

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



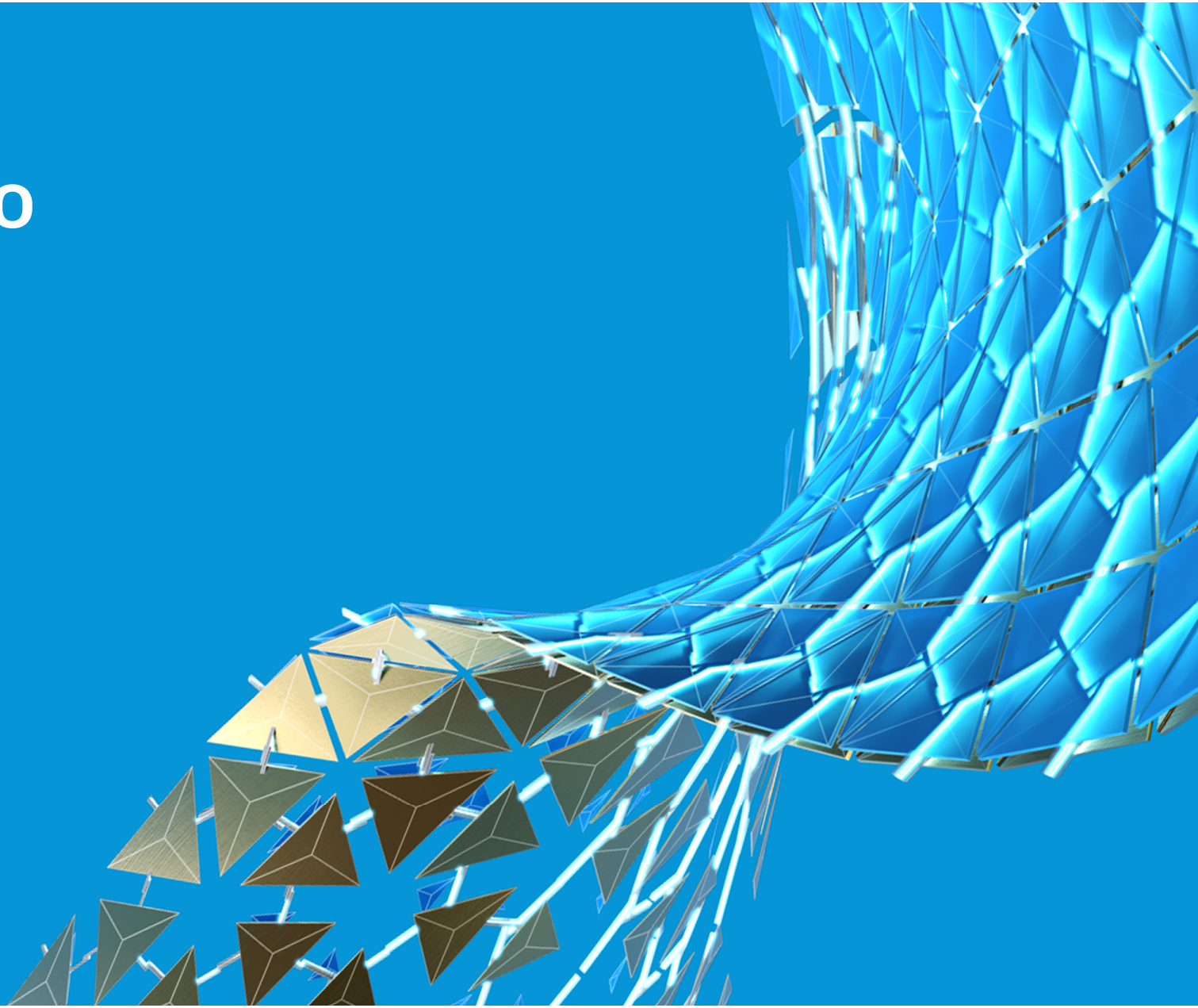
About The Speaker

Magne Ganz | BIM-Specialist

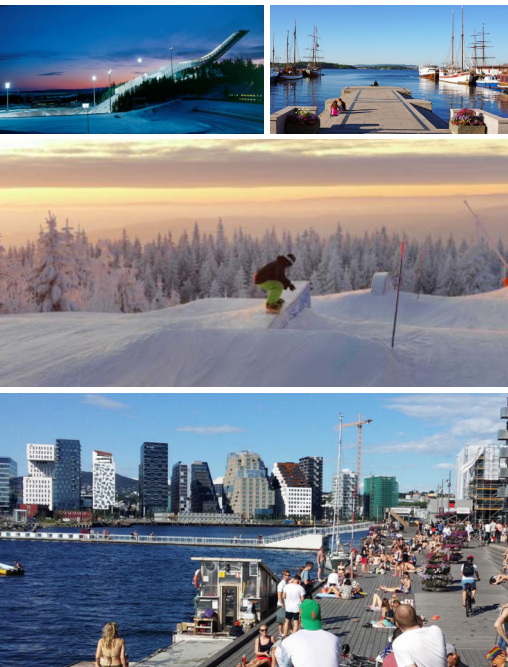
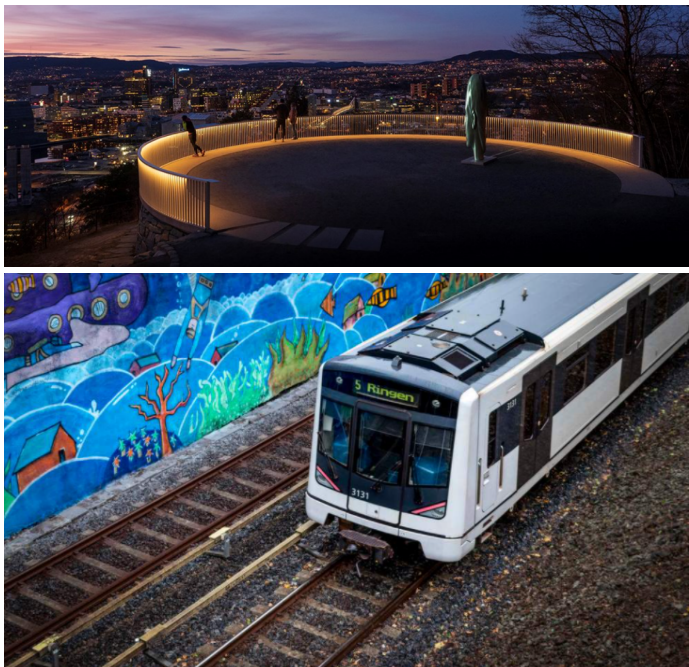
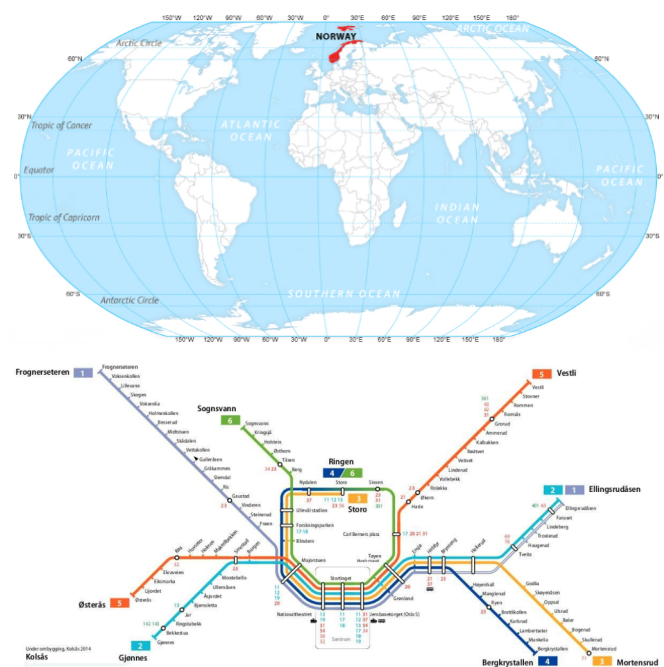
Magne has a Masters degree in Structural Engineering from 2002 and has since 2006 had a strong focus on BIM and connected technologies. Revit, Dynamo, data flow and task automation is the passion. Being in the industry for 18 years and working only with VDC and BIM the last 9 years, gives Magne the perfect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

Multiconsult

Project Intro



Welcome to Oslo, Norway



Fornebubanen - Project Intro

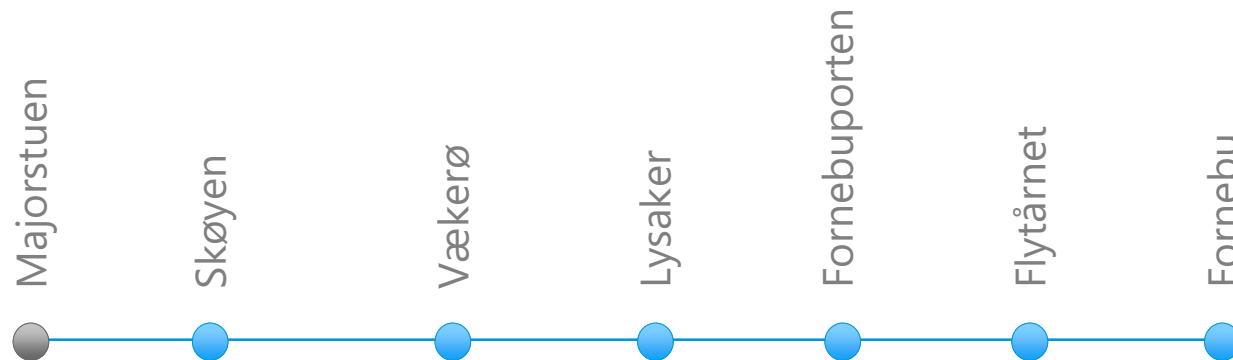
- New metro line
- From city center to outer suburb in 12 minutes
- 8 departures per hour
- 8000 passengers per hour vs 3000 today (bus)
- Largest metro project in Oslo in 20 years
- Project owner: Oslo municipality agency Fornebubanen



[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)**

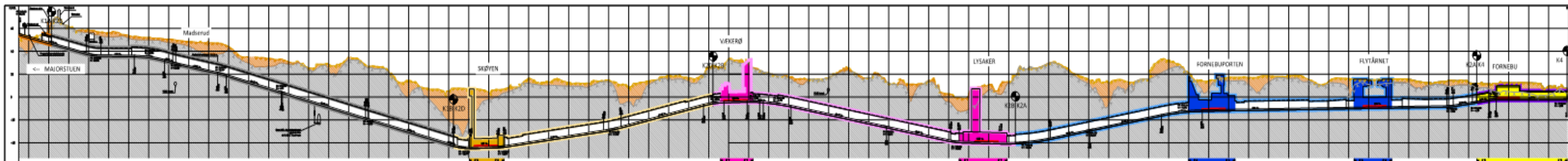
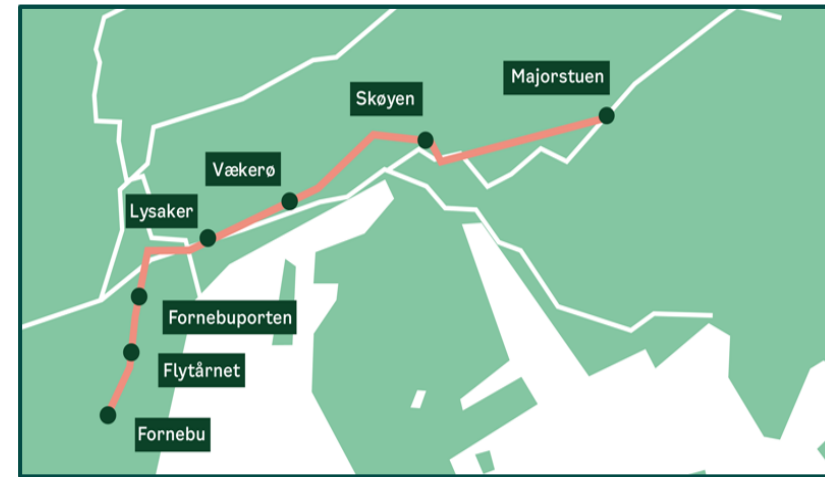
Construction period:
2020-2027

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



The Tunnel

The path is not straight in any direction.



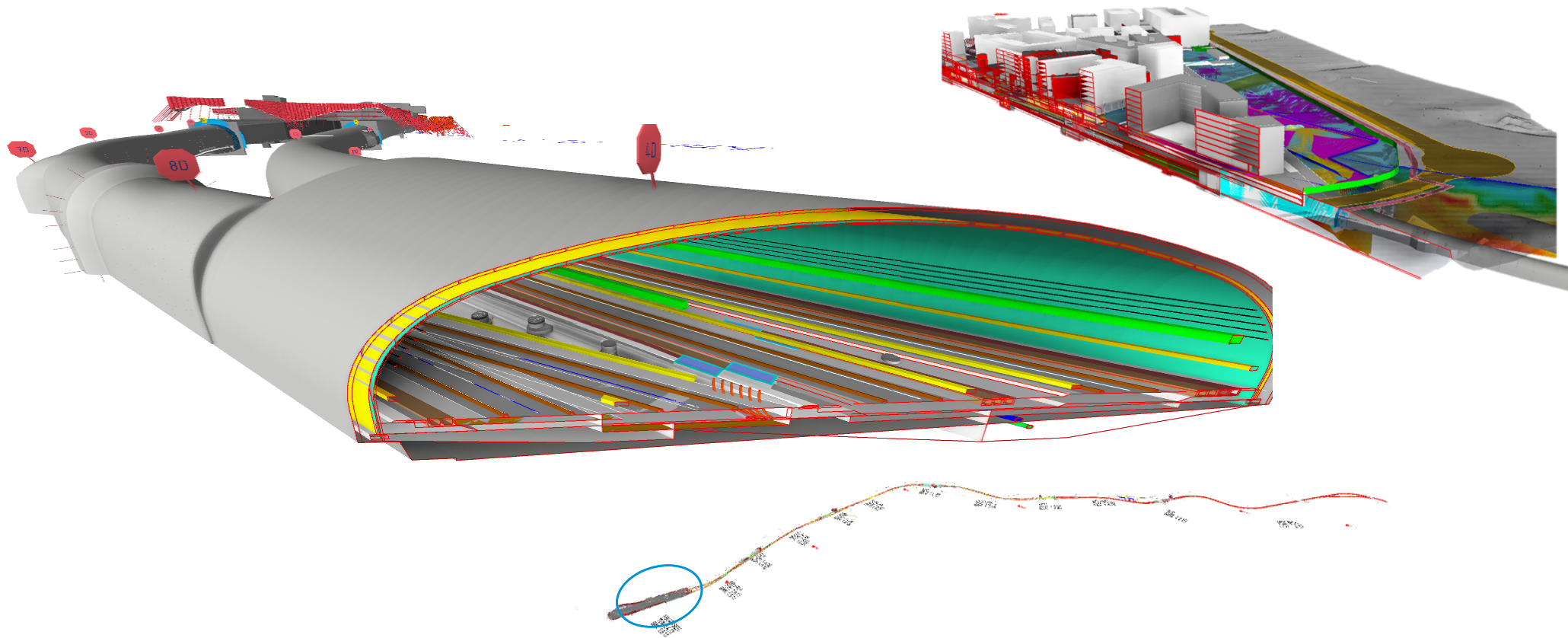
6 Stations + Operational and Maintenance Base

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

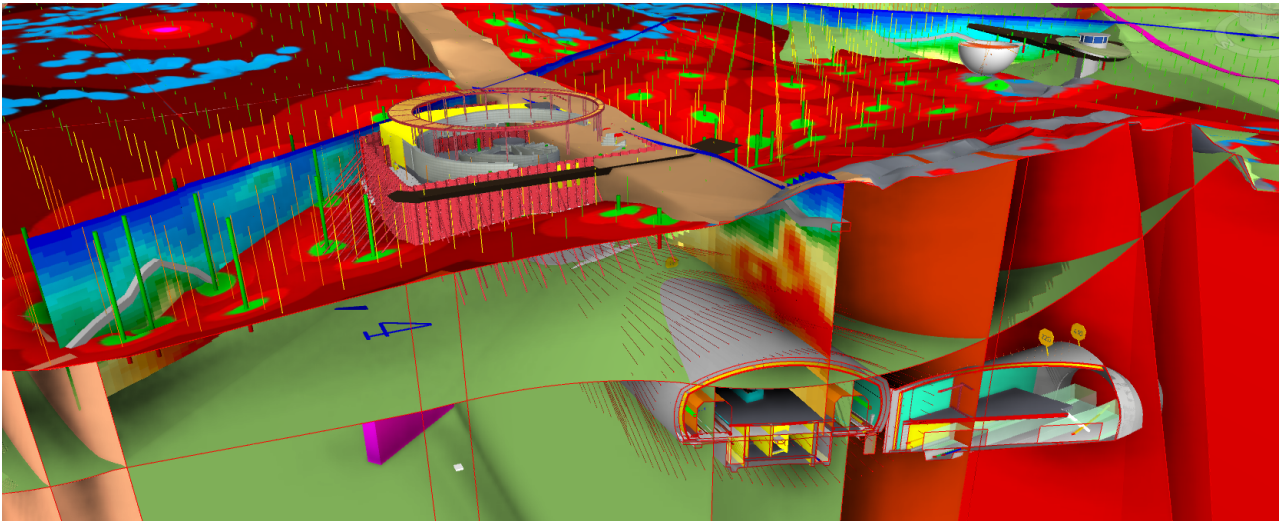
- **29 companies**
- **540 members**

Files

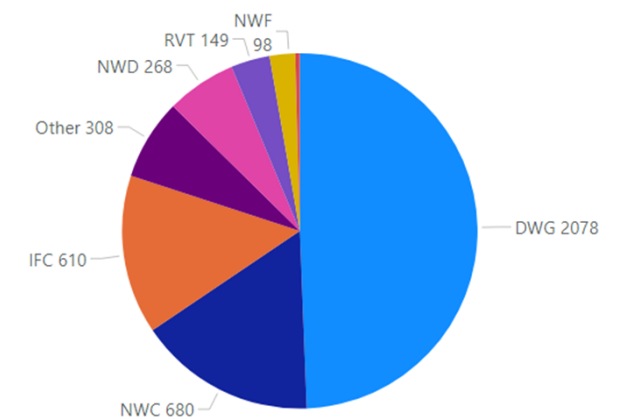
4208

Discipline models

2075



File types - number of

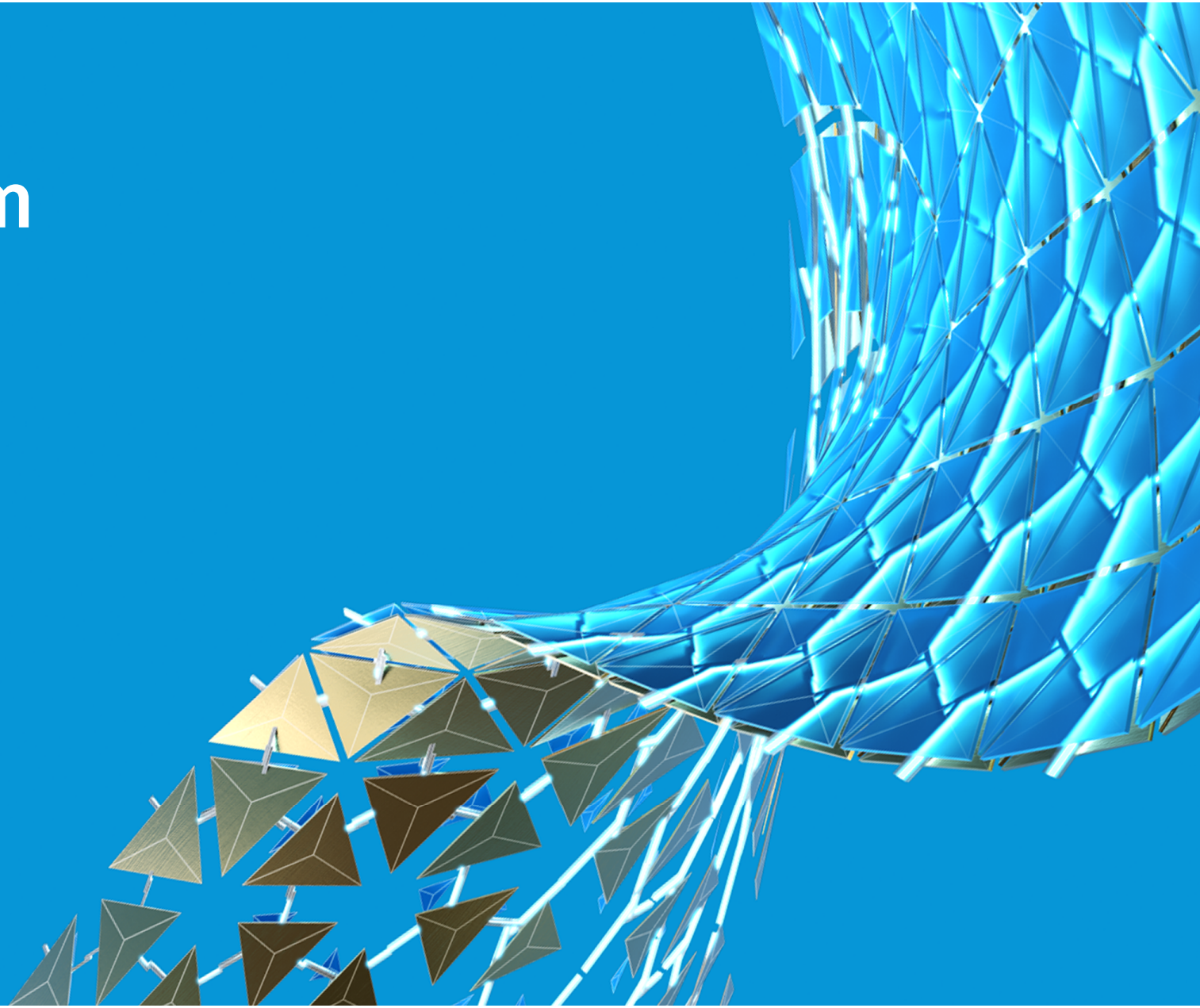


The Reason We Are Here Today

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**.

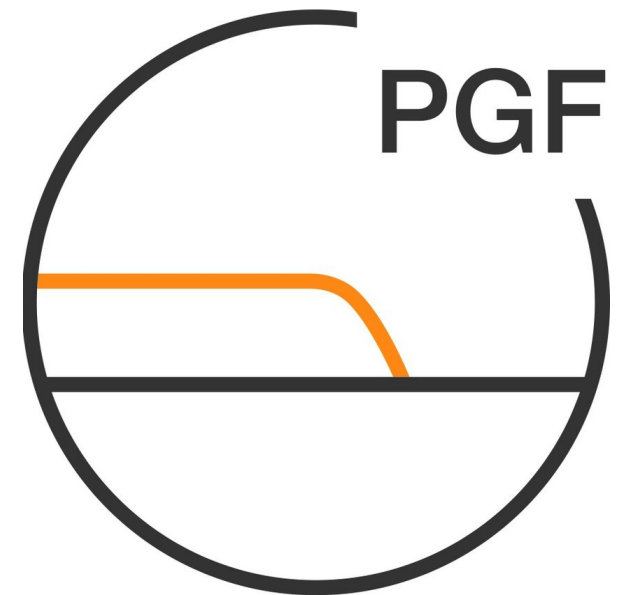


Design Team



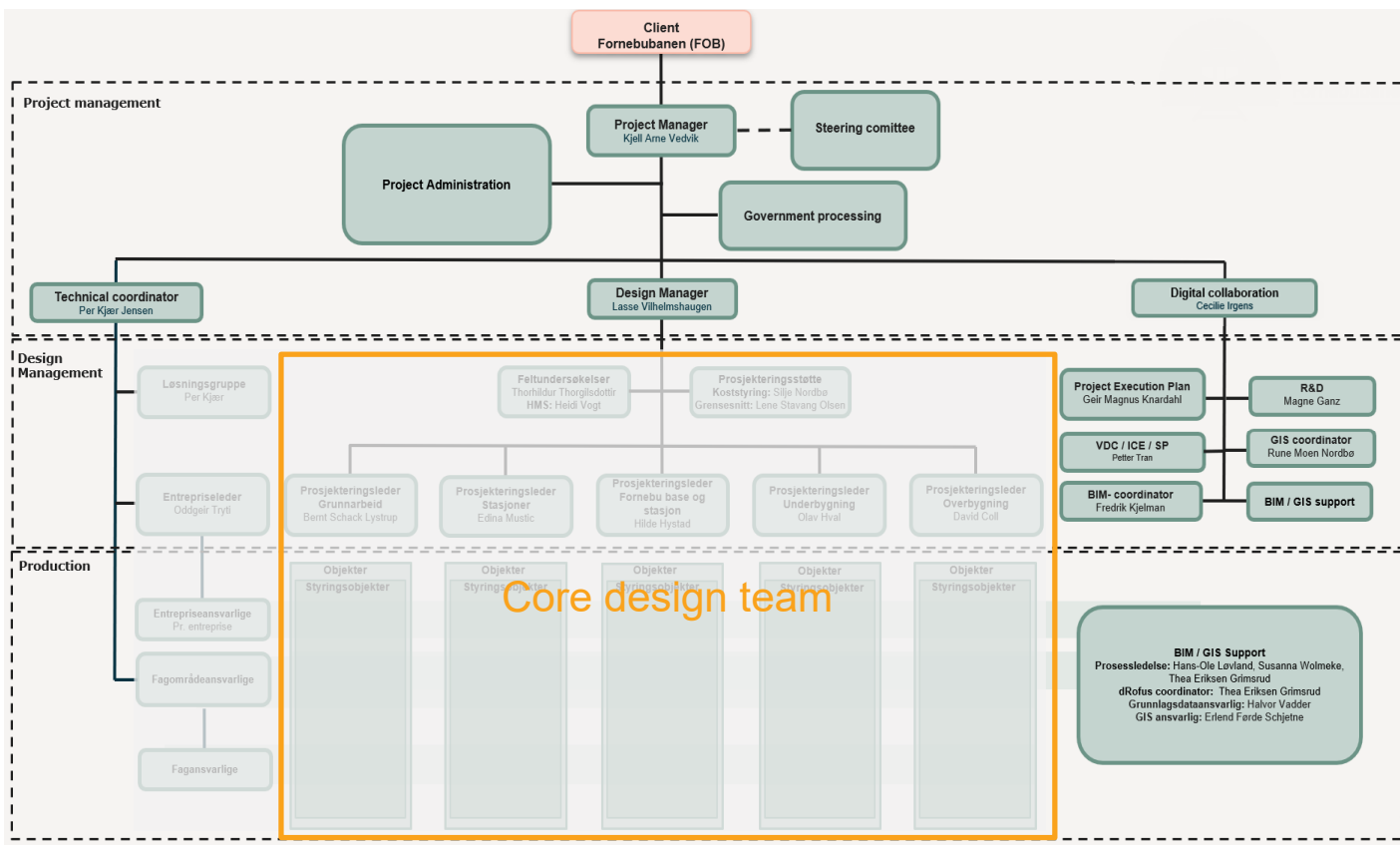
Design Team

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

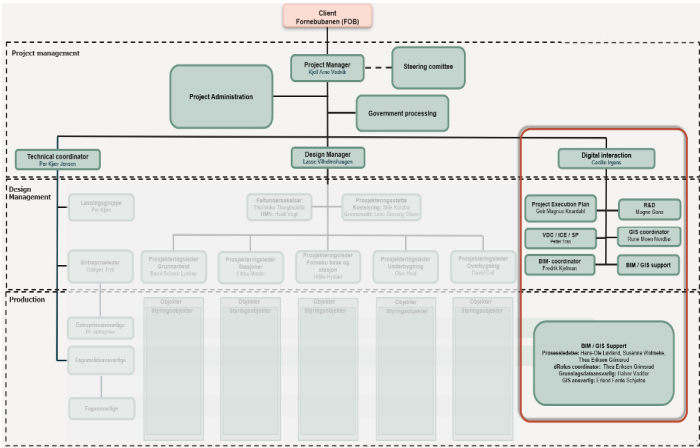


Organization and Why

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



Digital collaboration team



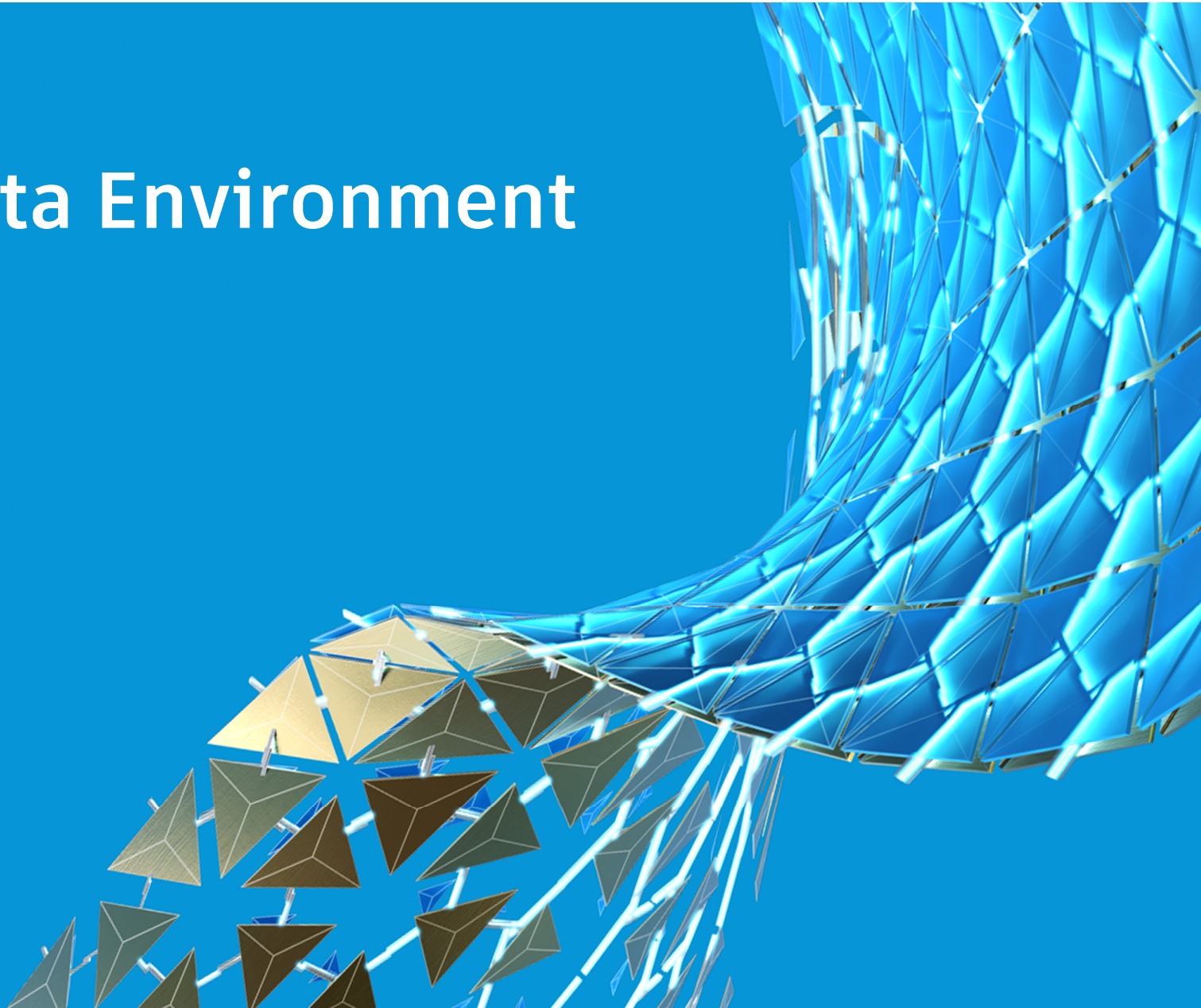
The function of the digital collaboration team is to standardize work tasks and processes, automate time thieves and implement processes and technology

The work of the digital collaboration team involves

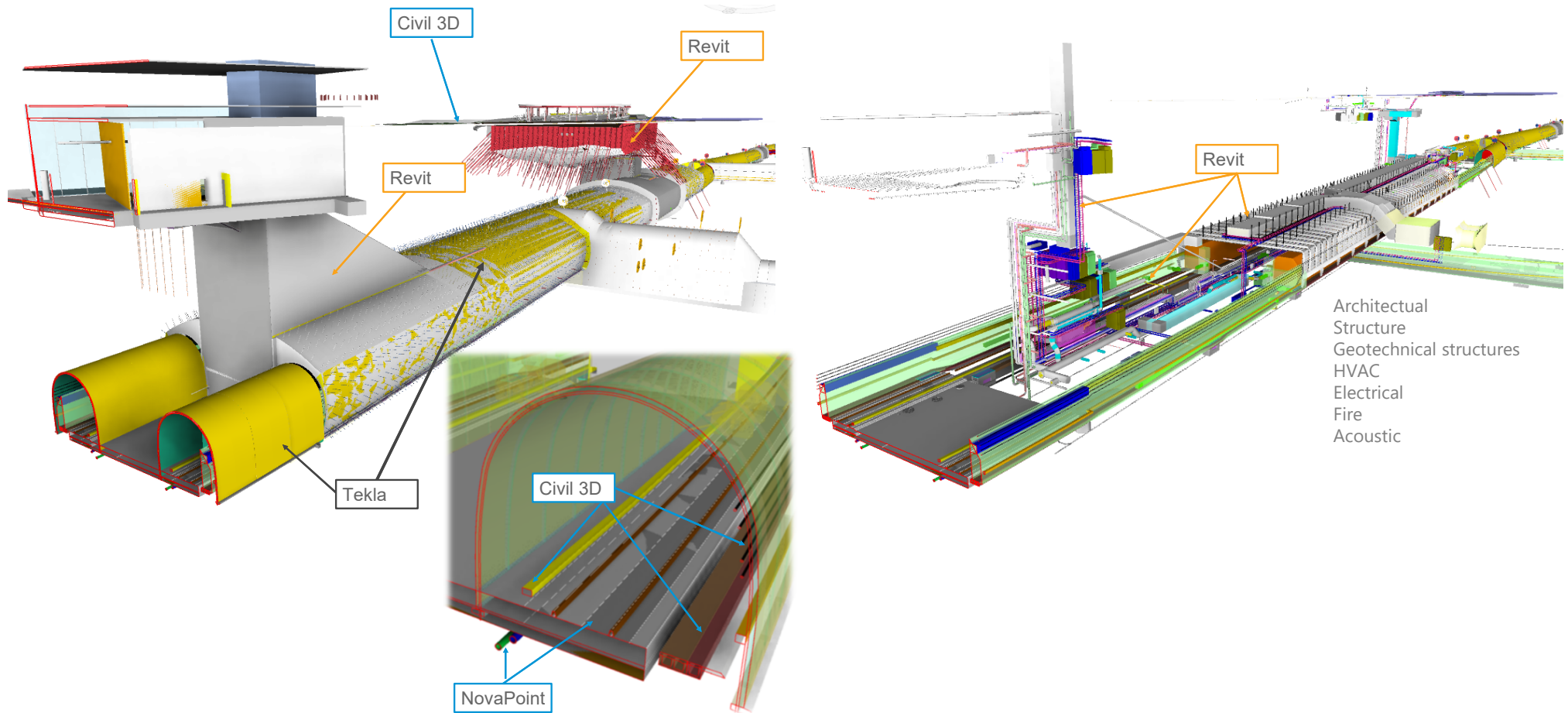
- **Develop and maintain**
 - Project Execution Plan
 - BIM Framework
 - Script, addins and apps
- **Support work and processes involving**
 - BIM
 - GIS
 - Basemaps
 - ICE
 - Cloud solutions / databases
- **Identify and lead digital innovation opportunities**
- **For all of the above, communicate and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

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

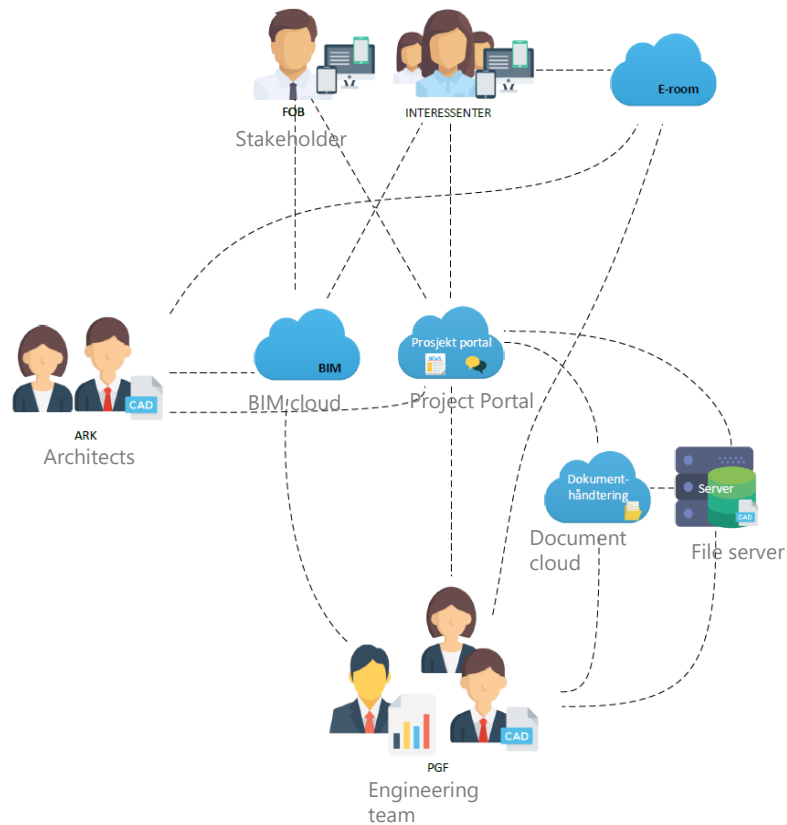
Common Data Environment



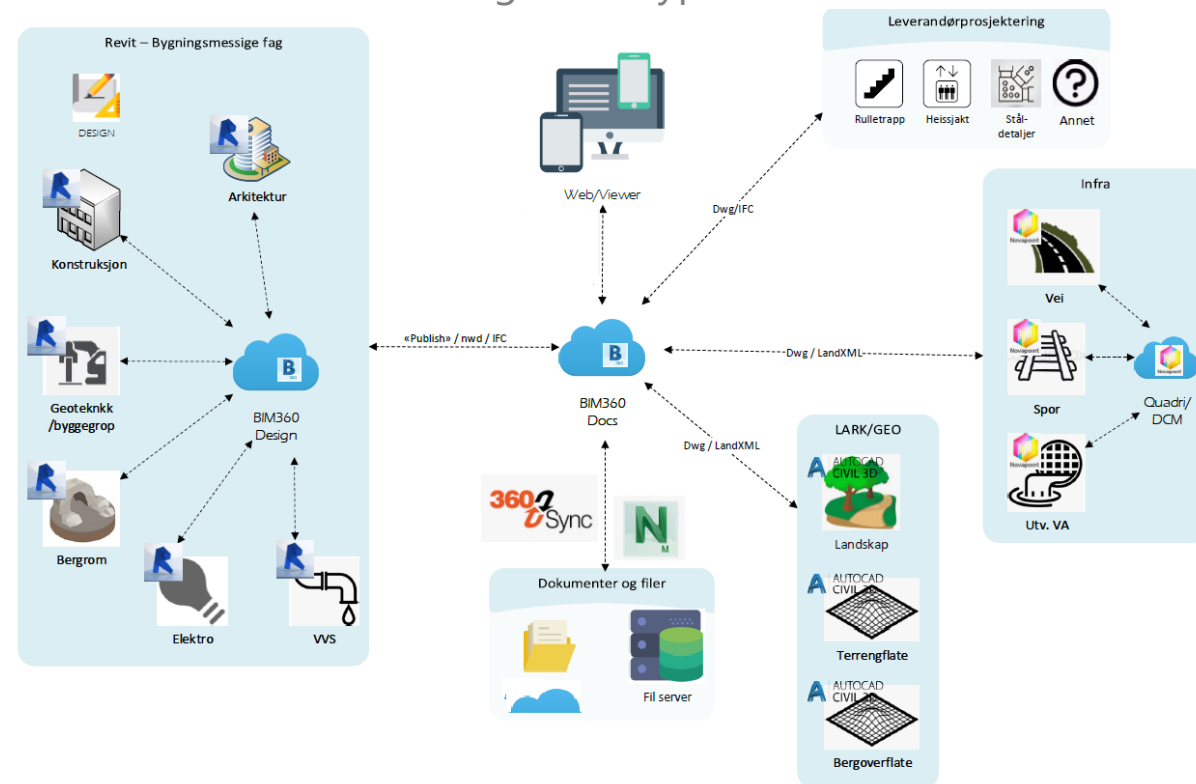
Design Software In Use



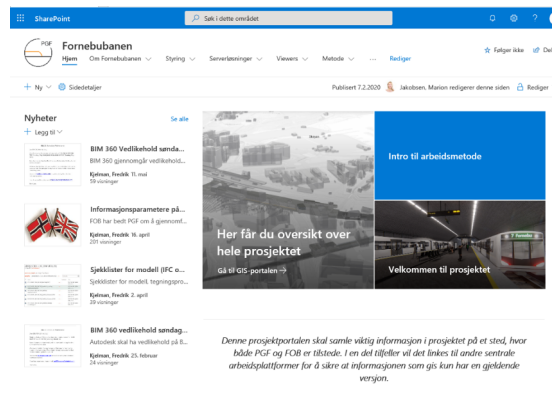
Dataflow Diagram



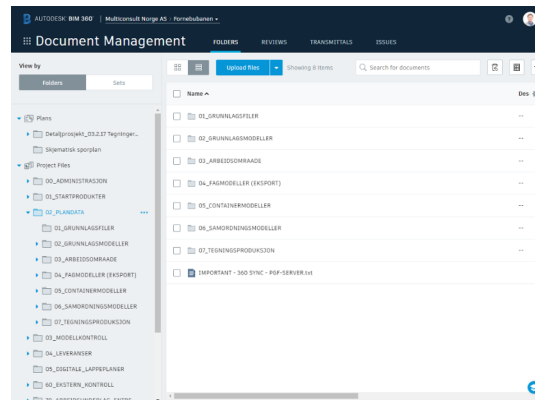
Dataflow diagram – Typical Station



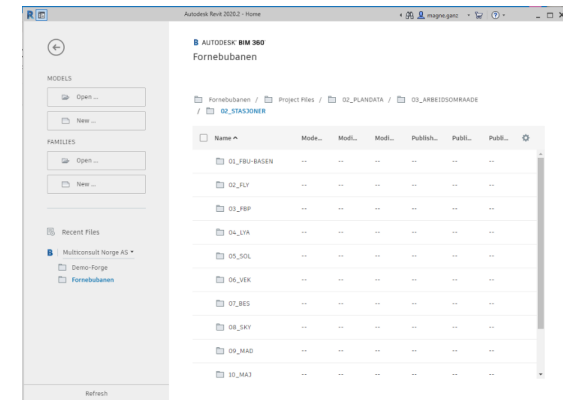
CDE – Common Data Environment



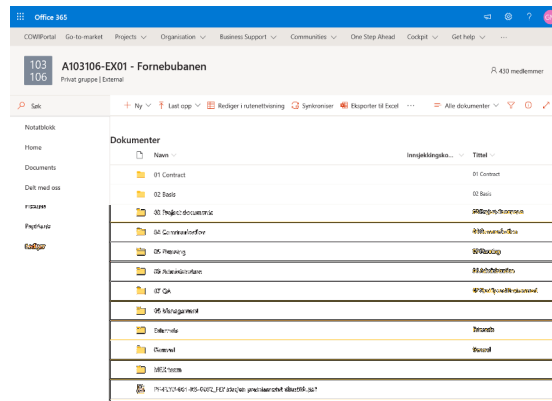
Sharepoint Information Site



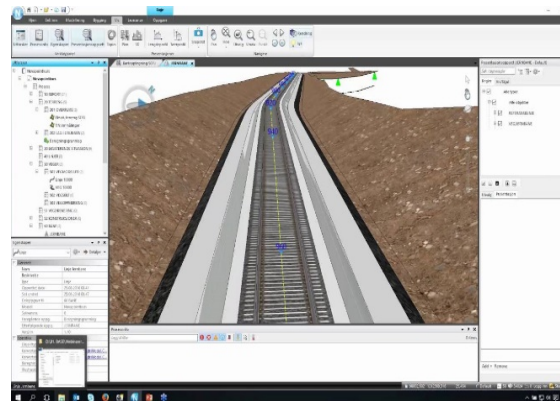
BIM 360 Docs



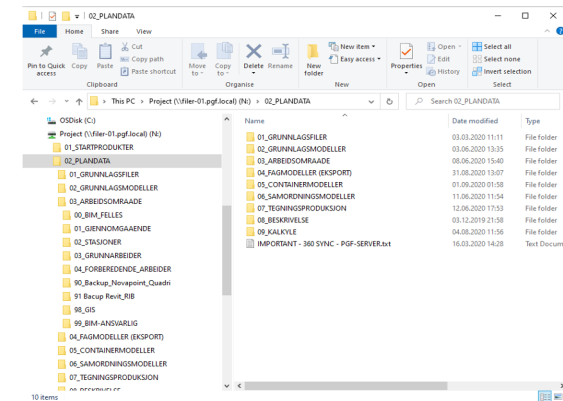
BIM 360 Design



MS Office 365



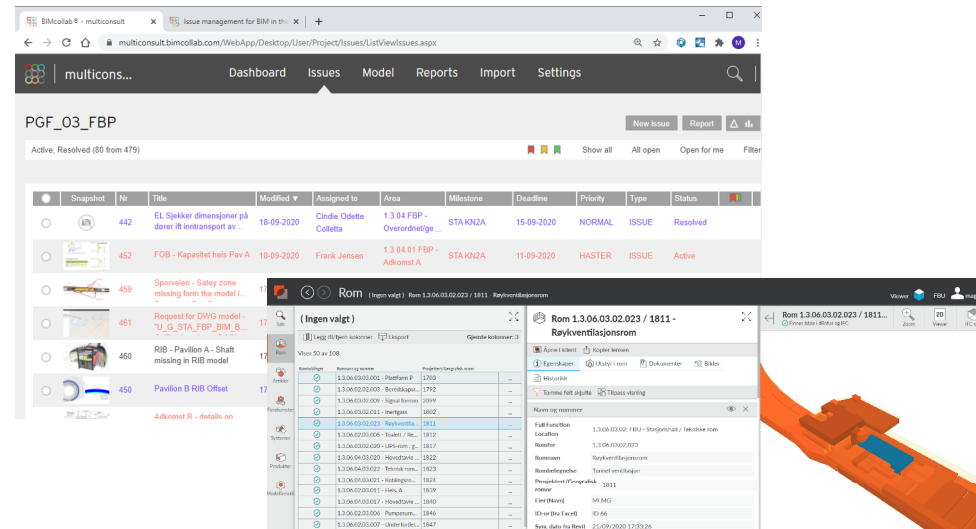
Trimble NovaPoint Quadri



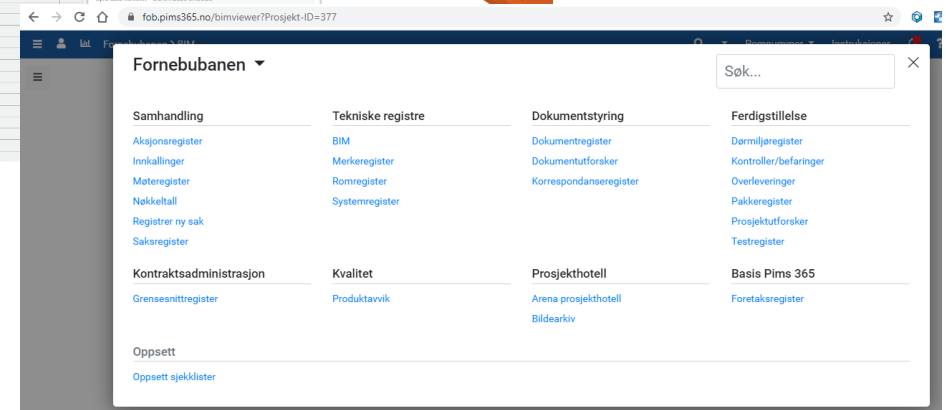
Common File Server

Additional Services

BIM Collab – BIM issue Management

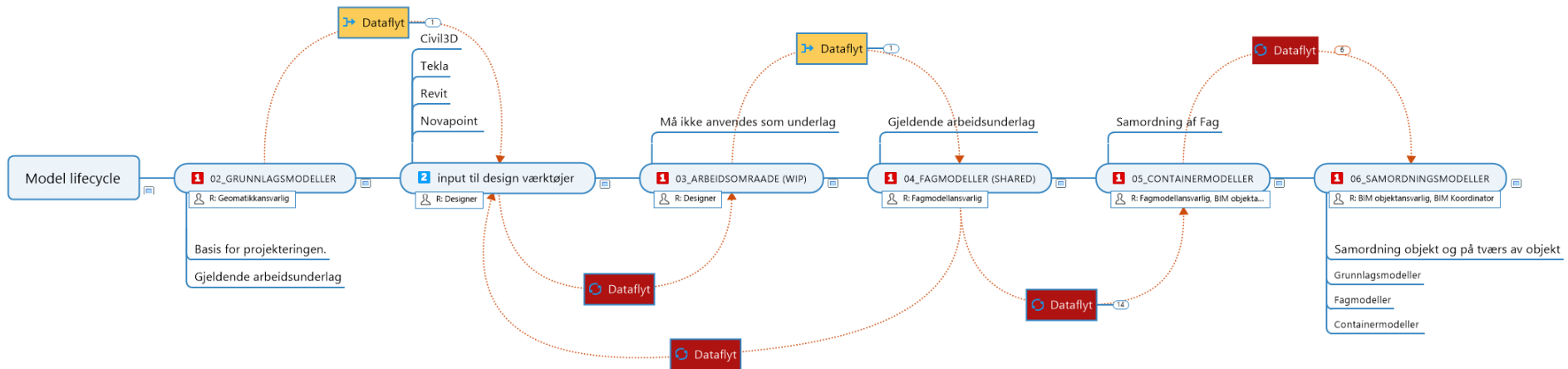


dRofus – BIM information management



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

[illegible]

Permissions settings in BIM 360

The screenshot displays the Autodesk BIM 360 interface. The left sidebar shows the 'Document Management' section with a tree view of folders. The main area is divided into two panels: 'FOLDERS' and 'PERMISSIONS'.

Document Management - FOLDERS

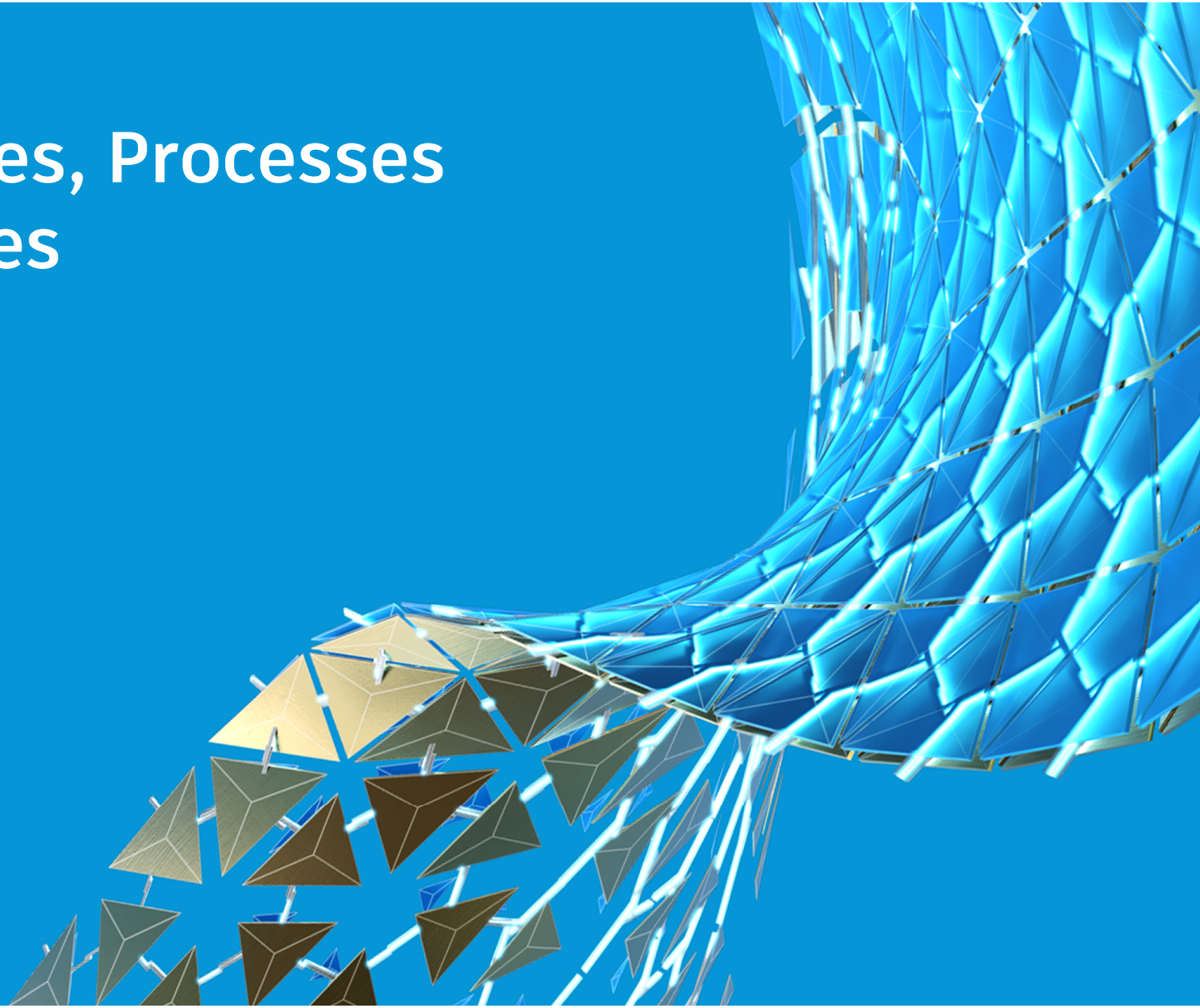
The 'FOLDERS' panel shows a list of folders under 'Project Files'. A context menu is open over the folder '03_ARBEIDSOMRAADE', showing options like 'Add subfolder', 'Rename', 'Upload', 'Share', 'Add attributes', 'Move folder', 'Sort by', 'Delete', 'Permissions', 'PDF Viewer', 'Subscribe', 'Submit for review', and 'Create transmittal'. The 'Permissions' option is highlighted.

Permissions - 03_ARBEIDSOMRA...

The 'Permissions' panel shows a table of users and their permissions. The table has columns for 'Name', 'Permission Level', and 'Type'. The 'Add' button is visible at the top left of the table.

| Name | Permission Level | Type |
|-------------------------------|---------------------------|---------|
| maginus jacob christens... | | User |
| ▶ Designer | View + Download | Role |
| ▶ BIM Manager | View + Download + Uplo... | Role |
| ▶ Surveyor | View + Download + Uplo... | Role |
| ▶ Zaha Hadid Architects | View + Download | Company |
| ▶ Arkitema | View + Download | Company |
| ▶ Gottlieb Paludan Archite... | View + Download | Company |
| ▶ Link Arkitektur | View + Download + Uplo... | Company |
| ▶ PGF-X | View + Download + Uplo... | Company |
| ▶ Longva Arkitekter | View + Download | Company |
| ▶ Multiconsult Norge AS | View + Download + Uplo... | Company |
| ▶ COWI AS | View + Download + Uplo... | Company |
| ▶ L2 Arkitekter | View + Download | Company |

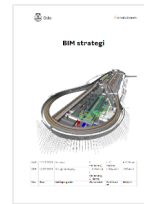
BIM Strategies, Processes and Guidelines



BIM Framework

BIM strategy

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



BIM Strategy



PEM

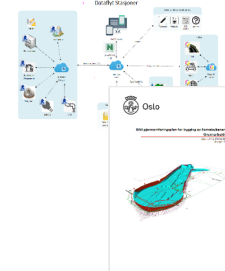
Strategic

BIM execution plan

- Roles and responsibilities
- Overall guidelines and process diagrams



BEP



Tactical

Digital production manual

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



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.”

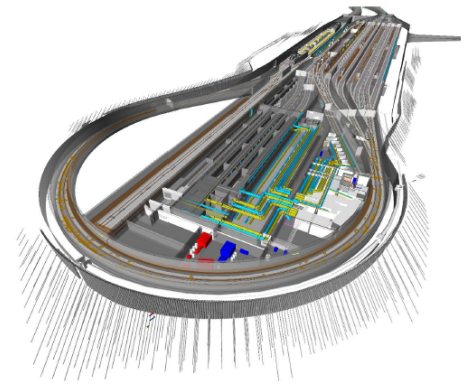
“A link between the construction schedule and the model shall be used to perform buildability analyses of the construction phase and for visual communication with stakeholders.”

“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.”



BIM strategi

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



| | | | | |
|------|------------|--|----------------|--------------|
| 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. Moseval |
| Rev. | Dato | Utarbeidet av | Kontrollert av | Godkjent |

BIM Execution plan for Design

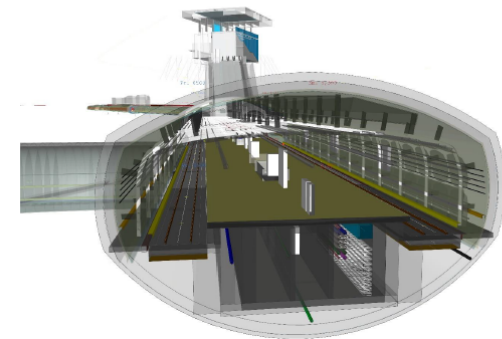
Describes in general how to achieve the goals in the BIM Strategy

- **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**



BIM gjennomføringsplan for prosjektering

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



| | | | | |
|------|------------|-------------------------|----------------------|--------------------|
| | | | | |
| 01 | 14.05.2020 | Tore Lie Falkenberg/PGF | Hans Christian Kruse | Ingeborg Krigsvoll |
| Rev. | Date | Utarbeidet av | Kontrollert av | Godkjent |

Digital Production Manual

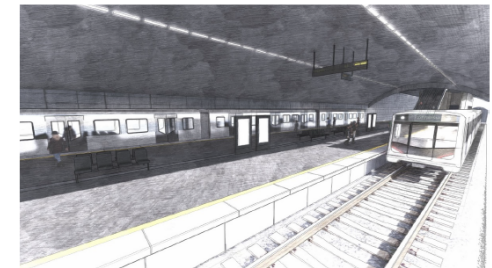
The digital production manual goes into detail of all BIM requirements. Software specific procedures are created as separate documents for each topic.

- **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**



Digital Produksjonsmanual Fornebu-banen

ADRESSE: Prosjektteringsgruppen
Fornebu-banen
Lysaker Torg 45
1366 Lysaker



| OPPROGSCODE | DOKUMENTNR. | | | | |
|-------------|------------------------|-----------------------------|-----------------|----------------|------------------|
| A103106/ | PGF-00-OPL-BIM-MAN-003 | | | | |
| VERSION | UTGIVELSESDATO | BESKRIVELSE | UTARBEIDET | KONTROLLERT | ODDOKJENT |
| 4.0 | 25.05.2020 | GFM, Info parametre, PHS... | Fredrik Kjelman | Cecilie Jrgens | Lasse Vilhelmsen |

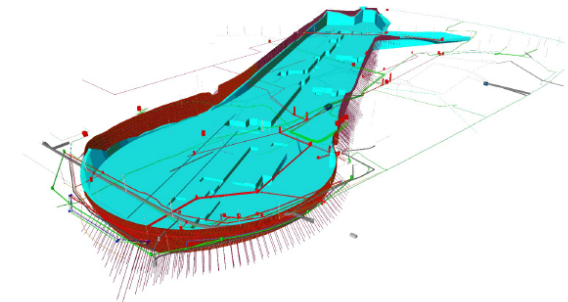
BIM Execution Plan for Construction

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

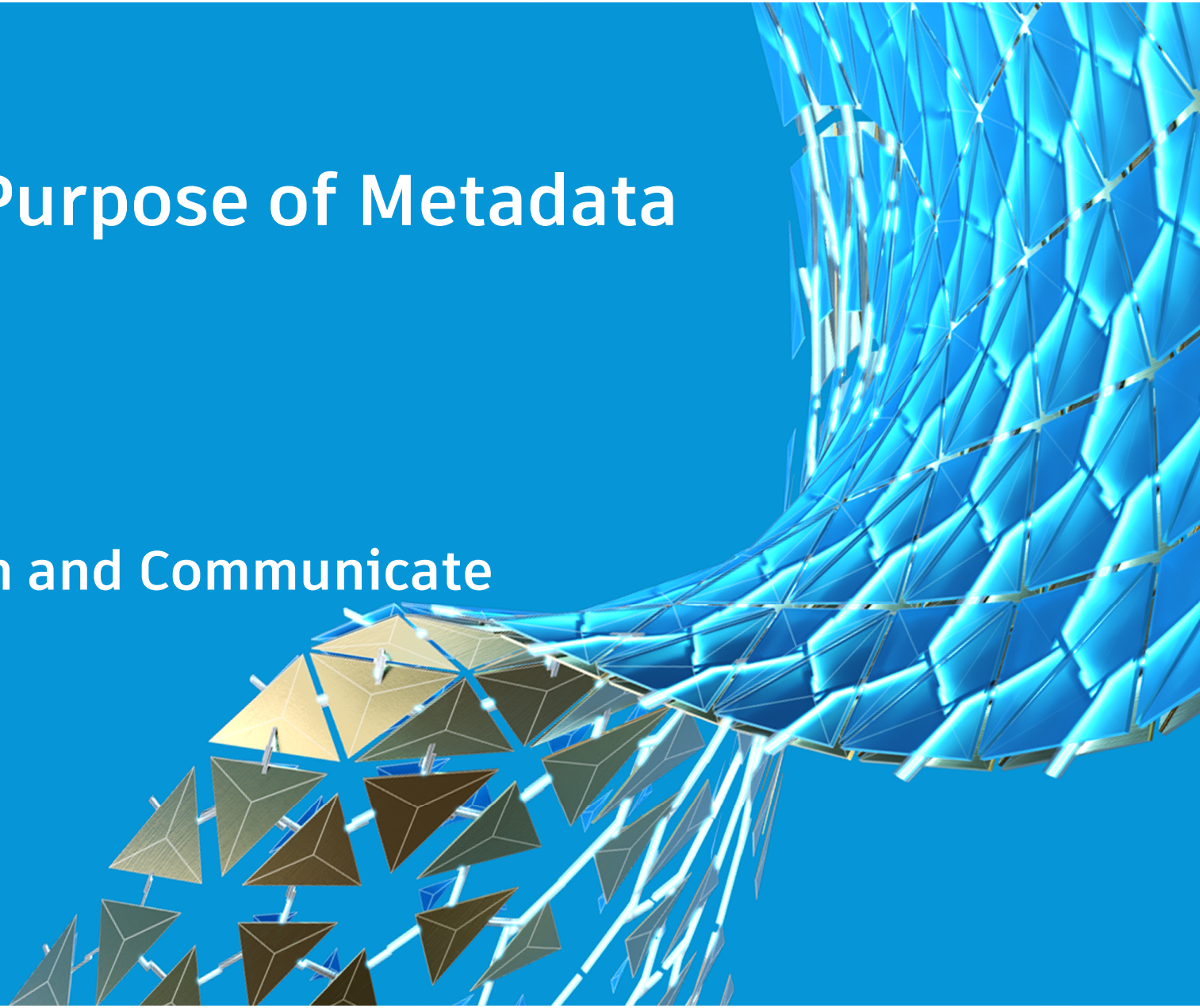


BIM-gjennomføringsplan for bygging av Fornebubanen -
Grunnarbeider
Dok.nr.: PF-U-070-AD-0005
Revisjon: 03A



The Greater Purpose of Metadata

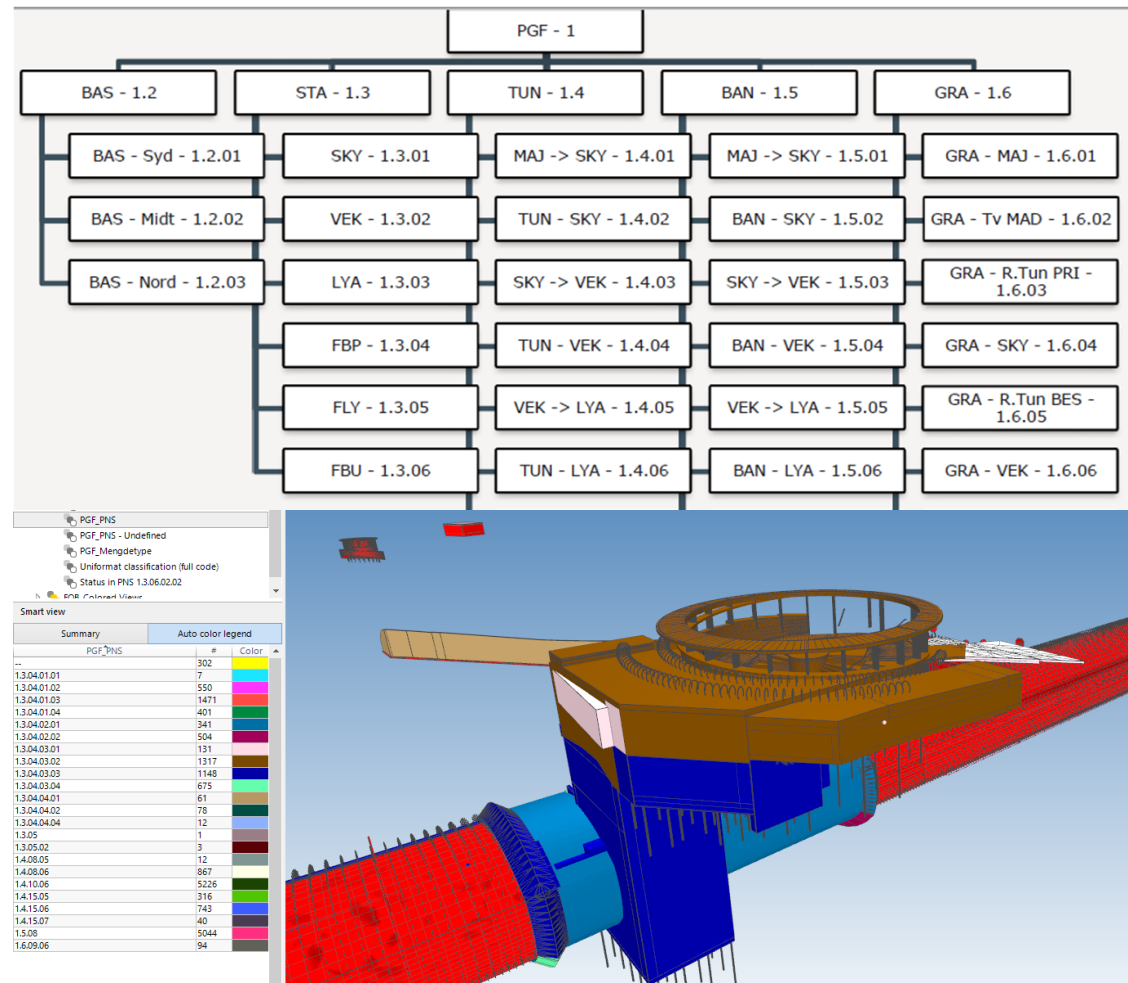
Structure, Inform and Communicate



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

Successful 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?”

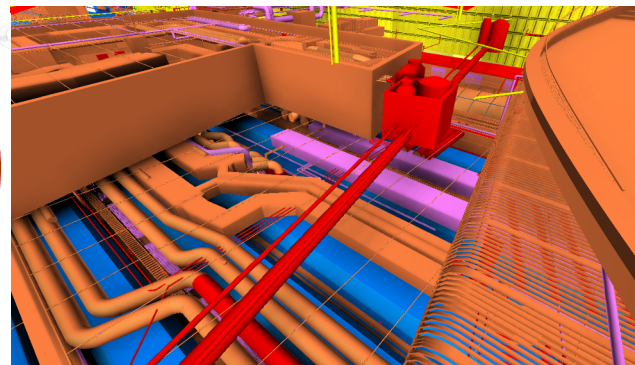
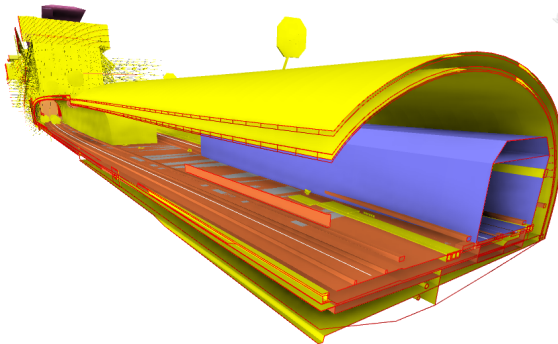
Communication of model maturity is important. It help us understand how the element can be treated.

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”.

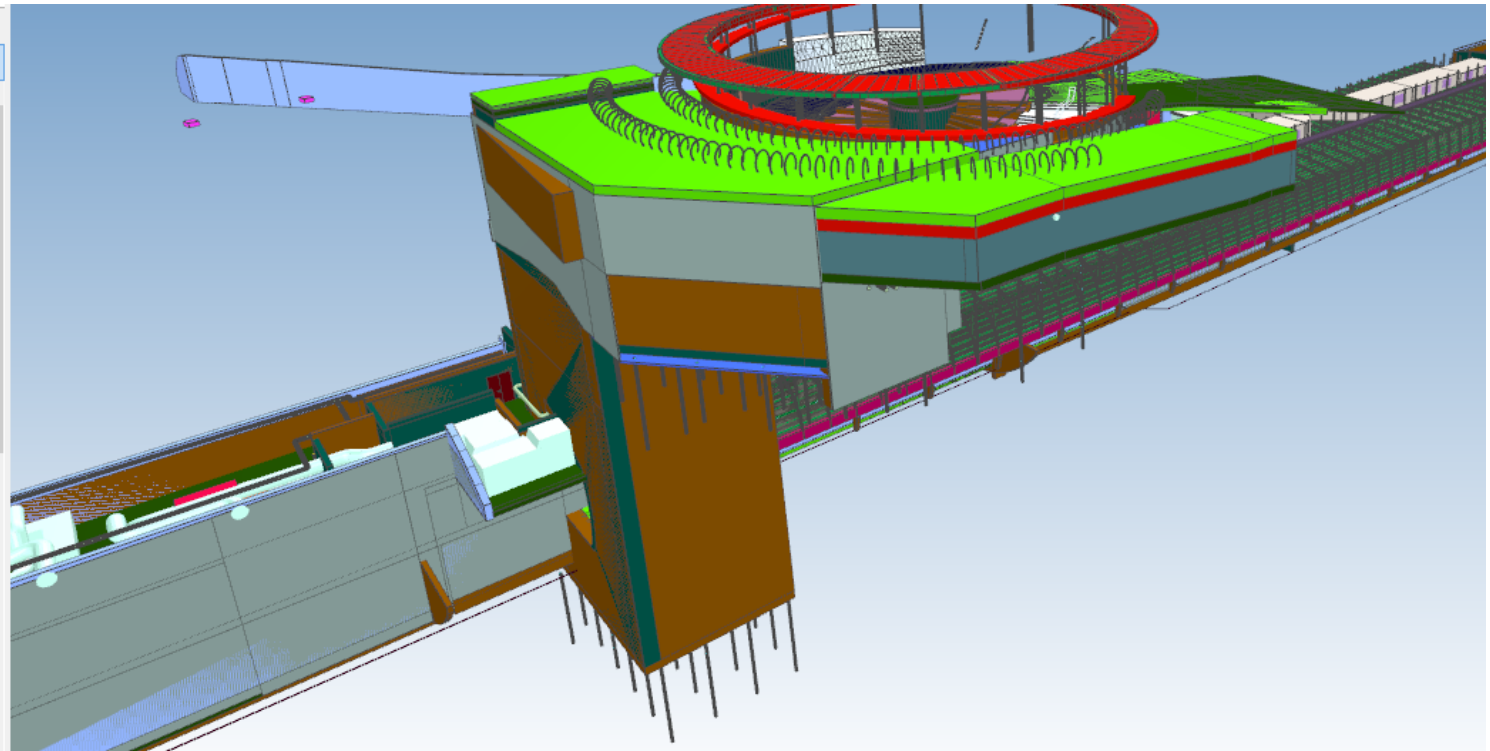


| Status Code | Color | Definition |
|-------------|-------|---|
| S0 | | Identified The model element is identified as a needed and roughly placed in the model. |
| S1 | | Preliminary Geometry: The model element is defined with preliminary position and outer geometry. Information: Element has correct 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. Further 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 |

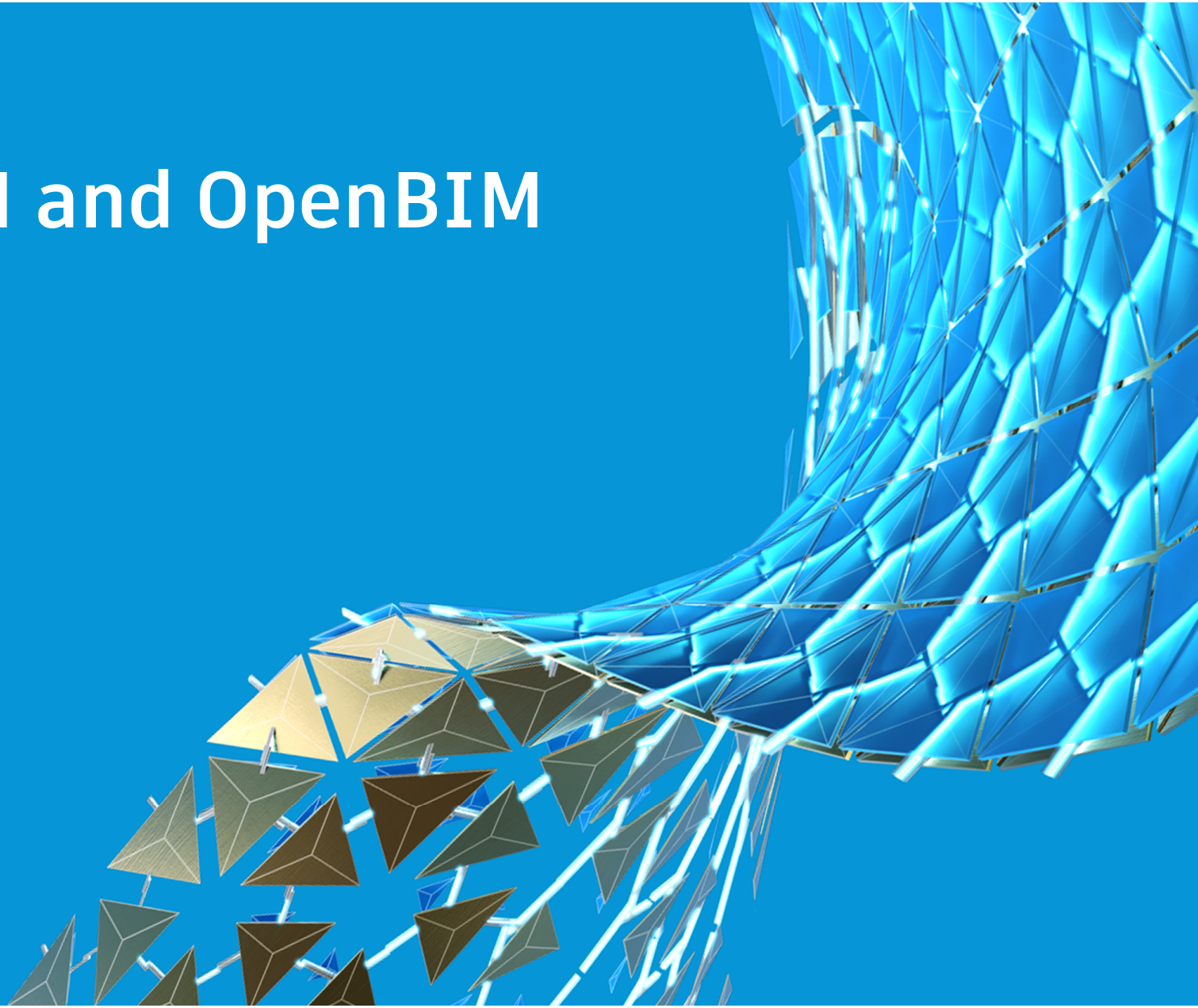
Classification – “What?”

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, Frittstående dekker | 121 | |
| 252, Gulv på grunn | 37 | |
| 253, Oppført 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 | |
| 284, Innredning | 20 | |



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

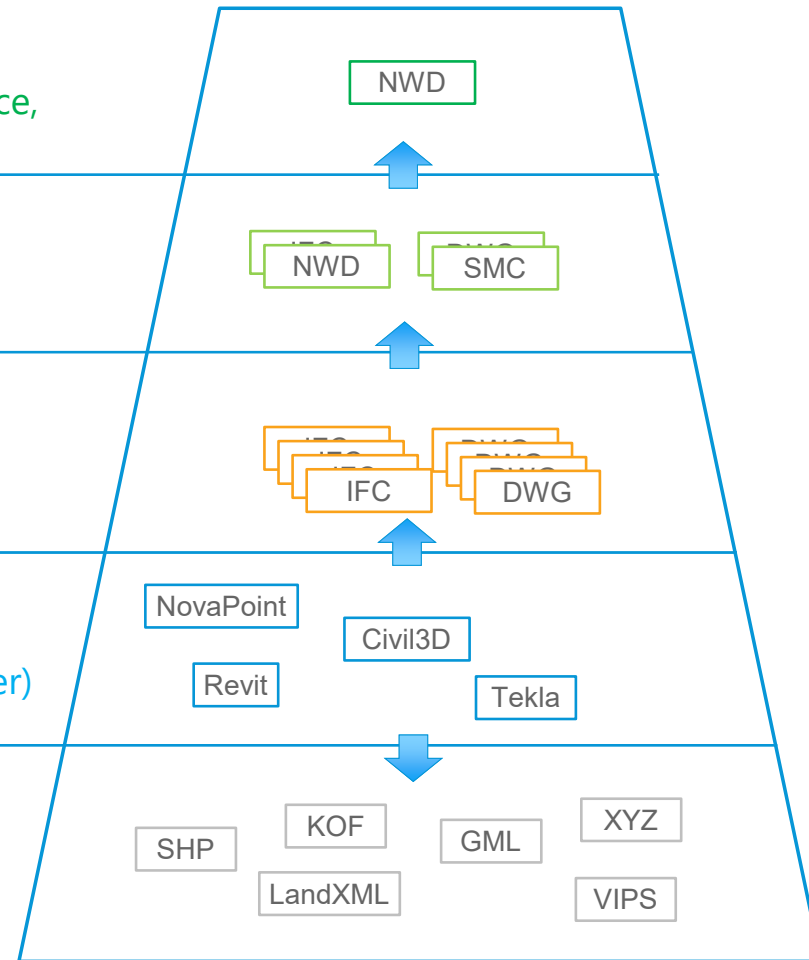
Solibri and/or NavisWorks

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

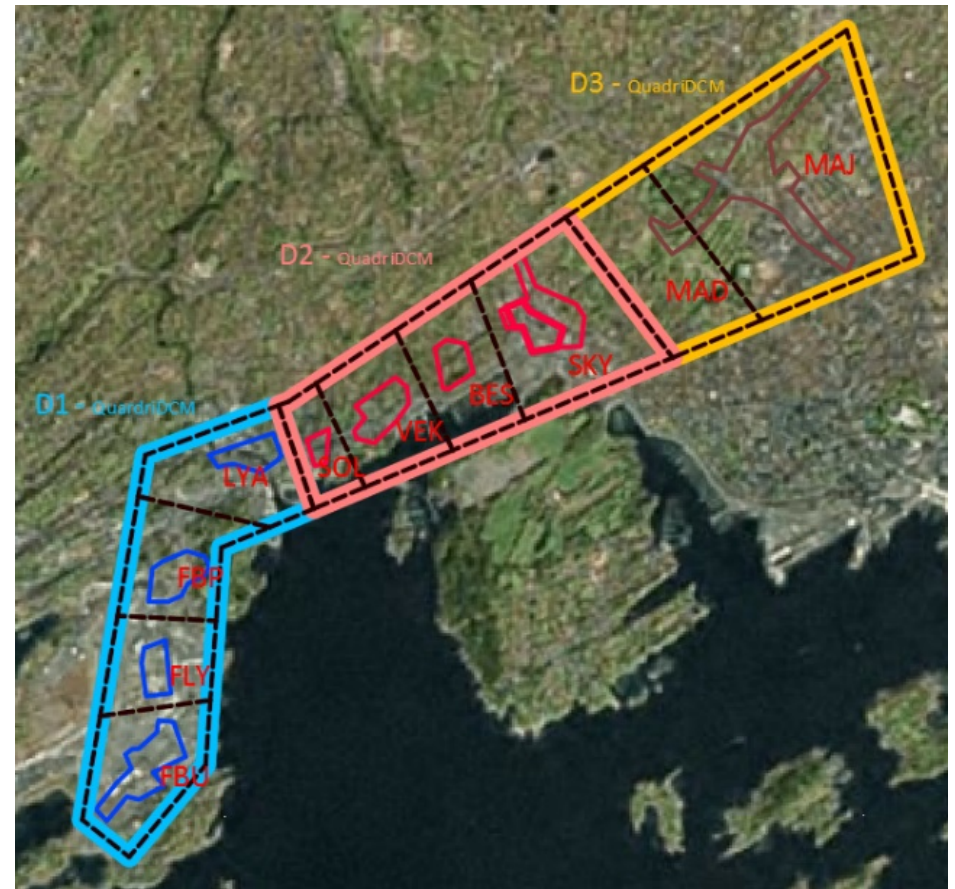
LYA – Lysaker

FBP – Fornebuporten

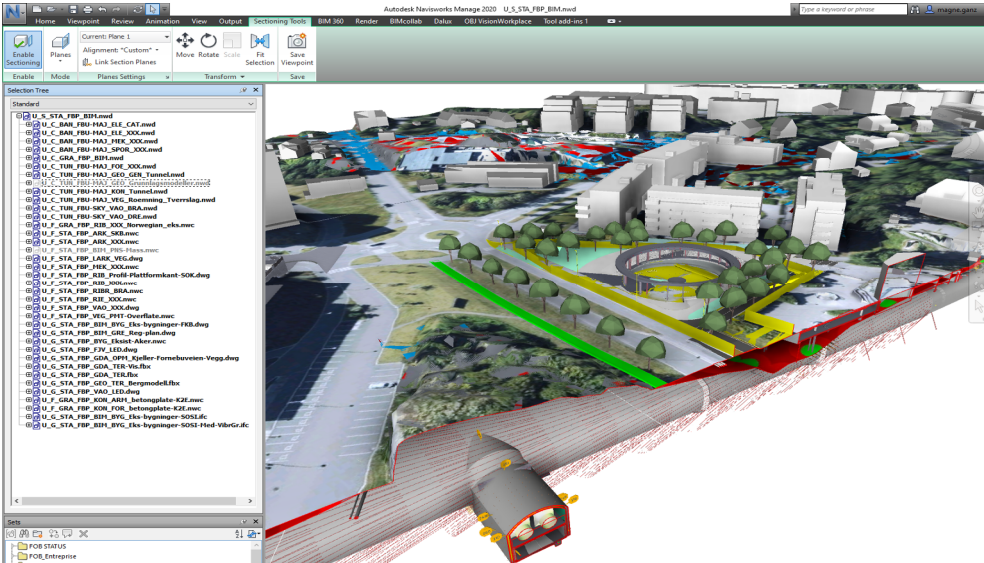
FLY – Flytårnet

FBU – Fornebu station and base

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



NavisWorks and Solibri



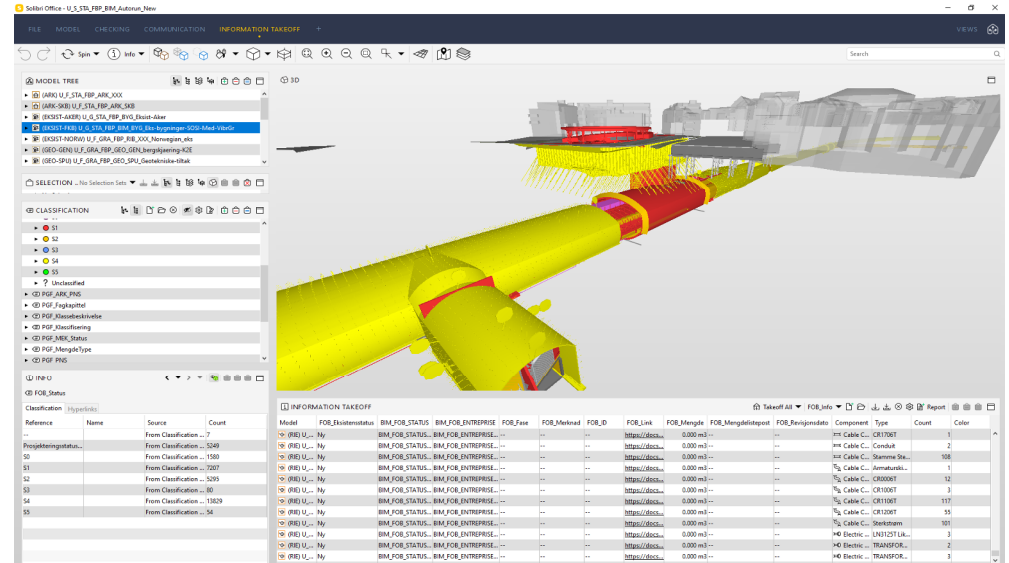
NavisWorks Manage:

Pros:

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

Cons:

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



Solibri Office:

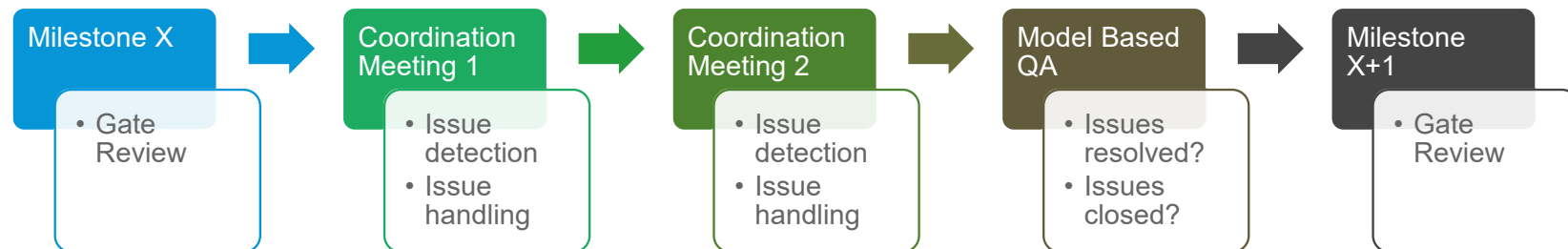
Pros:

- 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



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

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

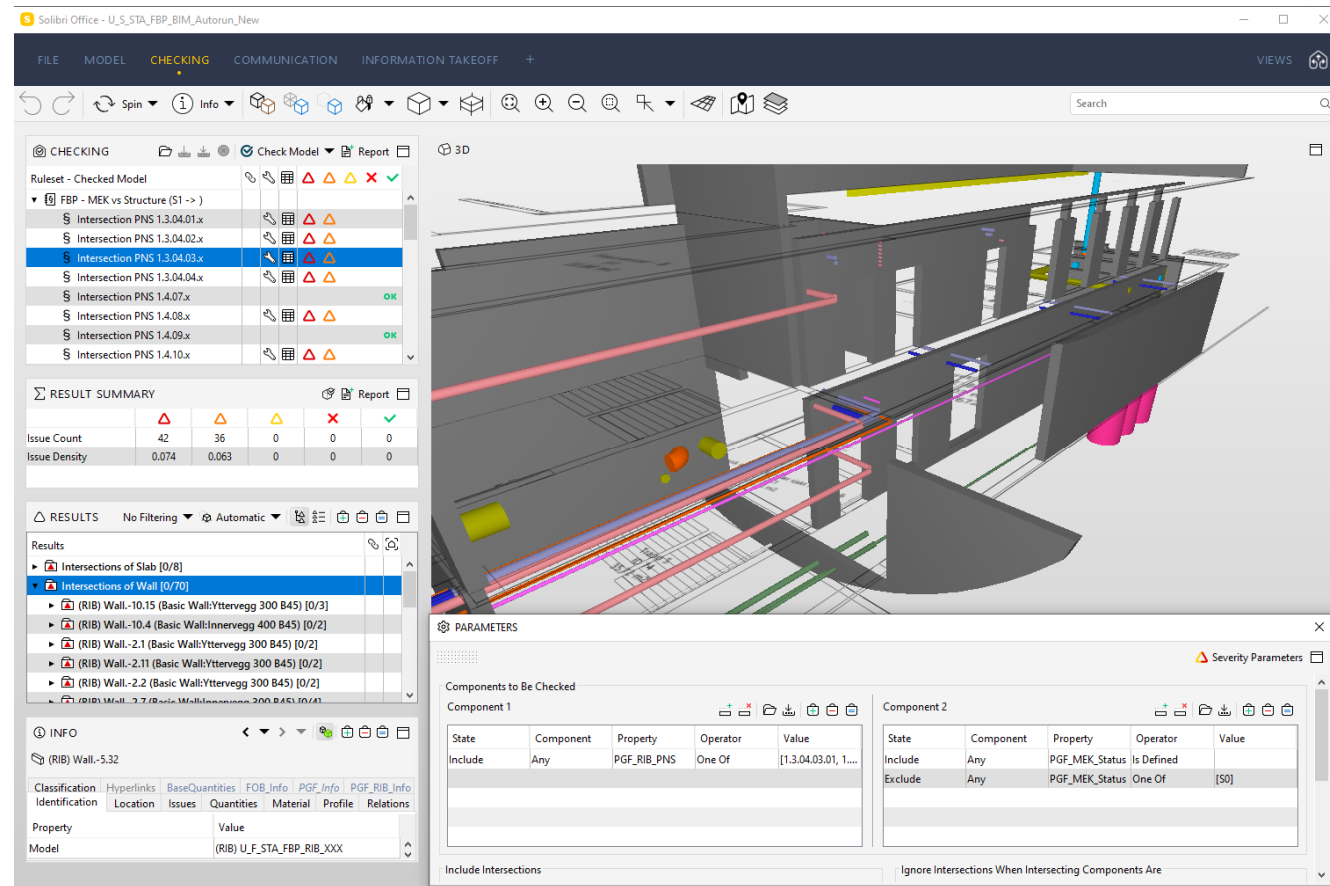
Model coordination is carried out as a continuous process with coordination meetings and issue management at steps defined by the design manager in between two milestones.

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.

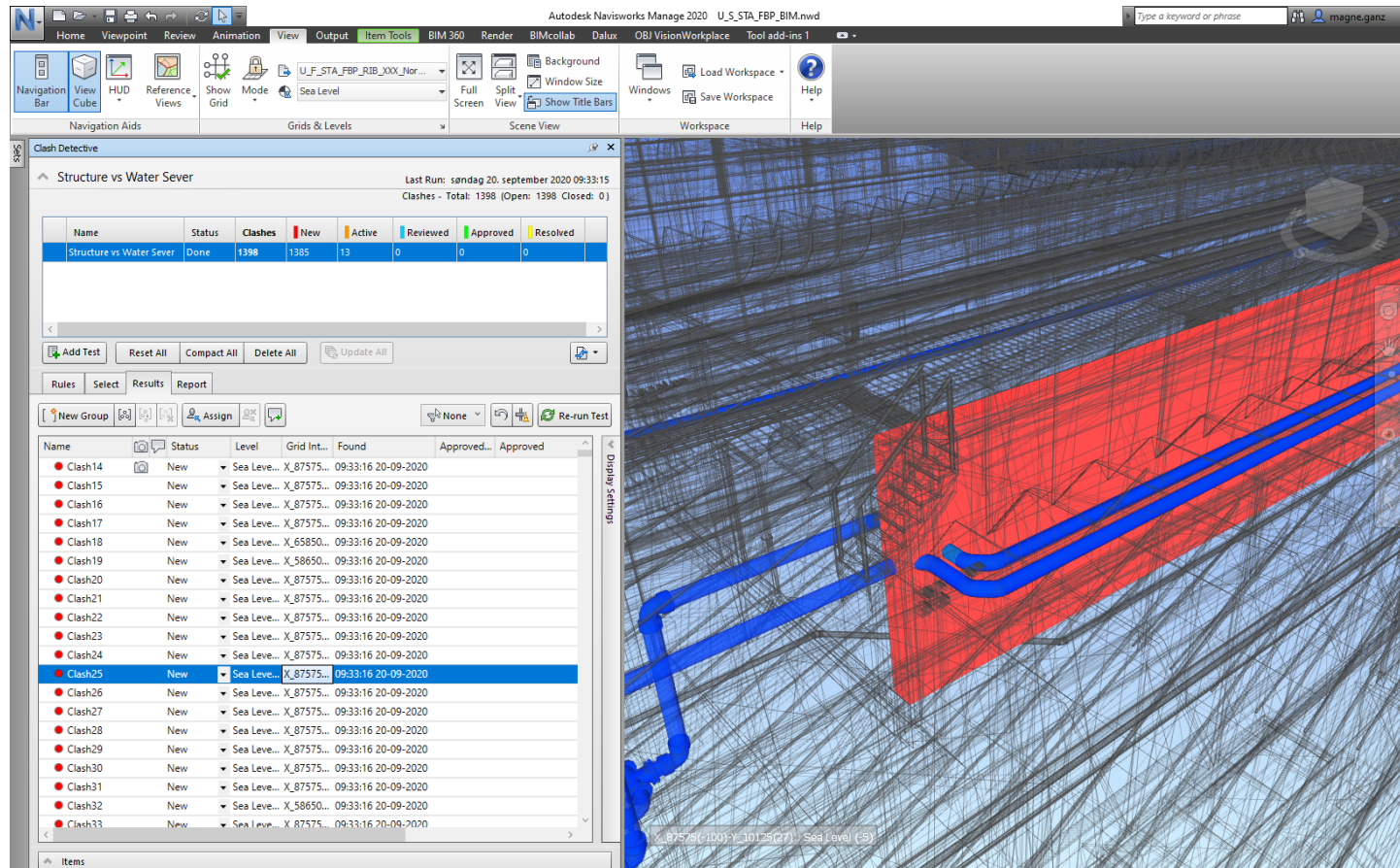
This is done through a combination of Classification Groups and Rule Parameters.



Clash Check and Visual Control

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

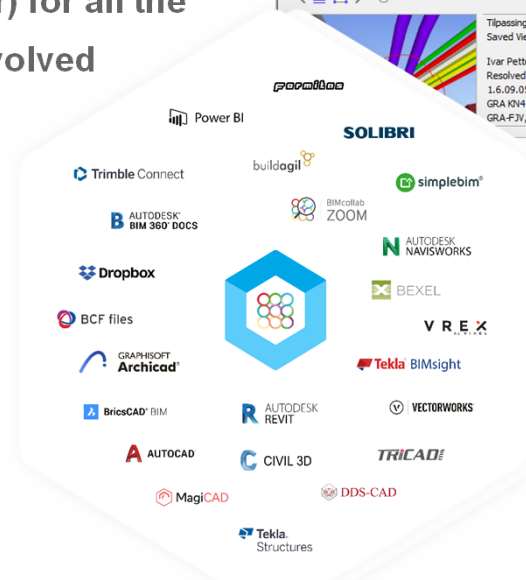
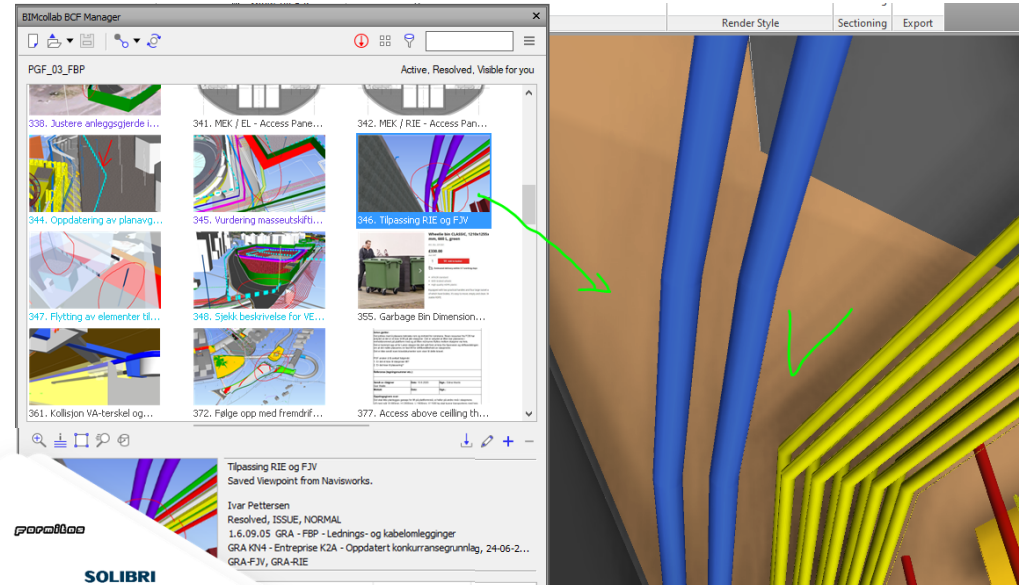
Navisworks is also the software used for visual control of the coordination models.



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



The image shows a screenshot of the BIMCollab web application. The top navigation bar includes links for Dashboard, Issues, Model, Reports, Import, and Settings. The main content area displays a list of issues for project PGF_03_FBP. The table below shows the details of these issues.

| Snapshot | Nr | Title | Modified | Assigned to | Area | Milestone | Deadline | Priority | Type | Status |
|----------|-----|---|------------|-----------------------|-----------------------------|-----------|------------|----------|-------|----------|
| 442 | 442 | EL Spøkkar dimensjoner på dør i B testtransport av... | 18-09-2020 | Cndie Odette Colletta | 1.3.04 FBP - Overordnede... | STA KN2A | 15-09-2020 | NORMAL | ISSUE | Resolved |
| 452 | 452 | FOB - Kapselhet i hals Pav A | 18-09-2020 | Frank Jensen | 1.3.04.01 FBP - Adkomst A | STA KN2A | 11-09-2020 | HASTER | ISSUE | Active |
| 459 | 459 | Sporveien - Safety zone missing from the model I... | 17-09-2020 | Muzammil Navid Sheikh | 1.3.04 FBP - Overordnede... | STA KN2A | 15-09-2020 | HASTER | ISSUE | Active |
| 461 | 461 | Request for DWG model - 'U_0_STA_FBP_BIM_B... | 17-09-2020 | Hans-Ole Lervik | 1.3.04 FBP - Overordnede... | STA KN2B | 16-09-2020 | NORMAL | ISSUE | Active |
| 460 | 460 | RIB - Pavillon A - Shaft missing in RIB model | 17-09-2020 | Thomas Bjørklund | 1.3.04.01 FBP - Adkomst A | STA KN2A | 28-09-2020 | HASTER | ISSUE | Active |
| 450 | 450 | Pavillon B RIB Offset | 17-09-2020 | Michele Depardi | 1.3.04.03 FBP - Adkomst B | STA KN2B | 14-09-2020 | NORMAL | ISSUE | Resolved |

Room Data Base and Asset Management - dRofus

Søk

Rom

Artikler

Forekomster

Systemer

Produkter

Modellinnstil

(Ingen valgt)

Legg til/fjern kolonner Eksport Gjemte kolonner: 3

Viser 50 av 108

| Romkoblinger | Romnavn og nummer | Prosjektert/Geografisk romnr |
|--------------|-------------------------------------|------------------------------|
| ✓ | 1.3.06.03.03.001 - Plattform P | 1703 |
| ✓ | 1.3.06.02.02.003 - Beredskapsr... | 1792 |
| ✓ | 1.3.06.03.02.009 - Signal forrom | 2099 |
| ✓ | 1.3.06.03.02.011 - Inertgass | 1802 |
| ✓ | 1.3.06.03.02.023 - Røykventila... | 1811 |
| ✓ | 1.3.06.02.03.005 - Toalett / Re... | 1812 |
| ✓ | 1.3.06.03.02.020 - UPS-rom , g... | 1817 |
| ✓ | 1.3.06.04.03.020 - Hovedtavle ... | 1822 |
| ✓ | 1.3.06.04.03.022 - Teknisk rom... | 1823 |
| ✓ | 1.3.06.04.03.021 - Koblingsro... | 1824 |
| ✓ | 1.3.06.02.03.011 - Hels, A | 1839 |
| ✓ | 1.3.06.04.03.017 - Hovedtavle ... | 1840 |
| ✓ | 1.3.06.02.03.006 - Pumpesum... | 1846 |
| ✓ | 1.3.06.02.03.007 - Underfordel... | 1847 |
| ✓ | 1.3.06.02.03.002 - Renholdsro... | 1848 |
| ✓ | 1.3.06.02.03.003 - Toalett / Re... | 1850 |
| ✓ | 1.3.06.02.03.001 - Pauserom t... | 1851 |
| ✓ | 1.3.06.02.03.004 - Adkomst Pl... | 1853 |
| ✓ | 1.3.06.04.03.007 - Hels, Fra pla... | 1855 |
| ✓ | 1.3.06.04.03.016 - Transformat... | 1856 |
| ✓ | 1.3.06.04.03.019 - Transformat... | 1858 |
| ✓ | 1.3.06.01.01.001 - Vendespor | 1859 |
| ✓ | 1.3.06.04.03.009 - Adkomst Pl... | 1860 |
| ✓ | 1.3.06.03.02.005 - Teknisk Korr... | 1864 |
| ✓ | 1.3.06.03.02.006 - Pauserom | 1865 |
| ✓ | 1.3.06.03.02.007 - Areal utbyg... | 1866 |
| ✓ | 1.3.06.03.01.002 - Teknisk sjak... | 1868 |
| ✓ | 1.3.06.03.02.024 - Batterirom | 1870 |

Rom 1.3.06.03.02.023 / 1811 - Røykventilasjonsrom

Åpne i klient Kopier lenken

Egenskaper Utstyr i rom Dokumenter Bilder

Historikk

Tomme felt skjulte Tilpass visning

Navn og nummer

Full Function 1.3.06.03.02: FBU - Stasjonshall / Tekniske rom

Location 1.3.06.03.02.023

Romfnr Røykventilasjonsrom

Rombetegnelse Tunnel ventilasjon

Prosjektert/Geografisk romnr 1811

Eier (Navn) MLMG

ID-nr (fra Excel) ID 66

Sync dato fra Revit 21/09/2020 17:33:26

Notat

Notat

Se fane i dette arket. Adkomst for vedlikehold må sikre overholdelse av RAMS krav. Romlengde avhenger av om vifter monteres vertikalt eller horisontalt og om lyddempere plasseres i rom eller sjakt . Forventet vifter størrelse 2,8 m (dvs med tragt 3,8 m i diameter), Ventilationsrate fordoblet pga. romhøyde tidligere navn: Vifterom 1 tunnel ventilasjon

Grupper

Fag MEK

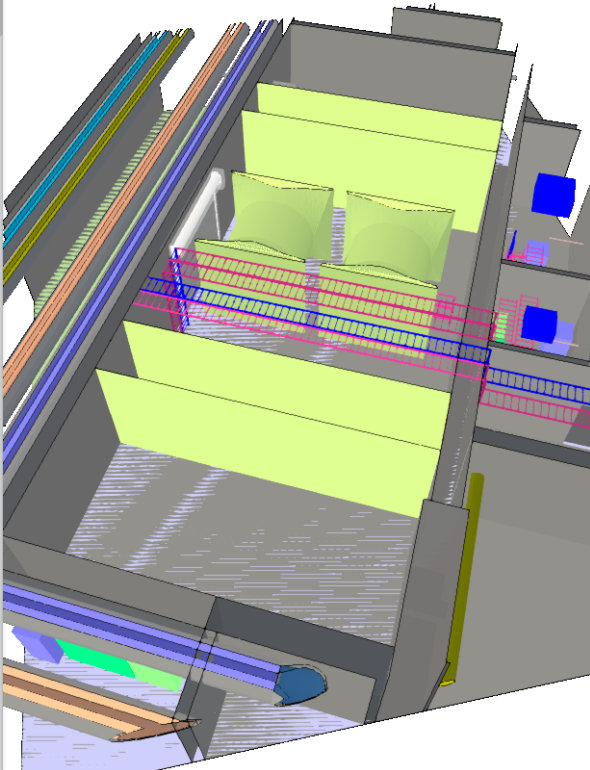
Arealer og mål

Rom 1.3.06.03.02.023 / 1811...

Finnes både i dRofus og IFC

Zoom Viewer IFC-data

Aktiver røntgenmodus Kutt lenger opp/ ned



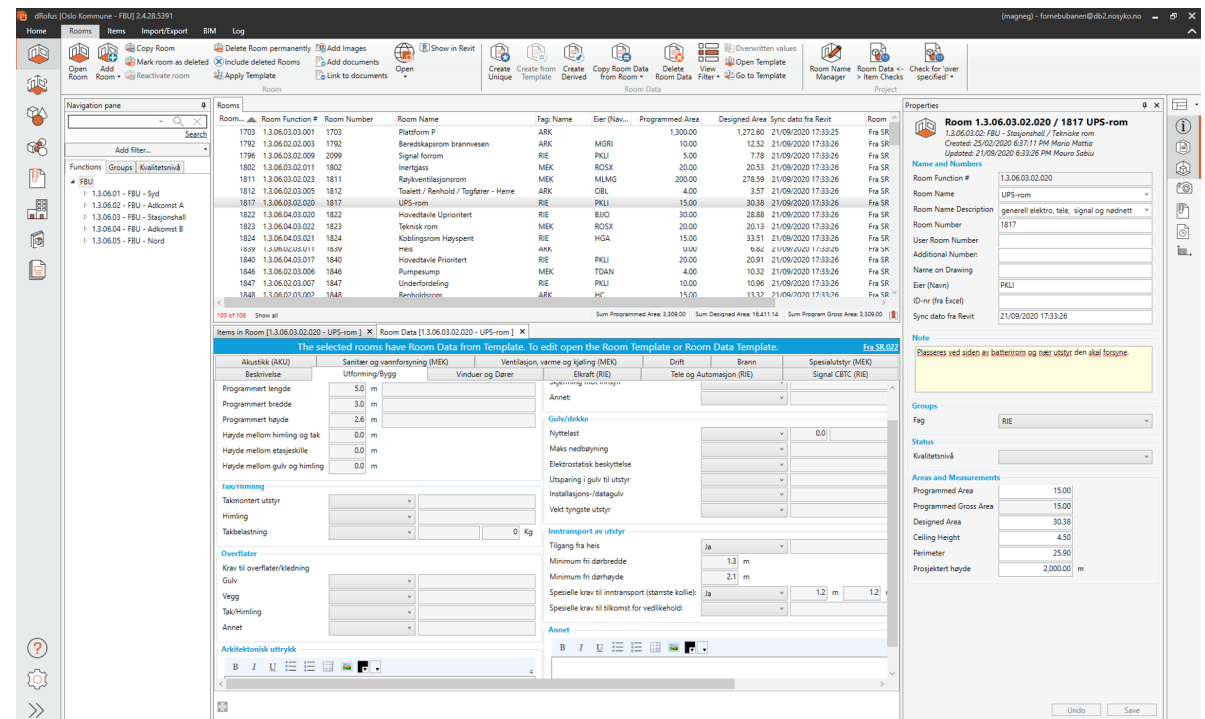
4.5.1

(Production)

Room Data Base and Requirements

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

- One database for the whole project subdivided 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

The screenshot displays the dRofus database interface. On the left, a sidebar contains navigation icons for 'Søk', 'Rom', 'Artikler', 'Forekomster', 'Systemer', 'Produkter', and 'Modellinnstilling'. The main area is titled 'Artikler' and shows a list of articles with columns for 'Artikkelnr', 'Navn', and 'Budsjettpris'. Article 72441.005 is highlighted. On the right, a detailed view for 'Artikkel 72441.005 / DØR002T - FBP_Dobbeldør - FBP_Ytterdør Stål Dobbel 26x29M' is shown. This view includes tabs for 'Egenskaper', 'Dokumenter', and 'Forekomster'. The 'Egenskaper' tab is active, displaying fields for 'Artikkelnr', 'Navn', 'Skal modelleres', 'Tilkoblinger', 'Ansvar', 'Notat', 'Klassifisering', 'Bygg', and 'Maskimale Dimensjoner Og Vekt'.

| Artikkelnr | Navn | Budsjettpris |
|------------|--|--------------|
| 005.003 | TestArtikkel | 0.00 |
| 301.001 | testArtikkel 2 | 0.00 |
| 72441.001 | Test Dør invendig enkelfløyet | 0.00 |
| 72441.002 | FBP_Dobbeldør - FBU_Innerdør Glass ... | 0.00 |
| 72441.003 | FBP_Dobbeldør - ID.SDD-01_INNER... | 0.00 |
| 423.001 | FS0001T - Hovedfordeling - FS0001T | 0.00 |
| 423.002 | FS2001T - Underfordeling Allminnelig ... | 0.00 |
| 72441.004 | Dør_Interiør_Single - 1100x2110mm | 0.00 |
| 72441.005 | FBP_Dobbeldør - FBP_Ytterdør Stål D... | 0.00 |
| 72441.006 | FBP_Dobbeldør - FBP_Innerdør Glass ... | 0.00 |
| 72441.007 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.008 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.009 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.010 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.011 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.012 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.013 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.014 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.015 | FBP_Dobbeldør - FBP_Ytterdør Glass ... | 0.00 |
| 72441.016 | FBP_Dobbeldør - FBP_Innerdør Stål D... | 0.00 |
| 72441.017 | FBP_Enkeldør - FBP_Innerdør Laminat ... | 0.00 |
| 72441.018 | FBP_Enkeldør - FBP_Innerdør Laminat ... | 0.00 |
| 72441.019 | FBP_Enkeldør - FBP_Innerdør Laminat ... | 0.00 |
| 72441.020 | FBP_Enkeldør - FBP_Innerdør Laminat ... | 0.00 |
| 72441.021 | FBP_Enkeldør - FBP_Innerdør Stål 9x2... | 0.00 |
| 72441.022 | FBP_Enkeldør - FBP_Innerdør Stål 8x2... | 0.00 |
| 72441.023 | FBP_Enkeldør - FBP_Innerdør Stål 10x... | 0.00 |
| 72441.024 | FBP_Enkeldør - FBP_Ytterdør Stål 12x... | 0.00 |
| 72441.025 | FBP_Enkeldør - FBP_Innerdør Stål 12x... | 0.00 |
| 72441.026 | FBP_Enkeldør - FBP_Ytterdør Glass 10... | 0.00 |
| 72441.027 | FBP_Enkeldør - FBP_Innerdør Glass 10... | 0.00 |
| 72441.028 | FBP_Enkeldør - FBP_Ytterdør Stål 10x... | 0.00 |

Artikkel 72441.005 / DØR002T - FBP_Dobbeldør - FBP_Ytterdør Stål Dobbel 26x29M

Apne i klient | Kopier lenken

Egenskaper | Dokumenter | Forekomster

Forekomster i standardrom/mal | Bilder

Tomme felt skjulte | Tilpass visning

Generelt

Artikkelnr: 72441.005

Navn: FBP_Dobbeldør - FBP_Ytterdør Stål Dobbel 26x29M

Skal modelleres: ☒

Tilkoblinger

Ansvar: Dør - Dør

Notat

Notat:

Klassifisering

SPK Type: DØR - Dør generelt

SPK Type: 002

Løpenummer: 002

SPK Type: Nummer: DØR002T

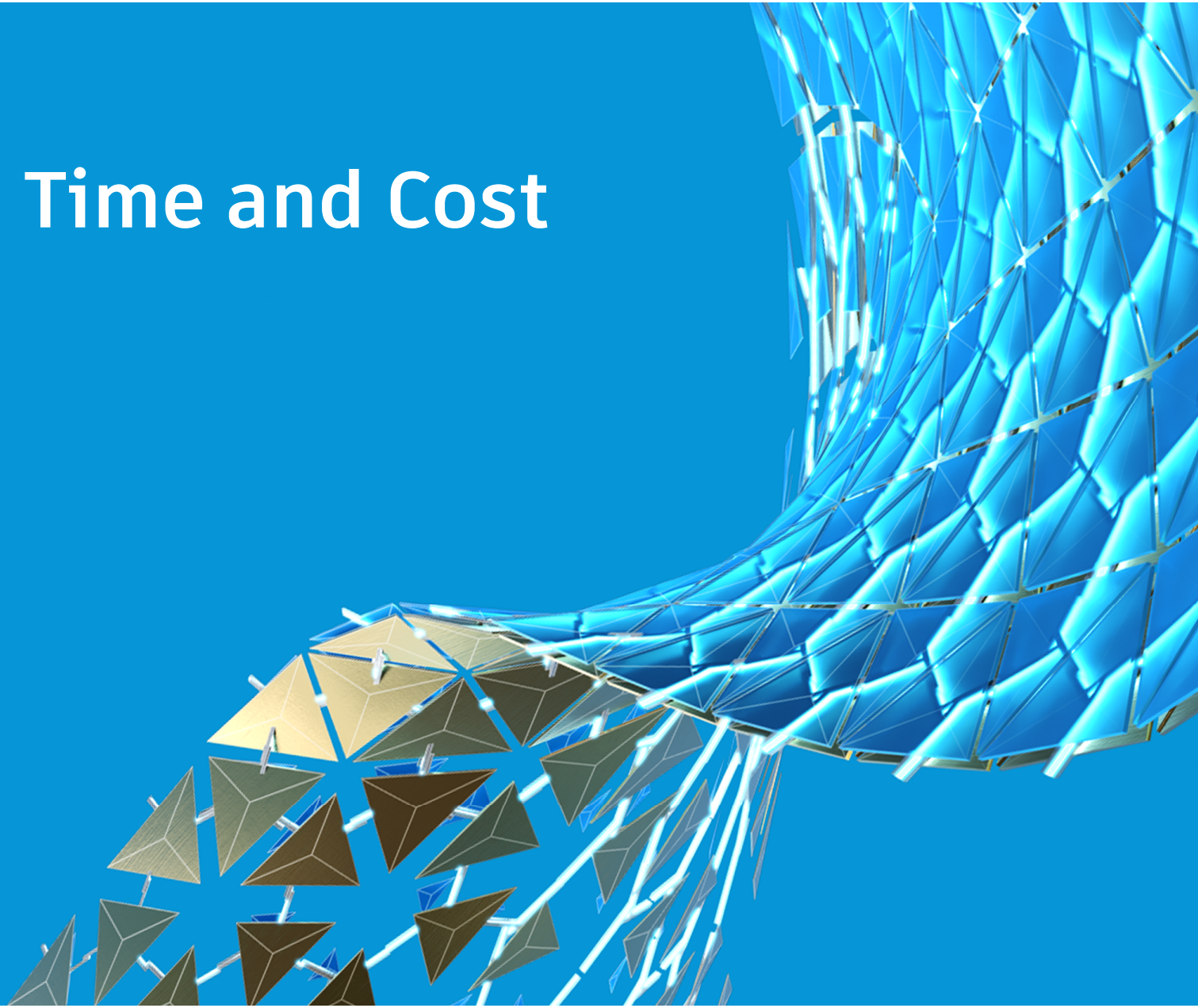
Bygg

Maskimale Dimensjoner Og Vekt

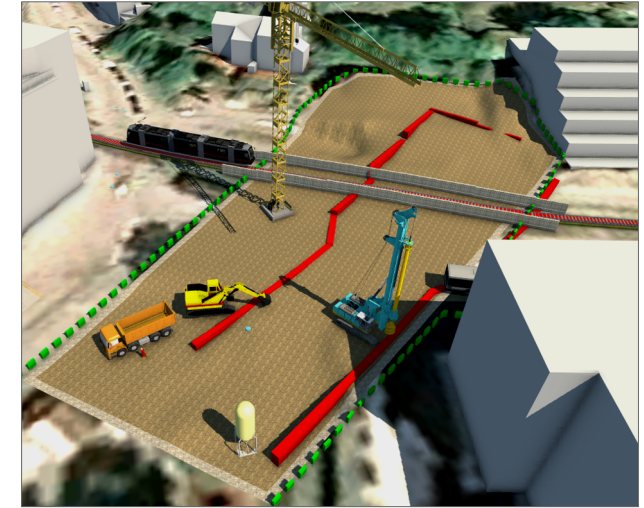
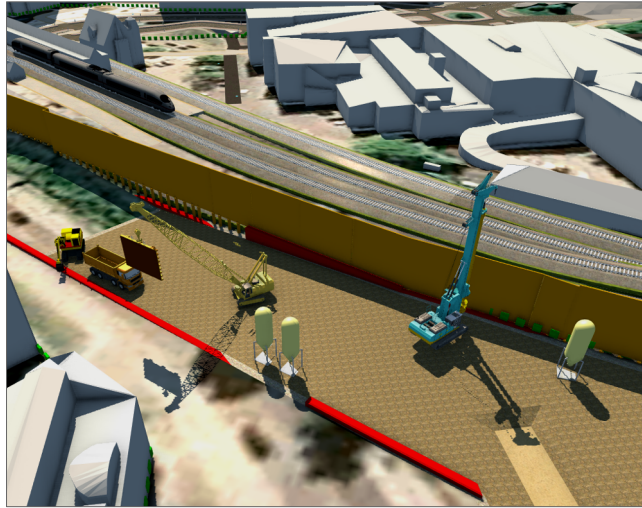
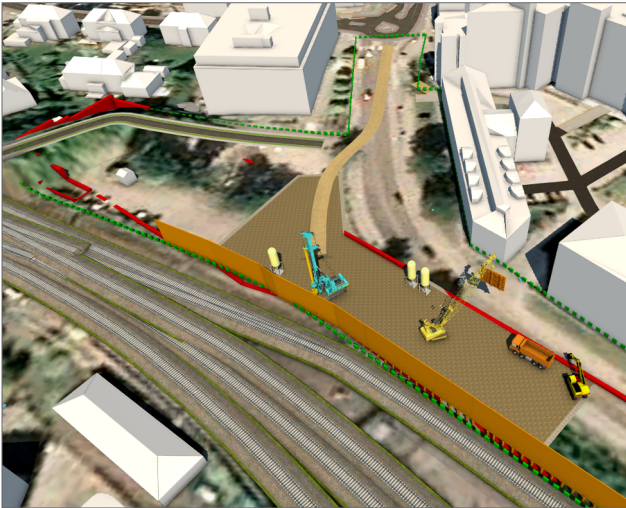
Bredde/lengde: 9 mm

Høyde: 10 mm

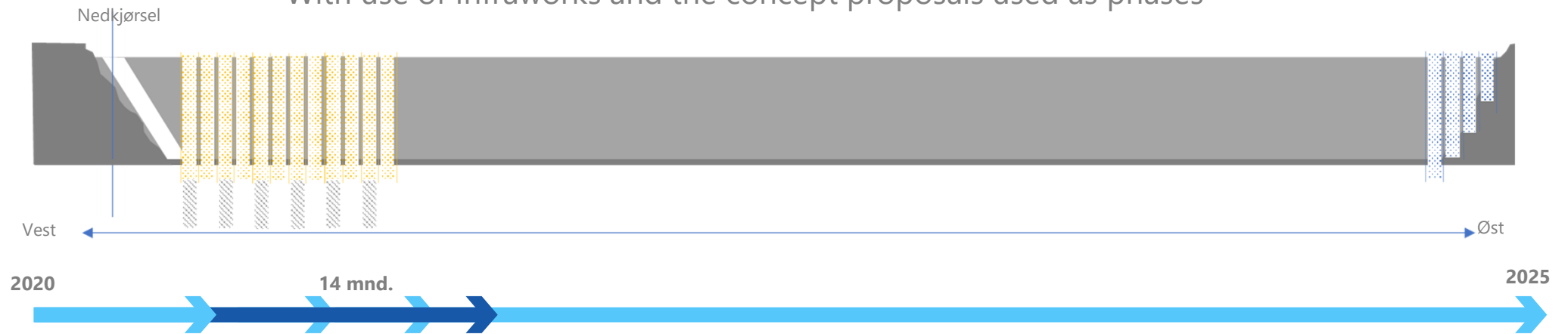
4D and 5D – Time and Cost



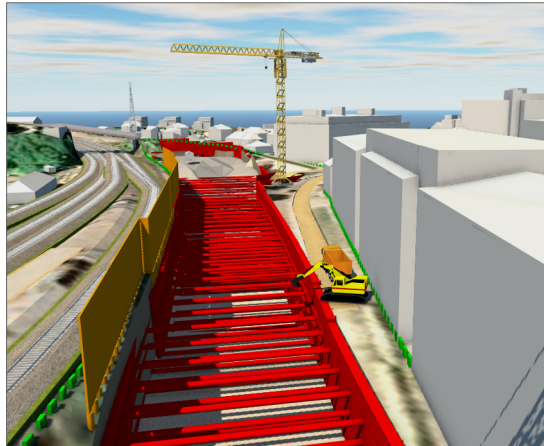
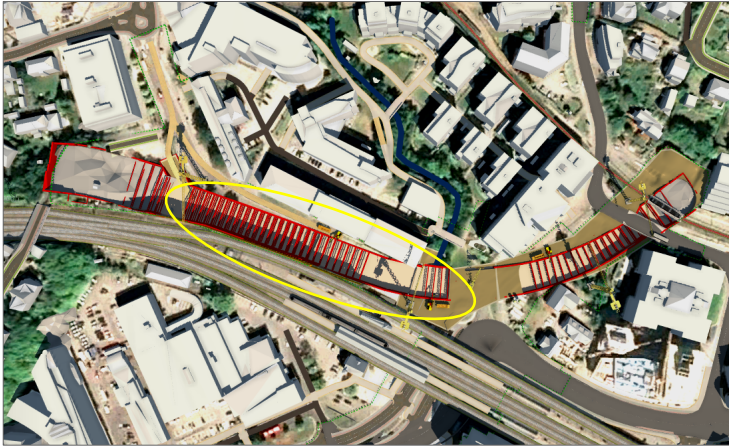
Construction Visualisation – “Semi-4D”



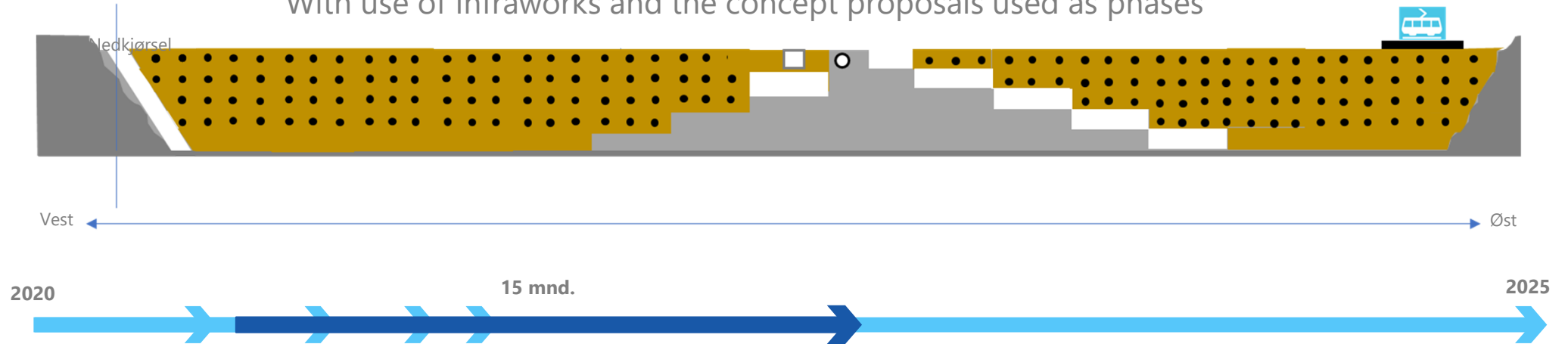
With use of Infraworks and the concept proposals used as phases



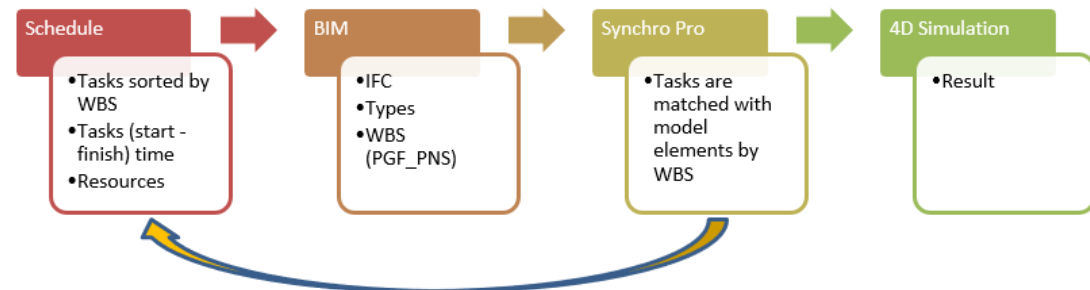
Construction visualization – “semi-4D”



With use of Infraworks and the concept proposals used as phases

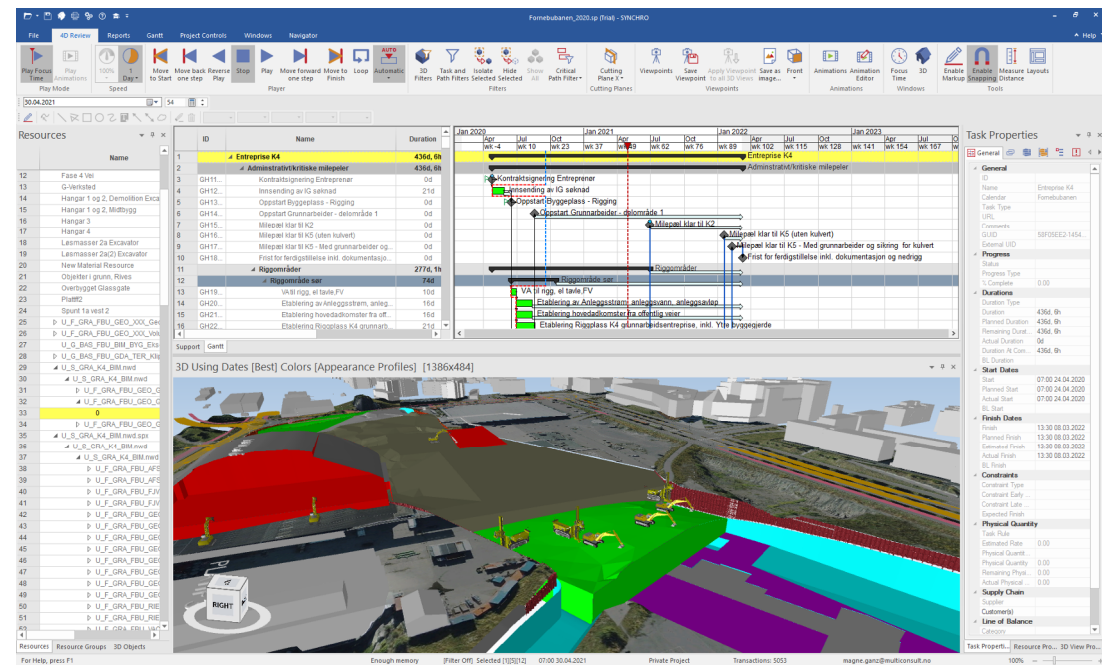


4D – Construction Simulation



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

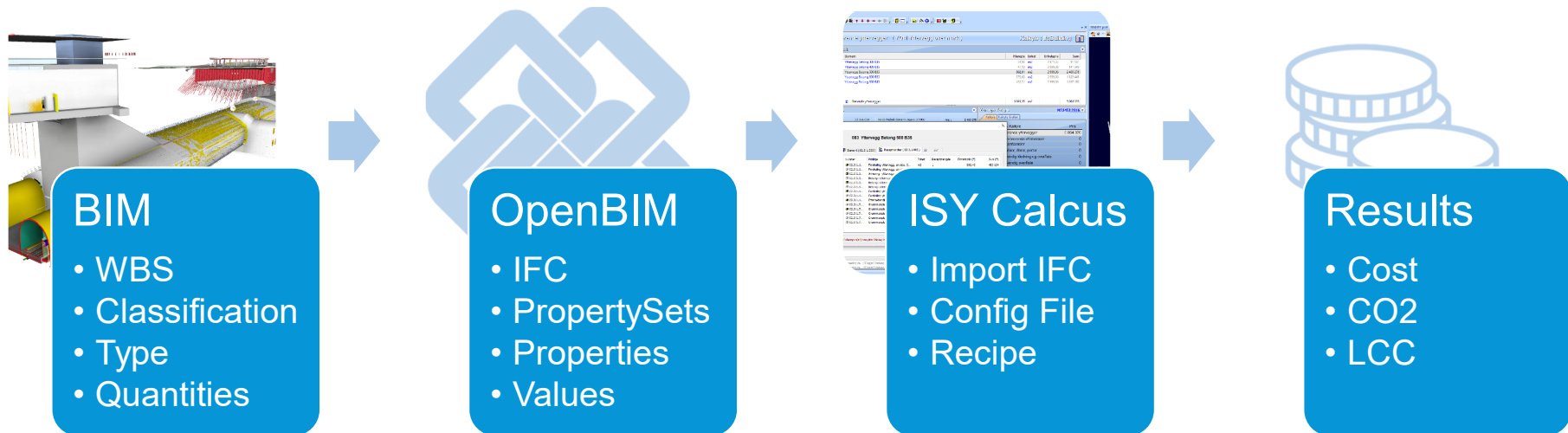
The result is a 4D simulation of the construction sequence.



4D-Video from Contract K4

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

5D – Cost calculation



ISY Calculus BIM - [RIB_FBU.ga3]

File Rediger Vis Prosjekt Elementer Verktøy Vindu Hjelp

RIB_FBU.ga3

Model Kalkyle

Kontoplan NS3453:2016

- 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

003 Yttervegg Betong 500 B35

Element (02.3.1.003) Reseptverdier (02.3.1.003)

| Nummer | Prislign | Enhet | Reseptmengde | Enhetspris (*) | Sum (*) |
|-------------|--|-------|--------------|----------------|---------|
| 02.3.1.1... | Forskaling yttervegg, en side. Støpehøyd... | m2 | 1 | 602,40 | 483 134 |
| 02.3.1.1... | Forskaling yttervegg, en side. Støpehøyd... | 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, lavkarbon klass... | m3 | 0 | 2 070,90 | 0 |
| 02.3.1.1... | Betong i yttervegg, B30, lavkarbon klass... | m3 | 0,30 | 2 360,44 | 567 929 |
| 02.3.1.1... | Betong i yttervegg, B45, lavkarbon klass... | m3 | 0 | 2 500,33 | 0 |
| 02.3.1.1... | Forskaling yttervegg, en side. Støpehøyd... | m2 | 1 | 602,40 | 483 134 |
| 02.3.1.1... | Forskaling yttervegg, en side. Støpehøyd... | m2 | 0 | 685,07 | 0 |
| 02.3.1.1... | Etterbehandling av betongyttervegg | m2 | 1 | 65,94 | 52 888 |
| 02.3.1.7... | Grunnmursplate XPS, t = 50 mm, inkl. fib... | m2 | 0 | 288,55 | 0 |
| 02.3.1.7... | Grunnmursplate XPS, t = 100 mm, inkl. fib... | m2 | 1 | 402,78 | 323 032 |
| 02.3.1.7... | Grunnmursplate XPS, t = 150 mm, inkl. fib... | m2 | 0 | 517,01 | 0 |
| 02.3.1.7... | Grunnmursplate EPS, t = 50 mm, inkl. fib... | m2 | 0 | 215,61 | 0 |
| 02.3.1.7... | Grunnmursplate EPS, t = 100 mm, inkl. fib... | m2 | 0 | 317,48 | 0 |

(*) Enhetspris(er) benytter Påslag % 12, 12, 531 - (M,U,T,P) ---> fra konto 02 Bygning

Cost Sum

| 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 |
| m2 | 2 425,11 | 133,99 | 171,32 |
| m2 | 1 603,94 | 88,62 | 114,17 |
| m2 | 1 711,56 | 94,57 | 126,44 |

Viewer

BIM/IFC plot

Aabb: 65637,799 m3 2287,031 m2(h) 1506,750 m2(v) 192,125 m(perimeter)

Materialregister NS3420 Breenregistrer

Autosave RIB_FBU.ga3 klokken 14:32

Multiconsult Norge AS 13 lisenser. CAP NUM SCRL

Cost, LCC and Co2 Model Based Approach

Visninger Kalkyle NS3453:2016

Kalkyle Kalkyle Grafisk

| # | Konto - Kalkyle | Pris |
|----|-----------------------------|------------|
| 01 | Felleskostnader | 0 |
| 02 | Bygning | 19 638 933 |
| 03 | VVS-installasjoner | 0 |
| 04 | Elkraft | 0 |
| 05 | Tele og automatisering | 0 |
| 06 | Andre installasjoner | 0 |
| 07 | SUM 01-06 HUSKOSTNAD | 19 638 933 |
| 07 | Utendørs | 0 |
| 08 | SUM 01-07 ENTREPRISEKOSTNAD | 19 638 933 |
| 08 | Generelle kostnader | 0 |
| 09 | SUM 01-08 BYGGEKOSTNAD | 19 638 933 |
| 09 | Spesielle kostnader | 0 |
| 10 | Mva | 0 |
| 10 | SUM 01-10 BASISKOSTNAD | 19 638 933 |
| 11 | Forventet tillegg | 0 |
| 11 | SUM 01-11 PROSJEKTKOSTNAD | 19 638 933 |
| 12 | Usikkerhetsavsetning | 0 |
| 12 | SUM 01-12 KOSTNADSRAMME | 19 638 933 |
| 13 | Prisregulering | 0 |
| 13 | SUM KONTOPLAN | 19 638 933 |

Kalkyle Kalkyle LCC Kalkyle Co2-eq Kalkyle Vekt Kalkyle Avfall

Cost Calculation

Visninger LCC [60 år] NS3453:2016

LCC LCC Grafisk

| # | Konto - LCC | Åk |
|----|-----------------------------|-----------|
| 01 | Felleskostnader | 0 |
| 02 | Bygning | 1 097 969 |
| 03 | VVS-installasjoner | 0 |
| 04 | Elkraft | 0 |
| 05 | Tele og automatisering | 0 |
| 06 | Andre installasjoner | 0 |
| 07 | SUM 01-06 HUSKOSTNAD | 1 097 969 |
| 07 | Utendørs | 0 |
| 08 | SUM 01-07 ENTREPRISEKOSTNAD | 1 097 969 |
| 08 | Generelle kostnader | 0 |
| 09 | SUM 01-08 BYGGEKOSTNAD | 1 097 969 |
| 09 | Spesielle kostnader | 0 |
| 10 | Mva | 0 |
| 10 | SUM 01-10 BASISKOSTNAD | 1 097 969 |
| 11 | Forventet tillegg | 0 |
| 11 | SUM 01-11 PROSJEKTKOSTNAD | 1 097 969 |
| 12 | Usikkerhetsavsetning | 0 |
| 12 | SUM 01-12 KOSTNADSRAMME | 1 097 969 |
| 13 | Prisregulering | 0 |
| 13 | SUM KONTOPLAN (60 år) | 1 097 969 |

Kalkyle Kalkyle LCC Kalkyle Co2-eq Kalkyle Vekt Kalkyle Avfall

LCC Calculation

Visninger Co2-eq [60 år] NS3453:2016

Co2-eq Co2-eq Grafisk

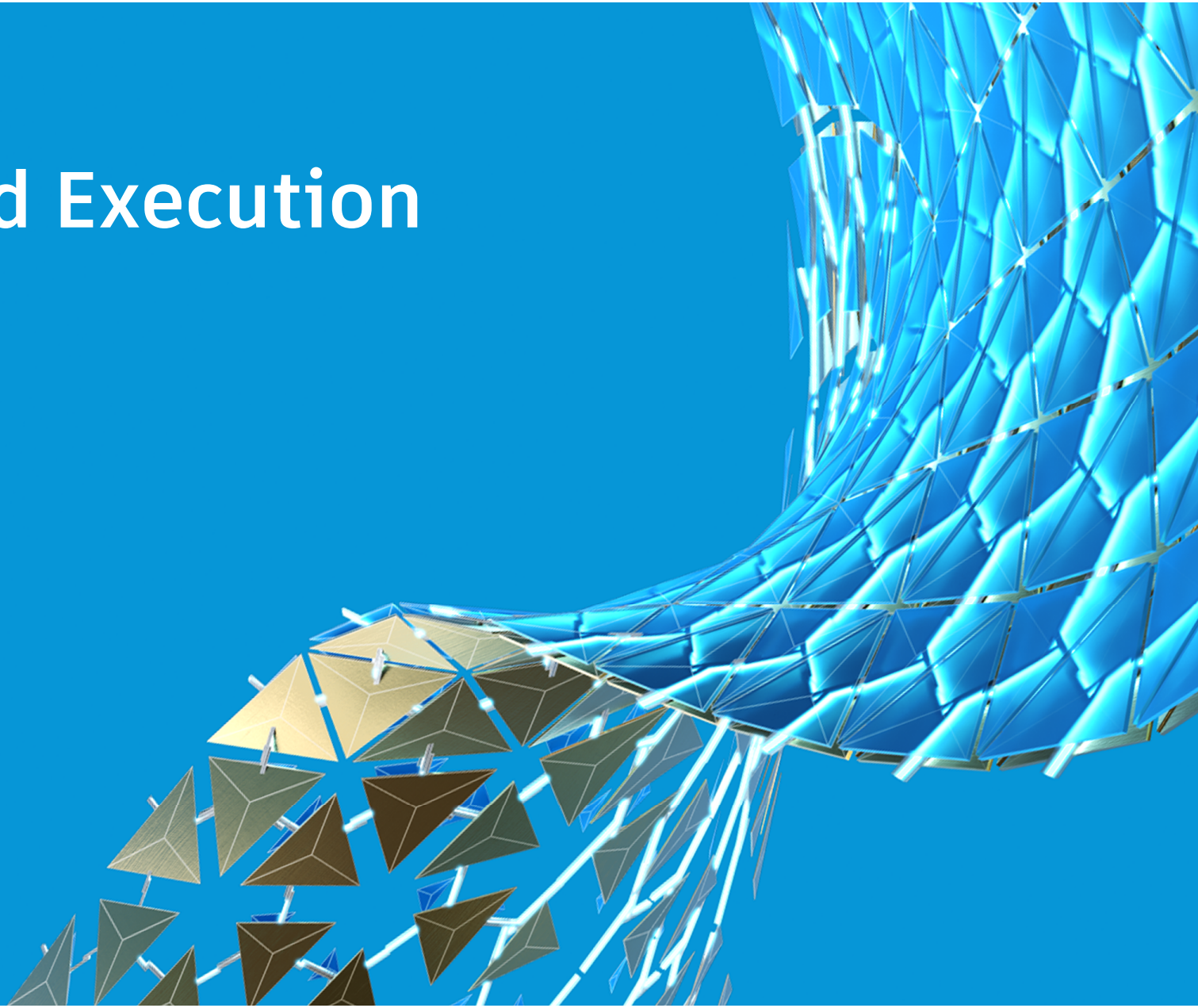
| # | Konto - Co2-eq | Co2-eq |
|----|-----------------------------|-----------|
| 01 | Felleskostnader | 0 |
| 02 | Bygning | 1 073 904 |
| 03 | VVS-installasjoner | 0 |
| 04 | Elkraft | 0 |
| 05 | Tele og automatisering | 0 |
| 06 | Andre installasjoner | 0 |
| 07 | SUM 01-06 HUSKOSTNAD | 1 073 904 |
| 07 | Utendørs | 0 |
| 08 | SUM 01-07 ENTREPRISEKOSTNAD | 1 073 904 |
| 08 | Generelle kostnader | 0 |
| 09 | SUM 01-08 BYGGEKOSTNAD | 1 073 904 |
| 09 | Spesielle kostnader | 0 |
| 10 | Mva | 0 |
| 10 | SUM 01-10 BASISKOSTNAD | 1 073 904 |
| 11 | Forventet tillegg | 0 |
| 11 | SUM 01-11 PROSJEKTKOSTNAD | 1 073 904 |
| 12 | Usikkerhetsavsetning | 0 |
| 12 | SUM 01-12 KOSTNADSRAMME | 1 073 904 |
| 13 | Prisregulering | 0 |
| 13 | SUM KONTOPLAN | 1 073 904 |

Co2-eq verdier er beregnet for 60 år

Kalkyle Kalkyle LCC Kalkyle Co2-eq Kalkyle Vekt Kalkyle Avfall

Co2-eq Calculation

Model Based Execution

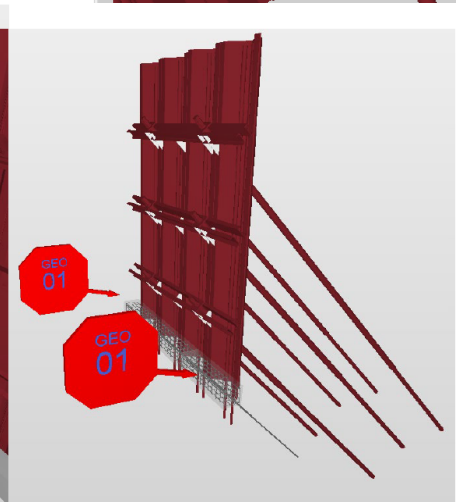
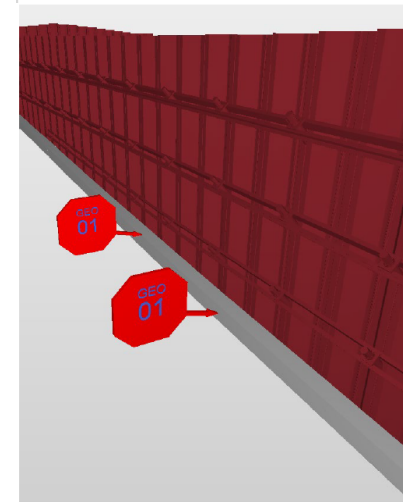
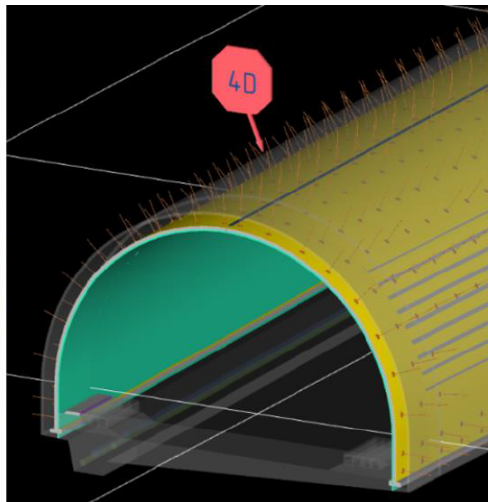
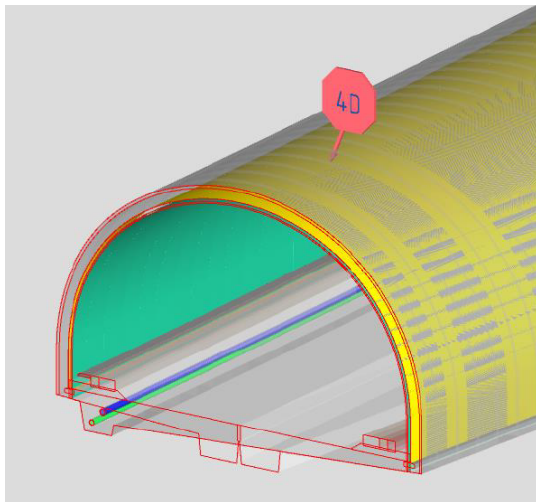
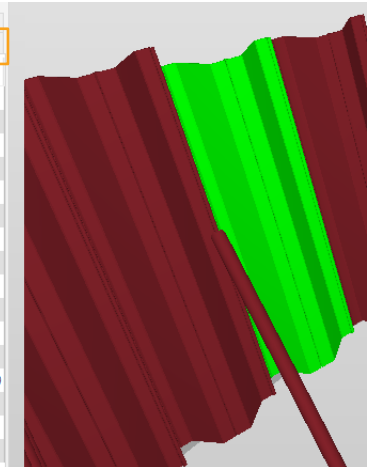


Customised Models

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

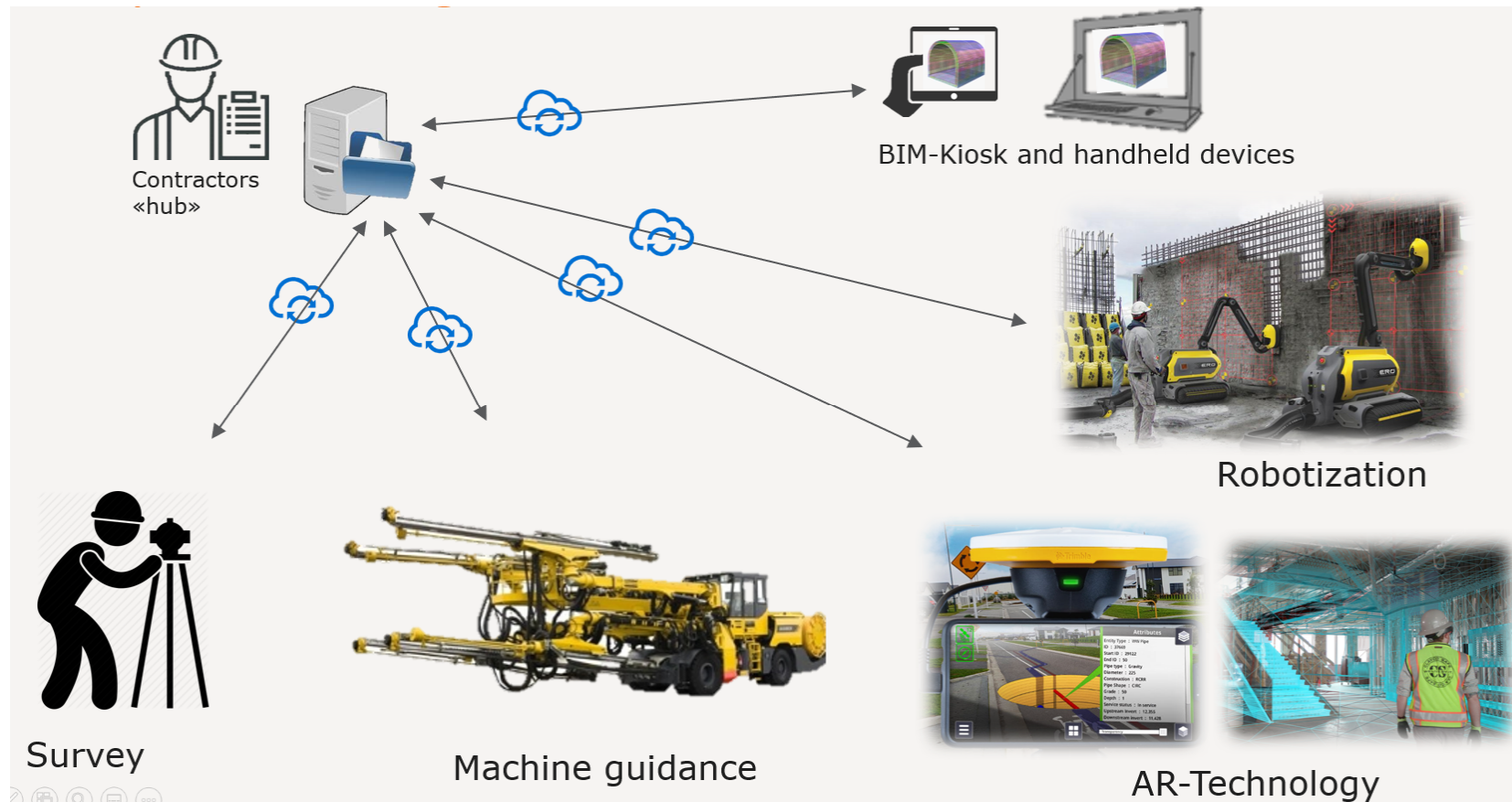
| Identification | Location | Quantities | Material | Relations | Classification |
|-----------------------|--|------------|-----------|--------------|----------------|
| Hyperlinks | BaseQuantities | FOB_Info | FOB_Merke | PGF_GEO_Info | PGF_Info |
| Property | Value | | | | |
| FOB_Eksistensstatus | 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 stålsjunt (m2) | | | | |
| FOB_Mengdelistepost 2 | 83.6134 Ramming av stålsjunt (m2) | | | | |
| FOB_Mengdelistepost 3 | 83.6151 Sveising av stålsjunt (m) | | | | |
| FOB_Mengdelistepost 4 | 83.6132 Påsveising av nær på stålsjunt (m) | | | | |
| FOB_Merknad | -- | | | | |
| FOB_Revisjonsdato | -- | | | | |
| FOB_Status | S4 | | | | |



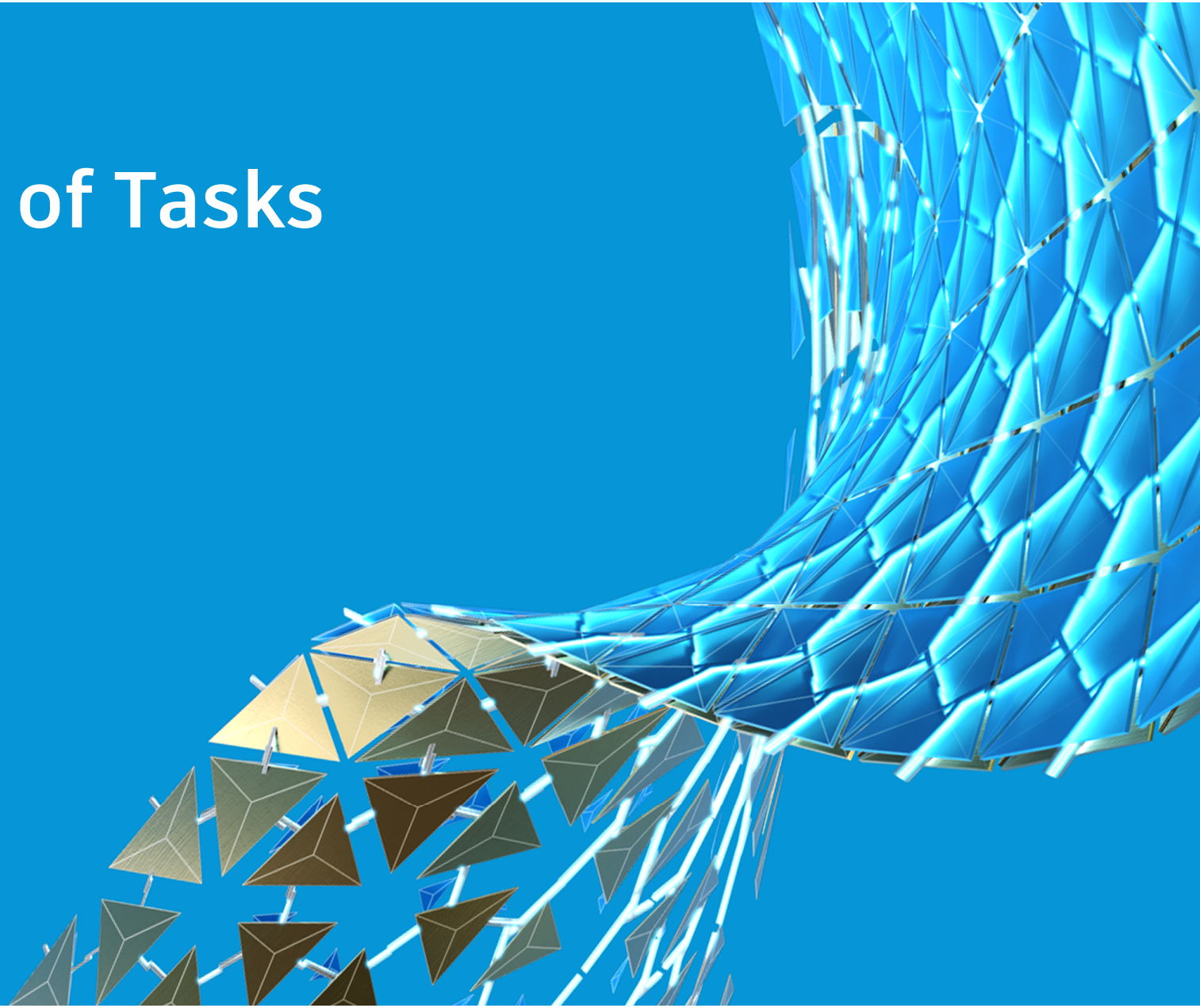
Possible Use of “New” Technology

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

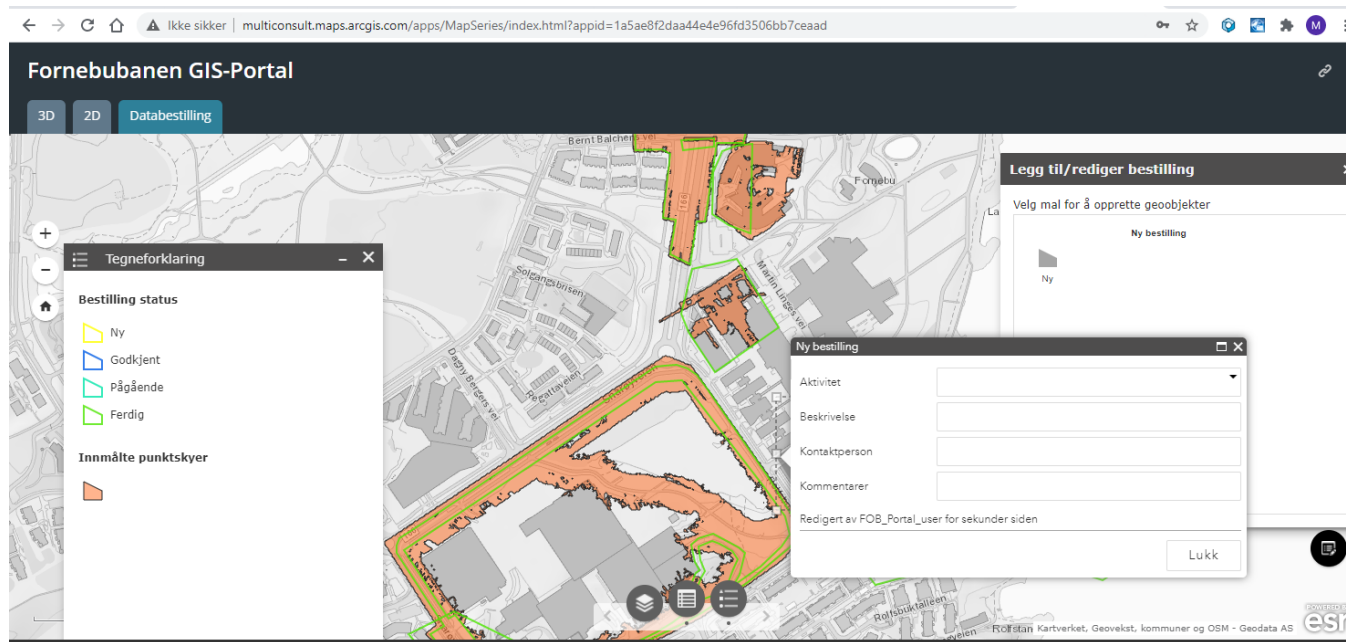
- Machine guiding (GPS) for excavation, piling and drilling
- AR and/or VR for the craftsmen at site
- Other use of handheld devices



Automation of Tasks



GIS Web Portal for order Basis Data – Reality Capture



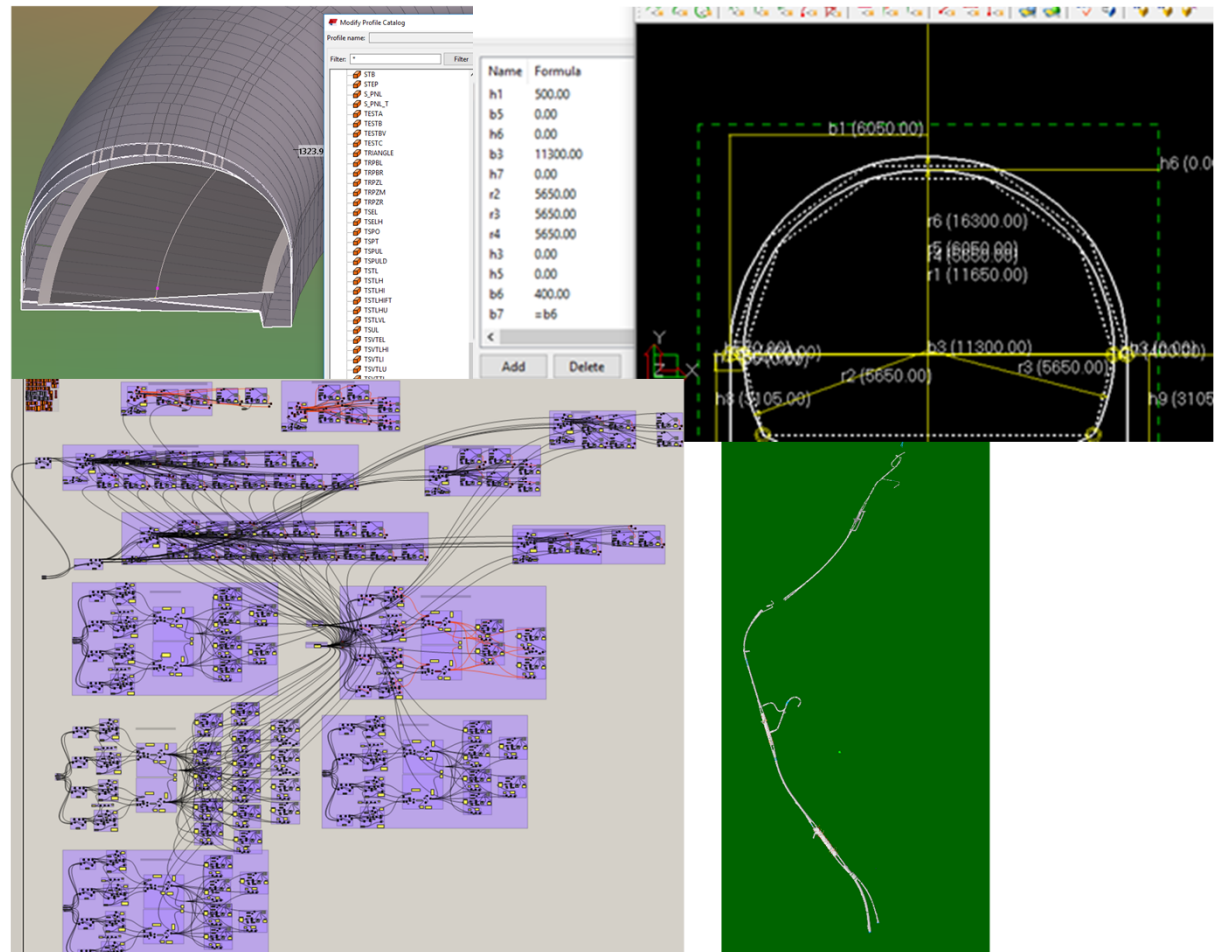
- **Web based system to keep track of:**
 - All data captures that have been collected
 - Easy to create a new order for reality capture
 - Draw a polygon
 - Enter what kind of data needed

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.

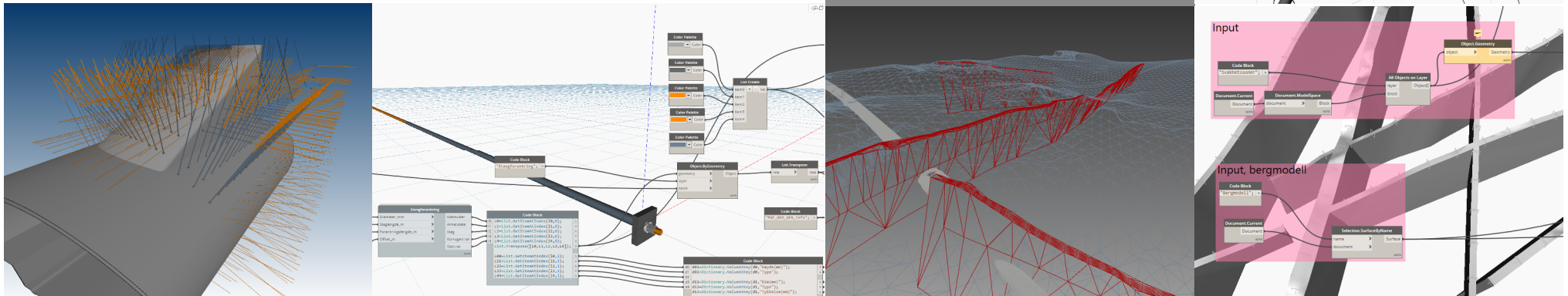


Dynamo and Civil 3D - Geology

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

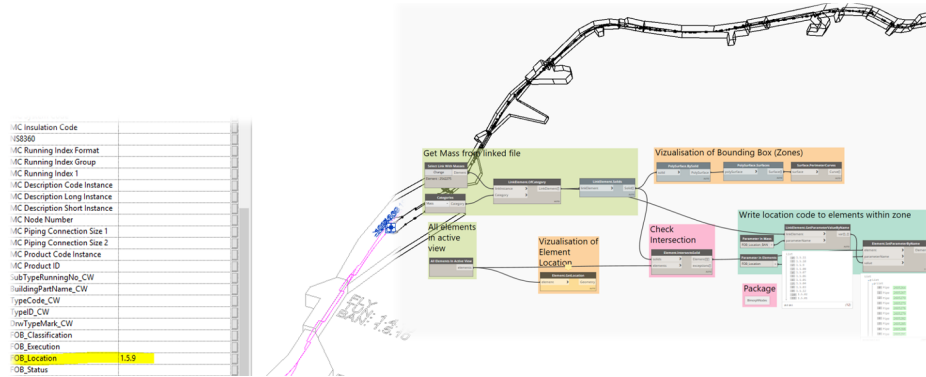
- Visualisation of drilling samples
- Modelling weakness zones in rock
- Modelling rock anchoring

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

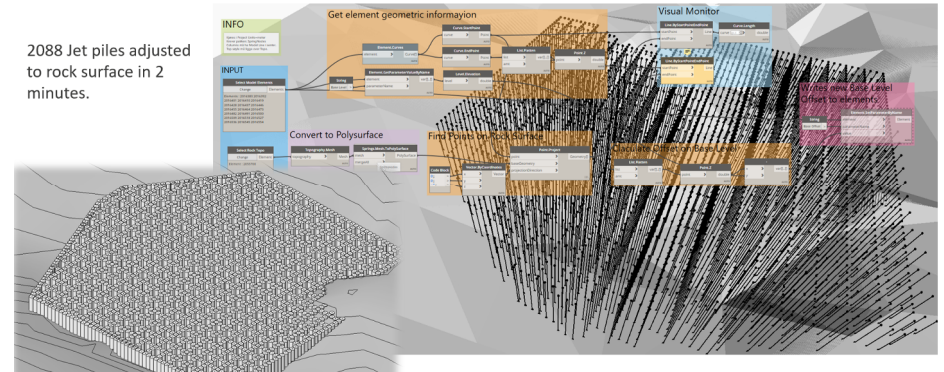


Over 30 Dynamo scripts in the project. Here are some..

Dynamo and Revit

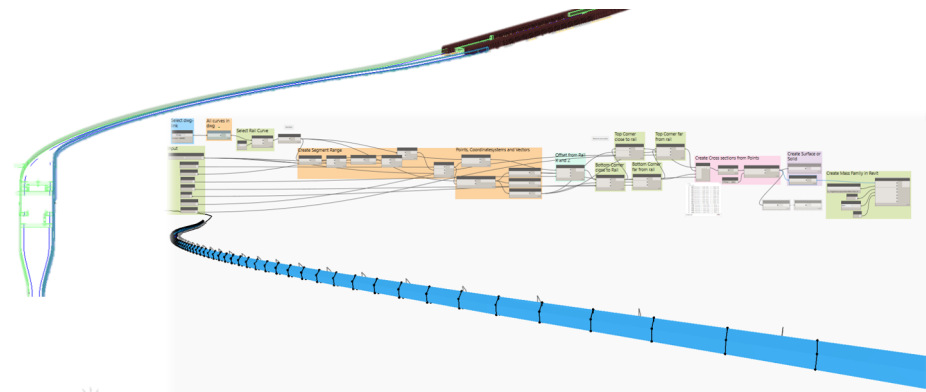


WBS-Coding of elements

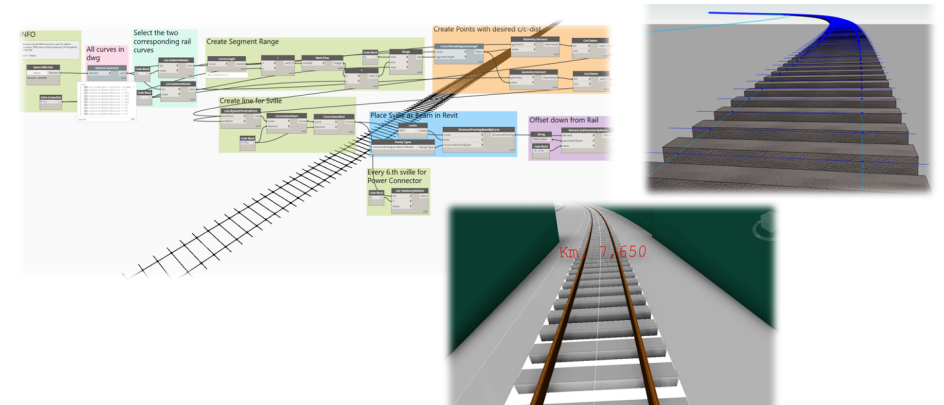


2088 Jet piles adjusted to rock surface in 2 minutes.

Jetpiles extend to surface



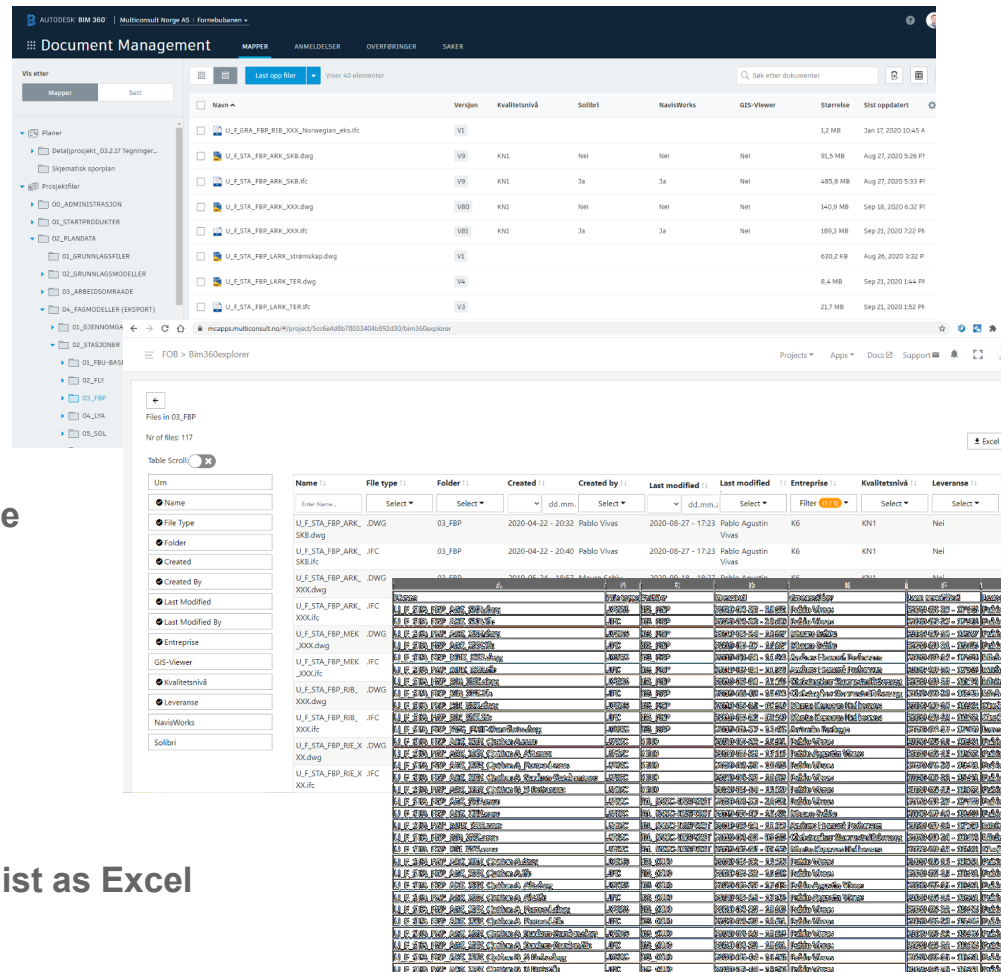
Model 3D escape zones along rail path



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

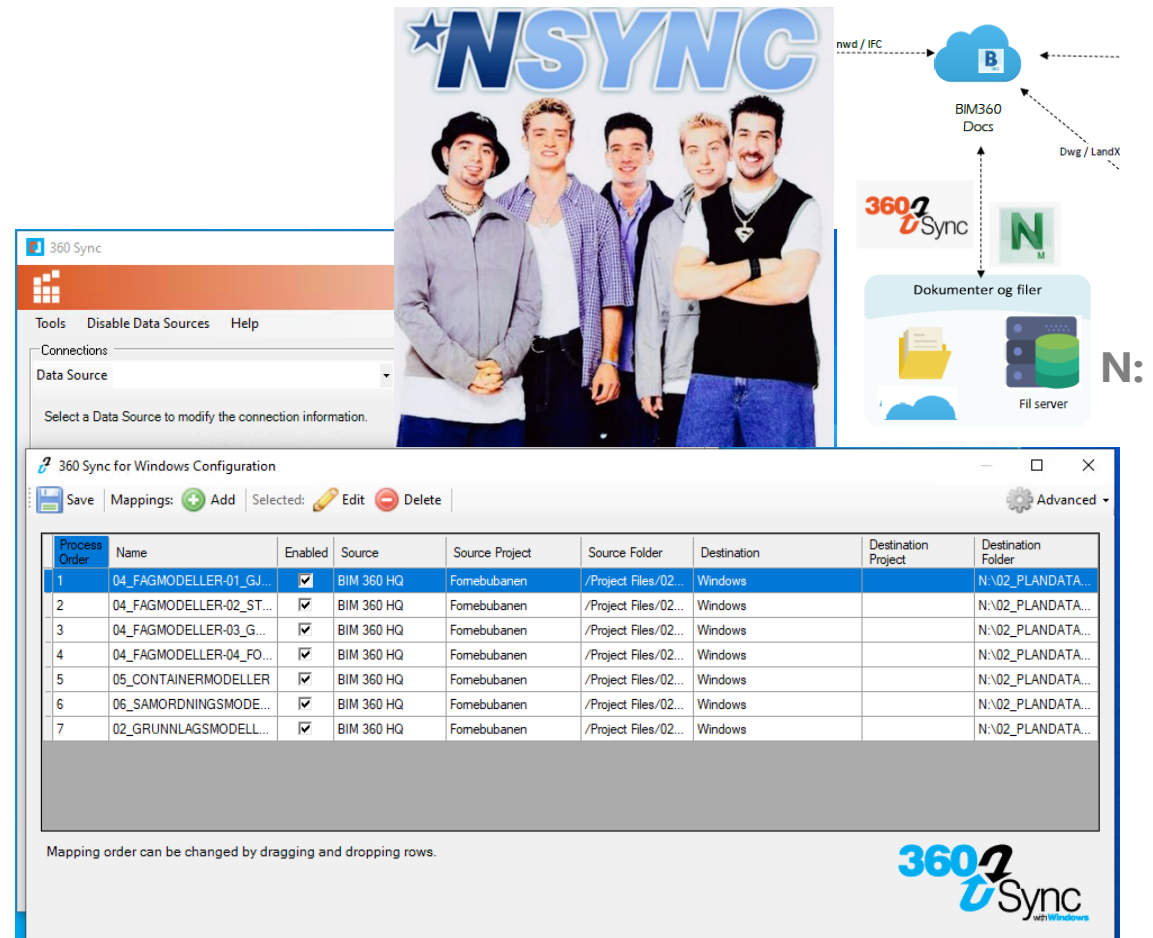
The 'NSync

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



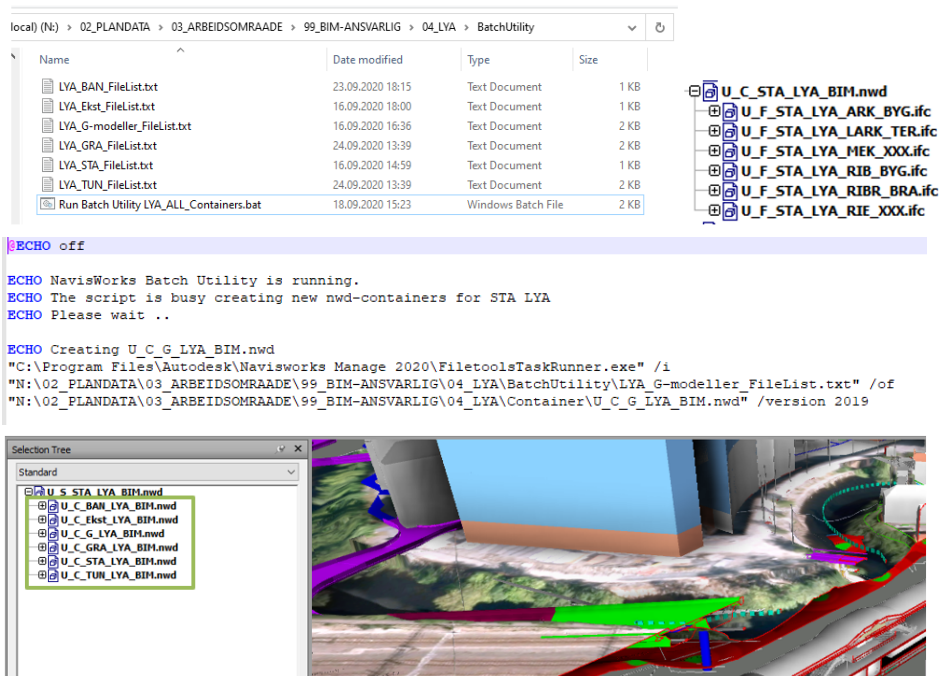
The diagram illustrates the 'NSync workflow. It shows a cloud icon labeled 'BIM360 Docs' connected to a local 'Fil server' (file server) via a dashed line labeled 'Dwg / LandX'. The 'Fil server' is represented by a folder icon and a server rack icon. The '360 Sync' application is shown as a window with a menu bar (Tools, Disable Data Sources, Help) and a 'Connections' section. Below this, a table titled '360 Sync for Windows Configuration' lists mappings between BIM 360 HQ and local folders. The table has columns for Process Order, Name, Enabled, Source, Source Project, Source Folder, Destination, Destination Project, and Destination Folder. The mappings are as follows:

| Process Order | Name | Enabled | Source | Source Project | Source Folder | Destination | Destination Project | Destination Folder |
|---------------|-------------------------|-------------------------------------|------------|----------------|----------------------|-------------|---------------------|--------------------|
| 1 | 04_FAGMODELLER-01_GJ... | <input checked="" type="checkbox"/> | BIM 360 HQ | Fomebubanen | /Project Files/02... | Windows | | N:\02_PLANDATA... |
| 2 | 04_FAGMODELLER-02_ST... | <input checked="" type="checkbox"/> | BIM 360 HQ | Fomebubanen | /Project Files/02... | Windows | | N:\02_PLANDATA... |
| 3 | 04_FAGMODELLER-03_G... | <input checked="" type="checkbox"/> | BIM 360 HQ | Fomebubanen | /Project Files/02... | Windows | | N:\02_PLANDATA... |
| 4 | 04_FAGMODELLER-04_FO... | <input checked="" type="checkbox"/> | BIM 360 HQ | Fomebubanen | /Project Files/02... | Windows | | N:\02_PLANDATA... |
| 5 | 05_CONTAINERMODELLER | <input checked="" type="checkbox"/> | BIM 360 HQ | Fomebubanen | /Project Files/02... | Windows | | N:\02_PLANDATA... |
| 6 | 06_SAMORDNINGSMODE... | <input checked="" type="checkbox"/> | BIM 360 HQ | Fomebubanen | /Project Files/02... | Windows | | N:\02_PLANDATA... |
| 7 | 02_GRUNNLAGSMODELL... | <input checked="" type="checkbox"/> | BIM 360 HQ | Fomebubanen | /Project Files/02... | Windows | | N:\02_PLANDATA... |

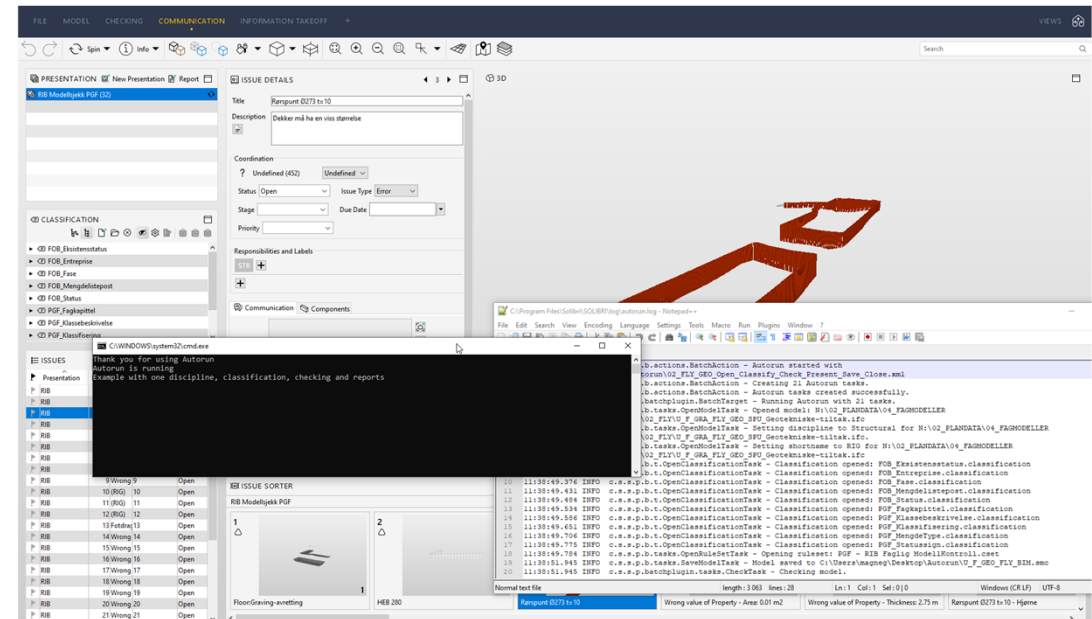
Below the table, a note states: 'Mapping order can be changed by dragging and dropping rows.' The 360 Sync logo is visible in the bottom right corner of the application window.

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.



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

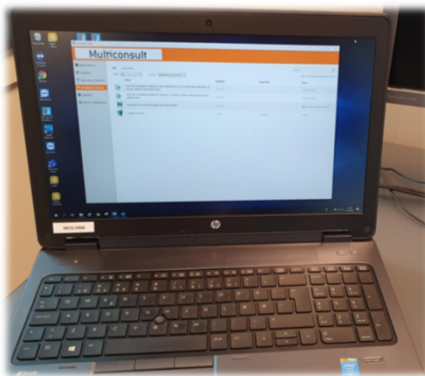


Task Scheduler

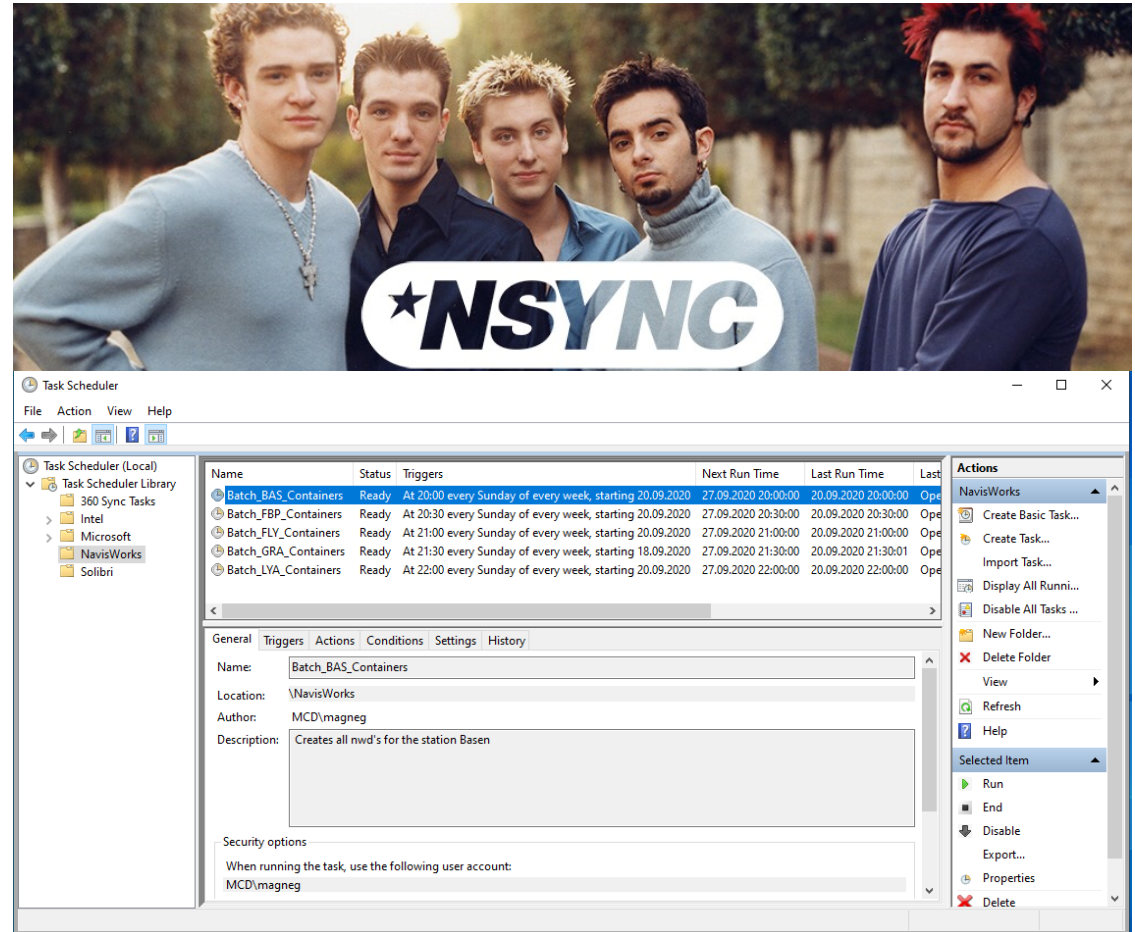
With a little help from our friend 'Nsync and Windows Task Scheduler both the 360 Sync, Navisworks Batch Utility and Solibri Autorun is executed outside office hours.

Synchronize files every night.

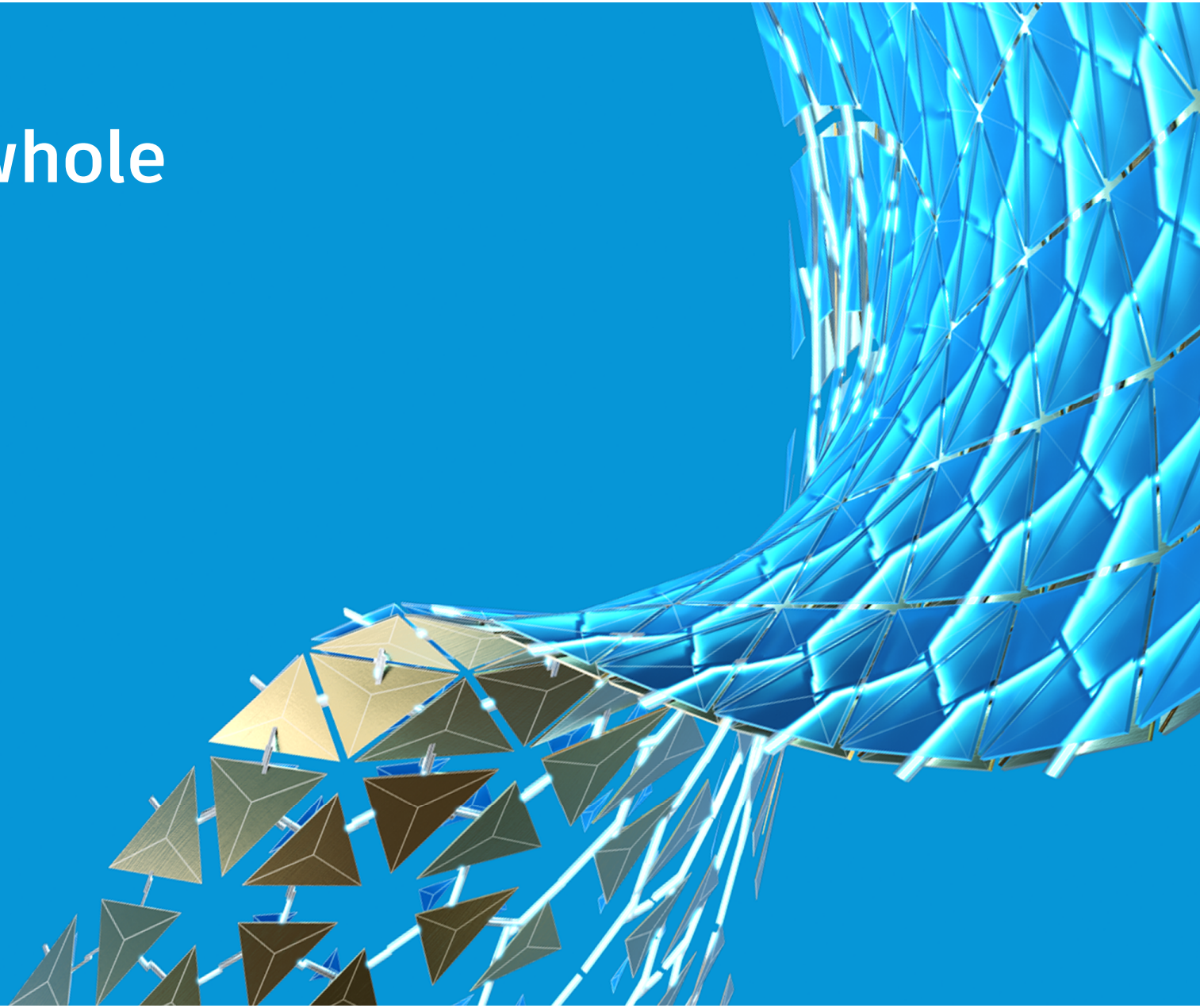
New Containers and Solibri models every Monday.



<- The real N'sync

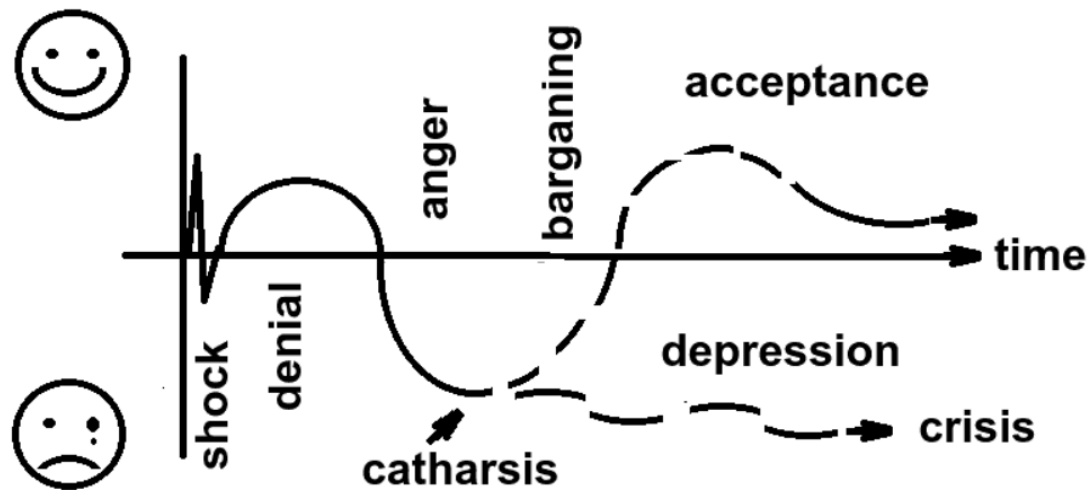


Involve the whole
organization



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

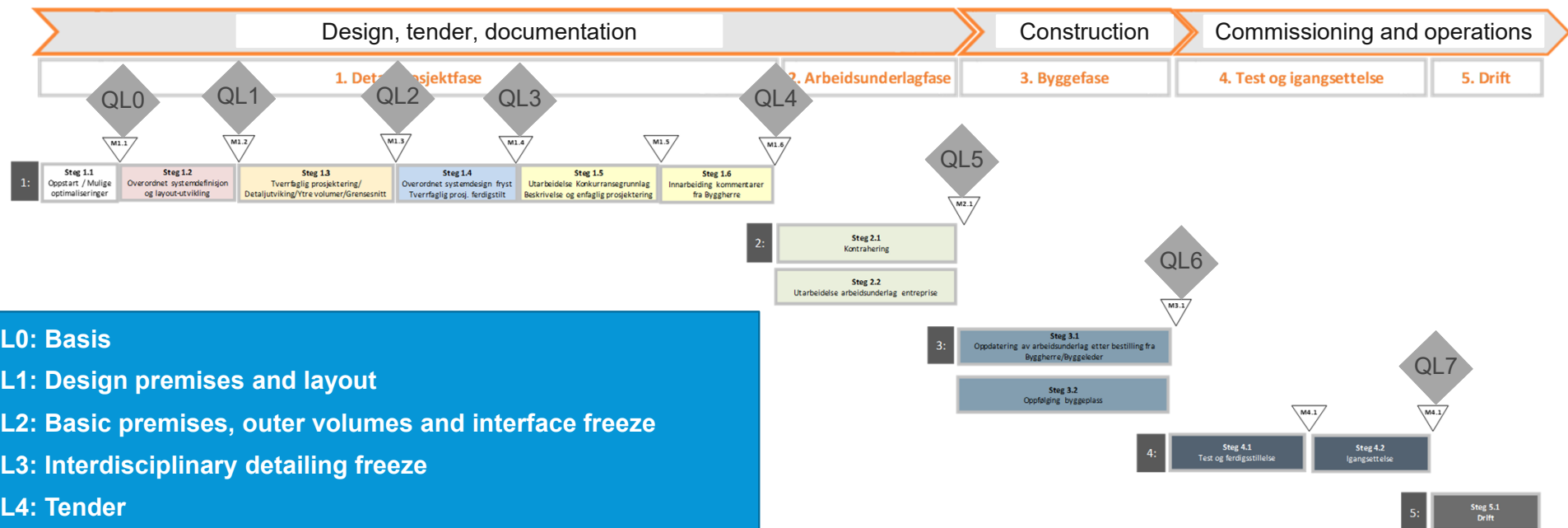
- Change management
 - Communication
- } Non-stop work in progress



Kübler-Ross model / Five stages of grief

How people react when introducing new methodology and software?

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

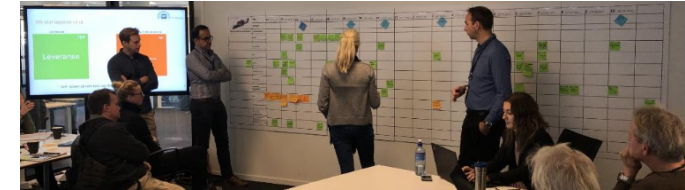
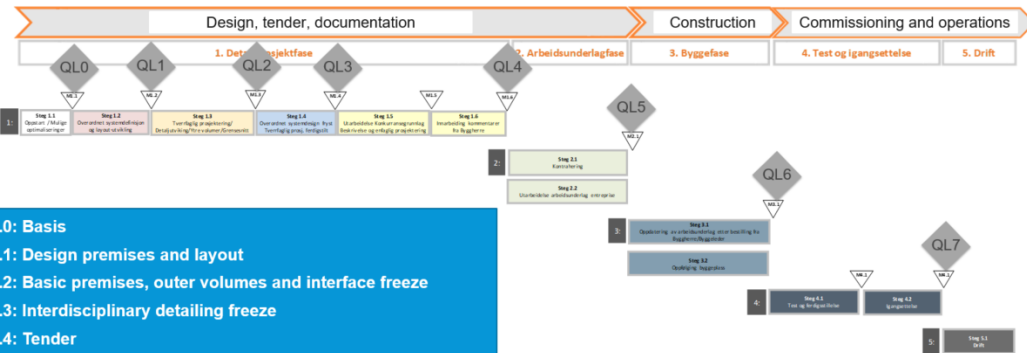
QL5: Work documentation ready

QL6: As built

QL7: Ready for operation

Planning and execution

Project Execution Model



Last Planner System (LPS)

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

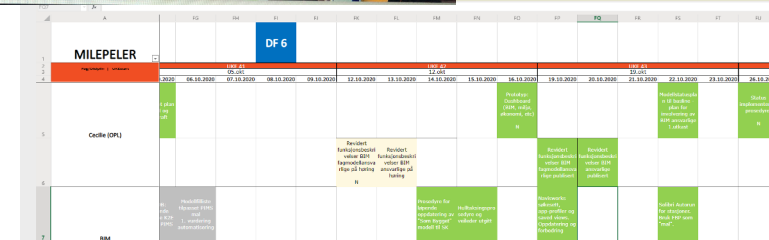
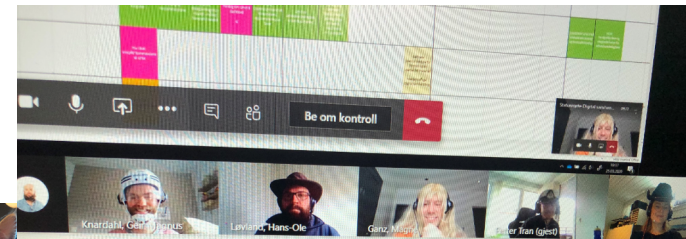
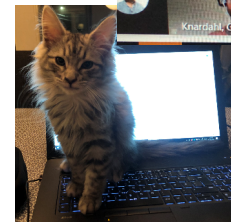
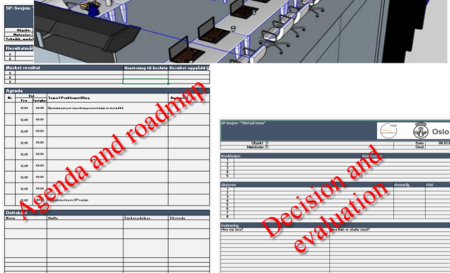
Preferred practice

Covid-19 style



ICE-sessions

- Strict agenda
- Correct resources
- Preparations required



Viewers for everyone

- Navisworks
- Web GIS

BIM is the key information element in our collaboration

- We use a simple user interface with easy accessibility
- There is a low user threshold, and necessary training is provided to everyone in the project
- A digital model is actively used in communication with the project's stakeholders

Vision

«The metro of the future is created by innovative collaboration»

Goals and success criteria for collaboration

Collaboration generates innovation

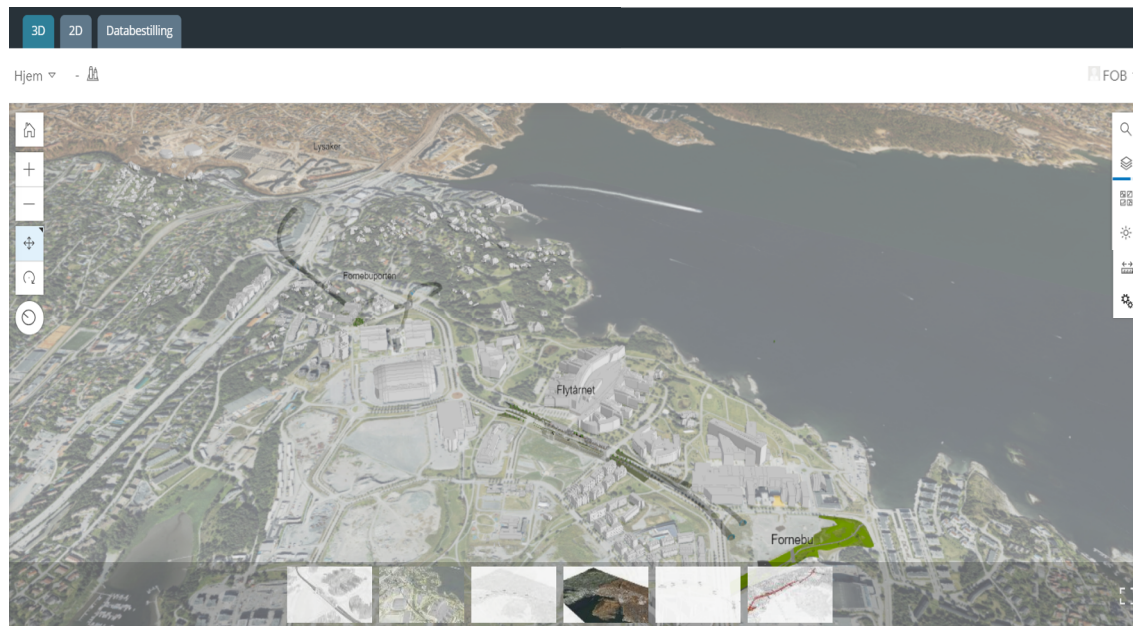
- We work actively with innovation in the project through a defined innovation process and our own workshops
- It is safe to put forward proposals
- We focus on efficiency and think "Lean" in solution development and design

BIM is the key information element in our collaboration

- We use a simple user interface with easy accessibility
- There is a low user threshold, and necessary training is provided to everyone in the project
- A digital model is actively used in communication with the project's stakeholders

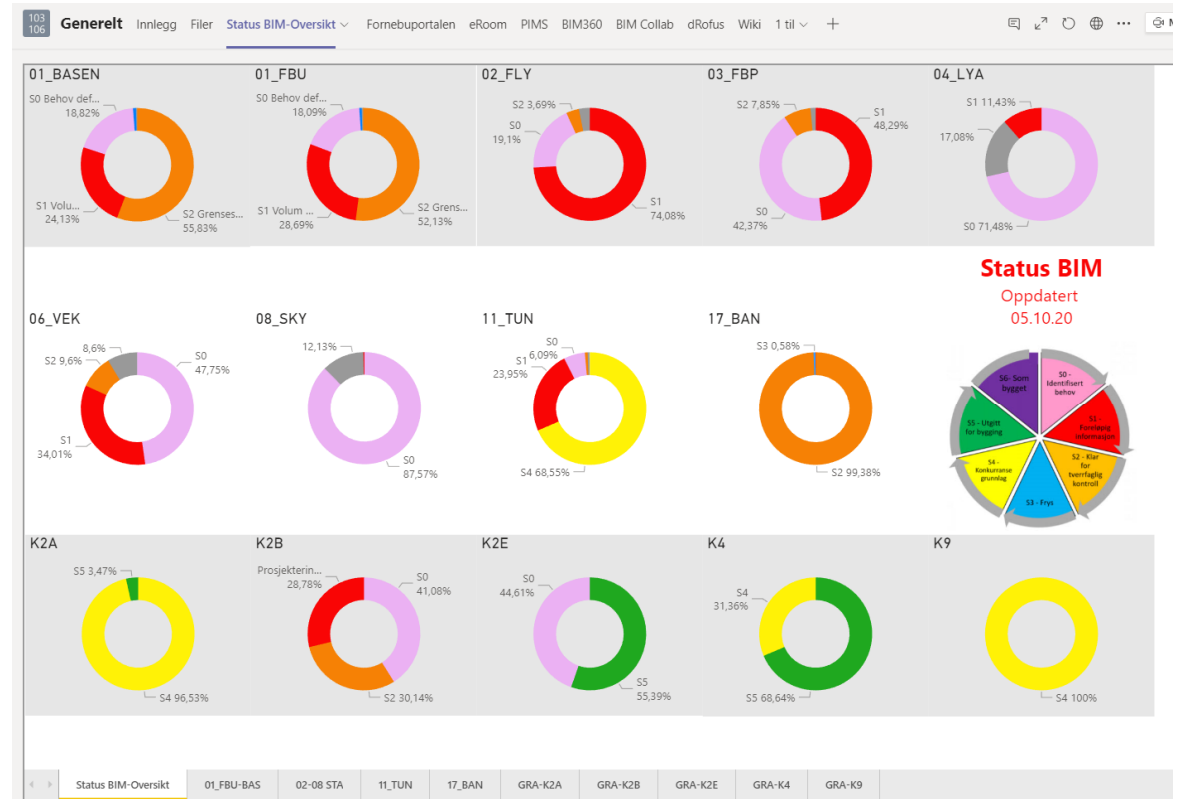
Insight and recognition of each other's roles and competencies will permeate the collaboration

- We work integrated and interdisciplinary
- The project organization and the various roles are clearly defined
- We are good at giving and receiving constructive feedback

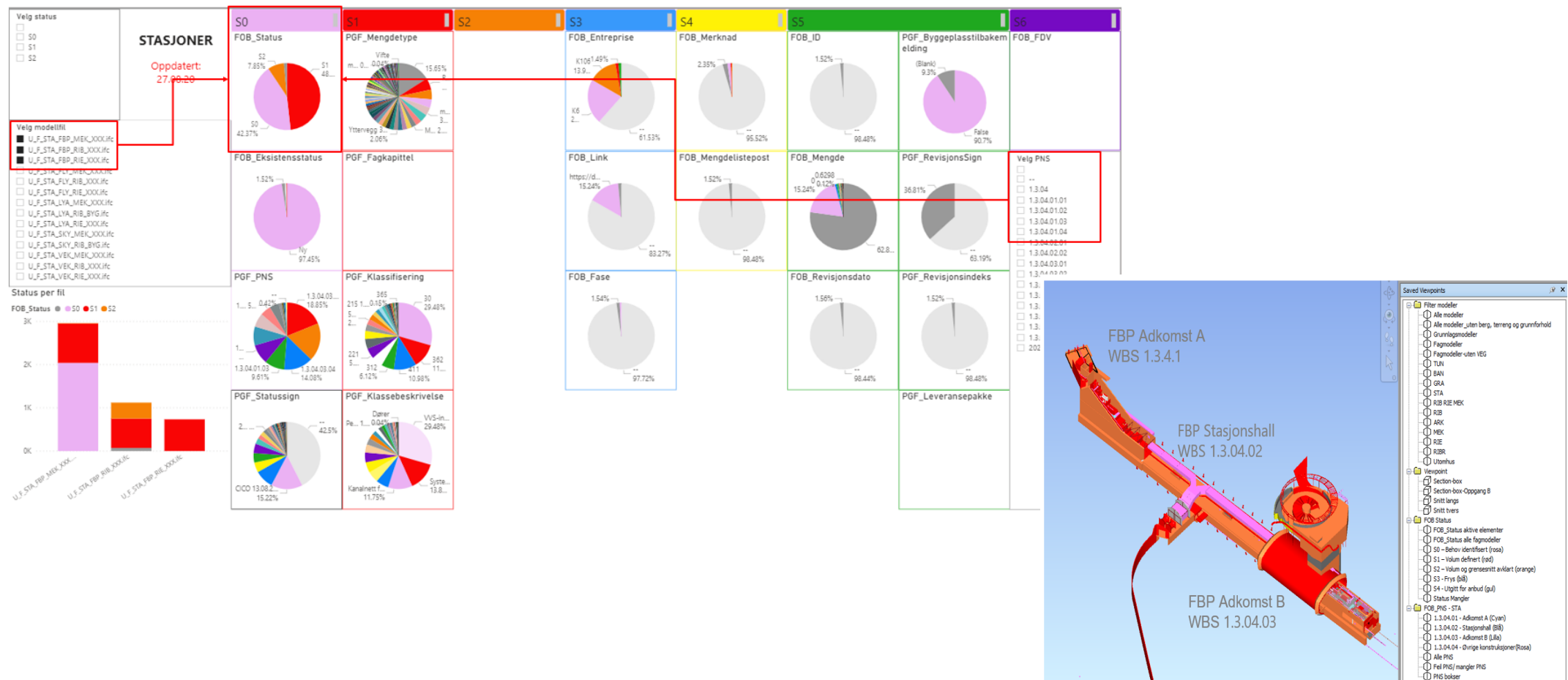


Progress

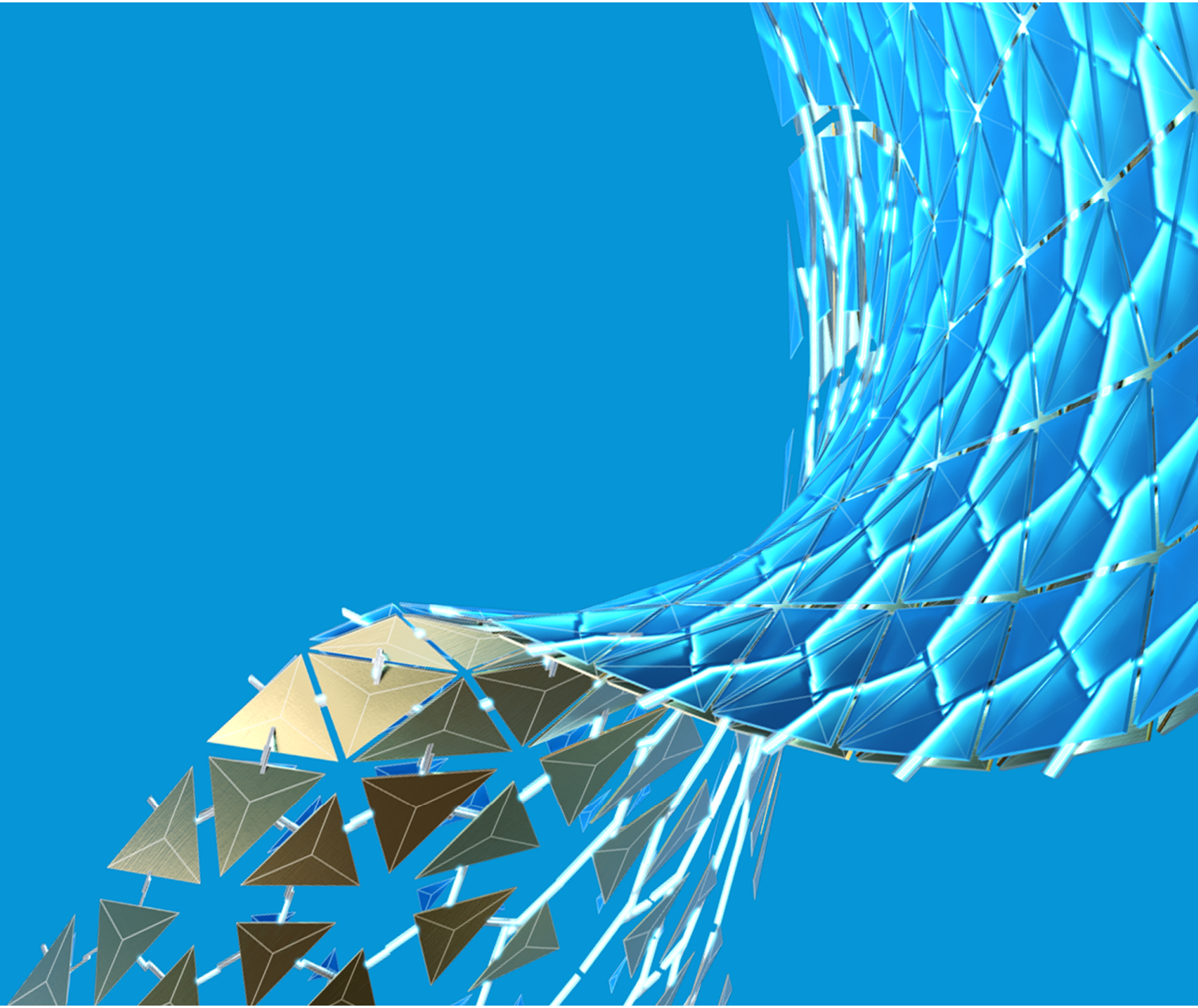
Overview - Progress at a glance
Reported status in all
coordination models



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 situation
 - Testrun of track
 - Universal design
- **Facility Management (using BIM-data in operations)**
- **Digital twin**



Thank you!

