IM321922

Autodesk PDMC and Vault Professional Optimize Multidisciplinary Workflows

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Learning Objectives

- PDMC & Vault Overview
  - Get an overview of major capabilities and workflows covered by the Product Design & Manufacturing Collection toolset
  - Learn how Vault Professional captures all relevant engineering data using built-in functionalities
  - Learn how iLogic Automation extends workflows beyond design automation
- Workflow Challenges
  - Get insights on challenges encountered when consolidating data for different disciplines, like sharing models for procurement or machining
- Where To Start With Automation
  - Learn how to access available configuration and automation samples that might help to eliminate unproductive steps in daily work

Description

The Product Design & Manufacturing Collection offers tools and workflows, enabling multidisciplinary collaboration from ideas to manufactured products. This class demonstrates use cases showing how Vault Professional software captures all relevant data to share the right information to all people involved at the right time. Follow best practices and practical use cases. Discuss challenges encountered in daily work of engineering and requirements of downstream processes of procurement, manufacturing planning, and machining. Watch live demonstrations using built-in capabilities, and learn how automation options of Inventor

software and Vault Professional may eliminate repetitive and tedious tasks. Additional class materials are going to share all samples, configurations, and automation snippets used and shown during the class.

Your AU Experts

Markus Koechl is a Solution Engineer for Vault Products. He targets customer needs, practical workflows, and is always eager to overcome barriers by extensions or automation. That's the simple reason that he started programming Inventor, Inventor iLogic, and Vault APIs with the background of a Mechanical Engineer.

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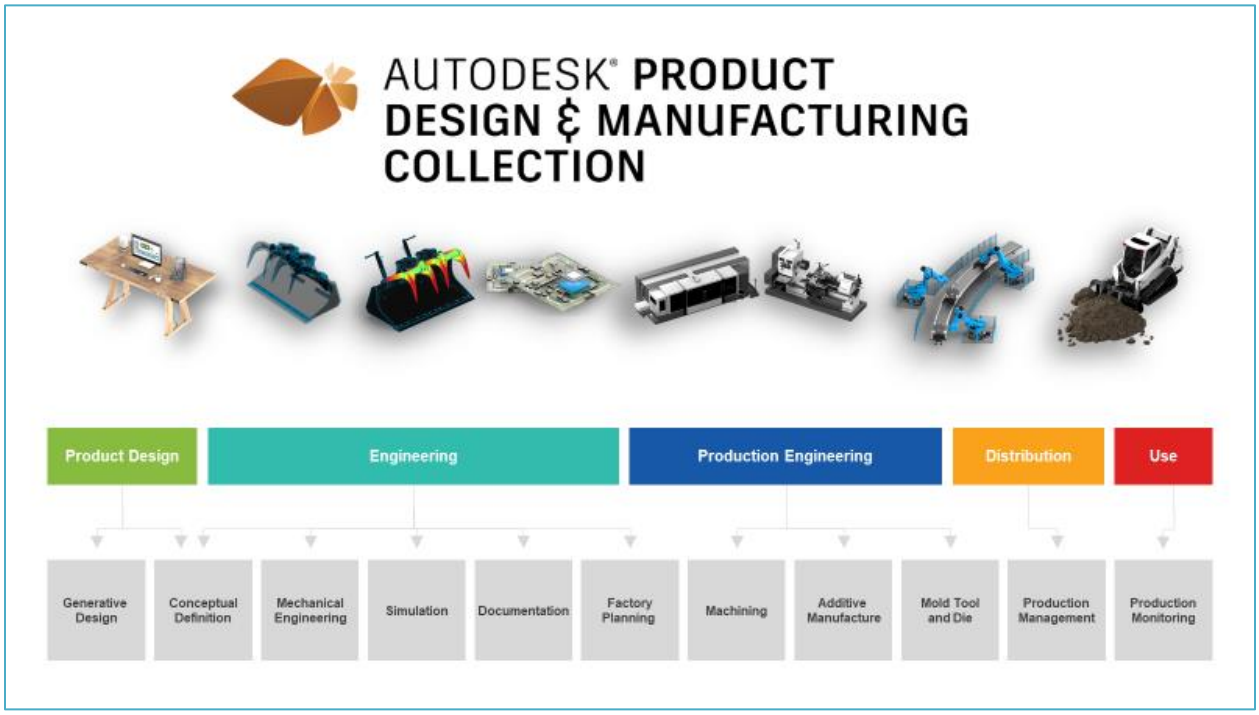
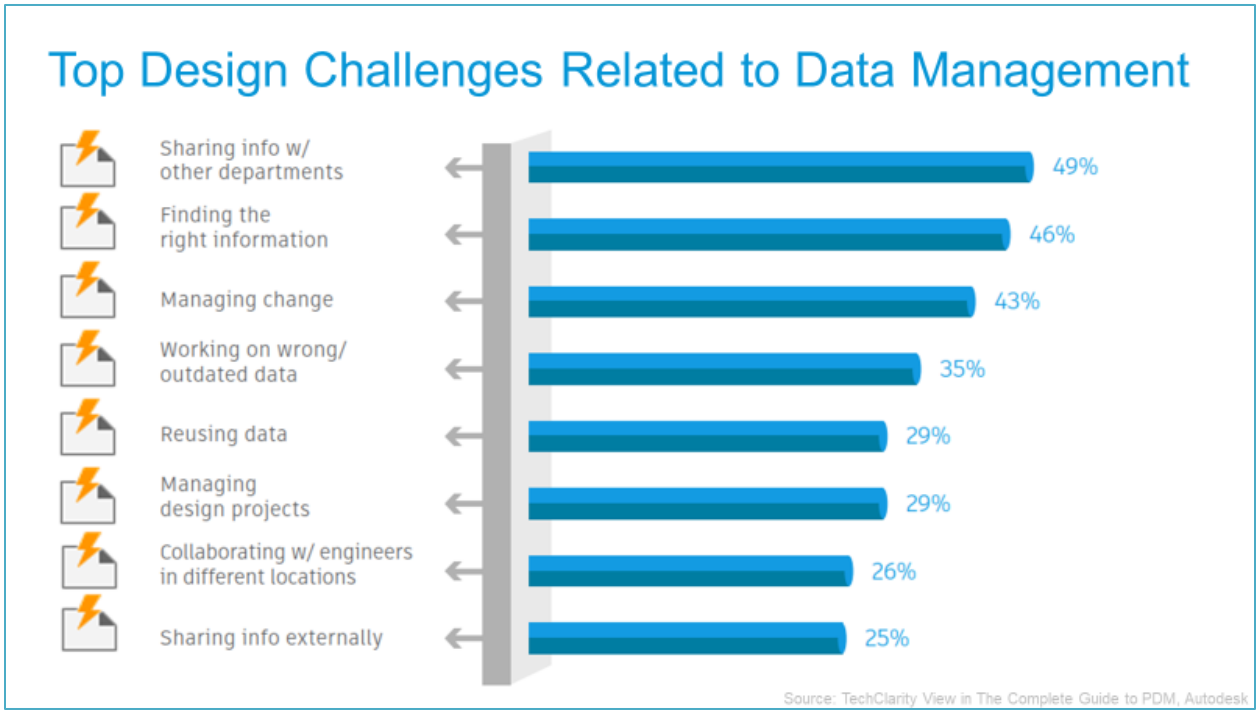
1 Overview – PDMC & Optimization Potential for Autodesk Vault

Let's start with the Product Design and Manufacturing Collection. This collection was put together based on the feedback we heard from our customers.
First, it simplifies access to your technology. One subscription that provides tools from concept to manufacturing.
Second, we put more functionality in Inventor. Don't force us to learn different UI's or deal with file translations associated with using multiple software applications.



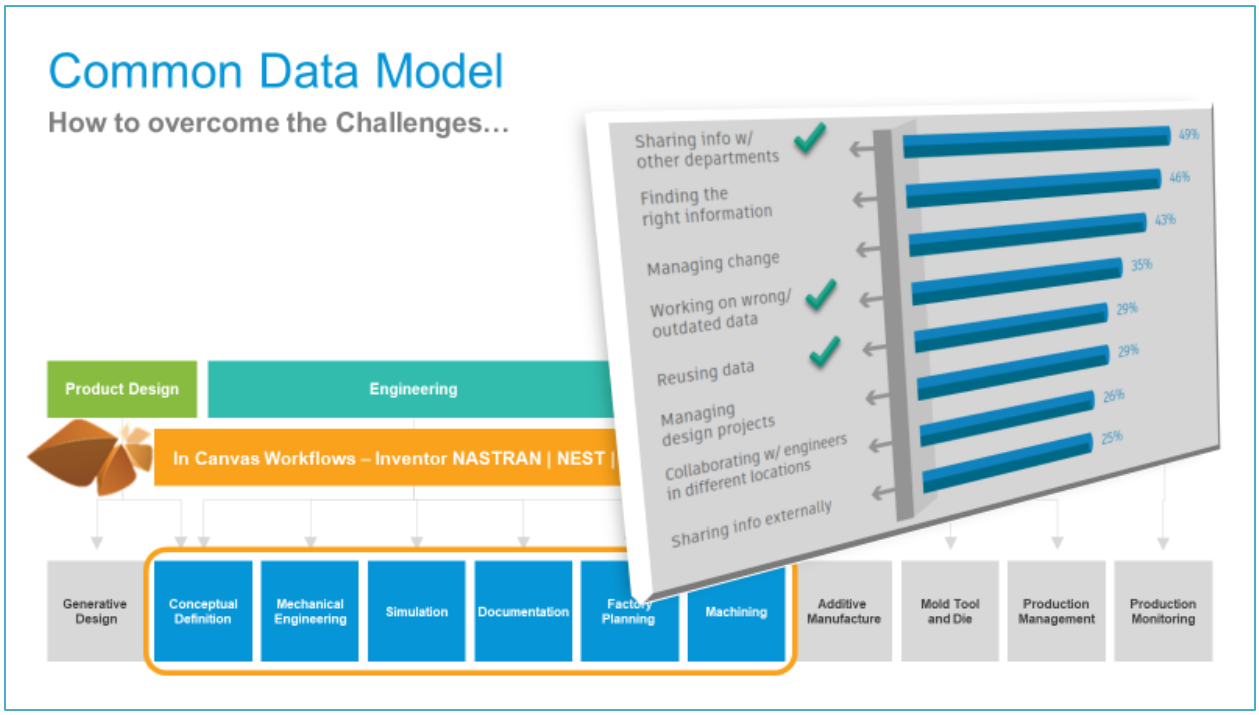
The two top priorities for PDMC may have sound idealizing. We need to acknowledge what challenges industry reports continuously tell.
Sharing and finding information – or working on outdated data. Does this resonate with your experiences?



The good news is that PDMC already helps to overcome the challenges. We added more in-canvas workflows to Inventor.

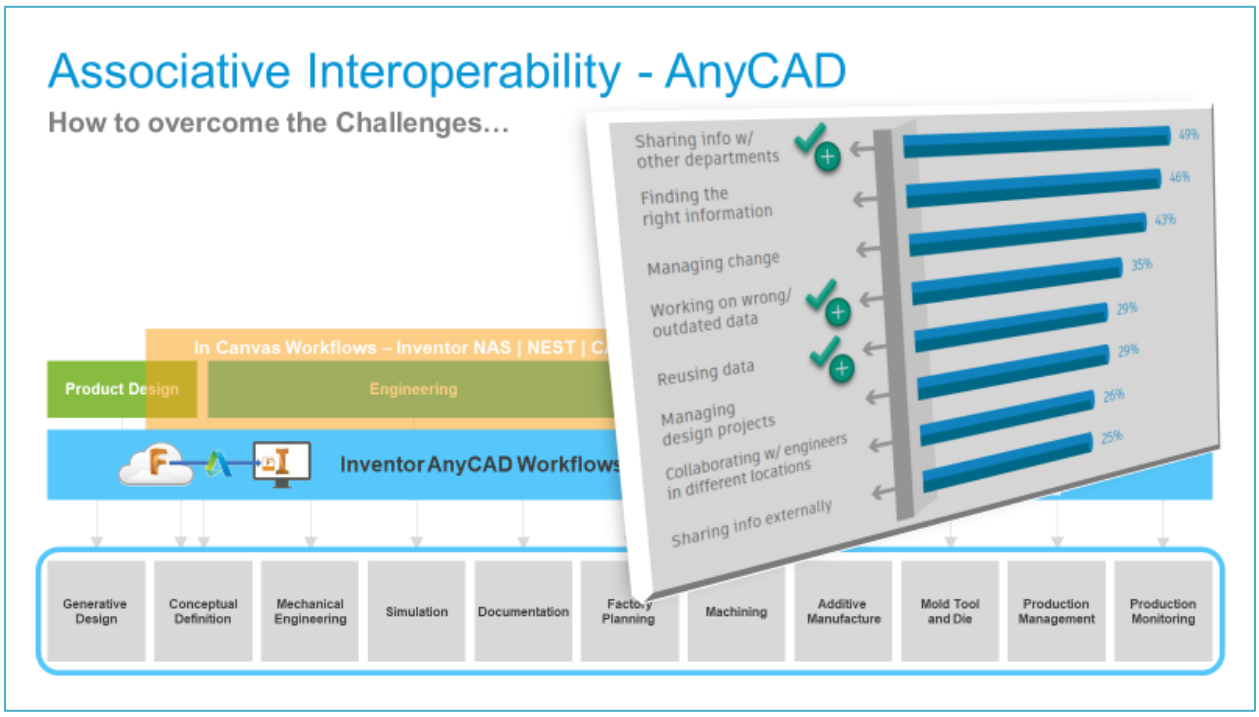
Users share the familiar user interface, and it avoids file disassociations by copying models for other disciplines, like Simulation, Tolerance Analysis, Sheet Metal Nesting, Factory, and Machine Layout Planning, or subtractive CNC Manufacturing.

And – it streamlines sharing and re-using the data across disciplines.



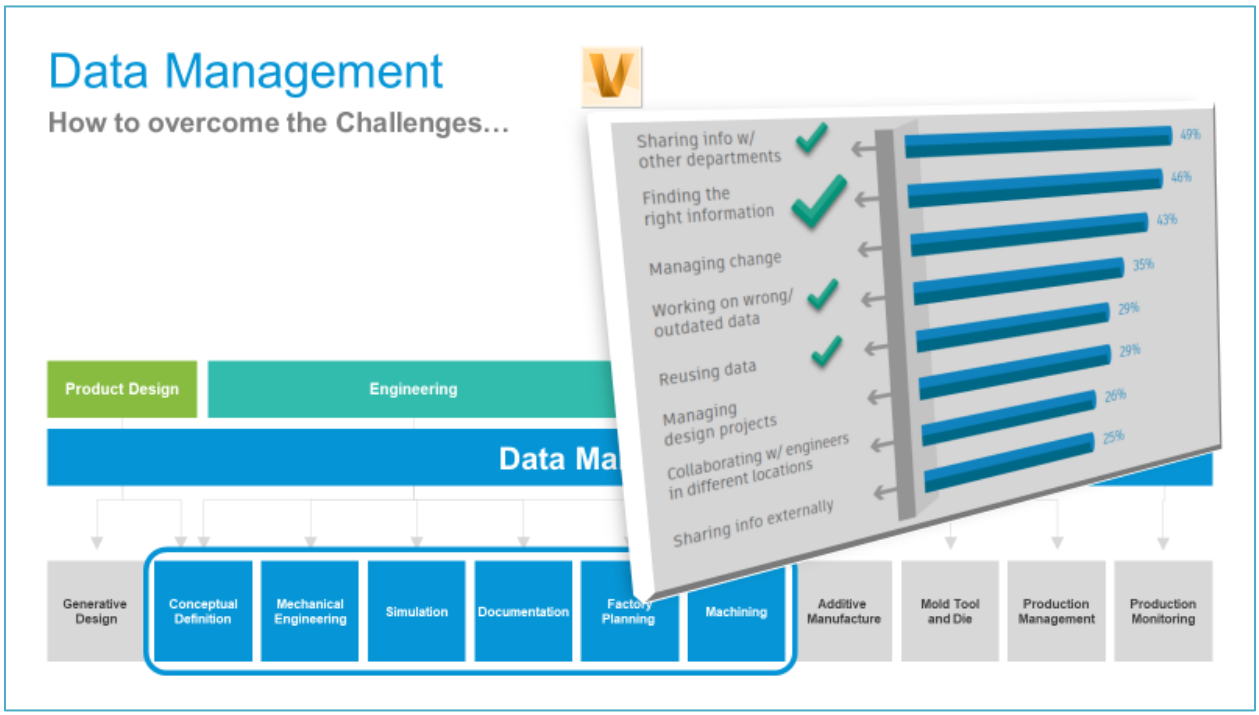
Some time back, we started offering AnyCAD workflows in Inventor.

The concept of associatively referencing data of other formats or platforms makes data sharing, collaboration, and re-use of up-to-date engineering content much easier.



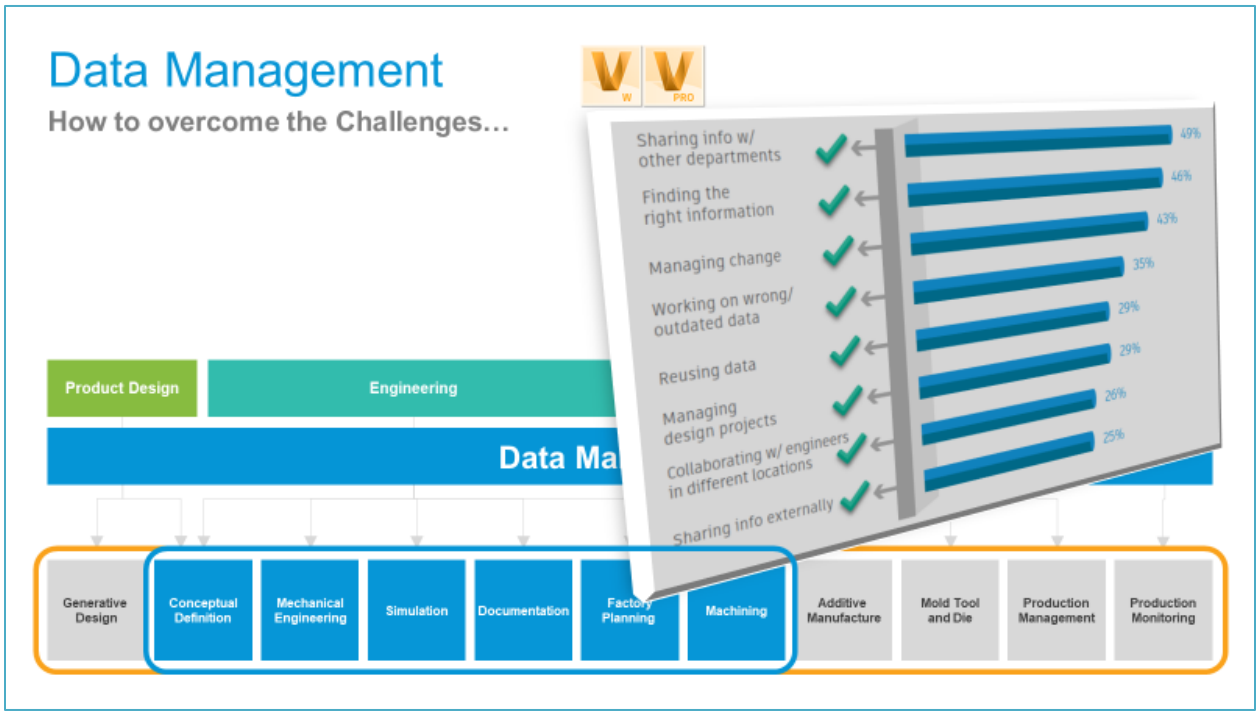
PDMC includes Vault Basic. Capturing files and properties in a database remove all barriers of finding information.

But staying honest, I can admit that several issues listed before remain uncovered.



Upgrading options of the Vault family – Vault Workgroup and Vault Professional - address the remaining challenges.

Revision and life cycle management, change orders, and a scalable toolset of bidirectionally communicating information from on-premise to, and back from cloud platforms are the major influencers.



Hold-on: are you saying the merely adding Vault data management solutions solve all the challenges per se?

Yes, and No:

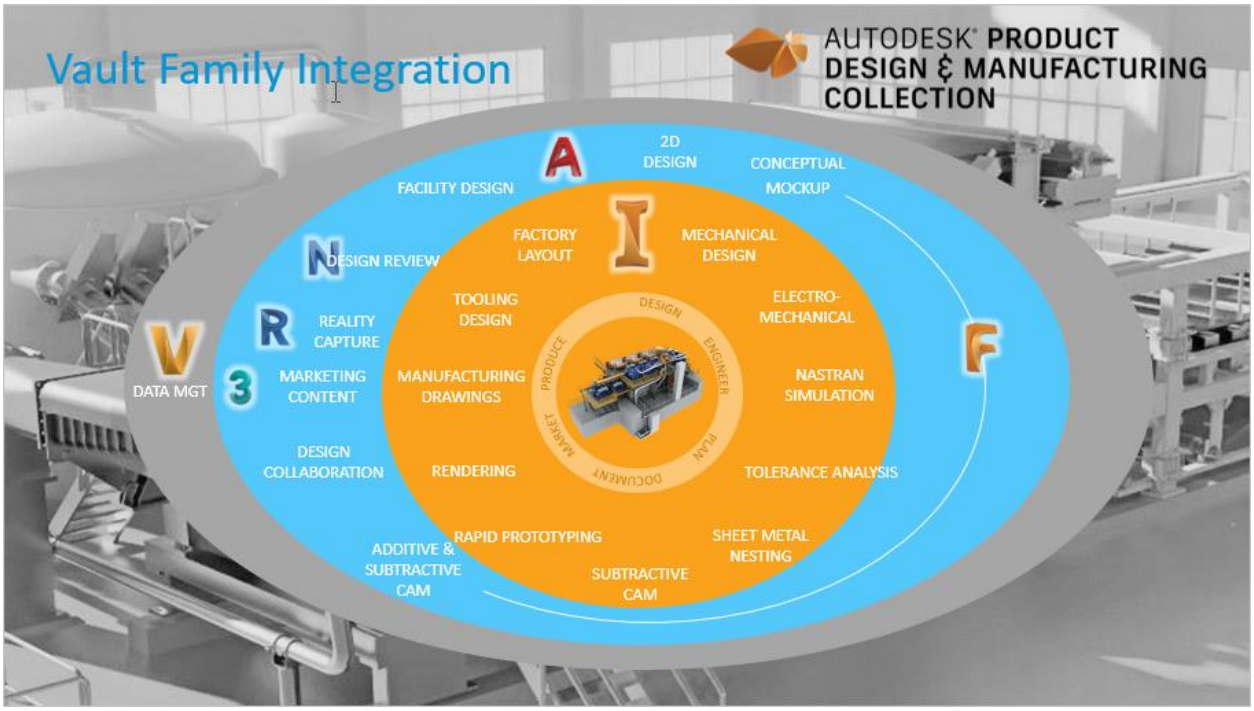
•There are complex tasks that we can solve quickly.

•There are more complex tasks that require implementation efforts.•

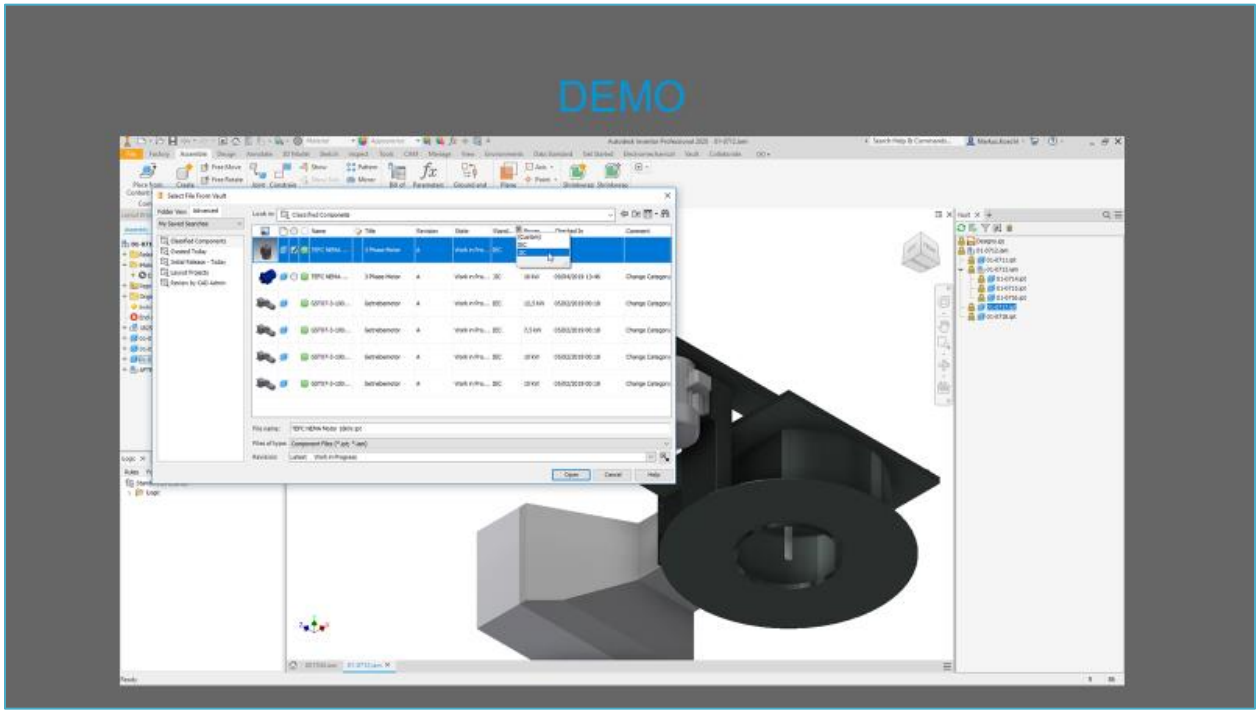
There are new challenges that PDM implies

In a few minutes, I show and discuss diverse scenarios and workflows. For some of them, the built-in capabilities have all potential of coverage. Others require to include more consideration on individual requirements and extended implementation.

In any case – I stick to available tools like iLogic, Vault custom Job Processing, and share these samples as a starting point for your customization.



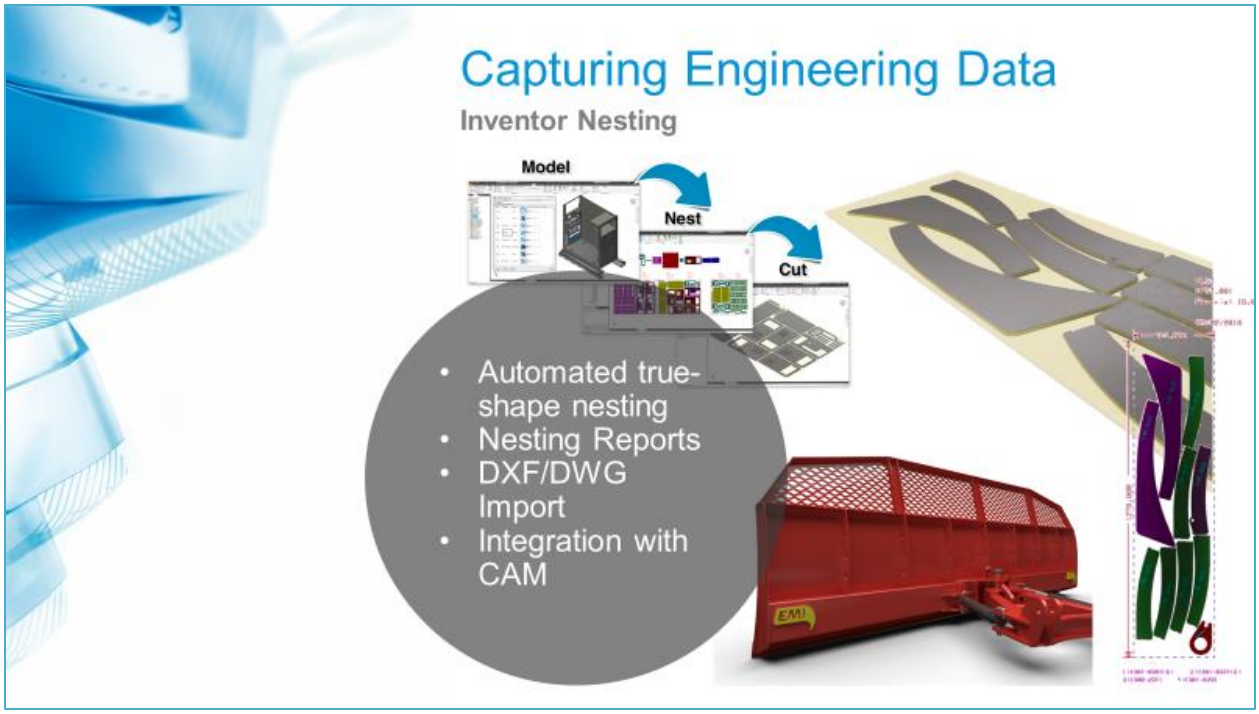
A short product demonstration gives insights into the power of data management in general. Watch how to find, re-use components, and track changes for downstream processes.



2 Built-in PDMC-Vault Workflows – Capturing Engineering Data

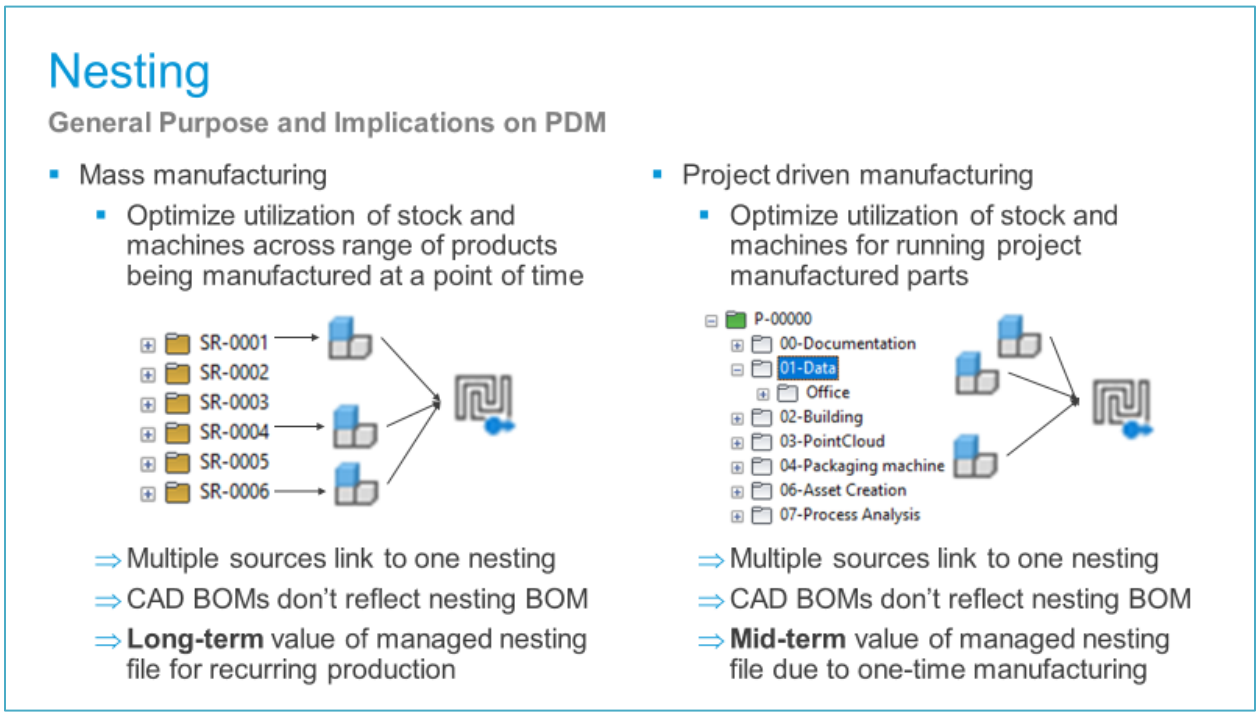
2.1 Capturing Engineering Data – Inventor Nesting-Vault

Capturing engineering data for manufacturing is an indispensable step.
Inventor Nesting targets to optimize sheet metal cutting.
Automatically find all cutting parts across many assemblies, arrange them on available sheet sizes, and integrate Inventor CAM's laser and water cutting options for rapid machining.

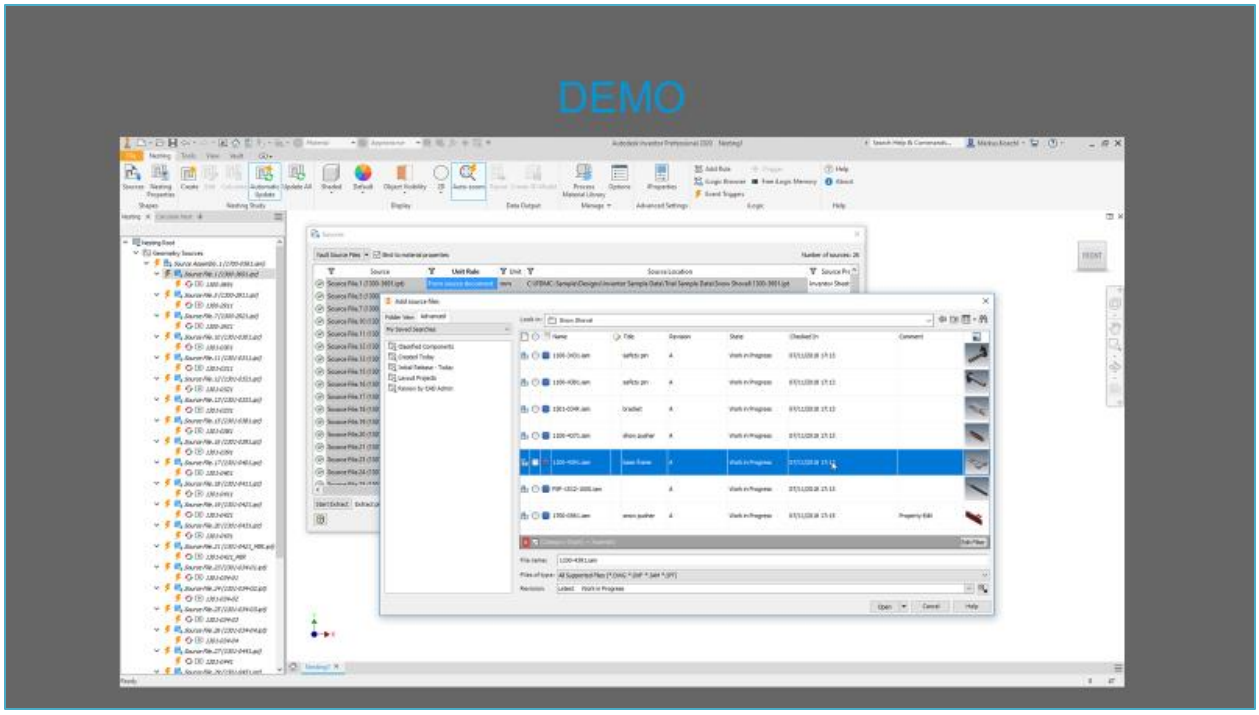


Sound's like push button-process – what it isn't yet, at least as of today.
However, we have customers who streamlined their workflow directly from Nesting to ERP or MRP systems.
Is there a benefit of adding PDM to this scenario?
Probably yes.
First, let's imagine the mass manufacturing of various products. Production planning aims at the best utilization of raw material and machines. So it may be worth spending time to find a set of products that result in the best utilization and keep this for future reference. Inventor Nesting integrates with Autodesk Vault to precisely capture these relationships for recurring production.
On the other hand, this raises a new challenge for BOM management. The engineering BOM continues to list all sheet metal parts (and other components that base on cutting stock). A procurement BOM has to aggregate differently and find out quantities from nesting reports while filtering the nested parts in the BOM.

Secondly, consider project-driven manufacturing. We cannot re-use existing arrangements of cutting parts, and we should avoid any efforts on archiving the nesting files long-term. Limited resources, costs, and environmental impact lead us to optimize utilization of stock and energy also in these manufacturing scenarios. Vault can help to collect assemblies from different projects and extract increasingly cutting components over a while. It is best practice saving a bunch of relating files in PDM, even if we re-use and search for it within one or two weeks.



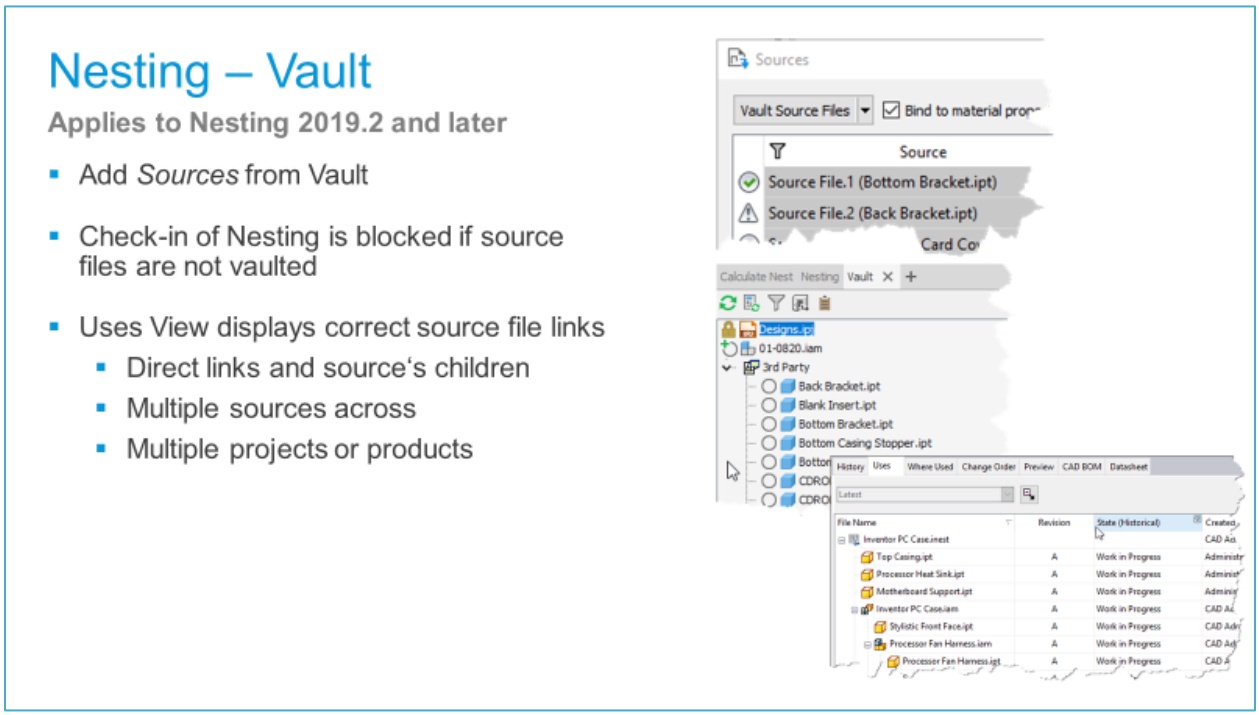
A brief product demonstration introduces the process of adding assembly for nesting component extraction. Once a nesting file saved to Vault, Uses and Where Used views list all related components instead of the source assembly parent files.



If you try the workflow on your own, take into account that Vault always insists on data consistency.

Therefore the check-in of Nesting blocks as long as source files reside outside of Vault.

The Uses and Where Used views lists vaulted files only, so the Nesting add-in consequently follows PDM principles.



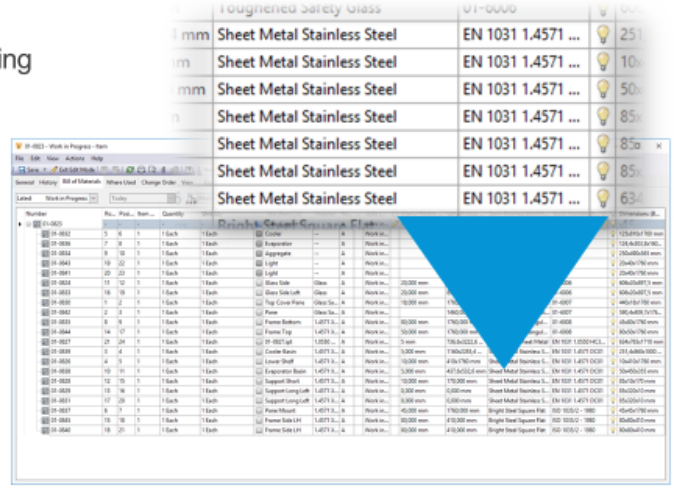
All parts linked to nesting assemblies for manufacturing require filtering on BOM reports or ERP exports.

There are no pre-defined criteria in Vault behaviors configuration. We need to include this in custom implementation planning.

Nesting – Vault Item BOM

Applies to BOM Reporting and ERP Export

- Filter Sheet Metal components from item BOM if
  - CAD BOM is base for manufacturing
  - SM components are nested.



Reviewing this chapter – we recommend setting the right expectations on the scope and potential of managing nesting workflows with Vault.

In any case – Vault, as a single source of truth, should save the nesting files as we manage the components already.

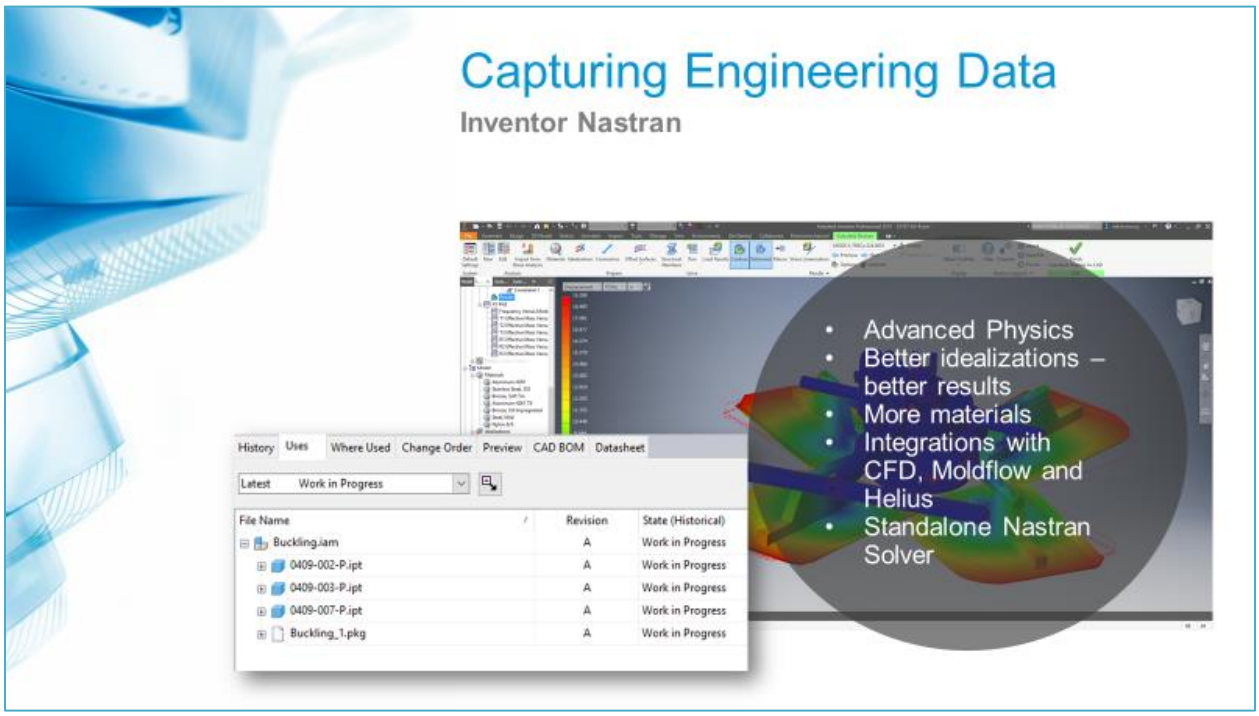
Eventually, the chapter “Integrating Manufacturing” might add more votes to a decision of managing everything, the NC code for each nesting included.

Don’t forget to select an option on handling the BOM related data of nesting.

2.2 Capturing Engineering Data – Inventor Nastran-Vault

Validating and simulating virtual products and prototypes has gotten a permanent role in Engineering.

PDMC added full NASTRAN solver capabilities and powerful study options to Inventor.



In-place or in-CAD simulation makes the studies' definitions and setup parameter associative to the models as a default.

What about the study results? You might argue that having the study setup archived allows re-running the validation again. Yes, but we shouldn't take for granted that re-running studies on new releases, e.g., updated solver technologies, calculate identical results.

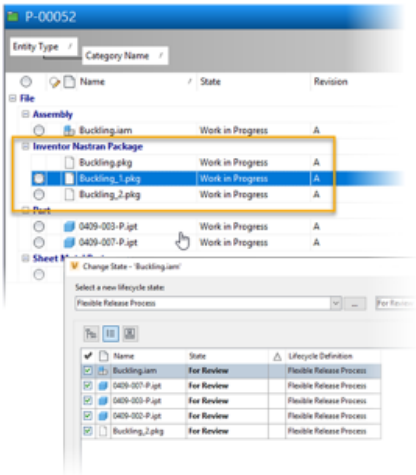
At least, the final design needs to reference back to the validation. It is an essential contribution to virtual prototypes/twins of products.

Not only in case of product failure but also cases of product improving revisions, design, and validation results have to continuously tight together.

Inventor Nastran

General Purpose and Implications on PDM

- In CAD tools aimed at the design engineer.
  - Associative FEM setup and solving
  - Include FEM data in design release process
- Validate design suitability before the product is built.
  - Complete virtual prototype/product
- Reduce over engineering.
- Prove and generate reports to backup design changes.
  - Revise design and validation data



A context command (right-click within the Nastran Model Tree) Create Updated Vault Package creates an equally named package file in parallel to the CAD file.

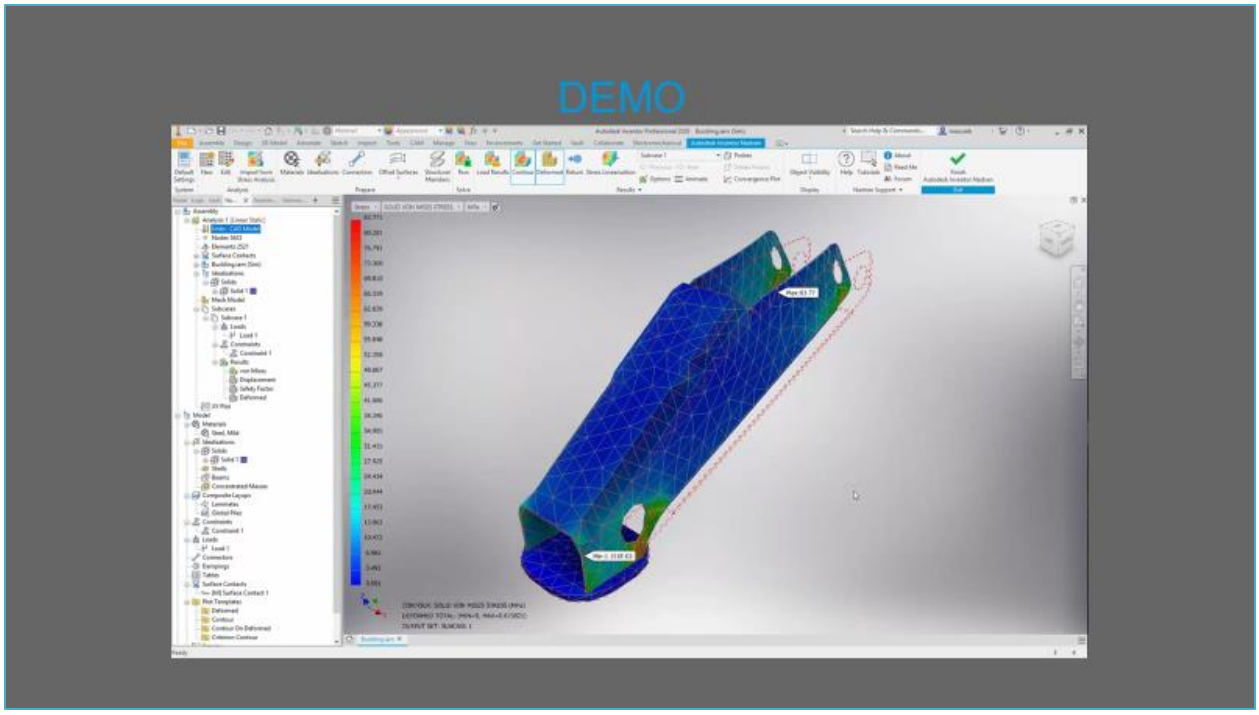
Nastran adds the *pkg file to external Inventor references (3rd party node). Vault as a default includes these reference types as a parent-child relationship during check-in.

Opening Inventor files with Nastran results downloads the results package. Loading results command within the Inventor Nastran environment silently extracts the package first in the background.

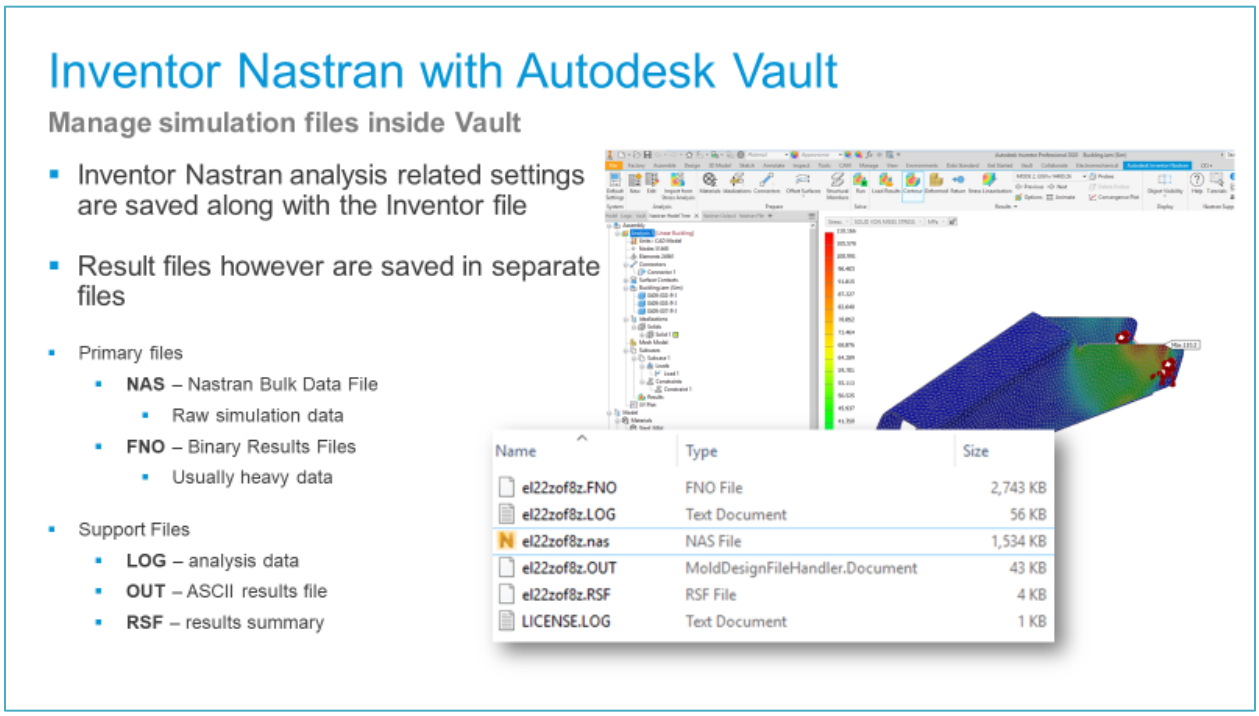
File open dialog preselects the extracted result file within the sub-folder structure.

Each updated result/package update increases the suffix counter based on the latest checked-in one.

As a result of this naming convention, Vault does not build history tracks of the package itself but includes each package result in the parent's history.



A look behind the scenes: Inventor Nastran result files are of different types depending on the study. They save in the file and folder structure, starting from the models' current directory. .\<modelname>\InCAD\FEA*.*



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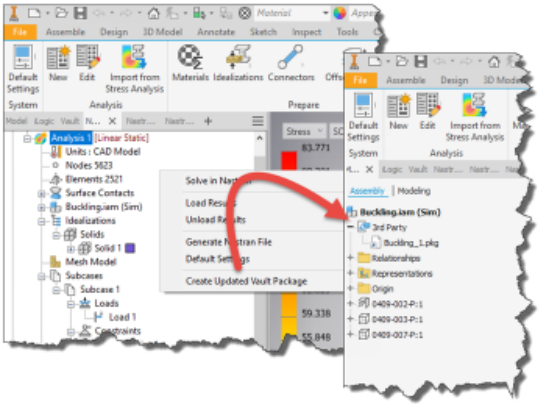
Inventor Nastran with Autodesk Vault

Inventor Nastran 2020 introduces new capabilities

- *Create Updated Vault Package* automates existing workflow and goes beyond
  - Creates archive from result files
    - adopts component file name
    - PKG is a zip of the subfolder \InCAD\FEA\
  - Links package as a 3rd party file to design file
- Treated during check-in and check-out as a reference



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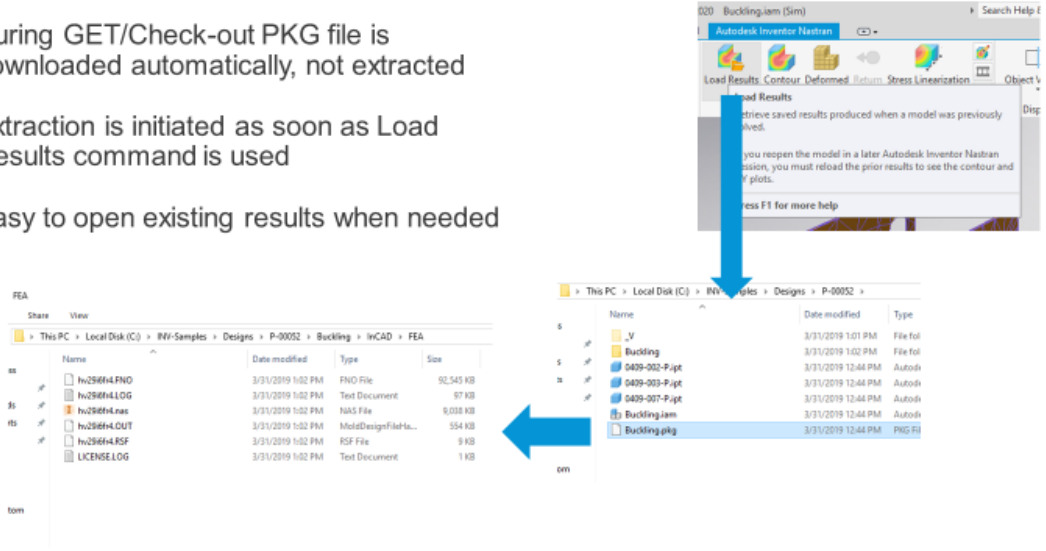
Inventor Nastran with Autodesk Vault

Simulation study files package handling

- During GET/Check-out PKG file is downloaded automatically, not extracted
- Extraction is initiated as soon as Load Results command is used
- Easy to open existing results when needed



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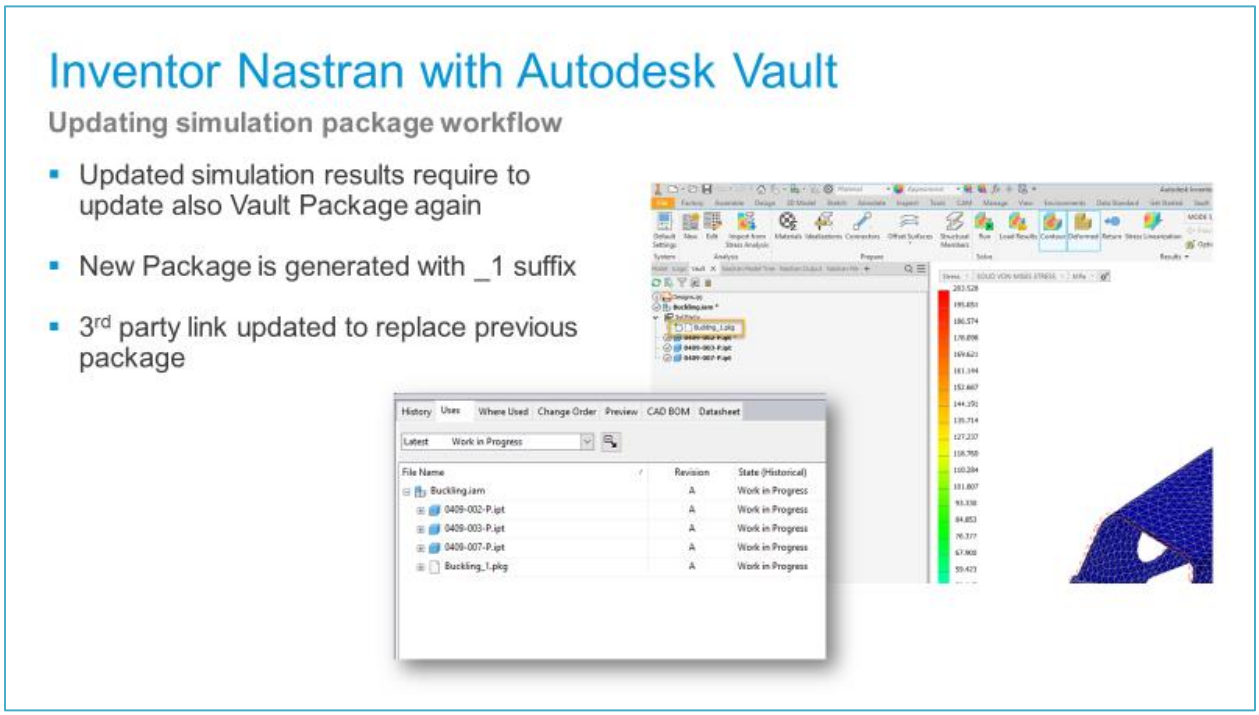
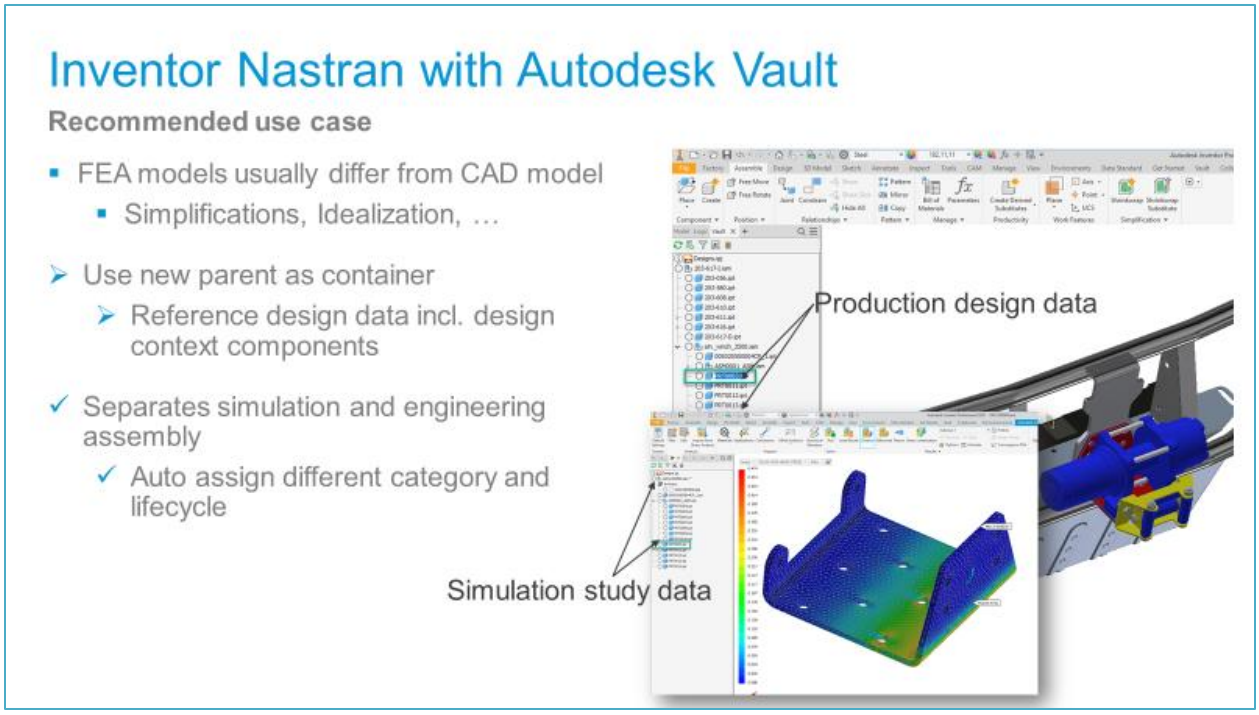


Engineers might tend to work on copies of the original CAD model file.

Whenever possible and appropriate, use an assembly or part-in-part container (derived part) instead. It allows to include reduced design context, separates the design and validation files, and finally helps to assign different categories/lifecycles in Vault.



Inventor Nastran package files are one of many design companion file formats. The subfolder structure is unique to this companion type, and users must not save intentionally other files to this folder structure.

The package would include any other file as well.

Companion files file formats that don't require property management in Vault. Instead of using a base category as a default, we recommend configuring a common category for companion packages like Nastran.

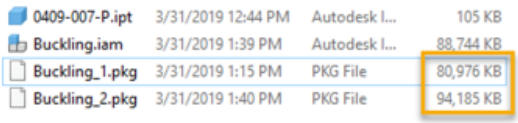
Later chapters in this document/presentation introduce more package types – but with the same behavioral intent in general.

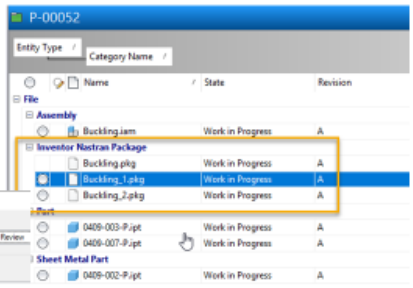
The use of parent container files allows specific release cycles. It might make sense to apply the same for child packages.

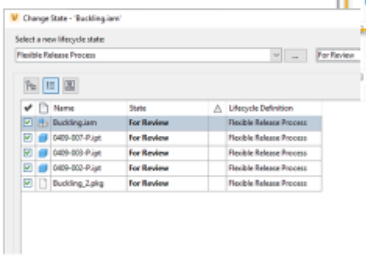
Inventor Nastran with Autodesk Vault

General recommendations

- Clean up simulation results before creating package, be sure to have the relevant simulation files only
- Managing pkg with specific category allows better filtering where needed and differentiation from other files
- Use lifecycle definitions of parent file to simplify release process



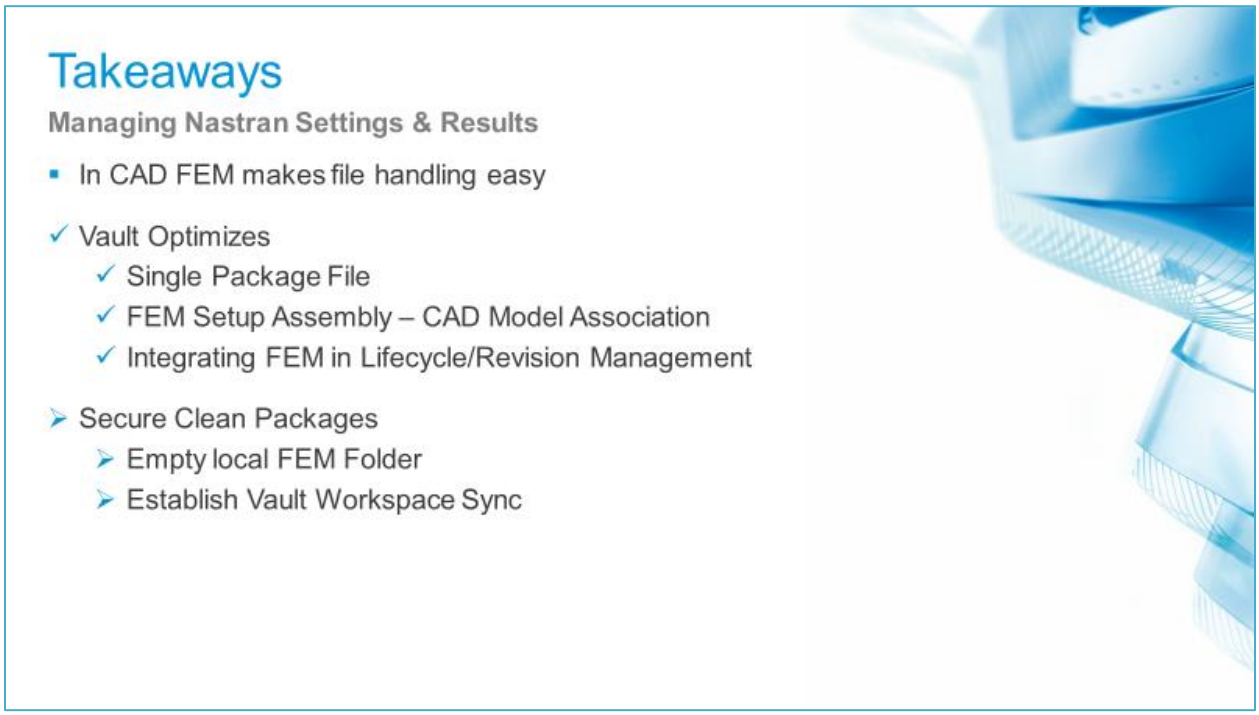




Embedded simulation eliminates any file transfer. The usage of independent parent “container” files even more requires a common environment that manages and maintains the referenced component structure.

The Inventor Nastran Vault integration enables by a single step to compile a single file for smart lifecycle and revision management in Vault.

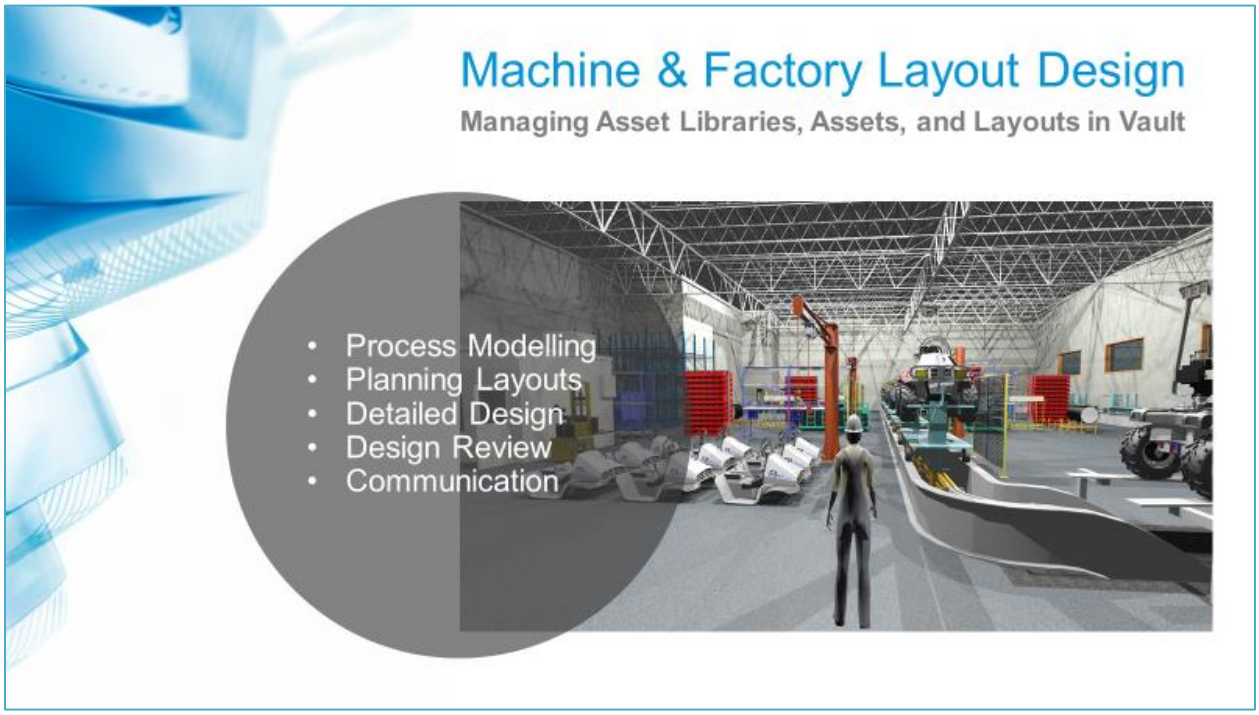
There is no need to keep Nastran files locally. Even if working folders purge once a day – Open from Vault delivers FEA result files alongside.



3 Built-in PDMC-Vault Workflows – Machine and Factory Layouts

Managing Asset Libraries, Assets, and Layouts in Vault

With Factory Design Utilities software, you can plan and validate factory layouts for efficient equipment placement that can improve production performance.

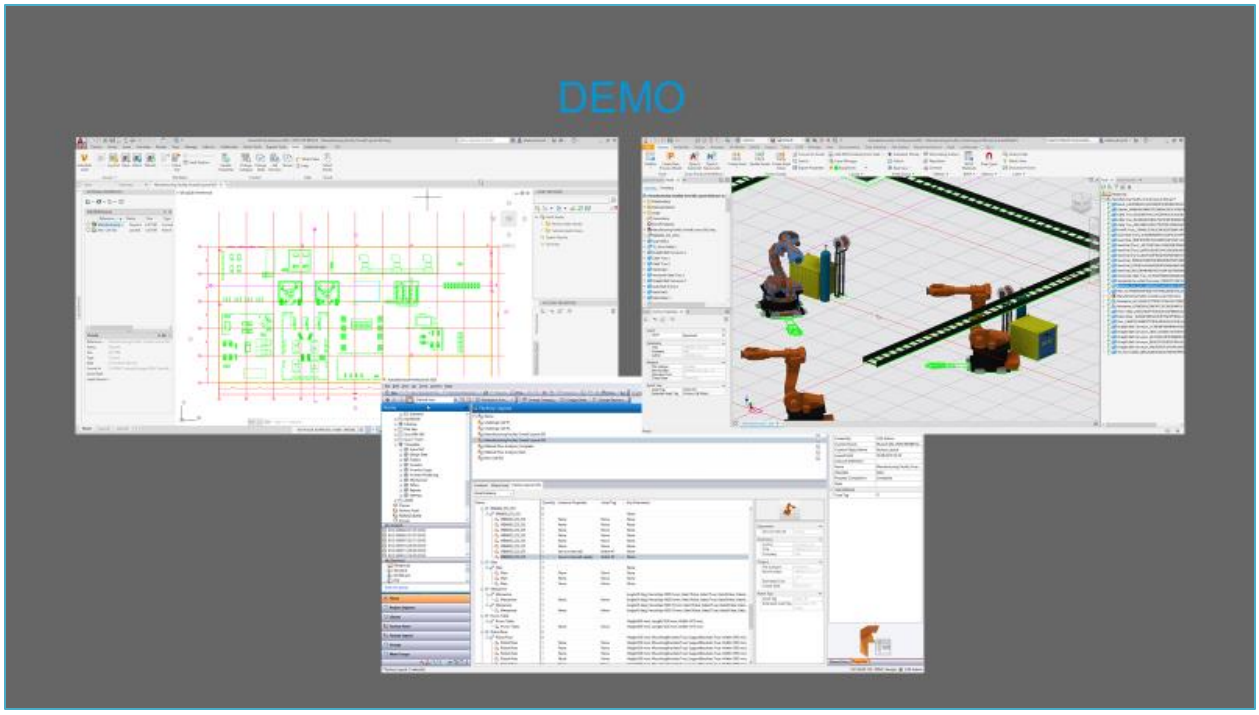


A layout project always has a joint project file – the layout data file. It works as the master, knowing independently of the CAD format dimension (2D, 3D, or 4D), which asset locate at any place in the 3D space, level, or layer.

Layouts assemble fast if all assets reside in a central company based or cloud-based repository. Assets reflecting intellectual property or product versions and configurations are managed best by Vault.

Revision management helps to create new layouts based on accurate, up-to-date, and available assets.

The FDU integrates with Vault, not only managing the library assets. Layouts in Vault share insights – without any need to open the files – on full content. Uses views drill down to individual asset configurations or instance information of multiple identical assets, like multiple robots.



The quick FDU demonstration highlighted the essential source of any layout in any dimension: the asset library.

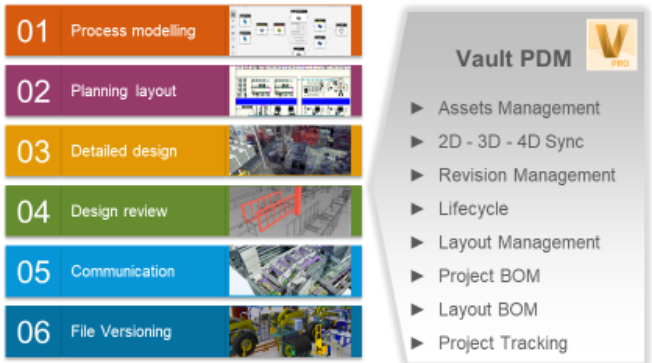
Vault is the only option in the market to publish, edit, and revision manage library assets.

While consuming assets from a Vault based library, the FDU integration creates Layout objects in Vault. These nodes open the deep insights you have heard before during the workflow introduction.

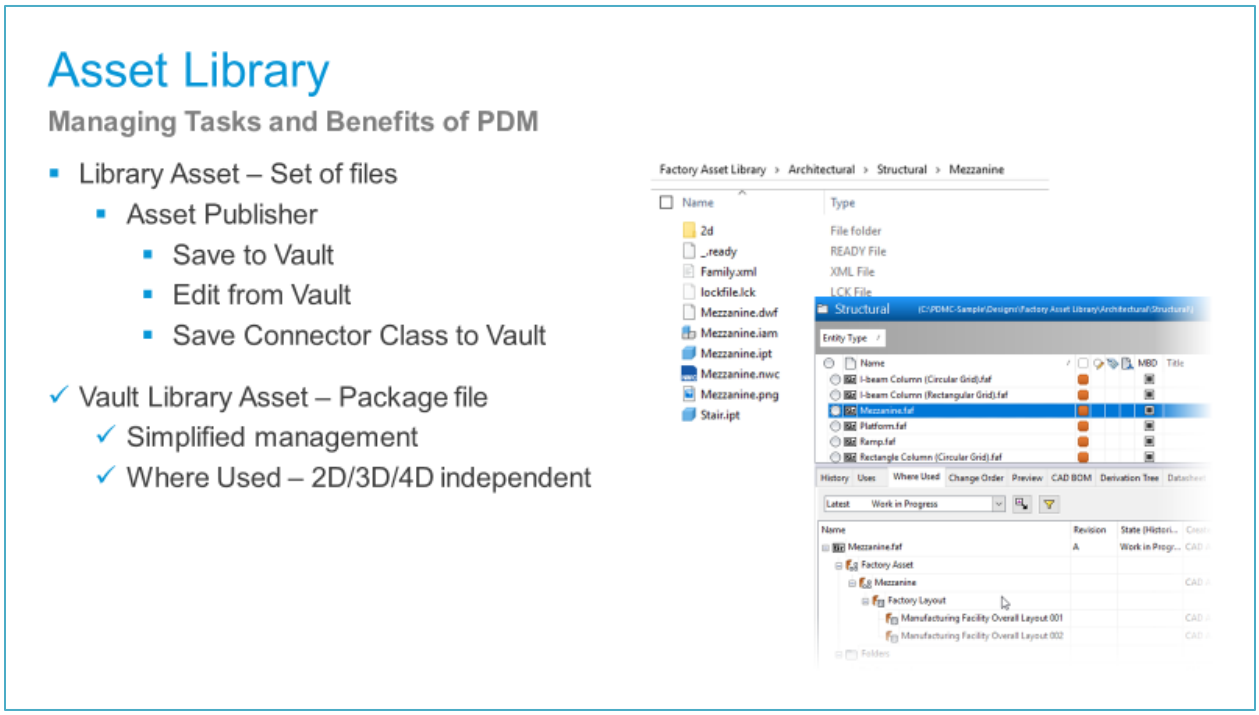
Factory Design Utilities

General Purpose and Implications on PDM

- Create Machine and Factory Layouts
  - Drag Assets from 2D/3D Library
  - Draft in 2D -> Auto-Open 3D/4D
- Asset Library
  - ✓ Vault – Revision Management
  - ✓ Vault – Where Used Information
- Layouts
  - ✓ Vault – Insight Content
  - ✓ Vault – Managing 2D – 3D – 4D
  - ✓ Vault – Extended Uses View
    - ✓ Assets
    - ✓ Asset Configuration
    - ✓ Asset Instance Information



A library asset is a set of files to represent the two- or three-dimensional geometry in the layout, property data in multiple languages, preview images, and lightweight 3D preview formats.
Vault FDU integration packages all of them, captures and links connector classes, and tracks their consumption.
"Where Used" information with instance details is one of many benefits.



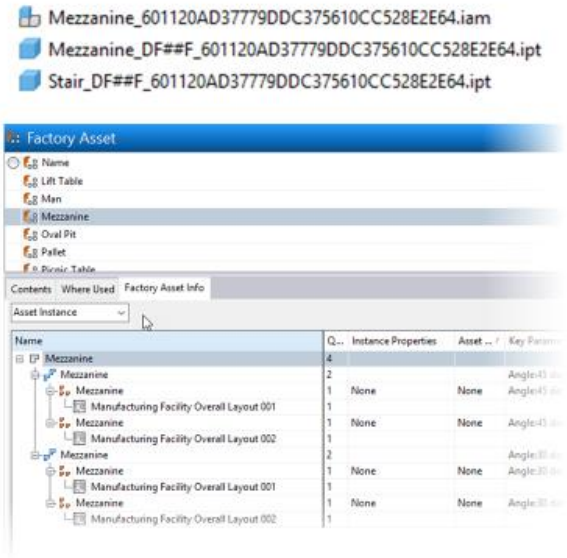
Factory Assets are consumed assets of variable or static library assets.
Vault FDU manages not only the re-usable file but also the connection to the library source and the Where Used location, like an individual instance in a giant machine or factory layout.

Factory Assets

Managing Tasks and Benefits of PDM

- Asset – Consumed Library Asset
  - Variants
  - Single File per Size/Variant
  - New Files on edits/library revision

✓ Vault Assets – Factory Asset Object
  ✓ Uses – Library Asset, any version, or revision
  ✓ Where Used – Layouts, detail levels
    ✓ Asset
    ✓ Asset Configuration
    ✓ Asset Instance



A layout data file represents a factory layout project.

Vault manages the file silently in the back but creates a Layout object node that references all related CAD files if multiple formats (2D, 3D, 4D) get activated.

This node also references building underlays or point clouds of scan data.

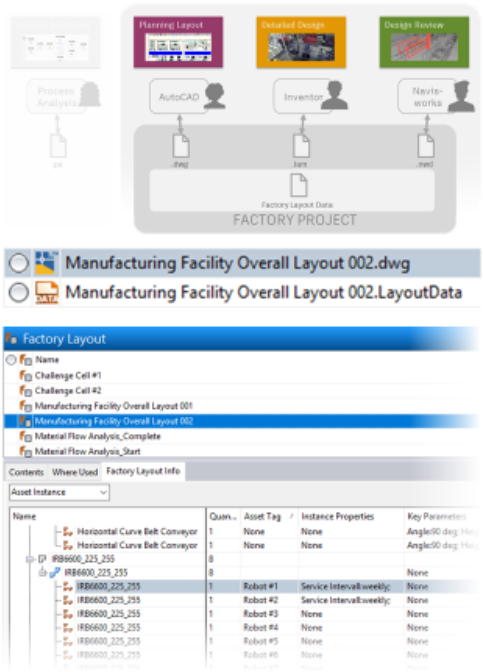
Like other FDU-Vault objects – also, the Layout object opens the deep insight into asset configurations and individual instance tags and properties.

Factory Layouts

Managing Tasks and Benefits of PDM

- Layout – Project File
  - Opens in AutoCAD, Inventor, Navisworks
  - Consumes 2D 3D or 4D Format (Library)
  - References Building Model

✓ Vault Assets – Factory Asset Object
  ✓ Uses – Library Asset, any Revision
  ✓ Where Used – Layouts, Detail Levels
    ✓ Asset
    ✓ Asset Configuration
    ✓ Asset Instance



Customer workflow – SCHEUCH uses Factory Design and Vault Professional managing all Library assets, and Layouts for sales to order process.

During order processing – Detailed Engineering starts from Vault, following all layout assets to activate detailed design and manufacturing drawing updates.

We sometimes call Factory Design Utilities, “the better Inventor”: the power of FDU depends on the asset library content.

Legacy AutoCAD block libraries are a valid starting option, but publishing assets from an Inventor model or simplified assembly unveils full automation options.

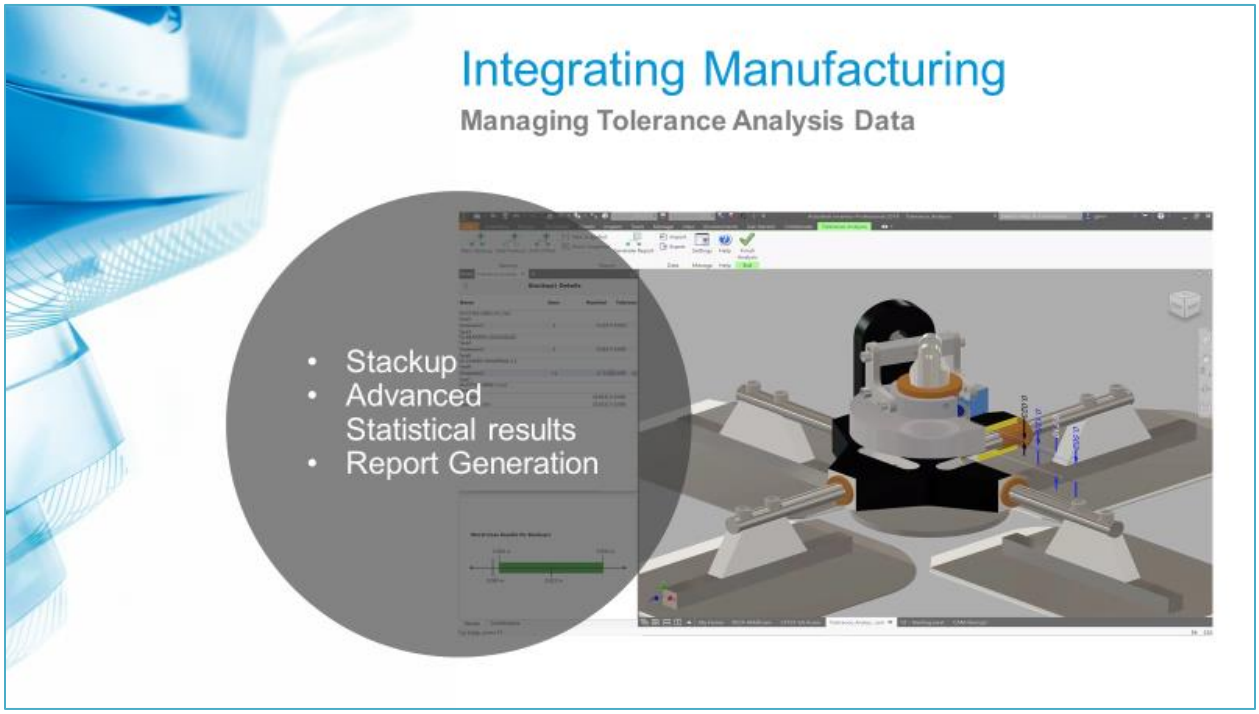
The publisher derives 2D and lightweight 3D formats, links all metadata and connector class information, and saves the package to Vault. Due to this, Vault Professional only integrates the full release management and enables the in-depth reporting and insight capabilities within the PDM views.

4 Extended PDMC-Vault Workflows – Integrating Manufacturing

4.1 Managing Tolerance Analysis Data in Vault

Inventor Tolerance Analysis software is designed to understand the cost impact of dimensional variation.

Stakeholders get invaluable decision criteria from advanced statistical results and reports based on dimensional and tolerance stackups.



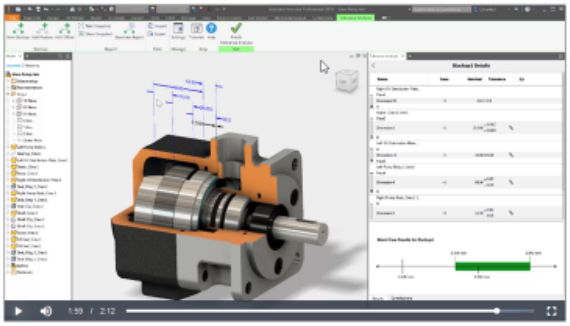
To get there, Inventor Tolerance Analysis manages product requirements, shared dimensions, tolerances for multiple stack ups.

The role of Vault is backing-up stacks, capturing result sheets, and link findings to required actions, like Engineering Change Orders or notifications.

Inventor Tolerance Analysis – PDM|PLM Workflows

Considerations and Options Leveraging Autodesk Vault Professional

- Inventor Tolerance Analysis manages
  - Product requirements
  - Common dimensions and tolerances for multiple stackups.
  - Calculation of geometric tolerances.
  - Calculation of statistical results.
- Objectives for PDM|PLM workflows
  - Backup external stack-up data
  - Capture statistical results sheets
  - Communicate findings and required actions



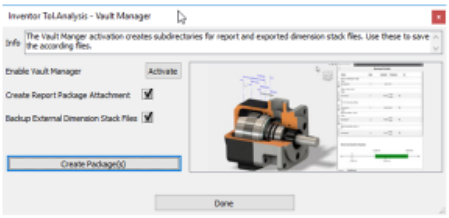
As of today (October 2019), Inventor Tolerance Analysis integrates not to Vault as a default. To get more insights, I have published a technical study based on iLogic rules. Like other Inventor Add-Ins, it repeats the concept of configuring output folders, capturing all results and stack-ups. One time more, these result in package files, and Vault tracks the parent-child relation.

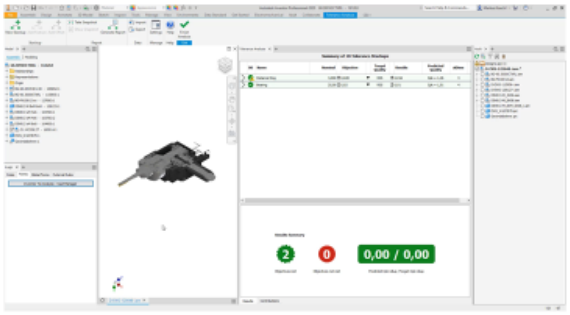
Another idea behind the concept is the option to initiate Engineering Change Order or notification.

Inventor Tolerance Analysis – Vault Concept

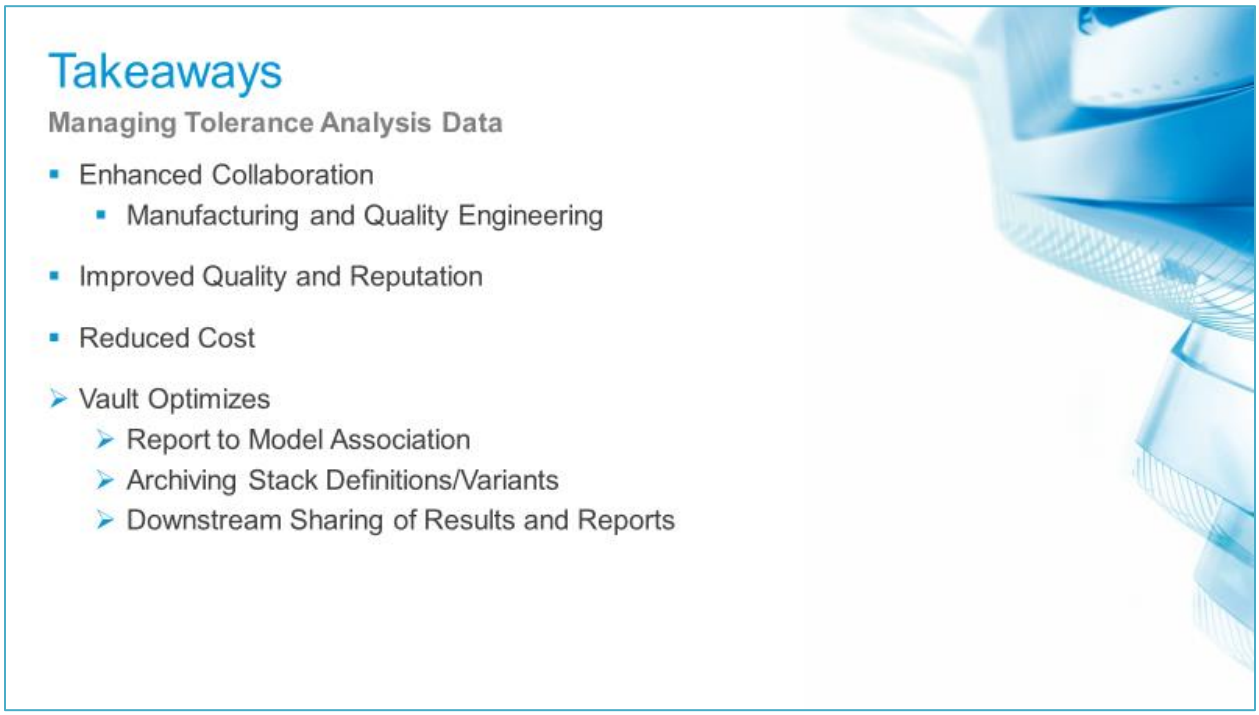
Managing Tolerance Stack-up Data and Reports

- Inventor iLogic – Package Manager
  - Backup external stack up data
  - Capture statistical results sheets
- Autodesk Vault
  - Include Report Package in design release process
  - Communicate findings and required actions via ECO notification





Generate detailed reports to collaborate with manufacturing and quality engineers. So it is more than worth managing all tolerance analysis file types related to their model. Simply adding reports and stack-up definitions to Vault helps to track relationships and revision dependencies. First evaluations were applying the iLogic based sample integration and direct to different requirements already. AU is always an excellent opportunity of discussing scenarios like this. Reach out to me, or my teammate Melanie Thilo @Autodesk in case you liked chiming into the planning of a deeper Integration.



4.2 Automating and Managing Inventor CAM & NC Data

This chapter dares to integrate automation capabilities of Inventor iLogic for Inventor CAM with multiple roles of Vault. The core application in this scenario is Inventor CAM. I can't focus on its power in 2,5- to 5-axis CAD/CAM programming features. Instead, I introduce a common challenge that CAD/CAM programmers face usually!

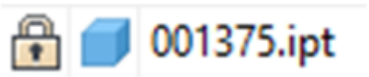
CAM programmers quickly start copying the CAD model of the machined part. They probably have to do this, because Engineering released and locked the workpiece model file but integrated CAM needs to save NC setup or toolpath definitions to the file. Or you edit features, suppressing geometry. Inventor is great in designing for manufacturing tolerances for far more than a decade.

Several years back my question was – how to integrate CAD/CAM in PDM based design workflows?

Workflow Challenges & Benefits

Inventor CAM – Associative CAM and Post Processing

- Integrated CAM tights source geometry and toolpath associatively
  - Saving NC setup and toolpath definition
  - Updating according design changes
- Toolpath definition might edit the work piece
  - Suppressing features
  - Activating median tolerances
  - …
  - …



Released to manufacturing

- How to integrate it in PDM based design workflows?

And – I got involved in solving more requirements: How to manage

Post Processor files per machine

NC Code files

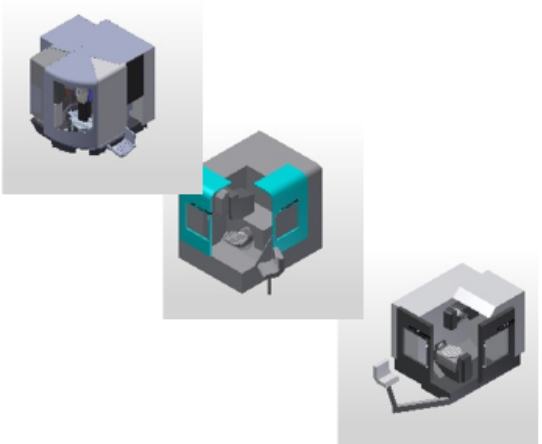
Setup Sheet files

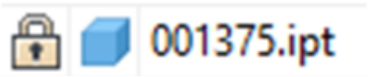
Including their relation ships?

Workflow Challenges & Benefits

Inventor CAM – Associative CAM and Post Processing

- Components might get manufactured on different machines based on availability

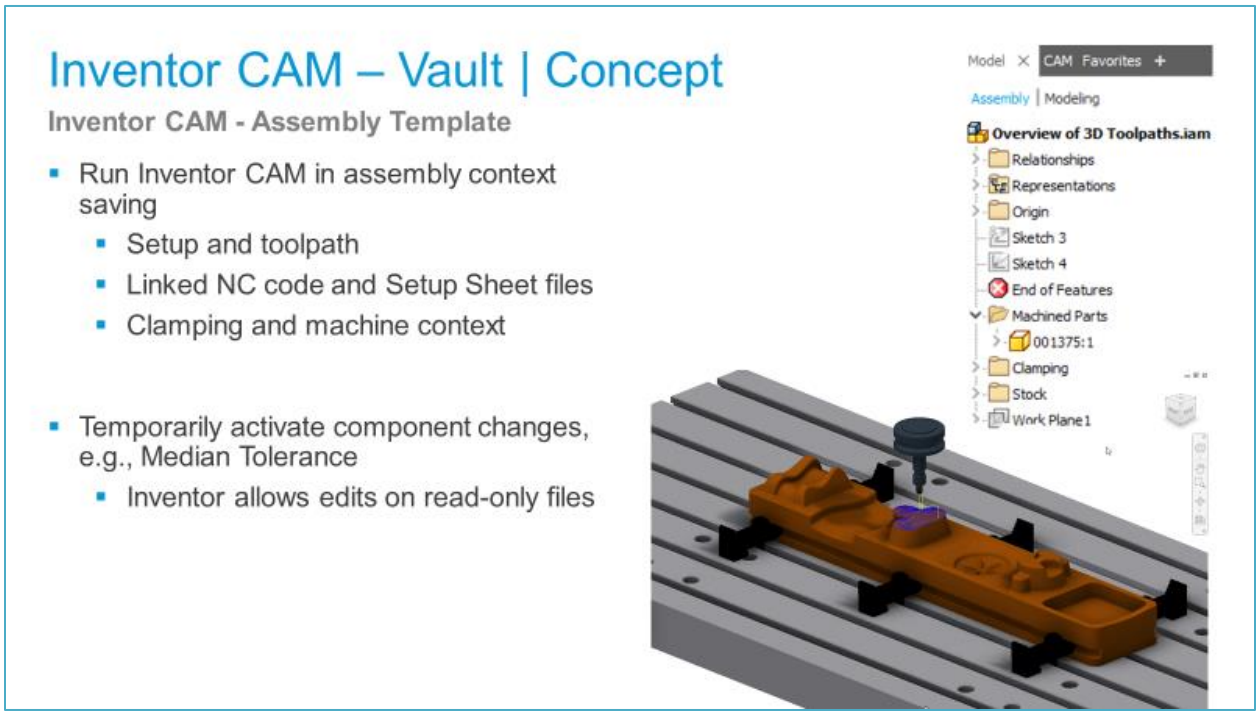




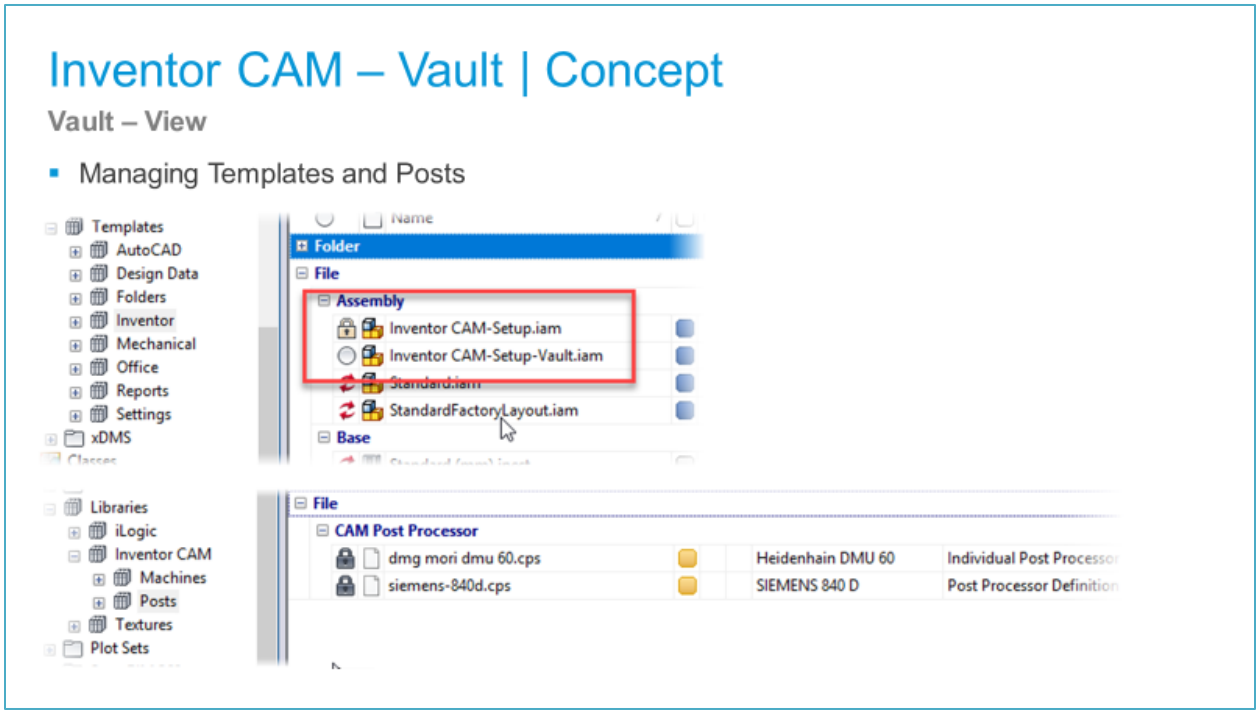
Released to manufacturing

- How to manage related links for ?
  - Post Processor – Machine
  - NC Code – Workpiece
  - Setup Sheet – NC Code
  - …

Our solution approach is to run Inventor CAM, starting from an assembly template. It may start with the existing geometry of the machine context and clamping components. Saving the setup and tool-paths is separated from workpiece models, and the Inventor assembly context allows the Vault add-in to edit the machined part files temporarily. We can start using median tolerance activation on locked files!

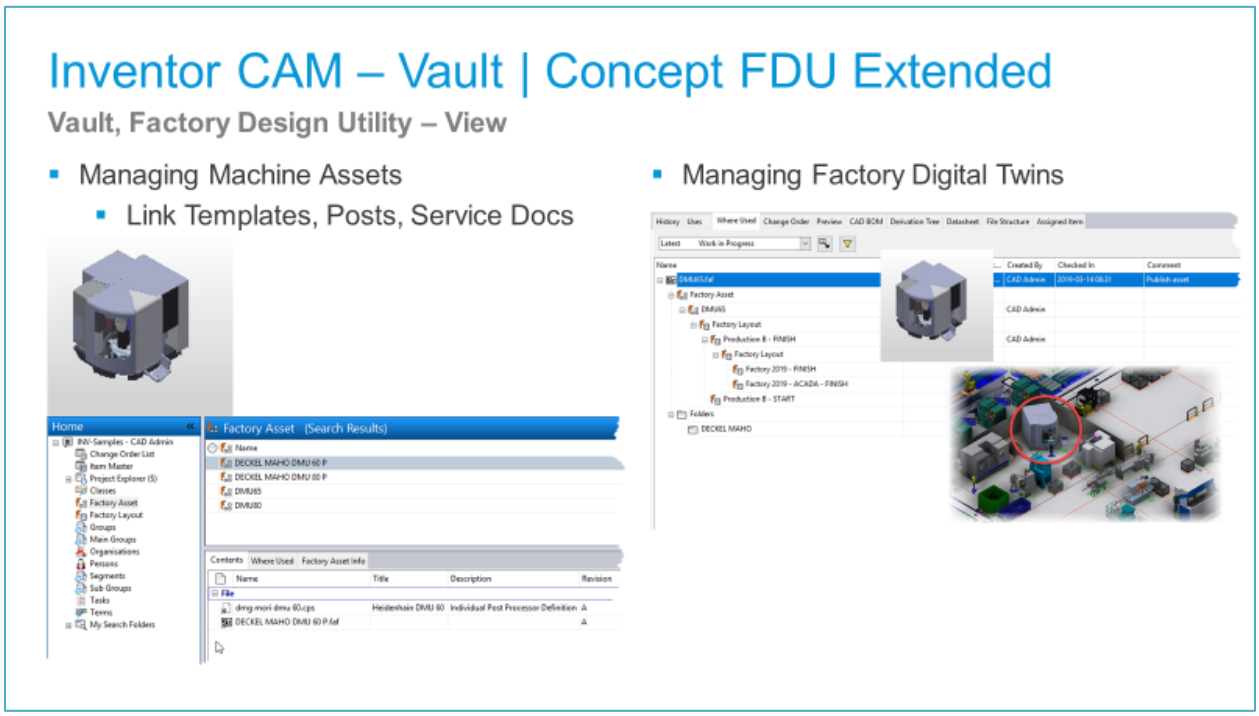


No question – Vault shares these templates based on revision and release management.The same applies to post-processor definition files. Starting from Autodesk's massive library of "Posts," adjustments are essential changes and should be kept safely.



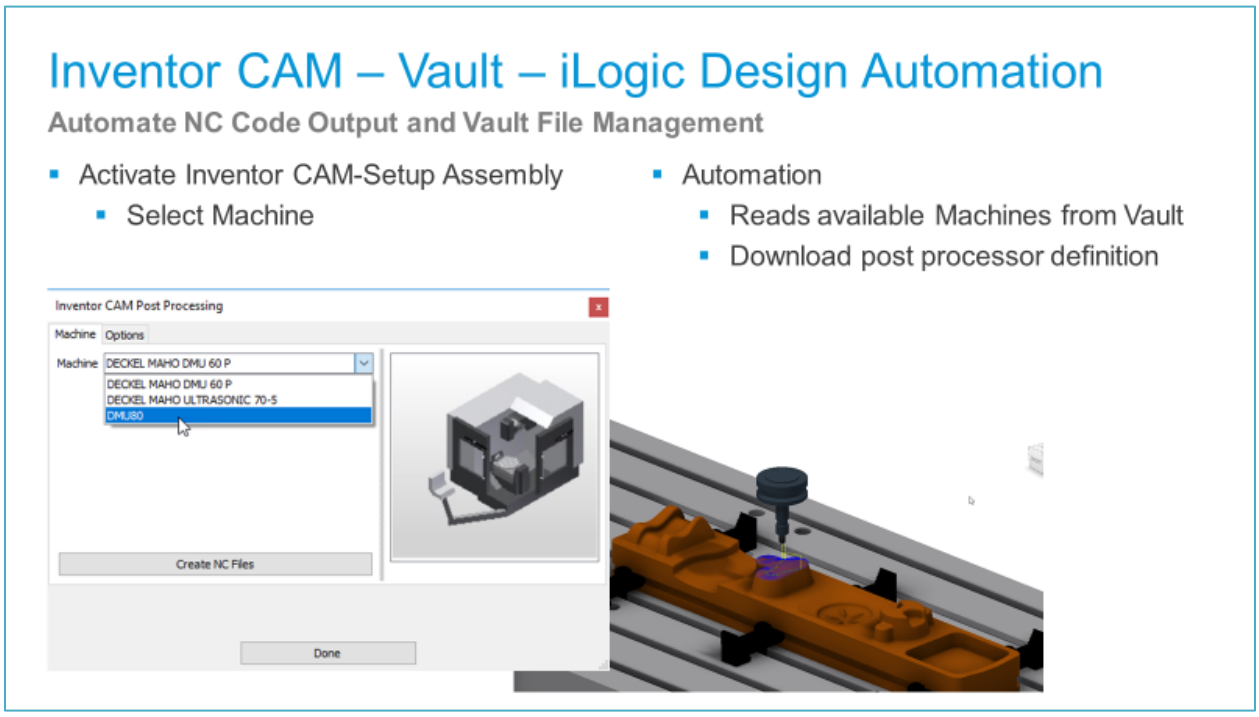
A side note – do you remember the Factory Design Integration discussed before? If CNC machines are in the vaulted library, we even can link the templates and post-processor files to them.

Back on track…, I want to introduce other pieces of the Inventor CAM – Vault workflow.



The solution approach starts, once the CAM programmer finished setup and tool-path definitions. Replacing several manual steps to gather all information and files for the NC output, the iLogic rule Inventor CAM Post Processing starts a dialog.

The user selects from a list of available machines. Which machine is available – the Vault knows all, if machines are either listed in Vault or managed as a vaulted asset. In any case, it downloads the post-processor definition file; it is a required input for NC Code generation.



Several options allow additional post-processing automation tasks:

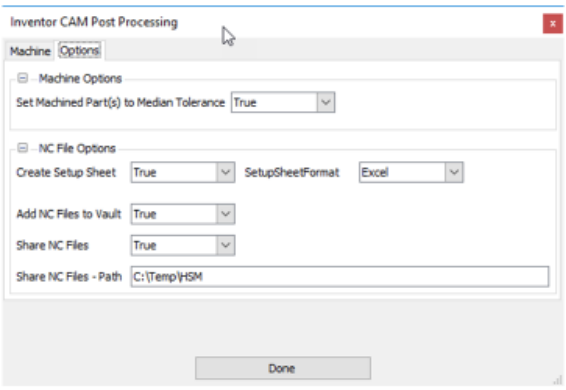
First of all – activate median tolerances, Yes/No?

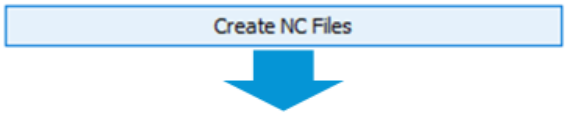
Others refer to the output format and paths, save locally, to a shared drive, to Vault, or both?

Inventor CAM – Vault – iLogic Design Automation

Automate NC Code Output and Vault File Management

- Activate Inventor CAM-Setup Assembly
  - Select Options





- Automation Machining - Tolerance
  - Iterates one to many work pieces activating median tolerance
- Automation NC-File
  - Create NC file for selected machine
  - Create Setup Sheet
  - Add Machine/NC Code to Vault
  - Copy NC Code/Setup to external share

Follow the process live:

Pressing the button “Create NC Files” fires the steps according to the selected options:

Iterate through one to many workpieces activating the median tolerances

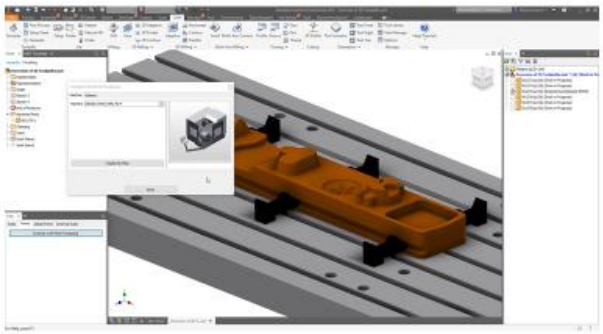
Creating the NC code based on the post-processor file downloaded from Vault

Writing the setup sheet output format.-For Vault check-in, all files are packaged and attached to the CAM assembly file

Inventor CAM – Vault – iLogic Design Automation

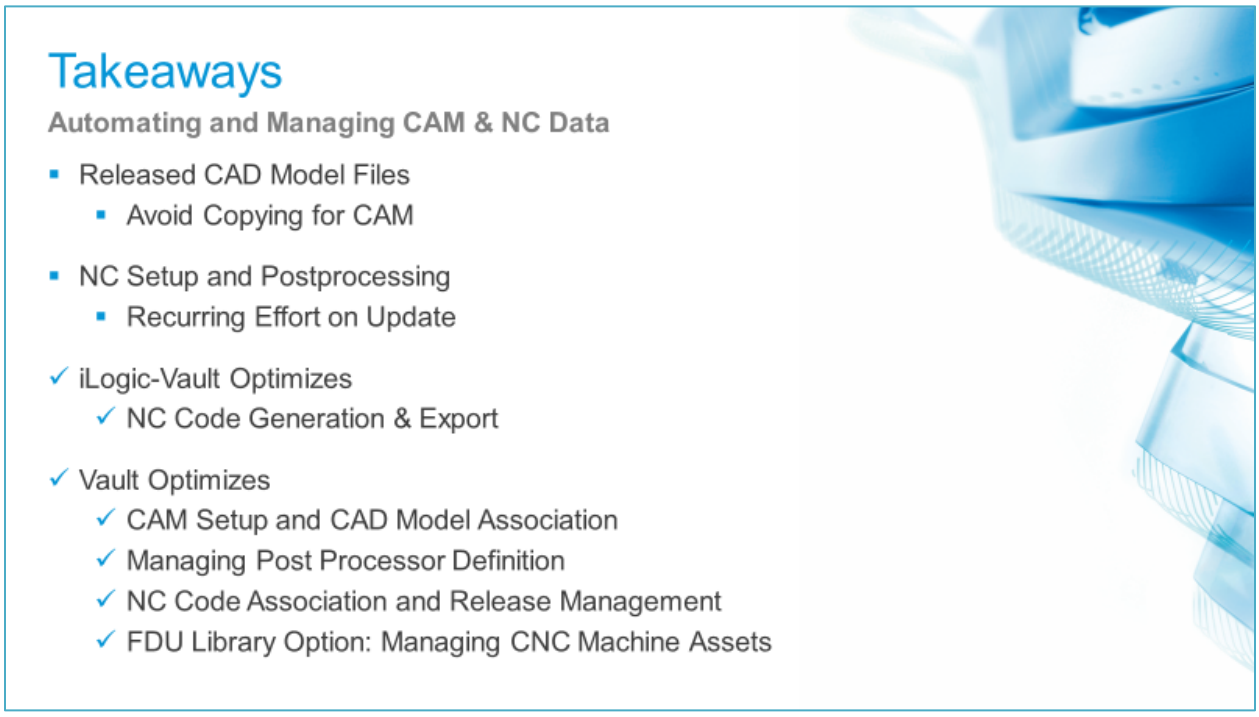
Automate NC Code Output and Vault File Management

- Video
  - Select Machine(s)
  - Activate Tolerances
  - Create NC output for 1 to n machines
  - Check-in to Vault
  - Include output into Manufacturing Release process



This workflow combined several built-in capabilities like median tolerance activation, associative CAM, and Vault release management.

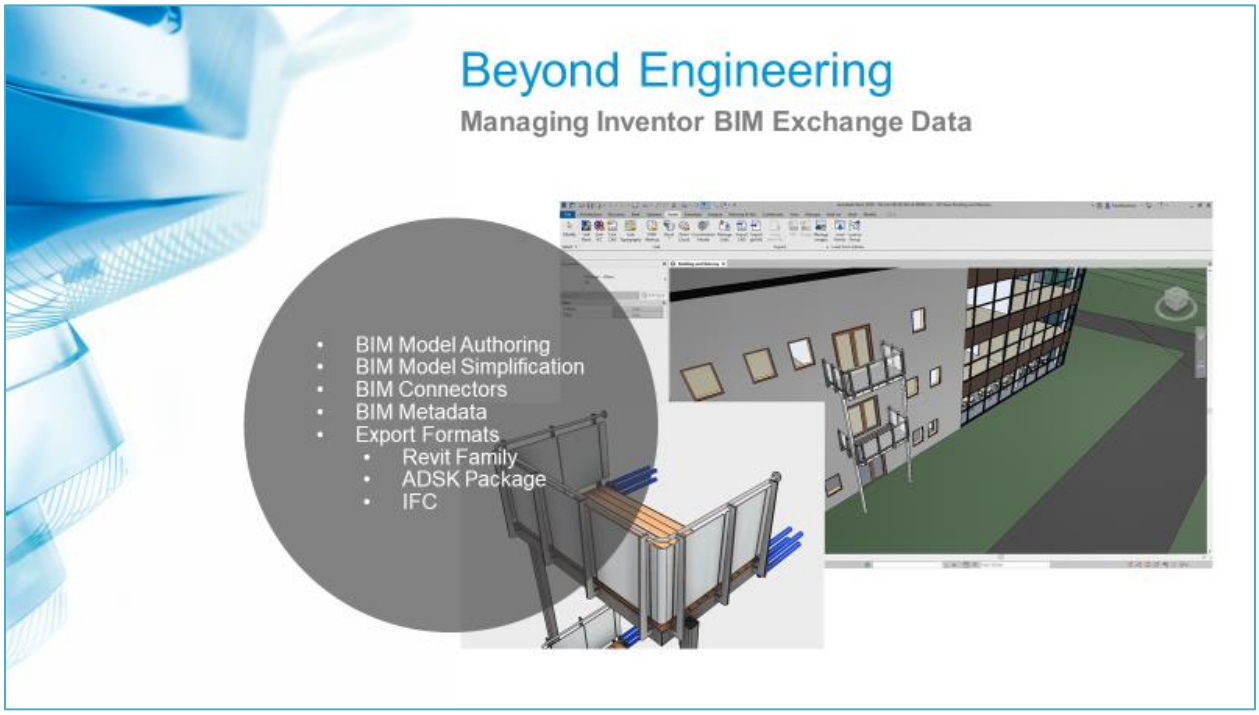
Built-in iLogic Automation offers automation capabilities, also integrates with Inventor CAM and Vault. Extended iLogic rules are the glue and grease of this automation approach.



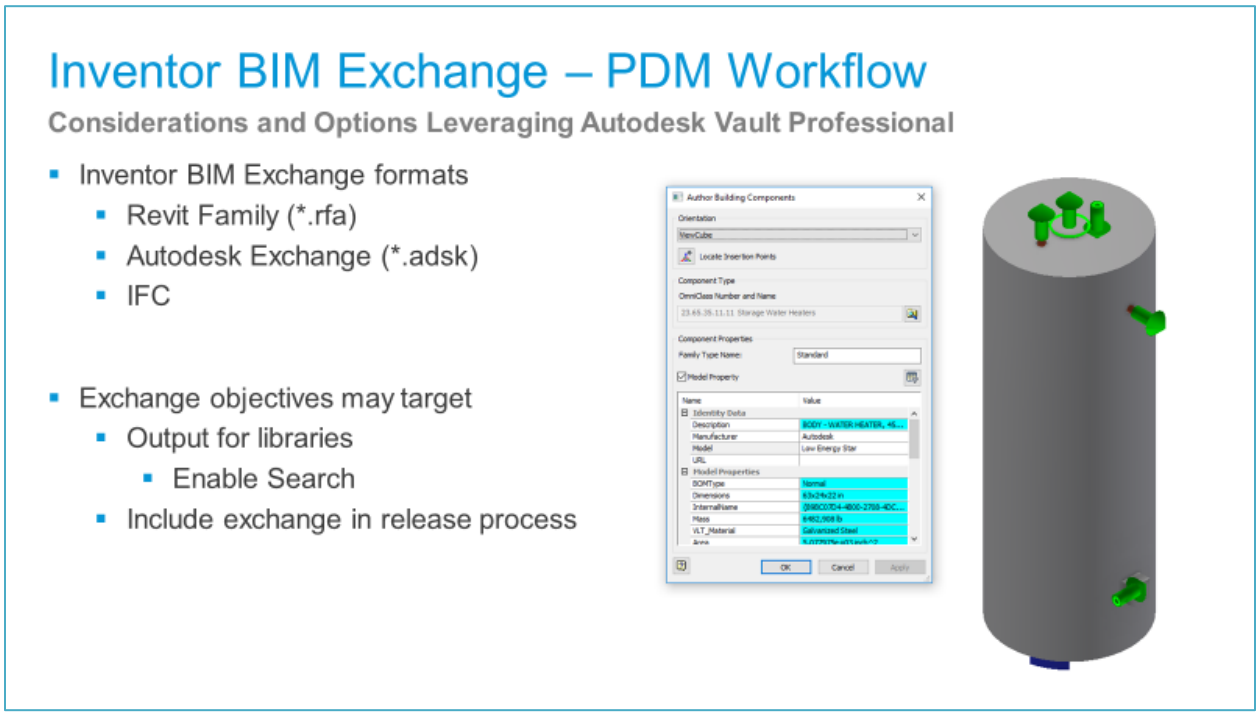
5 Beyond Mechanical Engineering

Beyond Engineering – to be more precise, I need to say: Beyond Mechanical Engineering. This short chapter discusses a solution approach combining requirements and partly solutions from two implementation projects.

For readers, not familiar with BIM and BIM Exchange, I prefer starting with a short excurse: BIM stands for Building Information Modeling and represents the creation processes of digital representations of buildings or places. And it continues, as a building is operated, maintained, renovated, or recycled. So, a BIM model has also a life cycle. Autodesk's core product for BIM is Autodesk Revit. BIM Exchange is an Autodesk Inventor add-in that uses Autodesk Inventor's geometric modeling commands to define models to be consumed in other Autodesk products. BIM Exchange has commands for defining connectors, simplifying and recognize model geometry/data, and exporting data to either a .RFA, .IFC, or .ADSK file.



The primary purpose of BIM exchange models is targeting libraries of BIM content. Large libraries are more useful if they are search enabled than content without index.



So Vault needs to index properties of the export formats to enable the search. Vault Professional comes with a default integration for Revit family files (.RFA), enabled during Autodesk Data Management Server installation. ADSK-files are package files and contain xml based data containing all classification and property data included by the BIM Exchange wizard. Mechanical libraries and BIM content have different owners. You might expect to notify each other if new content is available or existing content requires updating.

Inventor BIM Exchange – PDM Workflow

Considerations and Options Leveraging Autodesk Vault Professional

- Inventor BIM Exchange formats
  - Revit Family (*.rfa)
  - Autodesk Exchange (*.adsk)
  - IFC
- Exchange objectives may target
  - Output for libraries
    - Enable Search
  - Include exchange in release process
- Autodesk Vault Implications
  - Vault manages Revit families
  - Vault manages ADSK and IFC as standard file format
- Vault Workflow Implications
  - Notify library manager
  - Enable search for ADSK or IFC

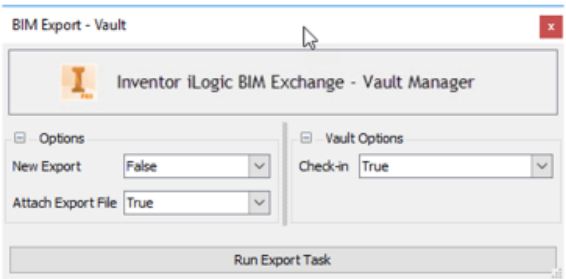
To create BIM Exchange content, users can follow a manual, a semi-automated, or an entirely silent automation workflow. For documentation purposes, I follow the semi-automated and user interactive implementation approach.

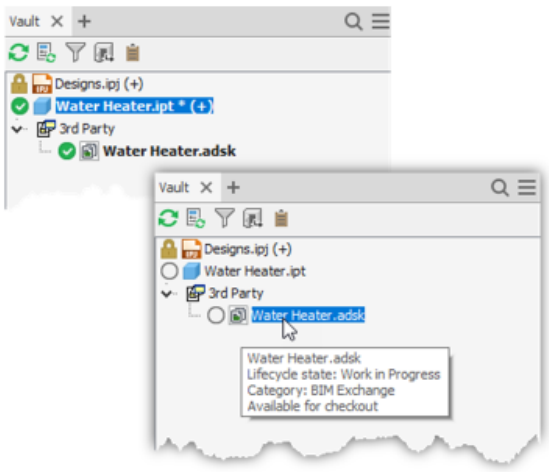
iLogic features quickly draft a dialog and add some options, like create new export, update existing, keep the export file(s) separate or attach them to the parent. And last but not least – an option to auto-check-in to Vault on creation.

Inventor BIM Exchange – Vault Options

Semi-Automation or Workflow Automation

- User Interactive Approach – iLogic
  - Automate save and attach
  - Check-in on finish
- Extendable to full BIM Exchange Setup
- Vault Result





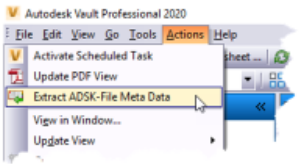
For .ADSK files the built-in Vault indexer gets support reading the nested xml attributes to Vault properties.

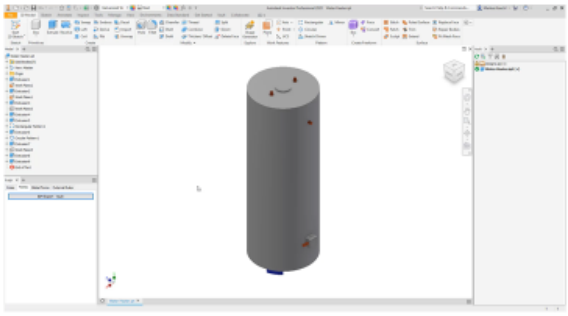
To notify the BIM content owner, ECO is a preferred option: submit an ECO, linking the new BIM content, and activate the routing through the BIM content publishing workflow.

Inventor BIM Exchange – Vault Options

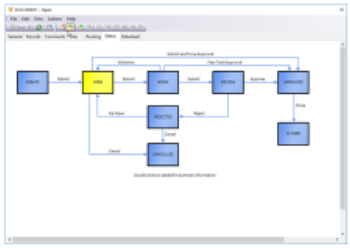
Semi-Automation or Workflow Automation by Job Processor

- User Interactive Approach – Vault
  - Enable Search / Index





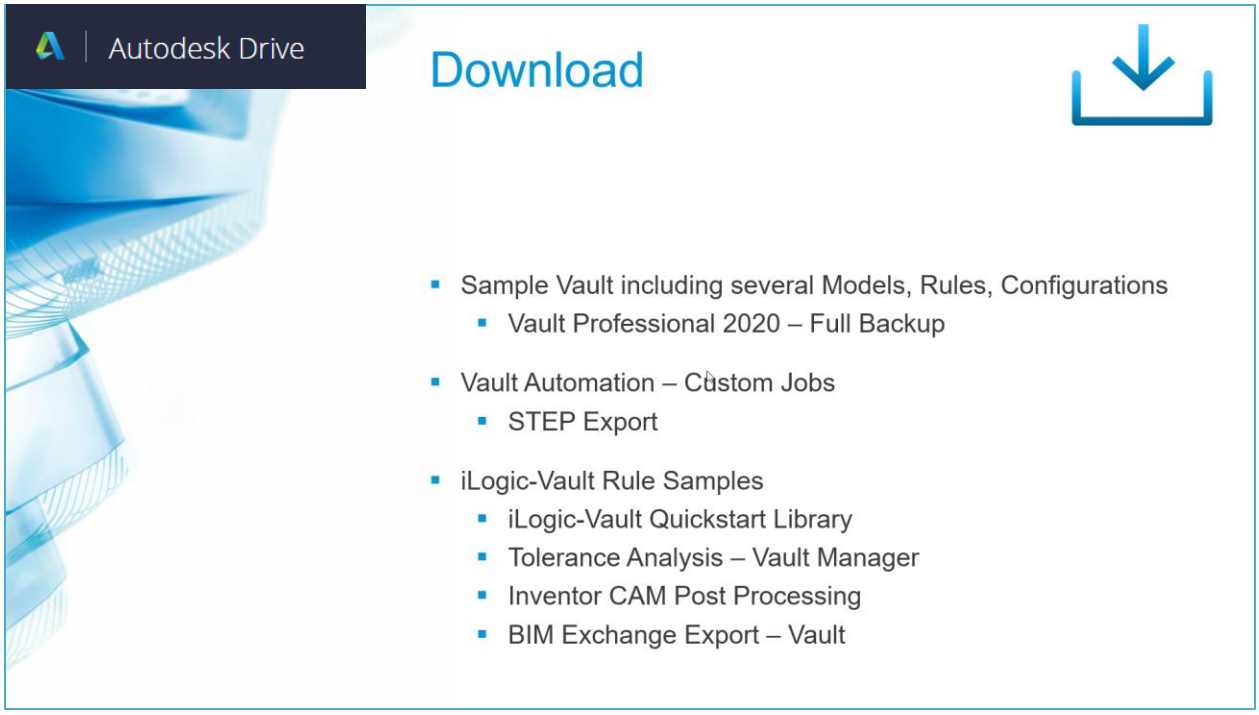
- Notify BIM Library Manager



Summarized – BIM demands increasingly content from building components or equipment manufacturers. We followed several interactive steps for explanation reasons. To fill and synchronize BIM content libraries, full automation of these steps is the path of choice. Vault Job Processor – having Inventor Server and the BIM Exchange API embedded offers the needed capabilities for implementation.

6 Links and Downloads

We scratched a bunch of topics, drilled into details, and discussed implementation approaches. It is a way to much to bear these in mind, even if you are interested in one particular topic only. The best documentation is often having a sample. I share most of the presented ones in a full Vault Professional 2020 backup. Other links are valuable to access particular portions without the overhead of the full sample Vault restore.



If you are saying – “this presentation/document is interesting but a way to much, I’d like to start a step before,” then I have a another recommendation to proceed: Go to the Autodesk Engineering Management and Collaboration web page and download the “Definite guide to PDM”.