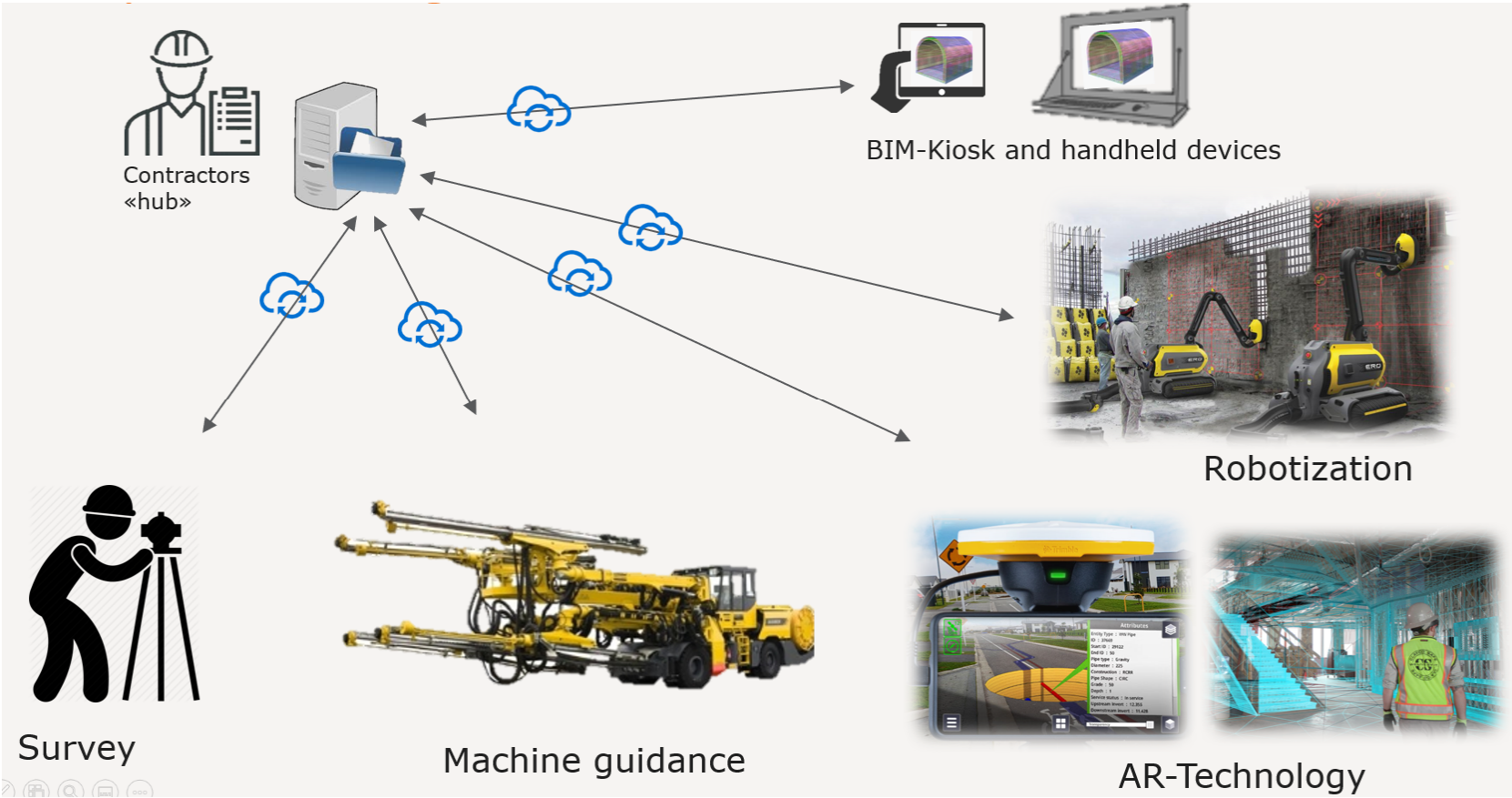




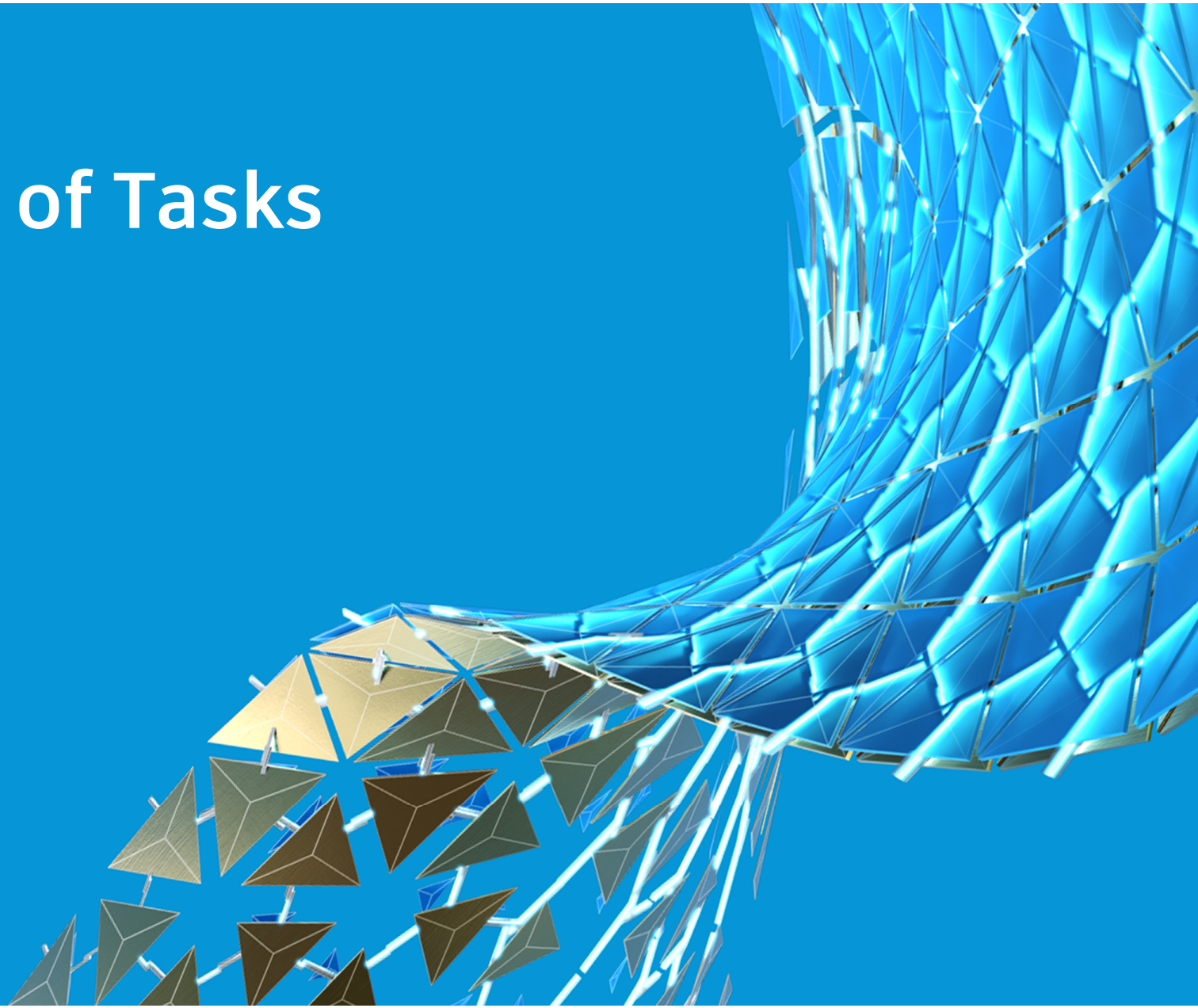
Possible Use of “New” Technology

It is very much up to the contractor to make the most out of the model-based approach in execution:

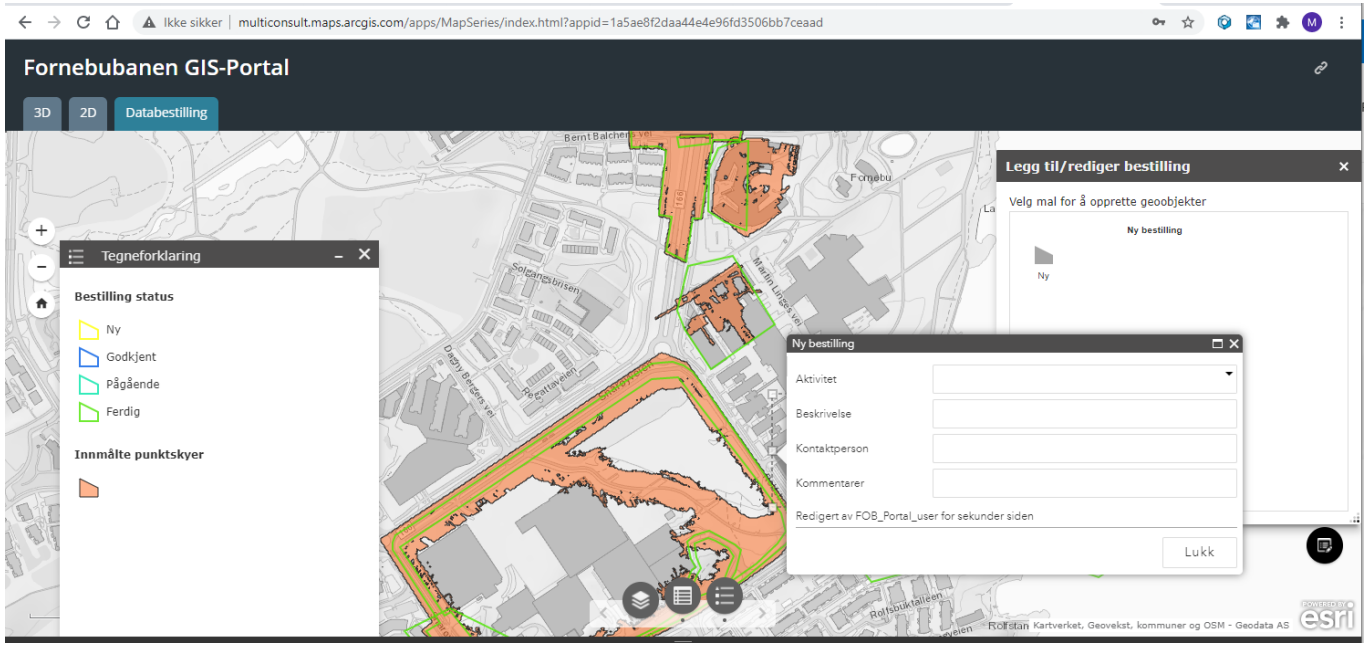
- Machine guiding (GPS) for excavation, piling and drilling
- AR and/or VR for the craftsmen at site
- Other use of handheld devices



Automation of Tasks



GIS Web Portal for order Basis Data – Reality Capture



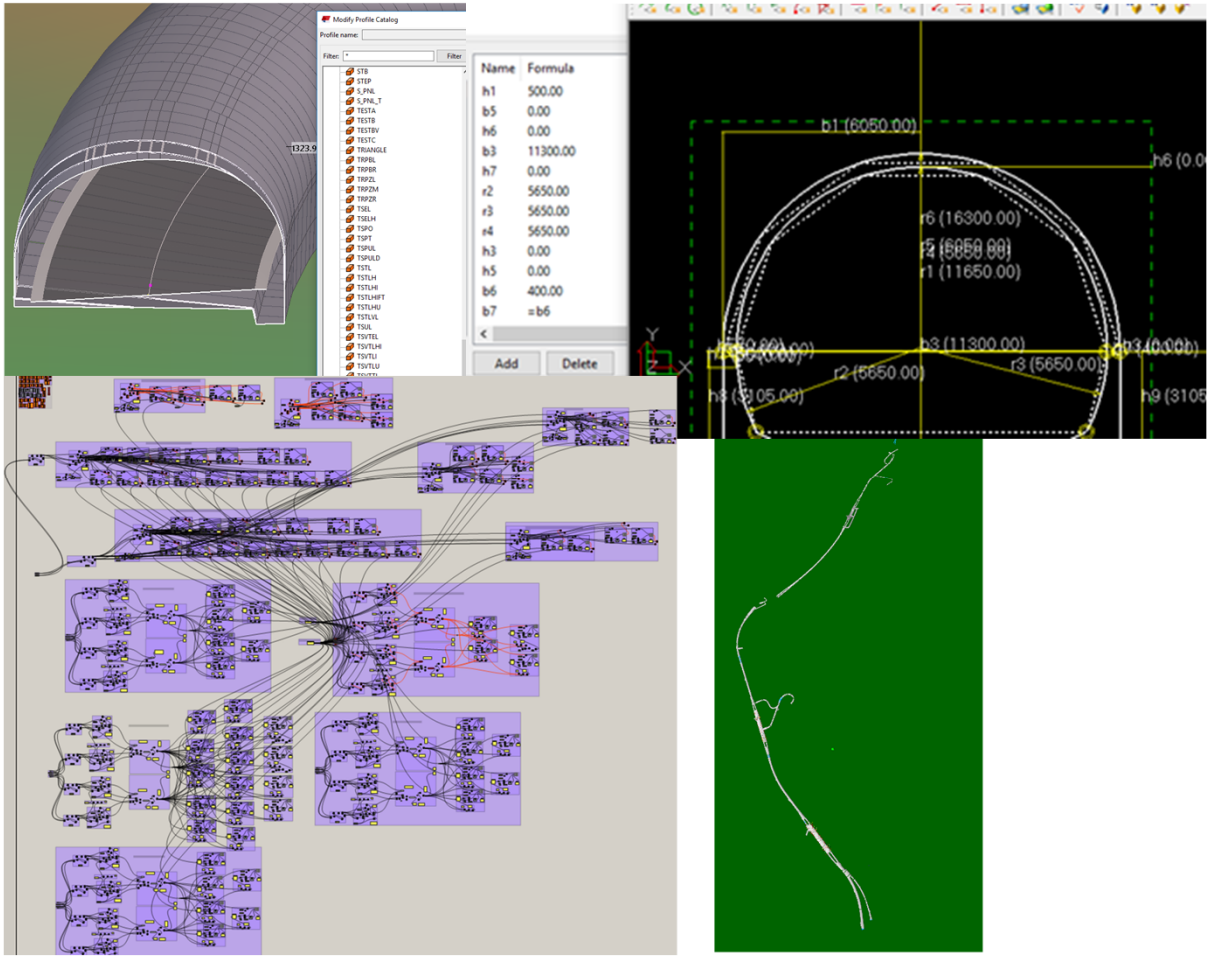
- **Web based system to keep track of:**
  - All data captures that have been collected
  - Easy to create a new order for reality capture
    - Draw a polygon
    - Enter what kind of data needed

Grasshopper and Tekla for Tunnel Structure

With the help of Grasshopper and parameter controlled cross sections in Tekla, tunnel structure is generated with the input of

- Rail centerlines (north bound and south bound)
- Geological information (Excel)

This saves around 60% of time used and creates a more accurate design.

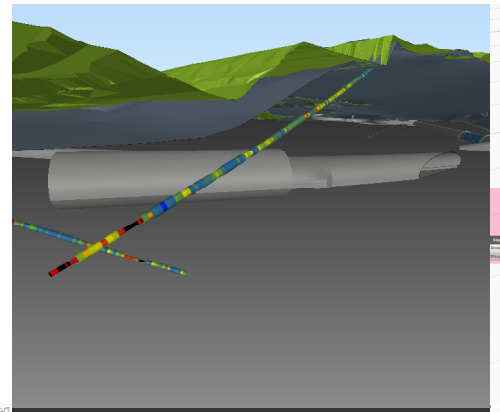


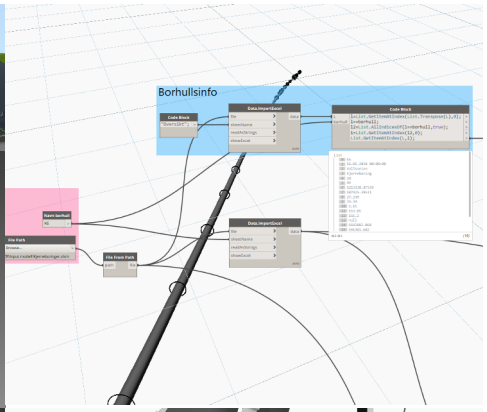
Dynamo and Civil 3D - Geology

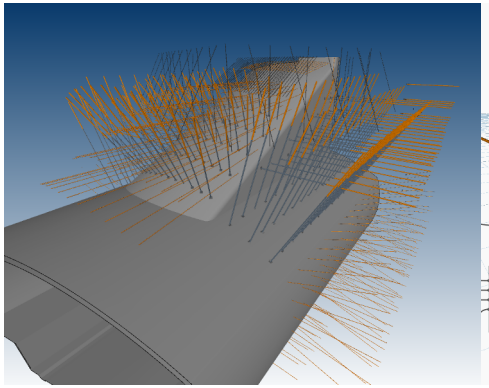
Dynamo and Civil 3D are used for different modeling tasks in the geology discipline:

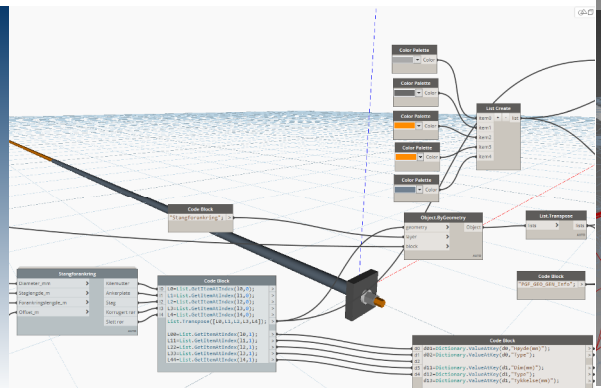
- Visualisation of drilling samples
- Modelling weakness zones in rock
- Modelling rock anchoring

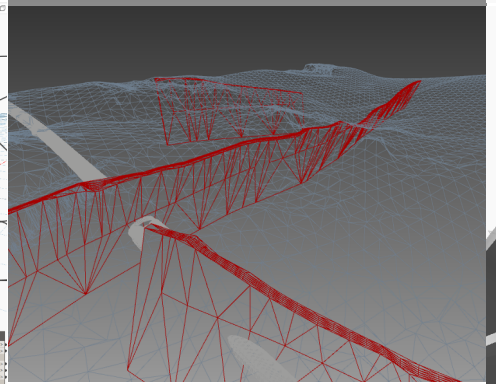
Being able to visualise this information has a direct effect on project cost, when choosing rail center line and placing stations.

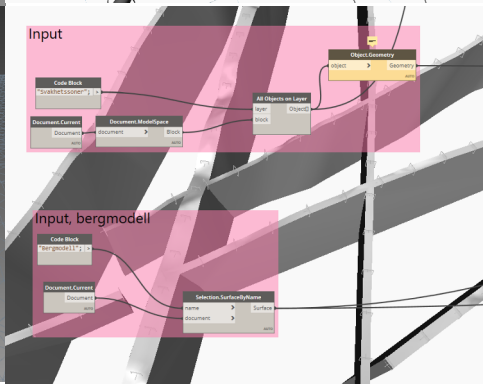






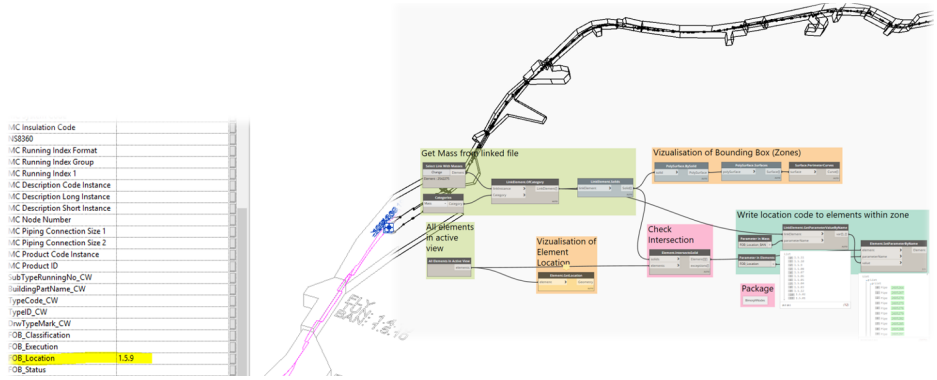




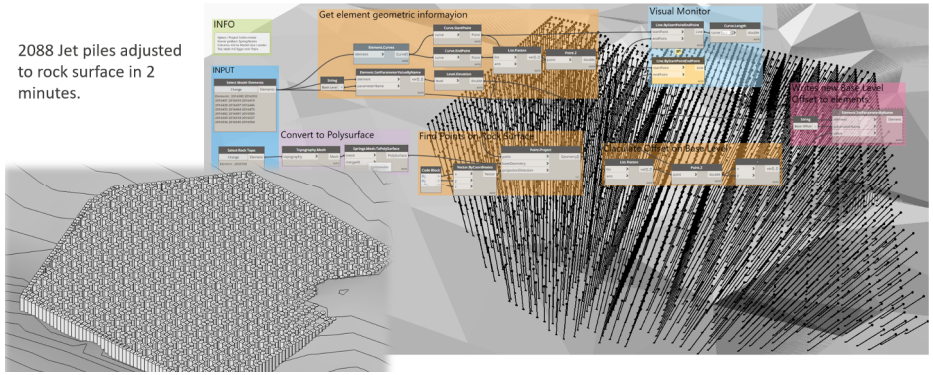


Dynamo and Revit

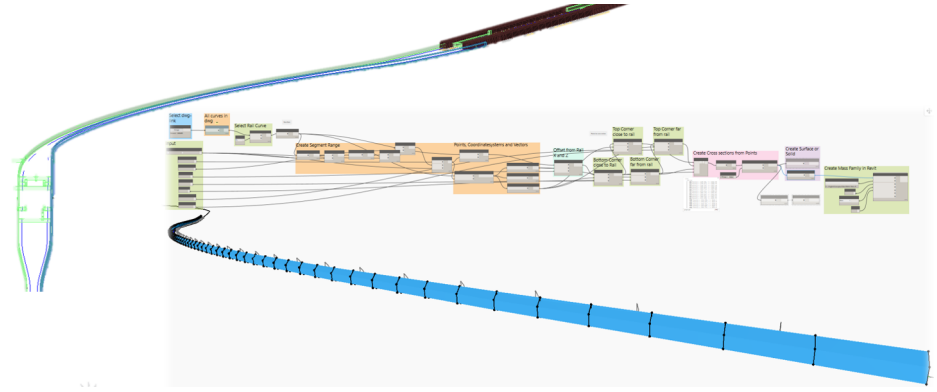
Over 30 Dynamo scripts in the project. Here are some..



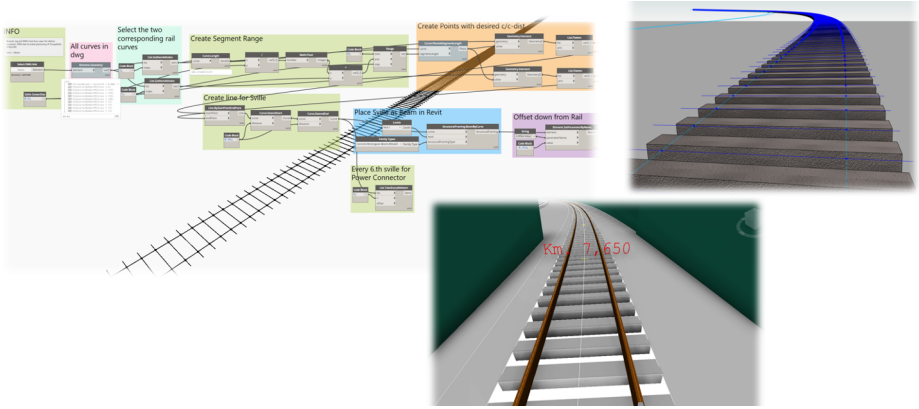
WBS-Coding of elements



Jetpiles extend to surface



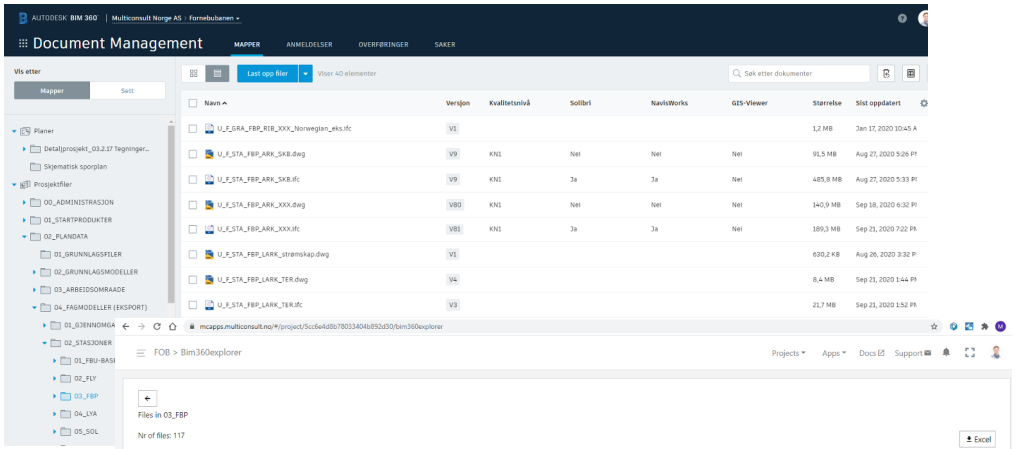
Model 3D escape zones along rail path



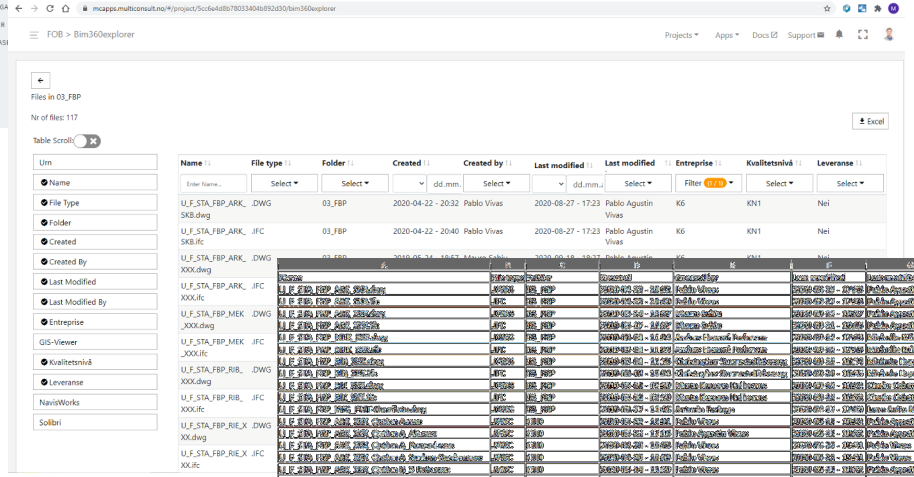
BIM'ification of rail sleepers

Automatic Model File List with Attributes

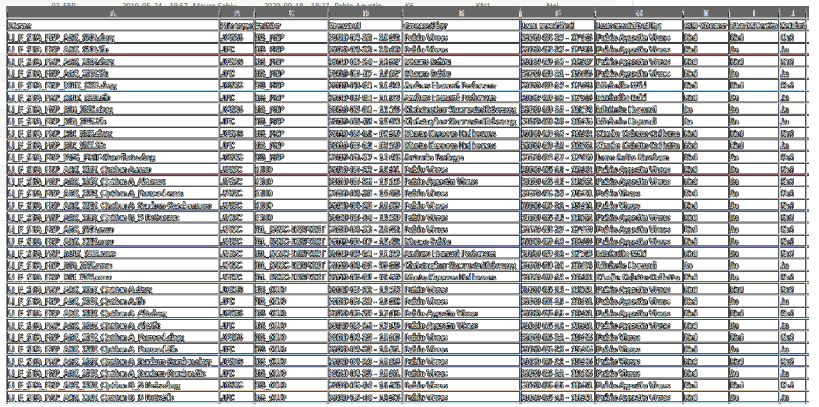
BIM 360 Docs with default and custom attributes



A web app based on Autodesk Forge that filters, sorts and exports



The exported model list as Excel



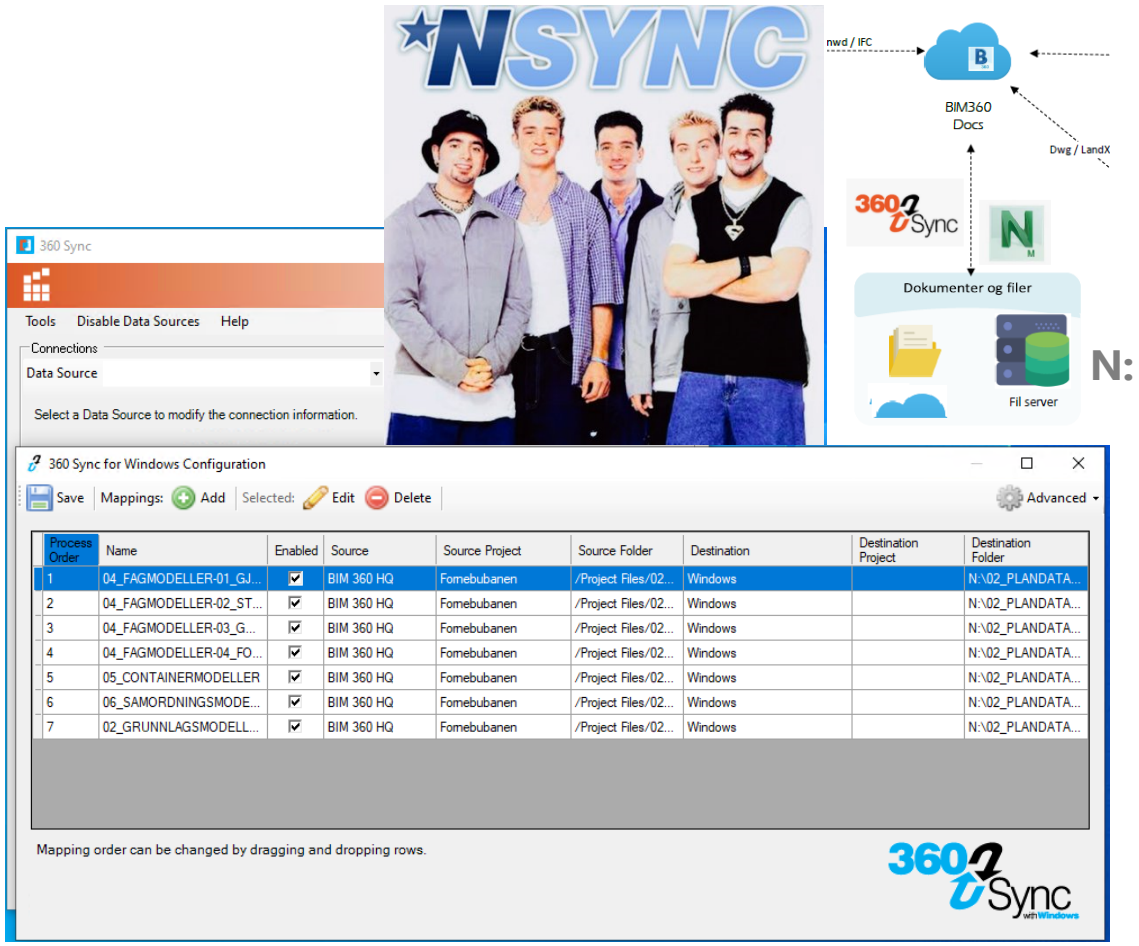
The ‘NSync

Not all software can use BIM 360 Docs or Design as an integrated workflow.

For example:

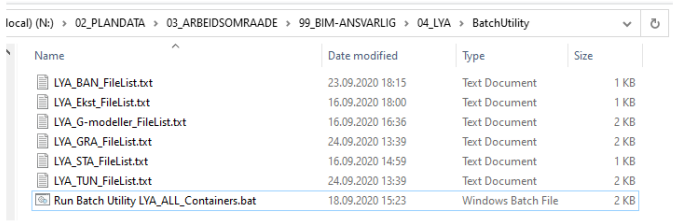
- Navisworks
- Tekla
- Solibri
- Novapoint
- Discipline specific software

Therefore we synchronize files from BIM 360 to the PGF-file server. The file server is mapped to the directory N: -> ‘NSync



Navisworks Batch Utility and Solibri Autorun

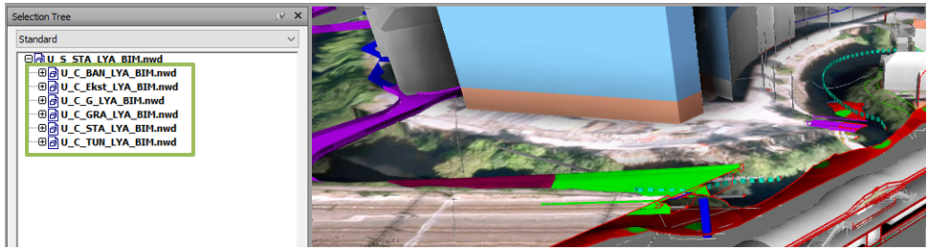
Navisworks Batch Utility combine discipline models (dwg, IFC and FBX) into Container models nwd-files, that are used in the Coordination models.



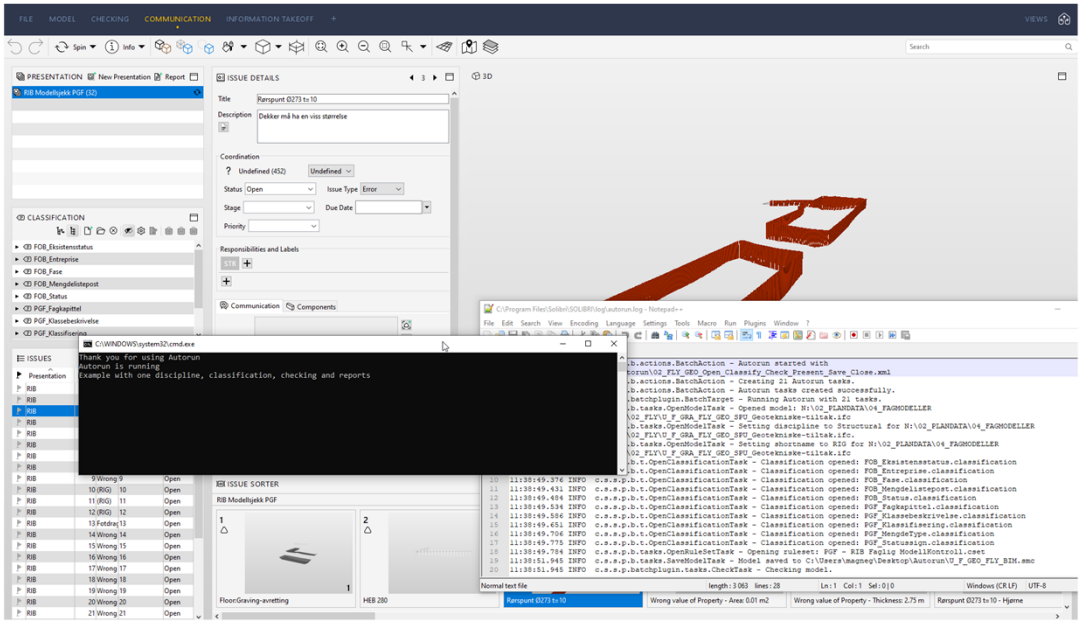

```
@ECHO off

ECHO NavisWorks Batch Utility is running.
ECHO The script is busy creating new nwd-containers for STA LYA
ECHO Please wait ..

ECHO Creating U_C_G_LYA_BIM.nwd
"C:\Program Files\Autodesk\Navisworks Manage 2020\FiletoolsTaskRunner.exe" /i
"N:\02_PLANDATA\03_ARBEIDSOMRAADE\99_BIM-ANSVARLIG\04_LYA\BatchUtility\LYA_G-modeller_FileList.txt" /of
"N:\02_PLANDATA\03_ARBEIDSOMRAADE\99_BIM-ANSVARLIG\04_LYA\Container\U_C_G_LYA_BIM.nwd" /version 2019
```



Solibri Autorun can load/update IFC-files, load Classifications, Rulesets, Run checker, create Presentation and save the coordination model.

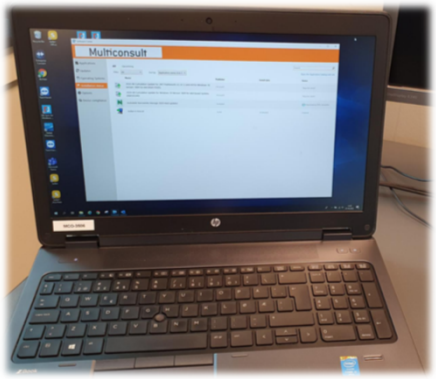


Task Scheduler

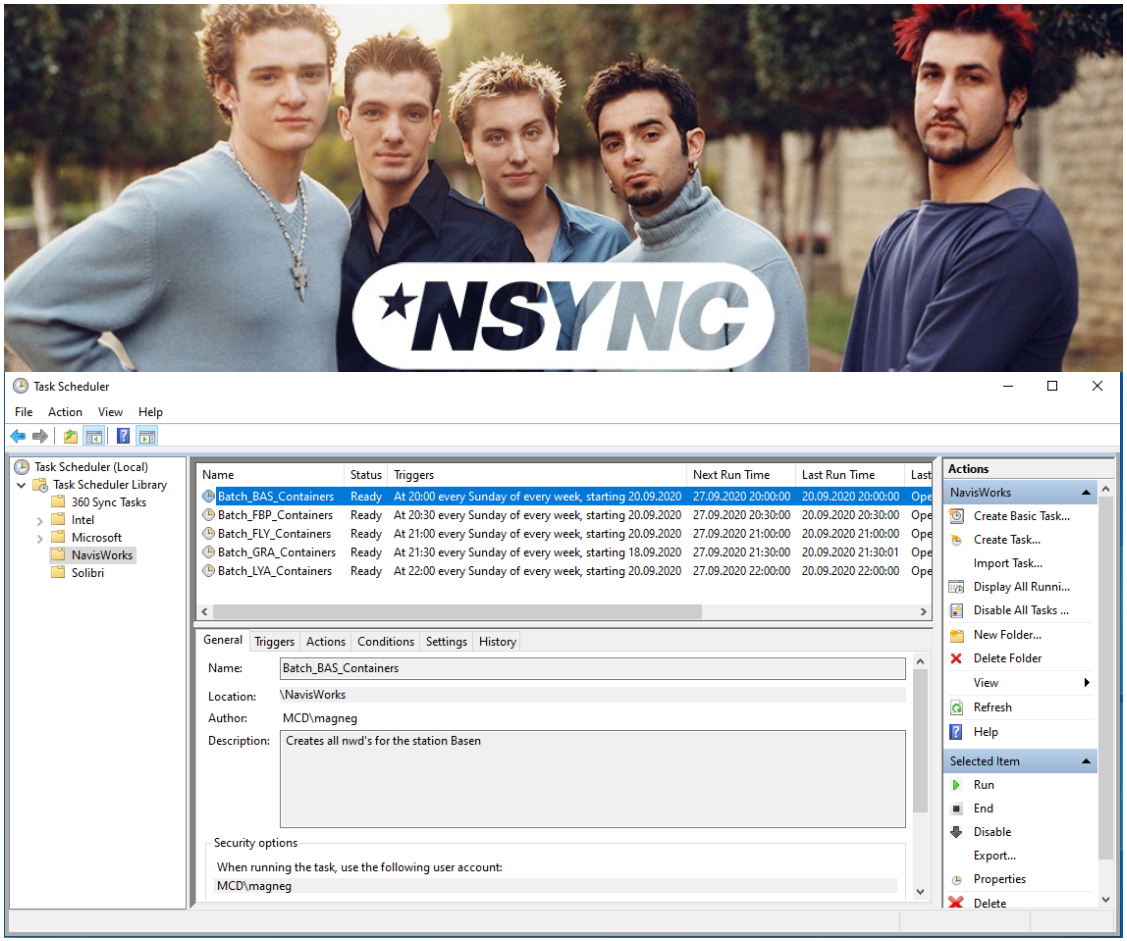
With a little help from our friend ‘Nsync and Windows Task Scheduler both the 360 Sync, Navisworks Batch Utility and Solibri Autorun is executed outside office hours.

Synchronize files every night.

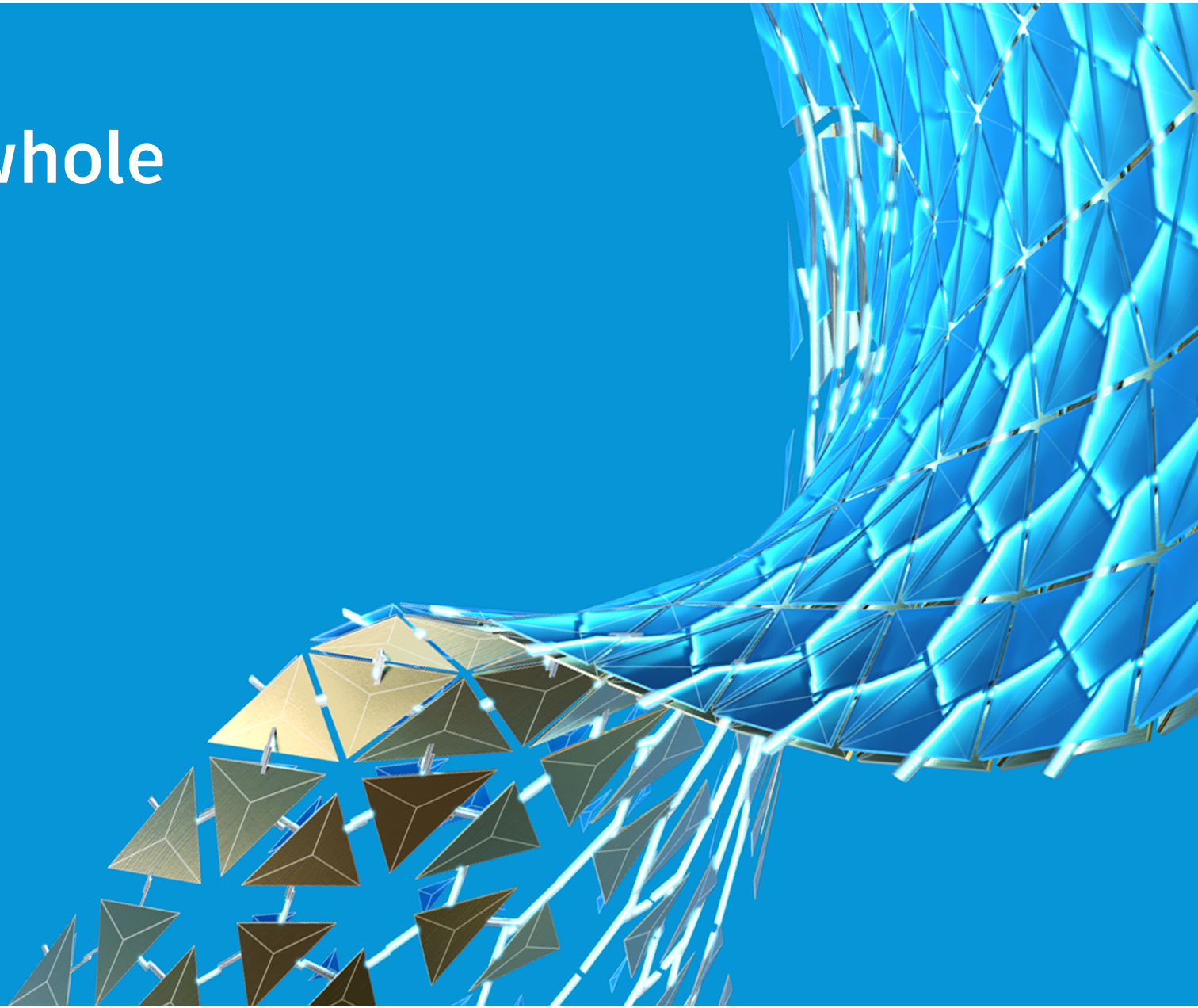
New Containers and Solibri models every Monday.



<- The real N’sync



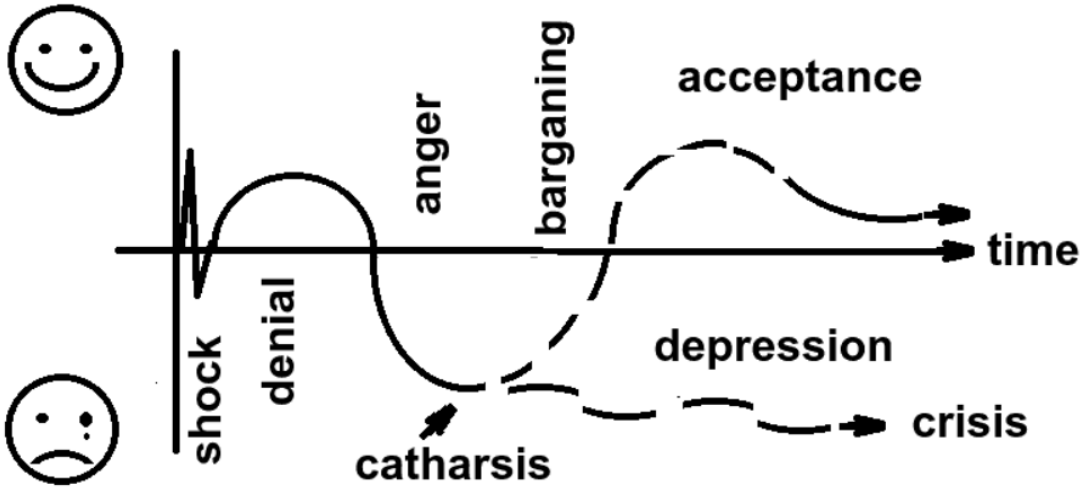
Involve the whole organization



How to get to: «That's the way we do things here»

- **Change management**
- **Communication**

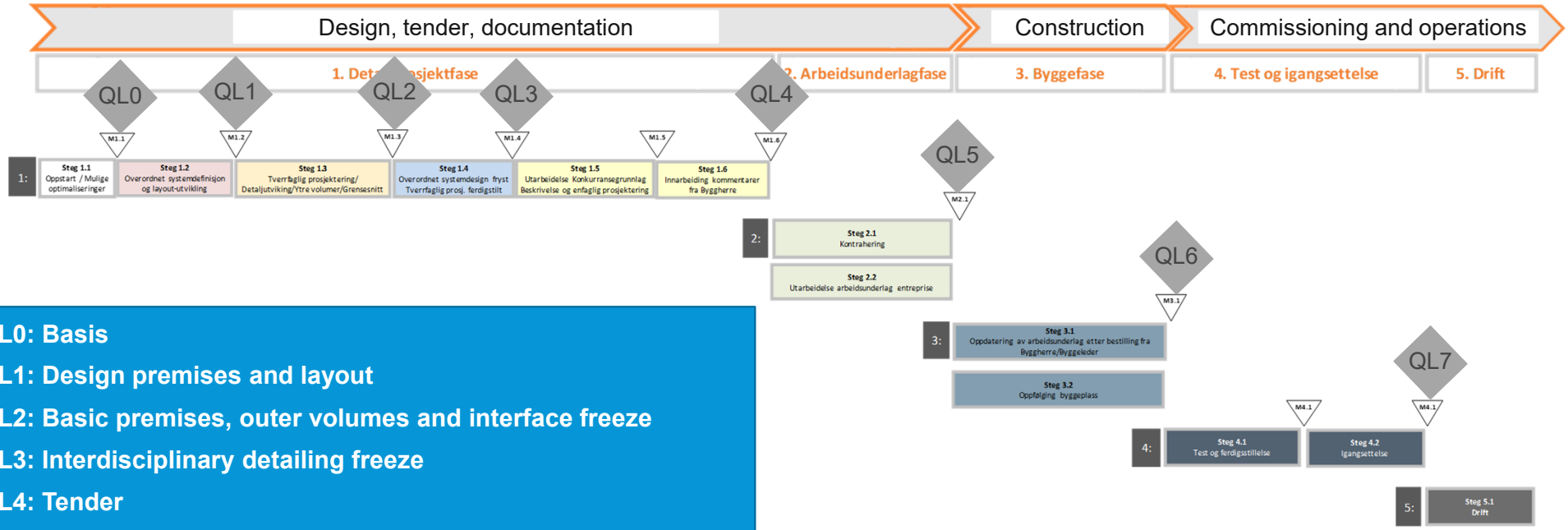
Non-stop work in progress



How people react when introdusing new methodology and software?

Kübler-Ross model / Five stages of grief

Project Execution Model (PEM)



QL0: Basis

QL1: Design premises and layout

QL2: Basic premises, outer volumes and interface freeze

QL3: Interdisciplinary detailing freeze

QL4: Tender

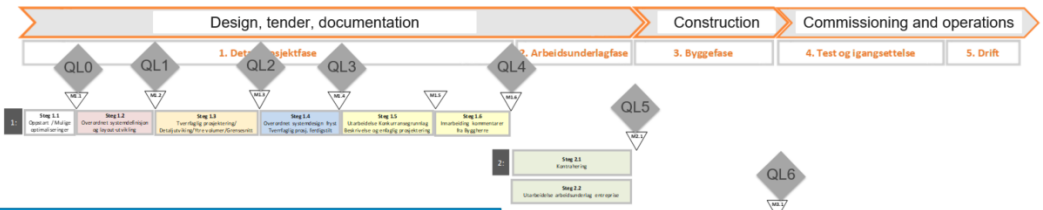
QL5: Work documentation ready

QL6: As built

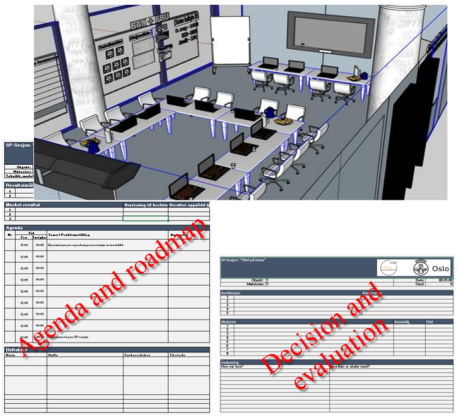
QL7: Ready for operation

Planning and execution

Project Execution Model

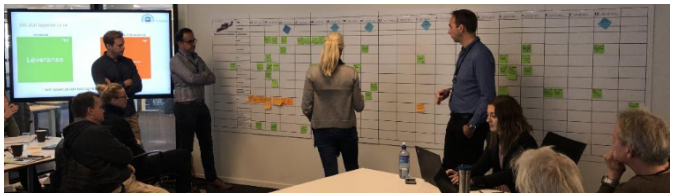


QL0: Basis
QL1: Design premises and layout
QL2: Basic premises, outer volumes and interface freeze
QL3: Interdisciplinary detailing freeze
QL4: Tender
QL5: Work documentation ready
QL6: As built
QL7: Ready for operation



ICE-sessions

- Strict agenda
- Correct resources
- Preparations required

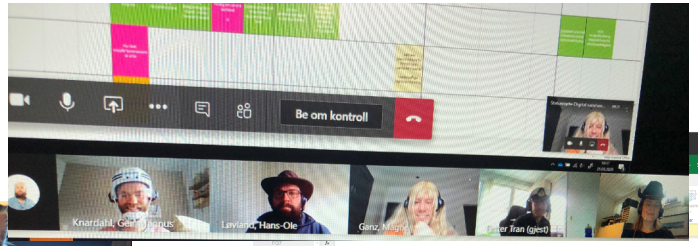


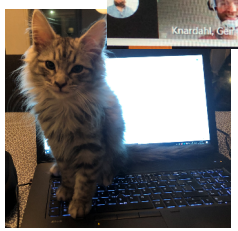
Last Planner System (LPS)

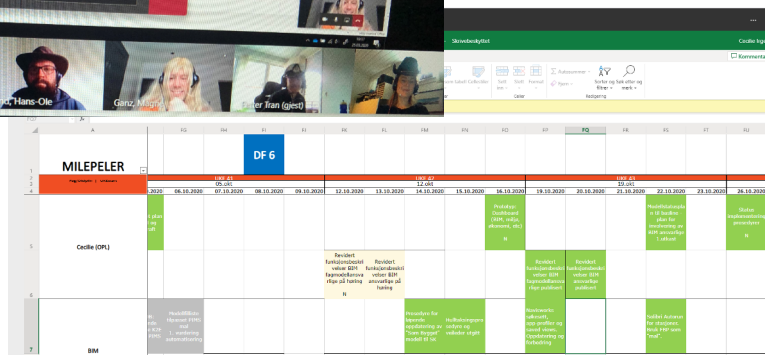
- Used for detailed scheduling
- Temporary digital solution in excel on BIM360

Preferred practice

Covid-19 style

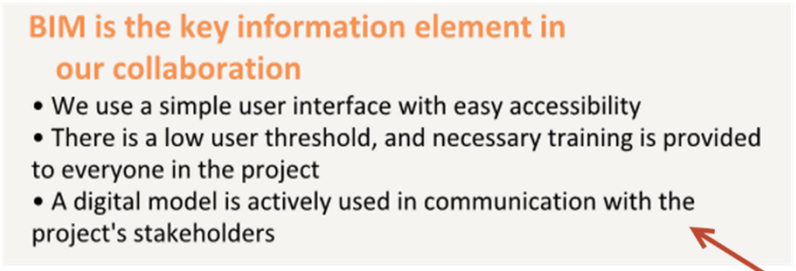


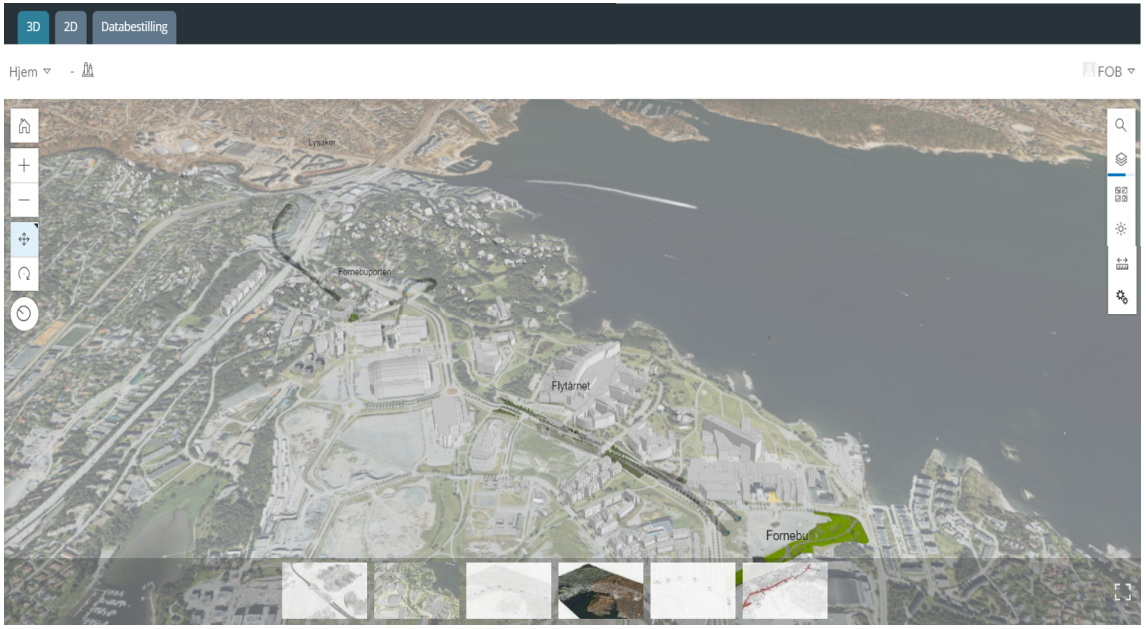




Viewers for everyone

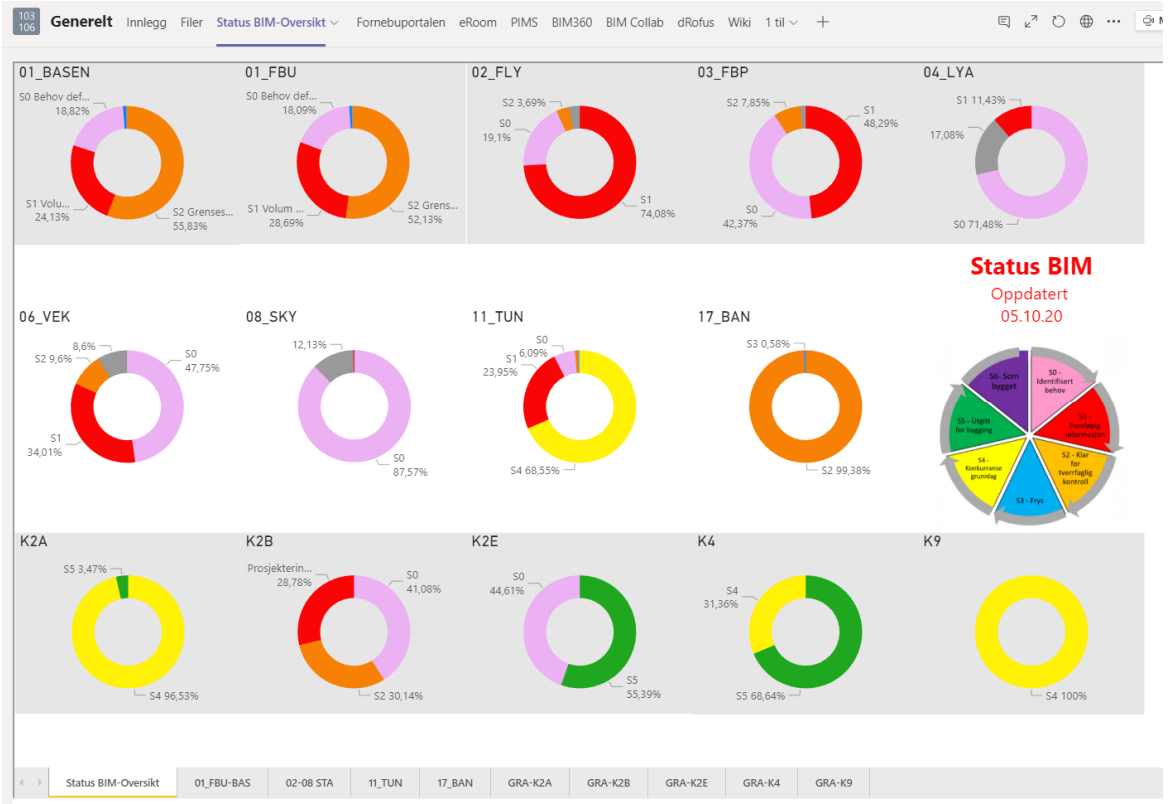
- **Navisworks**
- **Web GIS**



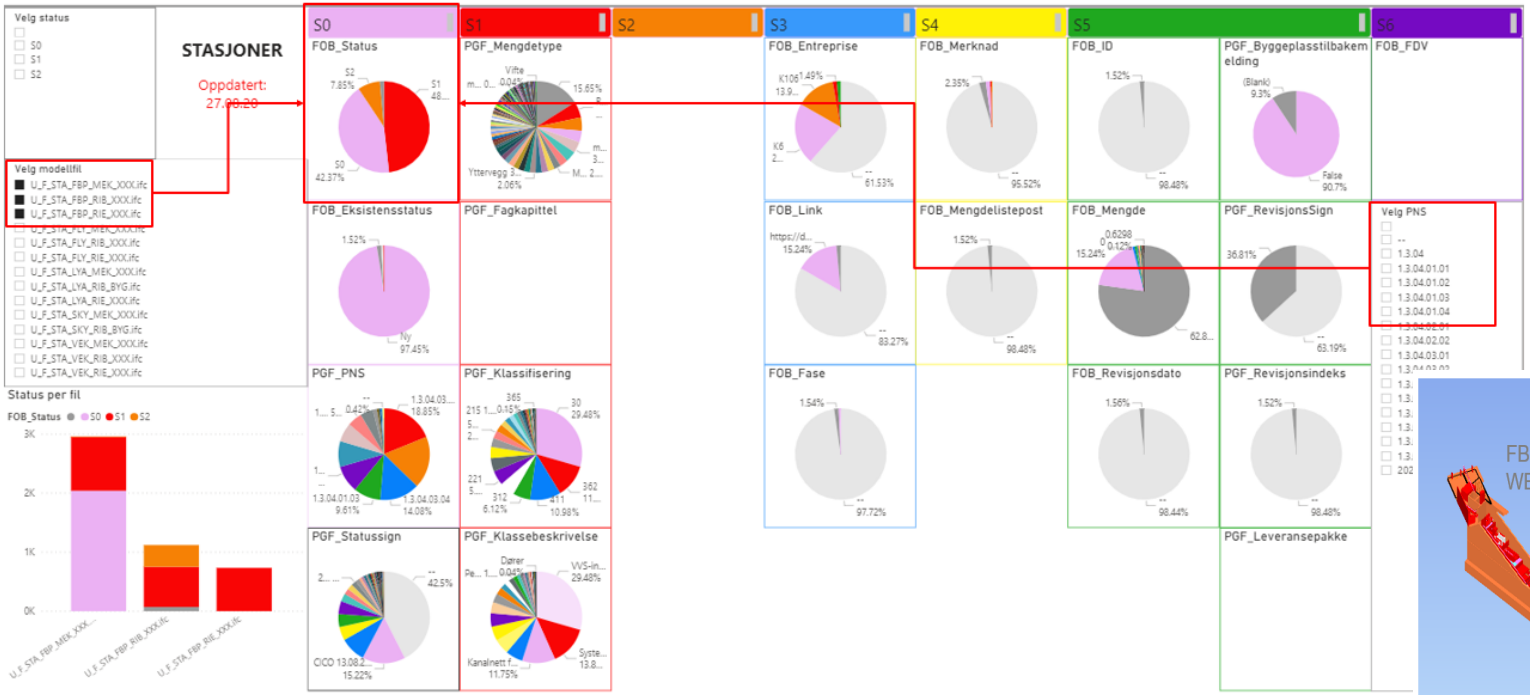


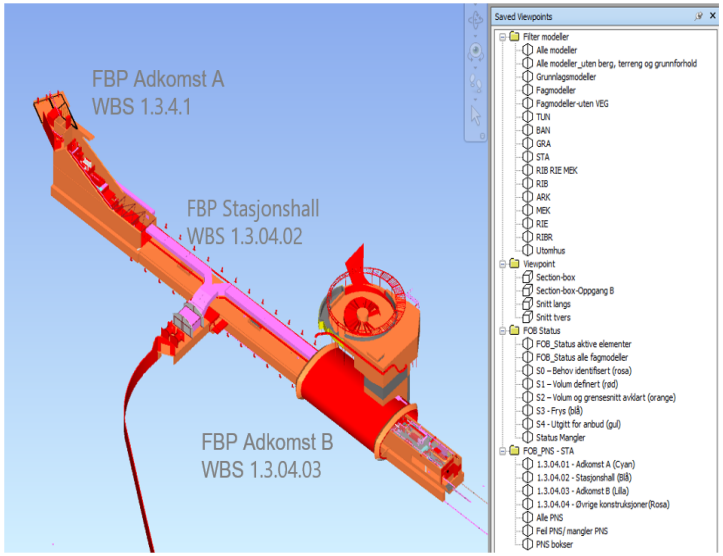
Progress

Overview - Progress at a glance
Reported status in all coordination models

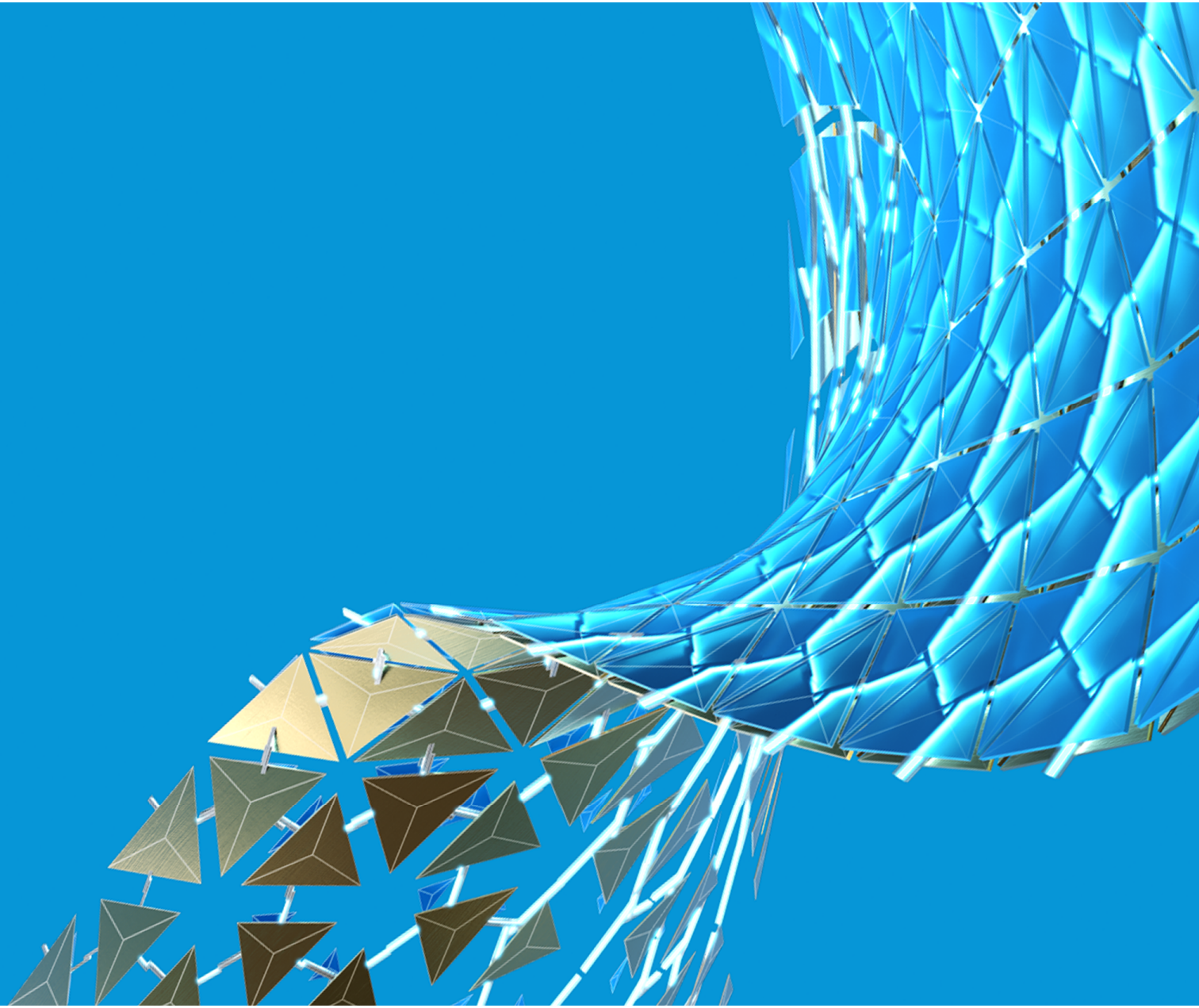


Compare and control





The future



The future

- **BIM for requirements (Fire, acoustics, safety, environment)**
- **Welcome entrepreneurs – Feedback time: fruitful collaboration or learning by doing?**
- **Gamification (includes VR)**
  - Evacuation in emergency sitation
  - Testrun of track
  - Universal design
- **Facility Management (using BIM-data in operations)**
- **Digital twin**

Thank you!


AUTODESK