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MFG501919

The Future of Integrated Factory Model Collaboration

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Learning Objectives

- Learn about the critical use cases for factory model collaboration, where cloud solutions can improve the entire process.
- Explore how to exchange data via the Desktop Connector between Vault Professional and Autodesk Docs or Fusion Team.
- Learn how to set up a holistic factory model in a model coordination space within Autodesk BIM Collaborate Pro and Navisworks Manage.
- Explore the possibilities of managing issues, reviewing issues & models and verifying & communicating model changes

Description

Building projects are already realized with the innovative Autodesk Construction Cloud, a data and collaboration platform enabling different planning disciplines and teams to work together in a common data environment. In a factory planning project, those planning disciplines are enhanced with teams needing to integrate complex production lines, conveyor systems, steel structure, and even logistic equipment. Hidden behind firewalls, software installed and running on-premises forces teams to handle time-consuming and inefficient data exchange, disconnected collaboration tracking processes, and inadequate viewing and reviewing of tasks. This class will demonstrate how Autodesk's Cloud Services make it possible to efficiently exchange data between on-premises systems and cloud solutions (off premises). We will showcase and provide a best practice approach and cover how to set up a model coordination space in Autodesk BIM Collaborate Pro to manage a holistic factory model, clashes, issues, and review tasks.

Speaker(s)

Robert Ostermann has been a Factory Designer at MAGNA since 2001 and has spoken at AU2015 and AU2018 Las Vegas concerning Factory Design. He has used the AEC and PD & PM Collection for several years. Further, he is responsible for method developments for "Digital Factory" planning at MAGNA Steyr Fahrzeugtechnik AG & Co KG.
After graduating from a higher technical school for mechanical engineering, he now has more than 20 years of experience in leveraging multiple approaches of different CAD systems for all the disciplines coming together in a factory.

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Introduction

Dear reader, thank you for your interest and reading this document about “The Future of Factory Model Coordination”.

This handout is meant for those trying to figure out the possibilities Autodesk’s cloud solutions can deliver in the context of Factory Planning. This document is for everyone in the AEC industry who’s struggling with machinery & equipment data from a planning and integration perspective as well as those who want to connect the missing links of Autodesk’s data management system (Vault Professional), the Autodesk Construction Cloud (ACC) and Fusion Team and build a better workflow. Additionally, if you are a machinery & equipment designer and can’t or aren’t interested in the Autodesk Construction Cloud, you’ll still gain valuable knowledge using Autodesk cloud solutions.
Together we can bring changes and improvement to the future and will no longer take common workflows for granted.
No matter what your skill level or your job role is, this handout will help you better understand possibilities, deliver insights and considerations that might not have been previously considered.
On AU and other learning platforms, there are and will be many classes teaching you about the products within this handout in considerable detail. However, this document is aimed at providing a bigger picture. Should some learning resources lack enough support, there will be detailed information as well.
Nevertheless, certain challenges can remain; the demanding work of implementing processes into your company or your workflows and convincing people to do things differently and to think beyond the current norms.
Industries as well as Autodesk software tools have developed in different ways due to their varying demands and approaches. With many believing that Autodesk bought some of those software products and should have stuck to AutoCAD as a basis.
In my opinion, AutoCAD specialized toolsets have developed in different ways, and most times a single platform gives you multitools that can do anything but is only good for some tasks.
An example could be; What craftsman would you trust? The one using only a hammer for each task or the one with the large toolbox?
Therefore, this class is about learning and seeing beneficial workflows done with Autodesk software products from at least three major disciplines, AEC, manufacturing and data management, combined into a factory planning workflow.
Moreover, I’d like to motivate those to being more open minded for common workflows from other Autodesk tools that might not be the focus, not only if you are a user, also if you are a CAD manager and particularly if you are an Autodesk AEC product manager.

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Content

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What has driven me to do such a project and to create this class?

The question has been whether or not the Autodesk Construction Cloud (BIM 360) is the right tool for factory planning processes. During a class at AU 2019 an automotive company showed a workflow where generated Navisworks files of the factory were manually uploaded to BIM360, with the only benefit of using the files in an issue management workflow. Further, using the Navisworks project and its review capabilities on a Microsoft OneDrive could have done the same without any additional costs. On the other hand, I a saw a very good class showing how to connect Vault with BIM360 Docs.
It occurred to me that it could be nice to gain the benefits of Vault Professional and possible cloud services and combine them in a workflow for factory planning.
And this chart below shows, what these benefits are for Magna and could be for you as well:

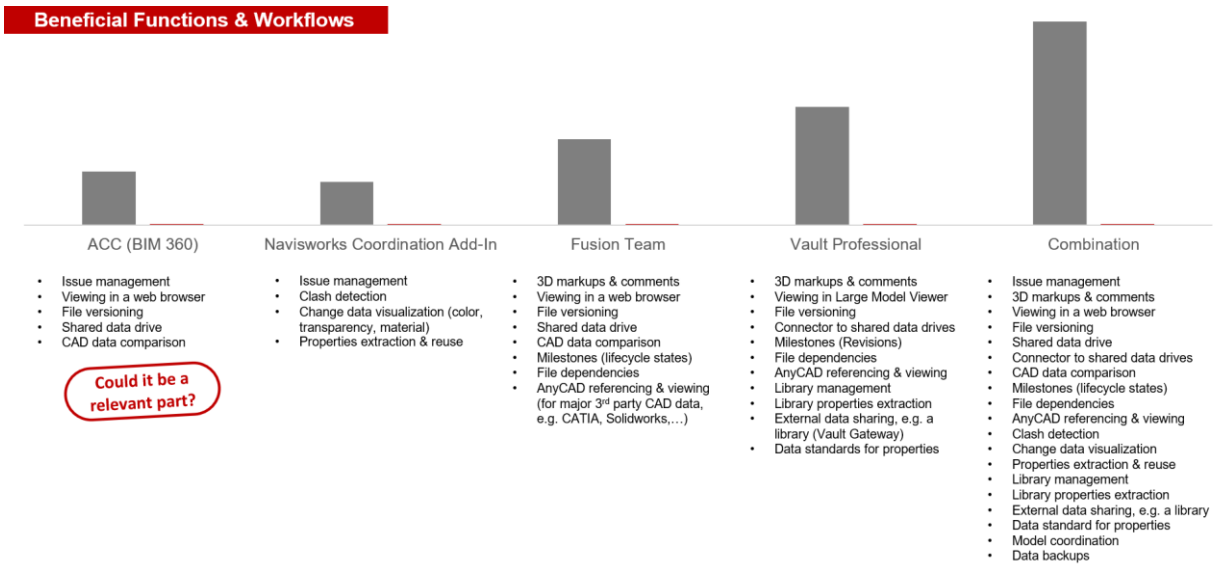

FIGURE 1: POSSIBLE BENEFITS OF COMBINING VAULT PROFESSIONAL AND AUTODESK CLOUD SERVICES

Vault & Magna Steyr Fahrzeugtechnik

Because this document is not specifically about Vault and its capabilities, I'd like to give a brief introduction and point out, that Vault Professional is still the best data management system to handle all of your factory data. That's not only true for Inventor & AutoCAD data or office documents, it's also true for CAD data, such as CATIA, Solidworks, and so on... being used in a Factory Design Utilities workflow.
However, for this handout the important advice is that Vault is also the best tool to:

- Host a Revit library (see Figure 2)
- Manage versions, lifecycle state and properties of your entire Revit projects and families (see Figure 3)
- Understand where and how your data is used, also in combination with Revit, Navisworks and other CAD data (see Figure 4)
- Understand which revision (milestone) of a file is being used in a Revit model (see Figure 5). Which is a more logical, better traceable and easier way compared to a shared and consumed workflows in ACC (see Figure 6)

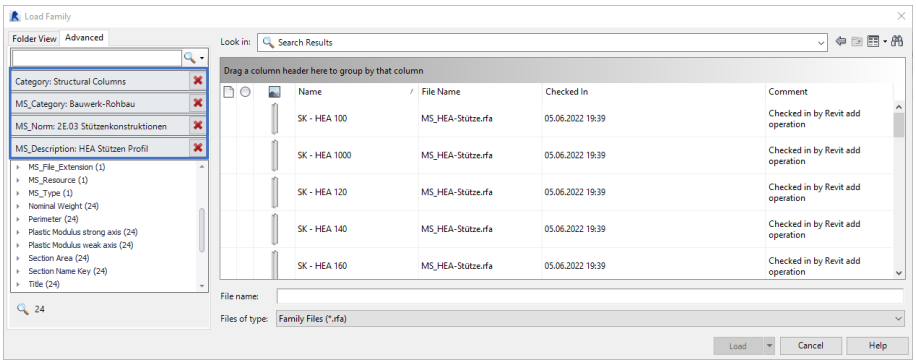

FIGURE 2: VAULT PROFESSIONAL MANAGED REVIT LIBRARY, SEARCHABLE BY ALL FAMILY PROPERTIES

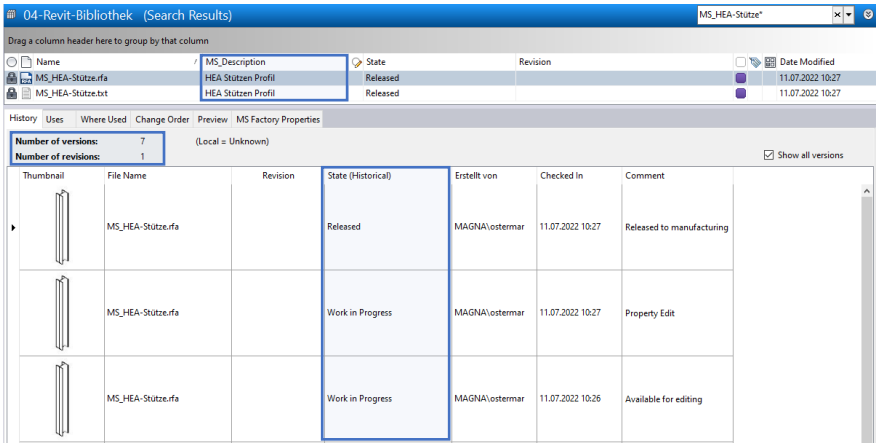

FIGURE 3: VAULT PROFESSIONAL MANAGED VERSIONS, LIFECYCLE STATES AND PROPERTIES FOR REVIT DATA

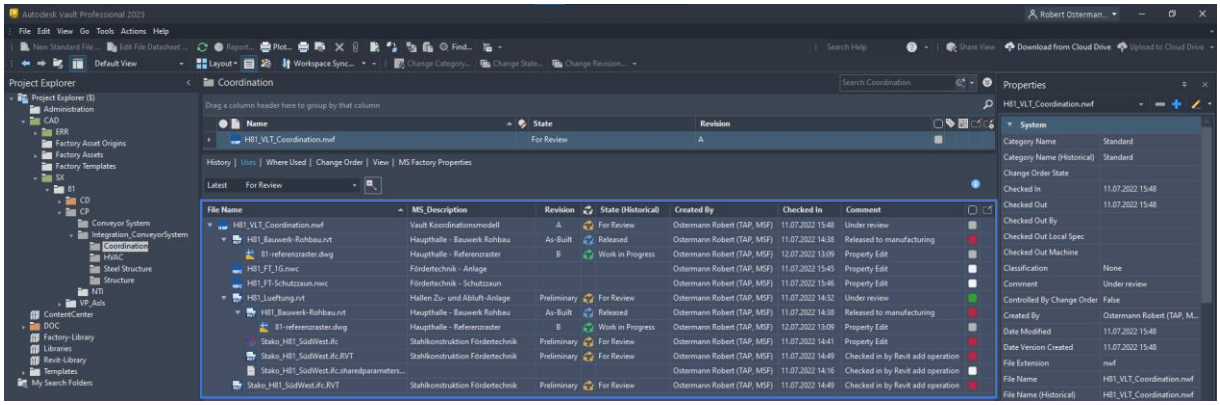

FIGURE 4: WHERE AND HOW FILES ARE USED IN COMBINATION WITH REVIT, NAVISWORKS AND OTHER CAD DATA

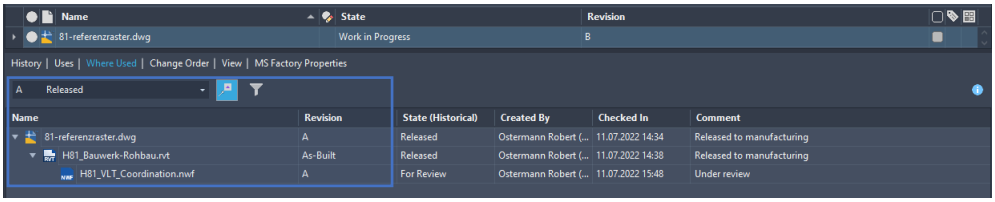

FIGURE 5: UNDERSTAND WHICH REVISION (MILESTONE) OF A FILE (DWG IN THIS CASE) IS BEING USED IN A REVIT MODEL

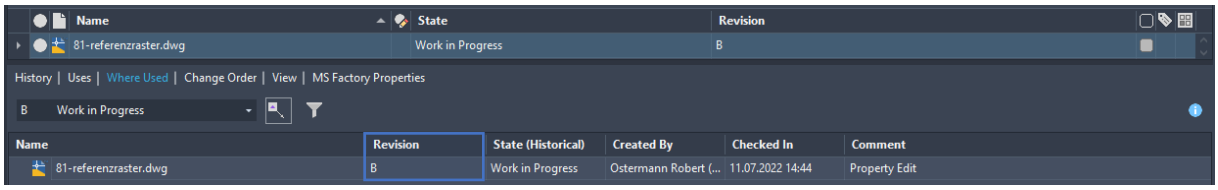

FIGURE 6: COMPARED TO PRIOR FIGURE YOU CAN SEE THAT A NEWER REVISION (B) EXISTS WHICH IS CURRENTLY IN THE STATUS "WORK IN PROGRESS" AND IS NOT BEING USED IN ANY MODEL (E.G. REVIT)

Those are topics, where the ACC (Autodesk Construction Cloud) currently needs improvement, especially if your project goes beyond a Revit project with some sub-models and additional AutoCAD data.
The good news is that you can combine the good functionalities of the ACC with Vault Professional and implement your machinery designs in a better way than by manually putting them into the ACC.

Powered by Autodesk's Cloud Solutions – The CAD Workflow

Additional problems motivated the need to do a project leveraging cloud solutions.
Since moving from hand drawn plans to digitally drawn plans and finally models out of parametric elements, level of details, files dependencies and so on, the gap between people being able to handle CAD and data management products and those who can't is constantly increasing. Several reasons may cause this problem and a separate class would be needed to even start a discussion on this topic.
Leveraging Autodesk cloud solutions enables the potential of bringing back mandatory functionalities in an easy way to a web browser. This will be summarized as decision and analysis tasks taking place directly on the model or plan in a traceable manner. Then, immediately communicate that information back to the right people at the right time.
Essential benefits are the reduction or elimination of data conversions, sent in sperate emails or systems, often happening with time delays and the need of different viewing tools. Which further leads to barely traceable file transmittals, different user experiences for common tasks (viewing, redlining…) and communication separated from the design data. Finally, the CAD models no longer remain integrated and verified in an overall planning process, which is even getting worse due to different external planning teams and disciplines.
For a building design process, the problem could be easily solved by using the ACC (Autodesk Construction Cloud) license package. However, in my opinion, the direction the ACC develops is not sufficient for factory plannings. Although Autodesk would have the knowledge, the ACC divides CAD users into two groups, the building planners and the machinery and equipment planners, who are basically excluded from ACC workflows.
The workflows in this document will outline a way of doing better.
To begin with, a workflow overview of how to implement Autodesk's Cloud Solutions, which is called the CAD workflow can be seen in the following figure.

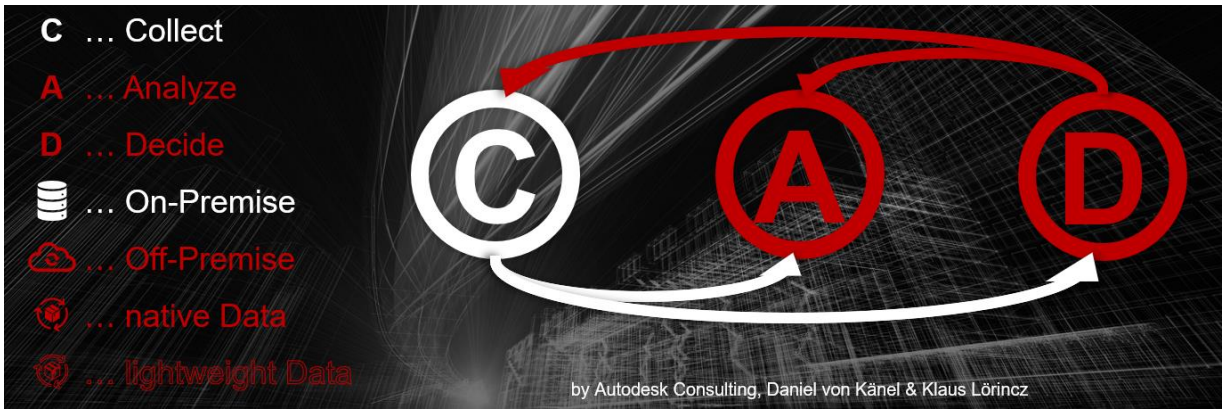

FIGURE 7: THE CAD WORKFLOW & THE USE OF DATA

As you may have seen from the legend, it doesn't mean Computer Aided Design. It means and describes a workflow of data that is collected and used on-premises, exchanged within a project team where decisions and analyses are made within this team, and as you can see from the colors, workflows in red are a cloud solution, white ones are an on-premises solution. Also, I'd like to point out, that both colors and an appropriate symbol will indicate the purpose of a workflow, throughout the entire handout. Sometimes you also will see the symbol to indicate whether data is used in its native format, or as a digital representation called lightweight data (see Figure 7).
It is important to mention, that the basis of this topic and the idea of naming the process the CAD Workflow, has emerged during an Autodesk Cloud consulting project, where we worked together with Autodesk to figure out the possibilities and limitations of relevant tools and services to enable this workflow.

Powered by Autodesk's Cloud Solutions – Involved Systems

Here is a more detailed overview about the systems being able to realize these processes concerning the CAD Workflow:

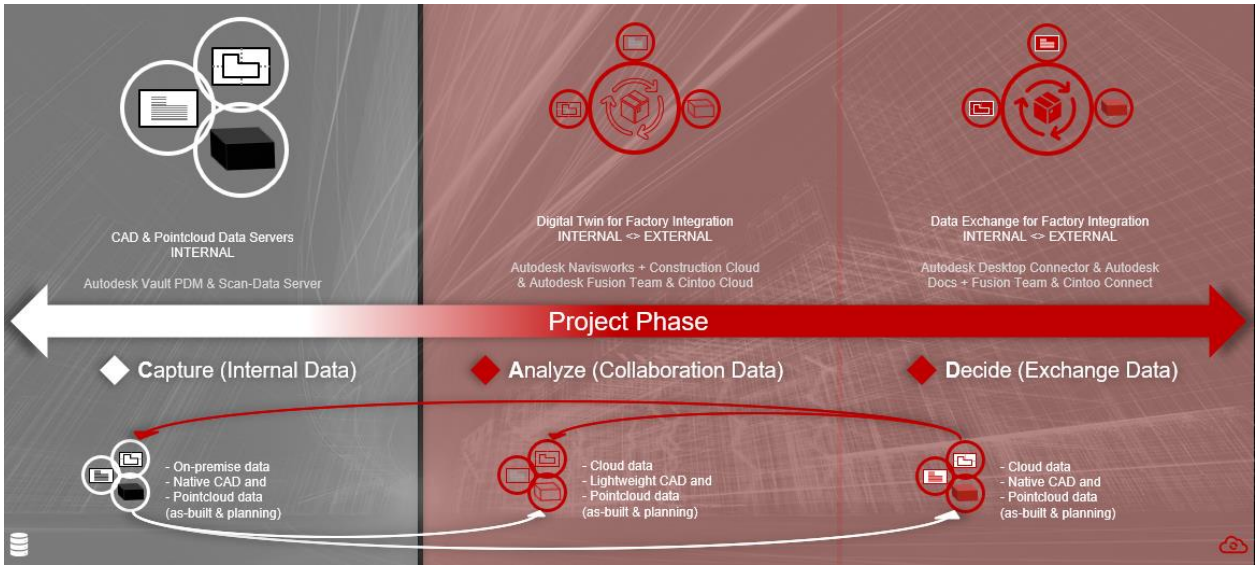

FIGURE 8: THE CAD WORKFLOW AND ITS SYSTEMS

On the left side you can see on-premises systems such as Autodesk VAULT and a Scan Data Server to manage all CAD and pointcloud data. On the right side, systems like Autodesk Docs, Fusion Team & Cintoo Connect guarantee an efficient data exchange to make decisions at the right time with the right data. In the middle, systems like Autodesk Construction Cloud & Fusion Team are being used to efficiently collaborate, communicate and analyze project data amongst different planning disciplines.

Powered by Autodesk's Cloud Solutions – Used Examples

In the handout, the model data being used, is a building structure, an air supply and a reference grid for coordination purposes and are hosted in Vault Professional at project start. A conveyor system with safety fence and supporting steel structure needs to be integrated in the existing situation and will be designed on Autodesk cloud services before being analyzed and communicated within the different teams.
For different reasons the model data will be synchronized back to Vault Professional during the project phase and at the end.

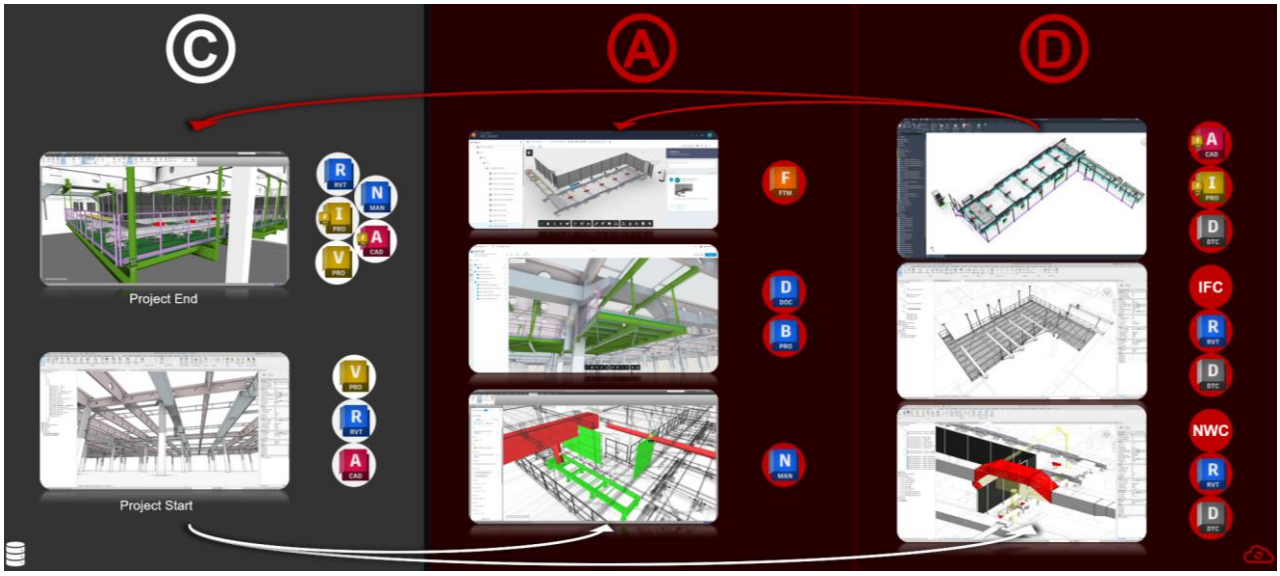

FIGURE 9: EXAMPLES USED FOR DEMONSTRATION PURPOSES IN THE HANDOUT

To see all model videos, you can watch the class recording and presentation on the AU class page: [MFG501919 | The Future of Integrated Factory Model Collaboration]

Powered by Autodesk's Cloud Solutions – Used Software Packages

Here is an overview of which software products will be necessary to enable these workflows:

- AEC Collection (Autodesk Docs Cloud Service) & BIM Collaborate Pro
- Product Design & Manufacturing Collection (Autodesk Fusion Team Cloud Service)
- Autodesk Vault Professional as the leading and connecting data management system

Powered by Autodesk's Cloud Solutions – Critical Use Cases

At Magna, before we started implementing new tools or cloud services, we had a very clear vision about what the most critical use cases were. We focused on processes which were

time consuming, non-transparent, excluding people from their responsibilities or led to the use of unconnected systems. For factory model collaboration we had defined them as:

1. CAD data exchange
2. CAD data issue management
3. CAD data viewing

The following content of this document is structured by these use cases.

Powered by Autodesk's Cloud Solutions – 1. Use Case

CAD Data Exchange for Factory Integration, Workflows & Systems

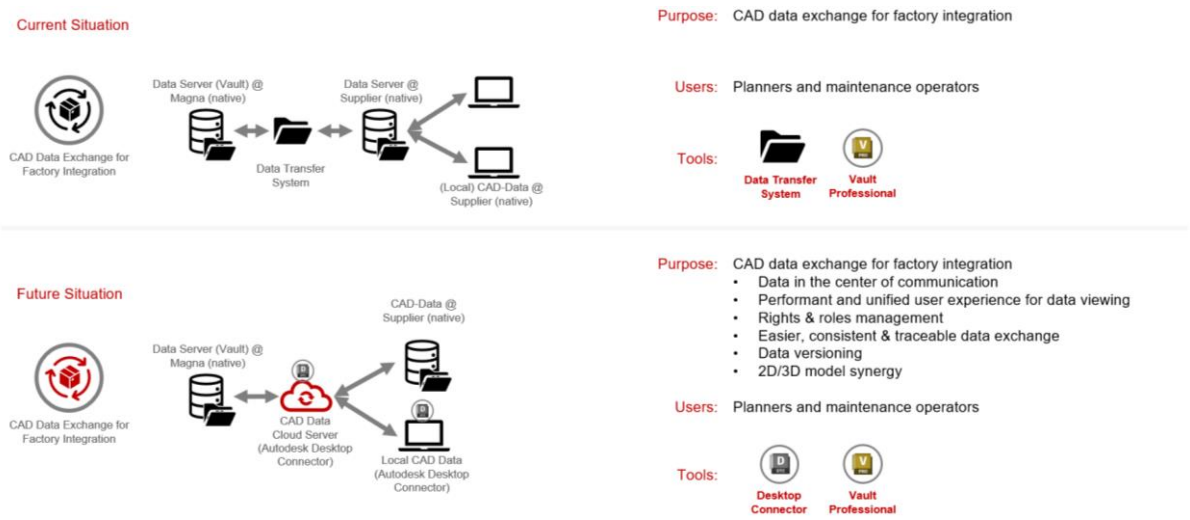

FIGURE 10: DATA EXCHANGE – UNDERSTANDING CURRENT AND FUTURE WORKFLOW WITH AUTODESK COULD SERVICES

It is important to understand your current situation, the difference between using a separate data transfer system or Vault Professional in combination with the Autodesk Desktop Connector (the piece of software connecting on-premises solutions with cloud solutions, similar to how Microsoft OneDrive syncs your local files with OneDrive, Sharepoint or Teams) and an Autodesk cloud service. The significant benefits of this combination are:

- You can view more than 80 file formats in a browser being transferred via the services with a unified and performant user experience.
- You will be able to communicate the content of these files with markups, measurements, issues and so on…
- Your data will be consistent and traceable due to file references being analyzed and transferred

This can be demonstrated in the following examples.

CAD Data Exchange for Factory Integration, Data Exchange: On-premises to Cloud Service

This case is a Revit file with an AutoCAD reference which will be synchronized from Vault Professional to Autodesk Docs via the Autodesk Desktop Connector (see Figure 11)

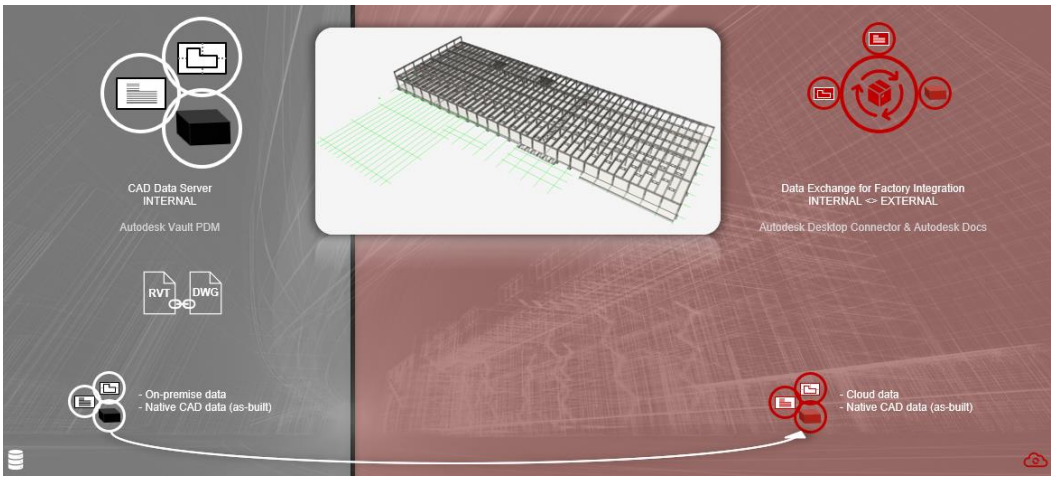

FIGURE 11: A REVIT FILE WITH AN AUTOCAD REFERENCE TO BE TRANSFERRED FROM AUTODESK VAULT TO AUTODESK DOCS VIA DESKTOP CONNECTOR

Therefor the Revit file in Vault (see Figure 12) can be selected and depending on the Vault Project Sync settings uploaded to the appropriate Autodesk Docs project.

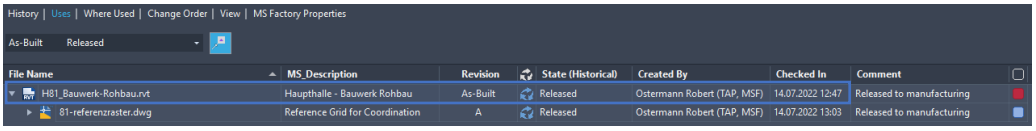

FIGURE 12: REVIT FILE WITH AUTOCAD REFERENCE IN VAULT PROFESSIONAL

A Vault Job and the Desktop Connector (see Figure 13) will transfer the main file and its references, even if not selected and found in different folders in Vault (see Figure 14).

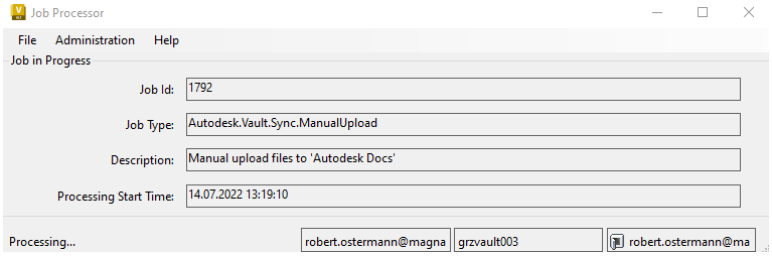

FIGURE 13: VAULT JOB PROCESSOR TRIGGERING DESKTOP CONNECTOR FOR FILE UPLOAD

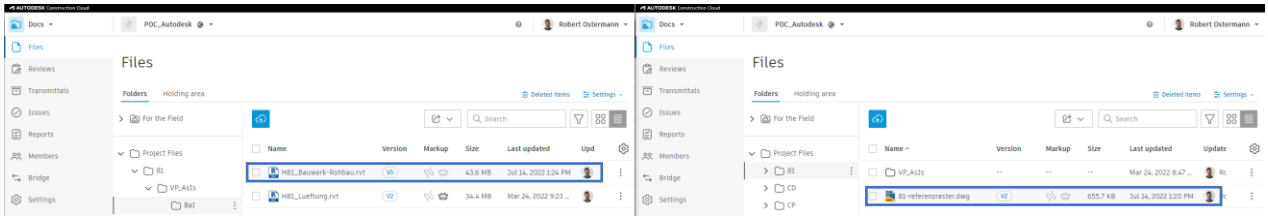

FIGURE 14: VIA VAULT PROJECT SYNC UPLOAD FILES IN AUTODESK DOCS – REVIT FILE (LEFT) WITH AUTOCAD REFERENCE (RIGHT)

Currently and because Docs cannot understand revisions (milestones) or lifecycles I recommend splitting as-build and project (planning) data synchronizations between Vault Professional and Autodesk Docs.

Then the transferred files can be viewed and communicated with other team members in a web browser as soon as a visualization file is processed (see Figure 15).

FIGURE 15: REVIT FILE READY TO BE VIEWED AND COMMUNICATED ON AUTODESK DOCS

CAD Data Exchange for Factory Integration, Workspace for a Building & Building Infrastructure Designer

If you are not familiar with Autodesk Docs and the Construction Cloud, you can think of it as a kind of Microsoft OneDrive with online functionalities to work with the data. So, as soon as data is transferred, it can be used on a shared drive by team members of a project having the appropriate roles & rights. E.g., in a new planning model for an HVAC (Heating, Ventilation, Air Condition) system, directly created on the cloud service (see Figure 16). The building structure model transferred, as seen in the last chapter, could be used or referenced.

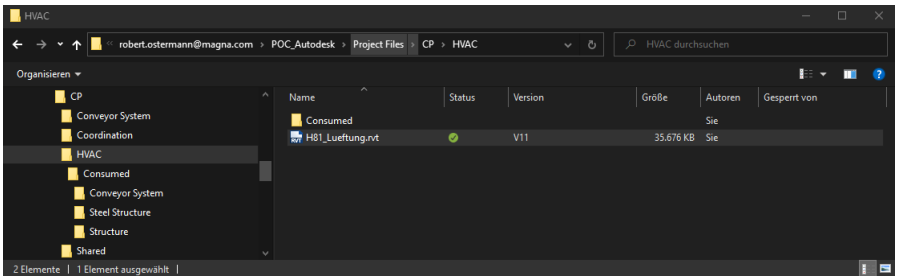

FIGURE 16: SHARED AUTODESK DOCS DRIVE ENABLED BY THE AUTODESK DESKTOP CONNECTOR

By using Revit for building and building infrastructure design directly on the cloud service (see Figure 17) additional functionalities of the Autodesk Construction Cloud will help you to better coordinated and manage your design intent directly in a web browser (see Figure 18).

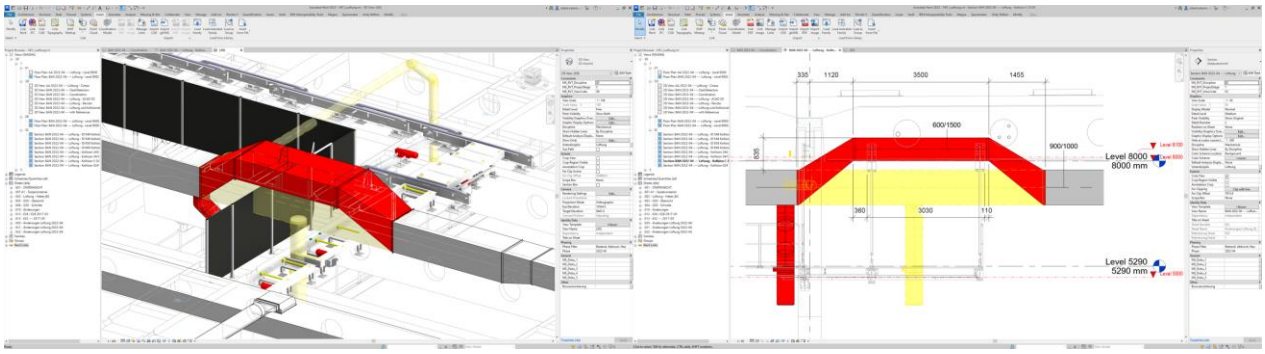

FIGURE 17: REVIT CLOUD MODEL SHOWING HVAC DESIGN

FIGURE 18: AUTODESK CONSTRUCTION CLOUD DESIGN COLLABORATION

From an AEC planner perspective, the entire data flow of this example can be seen as a summary on the following figure:

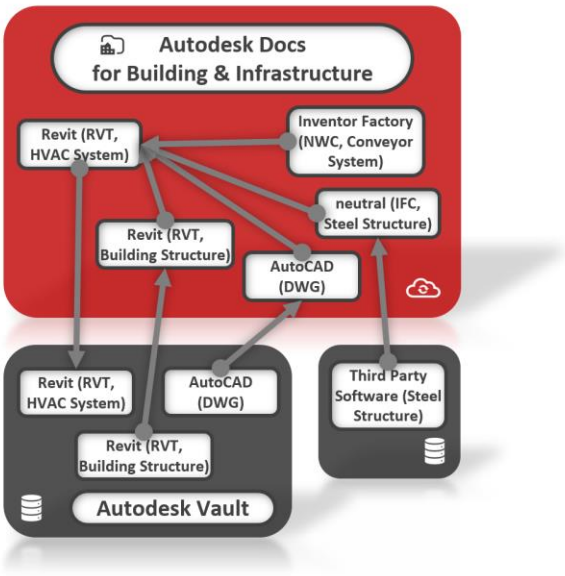

FIGURE 19: DATA FLOW COMBINING AUTODESK DOCS (ACC) WITH AUTODESK VAULT PROFESSIONAL AND THIRD-PARTY CAD DATA AS IFC

You can see a Revit and AutoCAD file for building structure has been submitted by Vault Professional to the cloud service. A model for a new steel structure supporting the conveyor system coming from a third-party software is uploaded as a neutral IFC file. The conveyor system that will come from Fusion Team via Vault Professional, can be seen in detail in the handout later. All models were used to design and coordinate the HVAC system in Revit, which then can be synchronized back to Vault Professional as the overall system being able to manage holistic factory data.

CAD Data Exchange for Factory Integration, Data Exchange: Cloud Service to On-premises DMS

The second case will show files from Fusion Team, which will be synchronized back to Vault Professional via the Autodesk Desktop Connector (see Figure 20)

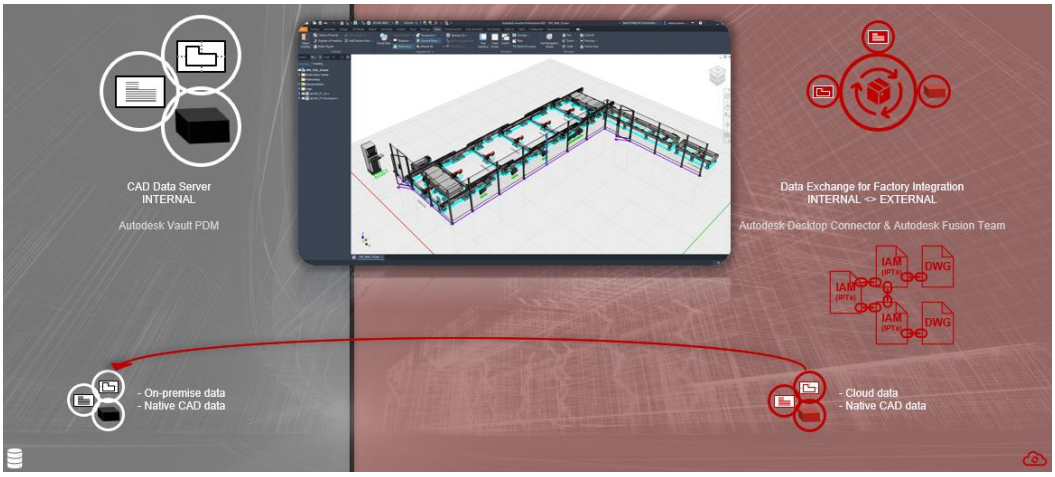

FIGURE 20: AN INVENTOR FACTORY MODEL WITH AN AUTOCAD REFERENCE TO BE TRANSFERRED FROM FUSION TEAM TO AUTODESK VAULT VIA AUTODESK DESKTOP CONNECTOR

Therefor the file on Fusion Team (see Figure 21) can be selected and depending on the Vault Project Sync settings be downloaded to the appropriate Vault Professional folder.

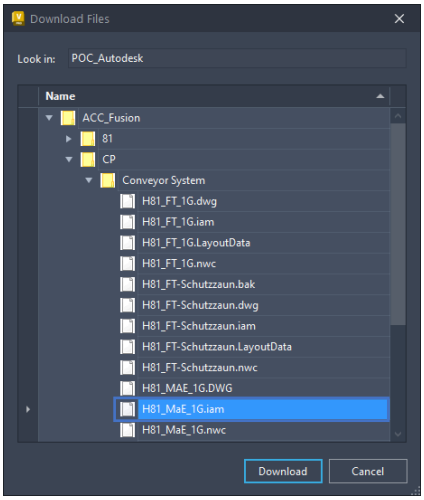

FIGURE 21: MANUAL DOWNLOAD TO VAULT PROFESSIONAL OF AN INVENTOR FACTORY ASSEMBLY

A huge difference between Fusion Team and Autodesk Docs (ACC) is that Fusion Team can understand at least Inventor assemblies, referenced AnyCAD files (which is a technology in Inventor and Fusion that allows 3rd party CAD model formats to be referenced into a design. The original 3rd party CAD package can edit and update the file referenced via AnyCAD and the model will update inside Inventor/Fusion) and AutoCAD references. All dependent files will be synchronized back to Vault, even if not selected and being in different folders. Currently Revit and Navisworks file dependencies will NOT be analyzed on any Autodesk Cloud service!
You will get more information about this later in the CAD Data Issue Management section. After getting the model from Fusion Team, it can be reviewed in Vault with the same user experience as on the web service (see Figure 22) visualizing the entire file structure (see Figure 23).

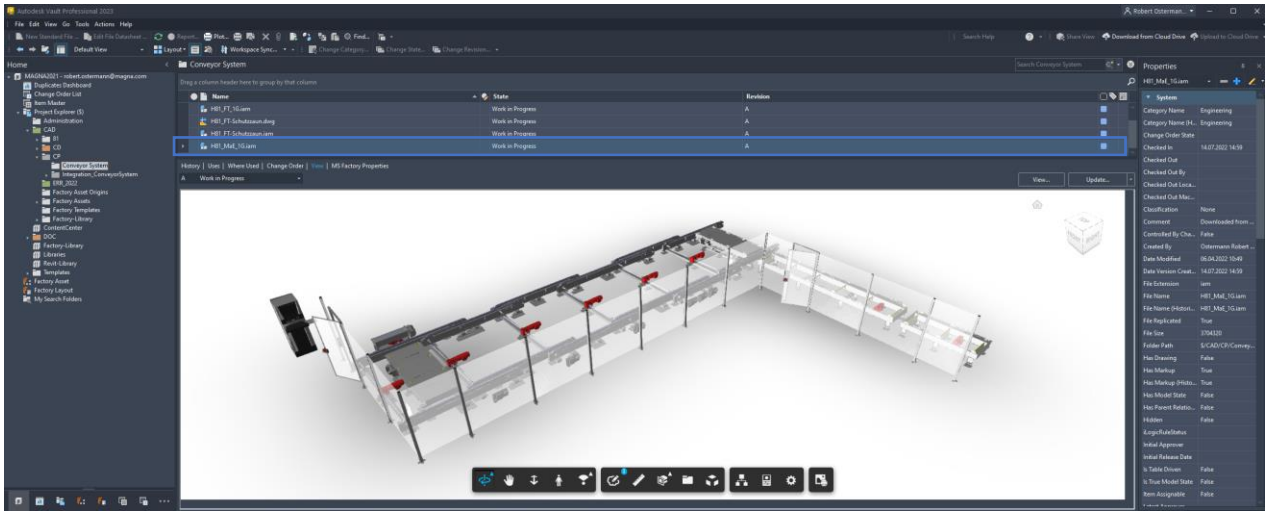

FIGURE 22: VISUALIZATION OF INVENTOR FACTORY MODEL SYNCHRONIZED BACK FROM FUSION TEAM TO VAULT PROFESSIONAL

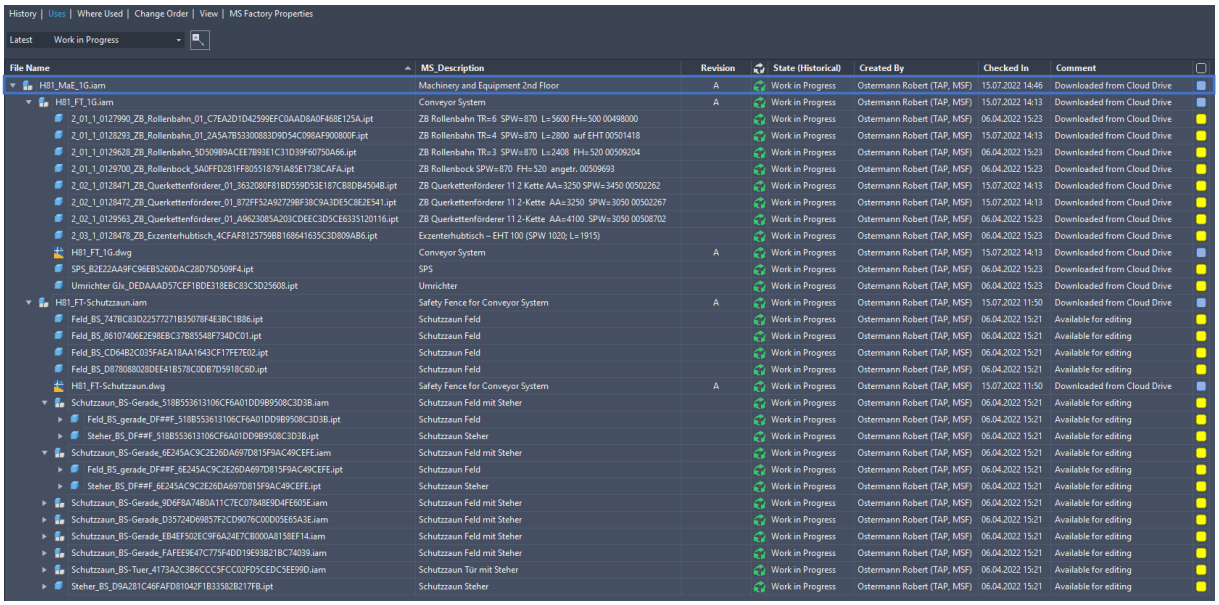

FIGURE 23: FILE STRUCTURE OF INVENTOR FACTORY MODEL SYNCHRONIZED BACK FROM FUSION TEAM TO VAULT PROFESSIONAL

CAD Data Exchange for Factory Integration, Data Exchange: New Project Data on Cloud Service

The final example concerning data exchange will show a library asset that's being created out of a CATIA model directly on Fusion Team due to its file dependency capabilities. This can be done by using the Autodesk Inventor Factory Design Utilities and their AnyCAD functionalities. This is extremely helpful in the case of a supplier wanting to share a CAD model, where it is challenging to bring it into an Autodesk ecosystem in such a way that it can easily include future updates of the model.
Therefore, the file is sent directly out of CATIA to the connected Fusion drive (see Figure 24).

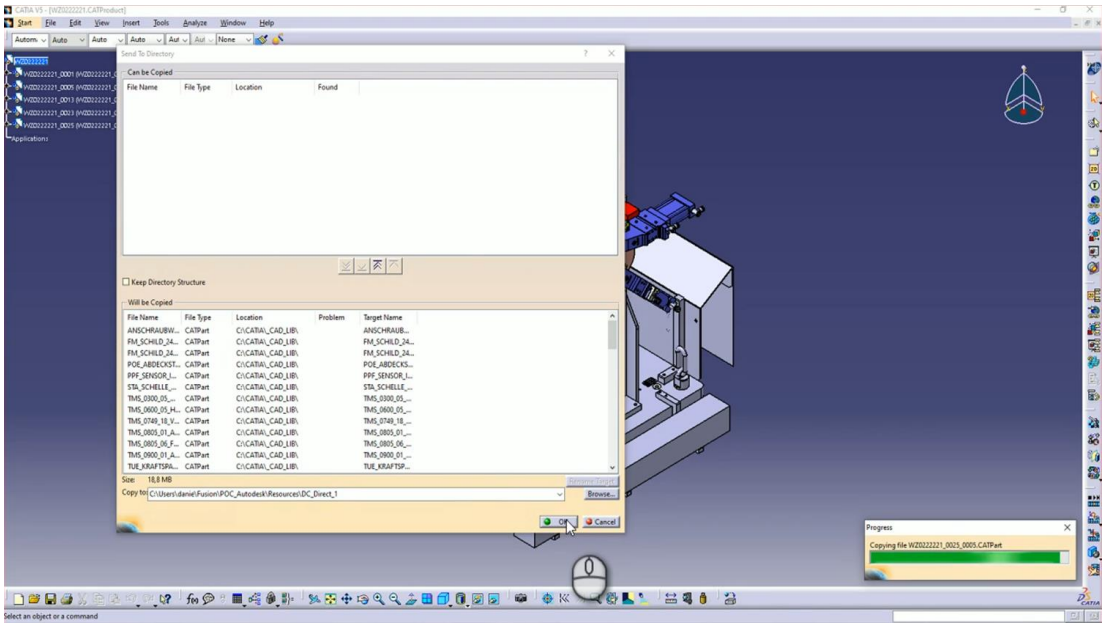

FIGURE 24: CATIA MODEL BEING SENT TO FUSION TEAM DRIVE

The CATIA model then will be referenced in Inventor, simplified and converted to an intelligent 2D/3D Factory Asset (see Figure 25).

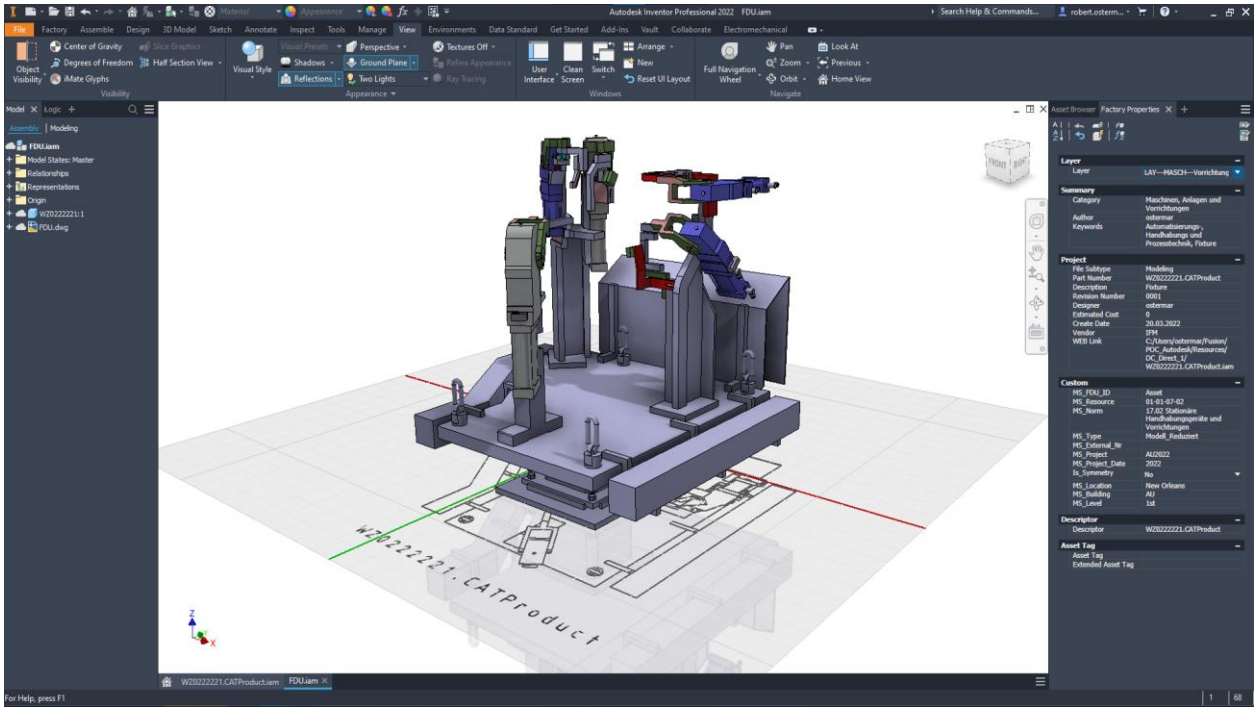

FIGURE 25: FACTORY ASSET GENERATED OUT OF SIMPLIFIED AND REFERENCED CATIA MODEL

As soon as the Inventor model with its CATIA reference is saved and closed, it will be synchronized to Fusion Team and the model can be reviewed and communicated to team members on the Fusion Team web service (see Figure 26).

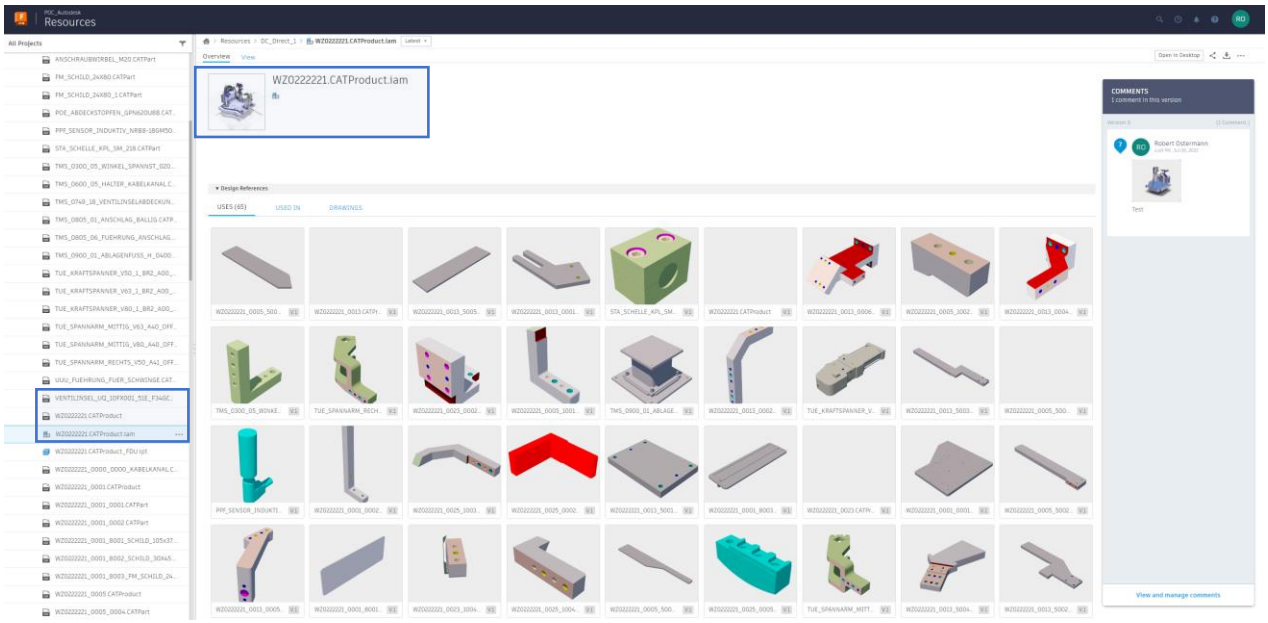

FIGURE 26: INVENTOR MODEL WITH REVERENCED CATIA ASSEMBLY AND SIMPLIFICATION (MODEL STATE) IN WEB BROWSER ON FUSION TEAM

The Factory Asset that's being created can also be reviewed in the Factory Library on the Fusion Team web service (see Figure 27).

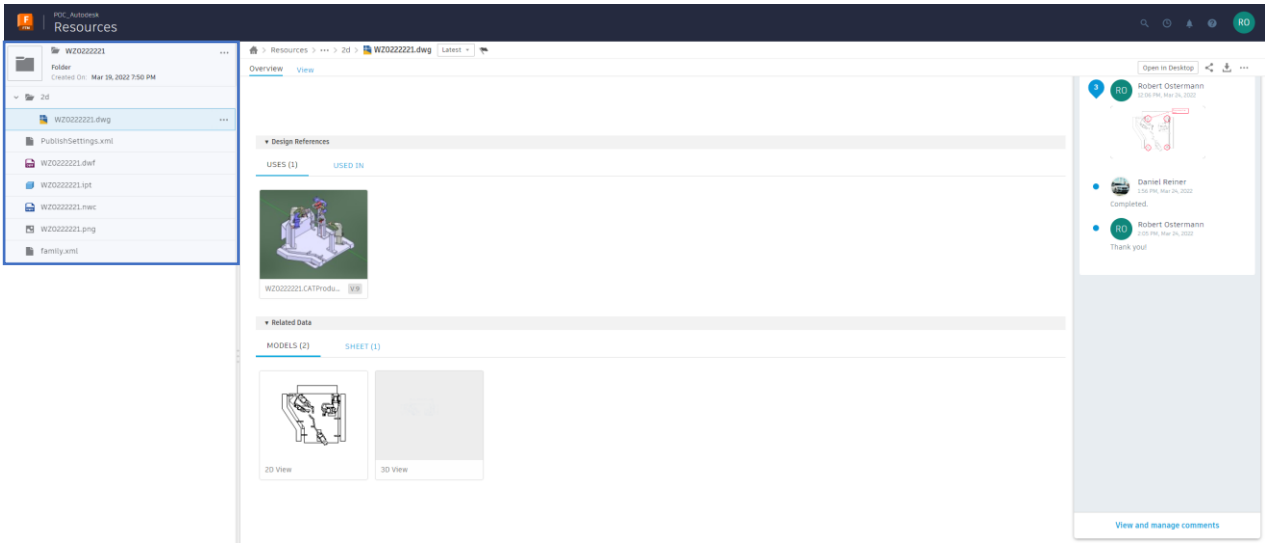

FIGURE 27: FACTORY LIBRARY ASSET ON FUSION TEAM

Both workflows will help machinery & equipment designers to better understand, trace and communicate their design data they are incorporating in an entire model for factory integration, providing they are not working in a data management environment.
These files can also be synchronized with the Vault data management system.

CAD Data Exchange for Factory Integration, Workspace of a Machinery & Equipment Designer

Basically, if you are not familiar with this system, you can compare Fusion Team to Autodesk Docs. Also, as soon as data is transferred, it can be used on a shared drive by team members of a project having the appropriate roles & rights. Using the Factory Design utilities, a new planning model for a conveyor system can be directly created on the cloud service (see Figure 28), by using Factory Asset library parts also hosted on the cloud service.

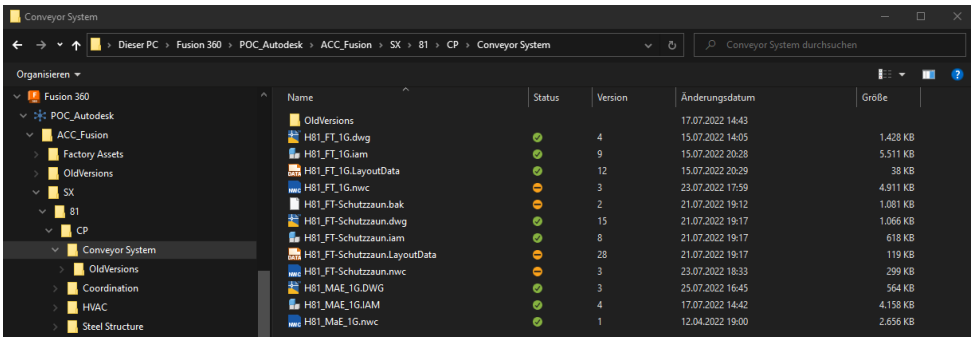

FIGURE 28: SHARED AUTODESK FUSION TEAM DRIVE ENABLED BY THE AUTODESK DESKTOP CONNECTOR

Doing so (see Figure 29), additional functionalities of Fusion Team will help you to better coordinate and manage your design intent directly in a web browser (see Figure 30) in a comparable way to Autodesk Docs with some major advantages and minor disadvantage.

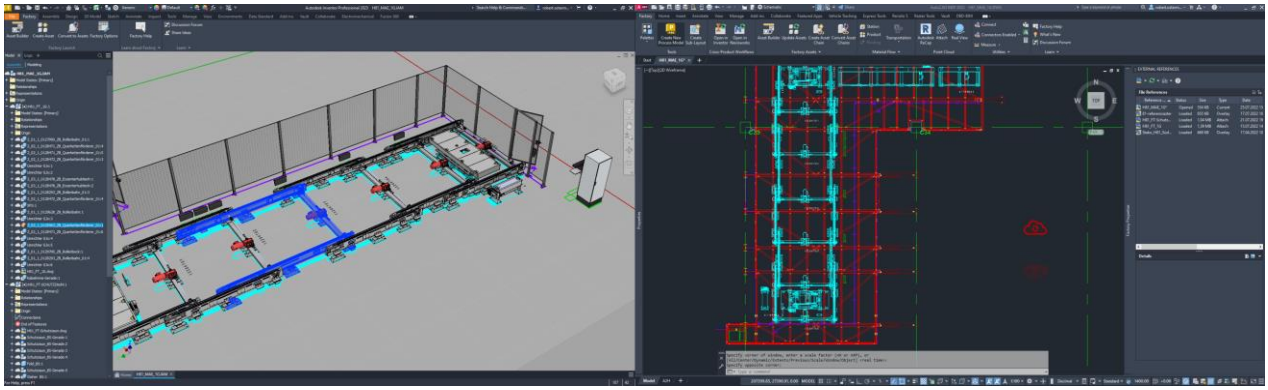

FIGURE 29: FACTORY DESIGN UTILITIES CLOUD MODEL AND SYNCHRONIZED PLAN SHOWING CONVEYOR SYSTEM

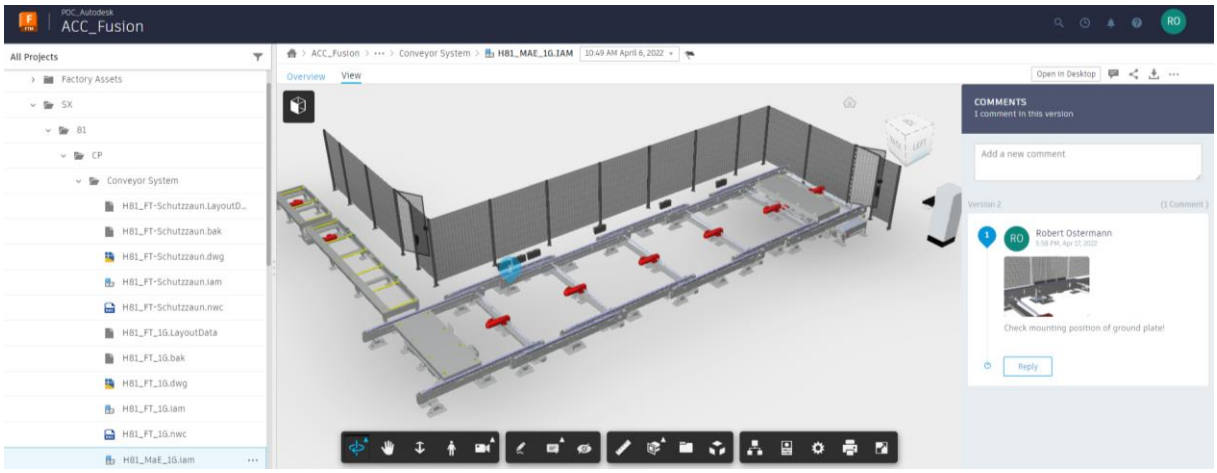

FIGURE 30: AUTODESK FUSION TEAM COLLABORATION

The entire data flow of this example can be seen as a summary on the following figure.

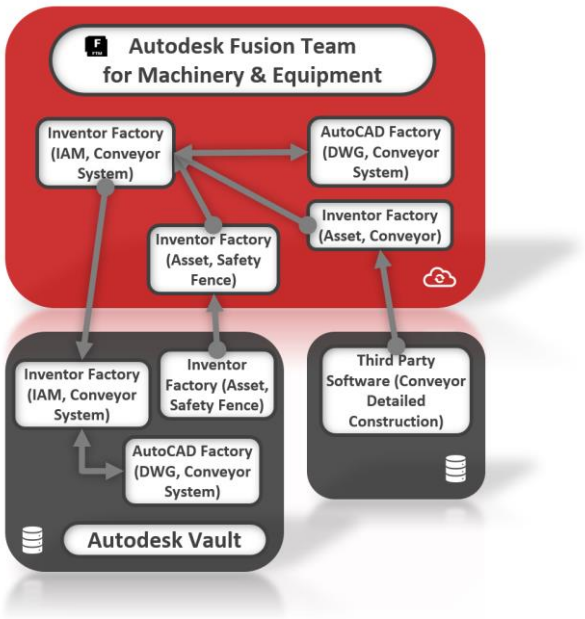

FIGURE 31: DATA FLOW COMBINING AUTODESK FUSION TEAM WITH AUTODESK VAULT PROFESSIONAL AND THIRD-PARTY NATIVE CAD DATA

In the prior example using a CATIA assembly, detailed construction was simplified and converted to a Factory Asset. The same process can be used to generate performant assets of conveyor elements to implement and coordinate a conveyor system design.
Additionally, out of Vault Professional, a parametric standard library for safety fences can also be transferred and used on the cloud drive. The result of using the Factory Design Utilities is a constantly synchronized 3D model in Inventor and a 2D plan in AutoCAD, which will make it easy to generate meaningful and efficient overall shopfloor plans of the entire factory.
The process to transfer the conveyor system to the Autodesk Construction Cloud via Vault will be described in the next section of the handout. The planning result of the conveyor system can also be synchronized back to Vault Professional as the overall system being able to manage all factory data, as seen at the beginning of this example (see Figure 20).

CAD Data Exchange for Factory Integration, Conclusion

The chart below and benefits highlighted in red show the advantages you can gain by combining Vault Professional and the Autodesk Construction Cloud & Fusion Team:

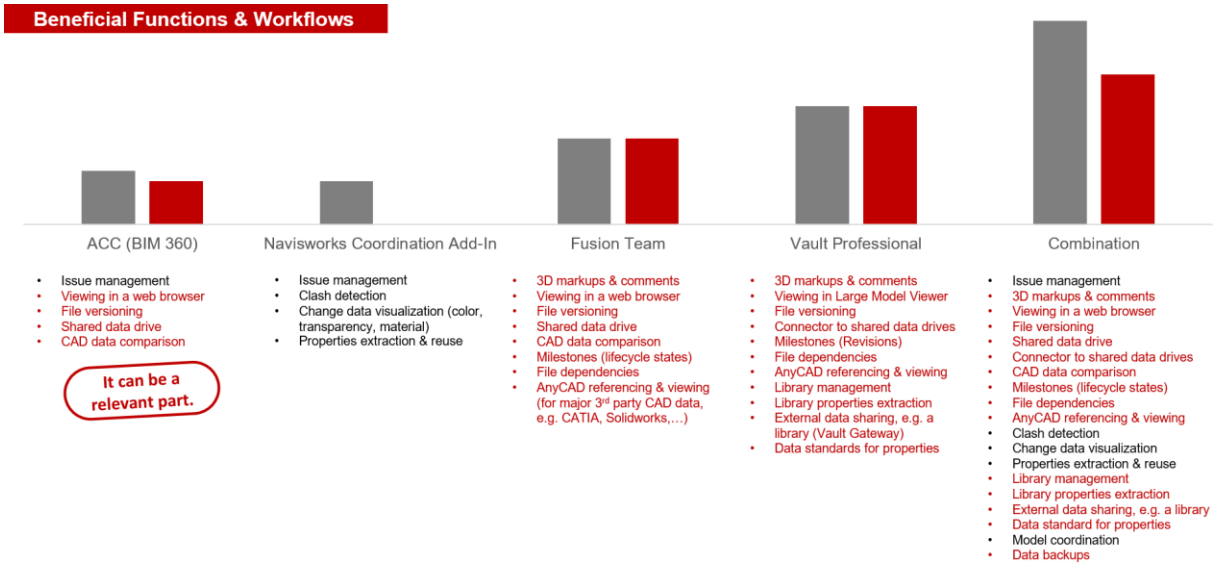

FIGURE 32: BENEFITS COMBINING VAULT PROFESSIONAL AND AUTODESK CLOUD SERVICES

As mentioned, one of the most valuable benefits is that using Fusion Team instead of Autodesk Docs (Part of Autodesk construction cloud or ACC) gives you the ability to understand file dependencies for Factory Design Utilities data (AutoCAD, Inventor & AnyCAD references). Also, a huge benefit is, if you have several different projects on your Autodesk cloud services, in Vault you can have one central place, where you can manage your standard libraries and synchronize them with the appropriate cloud projects.

Powered by Autodesk's Cloud Solutions – 2. Use Case

CAD Data Issue Management for Factory Integration, Workflows & Systems

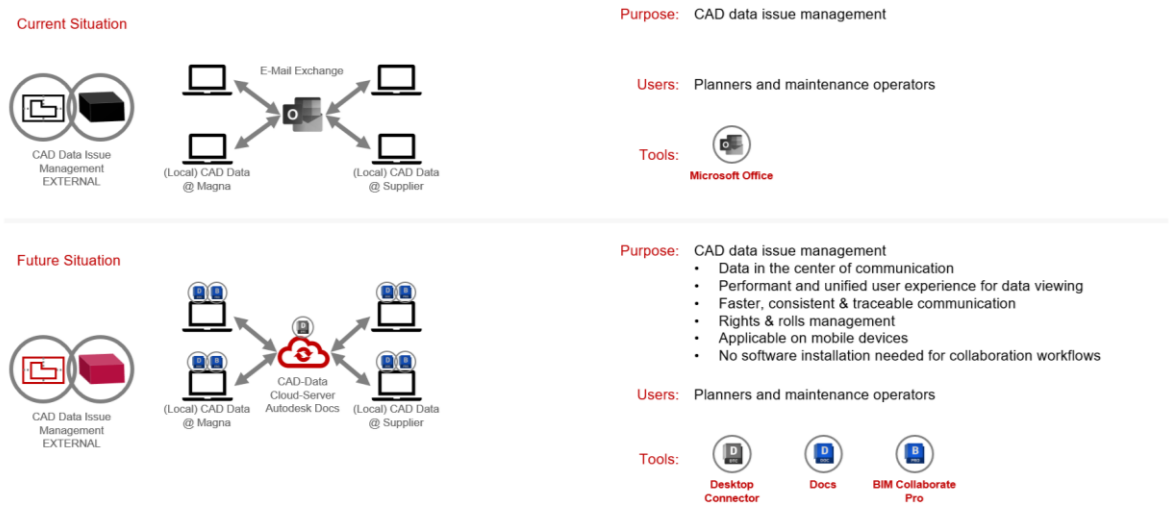

FIGURE 33: ISSUE MANAGEMENT (COLLABORATION TRACKING) – UNDERSTANDING CURRENT AND FUTURE WORKFLOW WITH AUTODESK COULD SERVICES

Currently there is still a lot of Microsoft Office based communication concerning CAD models, and even if the information is transferred via any collaboration tracking system, most times it remains separated from the CAD data and errors can occur. However, such communication takes place fully disconnected from the CAD data and its additional documents. The advantages of attaching analysis, decisions, and feedback to the design model using Autodesk cloud services are:

- Design data in the center of communication
- Faster, consistent and better traceable communication
- Usable on mobile devices as well as on desktops without any software installation
- A rights & roles management
- A unified user experience for data viewing

CAD Data Issue Management for Factory Integration, ACC Issue Management

Moving on to the possibility to set up an issue management process for a holistic factory model, meaning, not only building and building infrastructure is being used as usual, also machinery and equipment will be integrated.

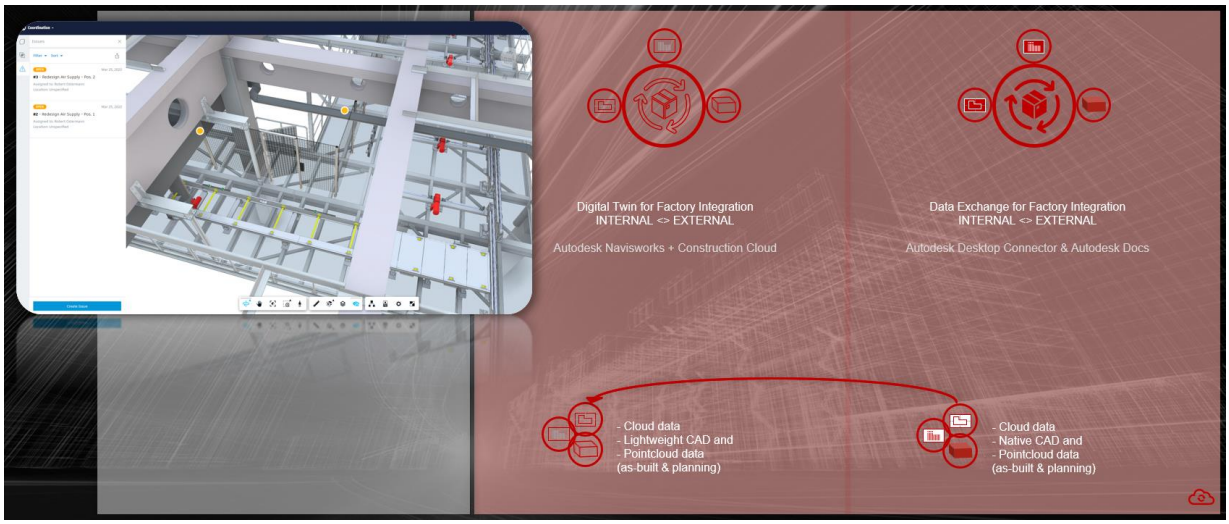

FIGURE 34: ISSUE MANAGEMENT FOR A HOLISTIC FACTORY DESIGN PROCESS

CAD Data Issue Management for Factory Integration, ACC Issue Management: Structure and Preparation

Especially those working daily with a data management system need to understand that a lifecycle and a lifecycle state isn't implemented within the ACC (Autodesk Construction Cloud). Those needs are represented as a folder structure with different purposes (see Figure 35).
Therefore, you can leverage the common shared/consumed workflow of the ACC Design Collaboration, where team members share expected milestone models in a documented and traceable way with other planning disciplines. These models are automatically exchanged within a predefined folder structure.

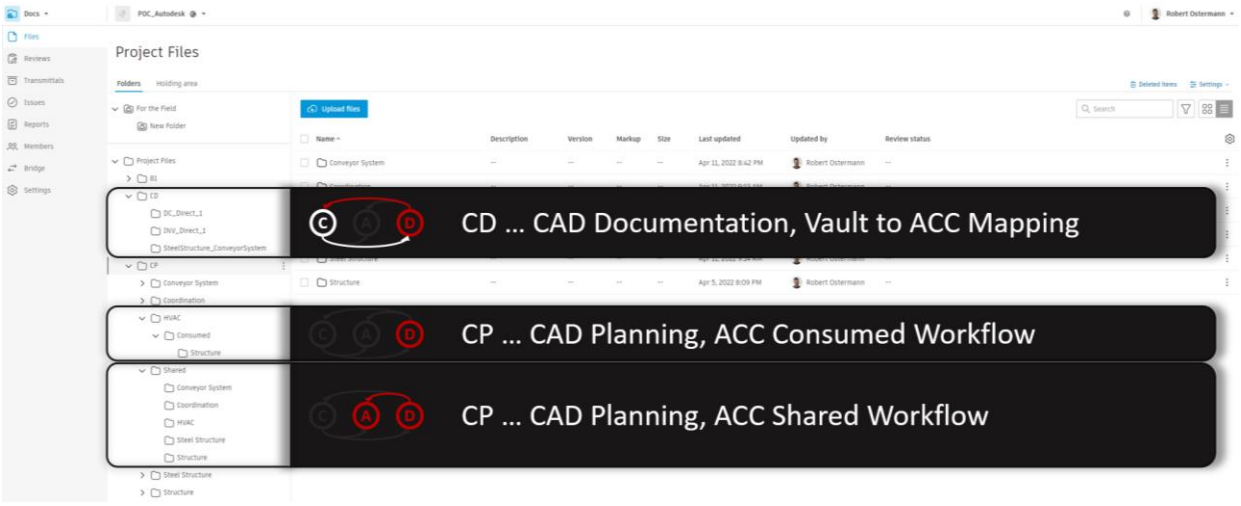

FIGURE 35: PREPARATION OF FOLDER STRUCTURE AS GENERAL BASIS AND FOR ACC ISSUE MANAGEMENT

To set this up for the CAD workflow, one folder hierarchy is used for 'as-built' data, which initially might have come from Vault in the case of a brown field planning, or it will be the folder where finalized data will be stored and synchronized back to Vault.
Another folder hierarchy is used for all planning data, where the different planning teams can access their data. Each planning team will also have a so called 'Consumed' folder, where planning data from other teams is going to land, as soon as they have shared their data in order to be used ('consumed') by other teams.
To enable a shared/consumed workflow where files are copied automatically, mandatory teams and team folders need to be set up in the Design Collaboration of an ACC project (see Figure 36).

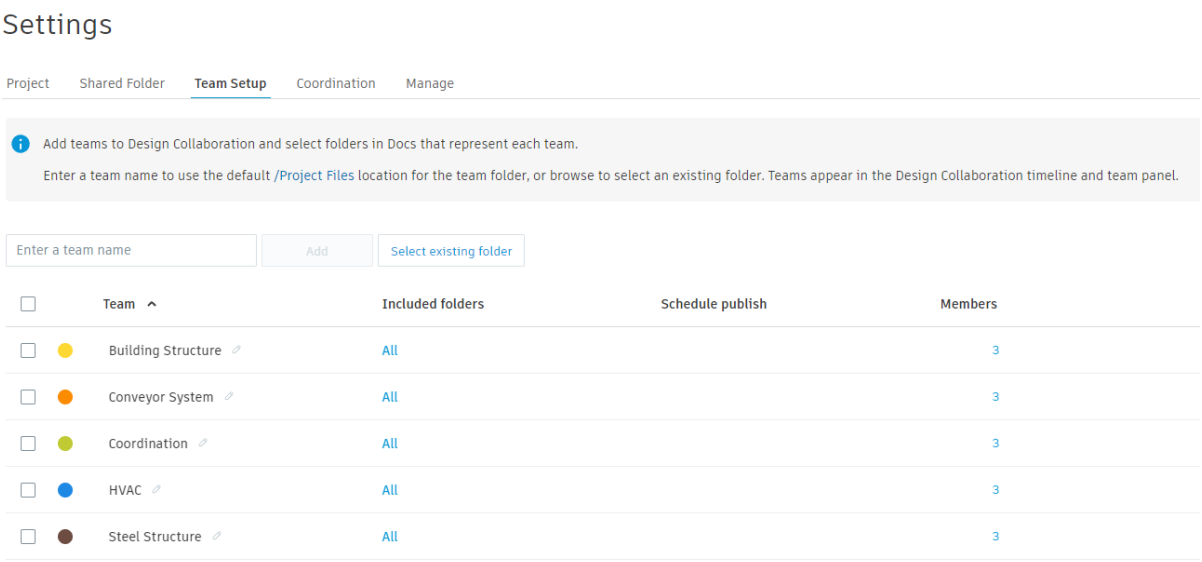

FIGURE 36: TEAM SETUP WITHIN ACC DESIGN COLLABORATION

I also recommend separating the initial and the final data in different folders, to better handle synchronizations due to the use of lifecycle states in Vault.

Comparted to a data management system, this slightly unusual set up of a folder structure could be compared with a rather simple lifecycle definition containing four lifecycle states in Vault Professional (see Figure 37).

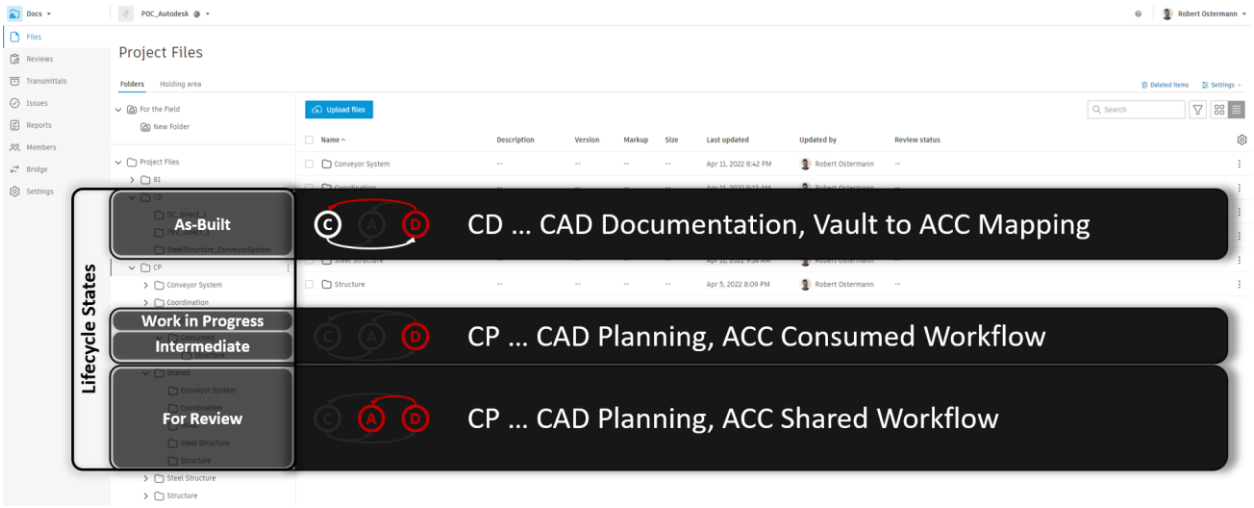

FIGURE 37: ACC FOLDER STRUCTURE COMPARED TO A DATA MANAGEMENT LIFECYCLE

CAD Data Issue Management for Factory Integration, ACC Issue Management: Fusion Team Integration

At Magna we are willing to use both relevant Autodesk Cloud Services for factory planning, Fusion Team for machinery & equipment and Autodesk Docs for building & building infrastructure.
To recap, Fusion Team has some beneficial features compared to the ACC. Fusion Team can analyze file dependencies for some Autodesk products like AutoCAD, Inventor or Inventor Factory, and that's crucial. But it also can show in an easy and straight forward way, if a new version or milestone for a planning model is available (see Figure 38).

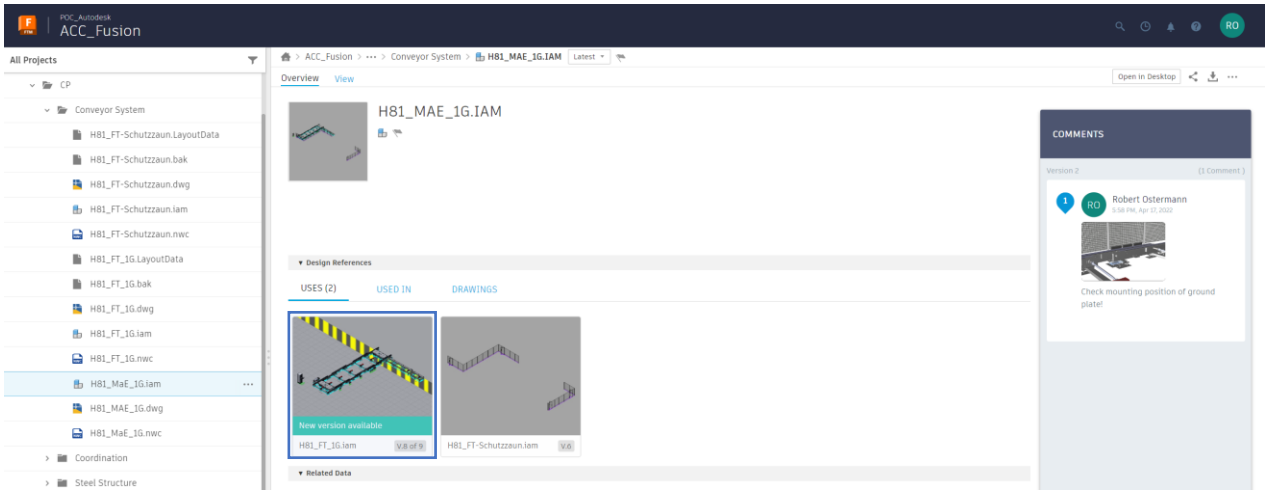

FIGURE 38: FUSION TEAM SHOWING NEW AVAILABLE VERSIONS OF REFERENCED MODELS

Because there is no direct connection possible between both services, it's necessary to set up a mapping using Vault's Project Sync (see Figure 39). This workflow will also guarantee a backup of the project data onto your Vault data servers.

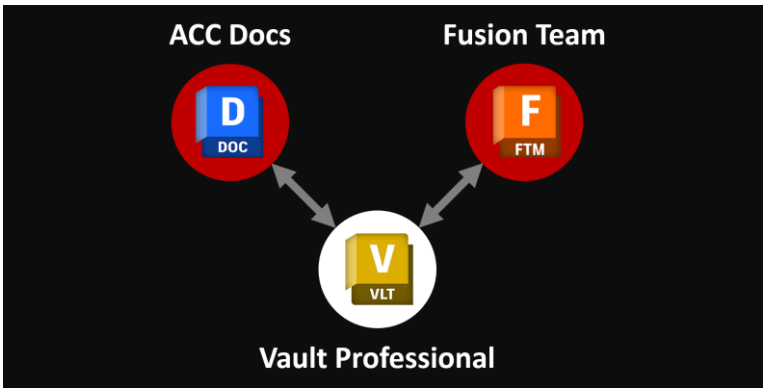

FIGURE 39: AUTODESK FUSION TEAM TO DOCS MAPPING VIA VAULT PROJECT SYNC

Also, it needs to be considered, that the ACC cannot use CAD data for machinery & equipment in any meaningful way, which also includes the clash detection service, comparison capabilities or the model coordination.
The best workaround so far is to generate and use Navisworks Cache files (NWC) for machinery & equipment data.
Therefore, it is possible to create a Navisworks project on Fusion Team, where all relevant design models are directly loaded into this project, which will automatically generate NWC files on the shared drive (see Figure 40).

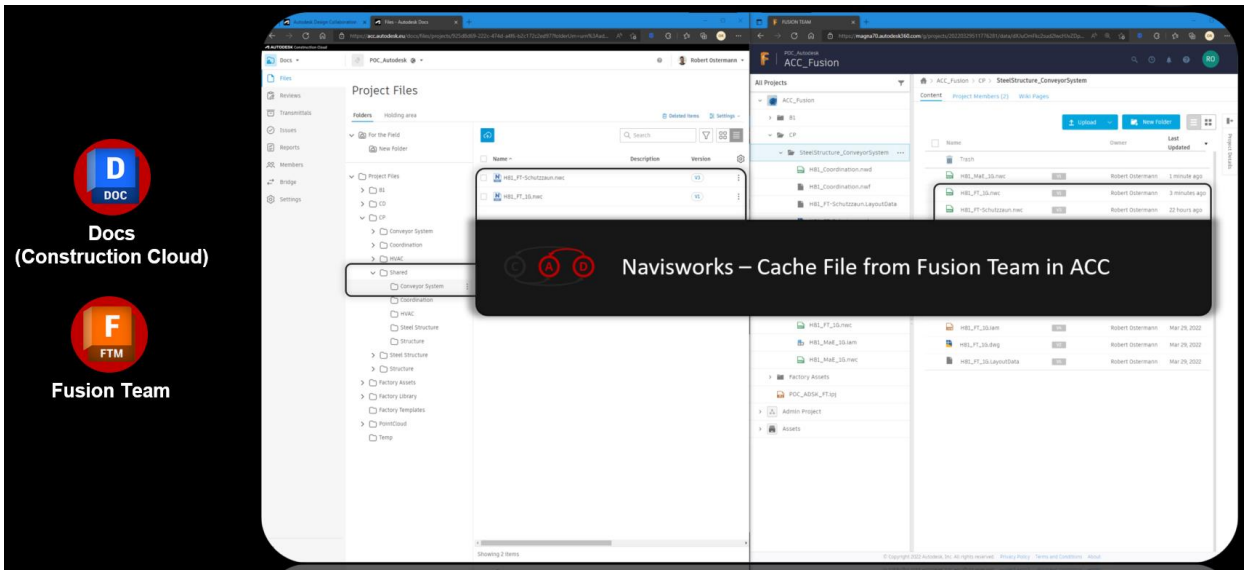

FIGURE 40: ACC & FUSION TEAM INTEGRATION OF NAVISWORKS CACHE FILES

For getting the files on a daily basis from Fusion Team, a download to Vault can be scheduled (see Figure 41)

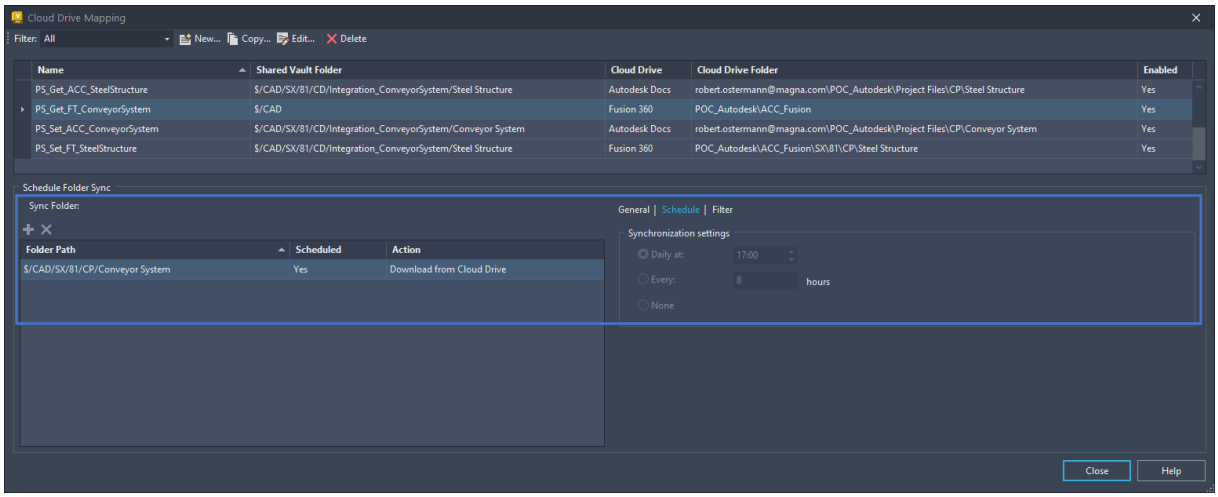

FIGURE 41: VAULT PROJECT SYNC TO TRANSFER FILES FROM FUSION TEAM ON A DAILY BASIS

To transfer only the NWC files to an ACC project, it's possible to schedule and filter the upload to Docs by file extensions (see Figure 42).

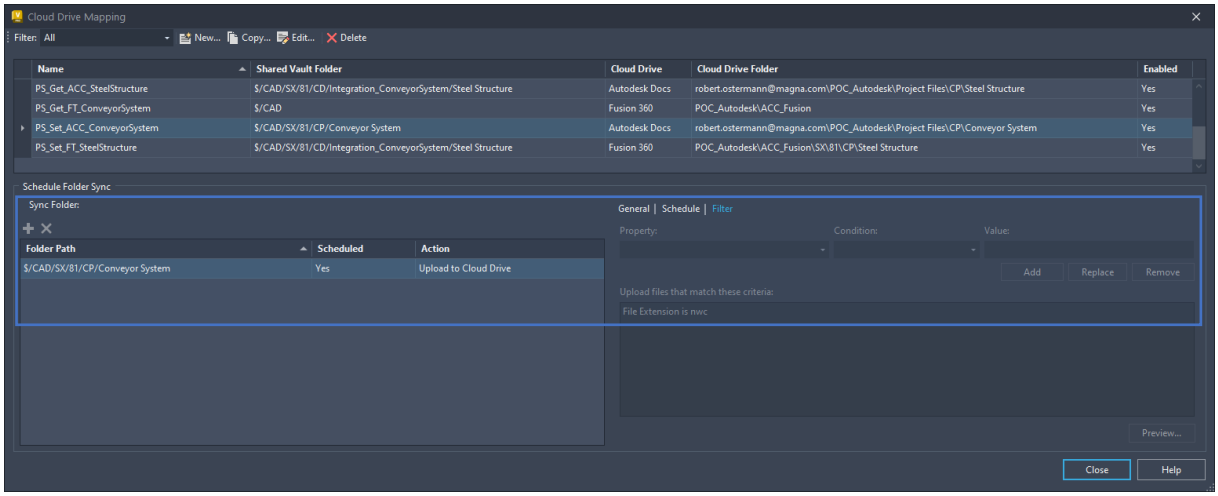

FIGURE 42: VAULT PROJECT SYNC TO TRANSFER FILES FROM VAULT PROFESSIONAL TO DOCS BY FILTER

For a more detailed learning resource concerning Vault Project Sync Management check out Carlos Lastrilla AU 2019 presentation: [Using Vault Professional and BIM 360 Docs—Publishing Drawings to the Outside World | Autodesk University]

The overall workflow can be summarized in the following figure and includes the previously shown examples for data exchanges.

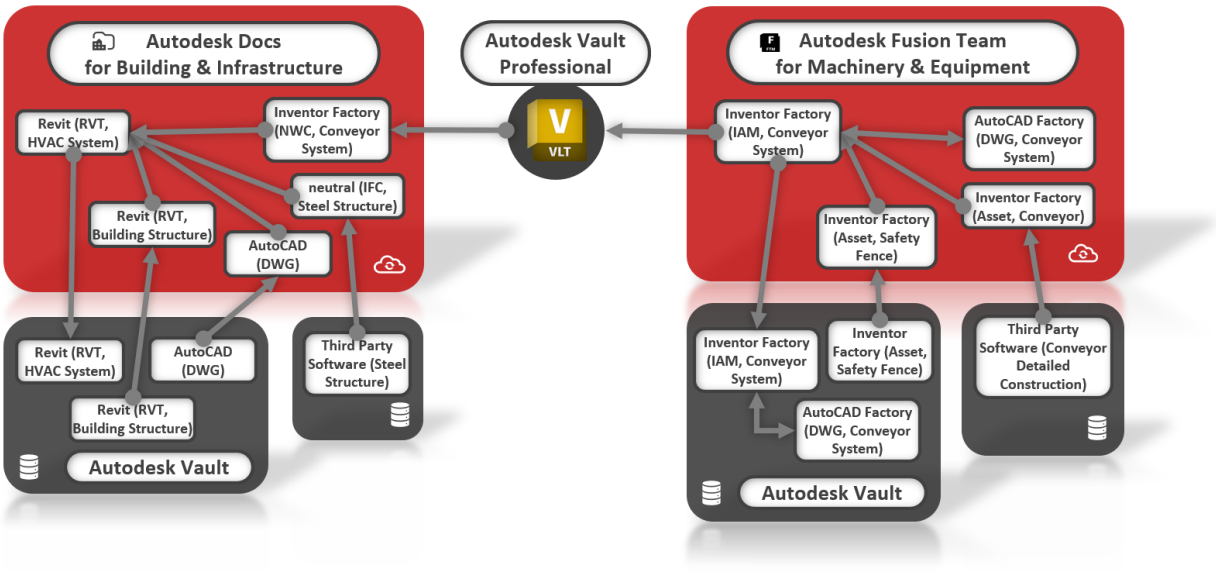

FIGURE 43: DATA FLOW COMBINING AUTODESK DOCS AND FUSION TEAM WITH AUTODESK VAULT PROFESSIONAL

CAD Data Issue Management for Factory Integration, ACC Issue Management: Coordination Space

Another issue that needs to be addressed is to set up a so-called model coordination space for the shared folder structure, where the 'to be reviewed' data of different teams is located, before a holistic factory model can be coordinated (see Figure 44). To be more precise, the shared folders, where milestone data is stored and shared with the entire factory planning team, are the model states, which are meant to be used for factory integration processes.

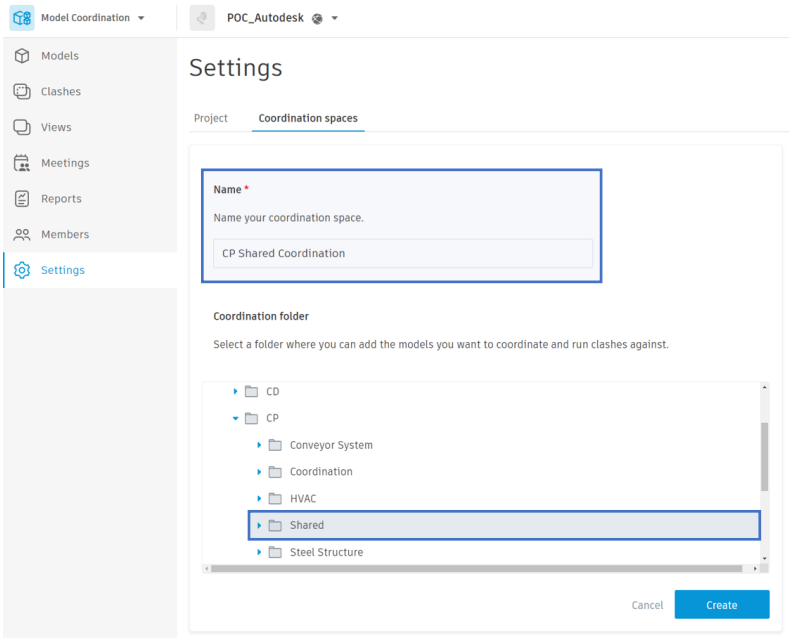

FIGURE 44: SET UP MODEL COORDINATION SPACE ON AUTODESK CONSTRUCTION CLOUD

From this coordination space the necessary models will be selected (see Figure 45),

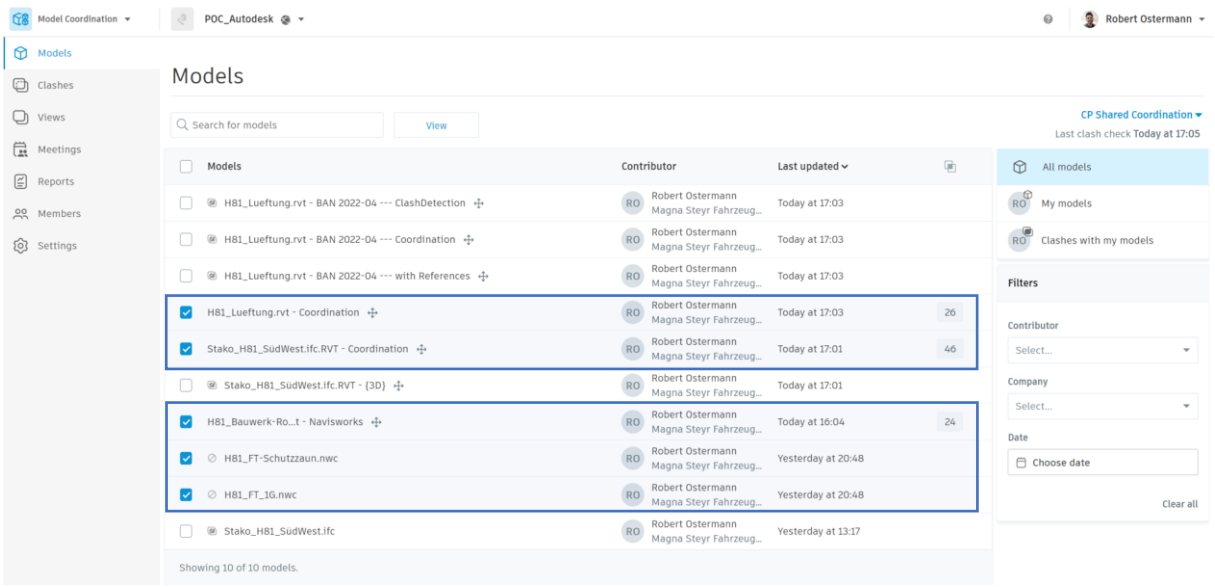

FIGURE 45: ACC COORDINATION SPACE - MODEL SELECTION

and will be combined to a holistic factory model in the web browser, where this combination of models from different disciplines can be reviewed and saved but most important, where issues and tasks can be created to manage and coordinate different teams (see Figure 46).

FIGURE 46: COORDINATION VIEW WITH MODELS FROM DEFINED COORDINATION SPACE

This coordination space can also be directly accessed within Navisworks (see Figure 47), where you can use the cloud managed models by installing the Coordination Issues Add-In.

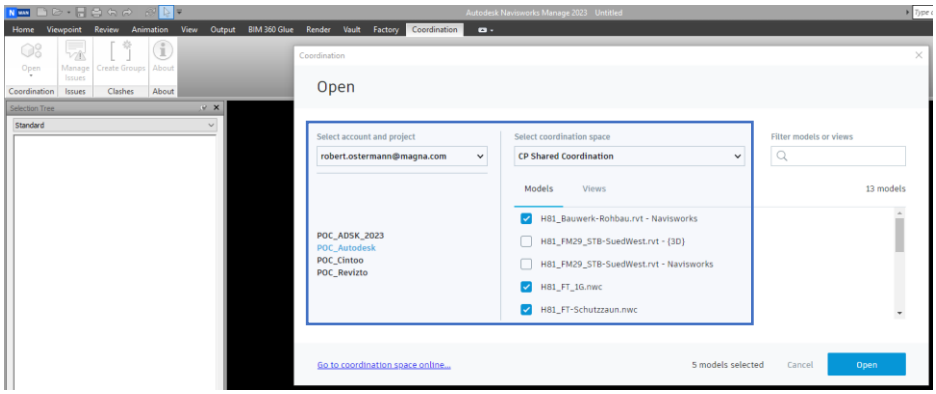

FIGURE 47: ACCESS ACC COORDINATION SPACE VIA NAVISWORKS

Currently, if you want to perform clashes between machinery & equipment and building & building infrastructure, you will have to do it via the Navisworks Clash Detective. Because this is also coordinating the cloud managed models, issues being created off-premises in Navisworks (see Figure 48), will be immediately mapped to the ACC and can be reviewed and managed on the web service.

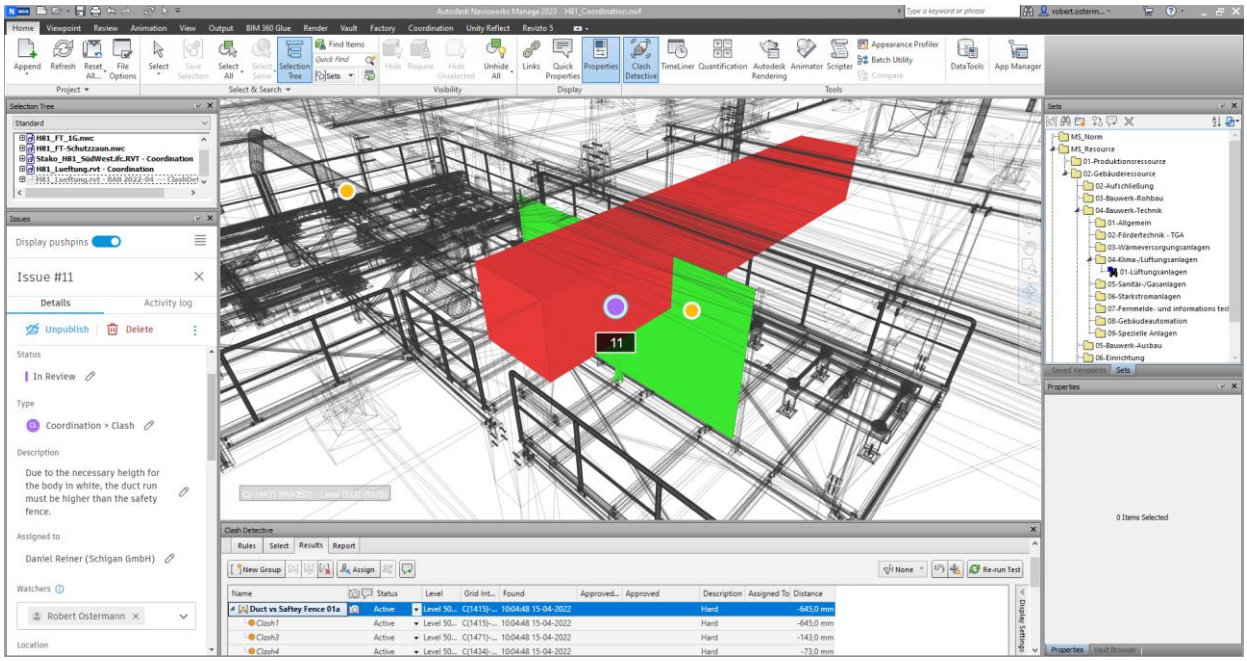

FIGURE 48: CREATE ACC ISSUES WITHIN NAVISWORKS

As mentioned, folders are used for different teams, where they are doing their planning work. As soon as a team shares a 'to be reviewed' model, the process automatically creates a copy of the current model state in the defined shared folder (see Figure 49) and can immediately be used and reviewed in a Navisworks coordination model.

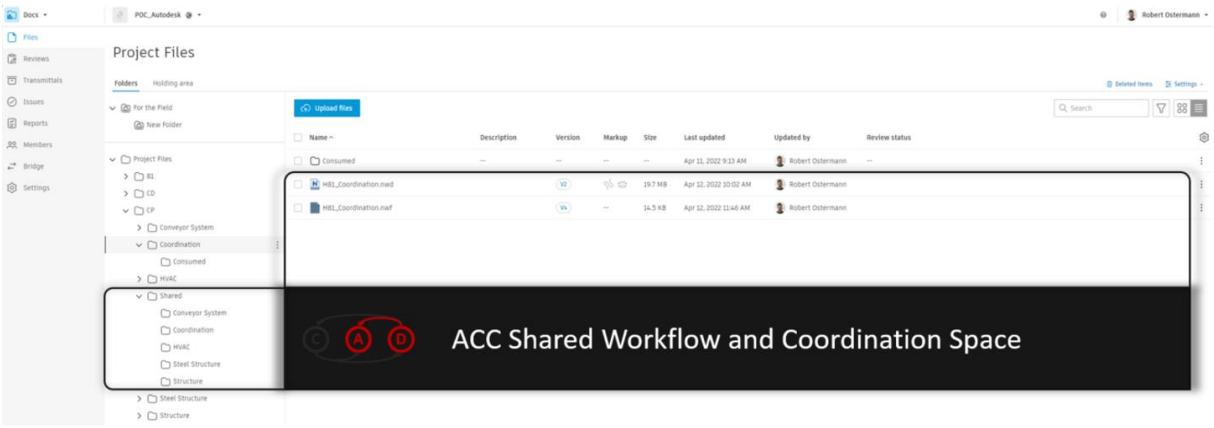

FIGURE 49: NAVISWORKS CLOUD COORDINATION MODEL ON ACC

The process of sharing and consuming data is also made visible on a timeline, where you can track and review, data that has been exchanged between teams (see Figure 50).

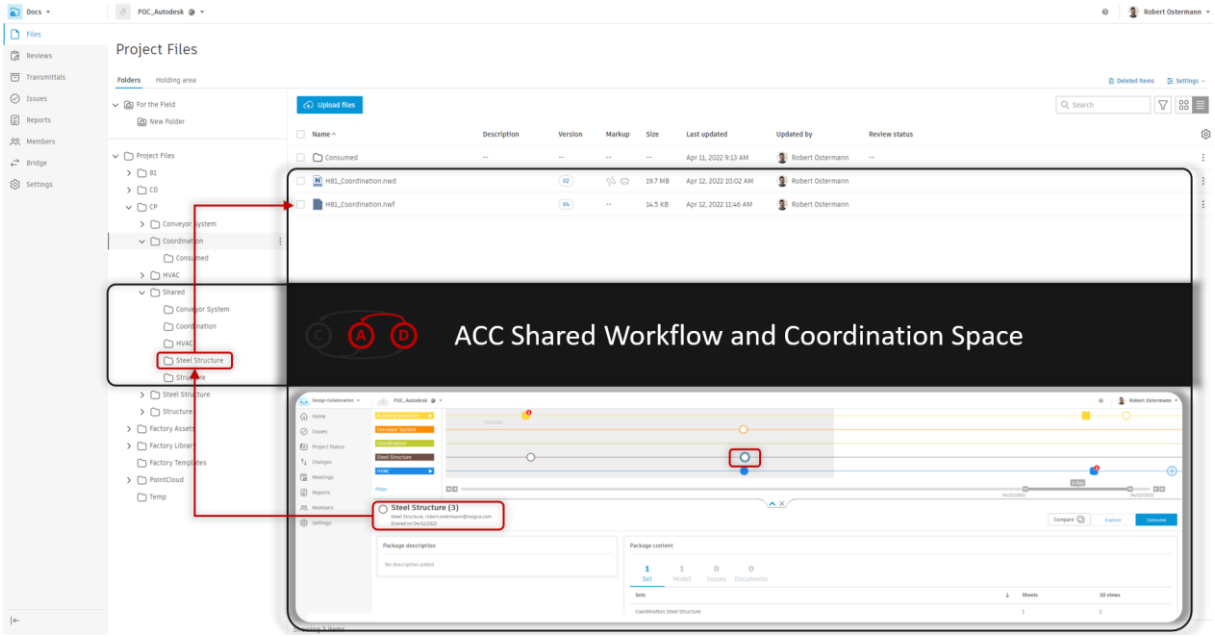

FIGURE 50: ACC DESIGN COLLABORATION TIMELINE FOR MODEL SHARING

CAD Data Issue Management for Factory Integration, ACC Issue Management: Review Process

In Figure 48, an issue was created, which requires a new solution for an HVAC system, where a conveyor system and a supporting steel structure needs to be integrated (see Figure 51). When working in Revit, I recommend using Navisworks cash files (NWC) for machinery & equipment CAD data instead of creating Revit files from Inventor, due to performance and traceability.

Check out the video of the class presentation to see this workflow in action.

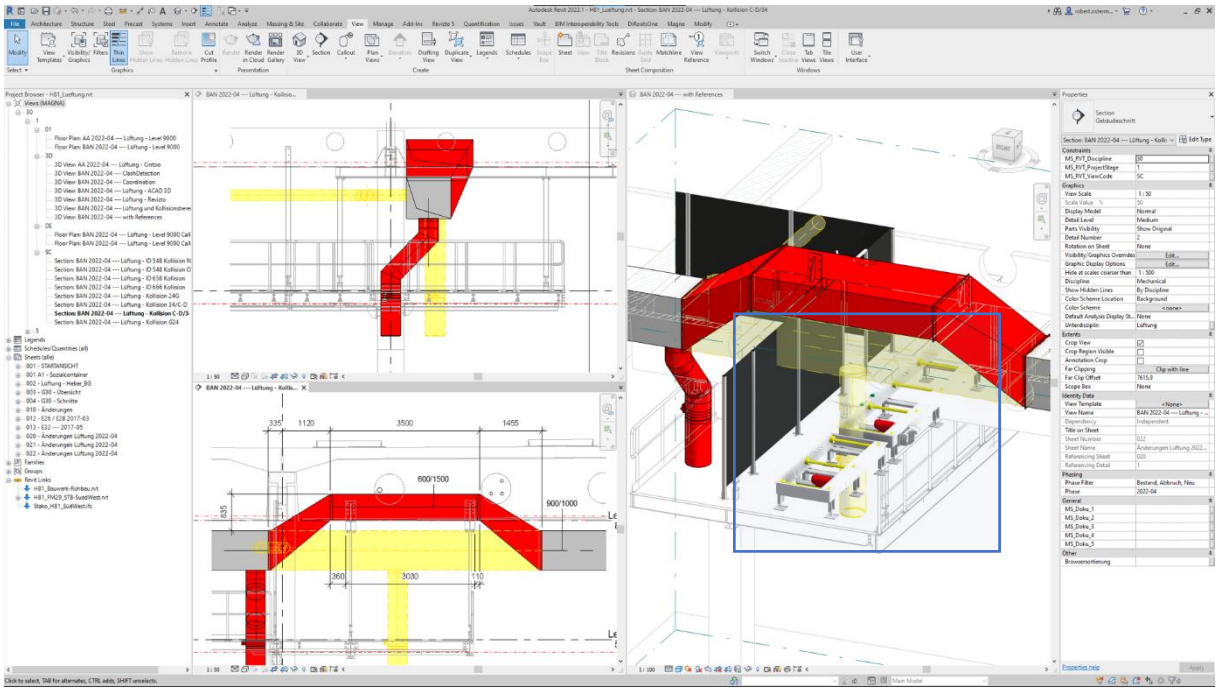

FIGURE 51: NEW REVIT DESIGN WITH REFERENCED NWC FILES

Within Revit and the newly designed solution, you can access ACC hosted issues and change the status. For example, to 'in review' (see Figure 52).

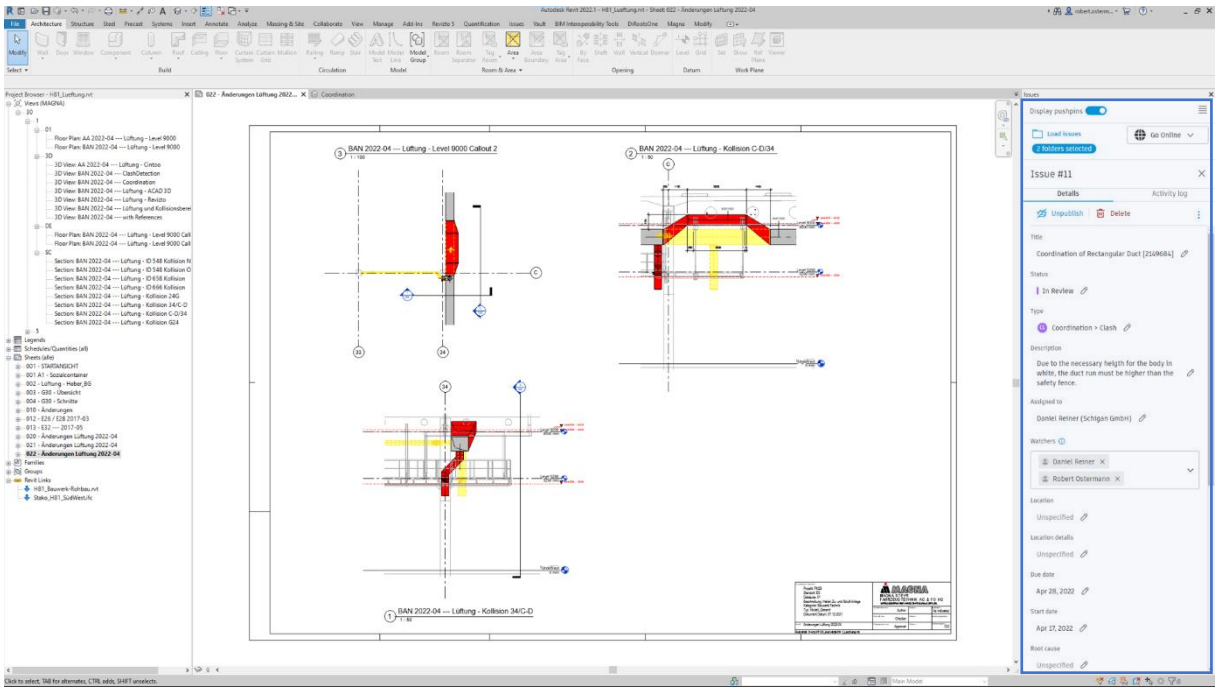

FIGURE 52: ACCESS ACC ISSUES DIRECTLY IN REVIT

In the next step a review task for a design approval can be created, which will also generate an email notification for defined team members (see Figure 53).

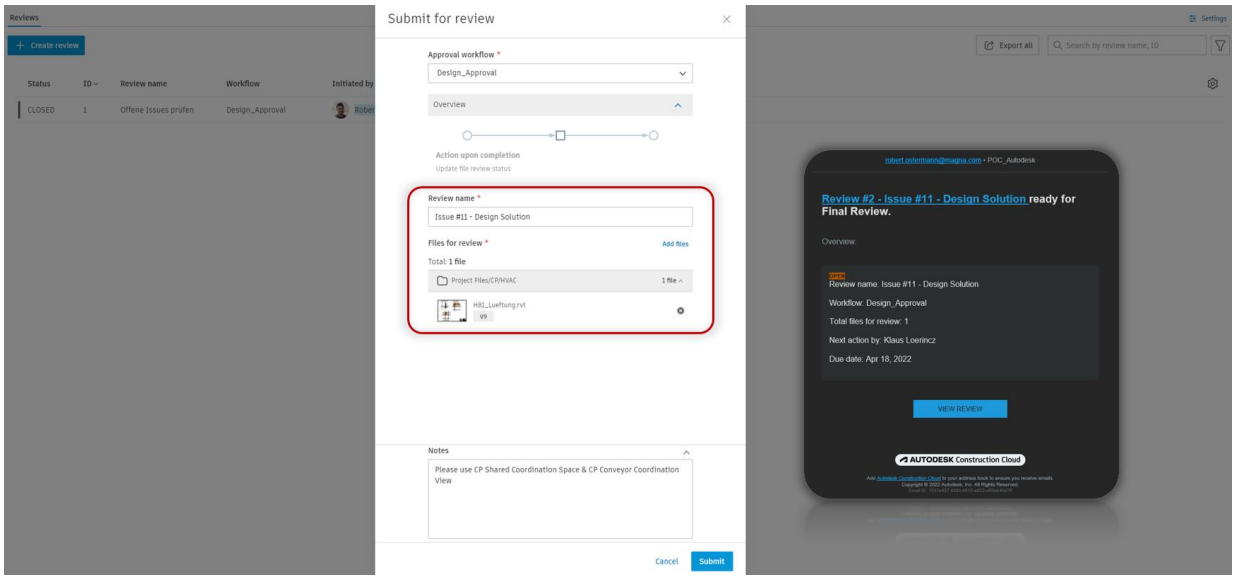

FIGURE 53: DESIGN APPROVALS ON ACC & E-MAIL NOTIFICATION

In the model coordination view, the new solution can be implemented, reviewed and analyzed (see Figure 54), verified and checked for collisions, as long as they are analyzed on the web service. If not, as it is the case for NWC files for machinery & equipment data, Navisworks (see Figure 55) has to be used to check for clashes, before final approval of the design solution (see Figure 56) can be done.

FIGURE 54: MODEL COORDINATION VIEW ON ACC INCLUDING NEW DESIGN SOLUTION

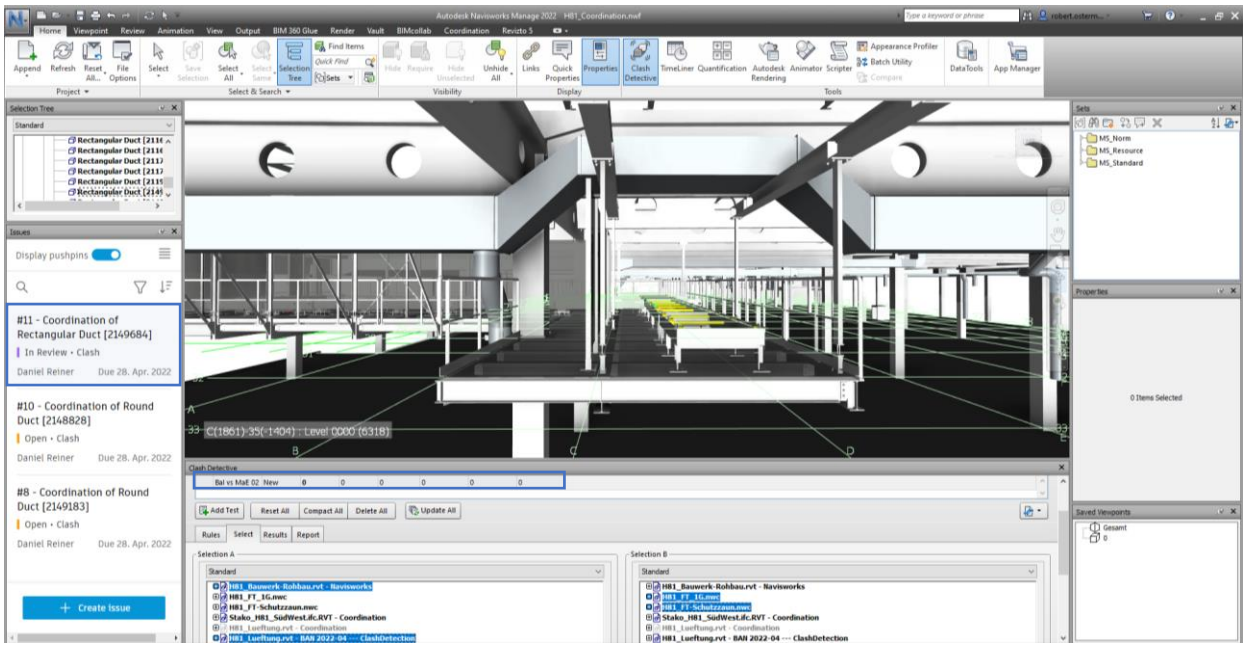

FIGURE 55: CHECK AND REVIEW NEW DESIGN SOLUTION IN NAVISWORKS

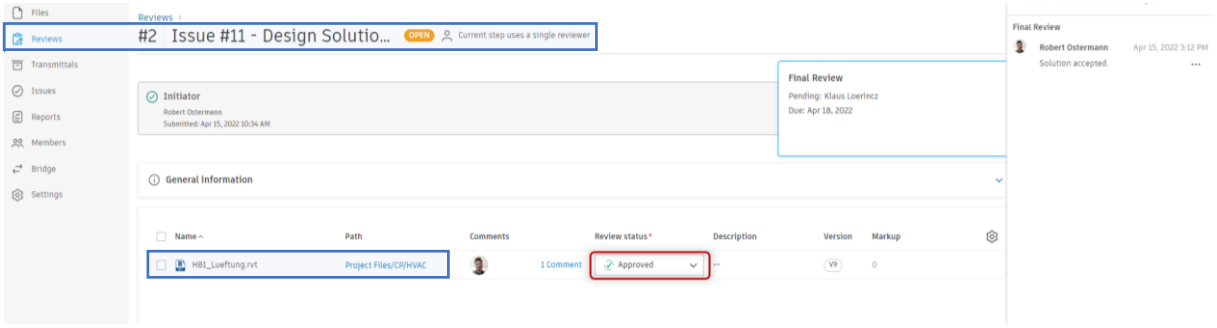

FIGURE 56: DESIGN APPROVAL OF NEW SOLUTION ON ACC

CAD Data Issue Management for Factory Integration, Coordination vs. Interoperability Models within Revit

Why a lightweight model workflow using NWC files to coordinate the HVAC design alteration and not an Inventor to Revit interoperability workflow? The short answer is, the workflow is too manual and time-consuming due to coordination purposes, but it delivers some necessary functionalities if constraints between the elements of Inventor and Revit are important. Detailed pros and cons can be seen on Figure 57. In particular, those highlighted in red are problematic in coordination workflows.

Inventor to Revit

- Exports sometimes taking far too long to finish
- Keeping the model up to date is too laborious and too difficult to trace
- Can't be used in a cloud shared Revit model!
- Needs to be converted into a Revit cloud model each time an update is available
- Critical due to performance in Revit
- Needs rework concerning views & levels in Revit
- Properties of elements aren't transferred to Revit
- Will enable clash detection for machinery & equipment on ACC
- Will be available in sections & views as well as for measuring & dimensioning within Revit

Better for workflows where elements of building & infrastructure and machinery & equipment need to match exactly

Inventor to NWC

- Referencing Inventor files is not a strength of Navisworks, but is acceptable due to time to finish
- Keeping all used Inventor models up to date is a klick on the Update button in the Navisworks project
- Visual appearance of elements can be easily changed in Navisworks
- Good performance of referenced NWC files in Revit
- NWC files aren't visible in Revit sheets
- NWC files can't be used for measurements and dimensions in Revit
- Elements of NWC files can't be selected or turned off in Revit
- Properties of NWC elements aren't available within Revit

Better for workflows concerning clashes and clearance between building & infrastructure and machinery & equipment design

FIGURE 57: PROS AND CONS OF IMPLEMENTING MACHINERY & EQUIPMENT AS NWC FILE OR INVENTOR-REVIT INTEROPERABILITY MODEL IN REVIT

To better understand the capabilities of the Inventor to Revit interoperability, Paul Munford has taught a very good class on this topic:
[Revit to Inventor: BIM Exchange for Custom Fabrication Hands-On Lab | Autodesk University]

CAD Data Issue Management for Factory Integration, Fusion Team Collaboration

Here is a look at Fusion Team and how issues can be managed for machinery design before these modes are being integrated onto the ACC.

FIGURE 58: ISSUE MANAGEMENT FOR MACHINERY & EQUIPMENT DESIGN ON FUSION TEAM

On Fusion Team markups and comments are well organized and related to specific versions. For critical tasks and to document an "intermediate" or "for review" state a milestone, made visible by a flag symbol, can be set (see Figure 59).

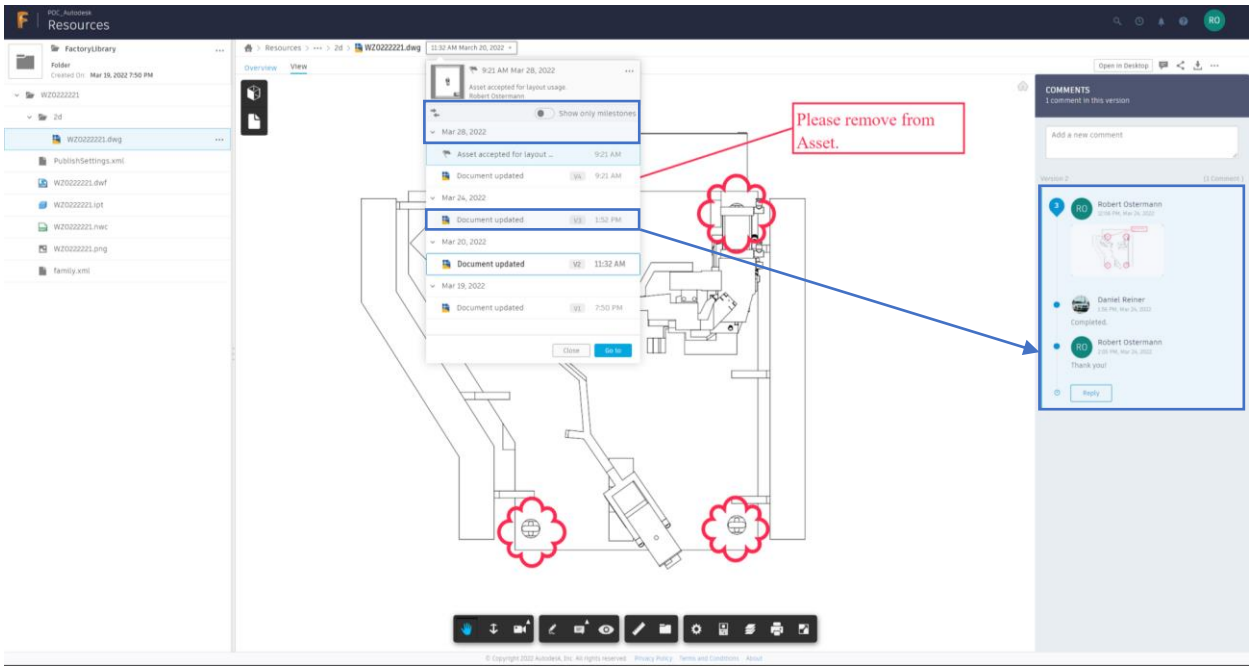

FIGURE 59: MARKUPS/ISSUES ON FUSION TEAM

Compared to the current functionalities of the ACC 3D markups per version can be made on Fusion Team (see Figure 60).

FIGURE 60: 3D MARKUPS ON FUSION TEAM

Also, an overview of existing markups can be seen on the model overview in the web browser (see Figure 61).

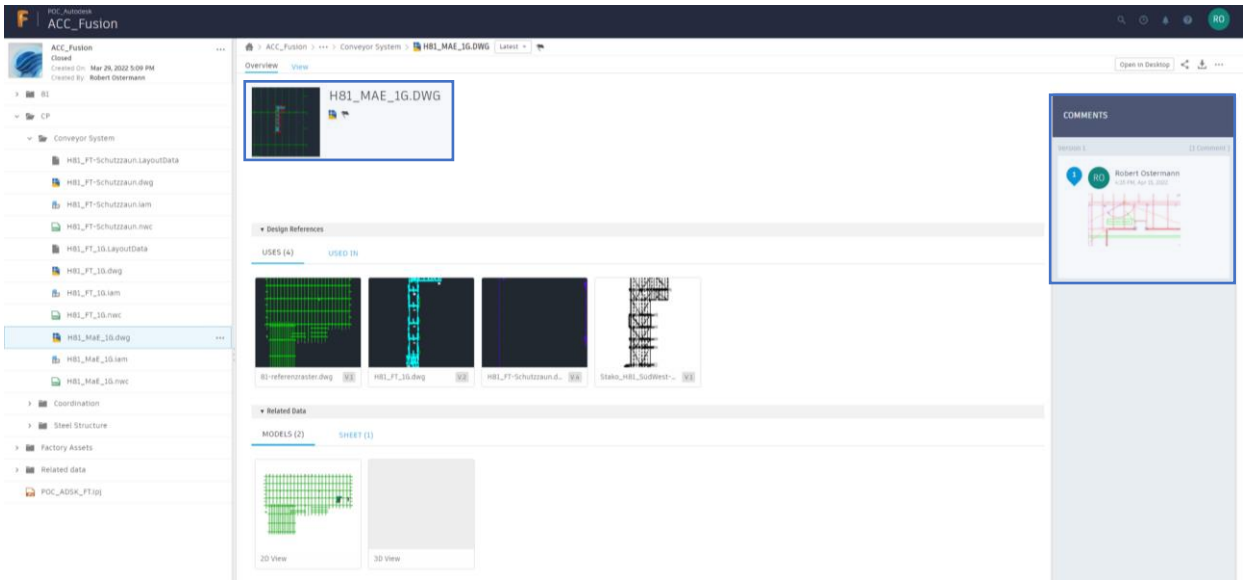

FIGURE 61: MARKUP OVERVIEW IN MODEL OVERVIEW ON FUSION TEAM

Currently Fusion Team doesn't have an issue and team management like ACC, where tasks can have a state and be assigned. Team members can only be mentioned in the comments by using the @ symbol to receive information via email.

CAD Data Issue Management for Factory Integration, Best Practice – Summary

To summarize, what you have read so far on how to set up an issue management process for an entire factory model is, the following:

- You can manage your building project data on Autodesk Docs
- Add machinery and equipment data from Fusion Team as NWC files, automatically transferred by Vault Professional
- Set up a coordination space for factory integration purposes
- Manage your machinery and equipment data on Fusion Team gaining some benefits concerning file dependencies and version control with milestones

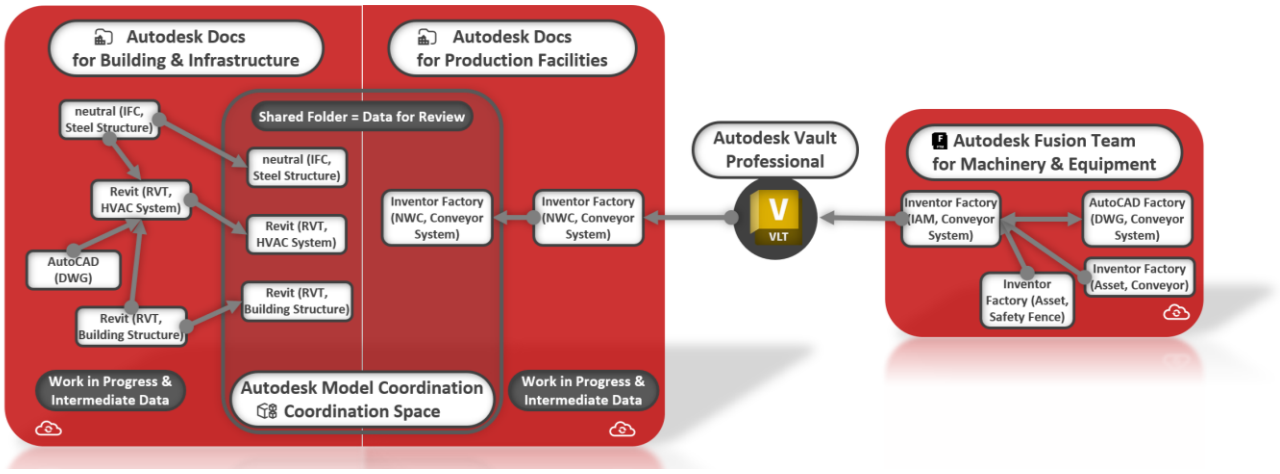

FIGURE 62: SUMMARY HOW TO SET UP AN ISSUE MANAGEMENT FOR A HOLISTIC FACTORY MODEL WITH AUTODESK CLOUD SERVICES

CAD Data Issue Management for Factory Integration, Conclusion

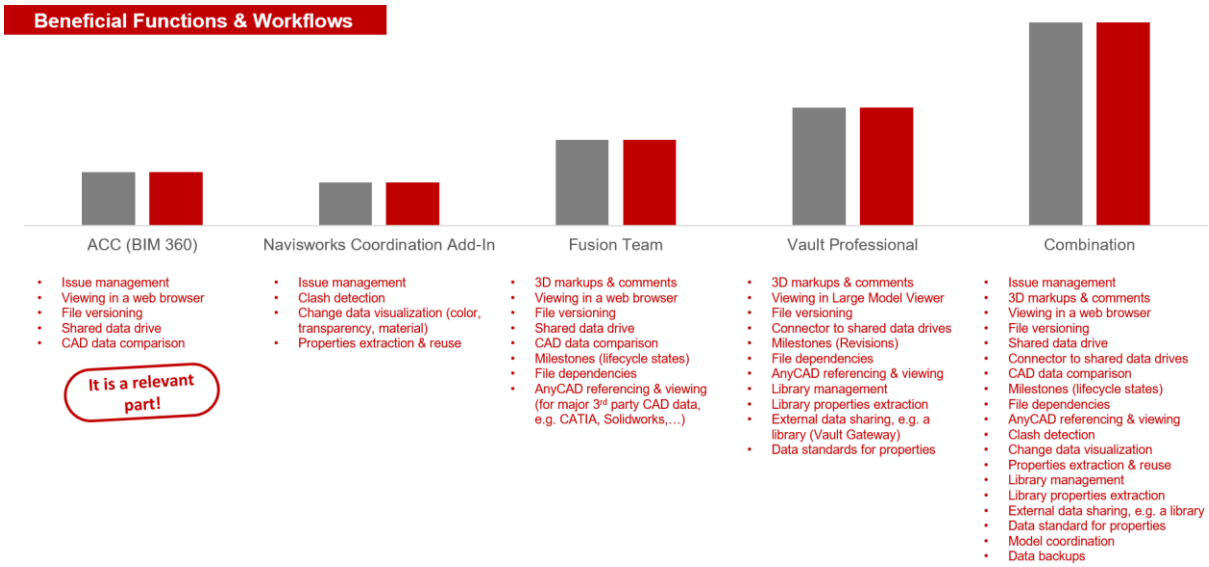

FIGURE 63: BENEFITS COMBINING VAULT PROFESSIONAL, NAVISWORKS COORDINATION ADD-IN AND AUTODESK CLOUD SERVICES

By combining the software tools as seen in prior examples and workflows the full potential for "Integrated Factory Model Collaboration" awakes. Due to the fact, that the ACC is a good extension for building and building infrastructure but has some significant gaps concerning the management of machinery & equipment data, the combination with Vault Professional and Fusion Team can close this gap. Implementing this data as Navisworks cache files via Vault Project Sync on the ACC enables a holistic factory integration process concerning the management of issues, tasks and review processes within the ACC Model Coordination environment. Additionally, the synchronization to Vault Professional will enable an automated and constant backup for project planning data on the Vault Data Management Server.

CAD Data Issue Management for Factory Integration, Model Coordination: Integration with 3rd party platforms

To close the CAD data issue management use case, I'd like to show you, that the ACC can be a good basis for other cloud services, and because it is a CDE you usually don't need to worry about file formats. You can directly link a model from the ACC (BIM360) to the Cintoo Cloud platform (see Figure 64) in order to make verification (see Figure 65) concerning existing conditions (see Figure 66).

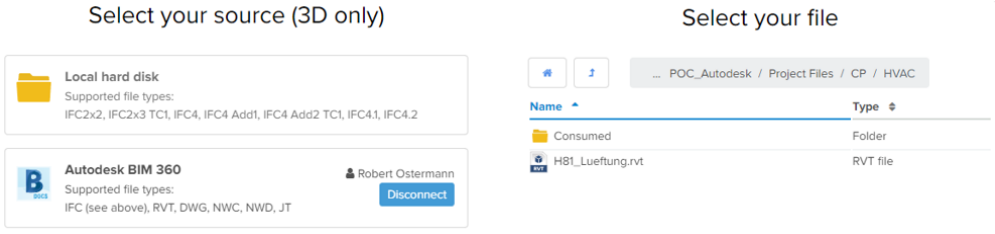

FIGURE 64: LINK ACC MODELS TO CINTOO CLOUD FOR REALITY VERIFICATION

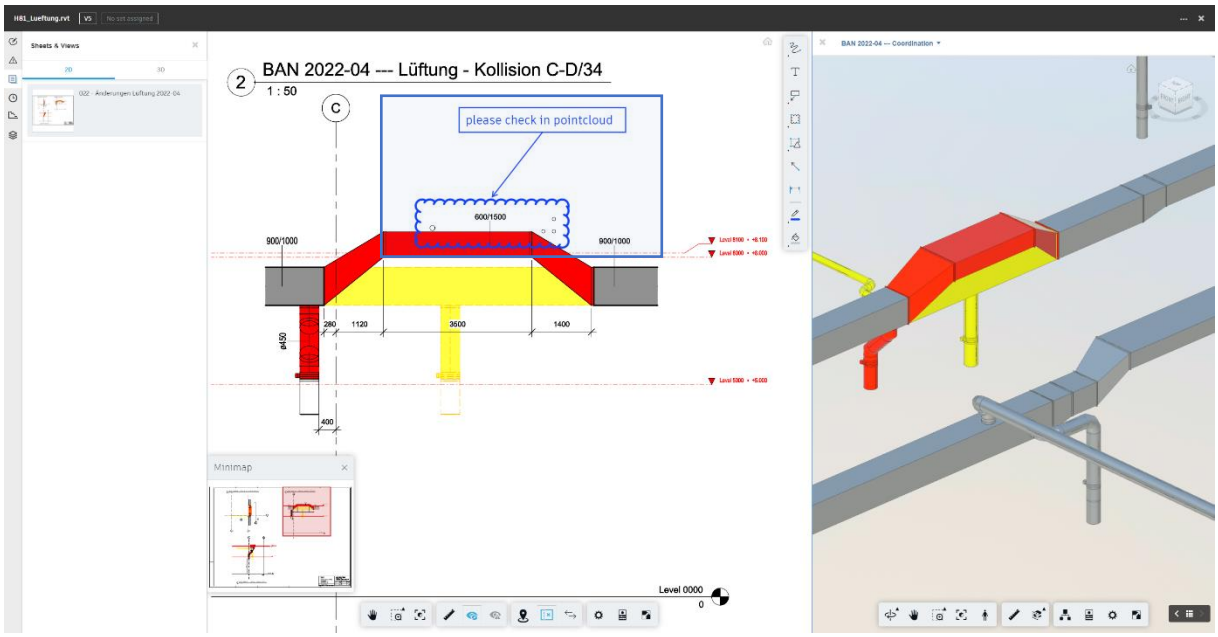

FIGURE 65: ACC MARKUP FOR VERIFICATION TASK

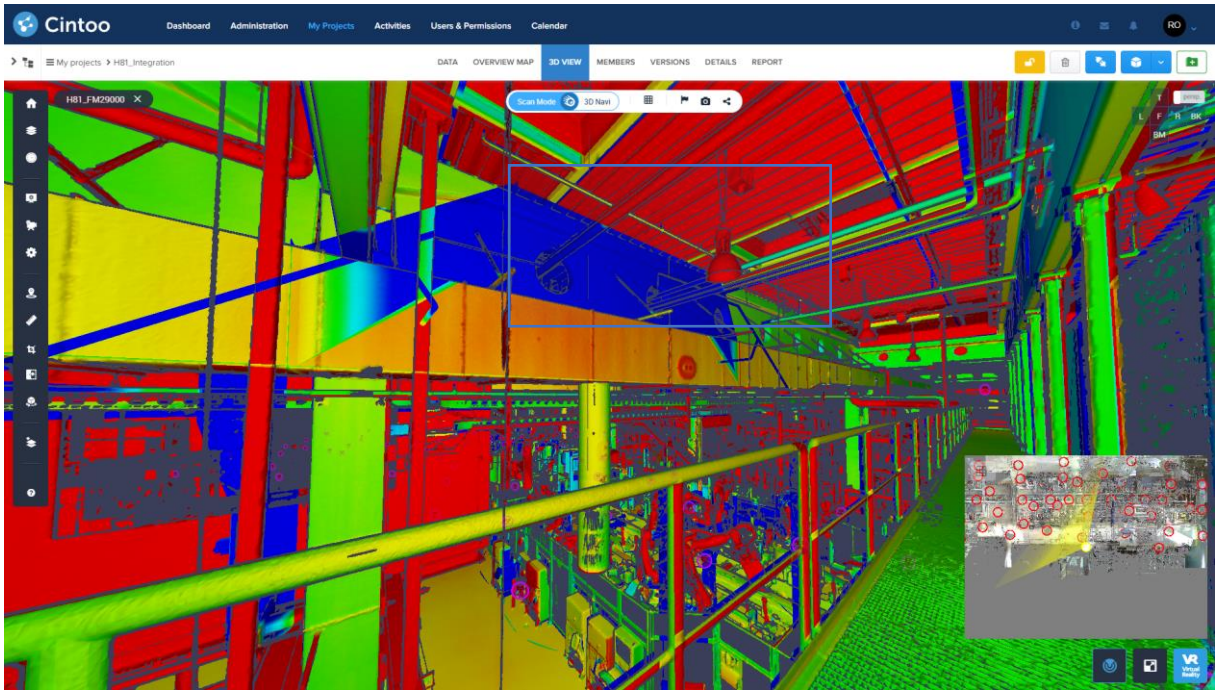

FIGURE 66: COMPARE PLANNING MODEL FROM ACC WITH EXISTING CONDITIONS ON CINTOO

Powered by Autodesk's Cloud Solutions – 3. Use Case

CAD Data Viewing for Factory Integration, Workflows & Systems

Last but not least, this section is about CAD data viewing for factory integration.

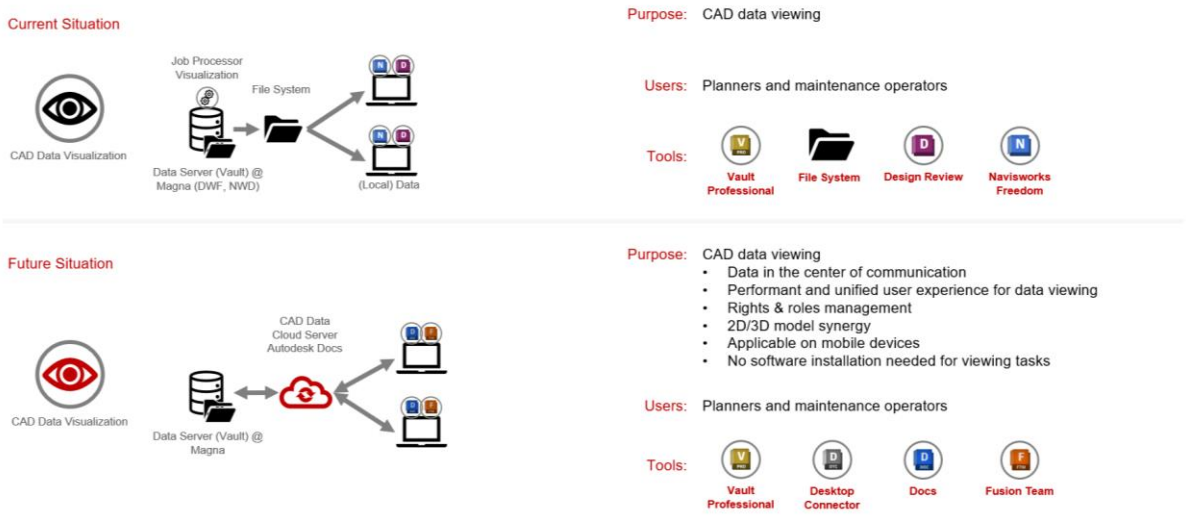

FIGURE 67: CAD DATA VIEWING – UNDERSTANDING CURRENT AND FUTURE WORKFLOW WITH AUTODESK COULD SERVICES

Especially I'd like to focus on how data is being viewed without a cloud service. Most times CAD data is automatically or manually converted into a lightweight format and sent between the different teams for communication purposes.

The benefits using Autodesk cloud services are:

- Design data is in the center of communication.
- A performant and unified user experience throughout different file formats will be possible.
- It is applicable on mobile devices as well as on desktops without any software installation.
- Rights & roles management to control data access can be set up.
- Visualization of 2D and 3D data as well as pointcloud data is possible.

CAD Data Viewing for Factory Integration, Viewing Experience: Comparison

In this chapter I would also like to show you some minor differences in the viewing experience between Autodesk Docs and Fusion Team. For example, the model measurements in Fusion Team are more visual due to the highlighting of faces and edges, but most of the viewing functionalities, for instance, the sectioning tool behave the same way (see Figure 68).

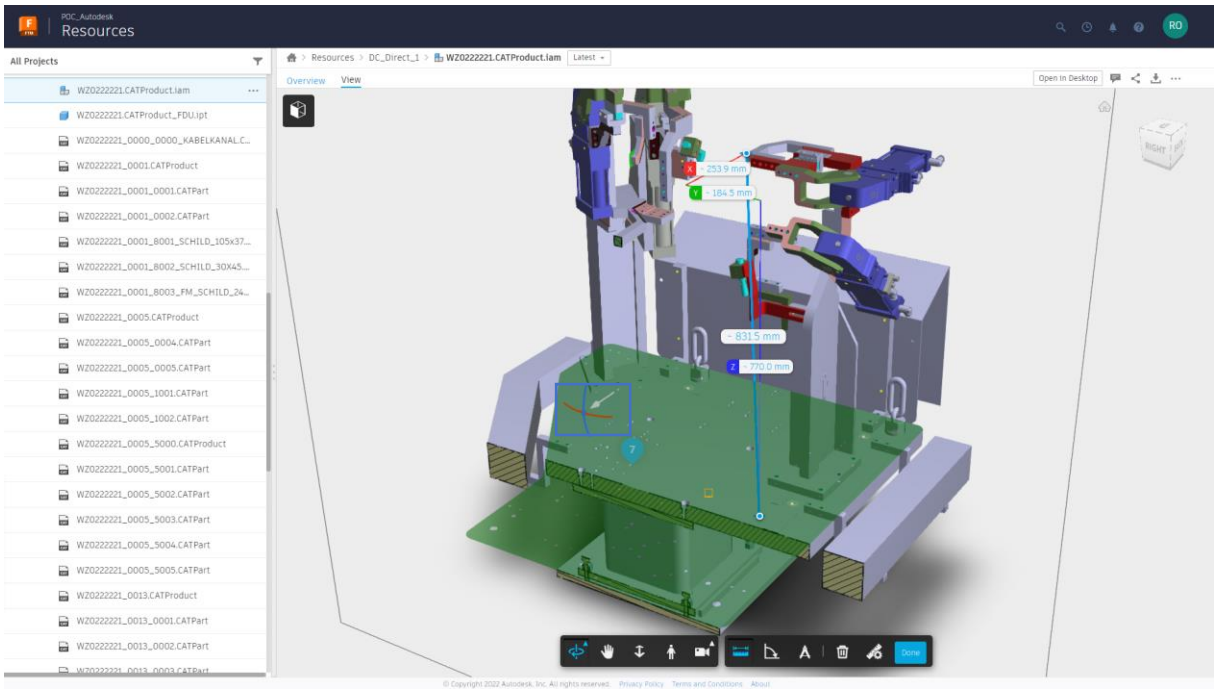

FIGURE 68: MODEL MEASUREMENTS ON FUSION TEAM

The biggest difference is that Fusion Team can show file dependencies for some file formats and visualize them, as the CATIA reference in Figure 69.

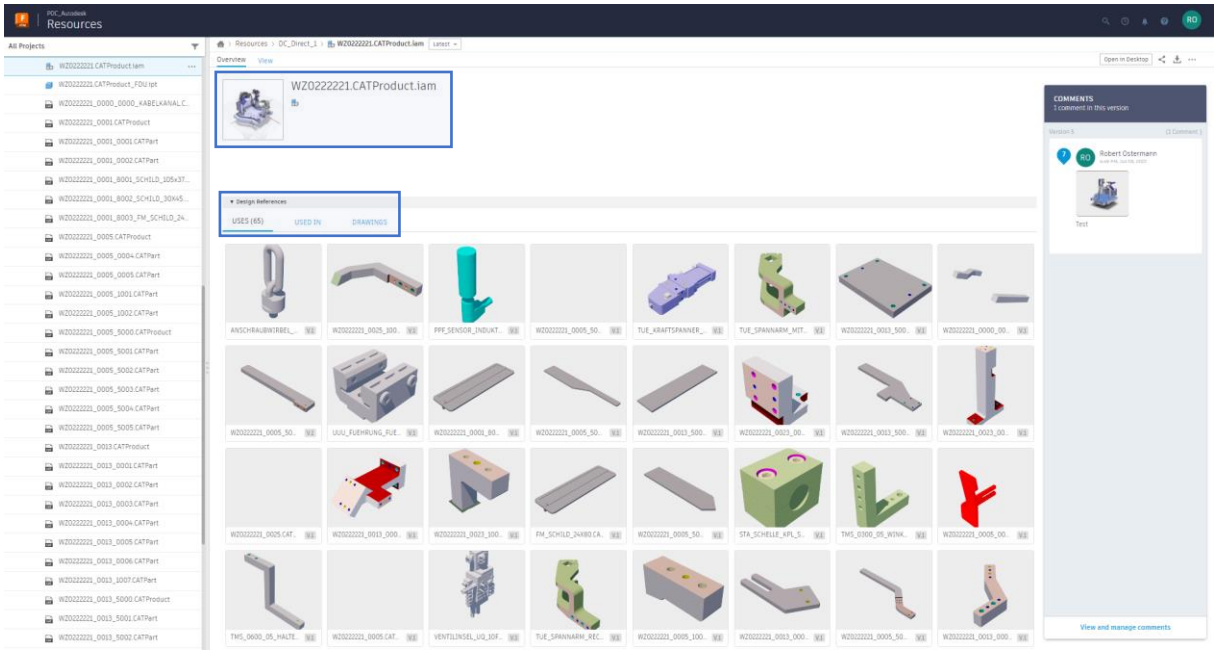

FIGURE 69: FILE DEPENDENCIES ON FUSION TEAM FOR INVENTOR/ANYCAD

Only the ACC is able to generate measurements in markups, but currently without any snapping support (see Figure 70).

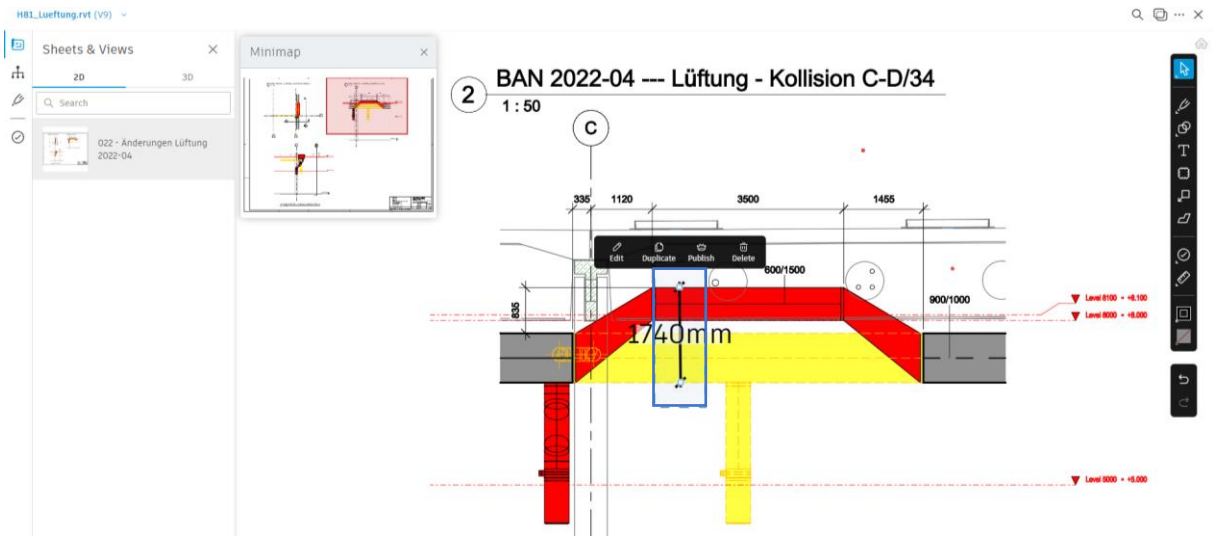

FIGURE 70: 2D MEASUREMENTS AS MARKUP ON ACC

Both cloud platforms can visualize the differences between versions for some file formats. For example, a Navisworks NWD file can be compared on either platform (see Figure 71), but Autodesk Inventor files (see Figure 72) can only be compared on Fusion Team, and Autodesk Revit files can only be compared on Autodesk Docs (see Figure 73).

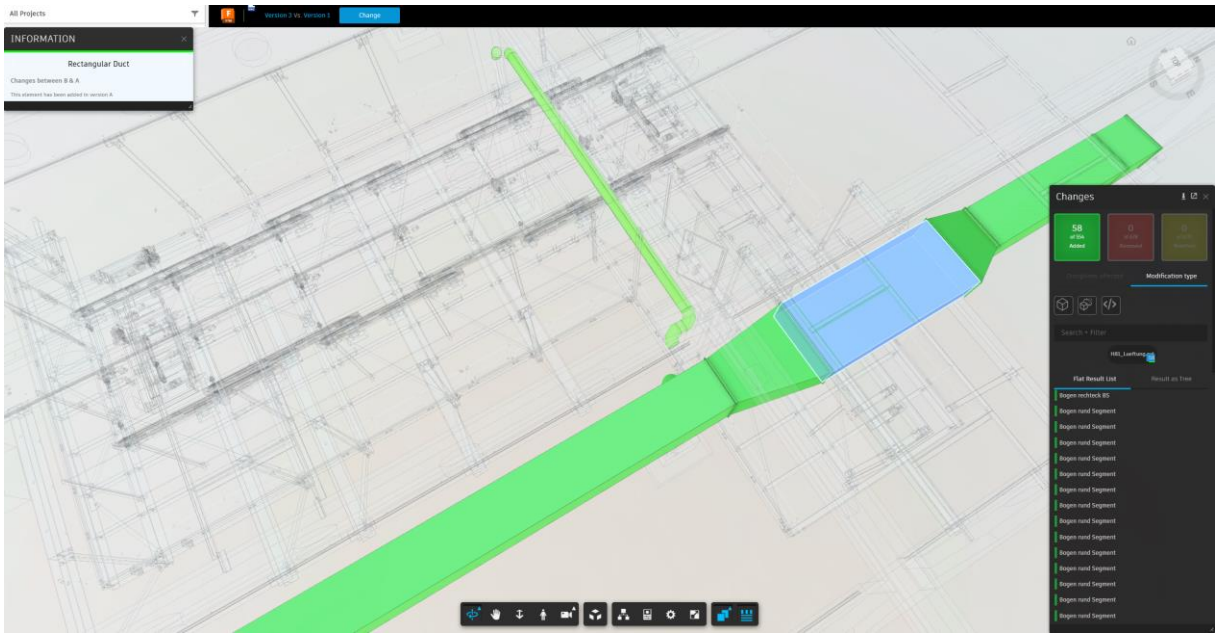

FIGURE 71: NAVISWORKS NWD MODEL VERSION COMPARISON

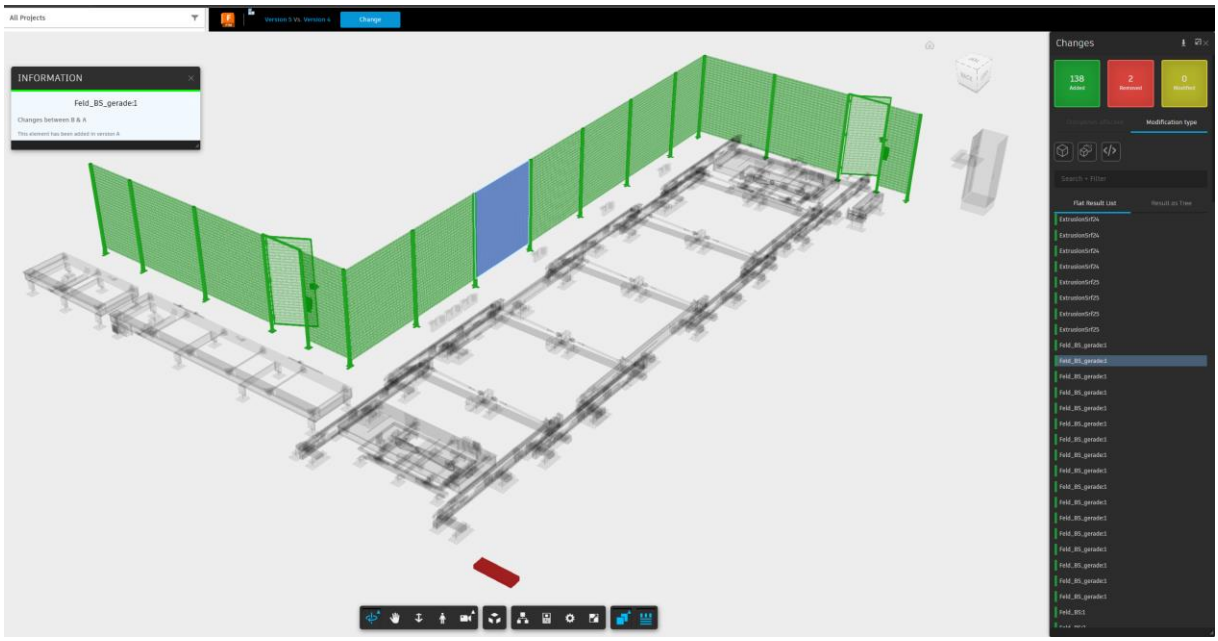

FIGURE 72: AUTODESK INVENTOR MODEL VERSION COMPARISON ON FUSION TEAM

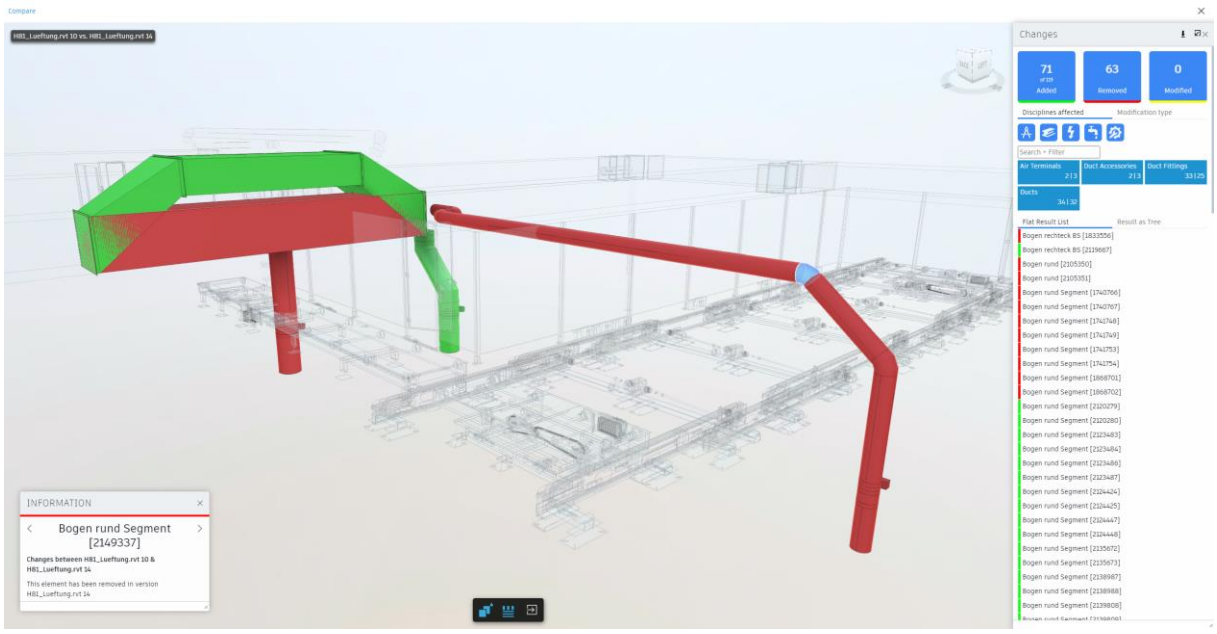

FIGURE 73: AUTODESK REVIT MODEL VERSION COMPARISON ON AUTODESK DOCS

Powered by Autodesk's Cloud Solutions – Conclusion

Dear reader, I hope this document can help to solve problems you may face in your daily work, which go beyond standard ACC workflows. Problems where a data management system such as Vault Professional or a cloud service such as Fusion Team can better handle specific data like complex machinery & equipment designs that need to be integrated into a building and coordinated with building infrastructure. Further, the following advantages are not only true for building designs but also for your entire factory data:

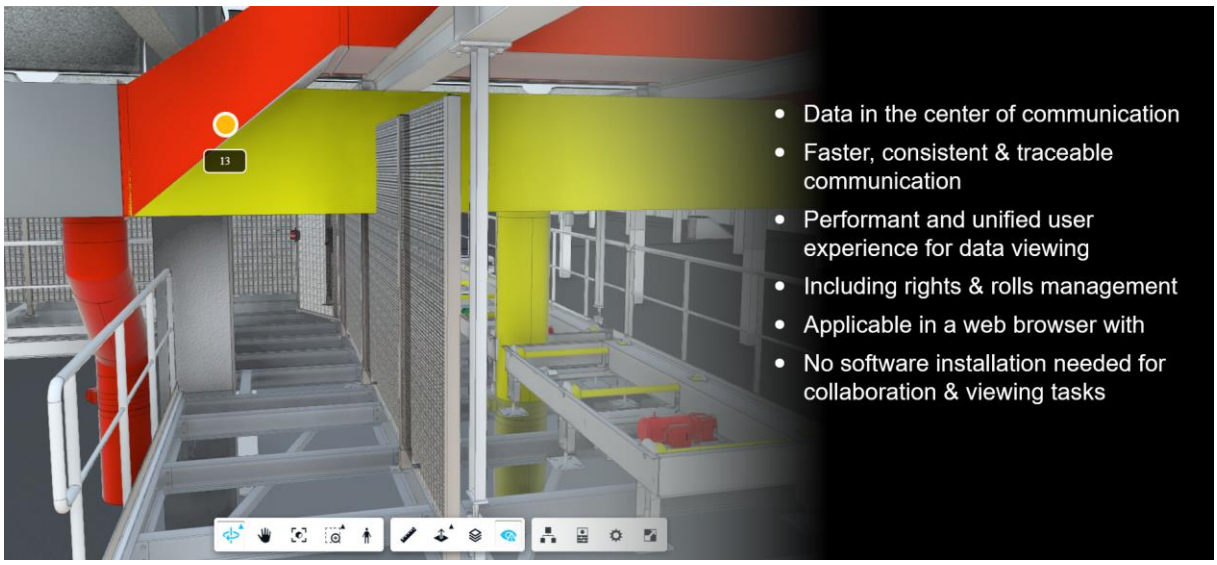

FIGURE 74: BENEFITS USING AUTODESK CLOUD SOLUTIONS FOR FACTORY PLANNING

I would like to thank you for reading this document and am looking forward to seeing you in person at the Autodesk University in New Orleans. Keep on inventing new workflows with Autodesk software, take care and stay safe.

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Q&A

Q: *Would you use pointclouds on Autodesk Construction Cloud?*
A: No, because the technology and the possibilities of Cintoo are years ahead of Autodesk's capabilities. On Cintoo the pointcloud data will be concerted in a factor 10 smaller format by uploading and transferred back to a ReCAP project when downloading. This process is 50% faster than uploading a ReCAP project on the ACC. The performance is much higher on the Cintoo platform. Also, Cintoo can easily compare pointclouds to pointclouds and pointcloud to geometry. Pointclouds on Cintoo are meshed as well and therefore better concerning viewing.

Q: *Would you recommend avoiding the Autodesk Construction Cloud for machinery & equipment data?*
A: Yes. If you are an Inventor & Factory Design Utilities user and don't need to manage the integration into a building / Revit, then Fusion Team is the better tool. If clash detection and managing issues aren't complex, you can use, mark-up and comment a Navisworks model (NWD) on Fusion Team. Only, if the integration is complex and requires several AEC teams, would I use the ACC as described in this class.

Q: *If Autodesk would ask you how to improve its tools in the future?*
A: I would recommend them splitting Navisworks into an AEC and PDC product line. I'd also make Product Managers of Revit responsible for improving and enhancing the Vault Professional integration because Docs as a data management system has many critical gaps compared to Vault Professional. Finally, I would ask to enhance Fusion Team with an issue management and a clash detection service to avoid using the ACC. Further, I would ask for an integration of a bi-directional connector to ACC, if teams working with Revit are needed to be integrated.

Q: *Did you encounter problems using Factory Design Utilities on an Autodesk Cloud Service?*
A: Yes, the FDU currently has several problems being used on a Cloud Service. Some of these problems include the poor performance, which is basically not good, but gets a lot worse when working on a shared cloud drive, even when working offline. In general, FDU is not a very stable program, problems get also worse when working on a shared cloud drive, the LayoutData file for example needs to be updated manually to avoid fatal crashes. Further, Inventor DWG, which appear in Factory Assets, aren't supported, or at least don't work correctly, which can cause problems updating Assets. The FDU itself has critical problems in working with model states since version 2022, the only stable way is to break a link to a base component, FDU so far doesn't understand suppressed links to base components and neither does any Autodesk cloud service. At Autodesk University you can ask me about my current knowledge about these problems.

Q: *Do you use tools to set up an entire digital planning twin of a factory?*
A: Yes, Revizto. Why? Because it has the most performant engine compared to Unity and Nvidia Omniverse. It also has several functionalities that are relevant in factory planning processes instead of just looking good like Nvidia Omniverse. In this context, Autodesk doesn't deliver a comparable product, and Navisworks is a "dead" product and has not been developed over the last 15 years.
New platforms such as Autodesk Tandem or The Wild are currently pure AEC products, and that's a clear no-go, because we are designing factories and not buildings.

Q: *Where do you see problems or missing functionalities concerning the Desktop Connector?*
A: Especially discouraging is, that Revit and Navisworks references aren't analyzed like they are when using AutoCAD or Inventor. In the future I hope CAD data is handled the same way no matter which Autodesk authoring system has been used. This is also the reason, why transferring Revit data back to Vault will ignore any referenced files, which further need to be manually selected.

Q: *Don't you think a lightweight model workflow similar to using Navisworks files in Revit would make sense for Inventor Factory?*
A: Absolutely, in a factory in many cases the necessary Revit models are huge, and the process referencing a Revit model takes far too long. Some basic functionalities would also be needed, such as the ability to snap to vertices, edges and planes similar to using a coordination model in AutoCAD, setting a transparency and enabling sectioning would also be highly demanded.

Acknowledgments

I would like to thank the Autodesk Consulting team, Daniel von Känel and Klaus Lörnicz, Oliver Neumann from the Business Development Automotive team, Maximilian Hämmerl our Strategic Account Manager who all helped us to find the ideal way implementing Autodesk Cloud Solutions. Special thanks go to Paul Munford, Industry Marketing Manager at Autodesk for technically reading and verifying this AU class and the documents coming with it, as well as to Melanie Tomaschitz, Language Consultants for making my English words more meaningful and better to understand. A big thanks also goes to Magna Steyr Fahrzeugtechnik and its management for making it possible to constantly improve and move forward!

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