

Instructions on how to work with Siemens Teamcenter for
university purpose

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As part of the implementation of Siemens Teamcenter in the curriculum at Lapland UAS, instructions for students were written. The instructions include how to use the Teamcenter Integration for Autodesk Inventor and SolidWorks and how to work with Siemens Teamcenter Active Workspace.

First, the most important basics of PLM, digital manufacturing, MES, and CAD are described. Scientific reports, books and internet sources found during the literature research served as a basis. The practical part deals with the implementation of the individual Teamcenter integrations at Lapland UAS and the instructions themselves.

The computers in the CAD computer room at Lapland UAS are equipped with the necessary Siemens Teamcenter integrations for Autodesk Inventor and SolidWorks to enable students to work flawlessly with these programs. There are currently no integrations for the Festo MES4 software, but there is a Python script that allows importing images from Teamcenter. The Siemens Teamcenter Active Workspace can be accessed from any computer at Lapland UAS, giving students the opportunity to work with it outside of class. The instructions written during this work are designed so that students who have never worked with the integrations or Active Workspace before can understand and apply the basic functions.

Key words Siemens Teamcenter, Inventor, SolidWorks, PLM, MES
Other information The thesis includes written instructions.

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FOREWORD

I would like to thank FH Technikum Wien and Lapland UAS for giving me the opportunity to participate in the Double Degree Program, and therefore, finishing my bachelor's degree in Kemi, Finland. This was truly a great journey and experience.

I am grateful to Ari for his valuable support throughout my studies. His guidance and advice helped me a lot navigating the challenges of the bachelor process. I would also like to thank Arto for his support and mentorship throughout my bachelor thesis.

Furthermore, I want to acknowledge my study and flatmates for their professional help as well as their social support. Lastly, I would like to thank my family for their great support throughout my studies.

SYMBOLS AND ABBREVIATIONS

CAD	Computer Aided Design
DCS	Distributed Control Systems
ERP	Enterprise Resource Planning
IloT	Industrial Internet of Things
IoT	Internet of Things
MES	Manufacturing Execution System
PLC	Programmable Logical Controllers
PLM	Project Lifecycle Management
SaaS	Software as a Service
SCADA	Supervisory Control and Data Acquisition
SOA	Service Oriented Architecture
TCAI	Teamcenter Integration for Autodesk Inventor
UAS	University of Applied Science

1 INTRODUCTION

Manufacturing execution systems (MES) and product lifecycle management (PLM) software are crucial components in Industry 4.0, which is a promising employer for Mechanical Engineering graduates. With the automatization line and the Festo MES4 software in the Smart Lab the Lapland UAS has the perfect conditions for the students to understand MES systems. To provide students with insight and knowledge about PLM, Siemens Teamcenter is now also integrated into the Lapland UAS curriculum. Siemens Teamcenter is a product lifecycle management software and accompanies a product from planning to production. The software functions as a connecting element between different programmes, but also between different employees, students, and lecturers.

To use the software in a general and interdisciplinary way, clear instructions on how to import CAD drawings to Siemens Teamcenter and use the Information in the Teamcenter are needed.

1.1 Scope and objective

The purpose of this thesis is to create instructions on how to store CAD-drawings and other information from CAD-environment in Siemens Teamcenter. Furthermore, it will also be explained how to use and manage this data in the Teamcenter. As a result, a full set of instructions for these purposes will be provided.

This work will only contain the instructions for the different software. There will be no work on the Festo smart factory itself.

1.2 Motivation

The integration of Siemens Teamcenter into the Lapland UAS curriculum marks an important step forward in teaching how to streamline and optimize engineering workflows. However, as with any new technology, there is a learning curve that can pose a challenge for both instructors and students.

To address this challenge, this thesis aims to provide a comprehensive set of instructions and guidelines for using Teamcenter in conjunction with popular

design software, such as Inventor and SolidWorks. By focusing on the most important functions of Siemens Teamcenter Active Workspace, the thesis seeks to equip instructors with good first instructions to provide for students.

2 PRODUCT LIFECYCLE MANAGEMENT

Product Lifecycle Management (PLM) has the purpose to manage a products lifecycle in the most efficient way. (John Stark 2022). Initially, PLM solutions were cad-centric and focused mainly on file and document management. To meet the challenges of globalisation and outsourcing, the programmes expanded regularly. Today's PLM software is strongly oriented towards the Software-as-a-Service (SaaS) model, allowing management without a full IT department. (ORACLE Deutschland 2023)

With bi-directional access to all information stored in the cloud from anywhere at any time, the former barriers of data silos can be removed, the complexity of data collection across supply networks can be addressed, and formerly separate business processes can be connected. All of this results in shorter time to market, better product quality, faster innovation, and reduced costs. (ORACLE Deutschland 2023.)

A product development has five phases, which are not standardised in the industry, but are always very similar in principle. The following is SAP's approach.

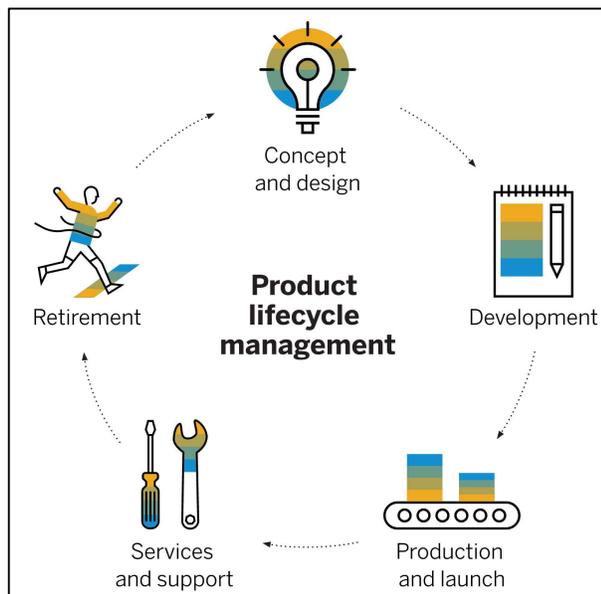


Figure 1. Product Lifecycle Management (SAP 2023)

1. Concept and design: This is the ideation phase, where the requirements for a product are defined based on the analysis of several factors such as market gaps, customer needs or competitors.
2. Development: Together with the necessary tool designs, the detailed design of the product is created. In this phase, the product is validated and analysed, prototypes are developed and tested in practice. This provides the necessary feedback on how the product is being used and what improvements are needed.
3. Production and launch: To further develop the product and create a market-ready version, feedback from the pilot project will be used. The production of the new product is scaled up, followed by the market launch, and distribution of the product.
4. Service and support: Service and support are offered after the introduction of the new product.
5. Retirement: The withdrawal of the product from the market or the possible reintroduction or adoption in a new concept at the end of its life cycle must be regulated. (SAP 2023.)

2.1 Digital twin

A digital twin is a digital representation of a physical asset that reflects the behaviour of the object and can be modelled as it is formed, designed, manipulated, and maintained. The virtual copy of the object is created for each step of the product lifecycle. All changes made to the object can be made in real time using PLM software and tracked by all involved. (ORACLE Deutschland 2023.)

2.2 Siemens Teamcenter

Siemens Teamcenter is a versatile and contemporary PLM software suite that has three deployment options (on-premise, cloud, SaaS) for a fast time-to-value and lower cost of ownership. (Siemens Digital Industries Software 2023a). As all parties involved in a project can access the entire documentation and CAD

models at any time and from anywhere and thus always have access to the current design, quality is improved, and downstream errors are eliminated. Furthermore, the project can be tracked by stakeholders without the need for multiple applications and databases through a simplified user interface. All information is stored in a central repository, which reduces the IT burden and eliminates the need to search for documents. (Siemens Digital Industries Software 2023b.)

Teamcenter can be based on the two-tier or the four-tier architecture model. As shown in Figure 2 the four-tier architecture model has a client tier, a web-tier, an enterprise-tier, and a resource tier. The two-tier architecture only uses the client-tier and the resource-tier and has therefore less features than the four-tier architecture model. (Siemens 2021.)

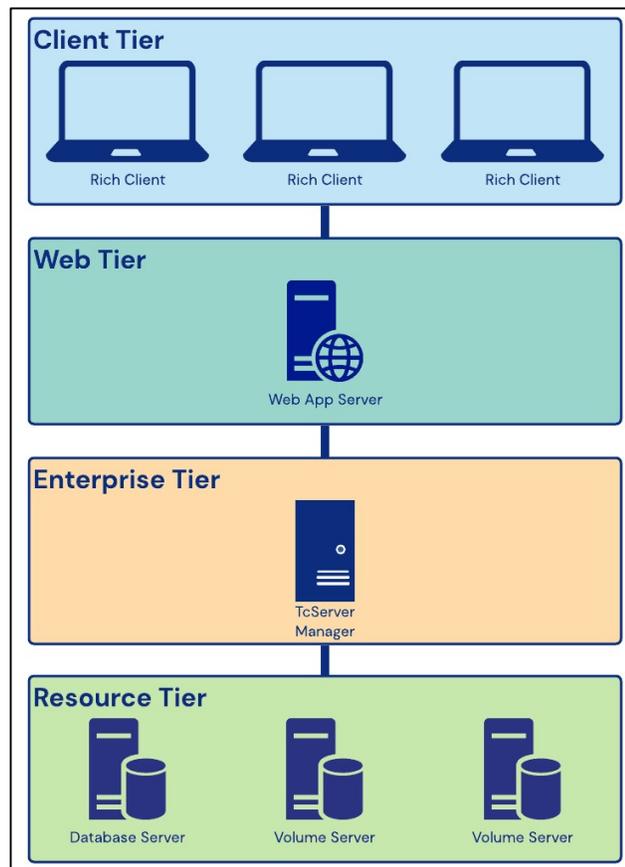


Figure 2. Four-tier architecture (PLM Coach 2022)

Client-tier:

The client-tier is responsible for the front-end components or user interface (UI) for the end-user to interact with. It provides the graphical user interface to allow users to perform various tasks such as viewing, creating, modifying, and managing product data and related information within the Teamcenter system. The Client Tier can be accessed through different types of clients, such as desktop applications, web browsers, or mobile devices, depending on the deployment and configuration of Teamcenter in an organization. (Siemens 2021.)

Web-tier:

The Teamcenter web-tier serves as a web application that enables communication between the client tier and enterprise tier, facilitating user access and interaction with Teamcenter through web browsers. It is responsible for providing the user interface and functionalities for accessing and managing product data and related information through web browsers. The web-tier includes features such as web-based search and navigation, data visualization, data input and modification, workflow management, and collaboration tools. (Siemens 2021.)

Enterprise-tier:

The enterprise-tier provides the core functionalities such as data management, security, and integration with other enterprise systems. Additionally it is responsible for collaboration between users and manages user access and permissions. (Siemens 2021.)

Resource-tier:

The resource-tier includes the database, volumes and file servers and is responsible for that the system has the necessary computing resources, storage, and network capabilities. (Siemens 2021.)

Active workspace

The Active Workspace is a web-based user interface provided by Siemens Teamcenter. It is designed to provide users with a modern and intuitive interface

for accessing and managing product data and related processes. The Active Workspace allows users to collaborate, view, and interact with product information, documents, and workflows through a web browser, making it accessible from different devices and locations. It provides features such as search, visualization, document management, workflow management, and reporting, among others, to help users efficiently navigate and manage product information within the Teamcenter PLM environment. (Siemens Product Lifecycle Management Software, Inc. 2019.)

As shown in Figure 3 it has a clear structure and is therefore a good introduction to PLM.

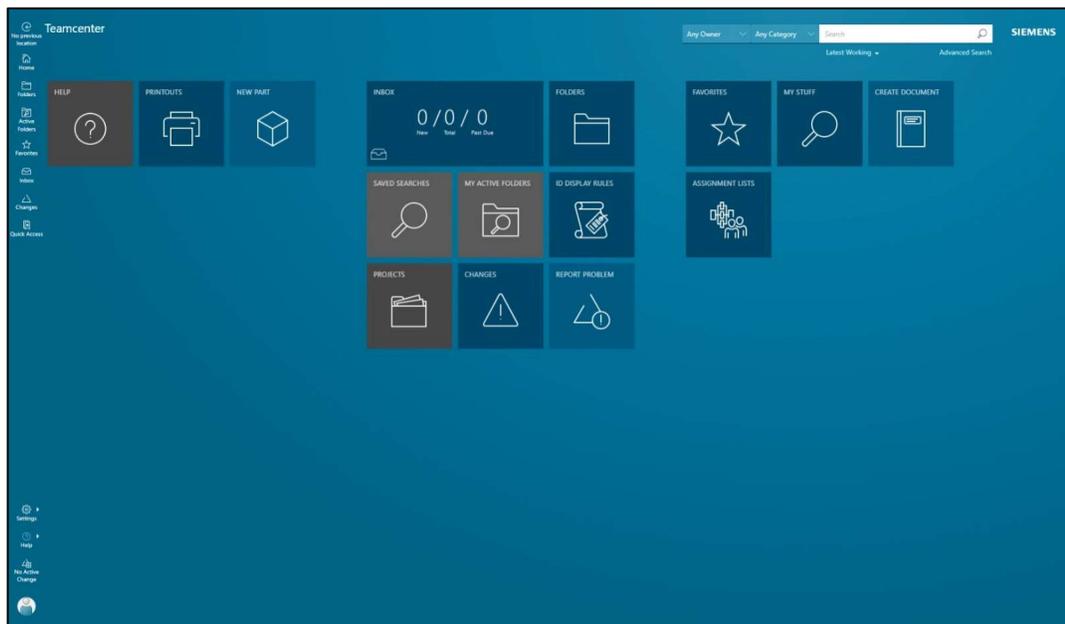


Figure 3. Teamcenter active workspace

3 DIGITAL MANUFACTURING

Digital manufacturing uses digital technology to improve and optimise the entire manufacturing process, from product design to marketing and distribution. To improve productivity, fasten the time to market, reduce the cost for manufacturing, various data analytics, software automation and other advanced technologies are used. (Paritala, Manchikatla & Yarlagadda 2017.)

To correspond to each part of the manufacturing process, digital manufacturing can be divided into three types:

Product life cycle: The life cycle of a product starts with the design phase, followed by sourcing, production, and customer service management. At each stage, the use of data analytics can help in monitoring and making necessary changes that can have an impact on the overall life cycle. (Coursera 2022.)

Smart factory: Real-time data about machine functions is communicated to workers through smart machines and sensors. This feedback connects the operations teams responsible for machine monitoring to the IT teams responsible for back-end systems. Both teams use business intelligence tools to analyse, track, and enhance performance. (Coursera 2022.)

Value chain management: To satisfy customer demands, let inventories stay lean and to let processes be integrated, chain management minimizes resources and continuously assesses value at every stage of the chain. (Coursera 2022.)

As shown in Figure 4, in digital manufacturing the suppliers, logistics, and production site are all connected with the help of a cloud-based system. This connection helps to make the whole process faster and more efficient. (Industrie 2025 2023.)

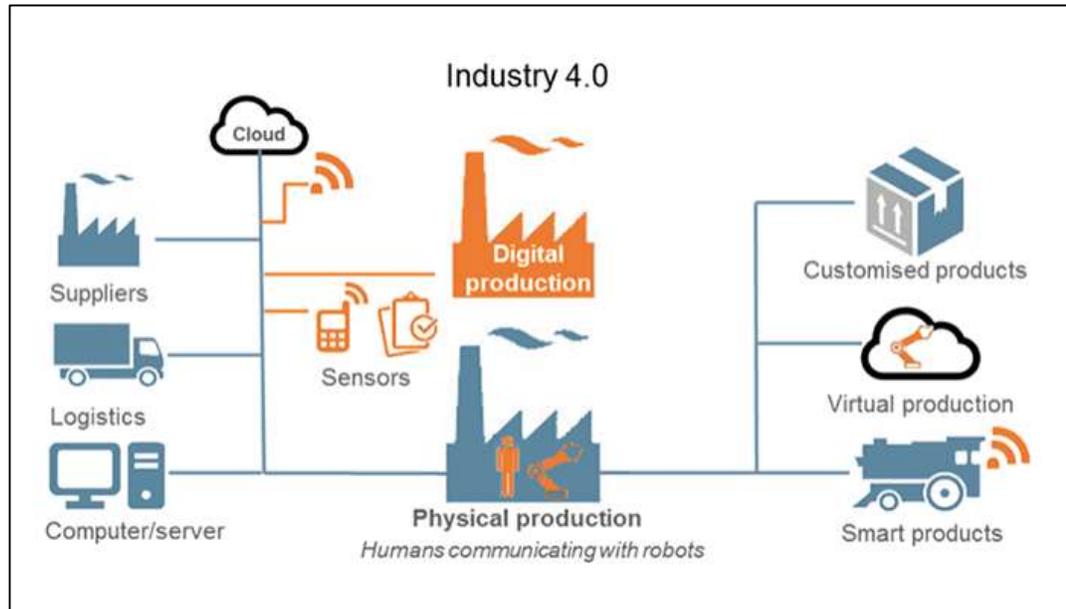


Figure 4. Digital Manufacturing (Karavan Advisory Enterprises 2023)

The goal is for the system to be able to control itself. To achieve this, every element in the production chain must be connected to each other, all components must be digitally recorded, and sufficient sensors must be installed in machines. this is referred to as the internet of things. (Jann Raveling 2020.)

Internet of Things

The Internet of Things (IoT) consists of individual physical devices that are connected in a network and can thus exchange information and data. To make this possible, the devices are equipped with certain software, technology, and sensors. The range of these devices starts by ordinary household objects and ends by sophisticated industrial tools.

In the industrial sector the technology, instrumentation and control of sensors and devices which include cloud technologies are referred to Industrial IoT (IIoT). (ORACLE 2023.)

4 MANUFACTURING EXECUTION SYSTEM

A manufacturing execution system is a dynamic and comprehensive software system, which documents, controls, tracks and monitors the process of manufacturing goods. It starts with the raw product and accompanies it until the finished product. Furthermore, MES acts as an intermediary between different sites, vendors and plants and it can be linked in with the controllers, equipment and enterprise applications. (SAP 2020; Siemens Digital Industries Software 2022)

MES started out as a connection between the shop floor and the Enterprise Resource Planning (ERP). ERP contains modules for inventory control, cost accounting, production planning and demand forecasting. It collects and integrates the information of these modules on a daily, weekly, or monthly basis from the shop floor and other sectors and this is too inaccurate to respond to every transaction on the shop floor. As a solution MES was developed to connect the shop floor with the ERP. By combining real time information on materials, operations and processes from the controls, machines and individuals on the shop floor with provisionally production plans from the ERP, MES creates a detailed operating plan. (Shojaeinasab et al. 2022.)

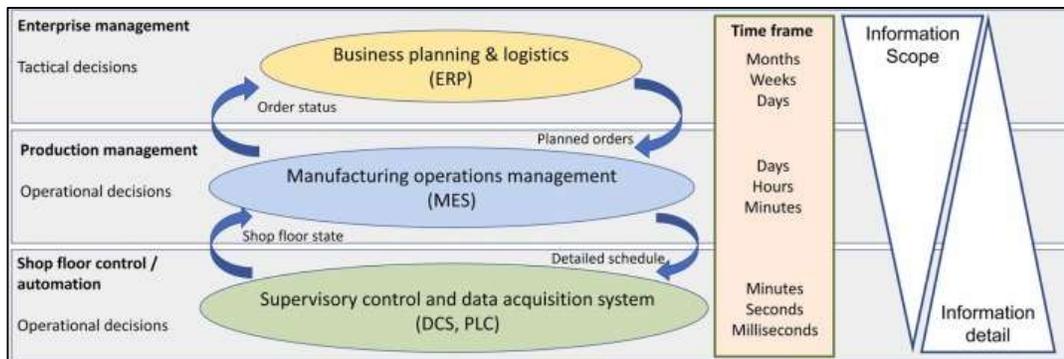


Figure 5. Manufacturing execution system (Shojaeinasab et al. 2022)

In Figure 5 you can see that the MES system is the main production management tool that provides the bidirectional link between the shop floor control/automation layer and the enterprise planning layer. From a bottom-top view, the MES receives data from actuators and sensors on the status of the shop floor which are monitored by supervisory control and data acquisition (SCADA) systems such

as distributed control systems (DCSs), programmable logical controllers (PLCs) and other smart devices. To meet the decision-making needs of the ERP system at the enterprise planning layer, the granular information with a limited scope generated by the SCADA system is abstracted to the required level. The abstracted information such as statuses of orders is used by the ERP system to decide on the release of upcoming planned orders. In a top to down view of the management pyramid, data on the planned orders for the MES is provided by the ERP system. Then the MES creates a detailed schedule for the execution in the shop floor. (Shojaeinasab et al. 2022.)

Festo MES4

To familiarise the Lapland UAS students with MES, there is a Festo teaching assembly system with several individual modules in the smart lab. This is controlled with the Festo MES4 software.

Festo's MES4 software is designed for smart factories and utilizes an ACCESS database. This system was specifically created for use in learning factories and meets all Industry 4.0 requirements. With transparent interfaces and open databases, it offers a strong foundation for learning and experimentation. The Service Oriented Architecture (SOA) of the MES4 is not rigidly structured hierarchically, enabling production cells to retrieve information independently if required. (Festo Didactic SE 2015.)

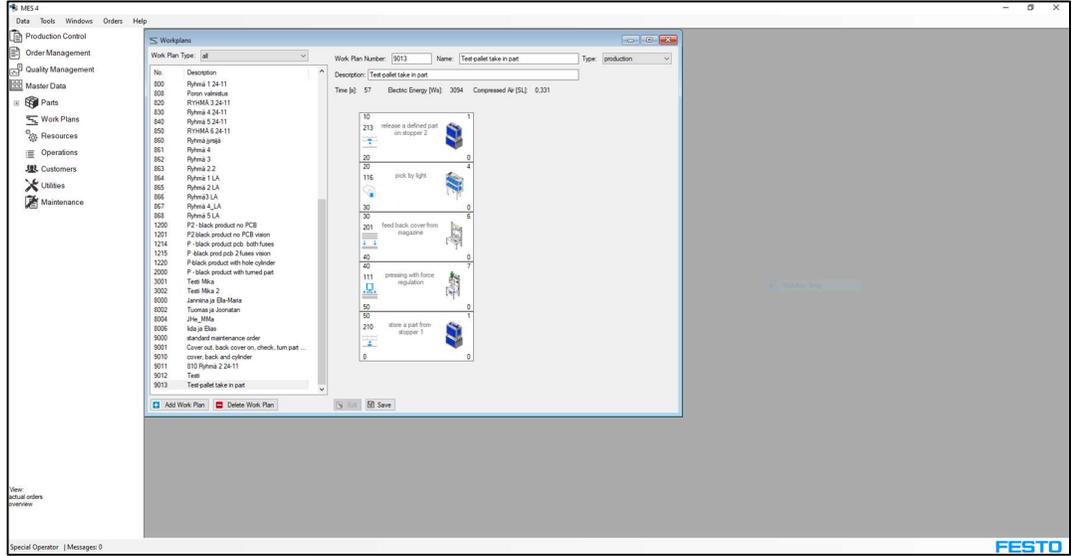


Figure 6. Festo MES4 example workplan

5 COMPUTER AIDED DESIGN

Computer aided design (CAD) helps the user to realise complex models in the field of metalworking, woodworking and 3D printing. It can handle a lot of calculations and helps to visualise single parts or whole assemblies. Another advantage of CAD programs is, that a design can be changed at any time afterwards without having to redraw the whole part or assembly. (Shivegowda, Boonyasopon, Rangappa & Siengchin 2022.)

CAD software focus on the representation of geometric models with all the necessary background information, such as the structural organisation processes and geometry modelling operations. To be able to present complex surfaces, solids and curves in the virtual environment, different technologies like geometry definition, interpolation, transformations, and approximation are needed. Furthermore, CAD provides the necessary base to perform model preparation and engineering tasks, like meshing operations. Design rules provide specific strategies and methods to be followed in the design process depending on the type of product and the desired characteristics of the model. CAD also provides the maintenance and preparation of geometrical data for simulation processes and subsequent calculation. For the generation of derivation of geometrically simplified simulation modes or approximated geometry models by triangulation CAD serves as a base. (Hirz, Dietrich, Gfrerrer & Lang 2013.)

5.1 Autodesk Inventor

Autodesk Inventor is a CAD software and part of the Autodesk solution for Digital Prototyping. It provides engineering and design solutions for 3D mechanical simulation, documentation, visualization, and design. 2D and 3D data can be integrated in one design environment to simulate a product and its form, function and fit before it is built. (Autodesk 2023; IMAGINiT 2023.)

With its freeform, direct, and parametric modelling tools, Inventor allows users to design products in a variety of ways that suit their preferences and workflows. The software's digital prototyping capabilities help to reduce development costs, shorten time-to-market, and ensure that high-quality products are created. By simulating and testing products digitally, users can identify and resolve potential

issues early in the design process, minimizing the need for physical prototypes and reducing the overall cost of product development. (Farnell 2016.)

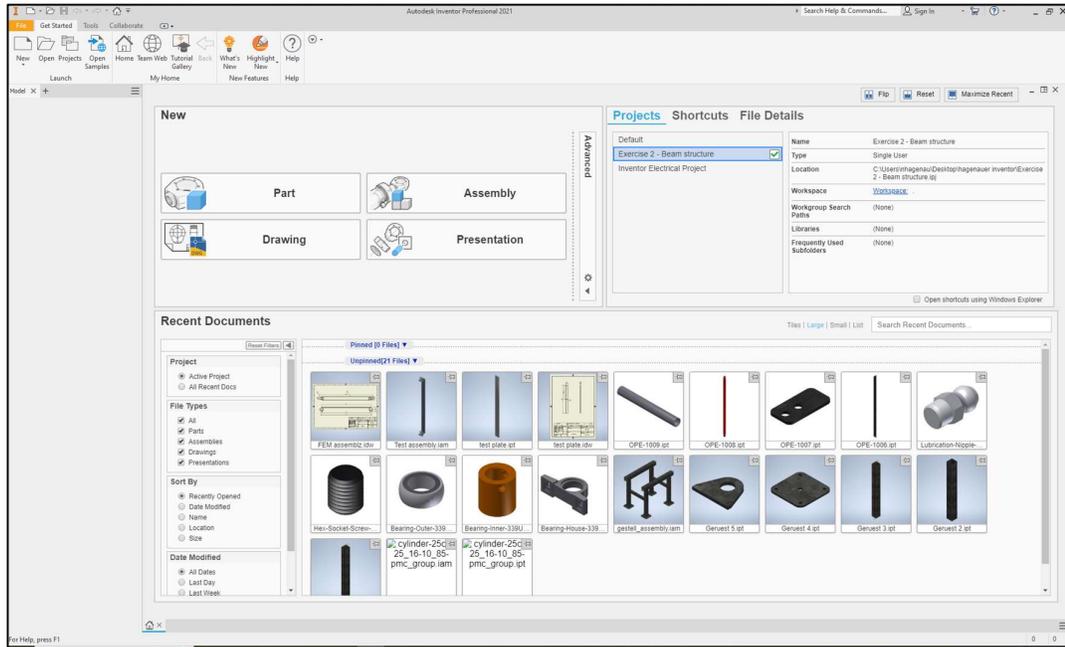


Figure 7. Autodesk Inventor

5.2 SolidWorks

SolidWorks is a professional 2D and 3D computer-aided design software package that allows engineers, designers, and architects to create and modify designs of various mechanical components, assemblies, and systems. It utilizes a solid modelling approach that involves the creation of three-dimensional models by combining basic geometrical shapes such as cubes, cylinders, spheres, and cones, among others. These basic shapes can be further modified, stretched, and transformed to create more complex models that accurately represent real-world objects. (Formlabs 2023.)

The software provides a user-friendly interface with a variety of powerful tools for creating and manipulating designs. These tools include sketching, surfacing, sheet metal design, weldments, simulation, and animation. SolidWorks also offers a range of features for collaboration and data management, including the ability to create and manage bills of materials, track design changes, and share

designs with team members and clients. (Formlabs 2023; Kai Inge Midtgård Rokstad 2022.)

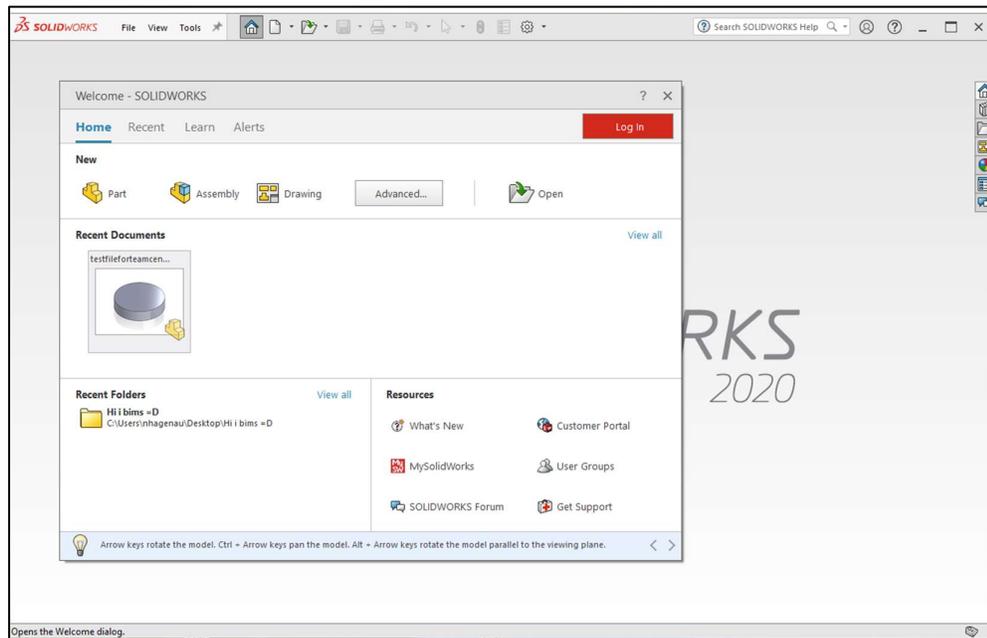


Figure 8. SolidWorks

6 SIEMENS TEAMCENTER IMPLEMENTATION AT THE LAPLAND UAS

To be able to use Siemens Teamcenter in SolidWorks and Inventor, there are software integrations for the respective programmes which must be installed on each computer with the CAD programmes. These are currently installed on the computers in the machine and electrical CAD room (1136) and on the Computer in the SmartLab (1171).

There is no such integration for the Festo MES4 software yet, but a python script to import pictures from Teamcenter to MES4 was written as a part of a bachelor thesis. The script was written with the local version of Siemens Teamcenter.

Teamcenter can be accessed via the Active Workspace. This is supported in all browsers and can be accessed from all computers on campus. Teamcenter is cloud-based and can therefore also be accessed from external computers with the right VPN connection. However, this VPN connection is only accessible to teaching staff.

6.1 Teamcenter Integration for Autodesk Inventor (TCAI)

6.1.1 User interface

With the Teamcenter Integration for Inventor, it is possible to access the Teamcenter in Inventor. This allows the user to access data in Teamcenter and save drawings, assemblies, and parts directly in Teamcenter.

In Figure 9 the user interface is shown. Number 1 is the new Teamcenter menu, which is added to the Inventor ribbon, number 2 is the TCAI - Home Browser and number 3 marks the TCAI - File Status Browser.

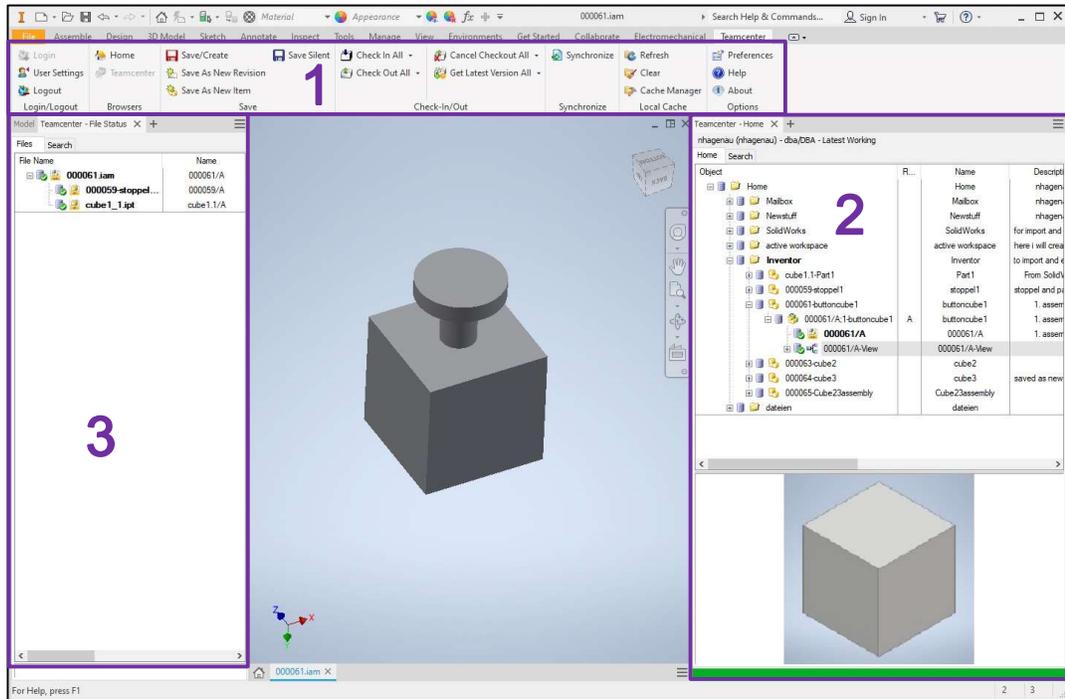


Figure 9. Teamcenter Integration in Inventor

6.1.2 Active Workspace

With the integration of Active Workspace, parts can also be added directly to a workflow, or the Active Workspace browser can be opened. To use the Active Workspace integration with TCAI proper configurations are required, which were not yet installed at the Lapland UAS. But this is only an extension and not necessary to use Teamcenter in inventor.

6.1.3 File management

The data stored in Teamcenter can be accessed from the TCAI Home Browser, as shown in Figure 10. From there, all parts, assemblies, and drawings saved in the Inventor file format can be opened. In the data master tree, all versions of a part are displayed, and each can be opened and edited. In addition, this interface offers a preview of the selected part or assembly, allowing for quick and easy access to visual information of the component. To save the assembly or part being worked on in Teamcenter, the Save/Create button in the Teamcenter menu located in the ribbon bar can be used. This feature enables users to store their

work in Teamcenter regardless of whether the part was initiated before or after logging into Teamcenter.

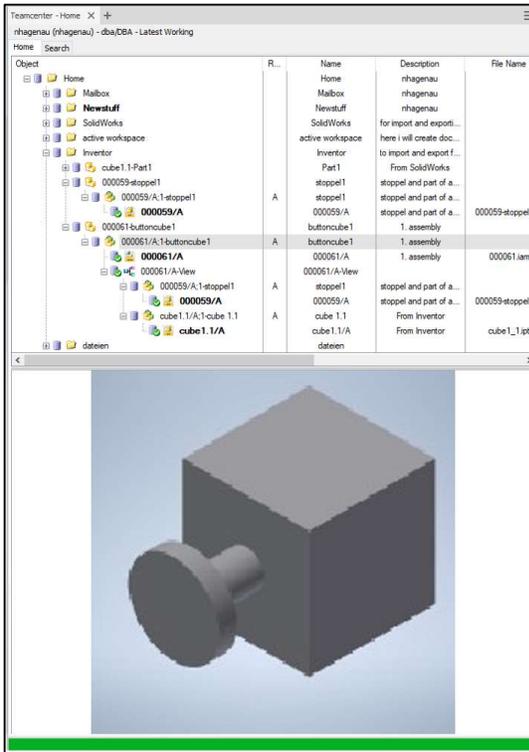


Figure 10. TCAI-Home

6.2 Teamcenter Integration for SolidWorks

6.2.1 User interface

With the Teamcenter Integration for SolidWorks, users can seamlessly access Teamcenter directly from within the SolidWorks environment. Figure 11 shows the Teamcenter user interfaces in SolidWorks. Number 1 is the Teamcenter Ribbon Bar, which is only displayed when a model is open, and number 2 shows the Teamcenter task pane.

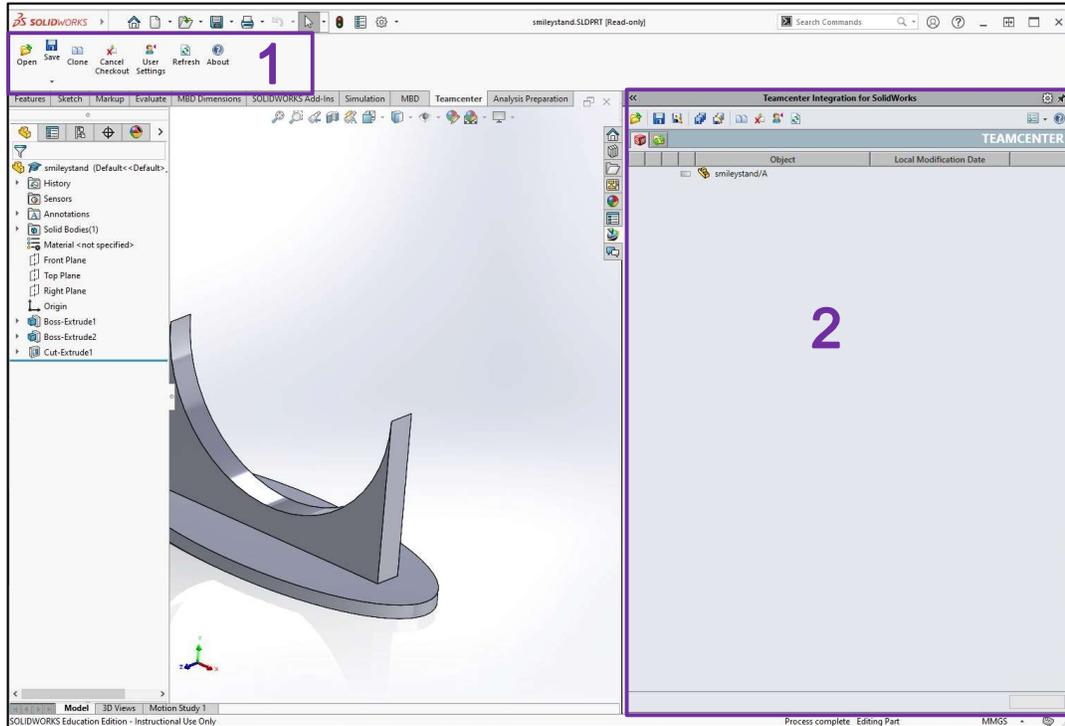


Figure 11. Teamcenter integration for SolidWorks

6.2.2 Active workspace

Once the Active Workspace integration is installed a third tab in the Teamcenter task pane will show and the user can work directly on an Active Workspace interface. However, to fully utilize the Active Workspace integration with TCAI, proper configurations must be installed, which are not yet available at Lapland UAS. It is important to note that the Active Workspace integration is an optional extension and is not required for using Teamcenter with SolidWorks.

6.2.3 File management

To open a part or assembly from Teamcenter in SolidWorks, the Open button in either the Teamcenter ribbon bar or the Teamcenter Task pane can be used. This will cause an additional window to appear, as shown in Figure 12, where the desired part or assembly can be selected for opening. Unlike in Inventor, where the entire Teamcenter data is always displayed in the Teamcenter task pane, only the files of the current workspace are displayed in the sidebar in SolidWorks.

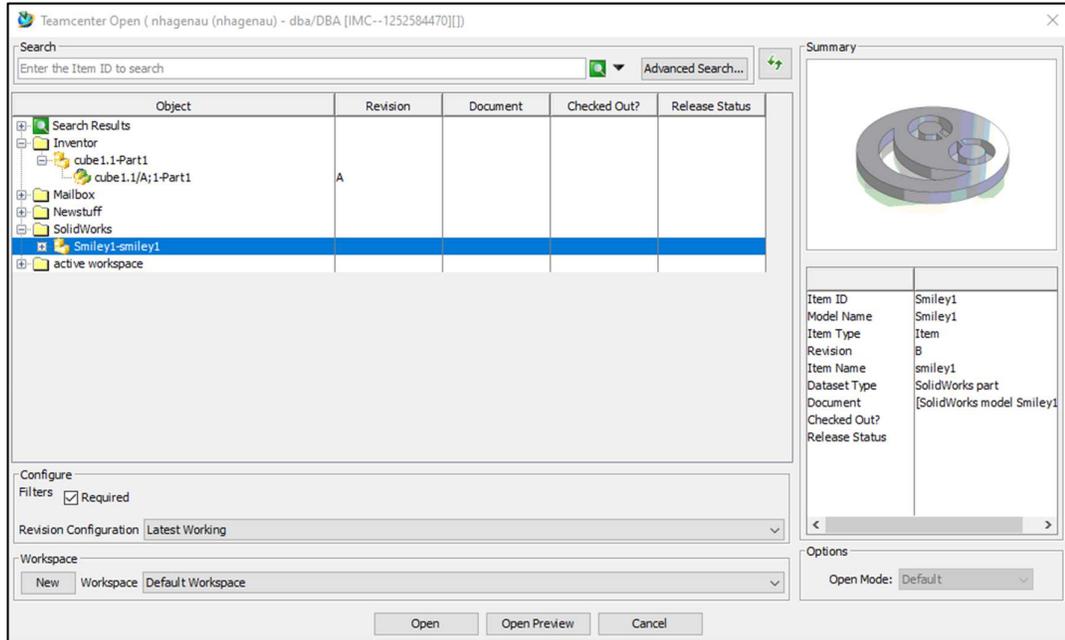


Figure 12. Teamcenter open in SolidWorks

When saving a part or assembly in Teamcenter, two scenarios may occur:

1. If the user was already logged in to Teamcenter and in the appropriate workspace when working on the part, the part can simply be saved by clicking the Save button in the Teamcenter ribbon bar.
2. If the user started working on the part before logging in to Teamcenter, the data must be imported to the current workspace before it can be saved in Teamcenter. Once this step is completed, the saving process is the same as in the first scenario.

6.2.4 Frequent Error

When the user creates a new model, the Teamcenter Alert in Figure 13 may show up. It says the creation failed because an input was not recognized as a valid DateTime. This error is caused by the Teamcenter when it cannot read the Time format of the computer. This is a common error and therefore there are several solutions in the Teamcenter Support Center.

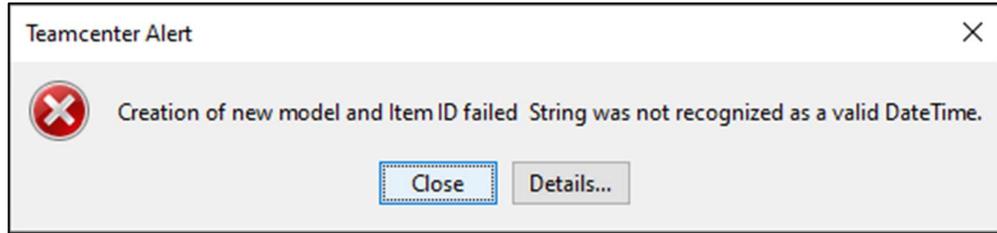


Figure 13. Teamcenter Alert invalid DateTime

Solution 1: Change time format of the computer to Spanish (Mexican)

The first solution suggested to change the time format of the computer to Spanish (Mexican). The time format can be changed in the Computer Settings in the menu *Time and Language* → *Date, time & regional formatting*. There, the Current format can be chosen out of a drop-down list. After changing the format SolidWorks needs to be closed and opened again.

This not only changes the time format, and language in the date of the computer, but also the language in SolidWorks to Spanish. As shown in Figure 14 this did not solve the problem, however the Alert was more specific by stating, that Teamcenter cannot recognise the word starting at index 20.



Figure 14. Teamcenter Alert invalid DateTime, time format Spanish (Mexican)

Solution 2: Disable all Add-Ins

After changing the Time format back to English (Finland) another solutions suggestion was tried. The idea was to disable all Add-Ins from SolidWorks itself. To disable the Add-Ins the user clicks on the *Options* button, as marked in Figure 15 and selects Add-Ins from the drop-down menu.

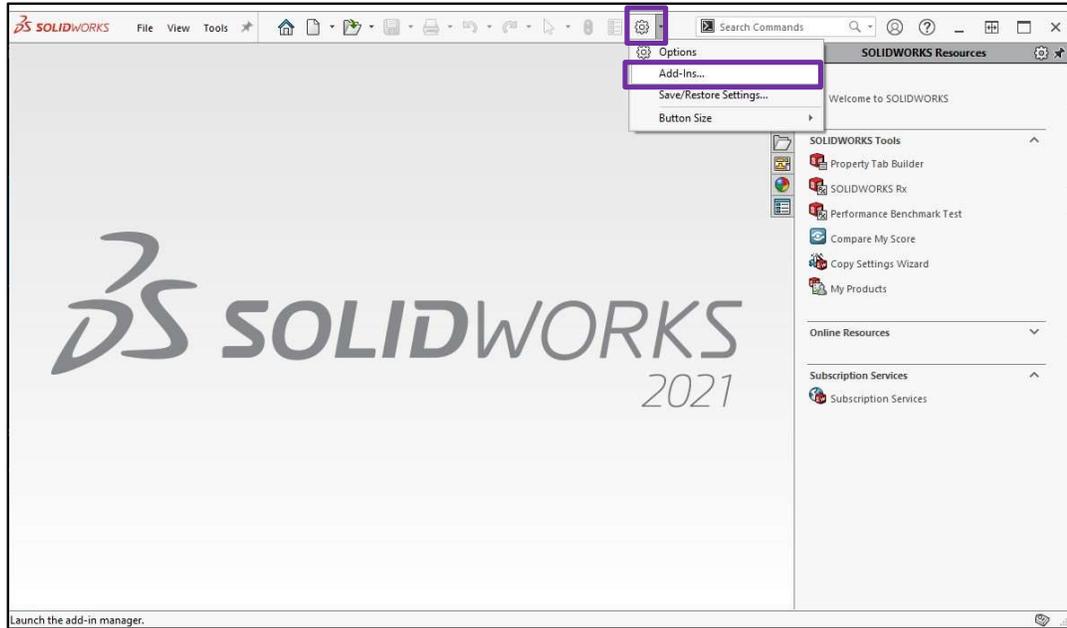


Figure 15. SolidWorks Options drop-down menu

In the Add-Ins menu, as shown in Figure 16, all Add-Ins are being disabled by removing the ticks in the boxes on the left side. Afterwards SolidWorks is being closed and started again. This solution also did not work and the original error (Figure 13) was shown again.

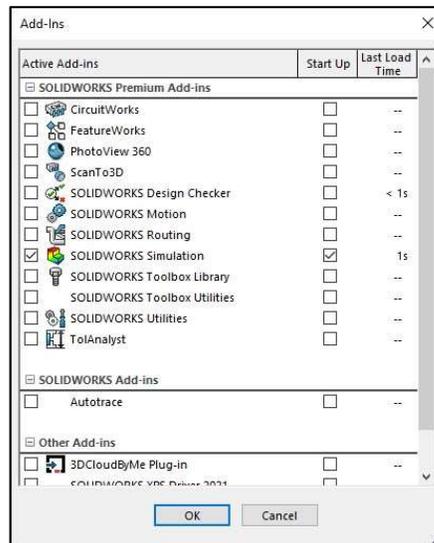


Figure 16. SolidWorks Add-Ins

Solution 3: Change time format to German or Russian

This solution was suggested for a different error, but it was tried as it closely resembled the first proposed solution. The idea was to change the time format to German or Russian. Due to the language skills in German, it was tried with the German date format, and it worked. This was not a good solution for the finish students since the SolidWorks interface was now also in German. So afterwards the time format was changed to Finnish (Finland) and it also worked with that.

In conclusion, to solve the problem, the time format must be changed in one of the formats mentioned above, then a component must be saved in SolidWorks Teamcenter, and afterwards the time format can be changed again to the desired format. This is not an optimal solution, Teamcenter itself says, but until now there is no other solution for this problem.

6.3 Festo MES4

A python script is used to export pictures from Teamcenter to the MES4 software. In the program, the Teamcenter directory is accessed, and a csv file stored in it is read out. In this csv file, short descriptions, and the names of the images to be imported are stored. The images are stored in the same directory as the csv file and can thus be found and imported into the MES4 directory. The images can then be accessed in the MES4 software. The exact python script can be found in the bachelor thesis from Henri Valta. (Valta 2022.)

The program was tested, and basically worked, except for the correct storage location, because for the python script a local version of Siemens Teamcenter was used. For this work the browser version of Siemens Teamcenter is used and therefore the program cannot be used.

6.4 Active Workspace

In the Active Workspace the user can either search for files with the search function or directly find them in the Folders. There, all Folders the user has access to are listed. When opening a folder first the contents will be listed on the right side, shown in Figure 17.

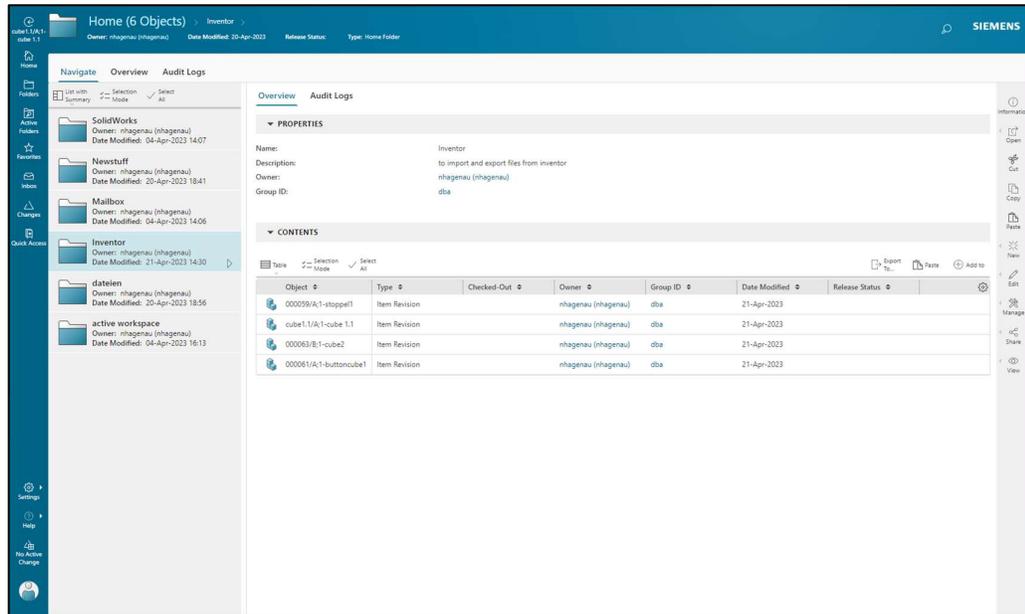


Figure 17. Active Workspace Folder overview

Now each part can be copied, downloaded, or opened directly in Inventor, or SolidWorks with the right integration. This integration needs to be installed separately for Inventor and SolidWorks and is not yet integrated in the Lapland UAS.

The parts can also be opened in the Active Workspace to get more detailed information. In Figure 18 the Overview section of a part is shown with some basic information on the part and a preview.

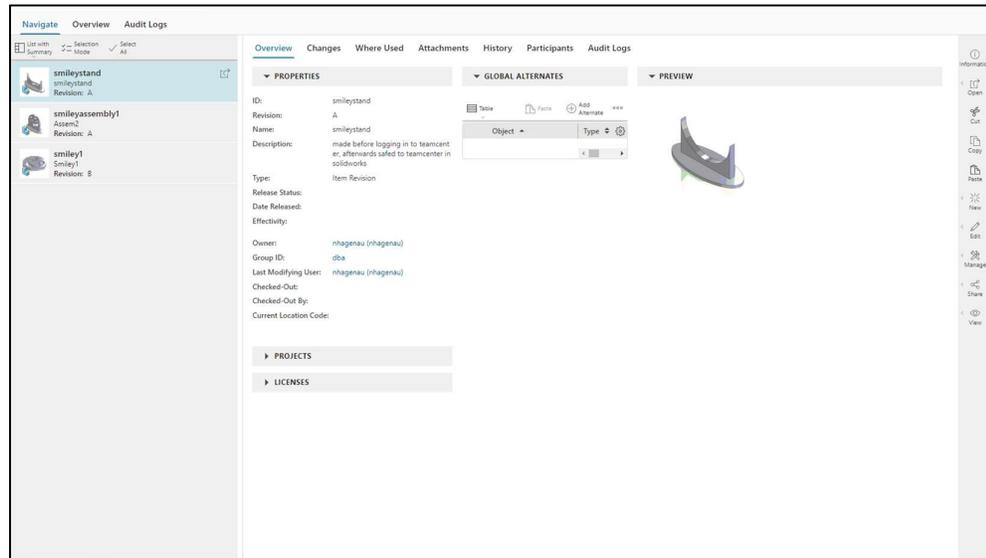


Figure 18. Active Workspace Part overview

The user can also see if and in which assembly a part is used, as shown in Figure 19 in the Where Used section. In the Attachment section, the part itself is deposited.

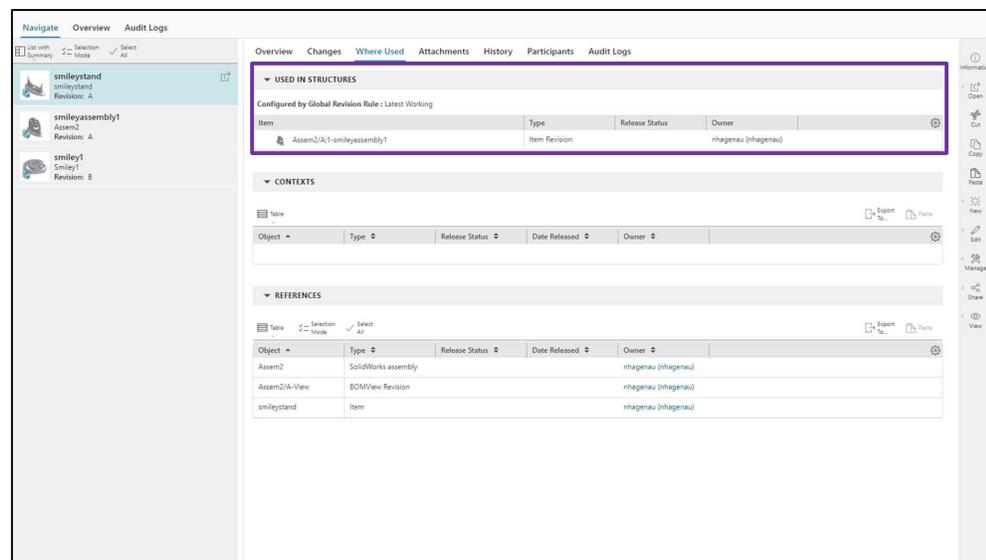


Figure 19. Active Workspace Part Where Used

If there were several versions or revisions made from a part these can be seen in the History section shown in Figure 20, where the user can also download the older version of a part or an assembly.

Overview Content Changes Where Used Attachments History Participants Audit Logs

▼ REVISION HISTORY

Object	Release Status	Date Released	Owner	Date Modified
000063/R1-cubx2			nhagenau (nhagenau)	21-Apr-2023
000063/A1-cubx2			nhagenau (nhagenau)	21-Apr-2023

▼ CHANGE HISTORY

Solution Item	Impacted Item	Authorizing Change ...	Closure	Maturity	Disposition	Incorporates Chang...	Incorporated by	Incorporated into	Incorporated Status
---------------	---------------	------------------------	---------	----------	-------------	-----------------------	-----------------	-------------------	---------------------

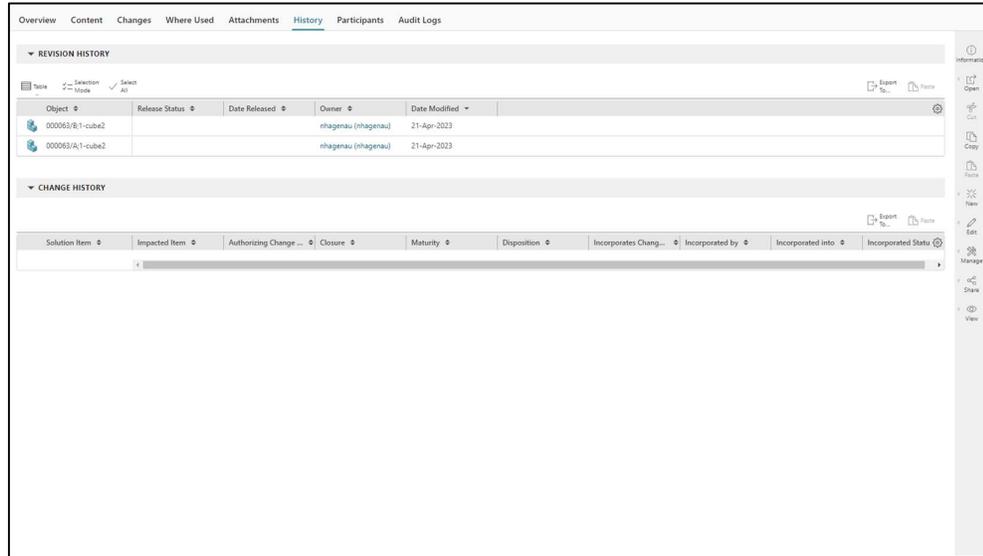


Figure 20. Active Workspace Part History

7 RESULTS

7.1 Teamcenter integration for Autodesk Inventor instructions

The instructions are a step-by-step guide for students, who have not used the Teamcenter integration for Autodesk Inventor before. The instructions start by explaining how to log into Teamcenter, followed by the file management and closing with how to save files to Teamcenter. Following the detailed structure is listed:

1. Log in
2. File Management
 - 2.1. Open Files
 - 2.2. Place parts in assembly
3. Save Files
 - 3.1. Save/Create
 - 3.2. Save As New Revision
 - 3.3. Save As New Revision

Since file management and opening files requires a different approach than saving data, the instructions have been further divided into these two main headings next to the log in section. The integration is already very well adapted to the Inventor environment and can therefore be used easily with a basic knowledge of Autodesk Inventor. The complete instructions can be found in Appendix 0.

7.2 Teamcenter integration for SolidWorks

The guide is written in such a way that students who have not worked with the Teamcenter integration for SolidWorks before are guided step by step from logging in to saving data and are introduced to the integration. The manual is divided into a short explanation of the log in, followed by a description of file management and the opening of files, then the saving of files, which differs from the approach to file management, and finally how to solve a frequently occurring error is explained. The exact table of contents is listed below, and the complete manual can be found in Appendix 0.

1. Log in
2. File Management
 - 2.1. Open from Teamcenter
 - 2.2. Open files not saved in Teamcenter
 - 2.3. Make/save new part
 - 2.4. Place parts in assembly
3. Save Files
4. Frequent Error

7.3 Siemens Teamcenter Active Workspace

The instructions serve as an introduction to the use of Siemens Teamcenter Active Workspace and explains the most important functions for students step by step. The instructions have been divided into three chapters: Log in, user interface and file management. The user interface of Active Workspace has been explained, with the use of direct screenshots to demonstrate it clearly. As Active workspace relies on clearly described and graphically represented commands, for the file management, also a lot of screenshots were used to give a good overview of the topic. The whole Instruction can be found in Appendix 0.

8 DISCUSSION

In summary, it can be said that the development of the instructions for the Teamcenter integration for Autodesk Inventor worked very well, as there was already prior knowledge of how to use Autodesk Inventor. For the development of the instructions for the Teamcenter integration for SolidWorks, it was first necessary to learn how to use SolidWorks itself to be able to work with the extension in the programme and to prepare the instructions accordingly. Furthermore, an error with the time format occurs regularly with this extension, the cause and solution of which had to be worked out.

While gathering information for the MES4 extension, it was discovered that there is still no official Teamcenter extension for this software. For the MES4 software, during a bachelor thesis carried out at Lapland UAS in 2022, a python script was written with which images can be imported from Teamcenter into the MES4 software. In this work, however, the student did not work with the browser application of Siemens Teamcenter, Active Workspace, with which the future students will work, but with the locally installed Teamcenter version. Therefore, this solution is not applicable for future teaching and no instructions for the process were written.

For the siemens Teamcenter active workspace development, the difficulty at first was to find suitable supporting material for me to understand the basic principle, because at first, I had no access to the data of the official Siemens Teamcenter support center, and the publicly available information was all out of date. Once this problem was solved, the programme was quickly learned, and the manual written.

In summary, the Teamcenter integrations for Autodesk Inventor and SolidWorks already work well, but small enhancements, as mentioned in chapters 6.1 and 6.2, should be installed for both to make the process even more user-friendly.

For Teamcenter Active Workspace, it would be beneficial for the students if it were possible to access the browser application from outside the university to be able to access the data stored in it at any time.

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10 APPENDICES

Appendix 1

Instructions for Siemens Teamcenter integration for Autodesk Inventor



Nathalie Hagenauer

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1. Log in

In Figure 21 the Inventor interface with the Teamcenter ribbon menu is shown. To sign in to Teamcenter and get access to the data, the user clicks the *Login* button in the upper left corner, as marked in Figure 21.

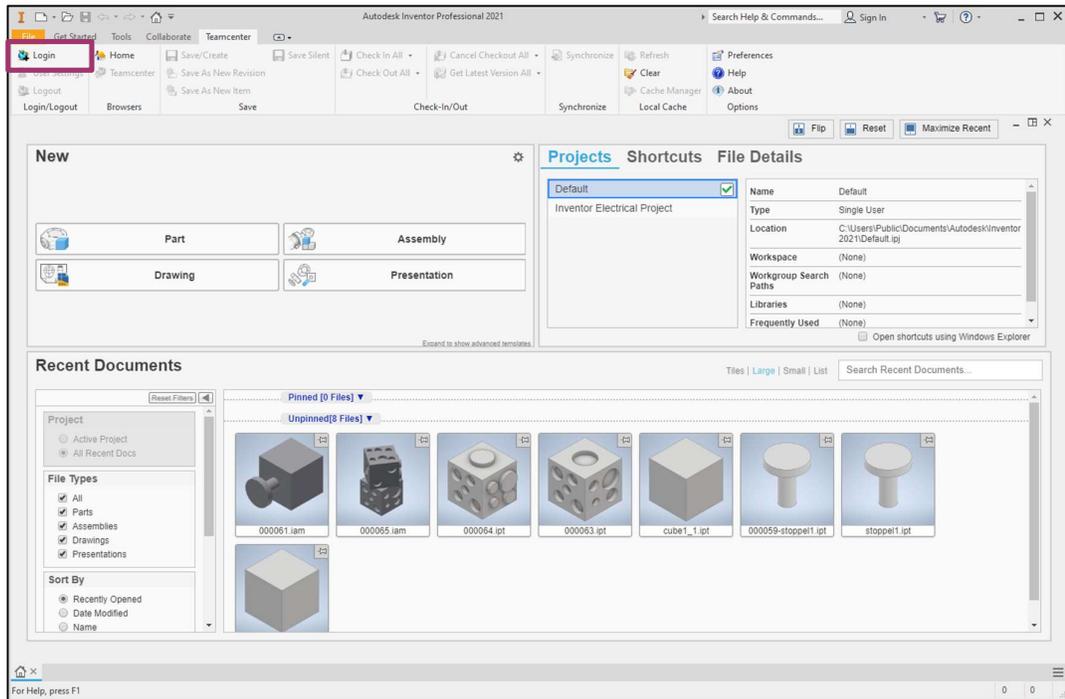


Figure 21. Inventor interface not signed in

By clicking on the *Login* Button, the Teamcenter TCCS Login window will pop up as shown in Figure 22. The user can log in by filling in the User ID and Password, the Group and Role field stay empty, and then click login.

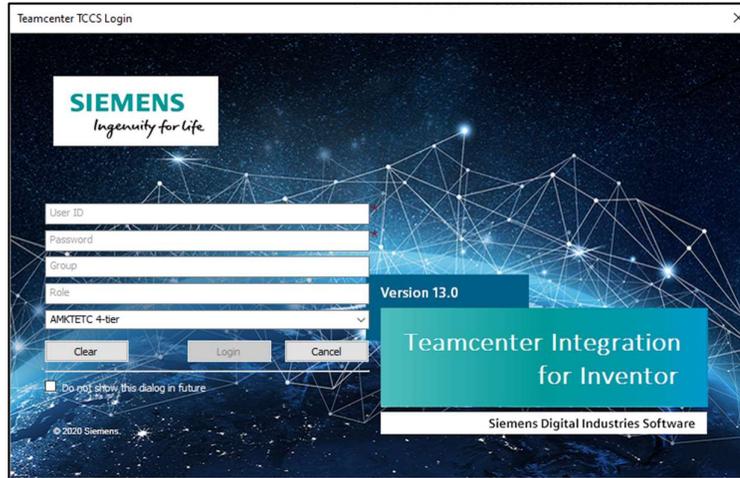


Figure 22. Teamcenter TCCS Login

It can occur that the warning shown in Figure 23 appears, however this should not affect the work and the user can click OK to continue.

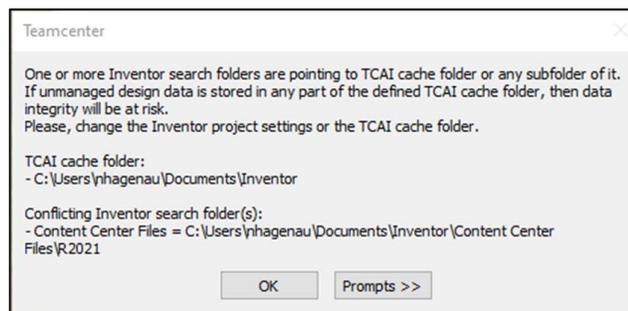


Figure 23. Folder conflict warning

In Figure 24 the logged in user interface is shown. Number 1 is the Teamcenter menu, number 2 is the Home Browser and number 3 marks the File Status Browser.

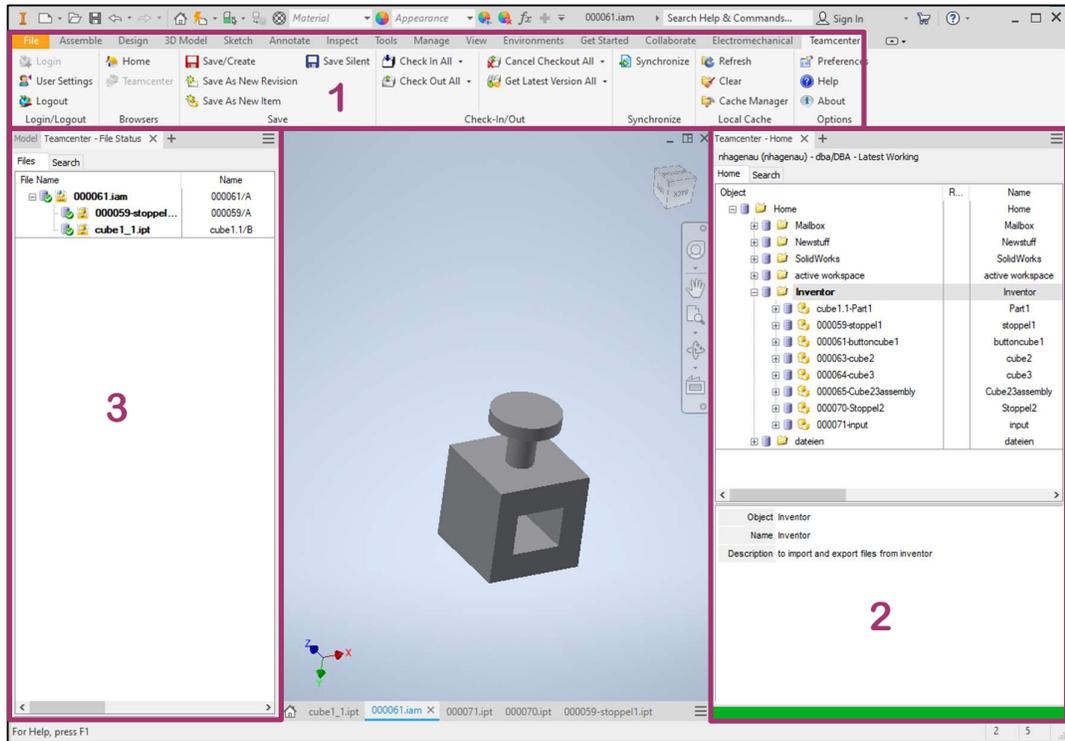


Figure 24. Inventor Teamcenter logged in

2. File Management

In the Teamcenter Home interface parts, assemblies, drawings, or presentations can be opened. This can be seen in Figure 25 and is opened by clicking the *Home* button marked in Figure 25.

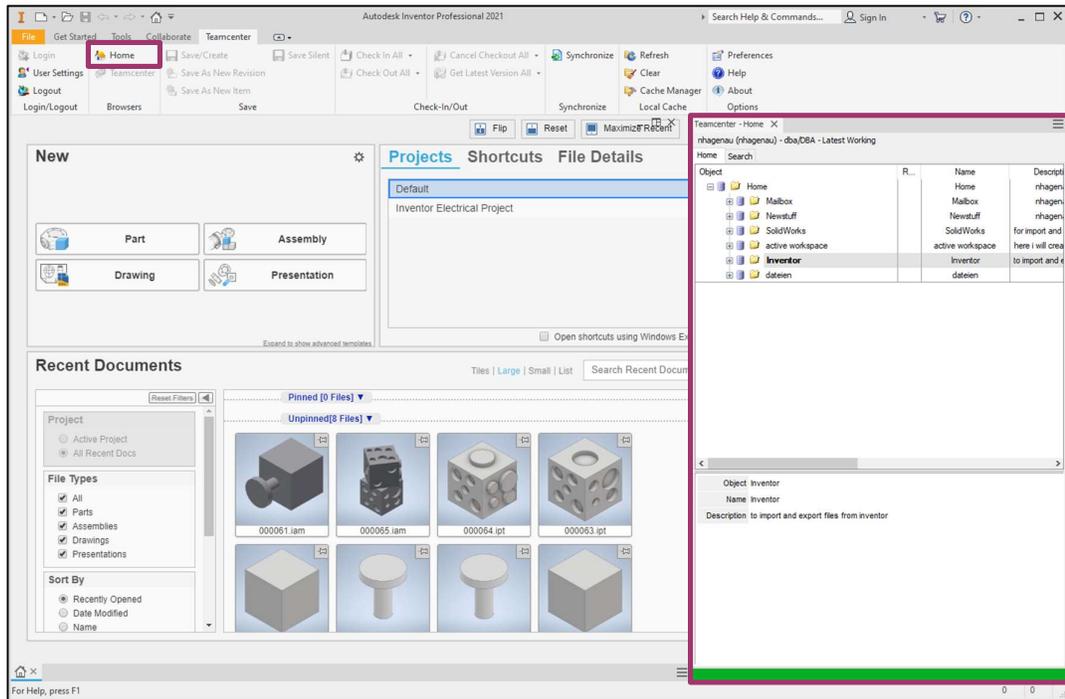


Figure 25. Inventor Teamcenter Home how to open

2.1. Open Files

In Teamcenter Home all folders on which the user has access to, are listed and files can be shown in the preview by clicking on them once and opened by clicking on them twice.

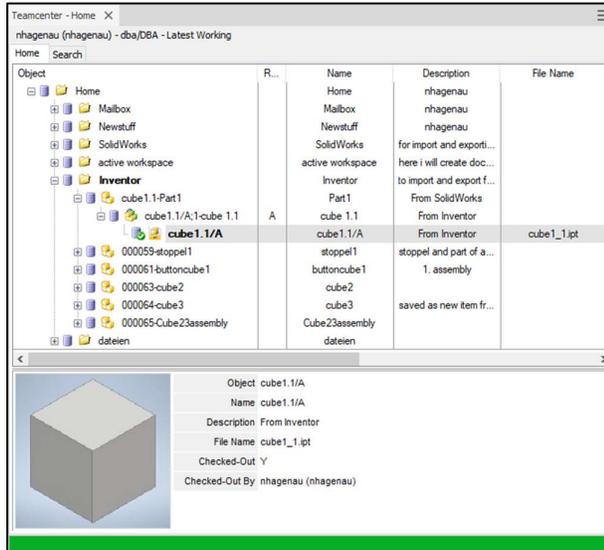


Figure 26. Inventor Teamcenter Home

If there are more versions (revisions) of one part or assembly, these will be listed in the data tree as shown in Figure 27.

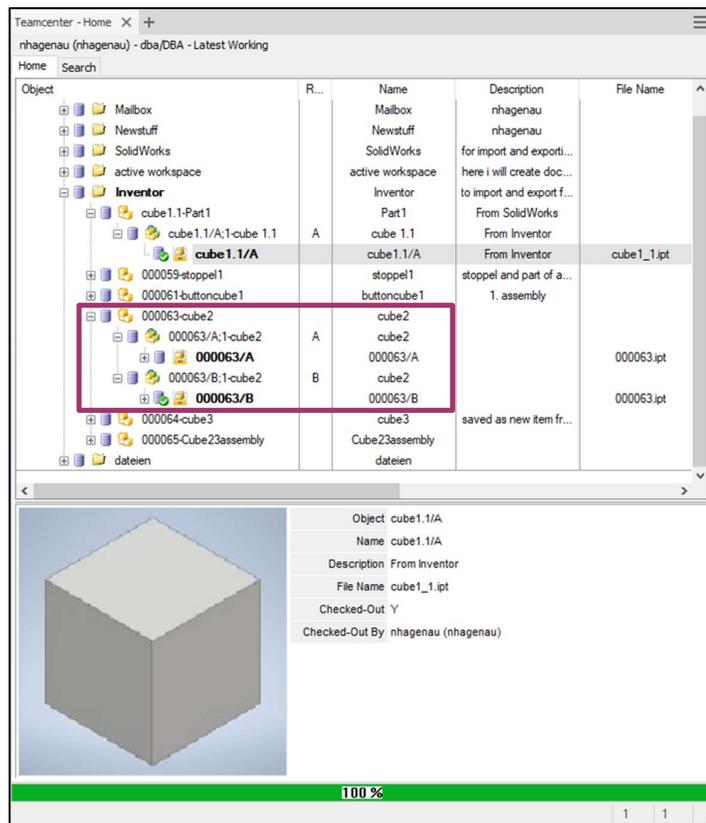


Figure 27. Part revision

When a file is open, the user can open the File Status browser by clicking the *plus* in the Model browser as marked in Figure 28 and selecting the *Teamcenter – File Status*.

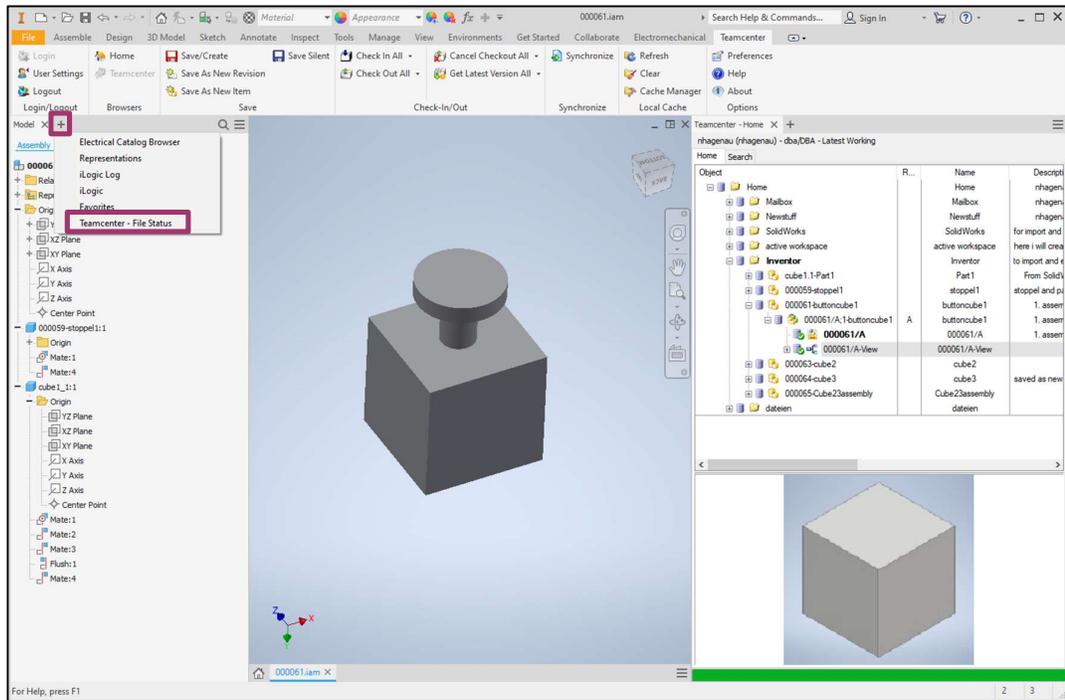


Figure 28. Open Teamcenter - File Status

In the File Status browser, the information of the currently opened component is displayed. (Figure 29)

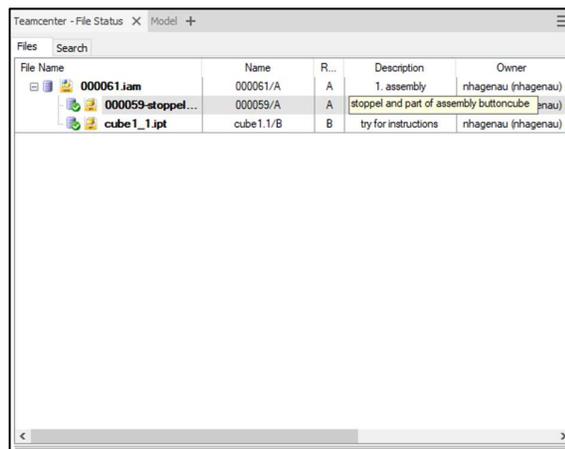


Figure 29. Teamcenter File Status browser

2.2. Place parts in assembly

To place a part from Teamcenter in the current assembly the user has to right-click on the part to be placed to open a drop-down menu. In this Place from Teamcenter as marked in Figure 10 can be clicked to place the part in the assembly.

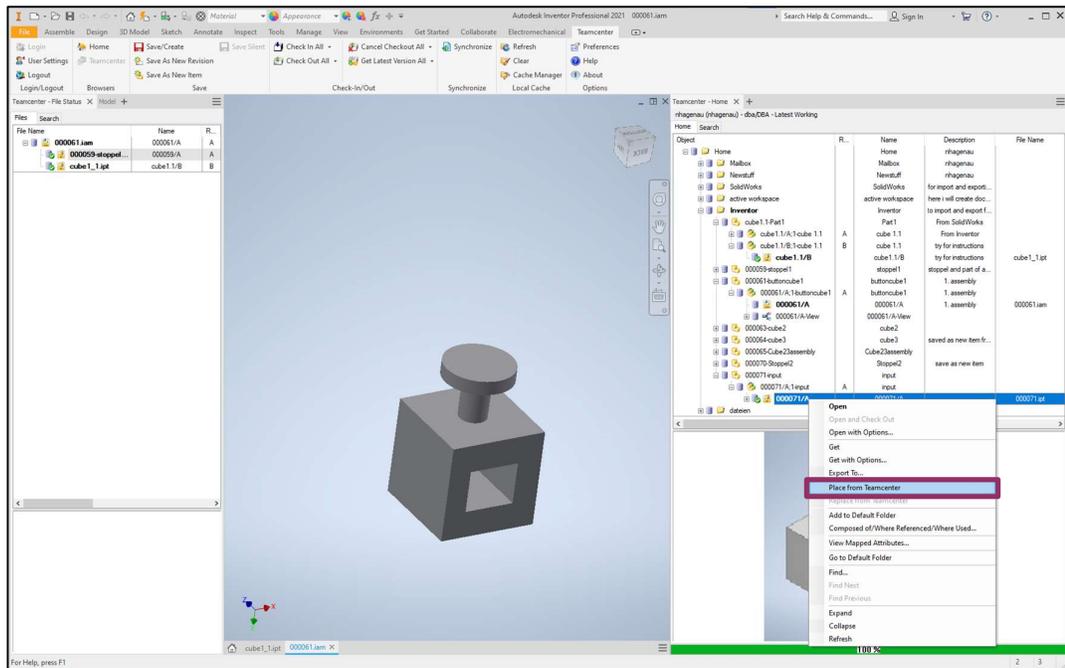


Figure 30. Paste from Teamcenter

3. Save Files

There are four different saving commands in the Teamcenter Save group in the menu bar as marked in Figure 31.

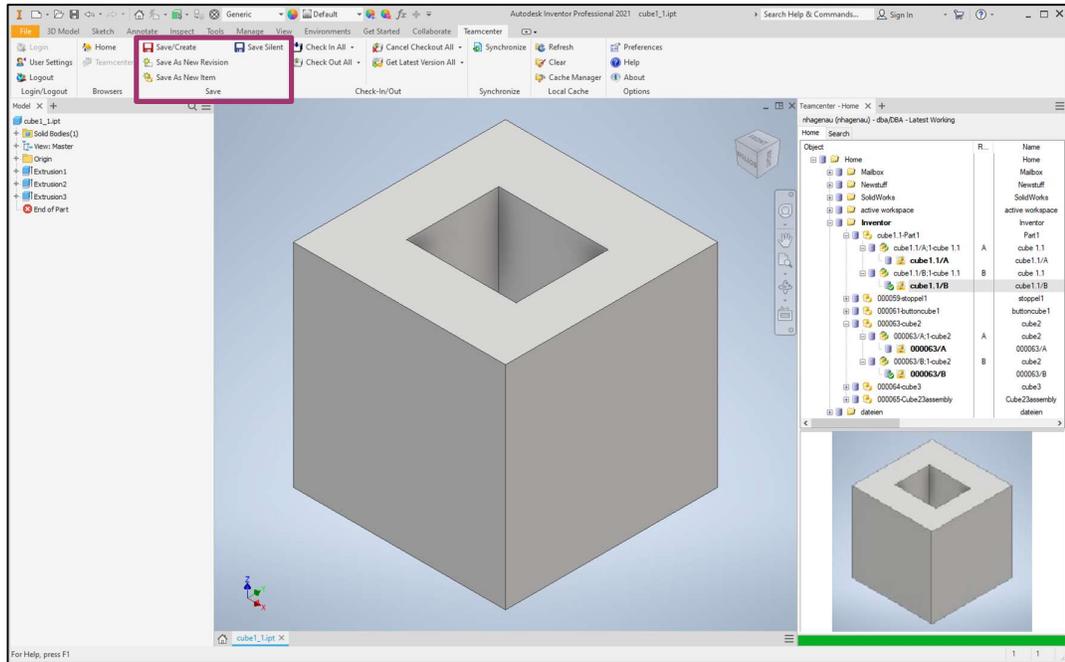


Figure 31. Teamcenter Save group

Save/Create: To save new Inventor Parts, assemblies, drawings, or presentation files to Teamcenter, the save window will open to set the properties and settings.

Save silent: This option will save modified components to Teamcenter without opening the save window, so if no property changes are made this command can be used. It is also useful to save work periodically during an ongoing CAD session.

Save As Revision: With this option a new revision of the selected component will be saved. In the save window the properties and settings can be set.

Save As New Item: To make a copy of the selected item with a new item ID. The save window will open to configure the properties and settings.

Note: The part must be saved as a **New Revision** or **New Item** before changes are made, because otherwise the original part will also be changed.

3.1. Save/Create

If a component is still being created and has not yet been saved in Teamcenter, all Check-In/Out and Save options are greyed out except for *Save/Create*, as the part must first be saved in Teamcenter to be able to execute these options. (Figure 32)

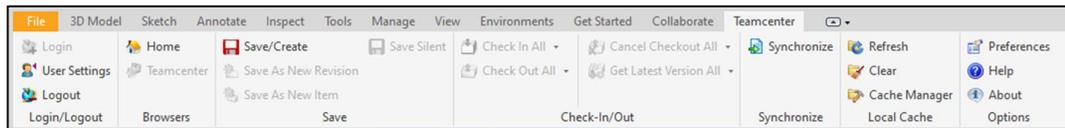


Figure 32. Teamcenter ribbon, part not saved in Teamcenter

By clicking on the *Save/Create* button, the Save Documents in Teamcenter window, as shown in Figure 33, will appear. In this window the item properties can be set. In Figure 33 on the left side the data involved in the saving session and their status is listed, in this case it is just one part. The Save Status is a red minus (\ominus), that means the part is not ready to be saved. By hovering the mouse over the icon, a small window, as marked in Figure 33, will appear and displays what the problems are.

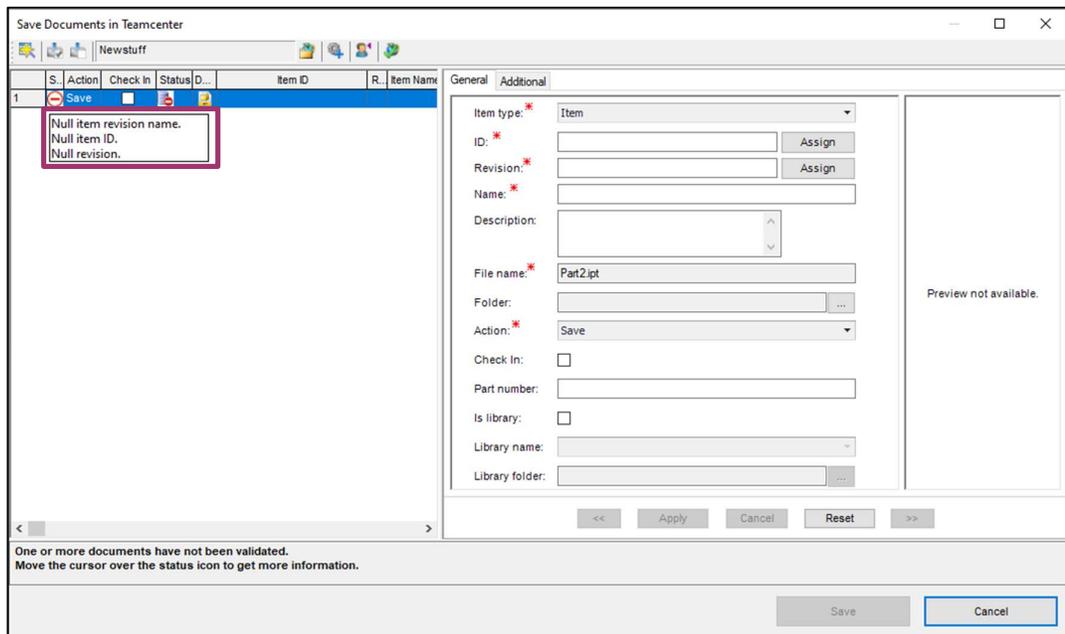


Figure 33. Save Documents in Teamcenter

Once these problems are fixed the Status will turn to a green plus (+) and the component can be saved.

The third column is the Status column which has three different statuses as shown in Table 1.

Table 1. Status icons

Icon	Status	Description
	Not in Teamcenter	Item has not been added to Teamcenter yet
	Checked in	Item is saved in Teamcenter
	Checked out by the current user	Item is being used by the current user

Dataset Type is the fourth column and indicates the kind of Inventor file. In Table 2 the basic types are shown.

Table 2. Inventor basic file types

Icon	Description	File Extension
	Inventor Part	.itp
	Inventor Assembly	.iam
	Inventor Drawing	.idw/.dwg
	Inventor Presentation	.ipn

On the right side of the save window the properties can be set. This can be done either by assigning them automatically by clicking one of the *Assign* buttons marked in Figure 34 or by filling it out manually.

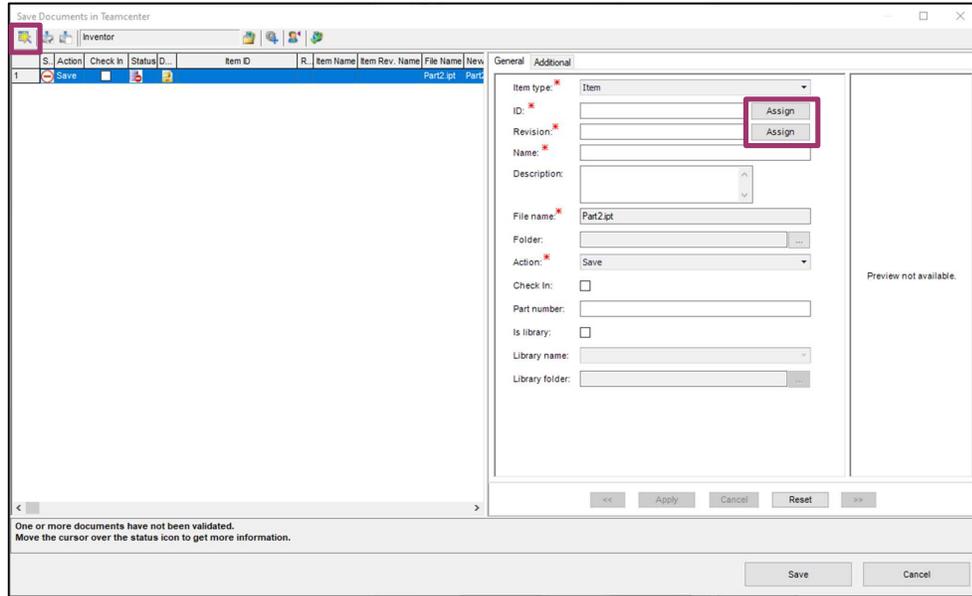


Figure 34. Save Documents in Teamcenter, Assign automatically

By clicking on the three dots next to the *Folder* field, possible folders to save the file in will appear to select from, as marked in Figure 35.

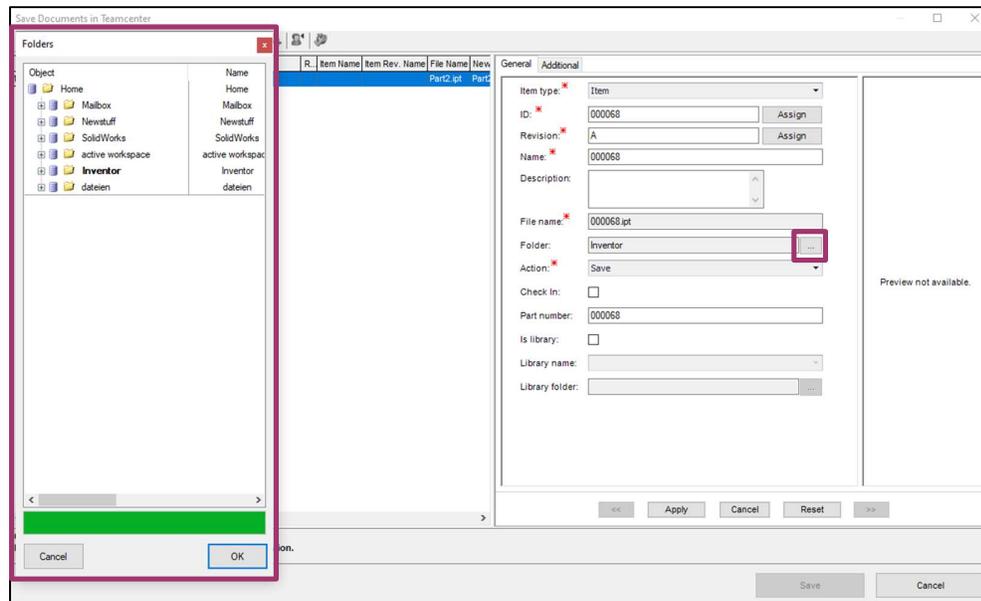


Figure 35. Save Documents Teamcenter properties, Folder

If the part does not show up in the folder after it was saved, the folder can be refreshed by right-click on the folder and clicking *Refresh* in the drop-down menu, as marked in Figure 36. After that all files should be listed in the file tree again.

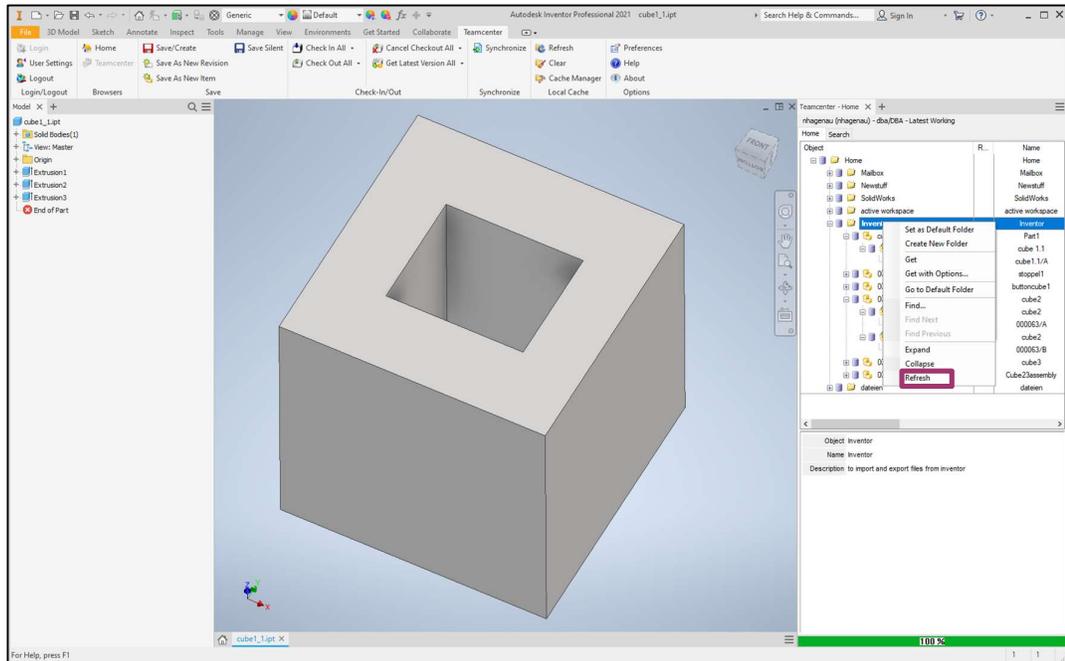


Figure 36. Refresh folder

3.2. Save As New Revision

To save a new revision of a part, drawing, presentation or assembly, the *Save As New Revision* command as marked in Figure 37 is executed.

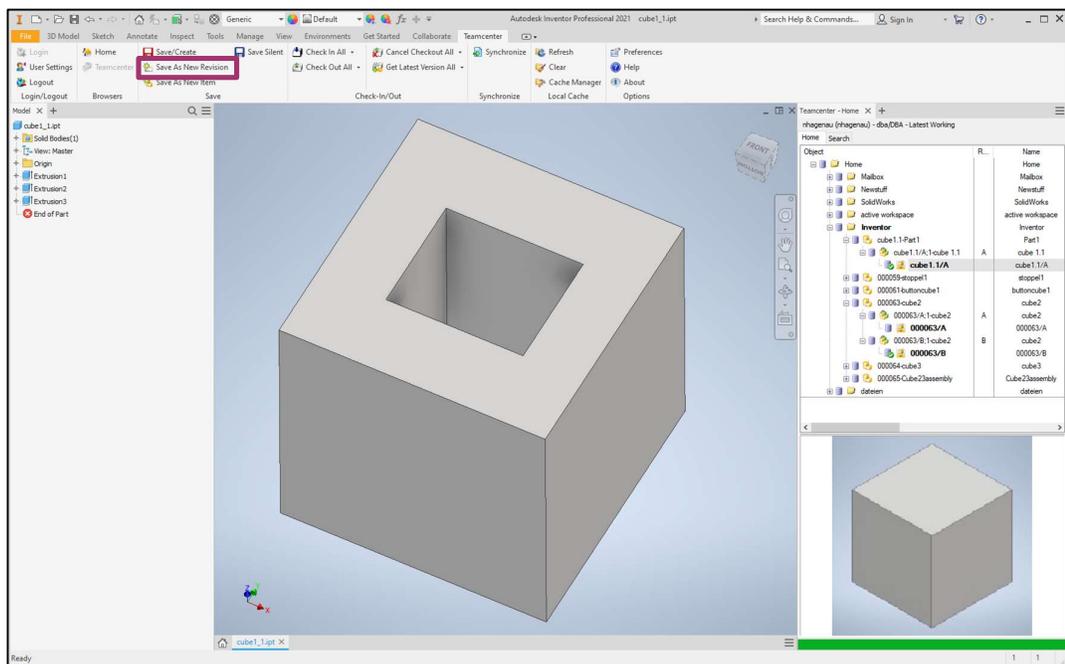


Figure 37. Save As New Revision

In the Create New Revision on Teamcenter window (Figure 38) the name can be changed, as well as the Revision number, which will be automatically prefilled. If changes are made there, they must be confirmed with the *Apply* button before the part can be saved. A Description can also be written. The folder does not need to be selected, as the revision is saved in the same folder as the original part.

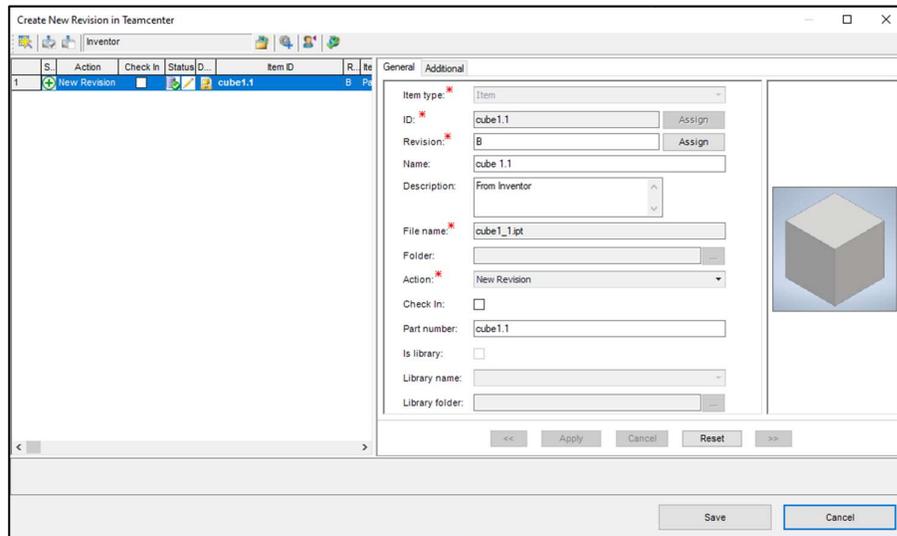


Figure 38. Create New Revision on Teamcenter

If the revision was made on a part of an assembly, next time the assembly is opened the question shown in Figure 39 will appear. This can be answered whether the assembly should also be updated or not.

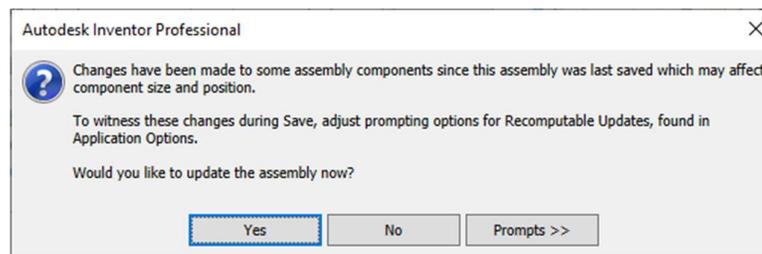


Figure 39. Assembly update

3.3. Save As New Item

To copy a part and make a new item the *Save As New Item* button marked in Figure 40 is used.

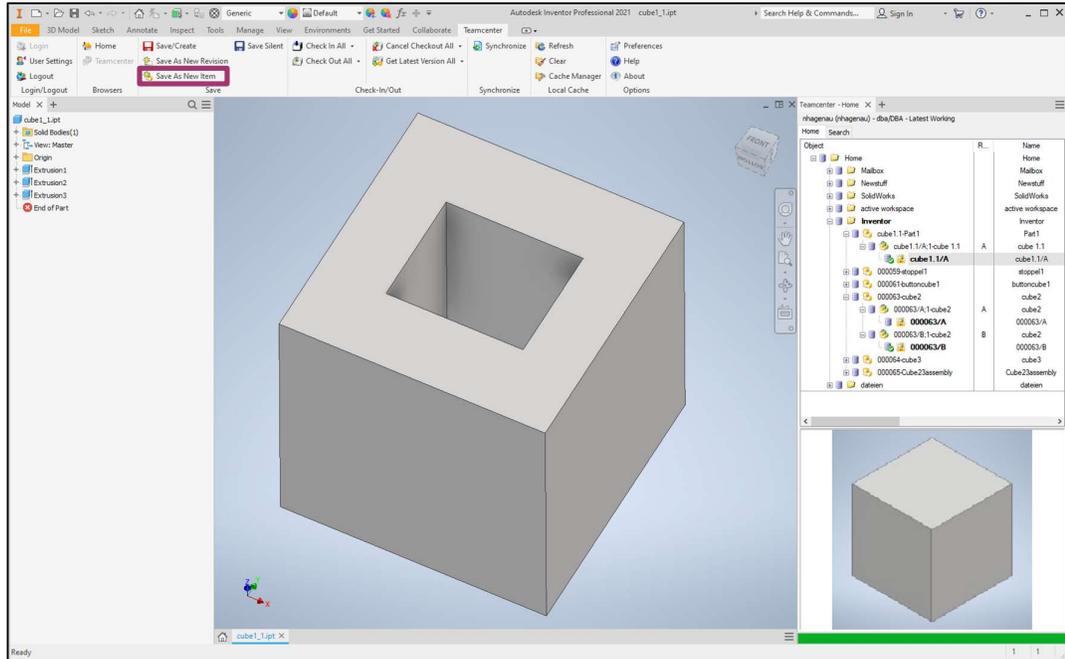
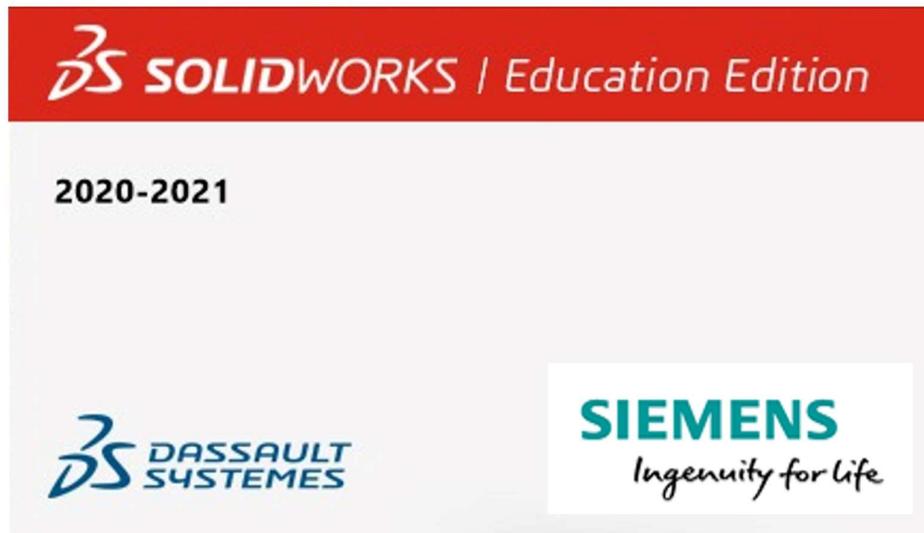


Figure 40. Save As New Item

In the Create New Item in Teamcenter window the properties can be set as in the Save/Create process.

Appendix 2

Instructions for Siemens Teamcenter integration for SolidWorks



Nathalie Hagenauer

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1. Log in

In Figure 41 the SolidWorks interface is shown. To log in to Teamcenter, click on number one to open the Teamcenter task pane and then number 2 or 3 to open the dialog window shown in Figure 42.

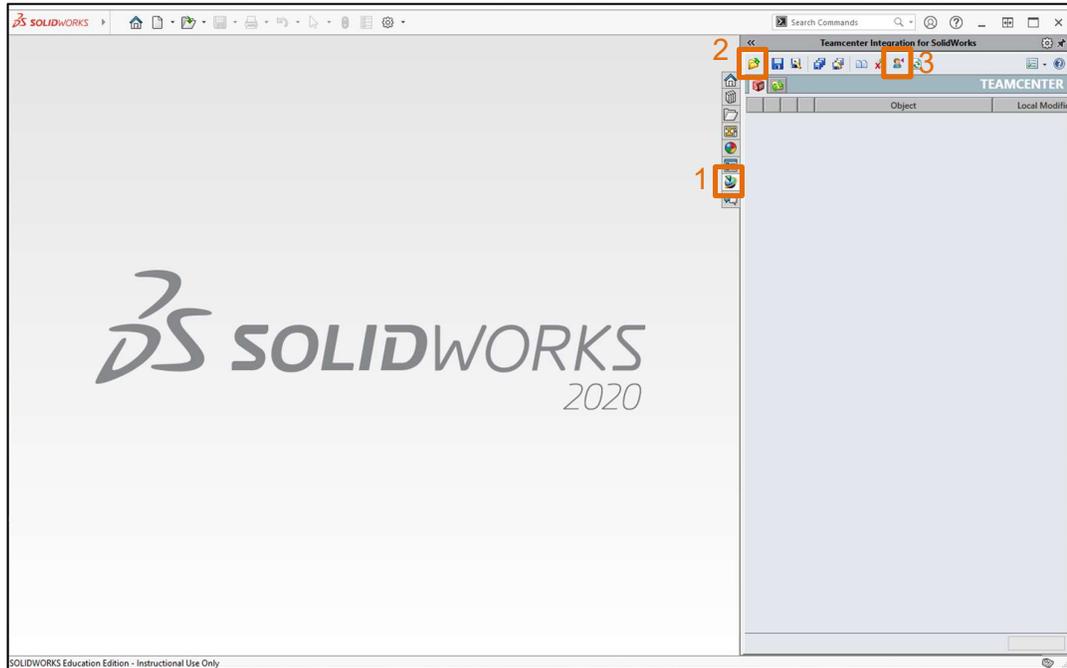


Figure 41. SolidWorks Teamcenter Interface logged out

After filling in Username and Password the user can click *Login*. The Group and the Role fields stay empty, and the Server is already chosen correctly, AMKTETC4-tier, as shown in Figure 42.

Figure 42. Teamcenter Login

If number 3 in Figure 41 was chosen to log in the window in Figure 43 will pop up, here nothing needs to be changed and the user can click **OK**.

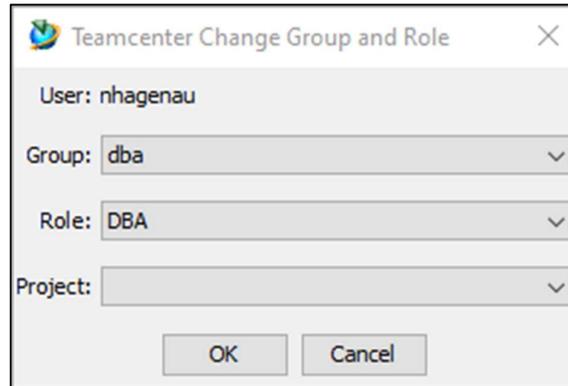


Figure 43. Teamcenter Change Group and Role

Figure 44 shows the user interface after logging in. Number 1 is the Teamcenter Ribbon Bar, which is only displayed when a model is open, and number 2 shows the Teamcenter task pane.

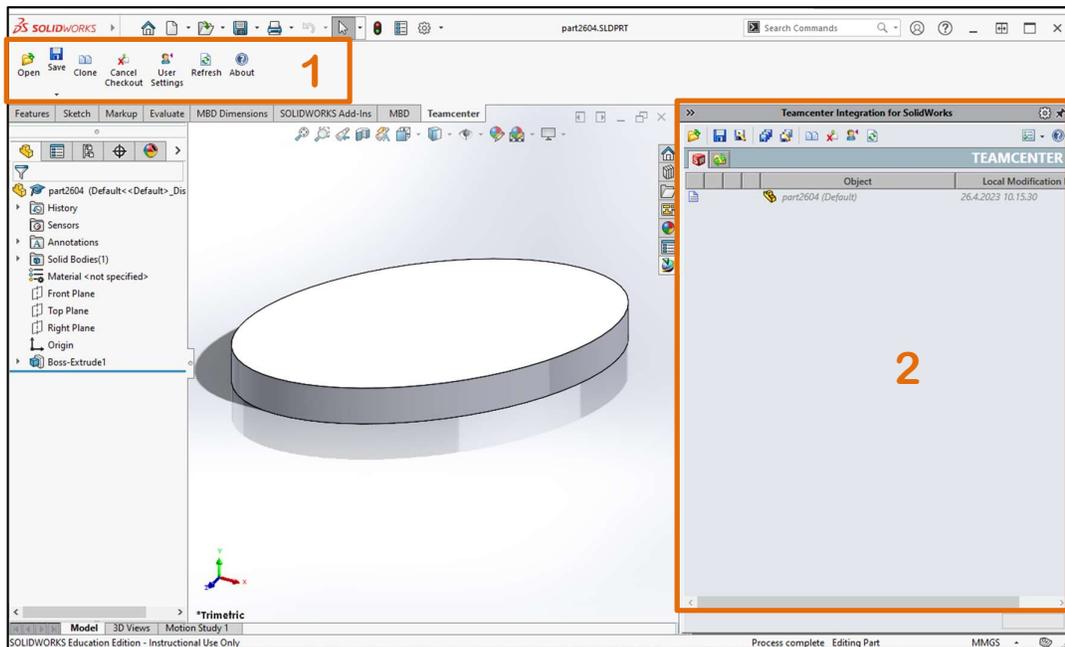


Figure 44. Teamcenter interface

2. File Management/open files

In the Teamcenter task pane the user can choose between two different views. The Active Model view, shown in Figure 45 in which the information of the opened model are displayed and the Cache Manager view in which all components of the current workspace are listed (Figure 46). In the Cache Manager a view file management activities like checking for, and update, out of date models, deleting or purging files, copying files into, or out of the Workspace, and creating or deleting entire workspaces can be executed.

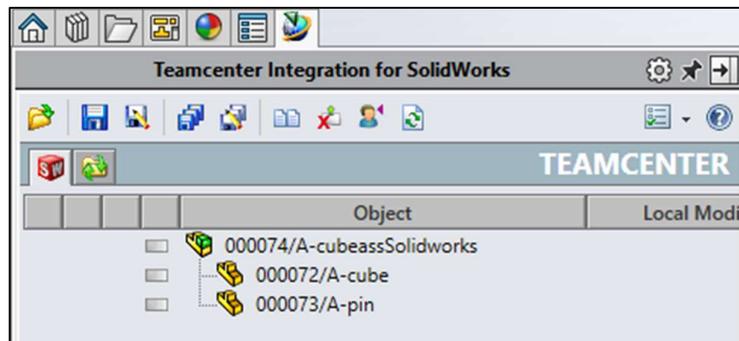


Figure 45. Active Model View

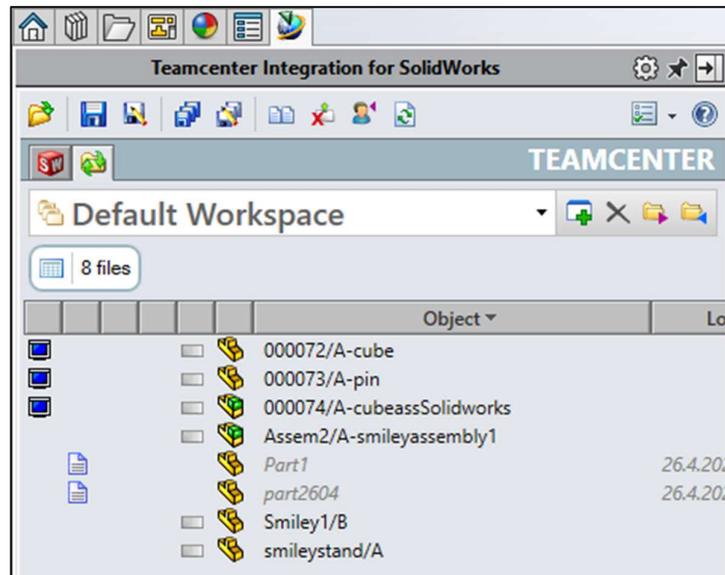


Figure 46. Cache Manager View

In the Cache manager different symbols indicate the status of the components in the current Workspace as listed in Table 1.

Table 1. Icon Status Symbols

Icon	Status	Description
	In-session	Models are in session.
	New	The model does not yet exist in Teamcenter.
	Modified	The model has been modified since last fetched.
	New Dataset	A newer version of the model is available in Teamcenter.
	New Item Revision	A newer item revision is available in Teamcenter.
	Ambiguity	The model status in Teamcenter is uncertain.
	In Teamcenter	The user has the latest revision of a model.
	Checked Out	Current user has checked out the model.
	Checkout Restricted	The model is checked out by another user.
	Released	The model has a status.
	Yield	The local model was exported from a different revision than what is being saved.

2.1. Open from Teamcenter

To open a file from Teamcenter in SolidWorks the *Open* Symbol either in the Teamcenter menu or in the Teamcenter task pane, as marked in Figure 47 can be used.

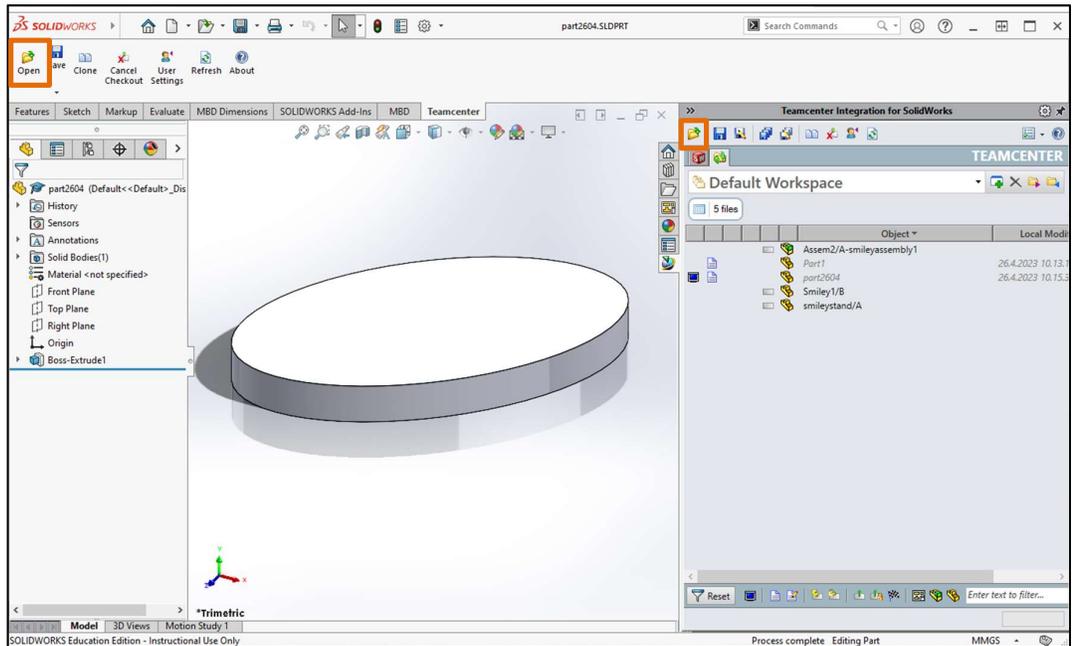


Figure 47. Open Teamcenter files

This will open the Teamcenter Open window, where all data the user has access to will be listed as shown in Figure 48. When the user clicks on a part or assembly a preview and summary of the component will be shown on the right side.

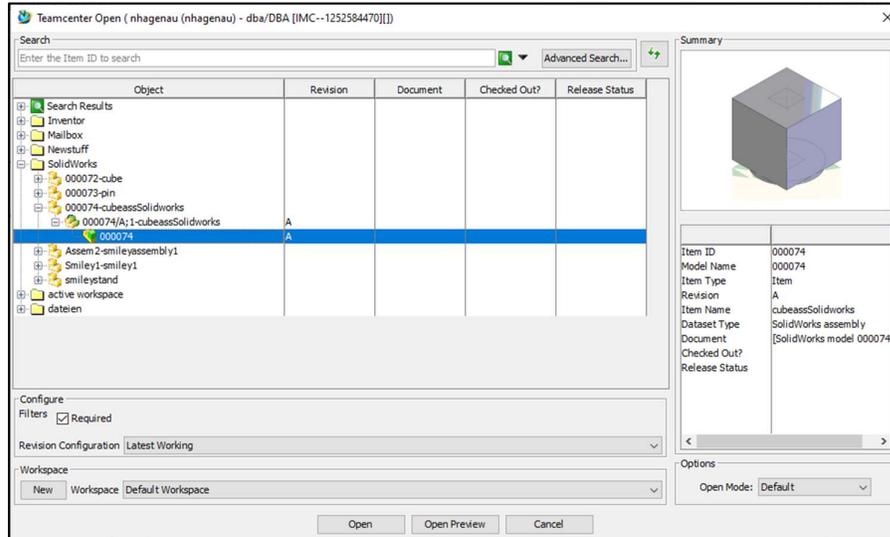


Figure 48. Teamcenter Open window

2.2. Open files not saved in Teamcenter

If the user wants to open a file which was not saved in the current workspace or in Teamcenter, it needs to be imported to Teamcenter first. This can be done with the *Import all SolidWorks files from a folder into the current workspace* () symbol marked in Figure 49. Then the Teamcenter Select Import Directory window will pop up (already open in Figure 49) and the user can choose the folder, which should be imported.

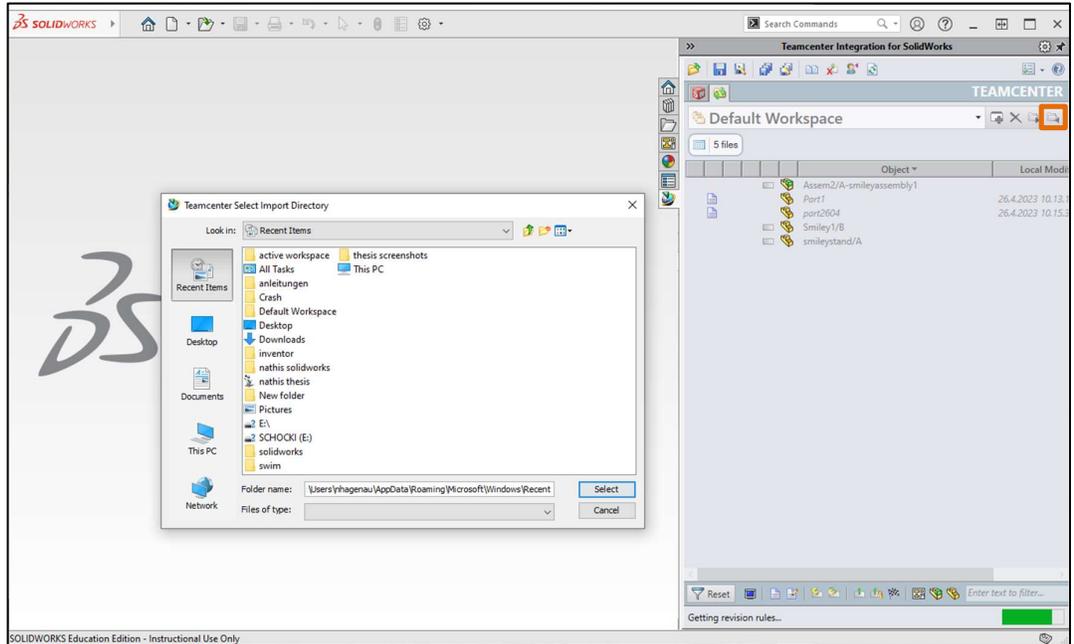


Figure 49. Import to current workspace

This can only be done while no file is opened in SolidWorks. Otherwise, the Alert shown in Figure 10 will appear and the user has to close the part before importing a folder.

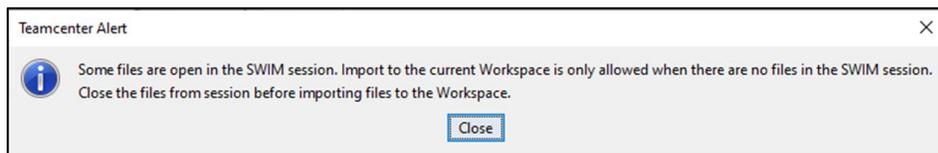


Figure 50. Teamcenter open files Alert

Complementary to this, if a user wants to export files from the current workspace to a folder this can be done with the Copy all SolidWorks files from the current workspace to a folder symbol (📁) next to the import symbol.

2.3. Make/save new part

If the user started working on a file, which was saved locally before logging in to Teamcenter, it needs to be imported to the current workspace before it can be saved to Teamcenter. How to do this is explained in chapter 2.2. If the user was logged in before making the new part Teamcenter will ask you if you want to manage the new file in Teamcenter with the window shown in Figure 51 and the user can decide.

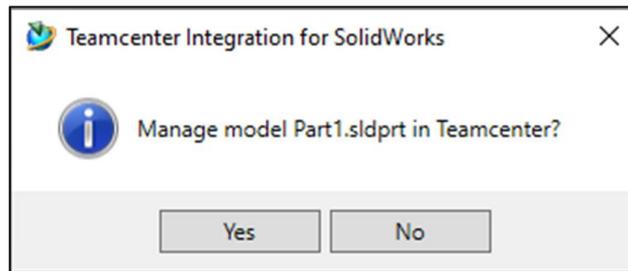


Figure 51. Manage file in Teamcenter?

If the user clicks *Yes* Teamcenter New Window will open, where the user can manage the Required Properties, the Optional Properties of the file and can select the folder in Teamcenter where it should be saved, as shown in Figure 52. After checking and filling out all information the user clicks *Create*.

The screenshot shows the 'Teamcenter New' dialog box. It is divided into three main sections: 'Required Properties', 'Optional Properties', and 'Folder Selection'.
- **Required Properties:** Contains fields for 'Item Type' (set to 'Item'), 'Item ID' (set to 'Part1' with a 'New' button), 'Item Revision' (set to 'A'), and 'Item Name' (set to 'Part1').
- **Optional Properties:** Includes tabs for 'Item', 'Item Master', 'ItemRevision', 'ItemRevision Master', and 'Dataset'. The 'Description' field contains 'From SolidWorks' and the 'Unit of Measure' is a dropdown menu.
- **Folder Selection:** Shows the 'Workspace' as 'Default Workspace' and the 'Teamcenter Folder' as 'Teamcenter\Home\Newstuff' with a 'Browse...' button.
At the bottom, there are 'Create' and 'Cancel' buttons.

Figure 52. Teamcenter New window

The Item ID can be auto generated by clicking *New* button next to it to generate the lowest possible ID which is not taken in Teamcenter yet. In the new Item ID is shown.

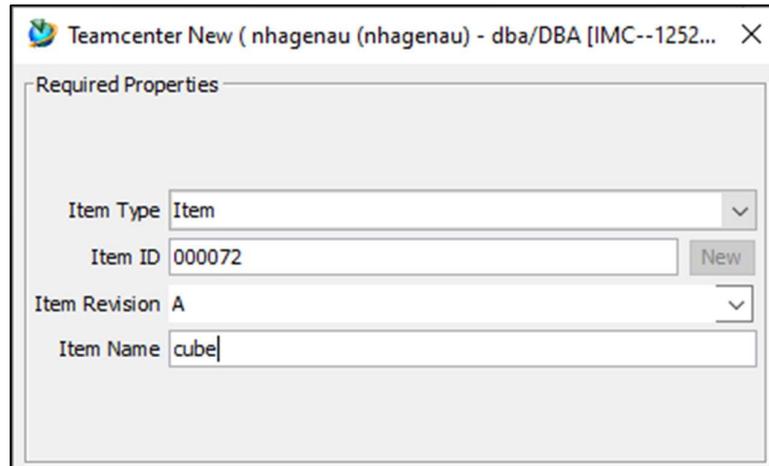


Figure 53. Item ID auto generated

2.4. Place parts in assembly

There are several possibilities to place a part in an Assembly. If the parts are open, the user can select them directly in the PropertyManager task pane on the left side, marked in Figure 54.

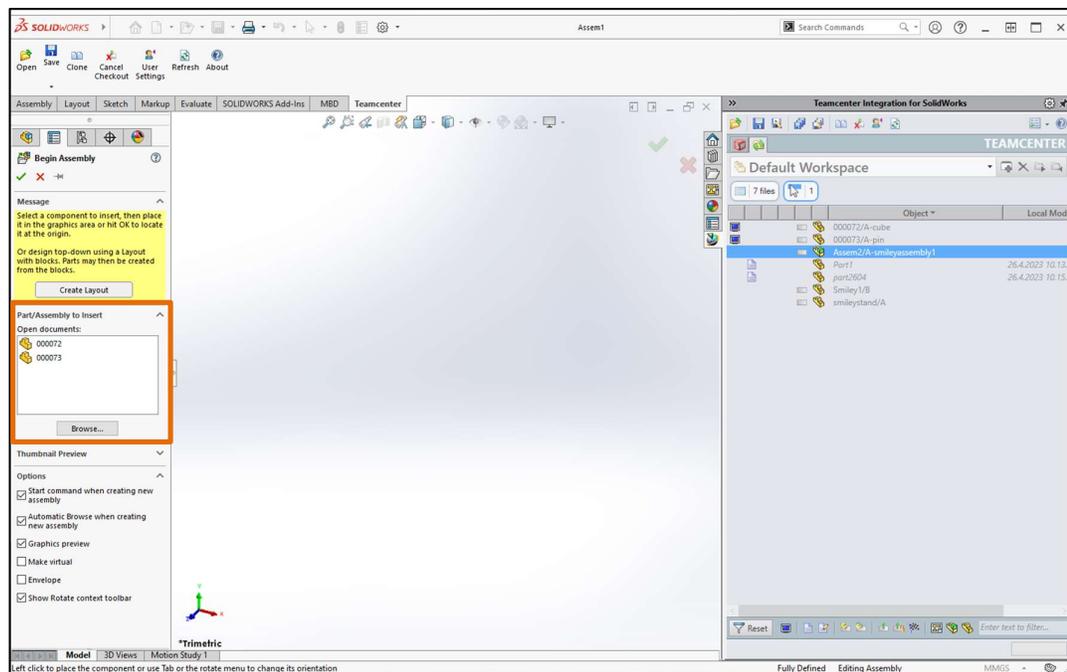


Figure 54. place parts from PropertyManager

Or if you want to open part from the current workspace the user can click on Browse and the storage location of the Default Workspace will open where parts can be chosen, as shown in Figure 55.

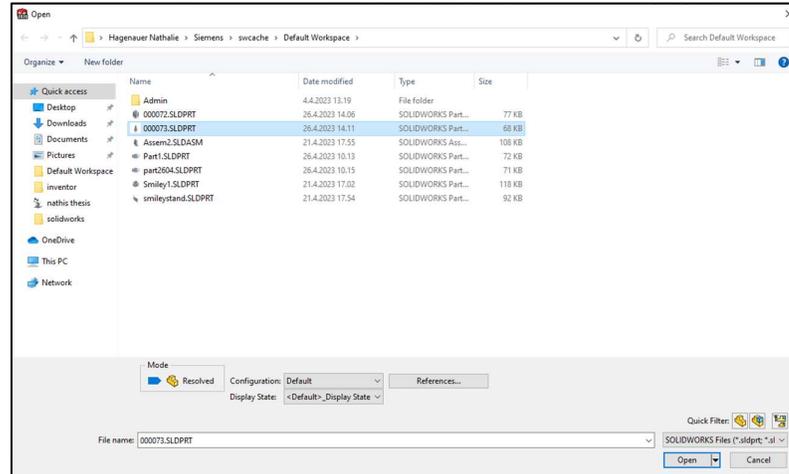


Figure 55. Place part from Default Workspace

Another way to place parts in an assembly is by drag and dropping them out of the Teamcenter task pane into the assembly, shown in Figure 56.

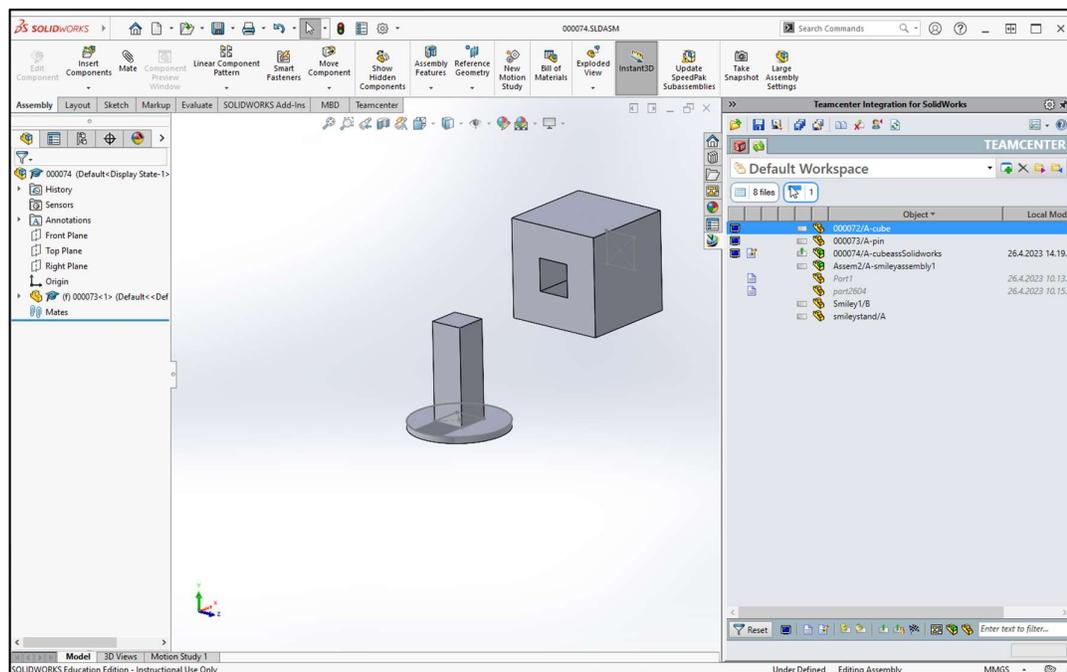


Figure 56. Drag and drop part in assembly

if the user wants to place a part which is not saved in Teamcenter, the user needs to import the part first in the default workspace before being able to place it in the assembly. The warning shown in Figure 57 will appear if the part is not imported to the current workspace.

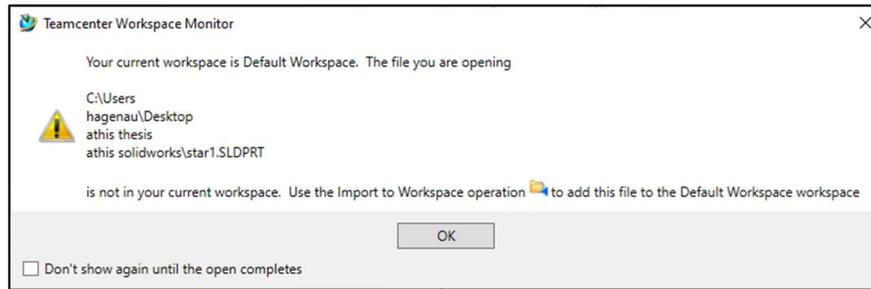


Figure 57. Part not in the Default Workspace warning

3. Save Files

Once the part, assembly, etc. the user is working on is part of the default Workspace or Teamcenter it can be saved by using one of the in fi marked symbols either in the Teamcenter task pane or in the Teamcenter menu in the ribbon bar.

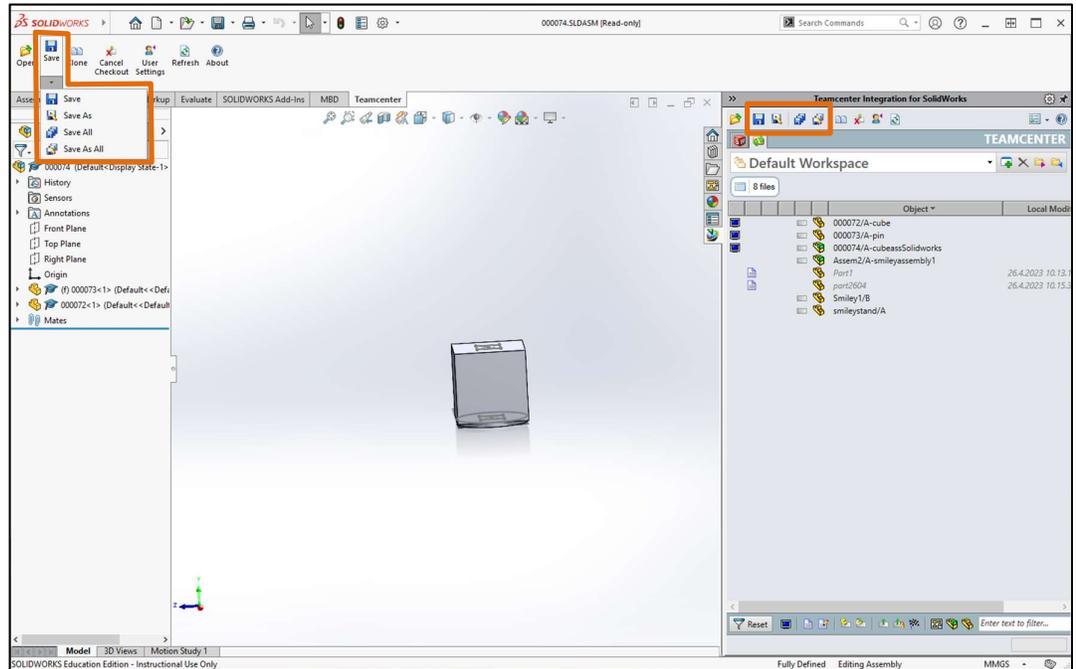


Figure 58. Save options

4. Frequent Error

When the user creates a new model, the Teamcenter Alert in Figure 13 may show up. It says the creation failed because an input was not recognized as a valid DateTime. This error is caused by the Teamcenter when it cannot read the Time format of the computer.

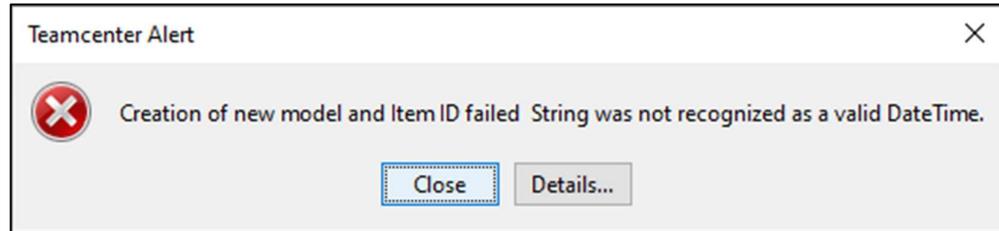


Figure 59. Teamcenter Alert invalid DateTime

To solve the problem, the time format must be changed in German, Spanish (Mexican) or Russian. The time format can be changed in the Computer Settings in the menu *Time and Language* → *Date, time & regional formatting*. In here the Current format can be chosen out of a drop down list. After changing the format SolidWorks needs to be closed and opened again. This not only changes the time format, and language in the date of the computer, but also the language in SolidWorks to the chosen language. So after a component was saved, the time format can be changed back to the desired time format and language and restart SolidWorks to acknowledge the changes and it works normally again.

Appendix 3

Siemens Teamcenter Active Workspace



Nathalie Hagenauer

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1 LOG IN	73
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1. Log in

On a school computer following link can be used to open Active workspace:
<http://amktetc01:3000/>. The log in screen shown in Figure 60 will be loaded and the User Name and the Password can be filled in.

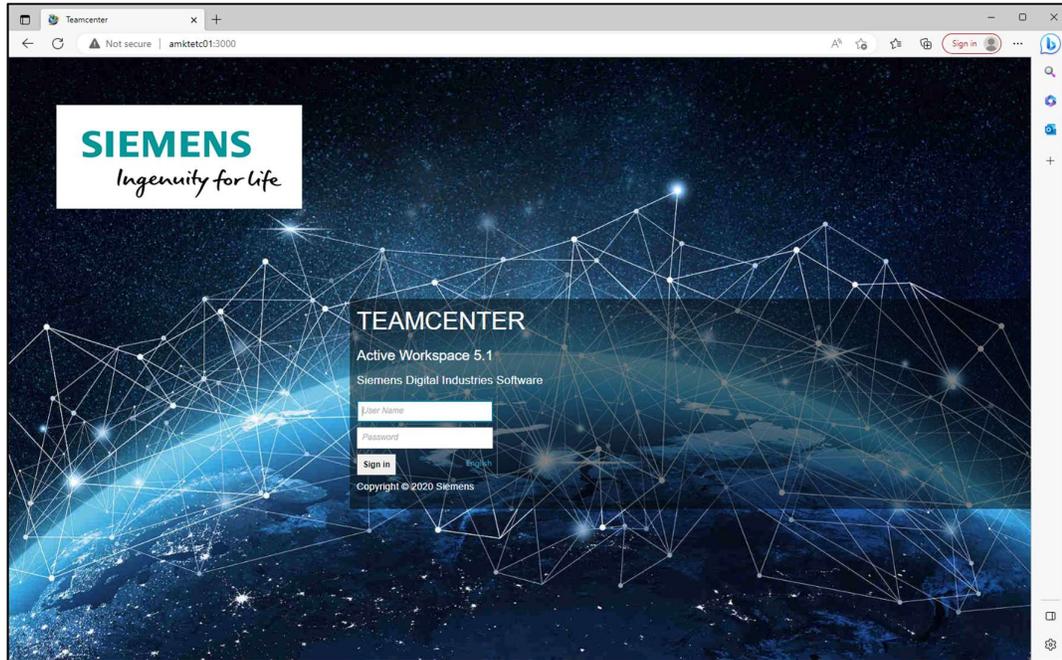


Figure 60. Active Workspace log in

2. User interface

In Figure 61 the user interface is shown. Number 1 marks the User settings interface, number 2 the navigation toolbar, number 3 is the work area and number 4 marks the search box.

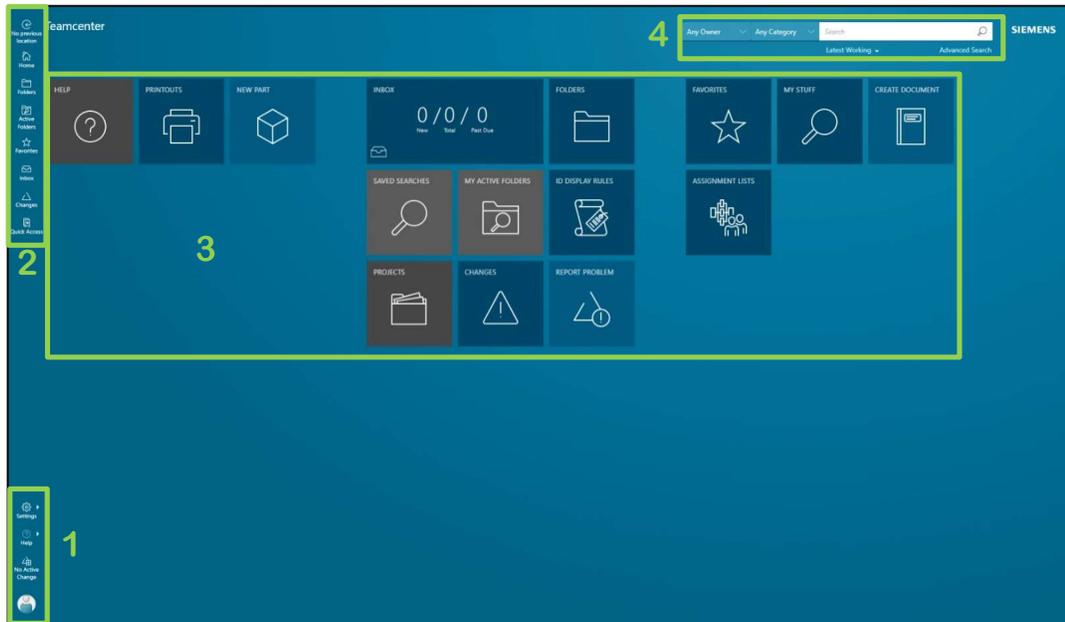


Figure 61. Active Workspace user interface

User settings interface

By clicking on the Profile button, as marked in Figure 62, the user can see her or his role and group and can view and edit the user profile or sign out.

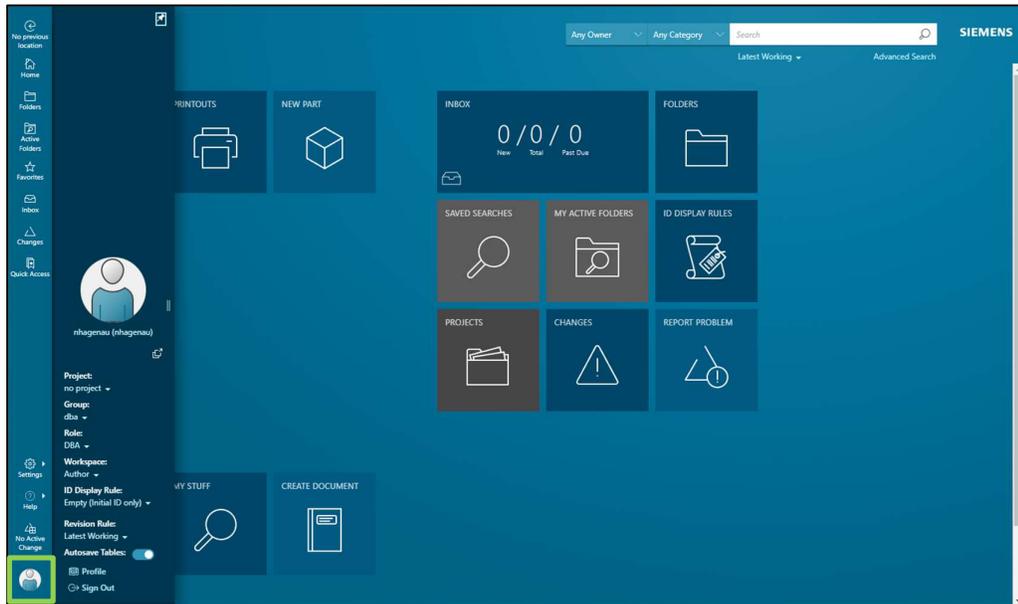


Figure 62. User Profile

Change Password

With the *Profile* command the user can access the profile settings. As marked in Figure 63 the password can be changed in *Manage* → *Change Password*.

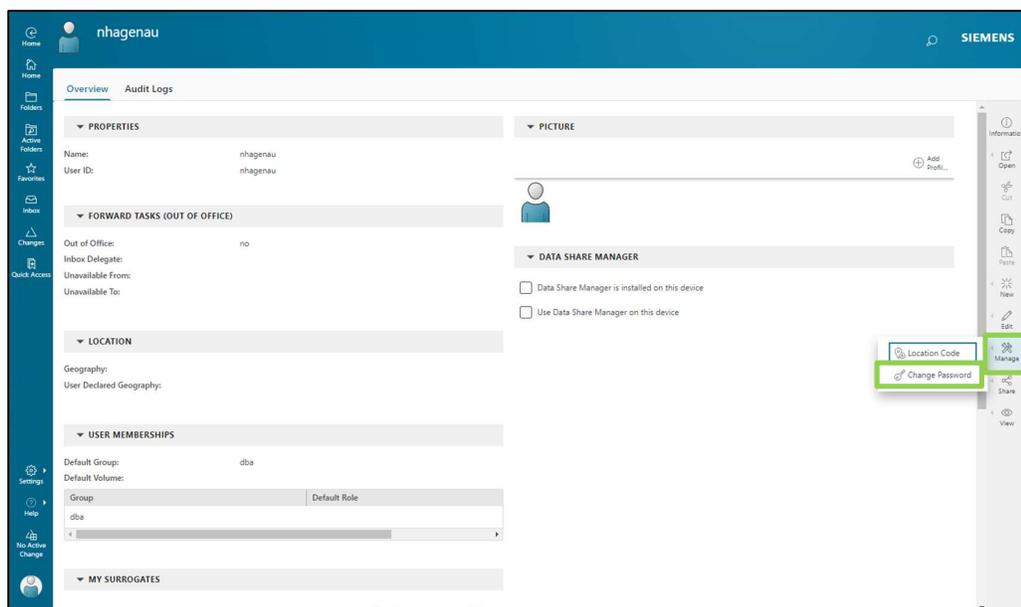


Figure 63. Change Password

Navigation toolbar

The Navigation toolbar helps to navigate quickly through the workspace. In Table 3 the different commands and their descriptions are listed.

Table 3. Navigation toolbar Symbols

Icon	Description
	Return to previous page.
 Home	Return to homepage.
 Folders	Open your home folder.
 Active Folders	View and manage your active folders.
 Favorites	View your favourites, recently opened objects, and projects where you are a member.
 Inbox	Access your inbox to view your tasks.
 Changes	View or manage all changes.
 Quick Access	Quickly access your recently viewed objects, clipboard, content, and favourites.

Search box

With the search box, the user can search for parts, documents or other files and filter the results. The search box is displayed in every workspace.

Right wall command bar

Once the user has opened an object or a folder the right wall command bar, marked in Figure 64 will appear. Here the user can edit, manage, copy, etc. the selected object or folder. The command bar will stay the same, but the individual commands of the separate main commands differ, depending on the object the user is working on.

The screenshot displays the Siemens PLM software interface for a specific item, 000063/B;1-cube2. The 'Where Used' tab is active, showing a table of items used in structures. The table has columns for Item, Type, Release Status, and Owner. The first row shows the item 000065/A;1-Cube2Assembly, which is an Item Revision owned by nhagenau (nhagenau).

Below the 'USED IN STRUCTURES' section, there are sections for 'CONTEXTS' and 'REFERENCES', each with a table of related objects. The 'REFERENCES' table has columns for Object, Type, Release Status, Date Released, and Owner. It lists three references: 000063-cube2 (Item), 000064/A;1 (Item Revision), and Td58AE3984uG68 (VisStructureContext), all owned by nhagenau (nhagenau).

A right-hand command bar is highlighted with a green box, containing icons for Information, Open, Copy, Paste, Edit, Manage, Share, and View.

Figure 64. Right wall command bar

3. File management

By clicking either on the Folder Symbol in the navigation toolbar or in the work area, as marked in Figure 65, the user can show all data he/she has access to.

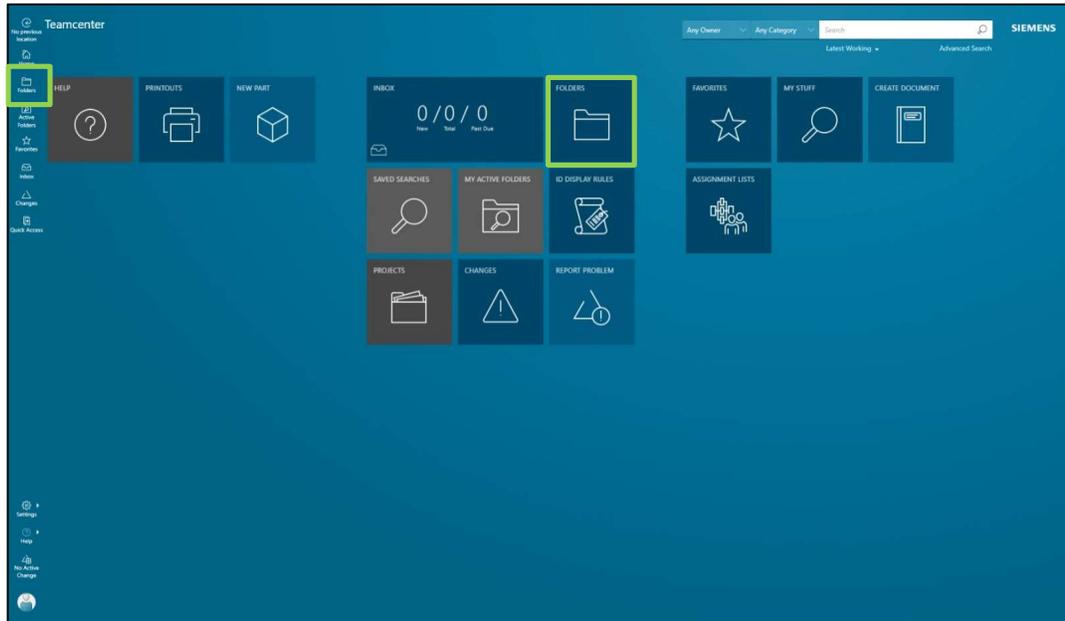


Figure 65. Opening Folder

In the Folders interface the folders are displayed on the left side (primary work area), and the information of the selected folder or file is presented on the right side (secondary work area). In Figure 66 the Inventor folder is selected and therefore all files saved in this folder are displayed in the secondary work area.

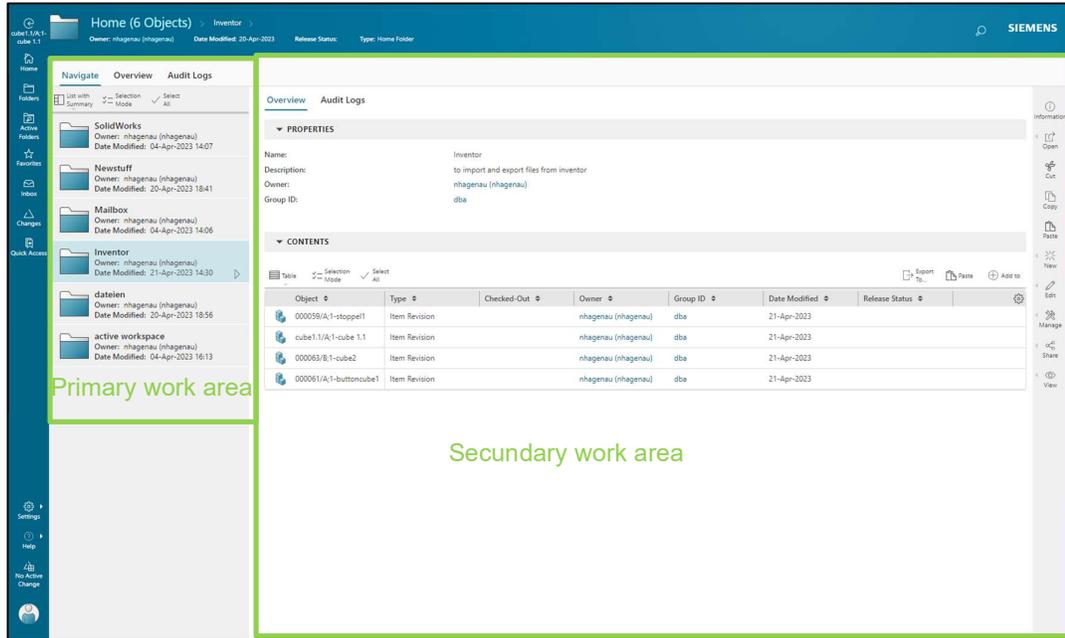


Figure 66. Folders Navigate

With the button marked in Figure 67 the listing of the content in the primary working area can be changed. In Figure 66 it was set to List with Summary, in Figure 67 to Tree with Summary, so that the content of the folders can be fold out and listed.

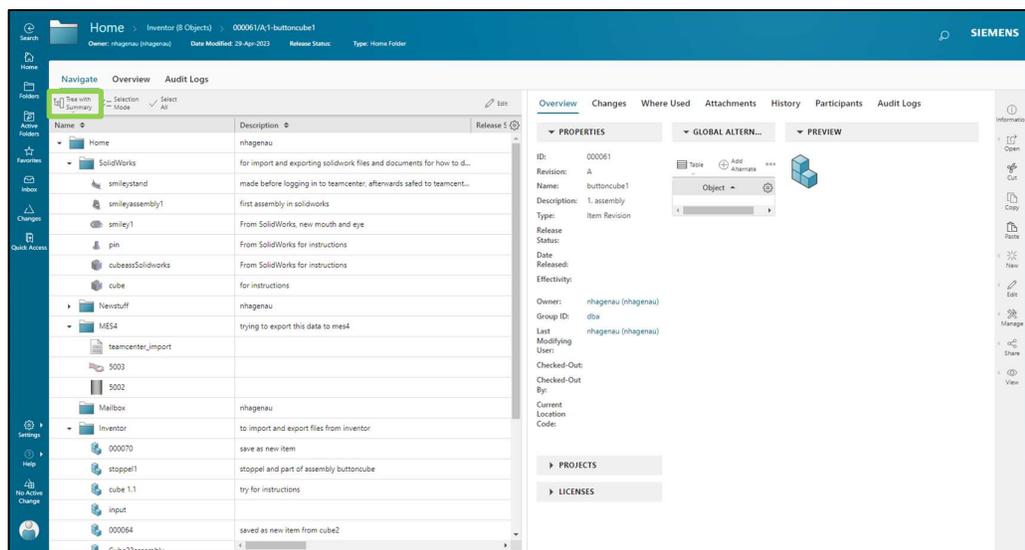


Figure 67. primary work area listing format change

By clicking twice on a file its information will be displayed in the secondary work area. In Figure 68 the Overview section of the selected part is shown, and the

secondary navigation tab is marked. With the help of this tab the user can display different information from the file.

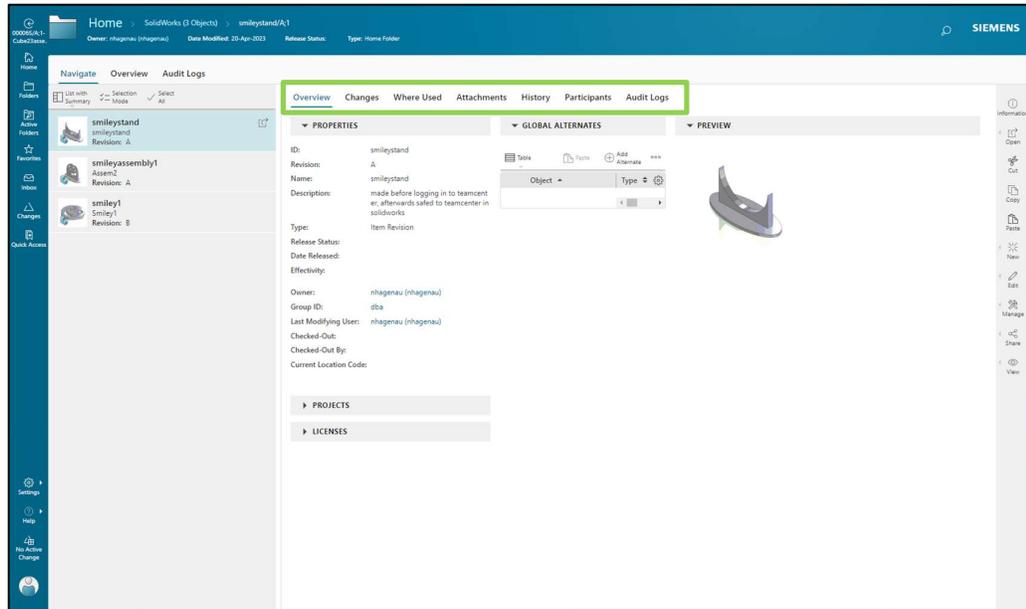


Figure 68. Part Overview

For example, in the *Where Used* section, all other files in which this part is used are listed, as shown in Figure 69.

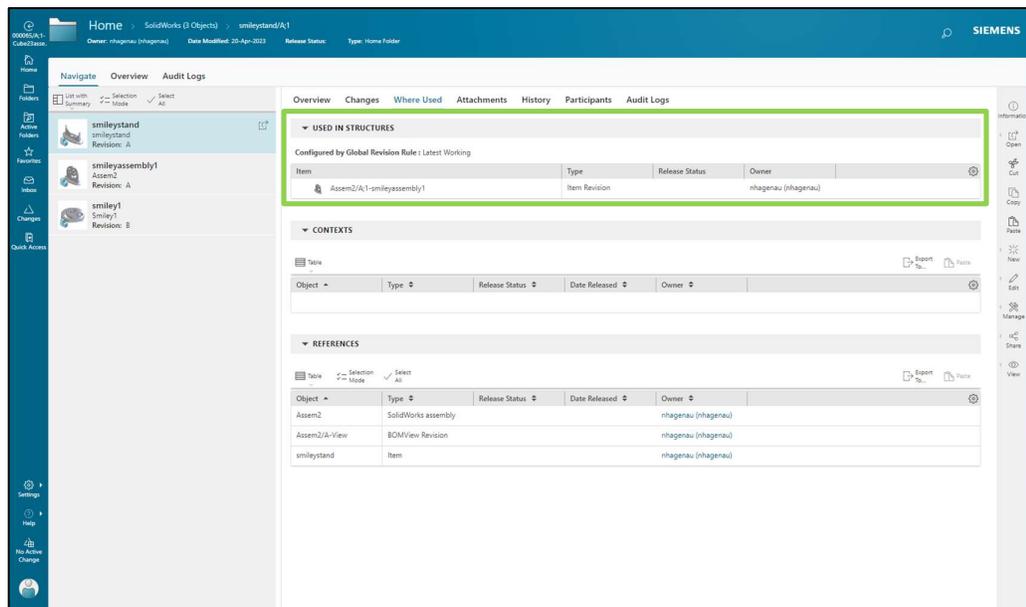


Figure 69. Part Where Used

In the *Attachment* section the part itself can be downloaded with the download symbol marked in Figure 70. This symbol appears when the user moves the mouse over the part.

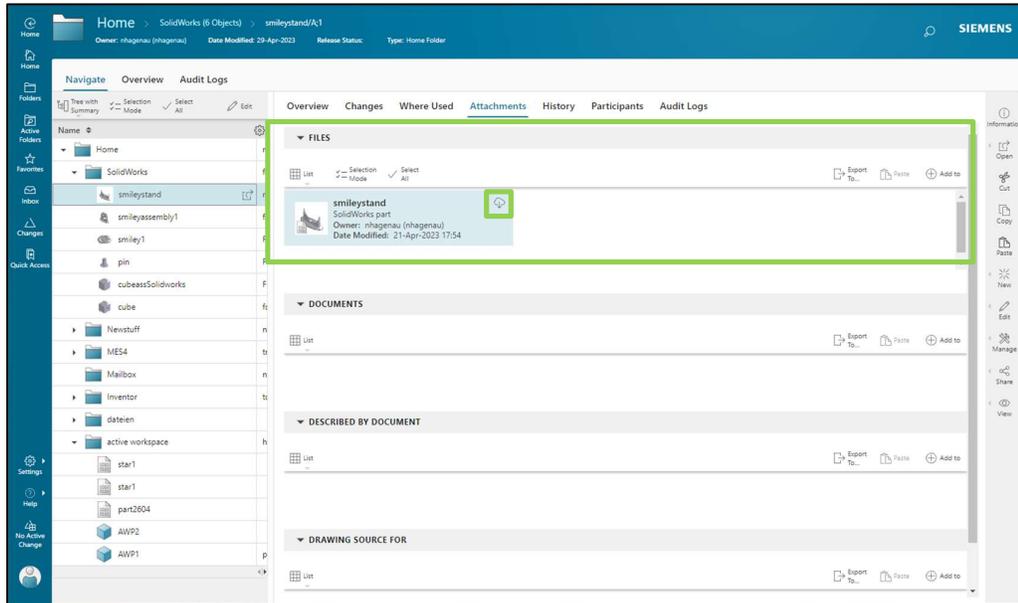


Figure 70. Part Attachments section

In the *History* section of the file, all revisions of the file are listed as marked in Figure 71. Here all versions can be downloaded separately.

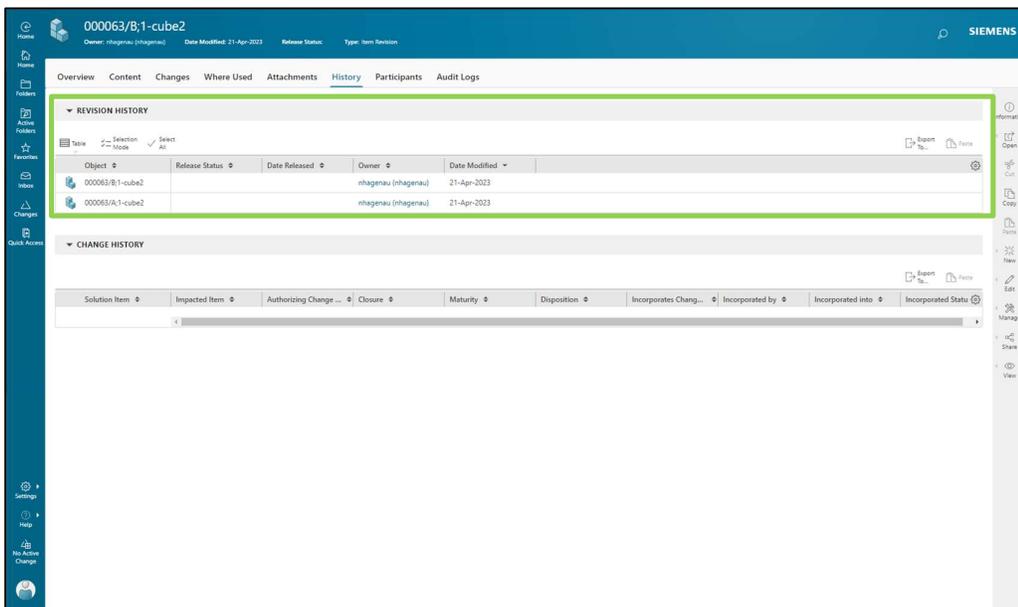


Figure 71. Part History section

Import files

As marked in Figure 72, by clicking on the new command in the Right wall command bar, a drop-down menu will appear, in which the *Add* command can be selected.

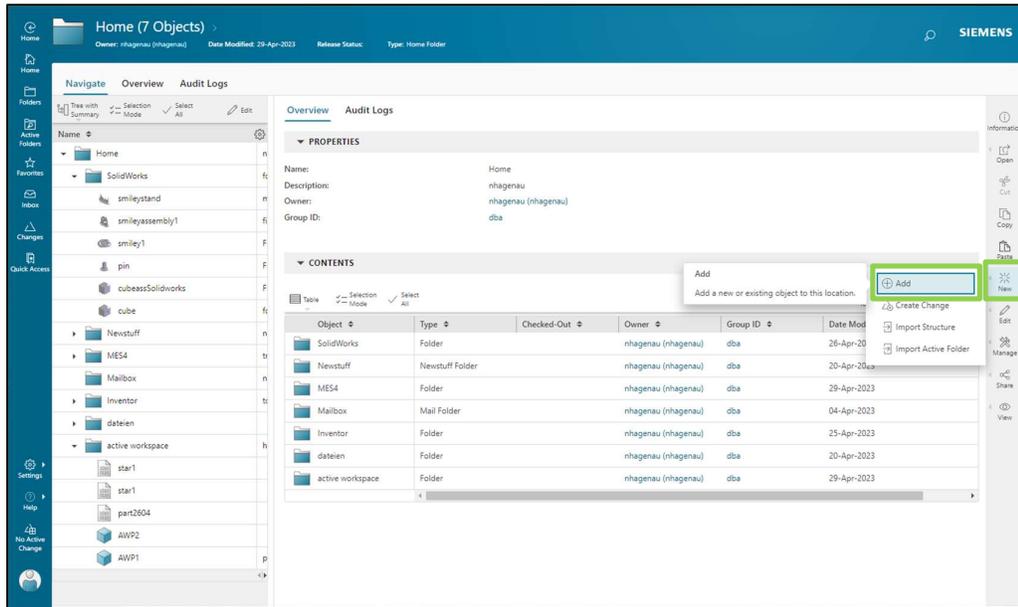


Figure 72. Add command

In the add command the user can choose what kind of object the user wants to create, as shown in Figure 73.

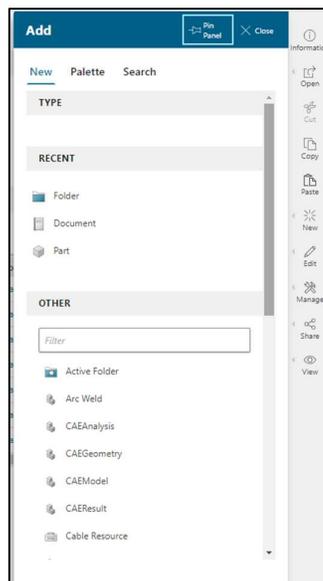


Figure 73. Add choose object type

To make a new folder the user selects Folder from the list shown in Figure 73. As shown in Figure 74. A Name must be assigned and a Description can be added. The folder will be saved in the folder where the user is currently located.

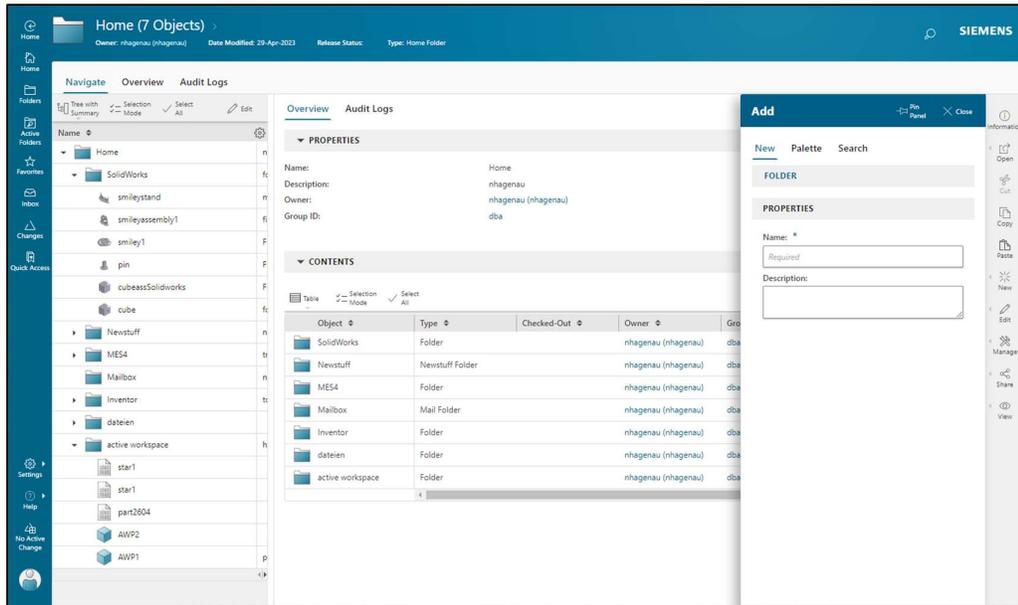


Figure 74. Add Folder

If the user wants to create a new file, he or she chooses the correct file type and with the *Choose file* button, as marked in Figure 75, or by drag and dropping, the user can add a file from the local drive.

The image shows a mobile application interface for adding a document. At the top, there is a blue header with the word "Add" and icons for "Pin Panel" and "Close". Below the header, there are three tabs: "New", "Palette", and "Search". The main content area is divided into several sections:

- DOCUMENT**: This section contains several input fields:
 - ID: ***: A text input field containing "000079".
 - Revision: ***: A text input field containing "A".
 - Name: ***: A text input field with a red asterisk and the word "Required" below it.
 - Description:**: A text input field.
 - Document Title:**: A text input field.
 - Document Author:**: A text input field.
 - Document Subject:**: A text input field.
 - Workflow:**: A dropdown menu.
- FILE ATTACHMENTS**: This section contains a "Drop here" label and a "Choose file" button, which is highlighted with a green box.
- OWNING PROJECT**: A section header.
- PROJECTS**: A section header.

At the bottom left, there is a small icon and the text "Add Project".

Figure 75. Add Document

Note: A new file can also be added by drag and dropping it directly into the desired folder.