CAD Forum 2024
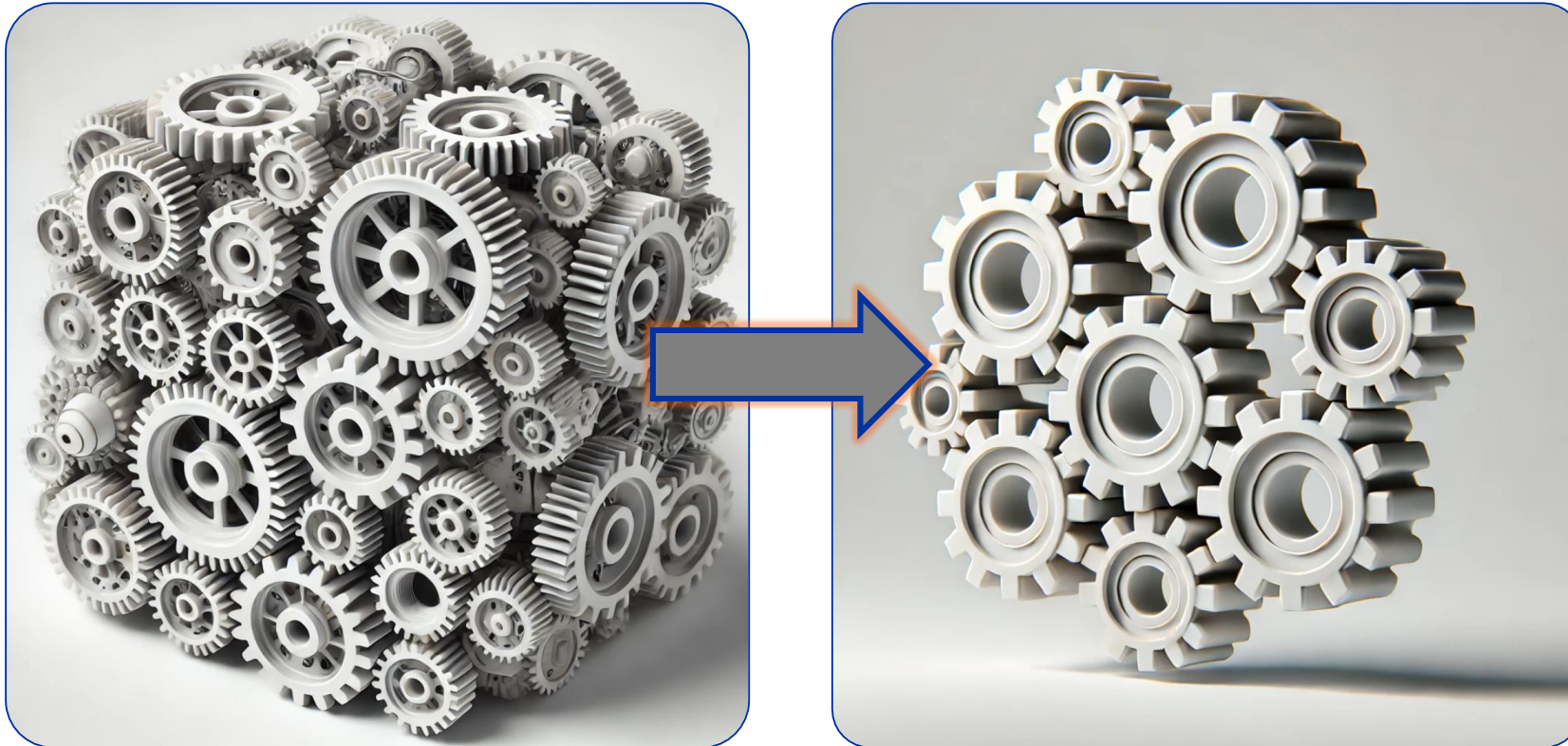## 24/10/2024
Simplification methods

GUCC working group #1

Anastasiya Magaznik, **Iliasse Derrag, Joao Oliveira, Karol Rapacz**, Scharif Mehanneche, Nicolas Chritin

Content

Introduction

Due to the ever-increasing complexity of CAD models, which require more and more processing power, the need to create lightweight, simplified models to maintain CAD software efficiency is becoming increasingly important.

To address these needs, our working group studied and documented simplification methods that can be applied to both new and existing files to improve software fluidity and save space.

This document may be useful not only for integration engineers but also for engineers collaborating with external laboratories or manufacturers, who require frequent CAD model exchanges and for engineers performing FEM simulations.

GUCC Working Group REPORT

Definition of the Methods for simplified 3D models generation from a CATIA V5 product/part

ABSTRACT:

The present document reports the results of the GUCC working group (WG#1) on the simplified model's generation from CATIA V5 products or parts. The document overviews the current methods and provides its comparison.

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EDMS document in the process of formal approval will be share soon

Introduction
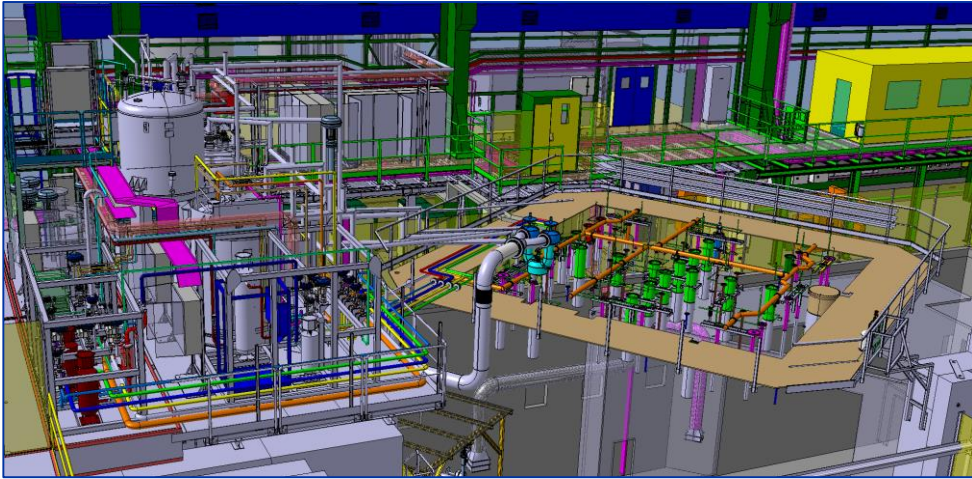
Constant increase of complexity in 3D models.
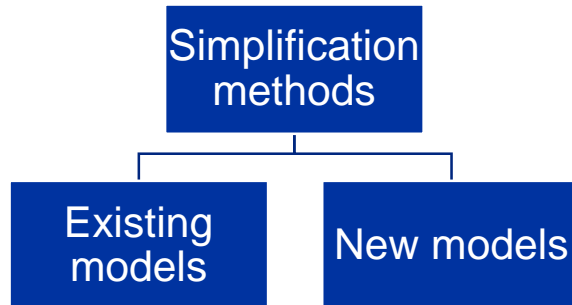
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Document useful for everyone – integration or not.

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Simplified Model

The main purpose of CAD model simplification is to create a lightweight yet sufficiently accurate representation of the original geometry that can be used for integration, file sharing, or FEM analysis. This means the aim is to reduce the file size yet keeping key features like mating interface, overall shape etc.

To simplify a CAD model, users must reduce the level of detail, using various techniques. This can be achieved by:

• Removing unnecessary submodels.
• Removing unnecessary model features (such as holes, chamfers, etc.).
• Removing complex constraints and unnecessary links between submodels.
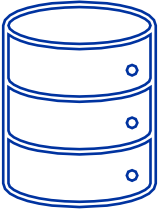• Replacing complex geometries with simple bodies.
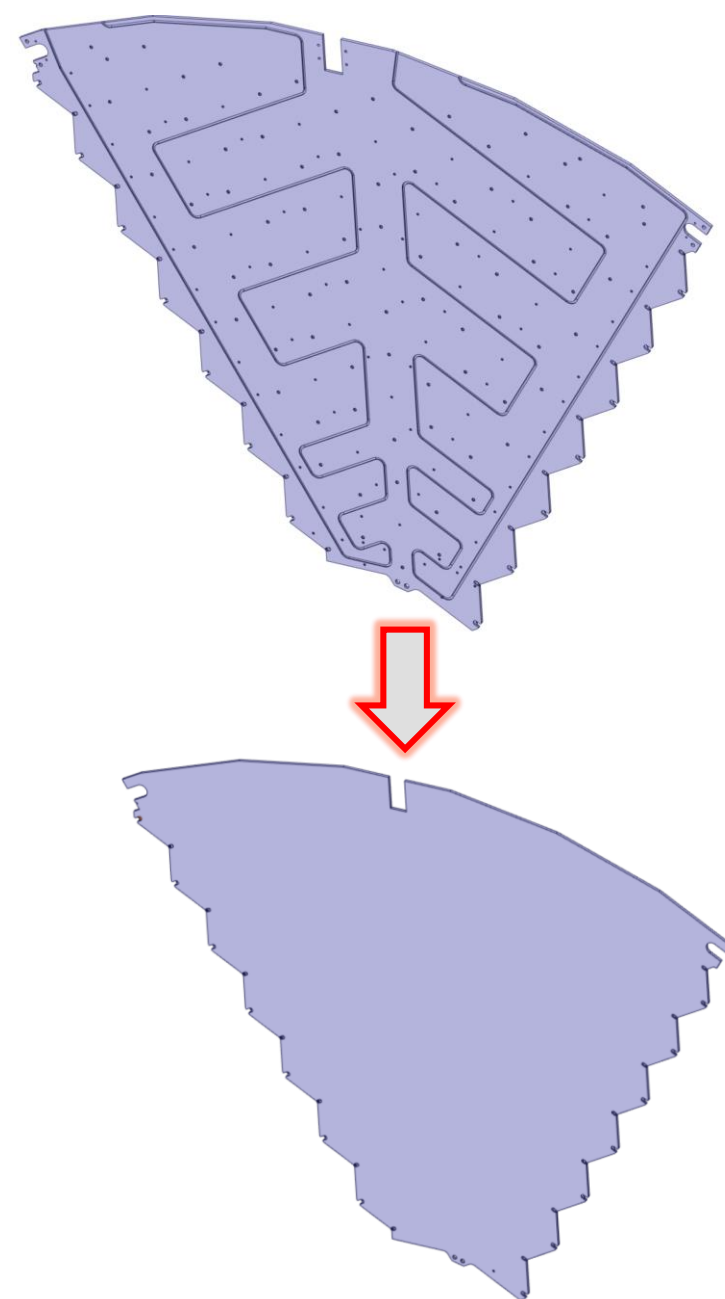
Simplified Model requirements

We define seven main requirements for the simplification of 3D CAD data:

1. Size – the size of the CAD model needs to be as small as possible.

2. Level of Details (LOD) – the required LOD depends on the equipment type and use and has to be defined be the main users.

3. Outer boundaries – for an accurate collision check, the envelope/outer shape of equipment should remain as the real geometry.

4. Interconnections – the interconnection relationships among equipment are of a great priority. It is necessary to consider ports, flanges etc as an important simplification factor.

5. Assembly constraints – it is essential that the simplified assembly has the Anchor attribution.

6. Naming or 3D CAD data in PDM/PLM – merging 3D CAD data between the detailed and the simplified model with nongeometric data is required in order to keep the track in the PLM/PDM system.

7. Reference systems – the equipment simplified model shall be repositioned according to the final use of the simplified 3D model.

Simplified Model requirements

Low file size

1

Level of Detail
Defined by users

2

Outer boundaries
Used for clash detection

3
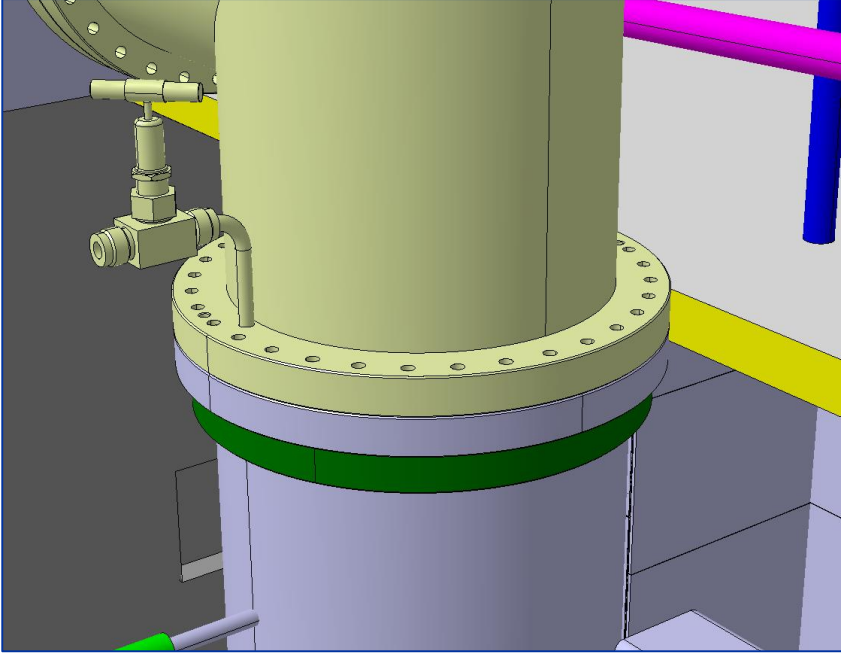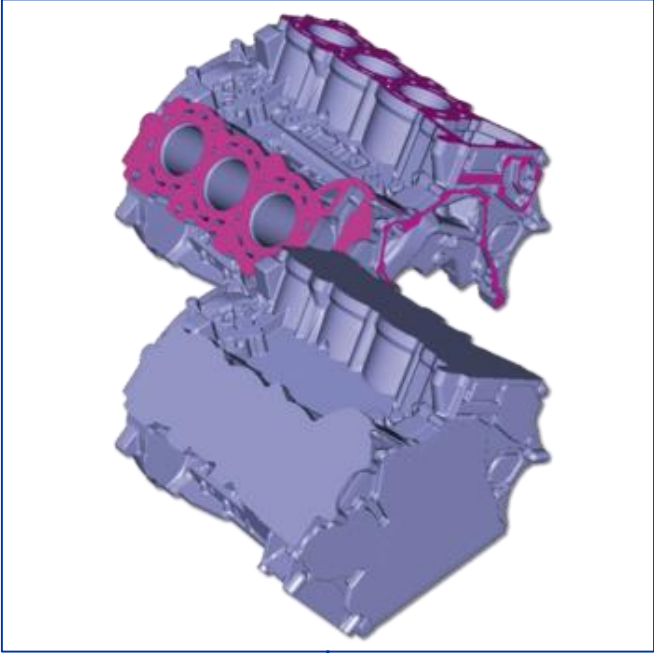
Priority simplification to interconnections
Ports, flanges...

4

Anchor constraints
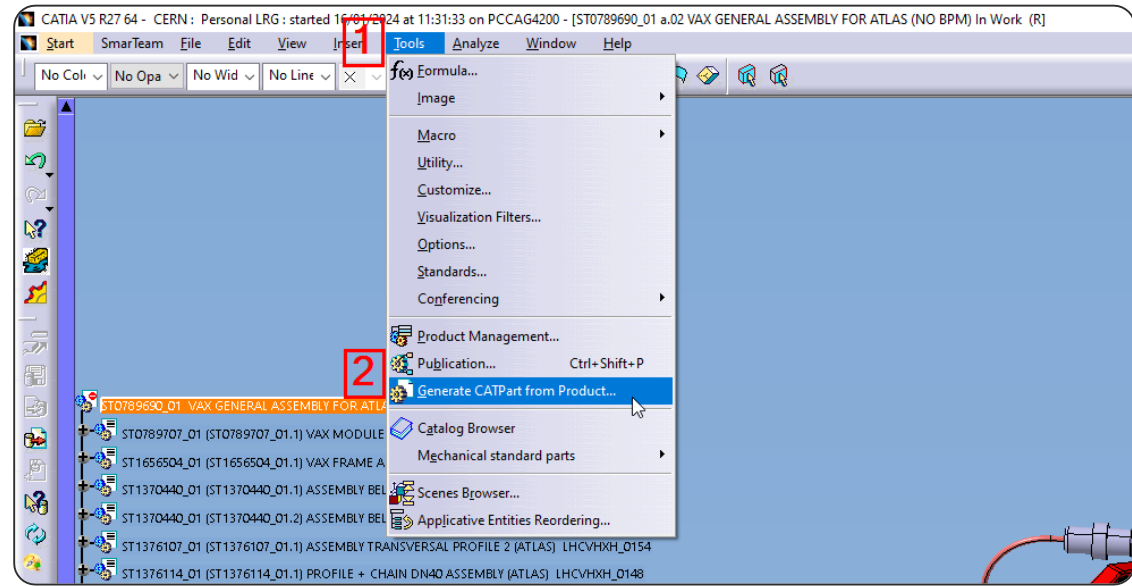*On all simplified assemblies*

5

PLM

Naming of 3D data
During merging

6

CATIA V5

1. Generate CATpart from Product

Quick and easy, yet very crude and doesn't work very well when applied to very complex assemblies.

Example use case:
Quick way to generate relatively lightweight files from small and medium assemblies for integration purposes, or to manufacturers to provide more details.
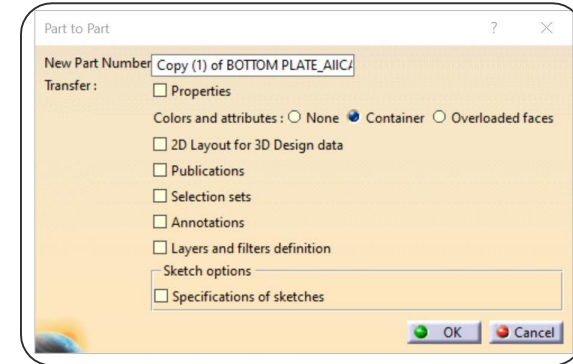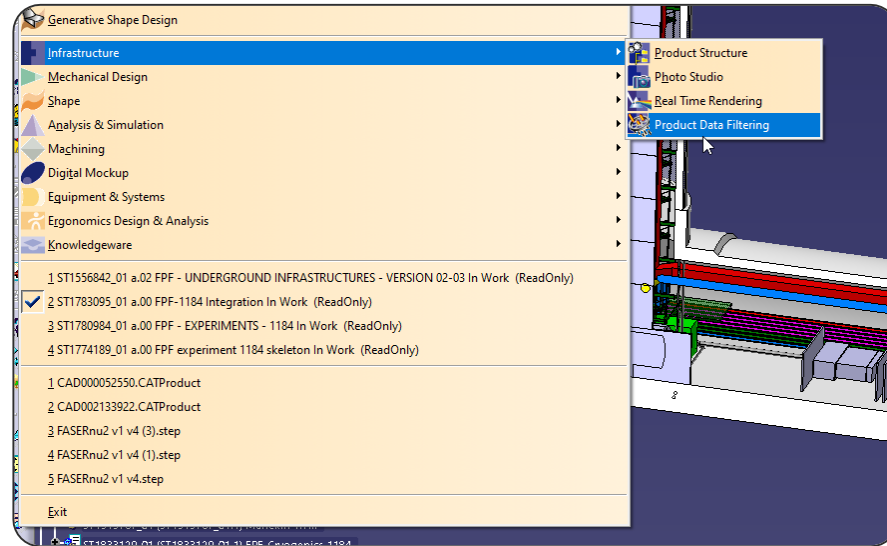

2. Generate 'Dead bodies' from Part or product

Similar to method #1 yet allows to have more control on what is to be kept in simplified model (properties, annotations etc.). Also allows to maintain tree structure in case of assemblies.
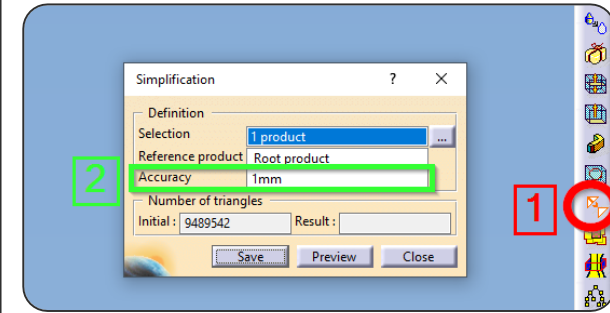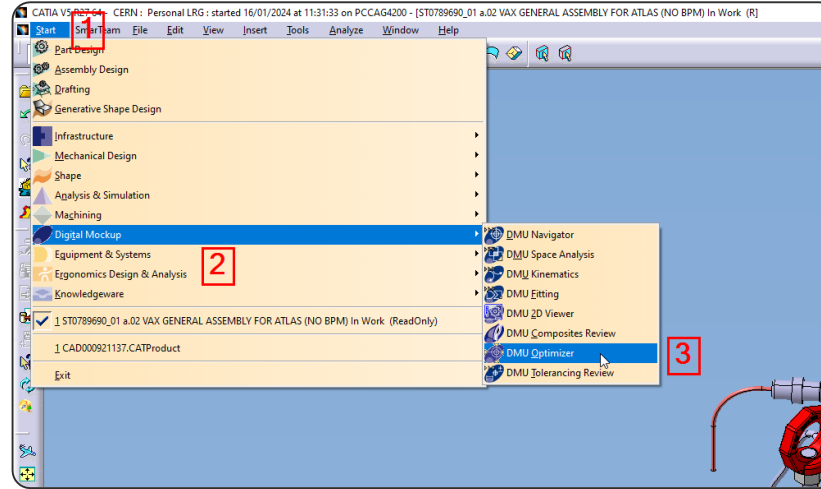
Example use case:
Similar as for method #1.

CATIA V5

3. Generate CGR

Extracts vertexes to create meshed representation of original CAD model. Can be applied to very big assemblies and generates very lightweight models, yet might too much inaccurate for many cases and doesn't allow to be used in generating 2D drawings

Example use case:
Big civil engineering projects in which super fine accuracy is not required.
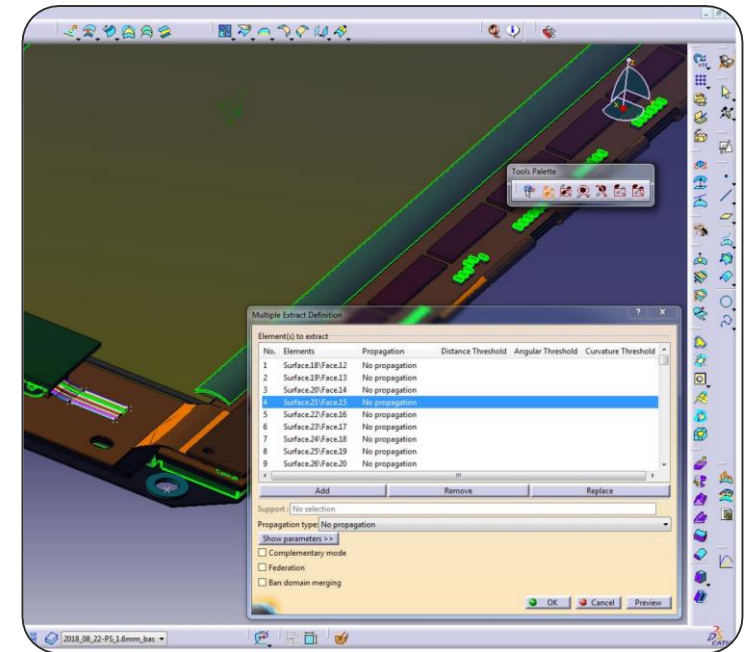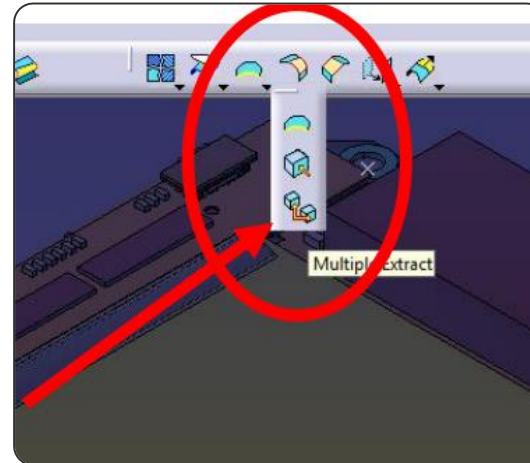

4. Extracting surfaces

Generates representation of solid bodies in form of surfaces. Requires good CATIA skills, but can provide very good results for complex assemblies consisting of repeatable objects.

Example use case:
Equipment that consists of many the same repeatable objects (e.g. detectors)

CATIA V5

5. Parameter model approach

Instead of simplifying models in the late design process this method encourages user to start with simple model that serves as core design to develop more complex assemblies. Requires solid CATIA skills and good understanding of the project interfaces and boundary conditions.

Example use case:
Equipment with well defined envelopes (e.g. detectors going through upgrades)
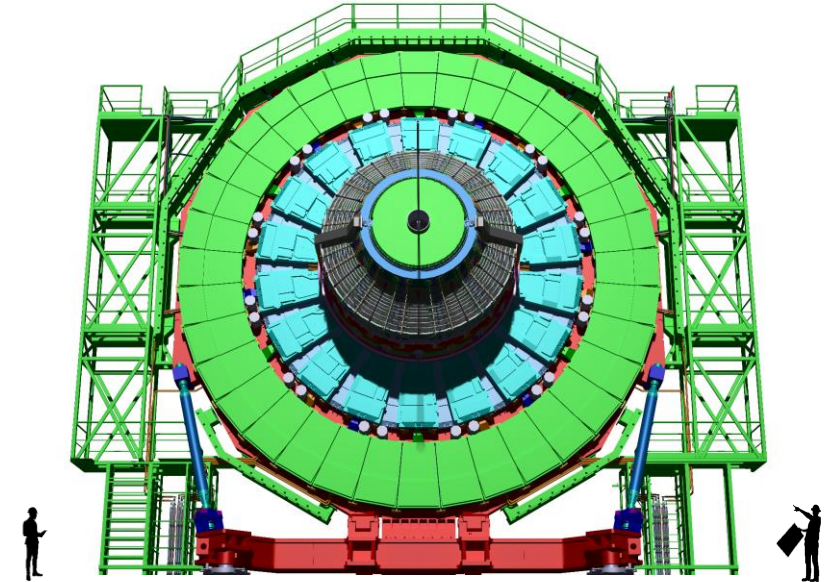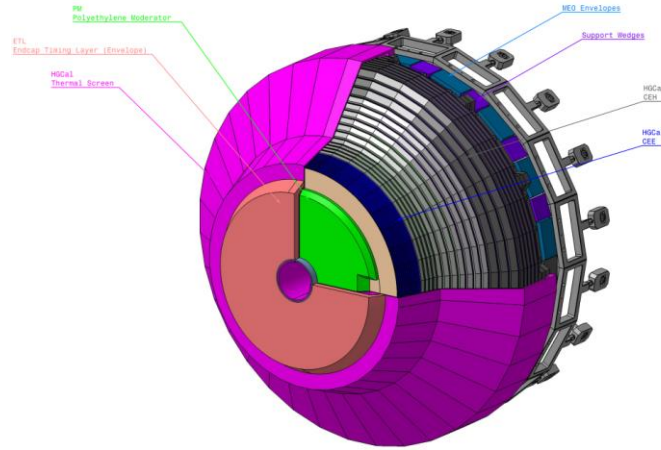
6. CATIA manual and automatic defeaturing methods

Using built in tools to manually or automatically suppress selected features. Allows for the fine tuning of the resulting model yet it is usually very time consuming and can produce some errors.

Example use case:
Well structured and moderately complex part and assemblies
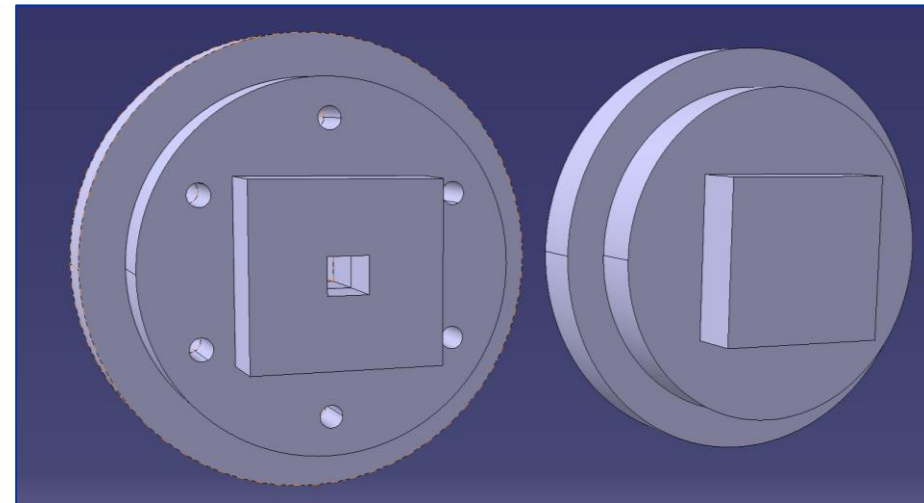
ANSYS Space Claim

7. Ansys included CAD software, which allows for efficient CAD models simplification:

- No additional license required (Spaceclaim already included inside the workbench)
- Dedicated simplification tools built-in
- Can read CATIA native files
- Removes original operations (like for .stp files export)
- Struggles with very heavy assemblies

Example use case:
Simplifying small and medium parts and assemblies, especially the ones that contain repeatable features like the same type of holes, extrusions etc.
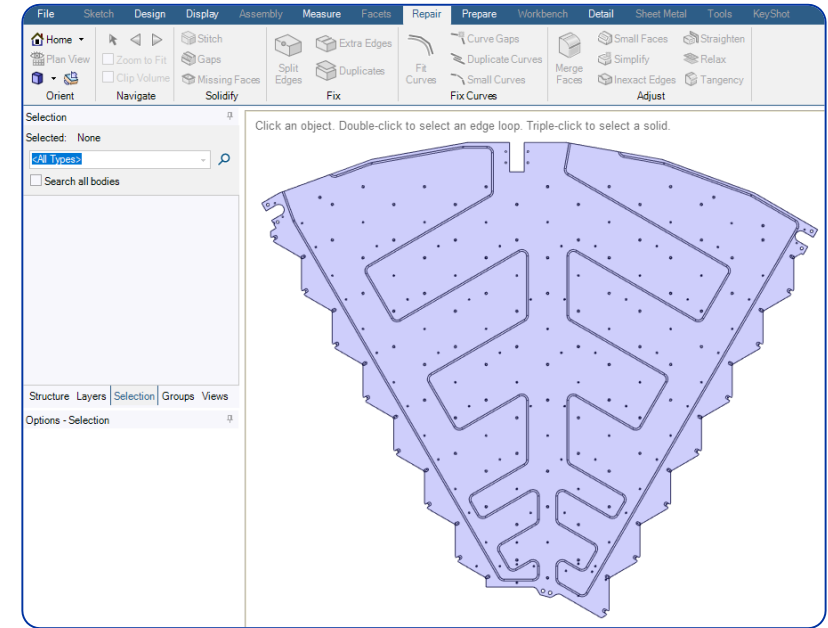
3D Evolution

8. Dedicated simplification software that requires additional licence:

- Can work with very large assemblies
- Includes variety of tools that allow for efficient simplification process
- Requires good software knowledge (training)
- Removes original operations (like for .stp files export), but can retain assembly structures

Example use case:
Complex and heavy assemblies that require fine tuned end results.
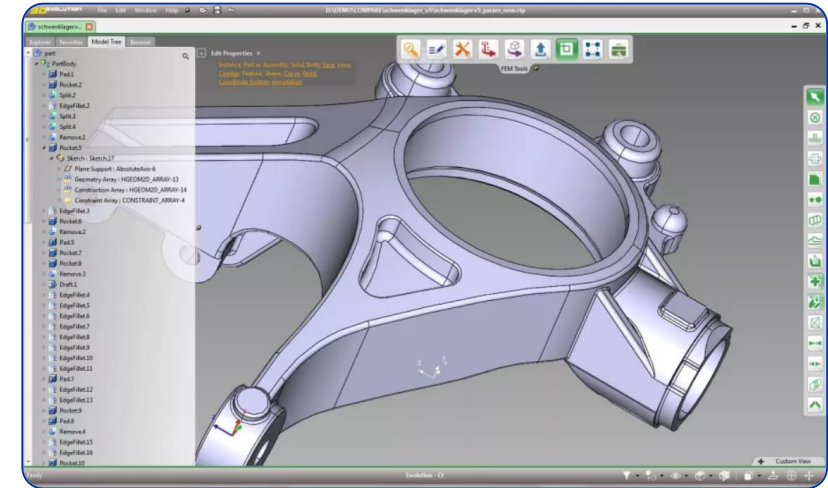
Benchmarking

Due to the variety of simplification methods, some benchmarking efforts were made to evaluate each method. (1 to 3 points for each benchmark parameter, the higher the better)

- Skills required for utilization of the software

- Additional license: Is the additional license already available at CERN, or does it need to be purchased?

- Time in terms of the getting a simplification done

- Training: 1 if training is required, 2 if some training is required, or 3 if no additional training is required.

- 2D generation: possibility to create accurate 2D drawings from simplified models .

- Simplification: result scored according to the quality of features of the final simplified model.

- File size scored according to the result.

Benchmarking

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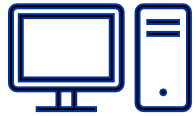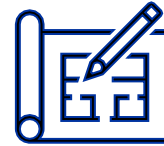
Skills   Licenses   Time   Training   2D drawings   Simplification   File size

Results

Method	Skills required	Additional License	Time	Training	2D generation	Simplification Result	File size	Total Score
CATIA CGR	3	3	3	3	1	1	2	16
CATIA AllCATPart	3	3	2	3	3	1	1	16
CATIA Publication	2	3	2	2	3	2	2	16
CATIA Extract surface	2	3	1	2	3	3	3	17
CATIA Manual	2	3	1	2	3	2	2	15
3D evolution	1	1	3	1	3	3	3	15
ANSYS Space Claim	1	1	2	1	3	3	3	14
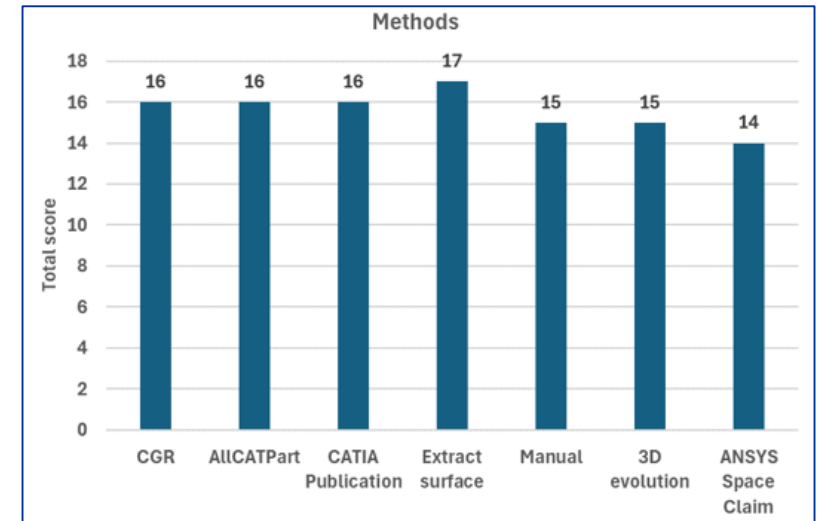
Conclusions

There is no single "perfect" method for simplifying CAD models that can be universally applied to all cases.

The appropriate simplification approach depends on various factors, including:

- Level of output detail: Determining the right balance between simplification and maintaining necessary details.
- Final file size: Managing file size to ensure efficiency without compromising quality.
- Output format: Choosing formats that align with your specific needs and toolsets.
- Workflow requirements: Considering whether the model is for internal use, collaboration, or sharing across teams.
- PLM integration: Ensuring the simplified model fits within the Product Lifecycle Management (PLM) environment.
- Addressing PLM Integration

The integration of simplified models into PLM systems remains an area that needs further development. With the planned transition to a new PLM client, we have a unique opportunity to embed simplified models into our workflows from the outset.
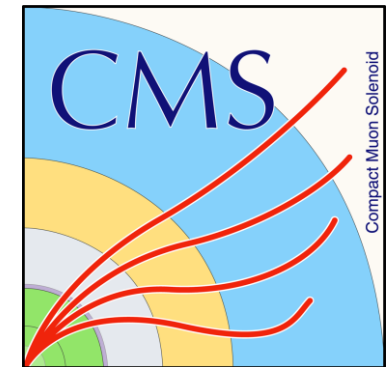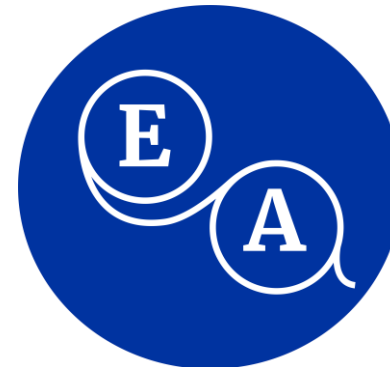
For more complex cases, we propose designating and training few 3D Evolution experts. These specialists could support the most demanding model simplification processes, ensuring quality and efficiency across the organization.

Demonstration
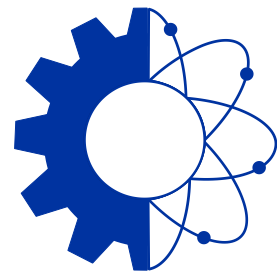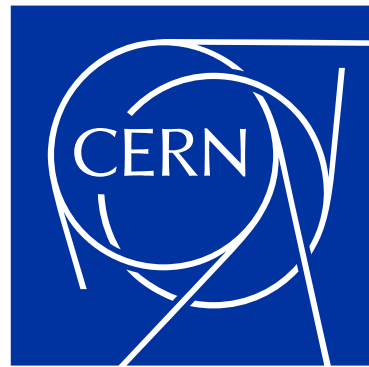
A special thanks to Nicolas Chritin, Anastasiya Magazinik, Scharif Mehanneche

and everyone that contributed to this presentation.

"If I have seen further, it is by standing on the shoulders of Giants."
From a letter to Robert Hooke in 1675, Sir Isaac Newton PRS.

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