The Secret Life of Geometric Modeling in the Digital Thread: *PMI & PDQ & Features, Oh My!*

2024 MBE Summit
16 April 2024

Ben Urick
co-founder, ***n***Variate
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Outline

- Background
- Current MBD issues

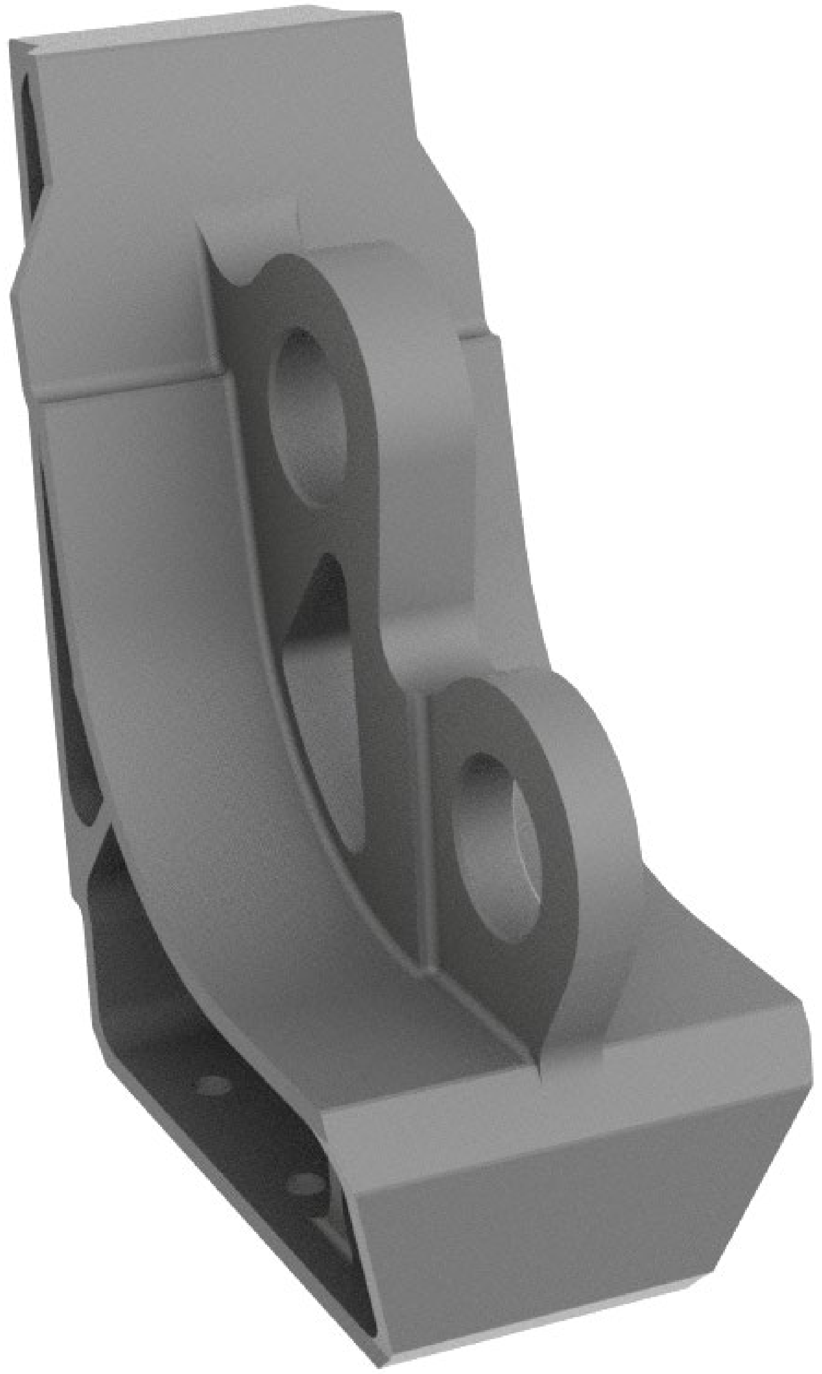
Background

- 10+ years in industry in **structural mechanics** and **analysis**
- frustrated **user** → **researcher** (*focus Isogeometric Analysis*)

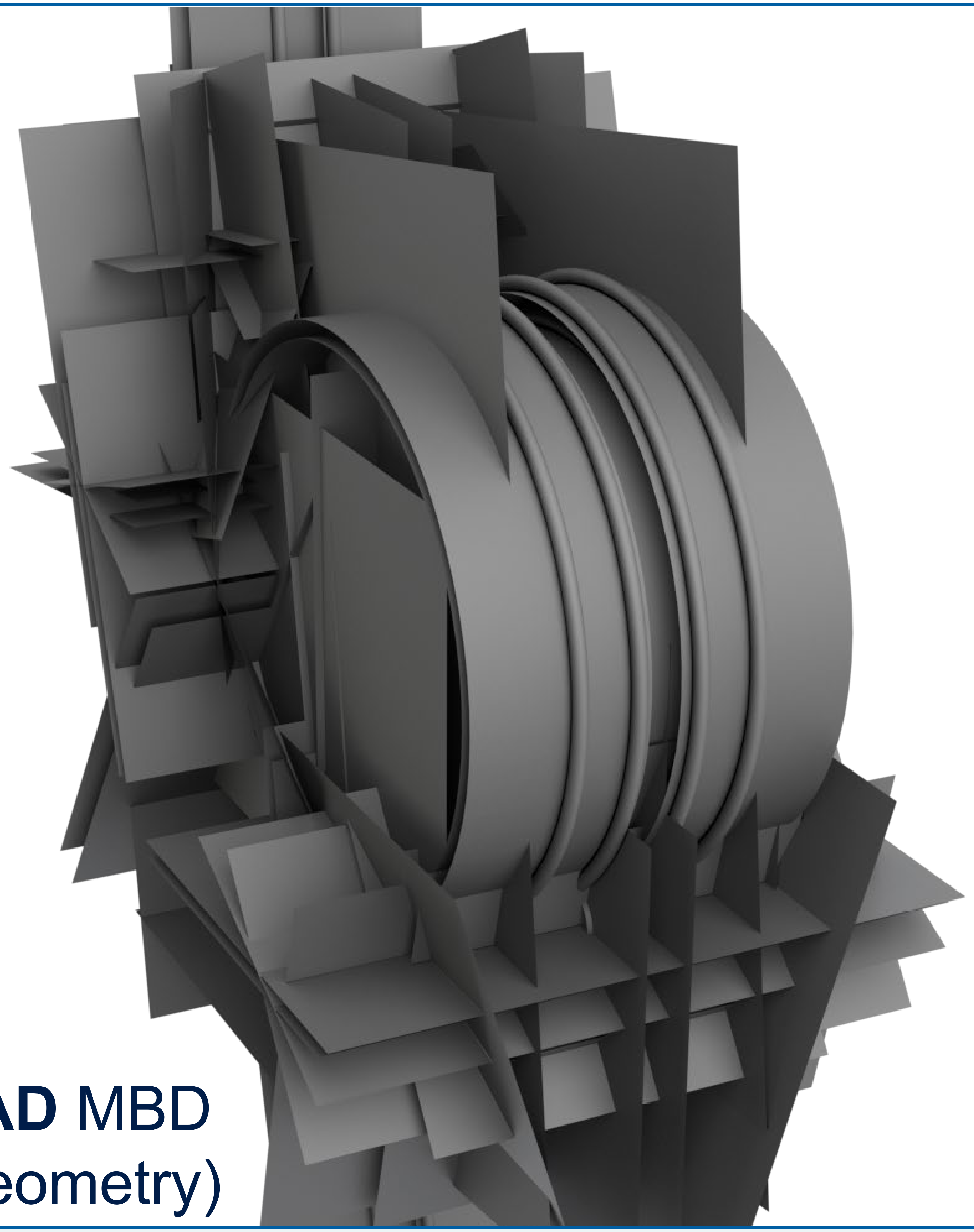
  researcher → **inventor**

  inventor → **developer**
- co-founder and president of ***n***Variate Inc.

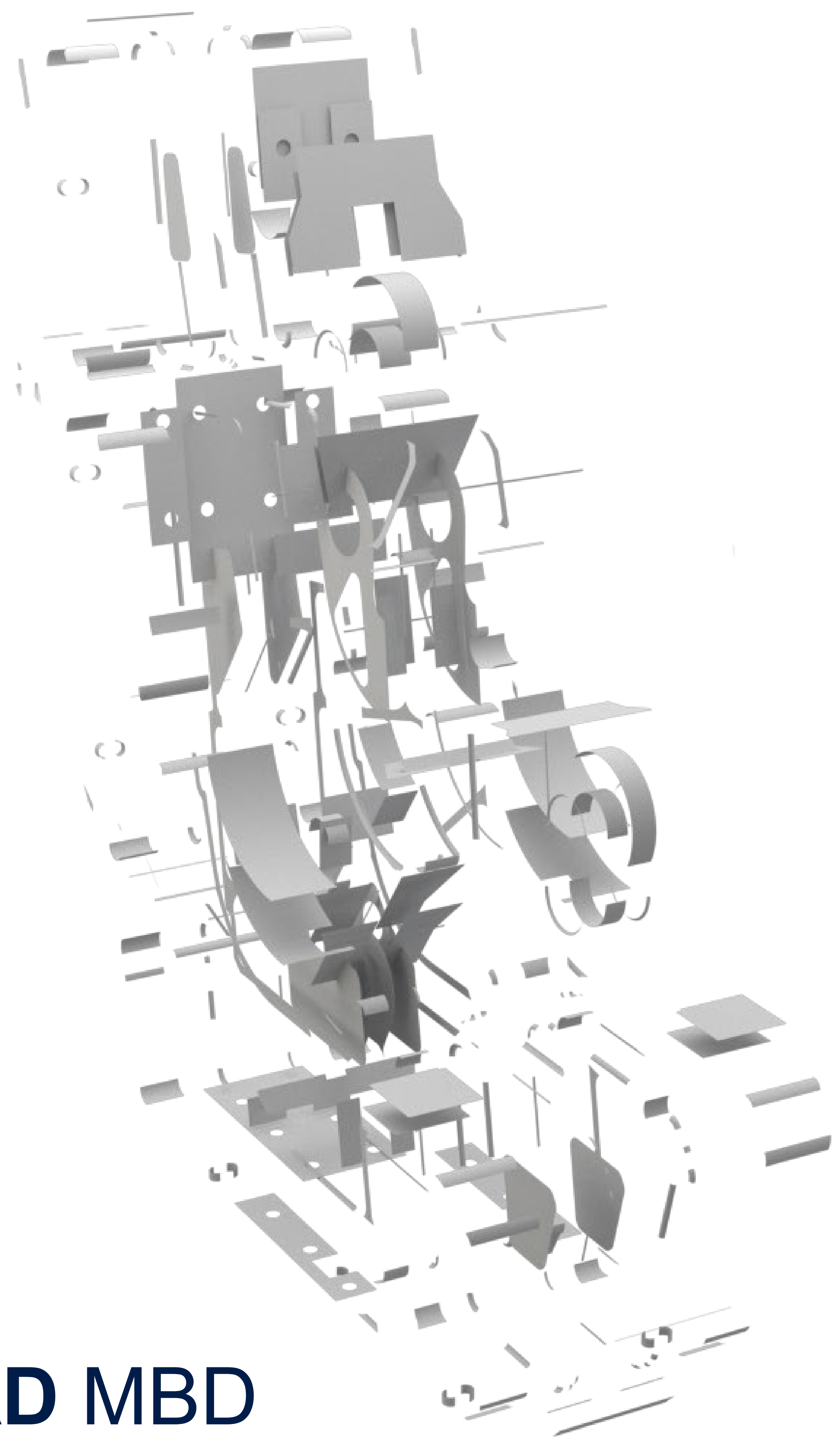
CAD representations



CAD MBD
(graphical)

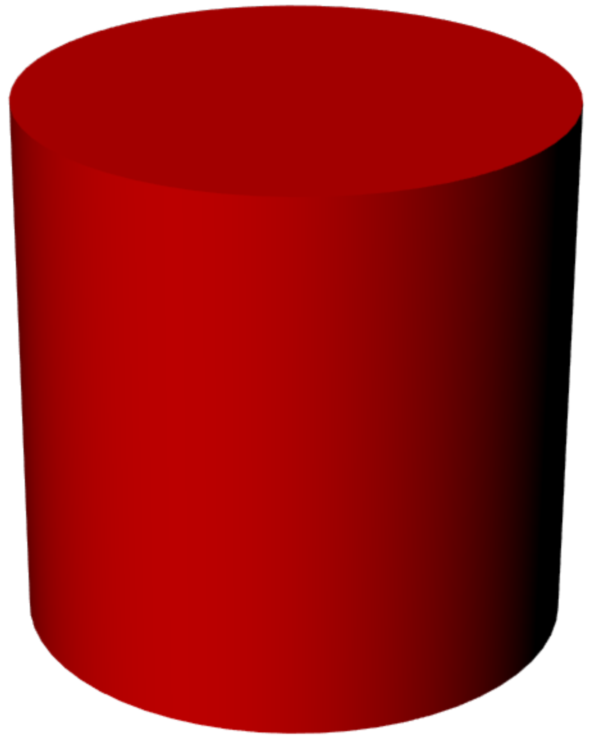


CAD MBD
(geometry)



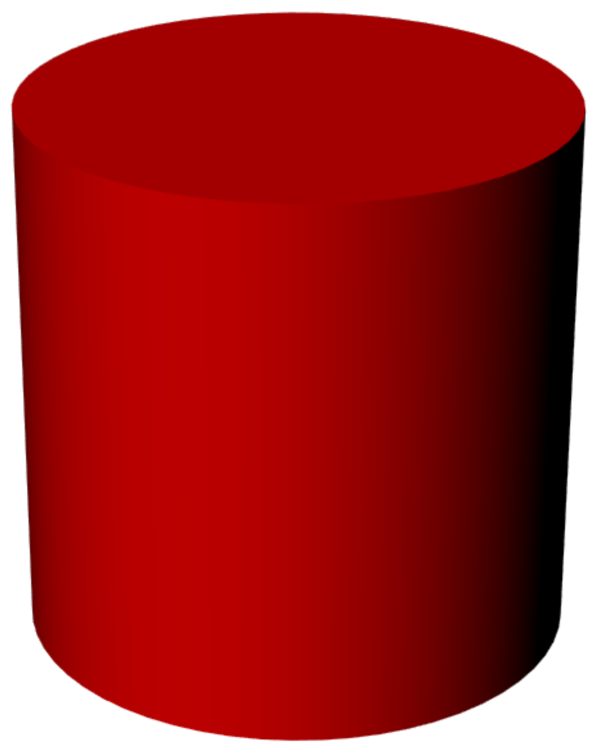
CAD MBD
(geometry exploded)

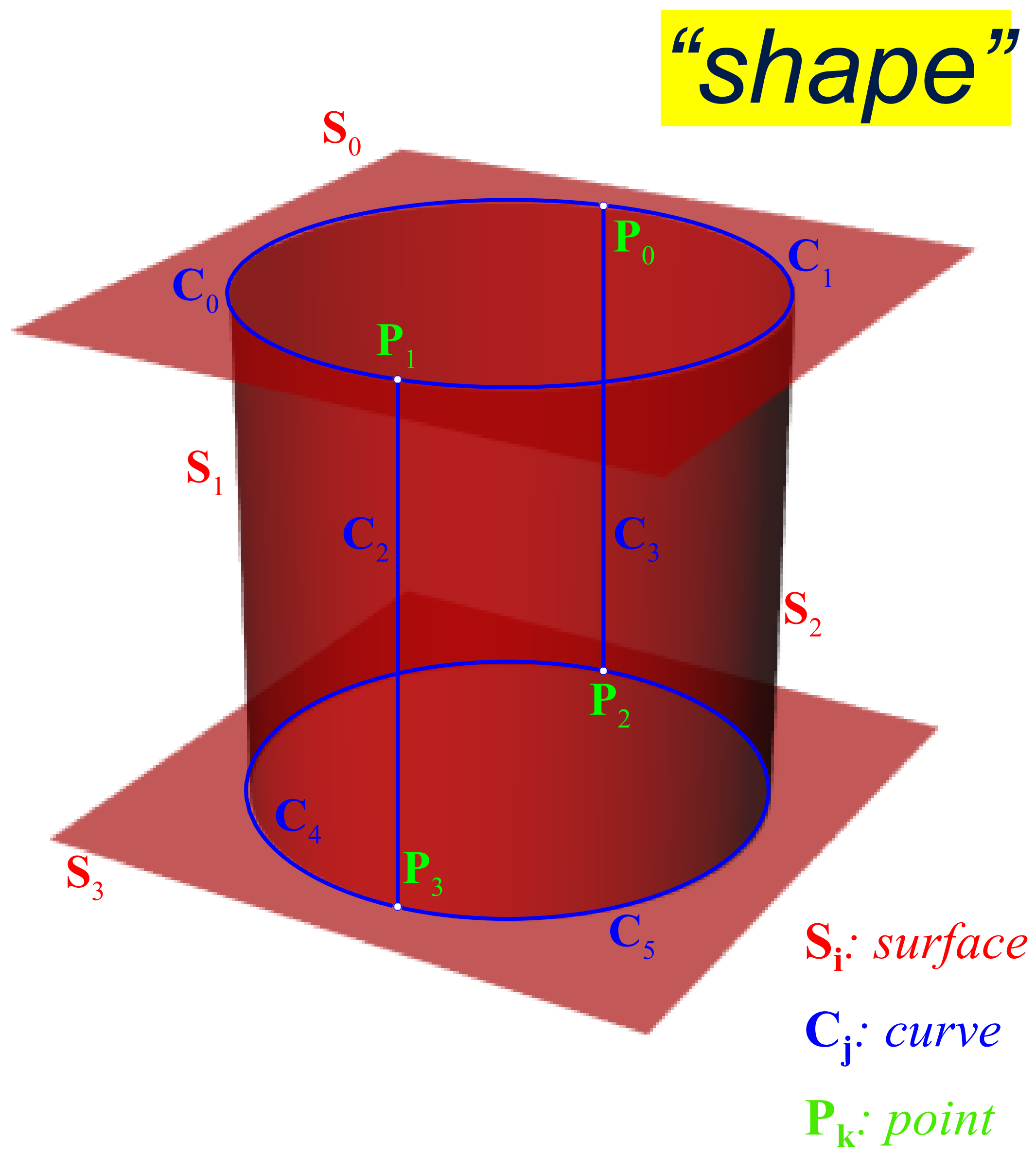
CAD MBD components



B-rep
graphical rendering

CAD MBD components



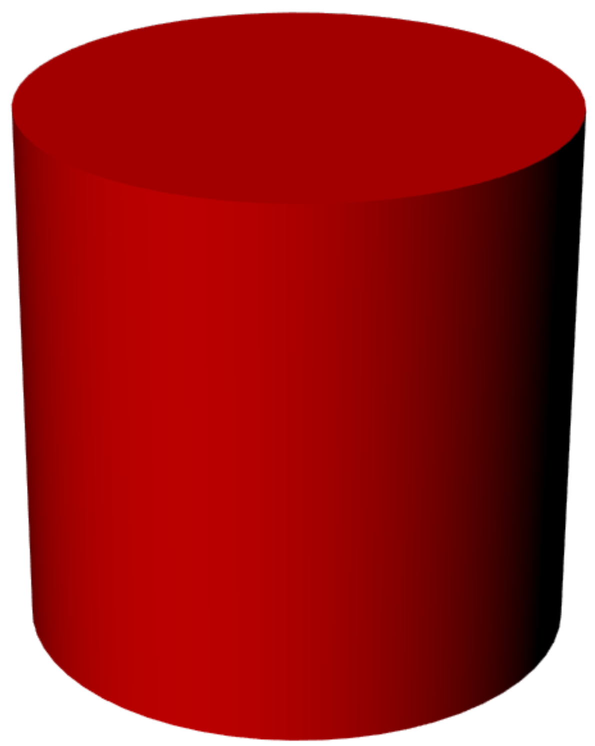


B-rep
graphical rendering

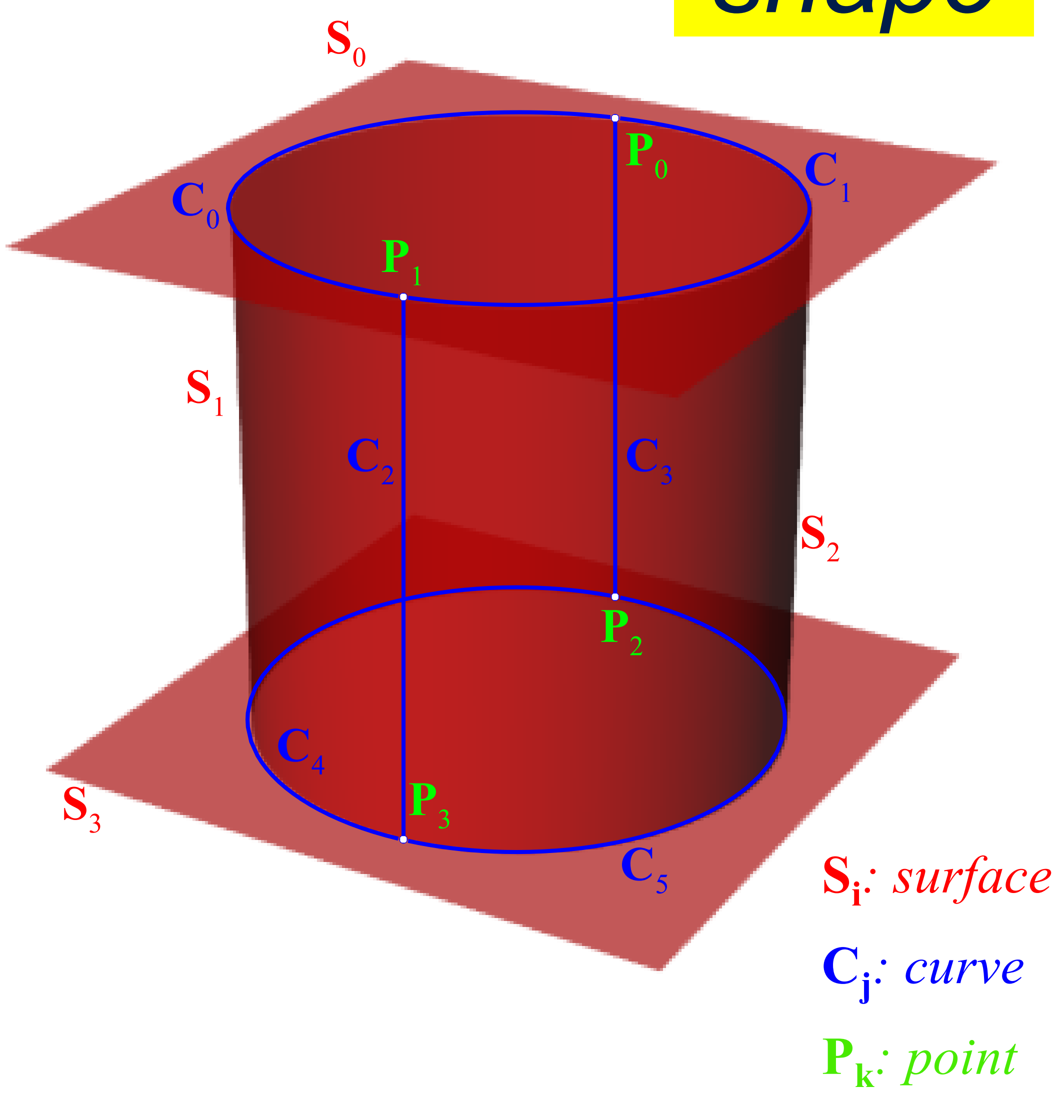
B-rep
geometry

geometrically <u>non</u>-watertight:
lacking G^n, C^n continuity

CAD MBD components

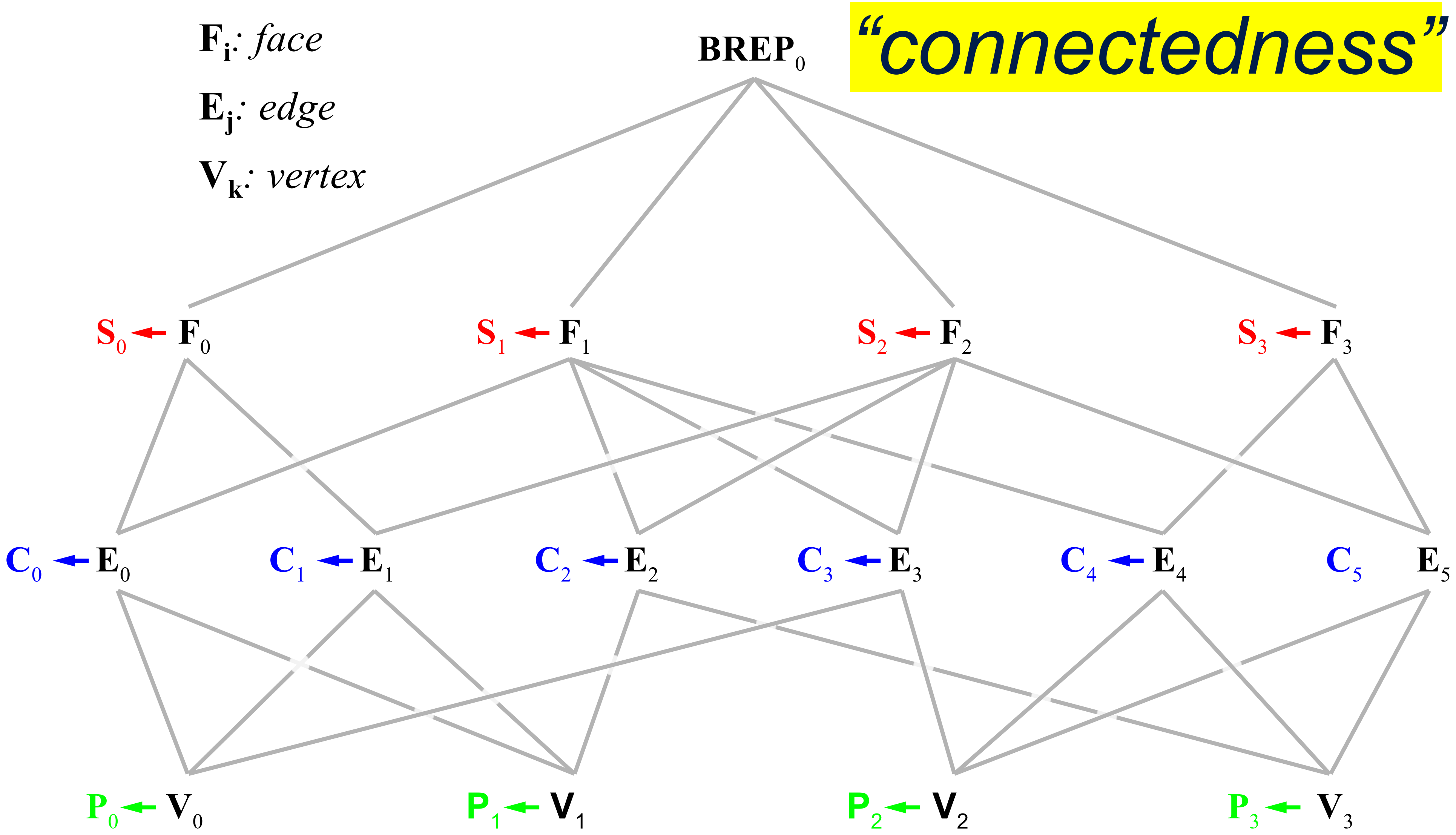


B-rep
graphical rendering



B-rep
geometry

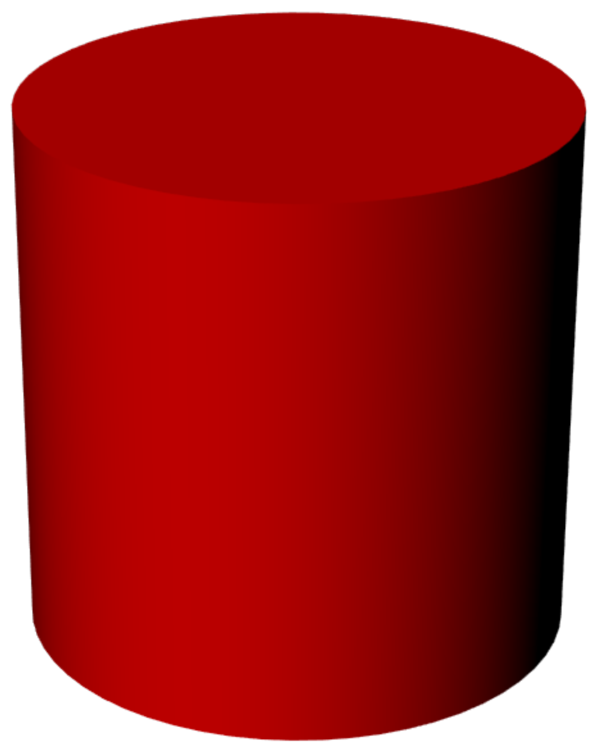
geometrically non-watertight:
lacking G^n, C^n continuity



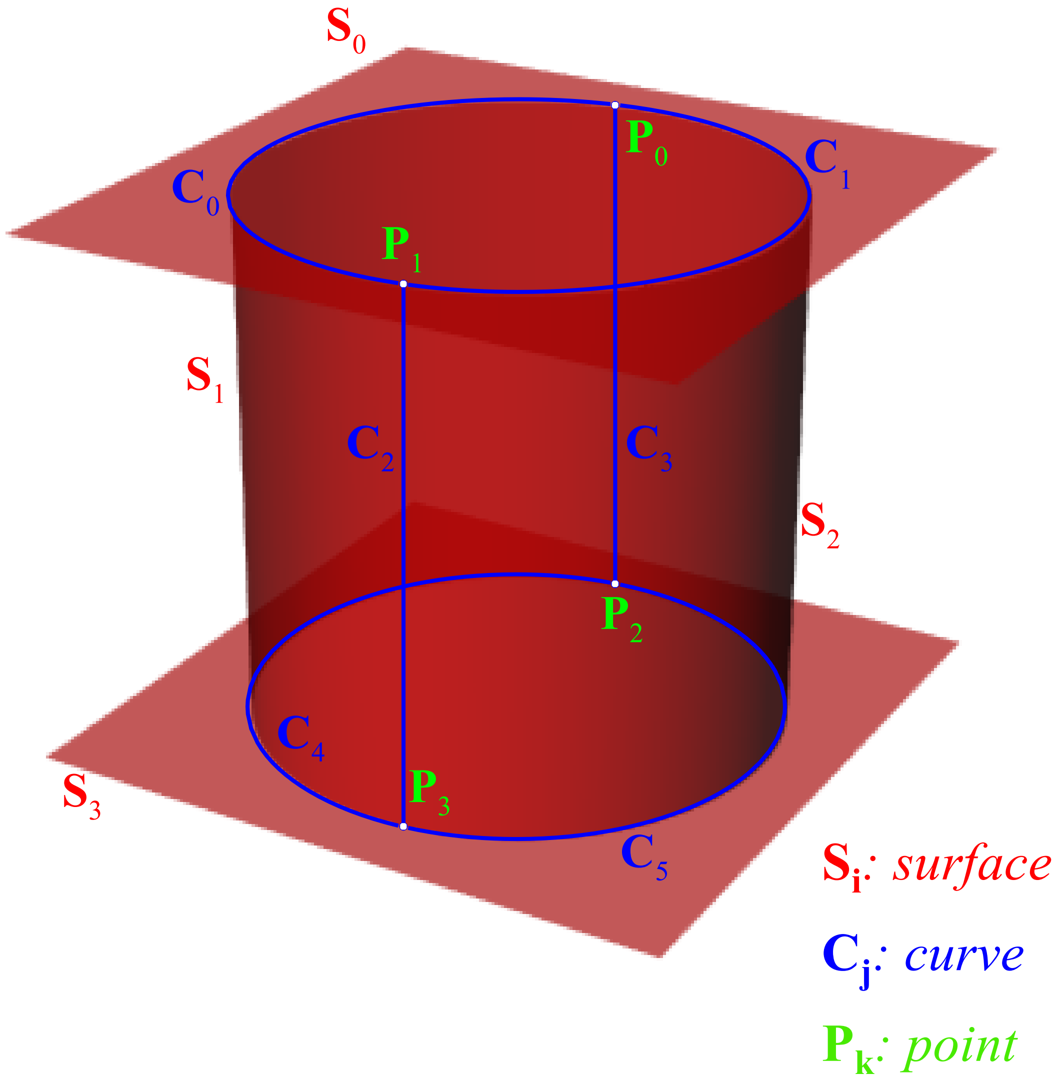
B-rep
topology

topologically watertight:
graph ("face-edge-vertex") satisfying closure metric

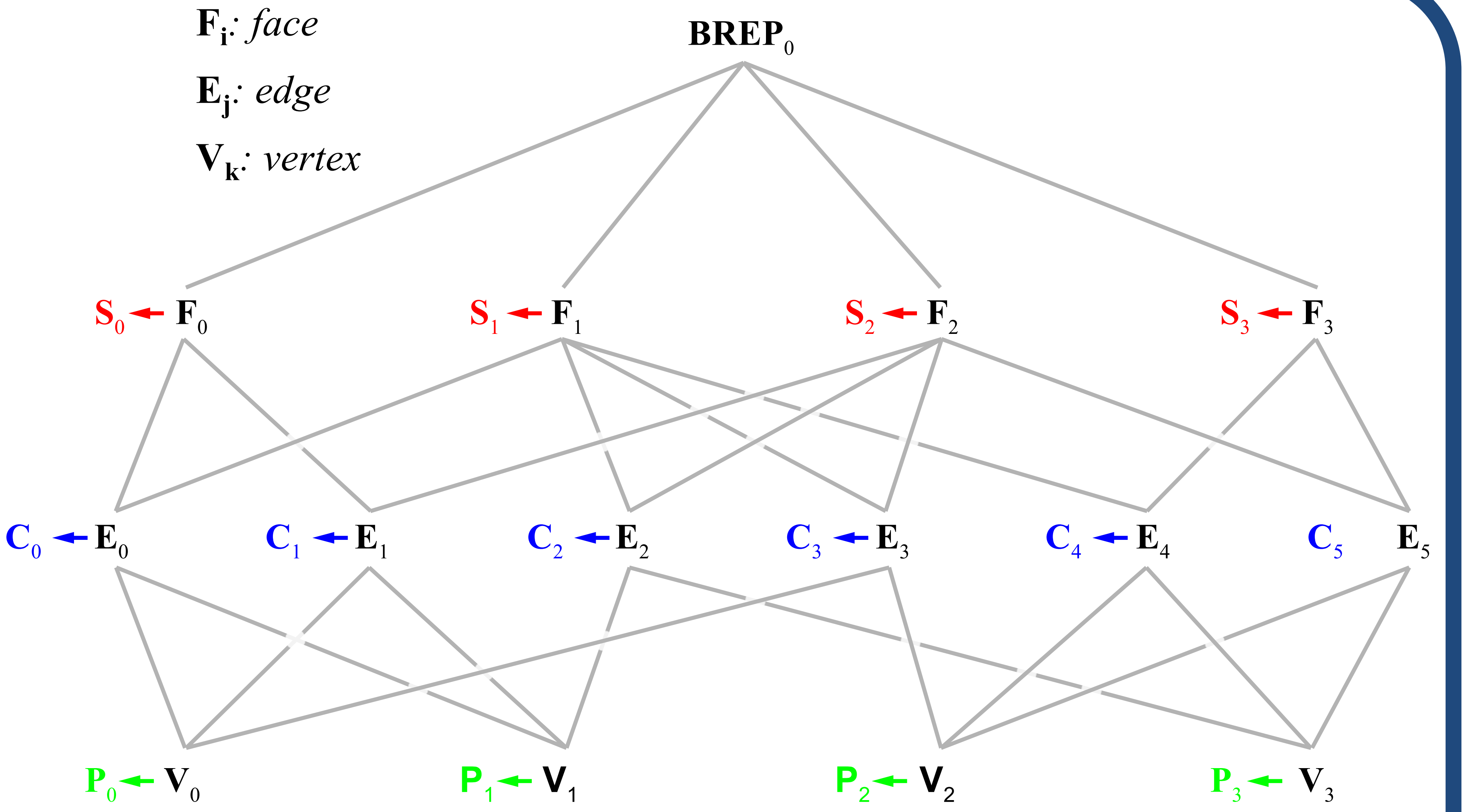
CAD MBD components



B-rep
graphical rendering



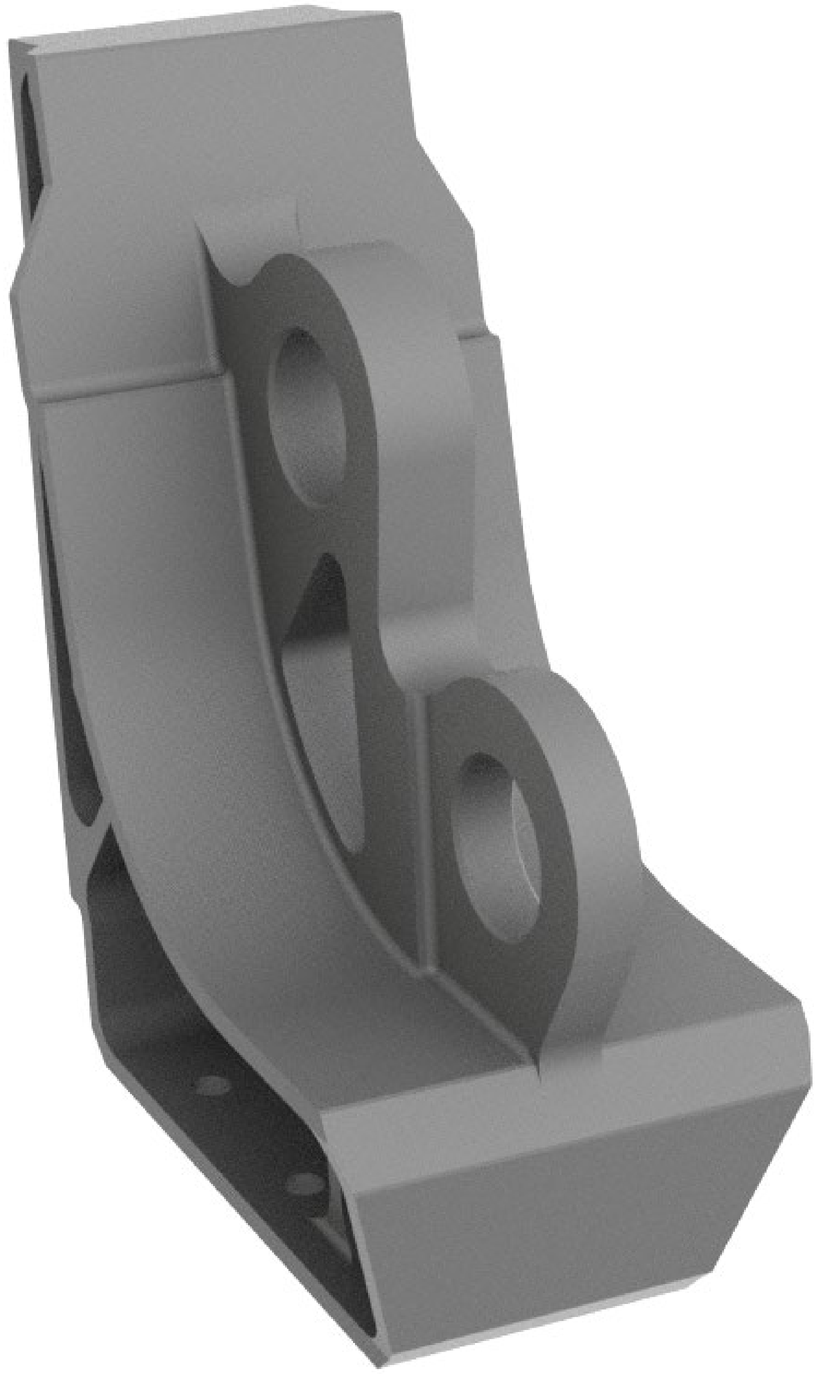
B-rep
geometry



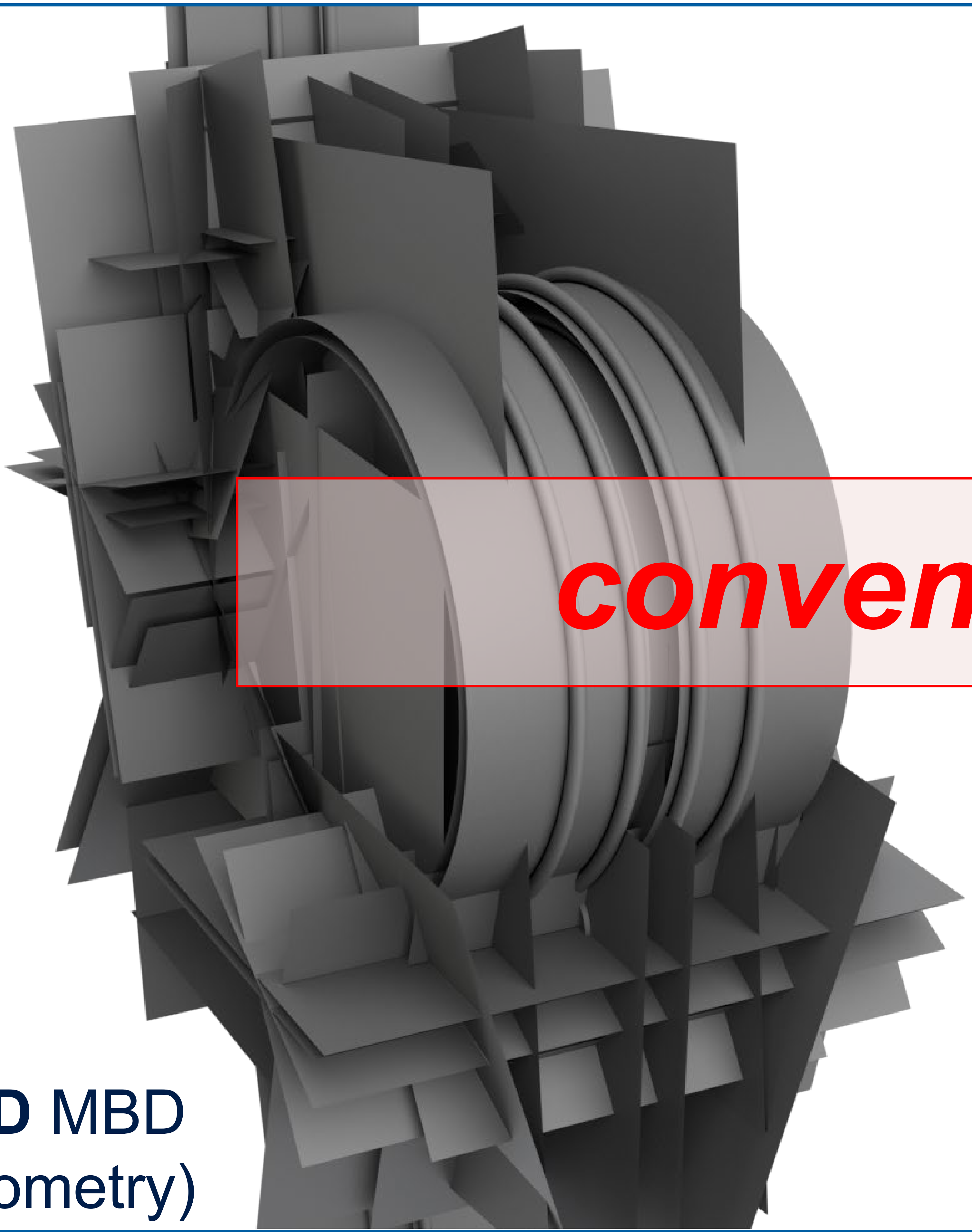
B-rep
topology

geometric / solid model* : *geometry* + *topology

Conventional CAD



CAD MBD
(graphical)

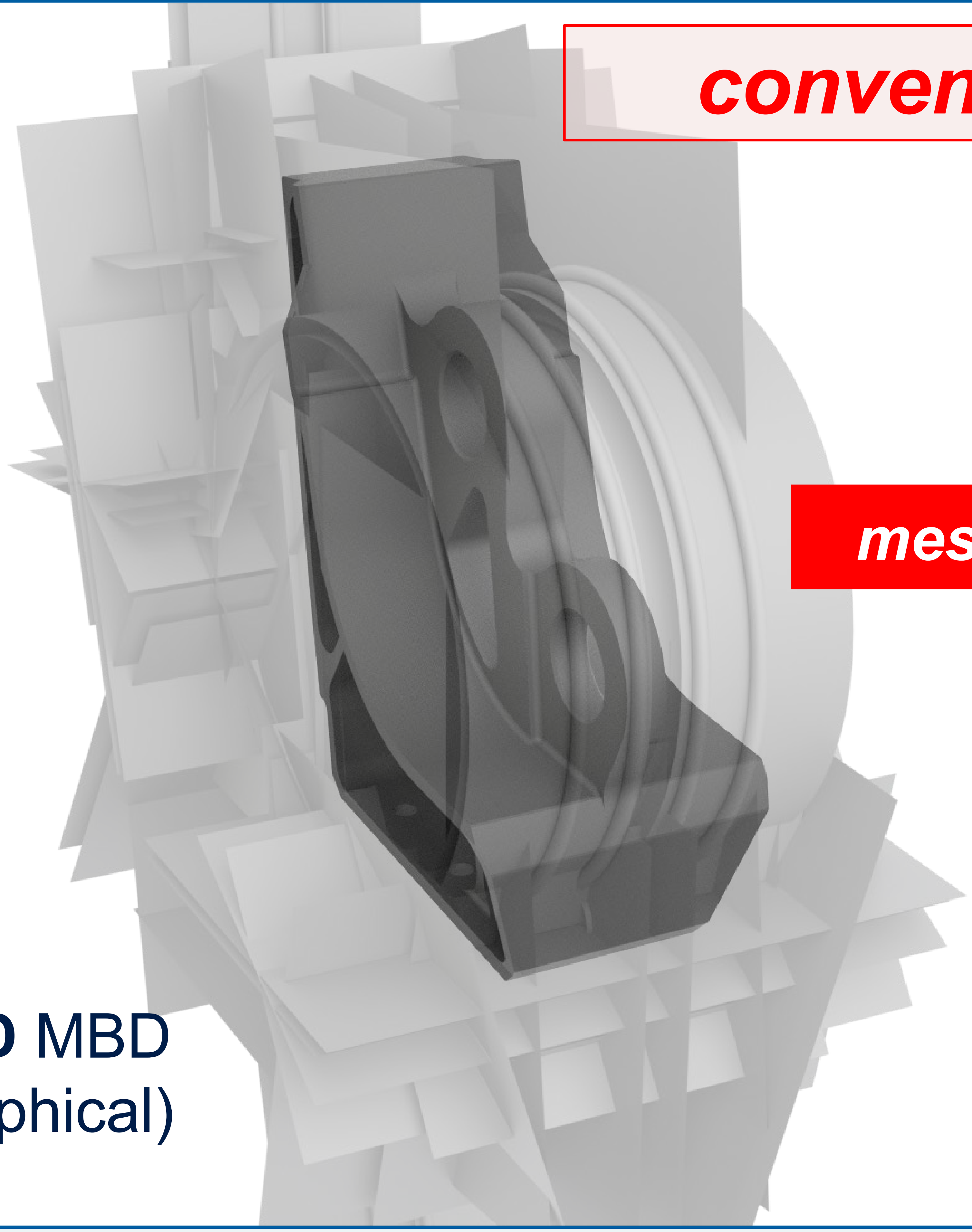


CAD MBD
(geometry)

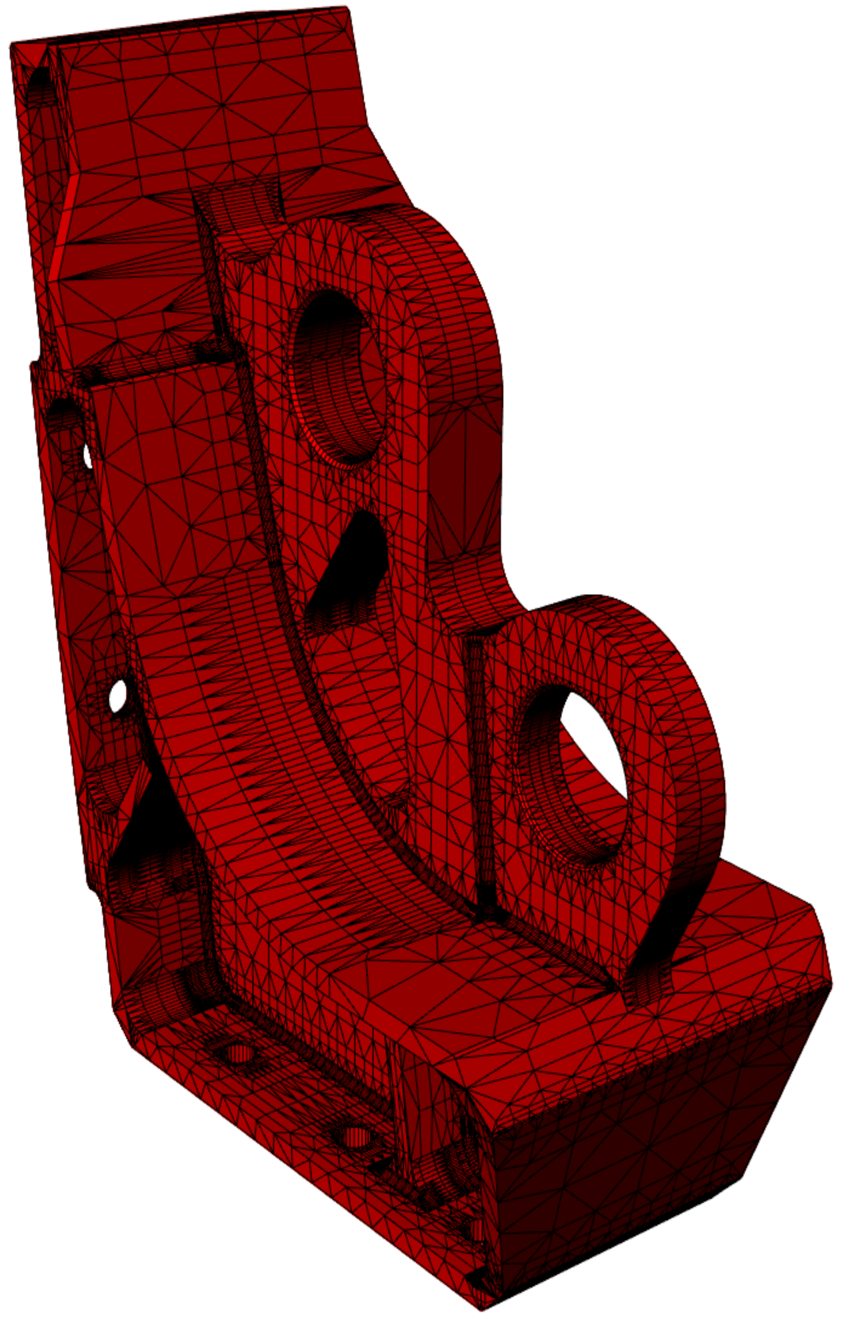
CAD MBD
(geometry exploded)

Conventional CAD-CAx *meshing* workflow

conventional



meshing

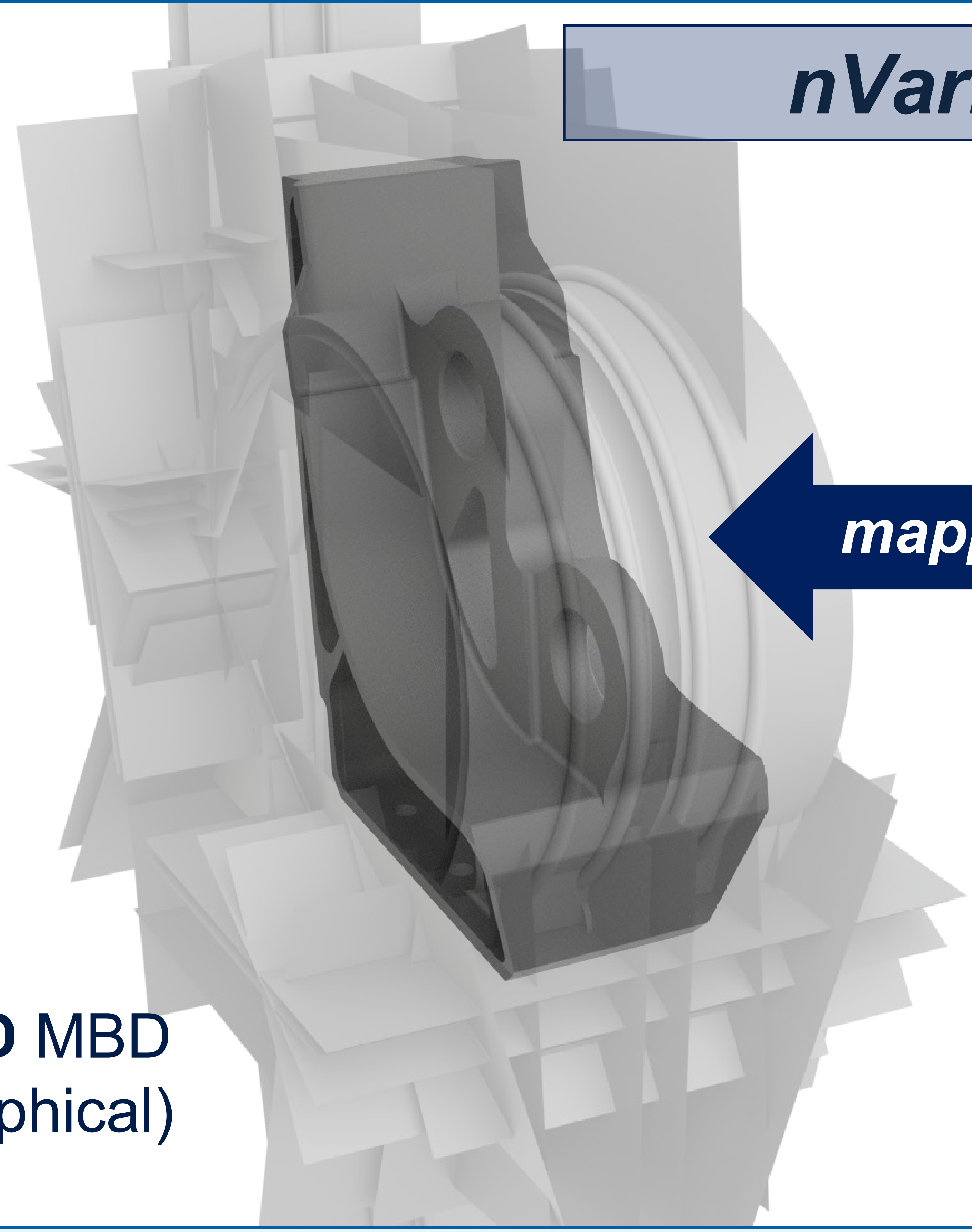


CAD MBD
(graphical)

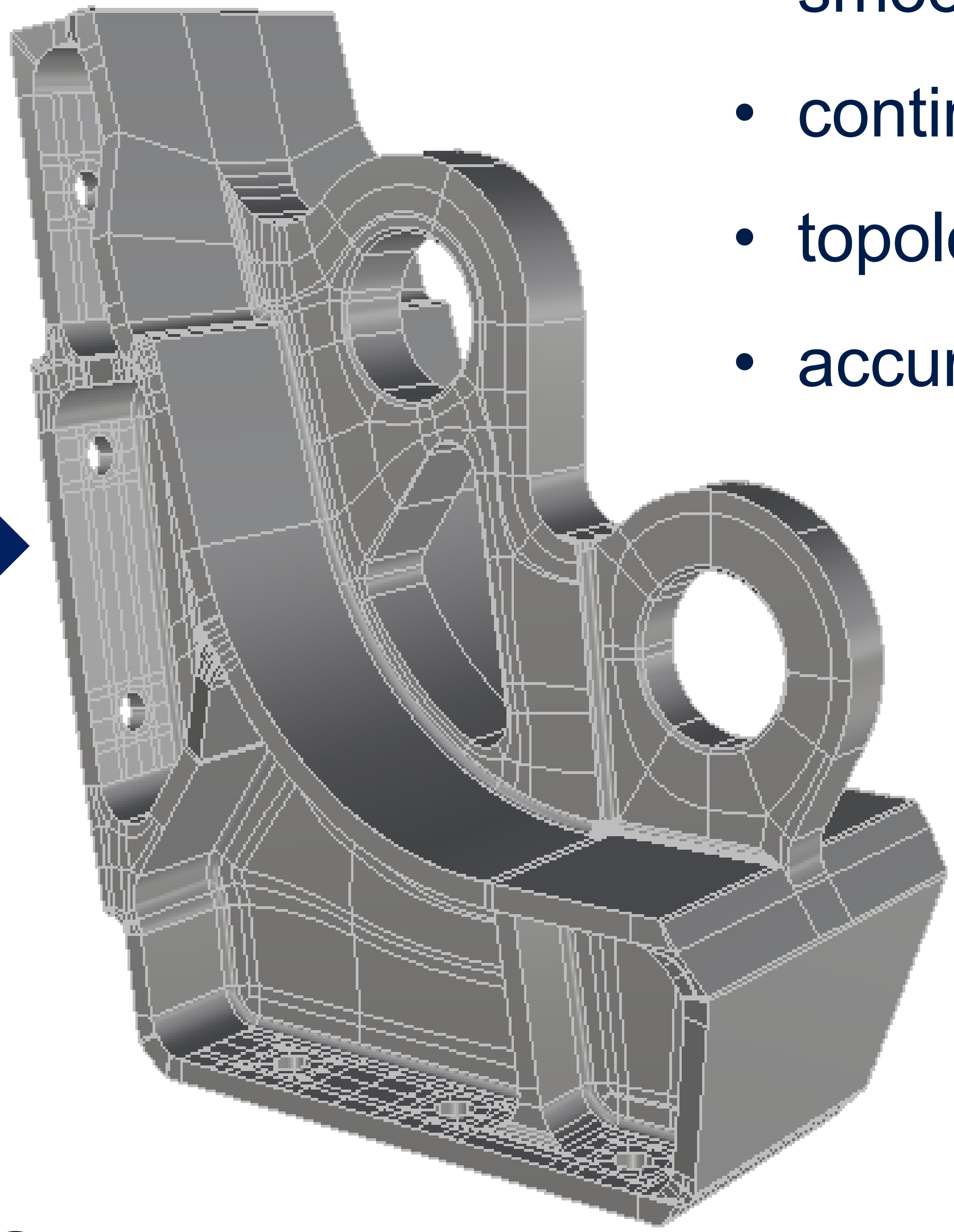
CAx MBD
(faceted mesh)

The *n*Variate approach

nVariate



mapping



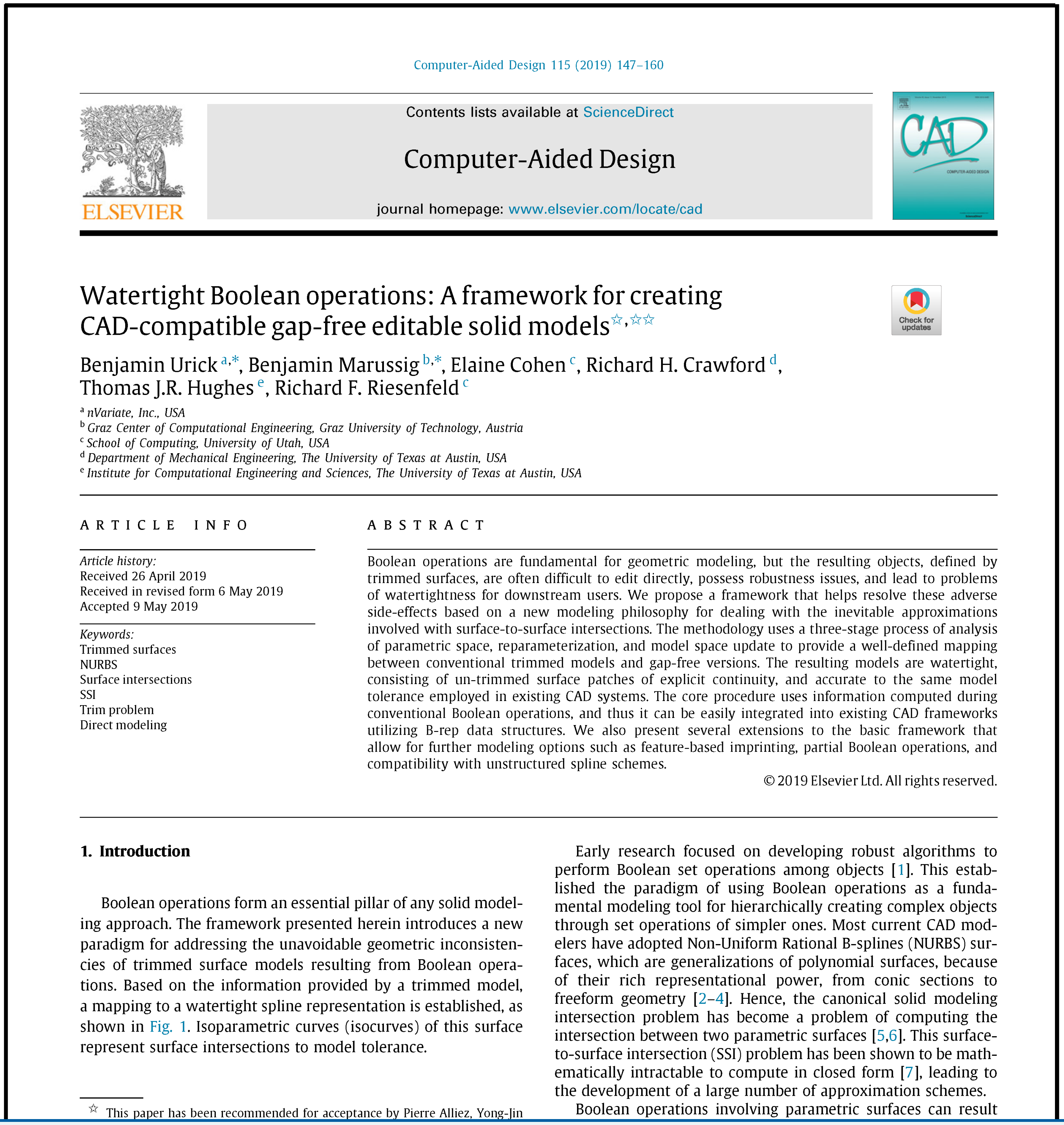
- smooth splines
- continuous at faces
- topology preserving
- accurate to CAD tolerance

CAD MBD
(graphical)

CAD MBD
(geometric model)

The *n*Variate approach

B. Urick, B. Marussig, E. Cohen, R. H. Crawford, T. J. R. Hughes, and R. F. Riesenfeld, **Watertight Boolean operations: A framework for creating CAD-compatible gap-free editable solid models**, Computer-Aided Design 115 (2019) 147–160.



Computer-Aided Design 115 (2019) 147–160

Contents lists available at ScienceDirect

Computer-Aided Design

journal homepage: www.elsevier.com/locate/cad

ELSEVIER

Watertight Boolean operations: A framework for creating CAD-compatible gap-free editable solid models☆,☆☆

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ARTICLE INFO

Article history:
Received 26 April 2019
Received in revised form 6 May 2019
Accepted 9 May 2019

Keywords:
Trimmed surfaces
NURBS
Surface intersections
SSI
Trim problem
Direct modeling

ABSTRACT

Boolean operations are fundamental for geometric modeling, but the resulting objects, defined by trimmed surfaces, are often difficult to edit directly, possess robustness issues, and lead to problems of watertightness for downstream users. We propose a framework that helps resolve these adverse side-effects based on a new modeling philosophy for dealing with the inevitable approximations involved with surface-to-surface intersections. The methodology uses a three-stage process of analysis of parametric space, reparameterization, and model space update to provide a well-defined mapping between conventional trimmed models and gap-free versions. The resulting models are watertight, consisting of un-trimmed surface patches of explicit continuity, and accurate to the same model tolerance employed in existing CAD systems. The core procedure uses information computed during conventional Boolean operations, and thus it can be easily integrated into existing CAD frameworks utilizing B-rep data structures. We also present several extensions to the basic framework that allow for further modeling options such as feature-based imprinting, partial Boolean operations, and compatibility with unstructured spline schemes.

1. Introduction

Boolean operations form an essential pillar of any solid modeling approach. The framework presented herein introduces a new paradigm for addressing the unavoidable geometric inconsistencies of trimmed surface models resulting from Boolean operations. Based on the information provided by a trimmed model, a mapping to a watertight spline representation is established, as shown in Fig. 1. Isoparametric curves (isocurves) of this surface represent surface intersections to model tolerance.

☆ This paper has been recommended for acceptance by Pierre Alliez, Yong-Jin

Early research focused on developing robust algorithms to perform Boolean set operations among objects [1]. This established the paradigm of using Boolean operations as a fundamental modeling tool for hierarchically creating complex objects through set operations of simpler ones. Most current CAD modelers have adopted Non-Uniform Rational B-splines (NURBS) surfaces, which are generalizations of polynomial surfaces, because of their rich representational power, from conic sections to freeform geometry [2–4]. Hence, the canonical solid modeling intersection problem has become a problem of computing the intersection between two parametric surfaces [5,6]. This surface-to-surface intersection (SSI) problem has been shown to be mathematically intractable to compute in closed form [7], leading to the development of a large number of approximation schemes.

Boolean operations involving parametric surfaces can result

The *n*Variate approach: as-x modeling

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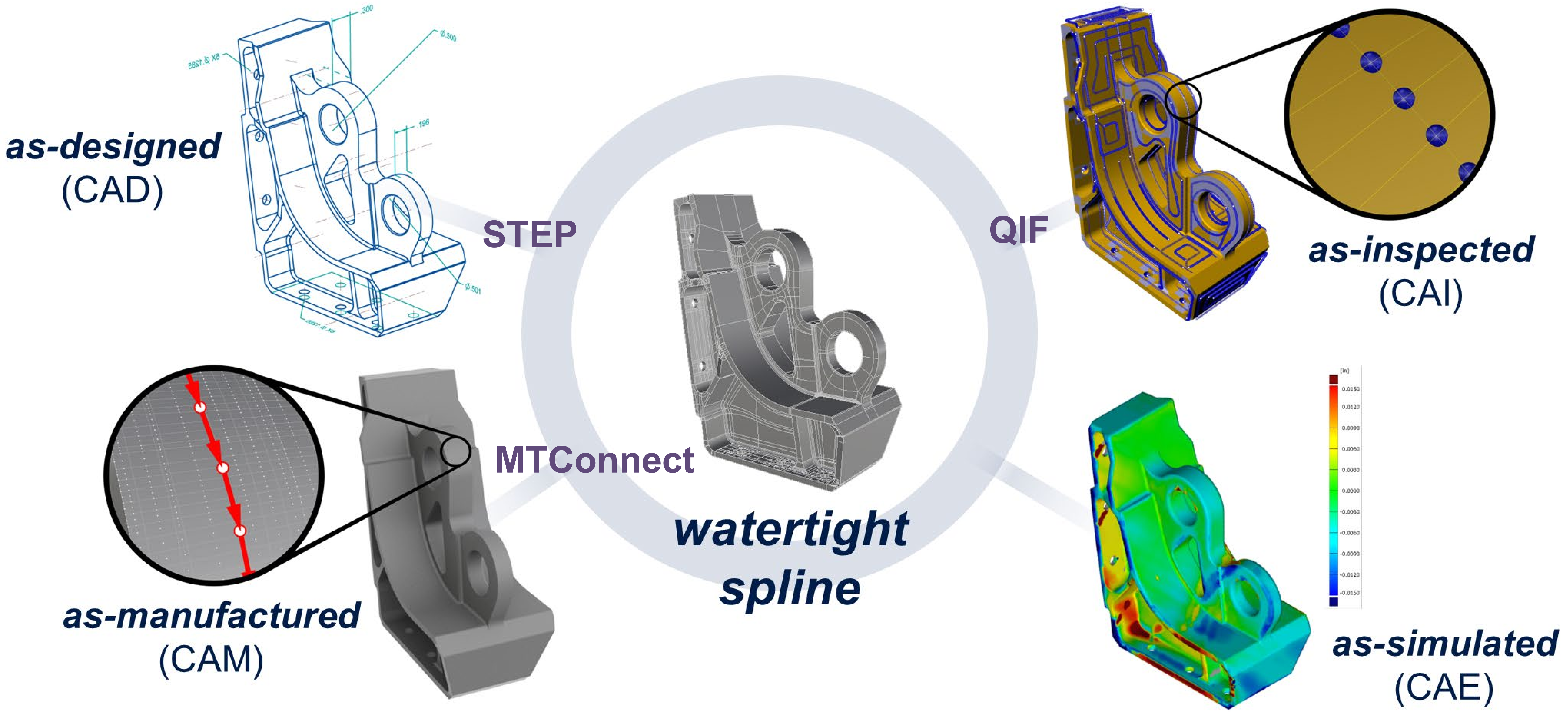
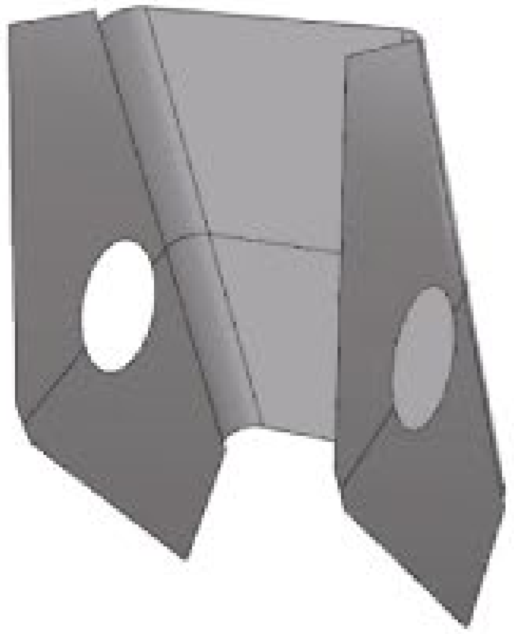
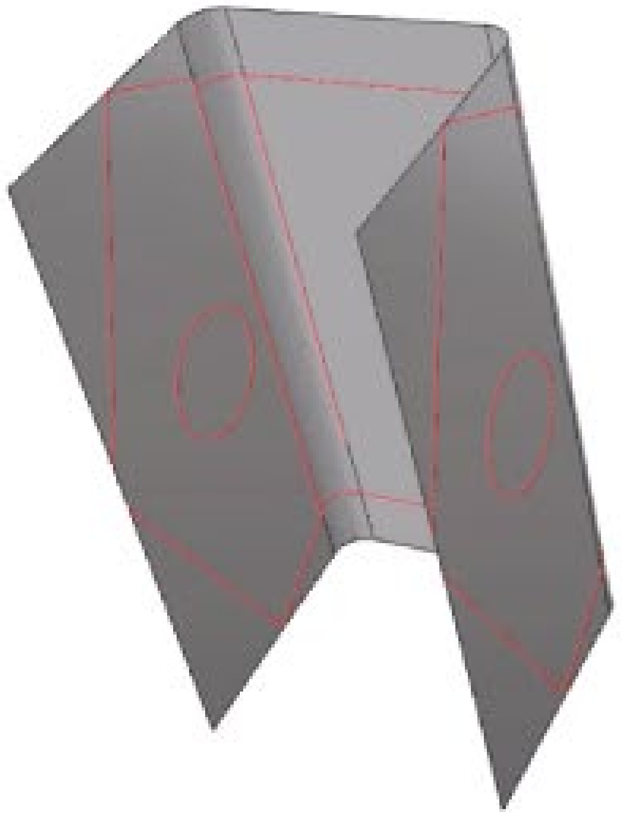


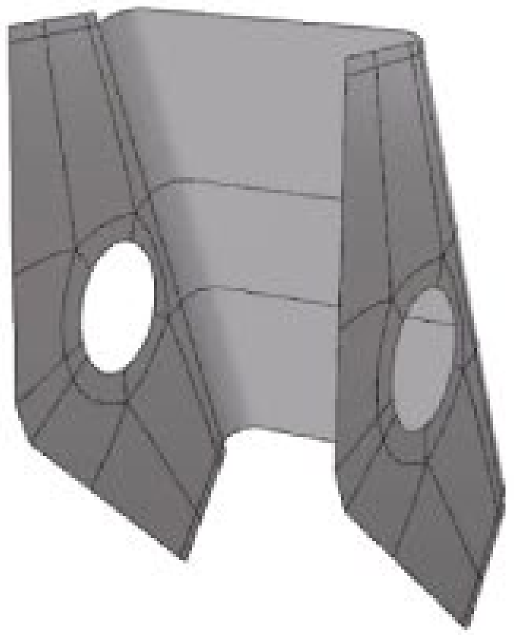
The *n*Variate approach : as-simulated (CAE)



CAD
graphical

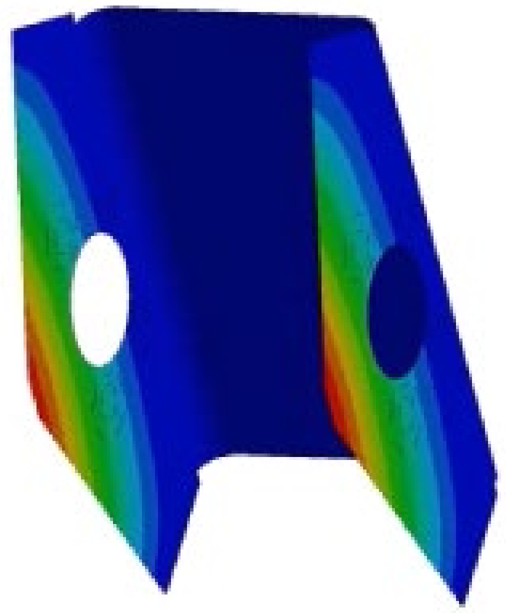


CAD
geometry



WatertightCAD
geometric model

WatertightCAD
geometric model
(element refined)

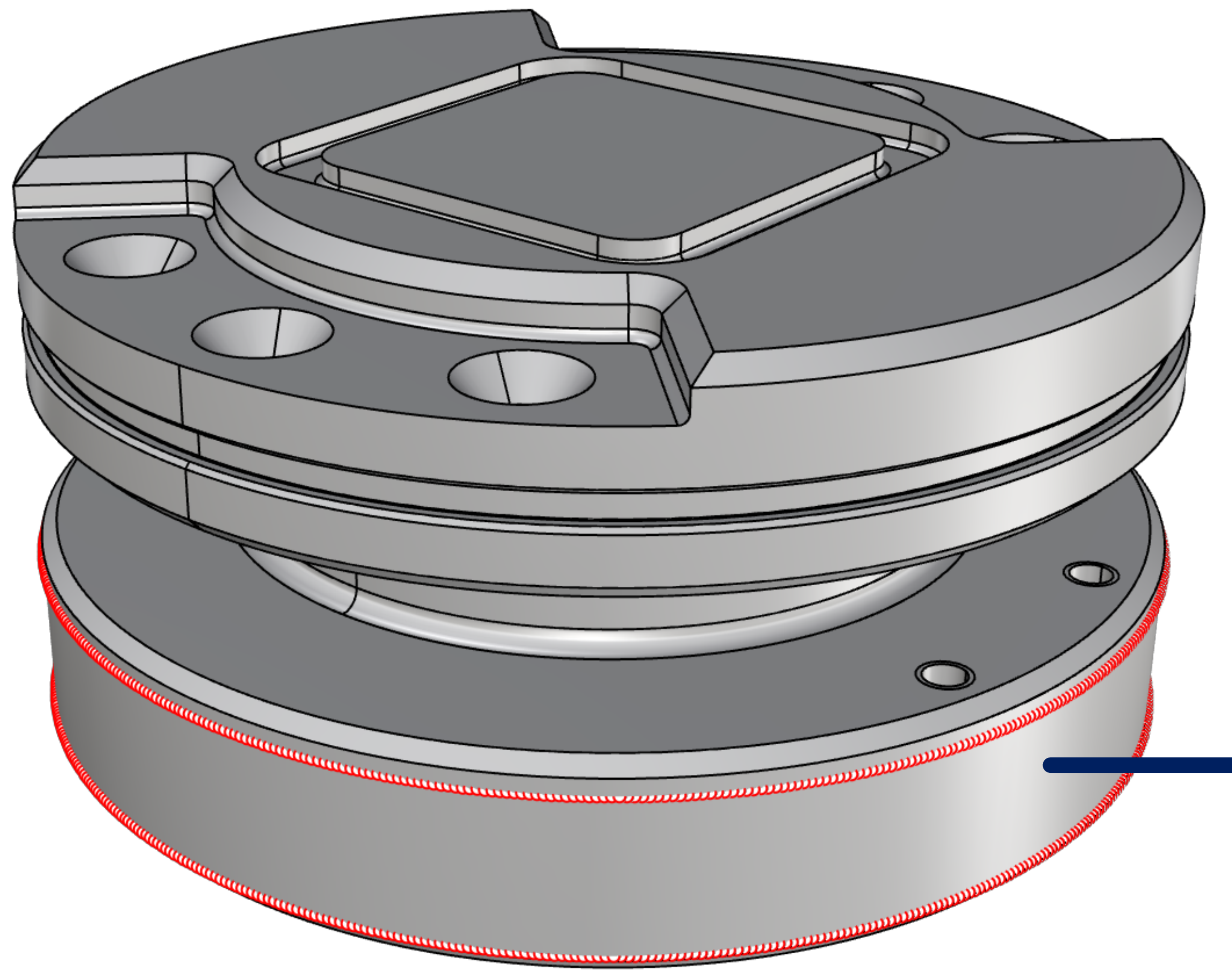


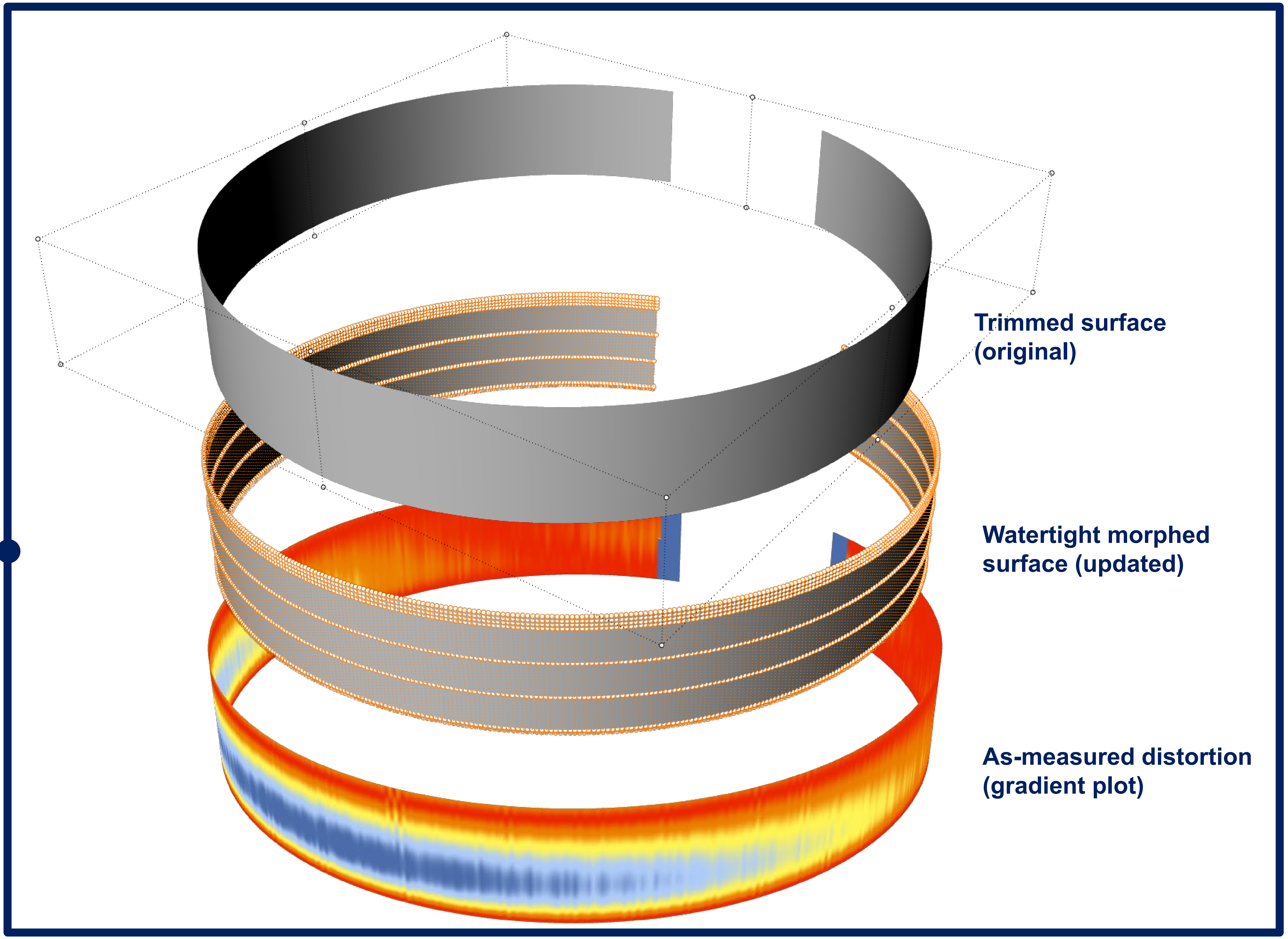
WatertightCAD
as-simulated
model

Current CAD

CAD + *n*Variate

The *n*Variate approach: as-inspected (CAI)





Background

- Ben Urick
  ISO 10303 (STEP) leader – **geometry** and **topology**
  (ISO SC4 TC184 WG12 **T1**)

ISO	***I****nternational* ***O****rganization for* ***S****tandardization*
TC 184	***T****echnical* ***C****ommittee* ***184****, "Automation systems and integration"*
SC 4	***S****ub****c****ommittee* ***4****, "Industrial data"*
WG 12	***W****orking* ***G****roup* ***12****, "STEP product modelling and resources"*
T1	***T****echnical group* ***1****, "Geometry and Topology"*

support from:

National Institute of Standards and Technology (**NIST**)
Communications Technology Laboratory (CTL)
The Smart Connected Systems Division (SCSD)
Smart Connected Manufacturing Systems Group

Current MBD issues

Current MBD issues

Consistent theme:

- Blind implementation / expectations of MBE technology
  - Unclear use-cases
  - Undefined value-adds

Current MBD issues

Consistent theme:

- Blind implementation / expectations of MBE technology
  - Unclear use-cases
  - Undefined value-adds

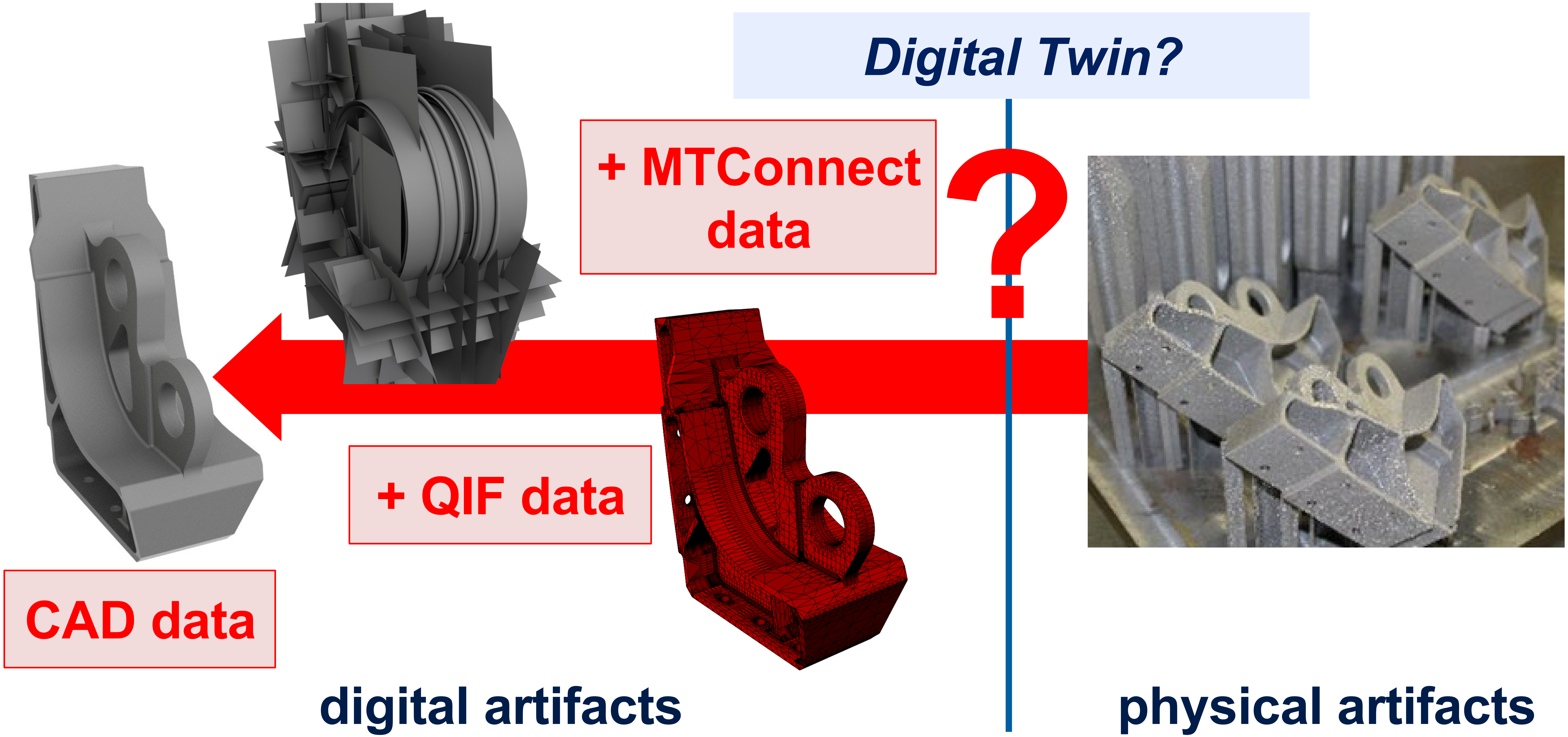
MBD manager questions:

- Do you have clearly defined deliverables / requirements?
- Do you have a defined workflow to achieve those deliverables?

...*is it model-based*???

Digital Twins

Digital Twins



Digital Twins in MBD

- current digital twin definitions used contain vague "boxes and arrows" as descriptions
- from a geometric and solid modeling perspective
  - aspirational goals or actual MBD implementations?
  - not based in real data / use cases / workflows
  - no “there there” from a ***geometric / solid modeling*** perspective

Digital Twins in MBD

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  - not based in real data / use cases / workflows
  - no “there there” from a ***geometric / solid modeling*** perspective

- digital twin only can be defined by ***use-case / value add***
- there is no ***digital twin*** without a ***digital twin use-case***

  what are you going to do with this "twin" and what value does it give to your business?

MBD: STEP AP242 ***OR*** QIF?

MBD: STEP AP242 *OR* QIF?

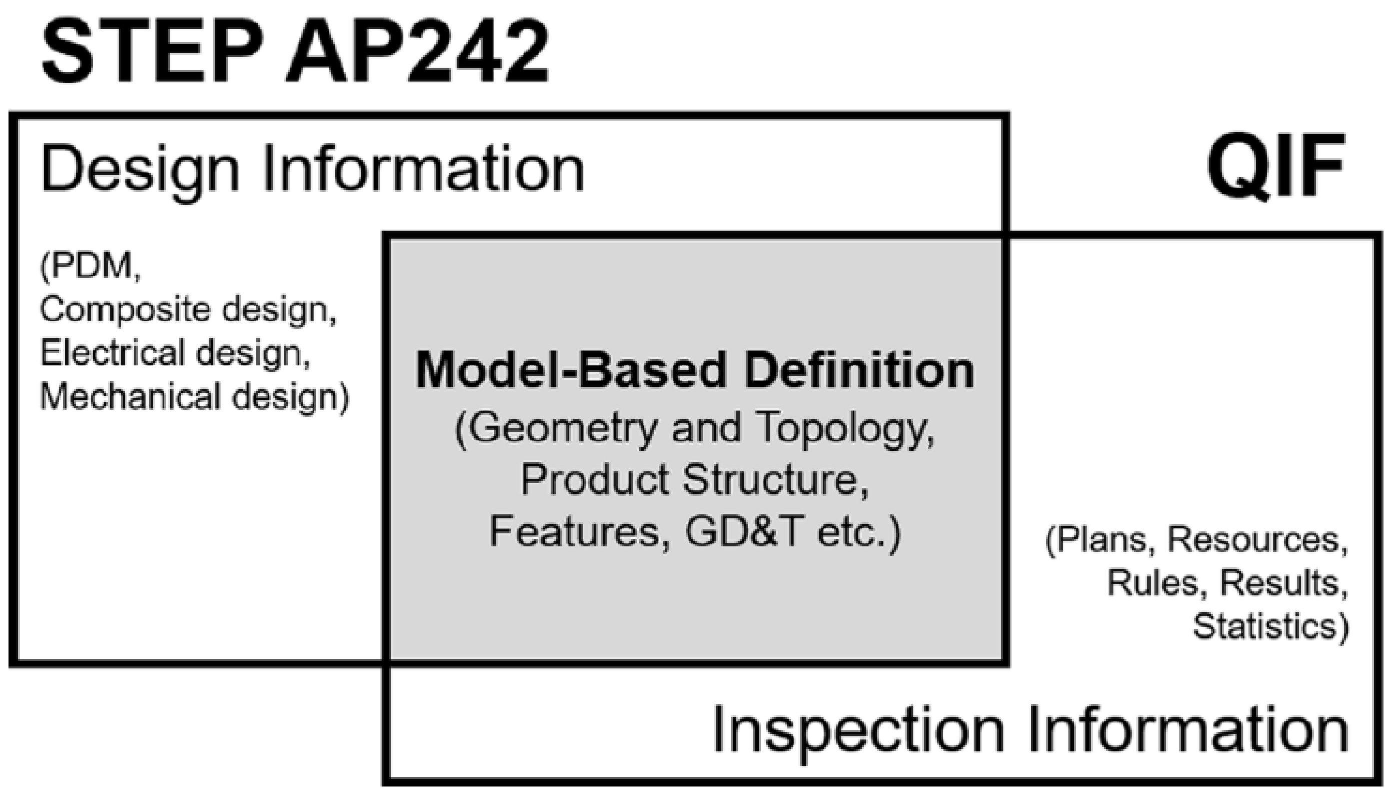
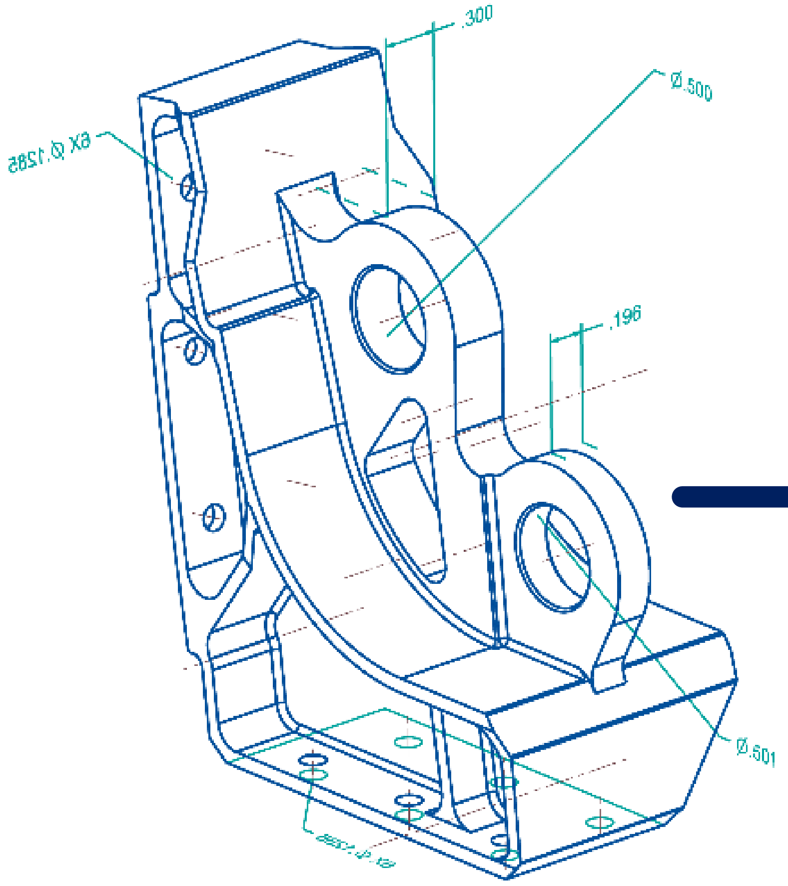


Fig. 3. Simplified view of the intersection between STEP AP242 and QIF.

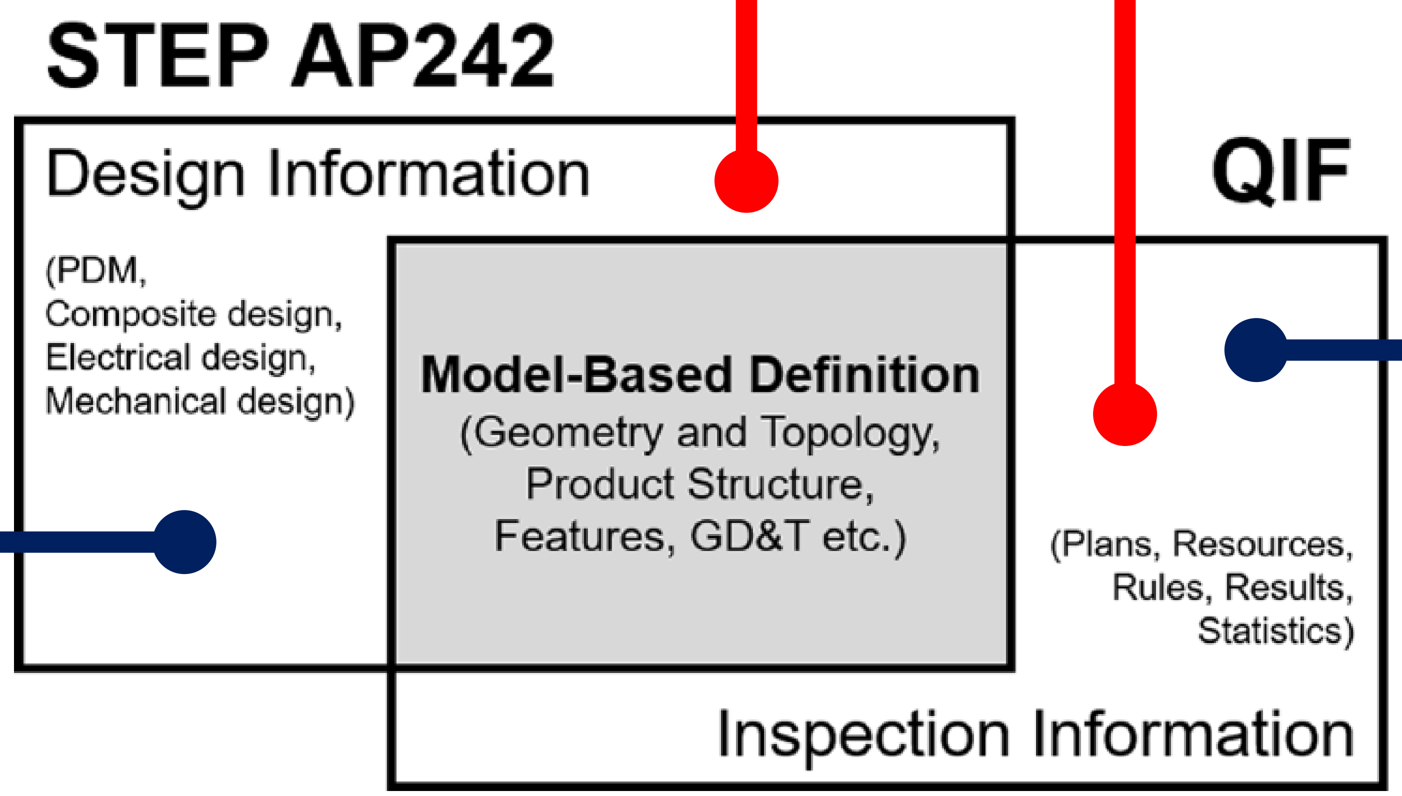
S. Kwon, L. V. Monnier, R. Barbau, and W. Z. Bernstein, "Enriching Standards-Based Digital Thread by Fusing As-Designed and As-Inspected Data Using Ontologies," vol. 46, Aug. 2020.

MBD: STEP AP242 ***AND / OR*** QIF?

CAD
as-designed



Non-translatable domain specific data



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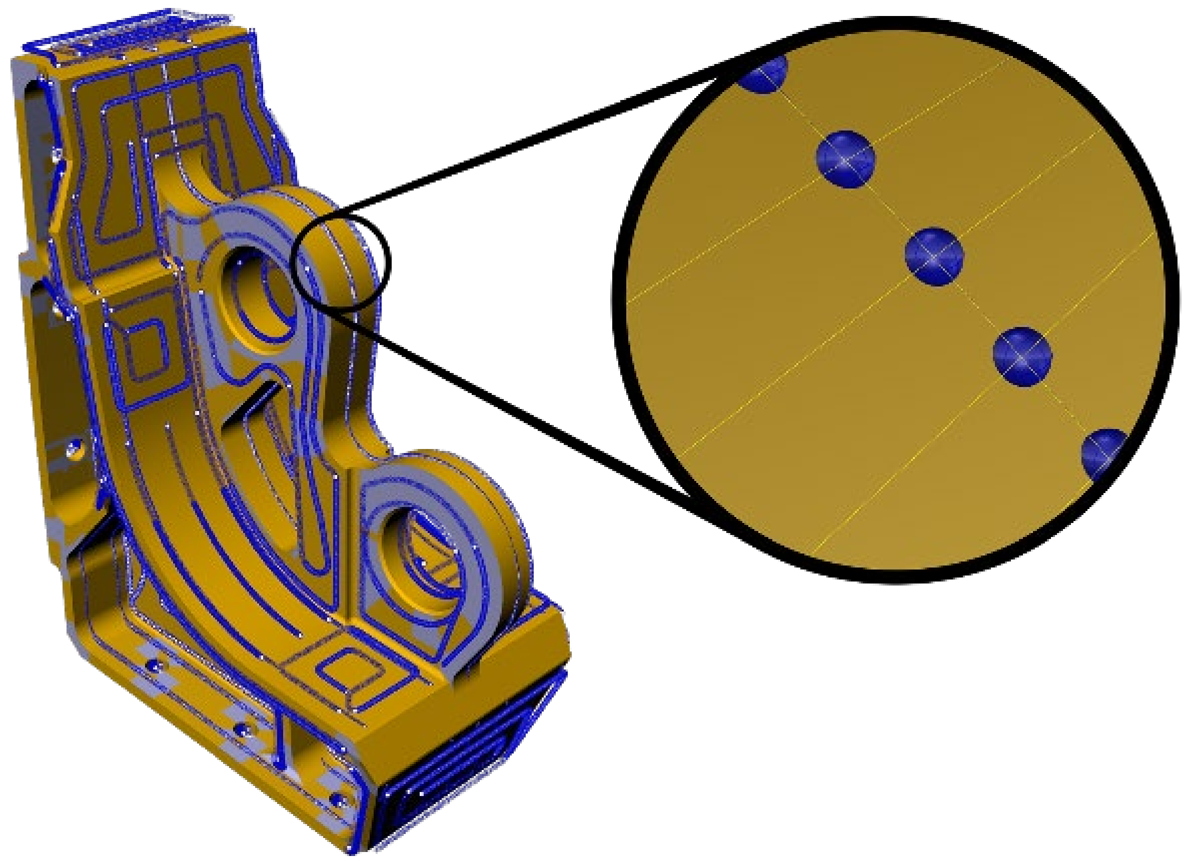
CAI
as-inspected



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MBD: STEP AP242 ***AND / OR*** QIF?

- STEP and QIF manage **different domains** of data (design and inspection, respectively)
- These data domains contain unique elements that are **non-translatable**
- Having both CAD and CAI data requires managing **MBD and PMI**
- MBD and PMI exchange is ultimately driven by use-case / value-add

*needs managed by personnel to be made **business specific***

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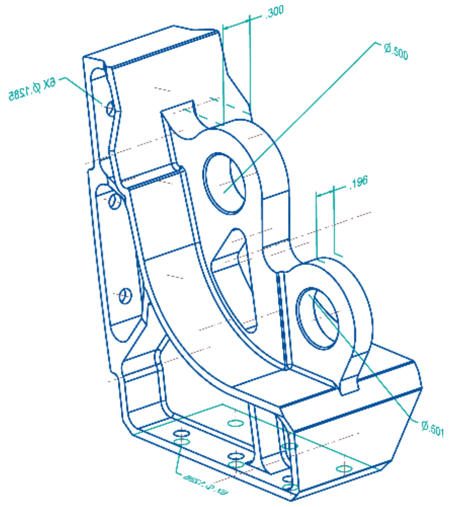
“Features”

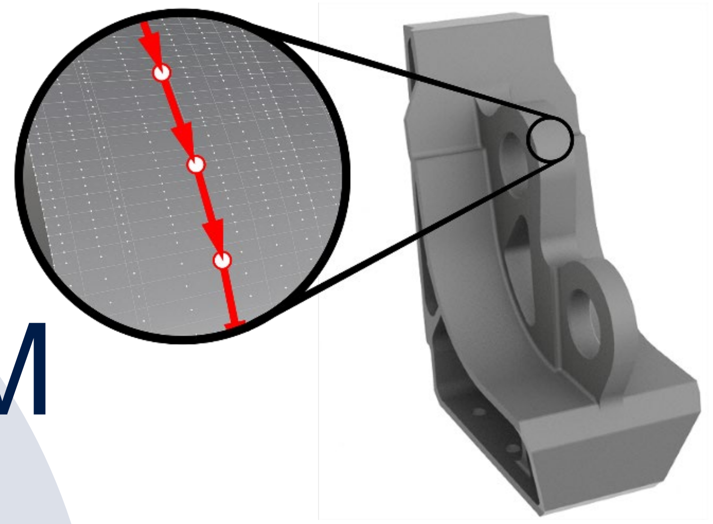
“Features”

design features



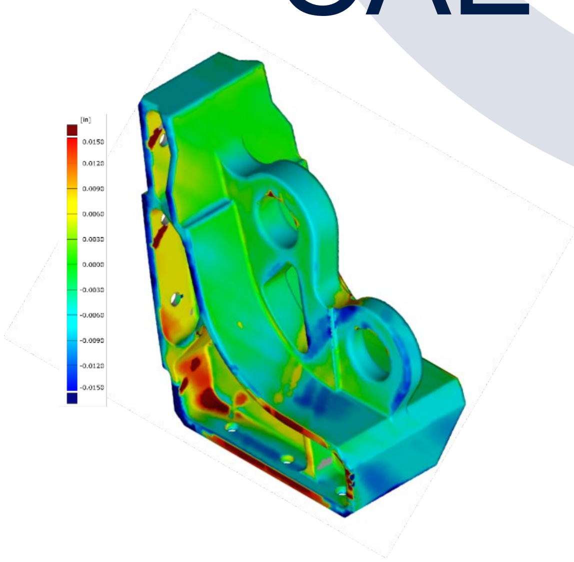
CAD

CAM



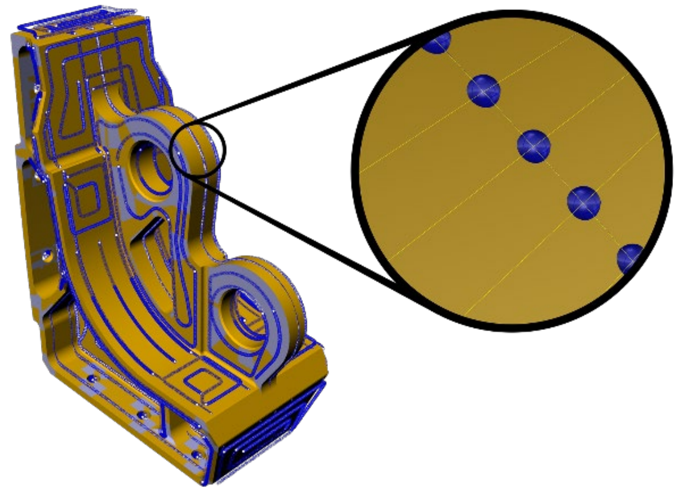
manufacturing features

engineering features



CAE

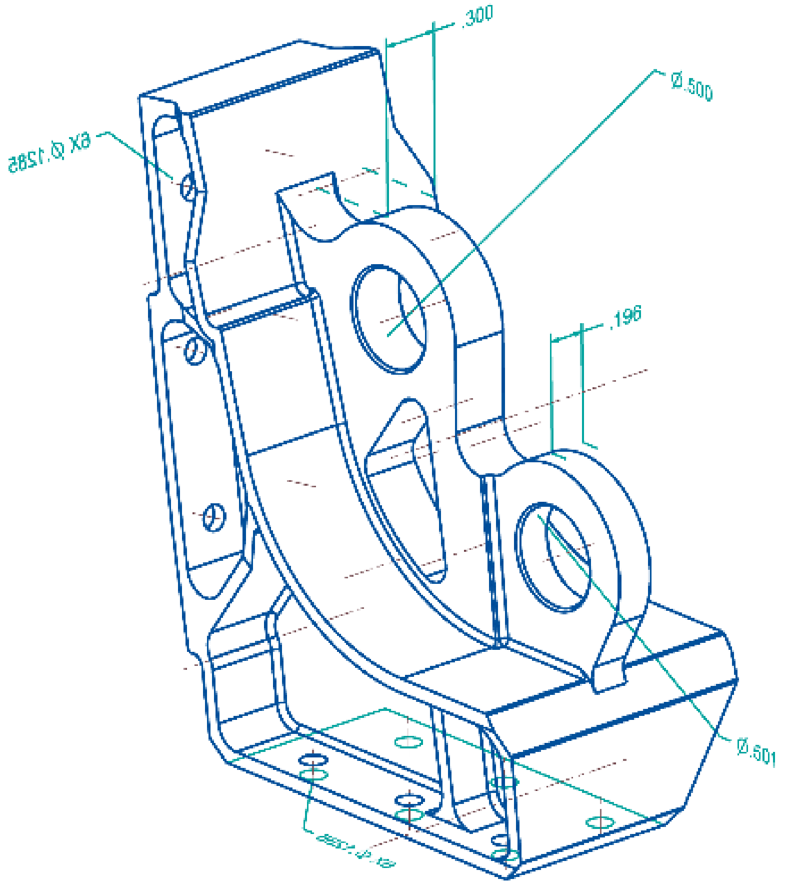
CAI



inspection features

"Feature mapping?"

CAD
as-designed



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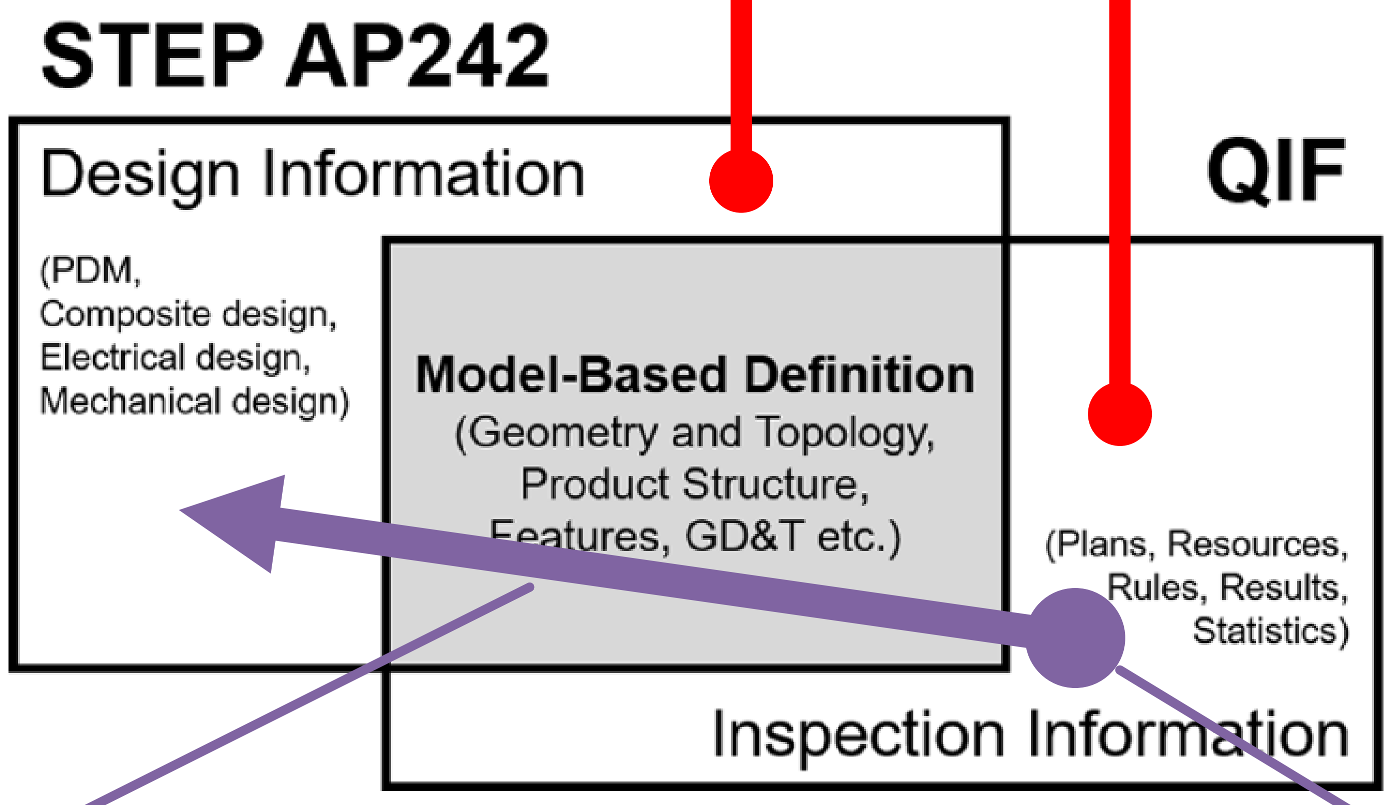

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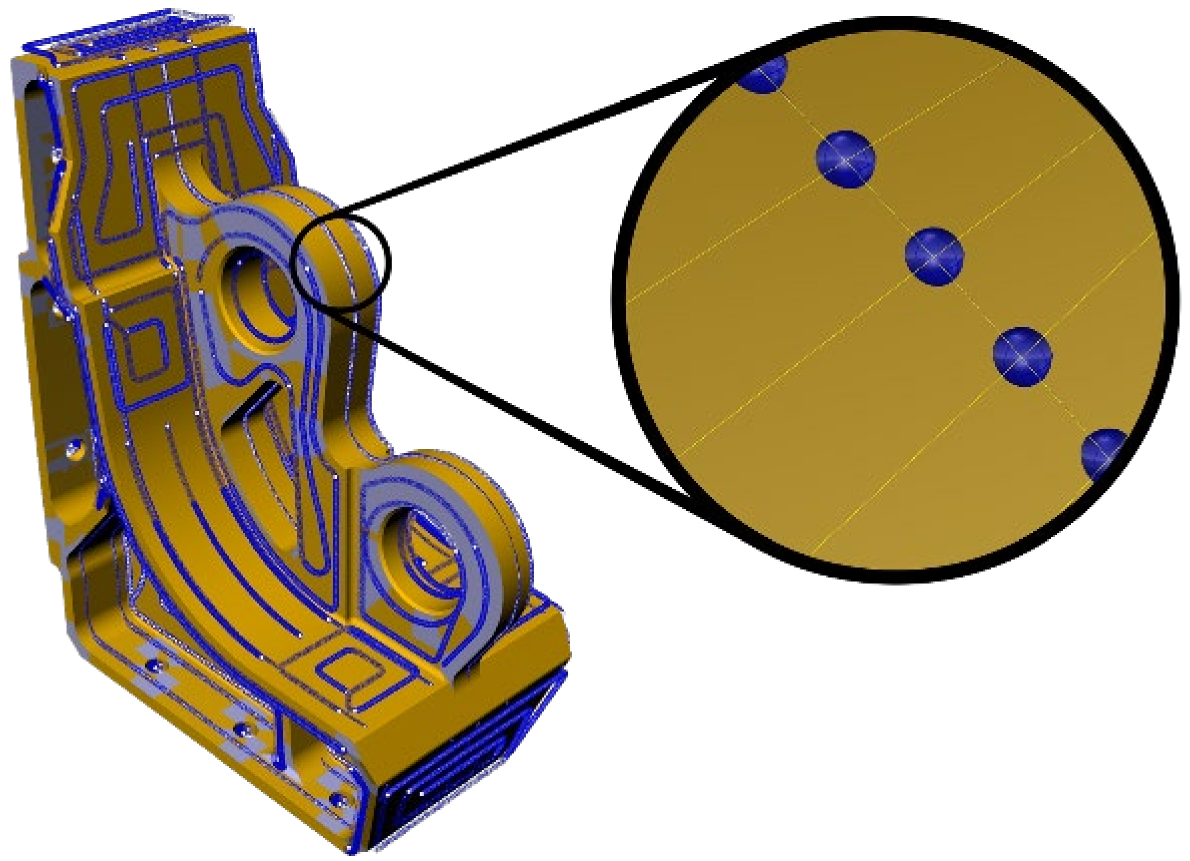
CAI
as-inspected



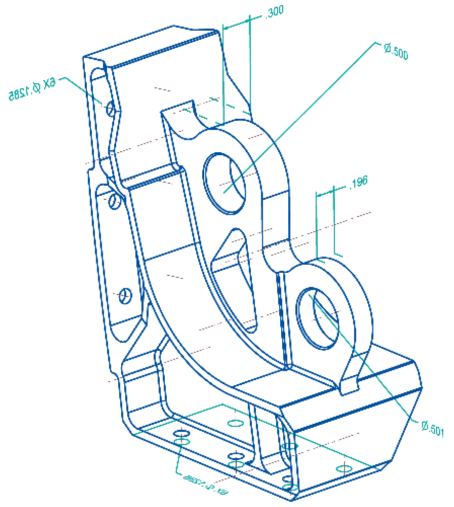
mapping?

S. Kwon, W. Z. Bernstein, L. V. Monnier, and R. Barbau, "Enriching Standards-Based Digital Thread by Fusing As-Designed and As-Inspected Data Using Ontologies," vol. 46, Aug. 2020.

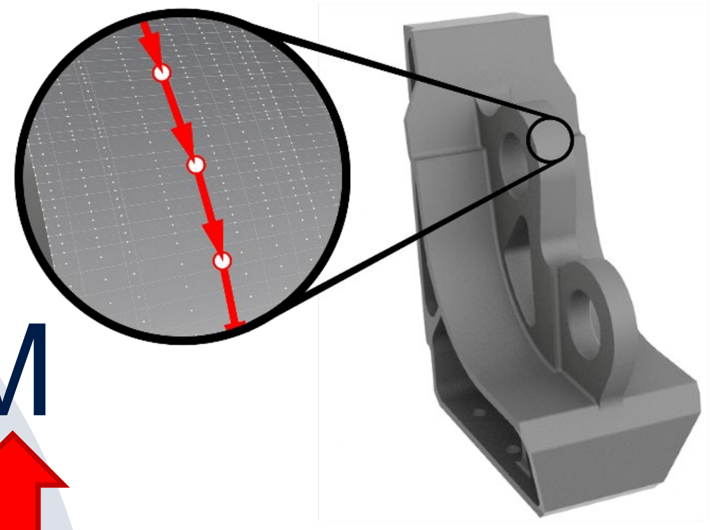
inspection features

“Feature mapping?”

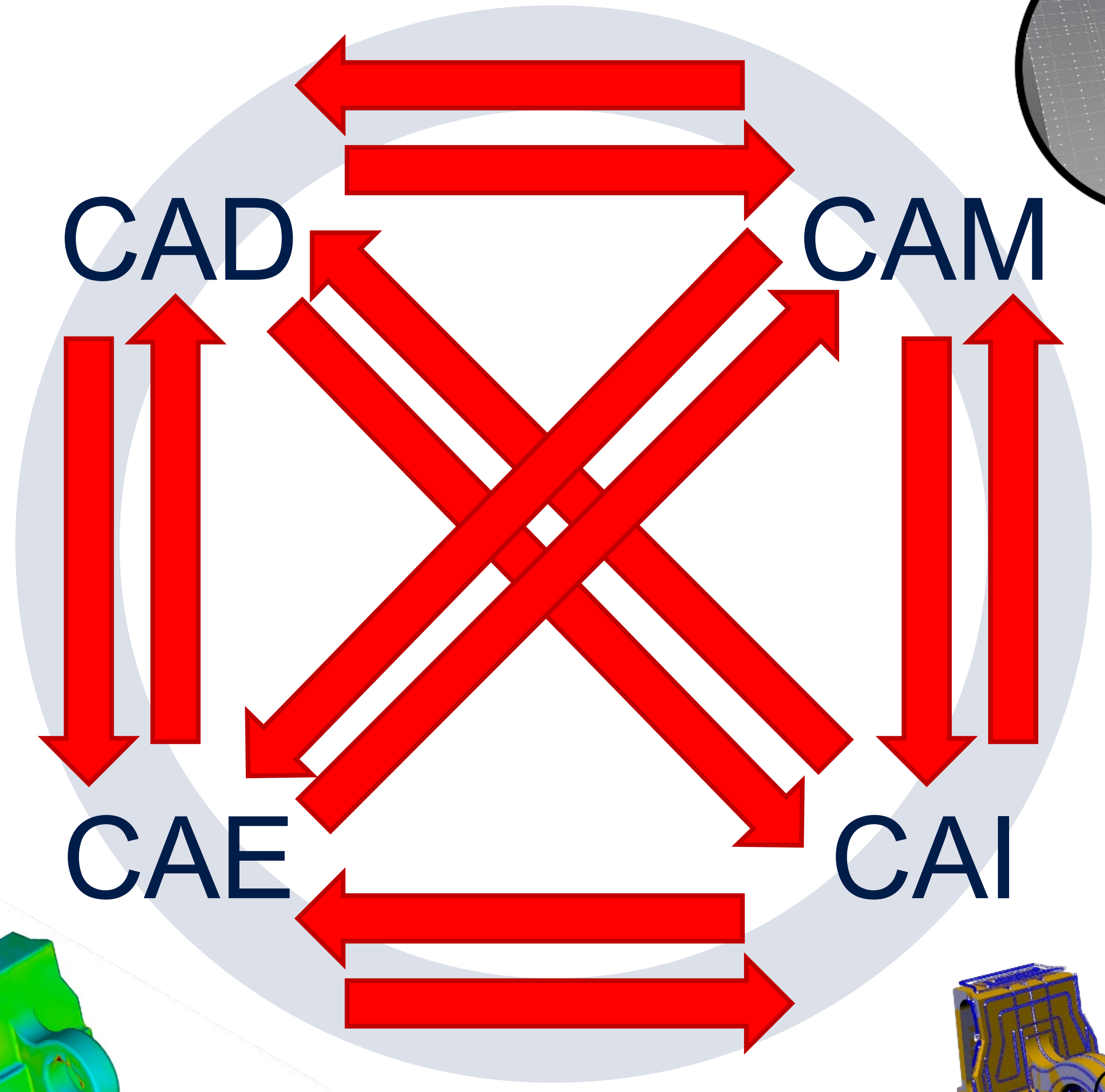
design features



manufacturing features

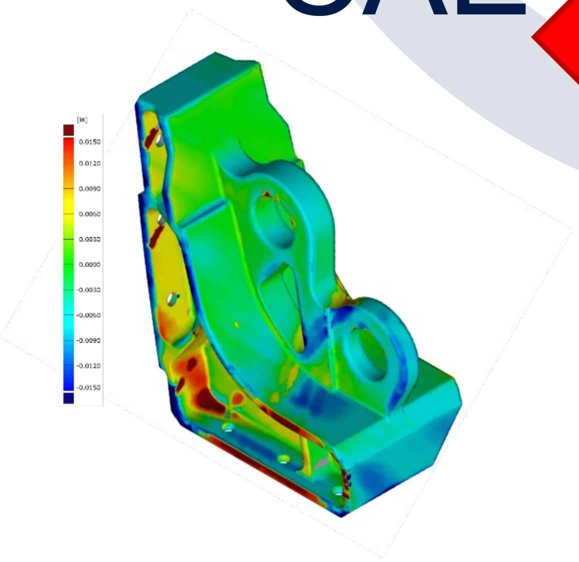


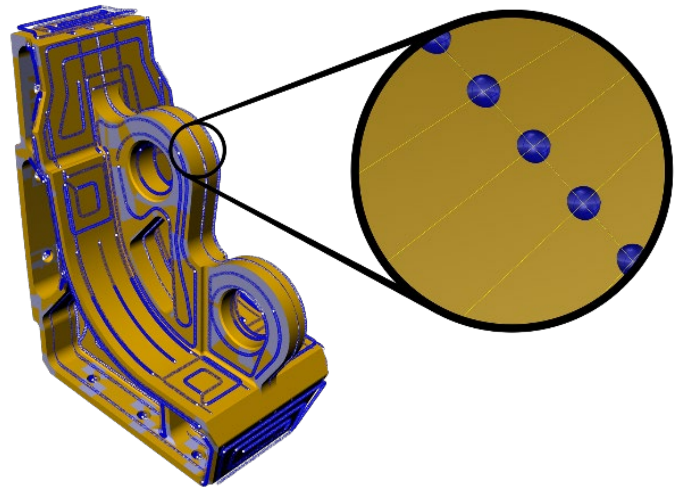
feature translation **?**



- ***redundant***
- ***updates?***
- ***maintenance?***

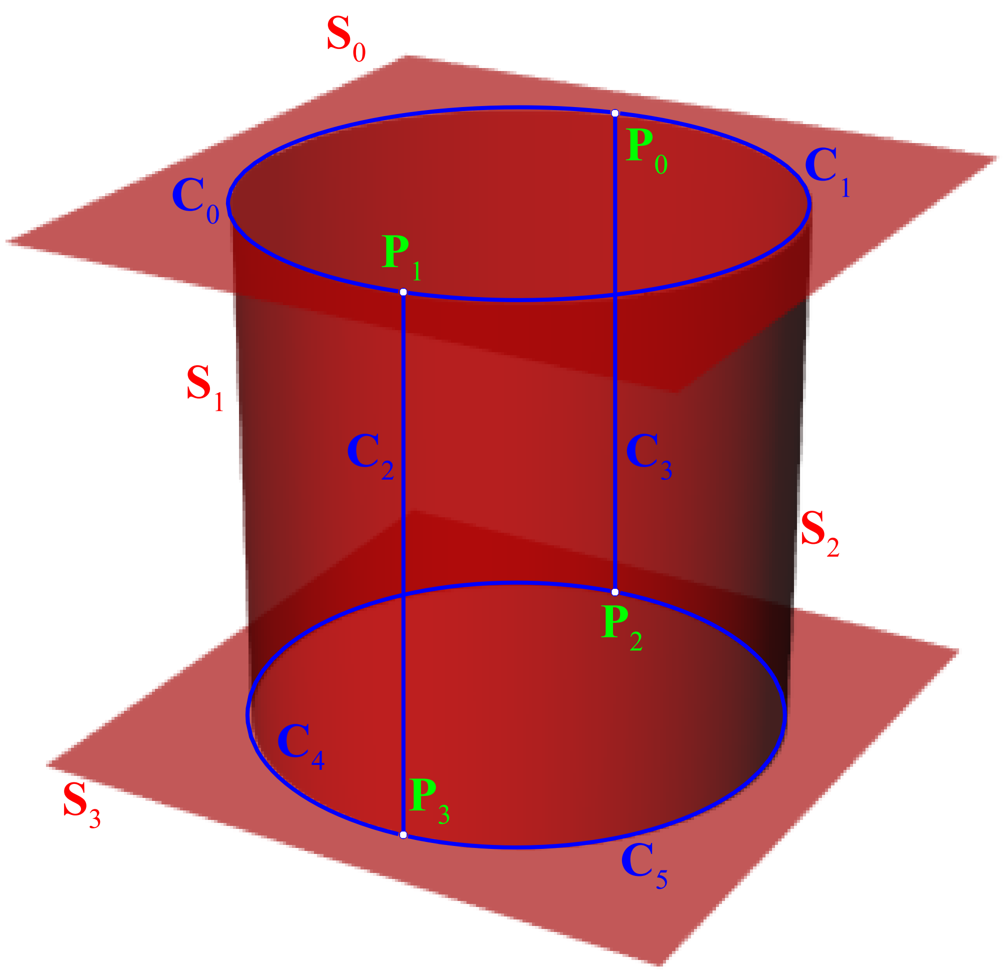
engineering features

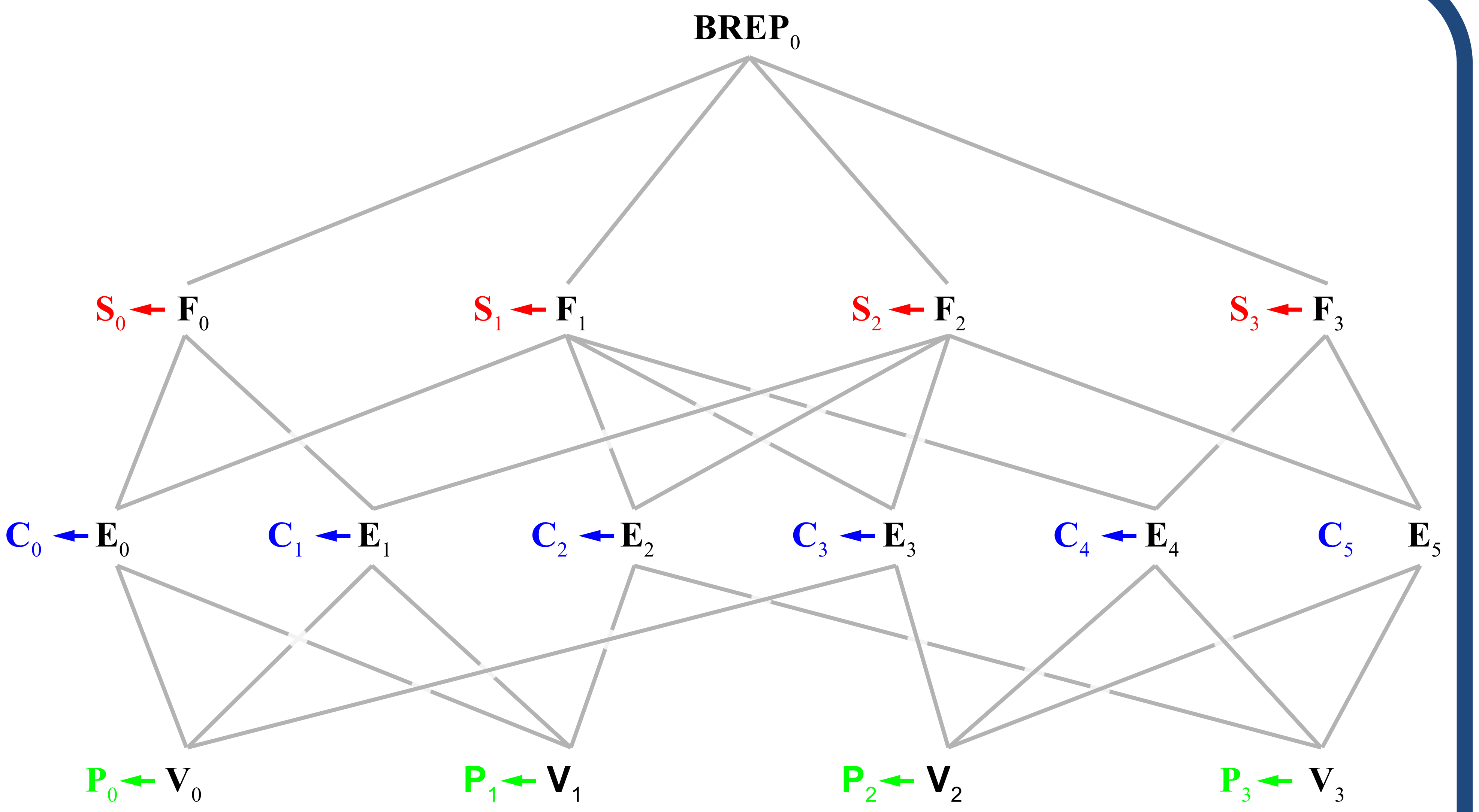




inspection features

“Feature mapping?”





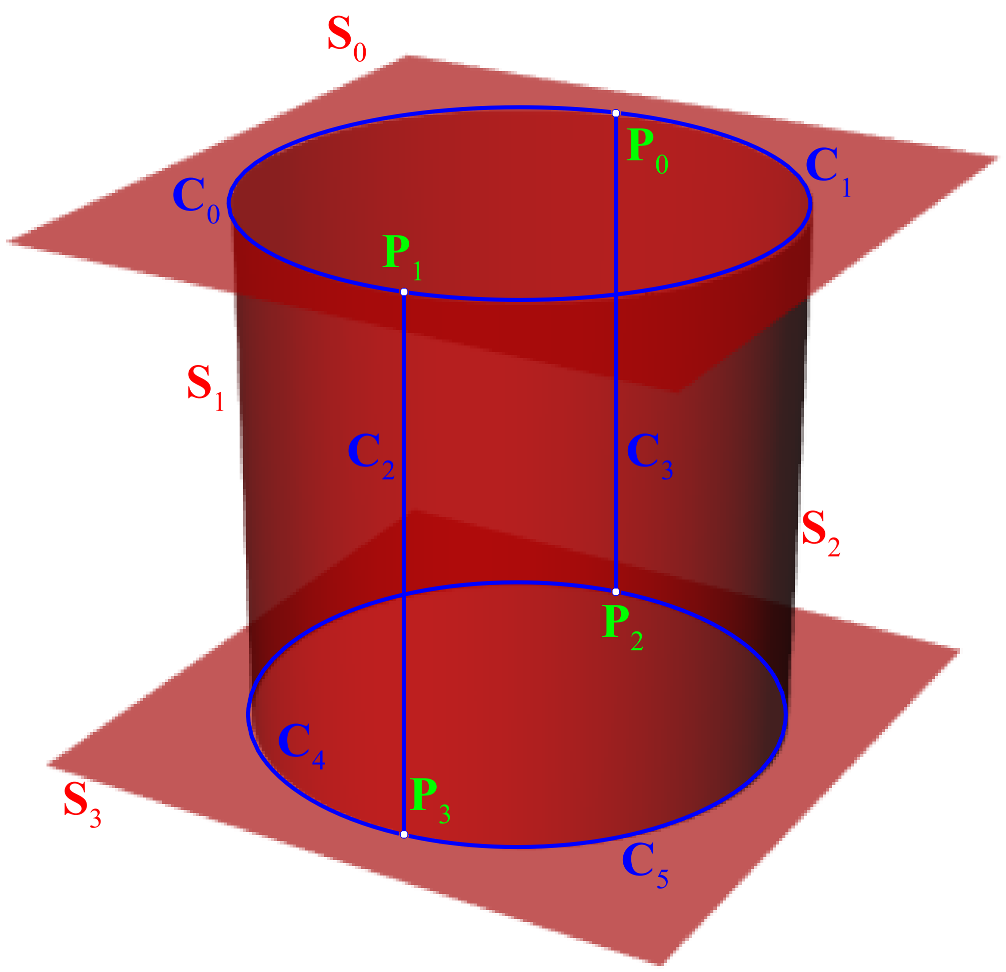
B-rep
geometry

B-rep
topology

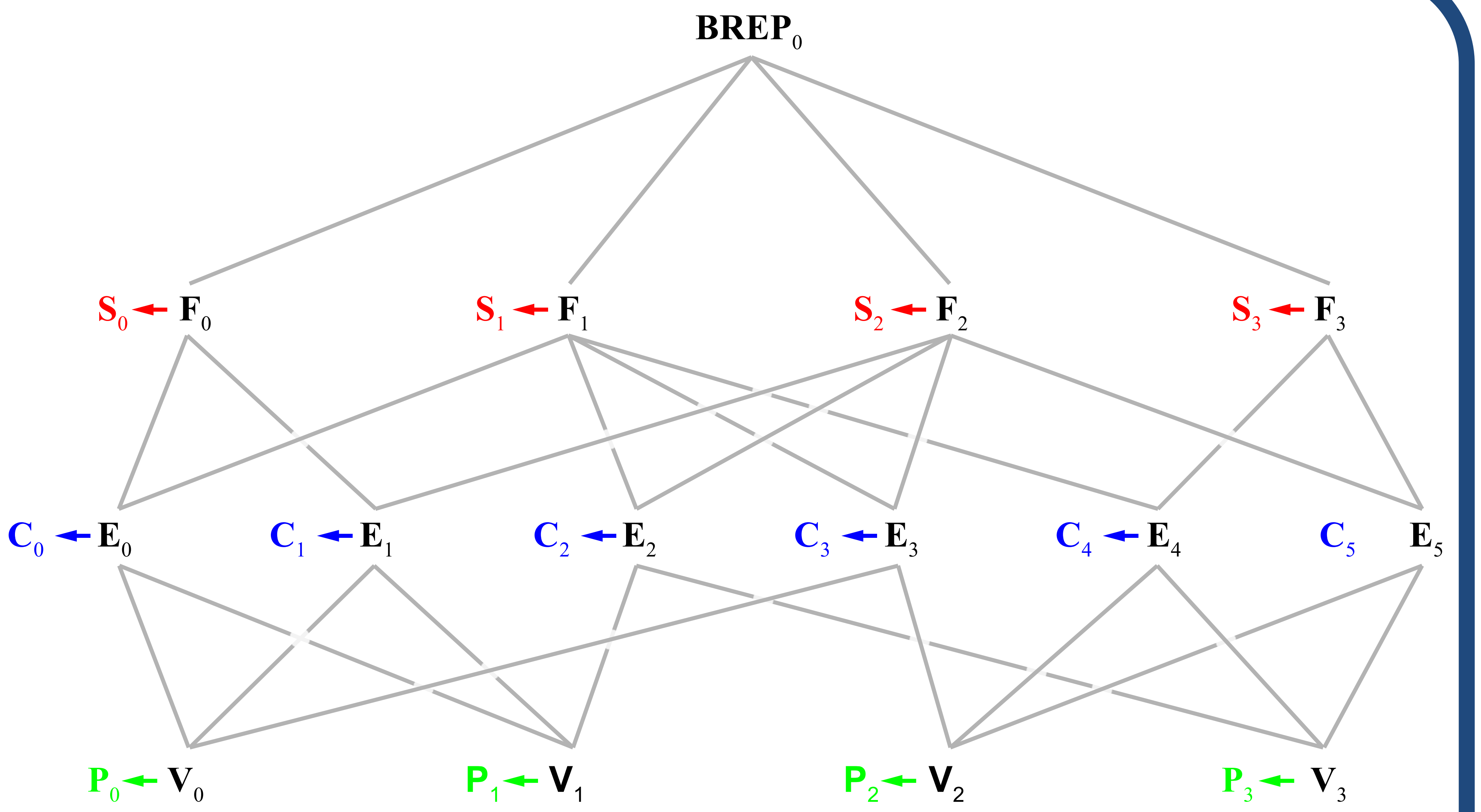
characteristics

geometric / solid model : *geometry* **+** *topology*

“Feature mapping?”



B-rep
geometry



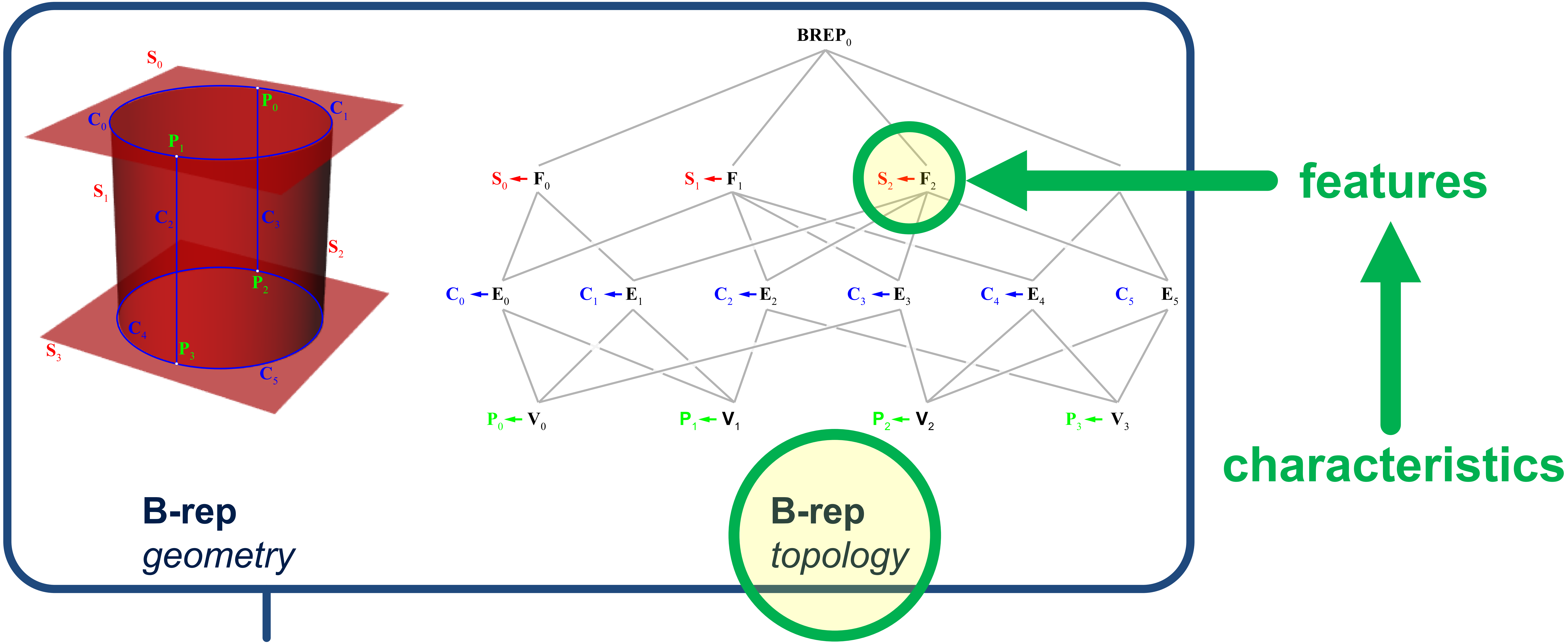
B-rep
topology

features

characteristics

geometric / solid model : *geometry* **+** *topology*

"Feature mapping?"



geometric / solid model : *geometry* **+** *topology*

“Feature mapping?”

<u>Across CAx domains:</u>

- Feature mapping ← **no**
- Feature reference / tracking ← **yes**

nVariate

PMI: Graphical VS Semantic

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- How to distinguish in data exchange?

  graphical and semantic are in dedicated scopes of standards

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- How to distinguish in data exchange?

  graphical and semantic are in dedicated scopes of standards

- What standard are CAD models for downstream CAx use authored to?

ASME Y14.41 MBD

1. **“geometry”**
2. **annotations**
3. **attributes**
4. **presentation**

PMI: Graphical VS Semantic

- How to distinguish in data exchange?

  graphical and semantic are in dedicated scopes of standards

- What standard are CAD models for downstream CAx use authored to?

ASME Y14.41 MBD

1. **"geometry"**
2. **annotations**
3. **attributes**
4. **presentation**

no reference to:

~~geometric model,~~ ~~topology~~

~~graphical vs semantic~~

~~PMI~~

PMI: Graphical VS Semantic

- How to distinguish in data exchange?

  graphical and semantic are in dedicated scopes of standards

- What standard are CAD models for downstream CAx use authored to?

ASME Y14.41 MBD

1. **"geometry"**
2. **annotations**
3. **attributes**
4. **presentation**

no mapping:

~~**geometric model,**~~ ~~**topology**~~

~~**graphical vs semantic**~~

~~**PMI**~~

PMI: Graphical VS Semantic

- How to distinguish in data exchange?

  graphical and semantic are in dedicated scopes of standards

- What standard are CAD models for downstream CAx use authored to?

ASME Y14.41 MBD

1. “geometry”
2. annotations
3. attributes
4. presentation

CAD

authoring

disconnect:

~~geometric model, topology~~

~~graphical vs semantic~~

~~PMI~~

CAI, CAM, CAE

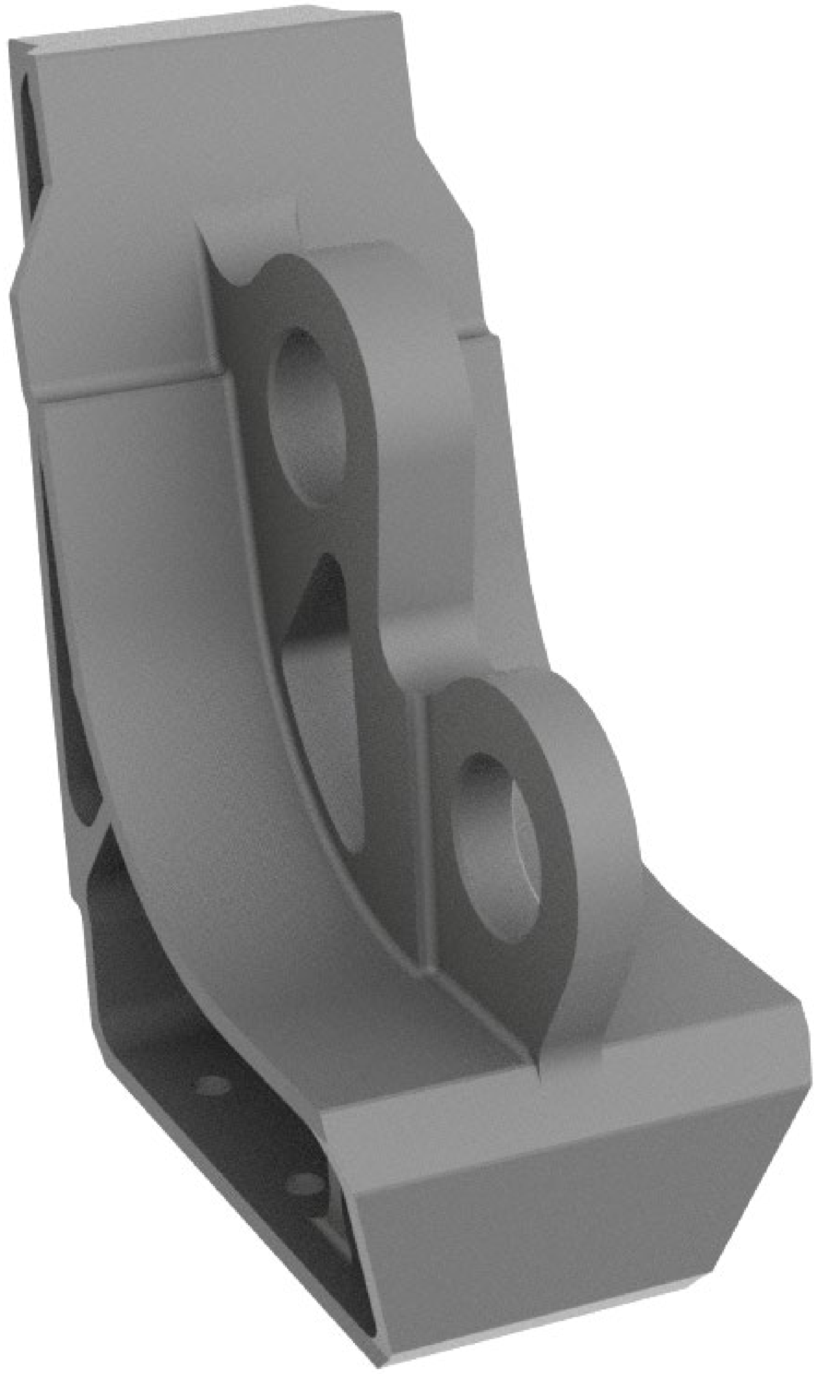
downstream consumption

PDQ

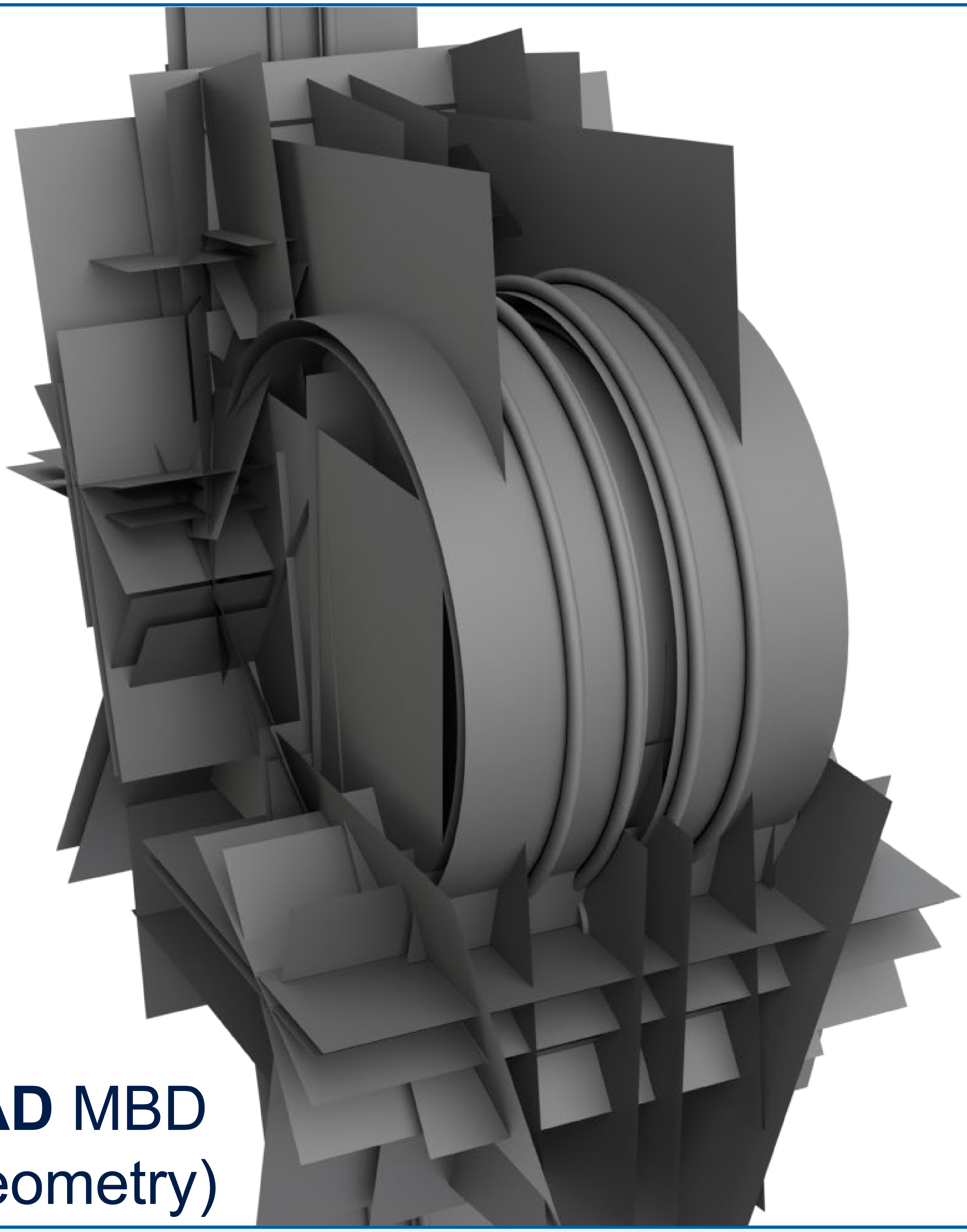
PDQ

- **PDQ** := “**P**roduct **D**ata **Q**uality”

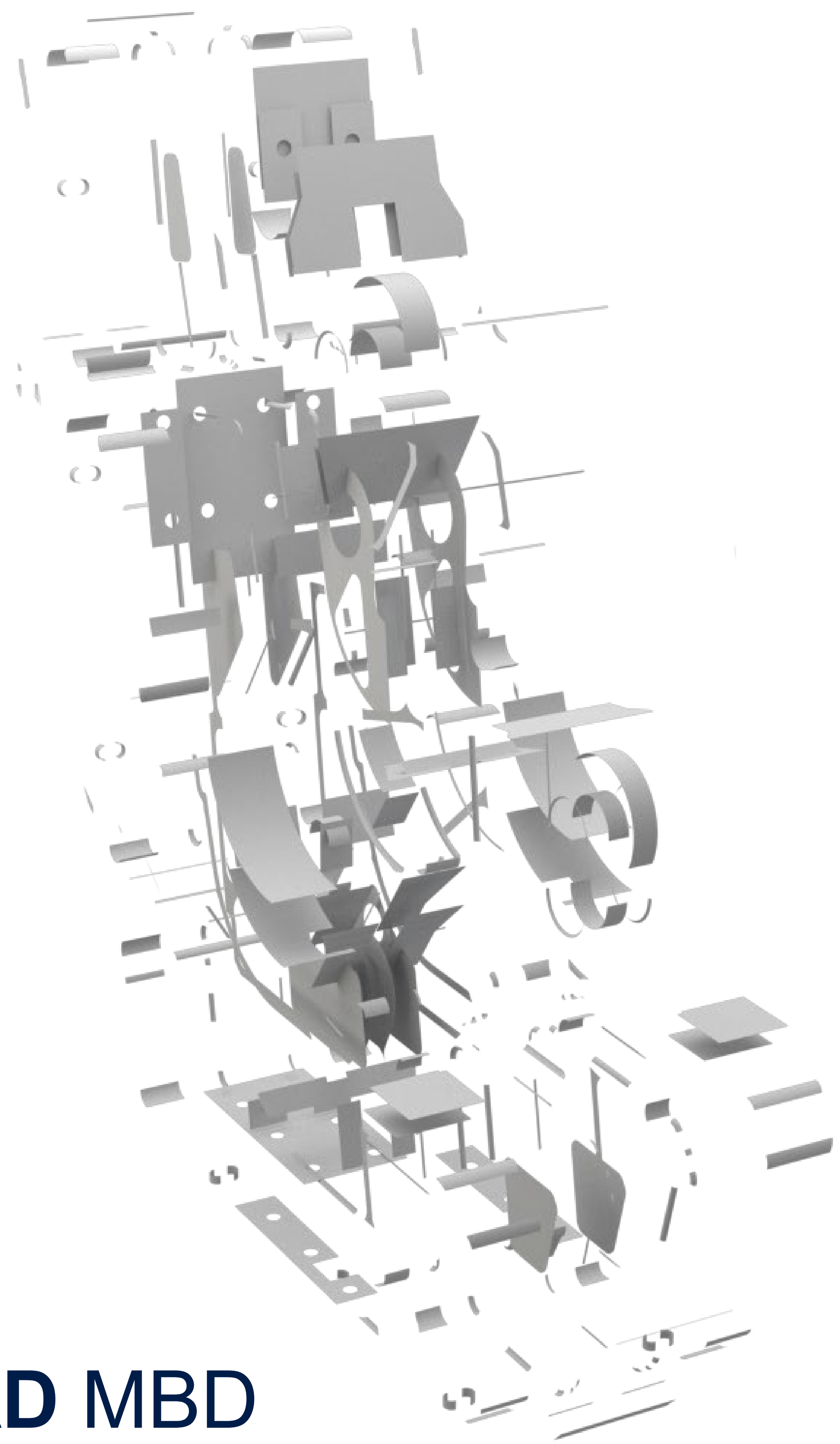
PDQ



CAD MBD
(graphical)

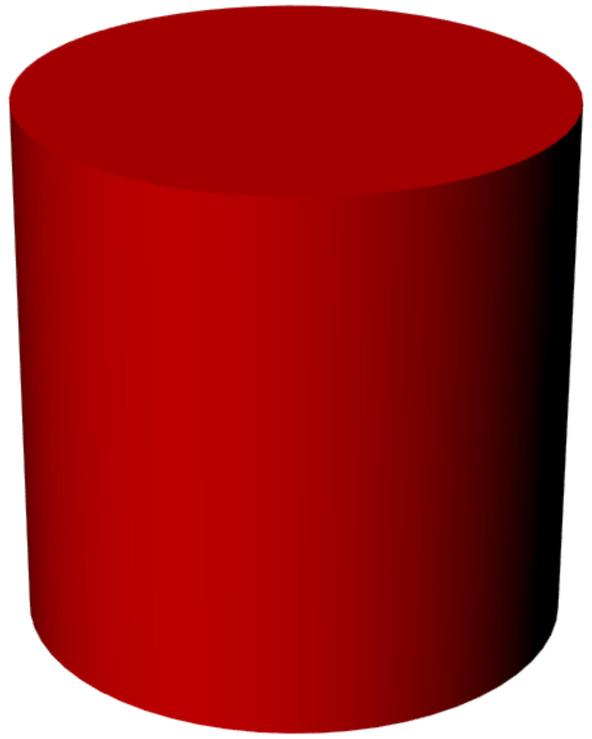


CAD MBD
(geometry)



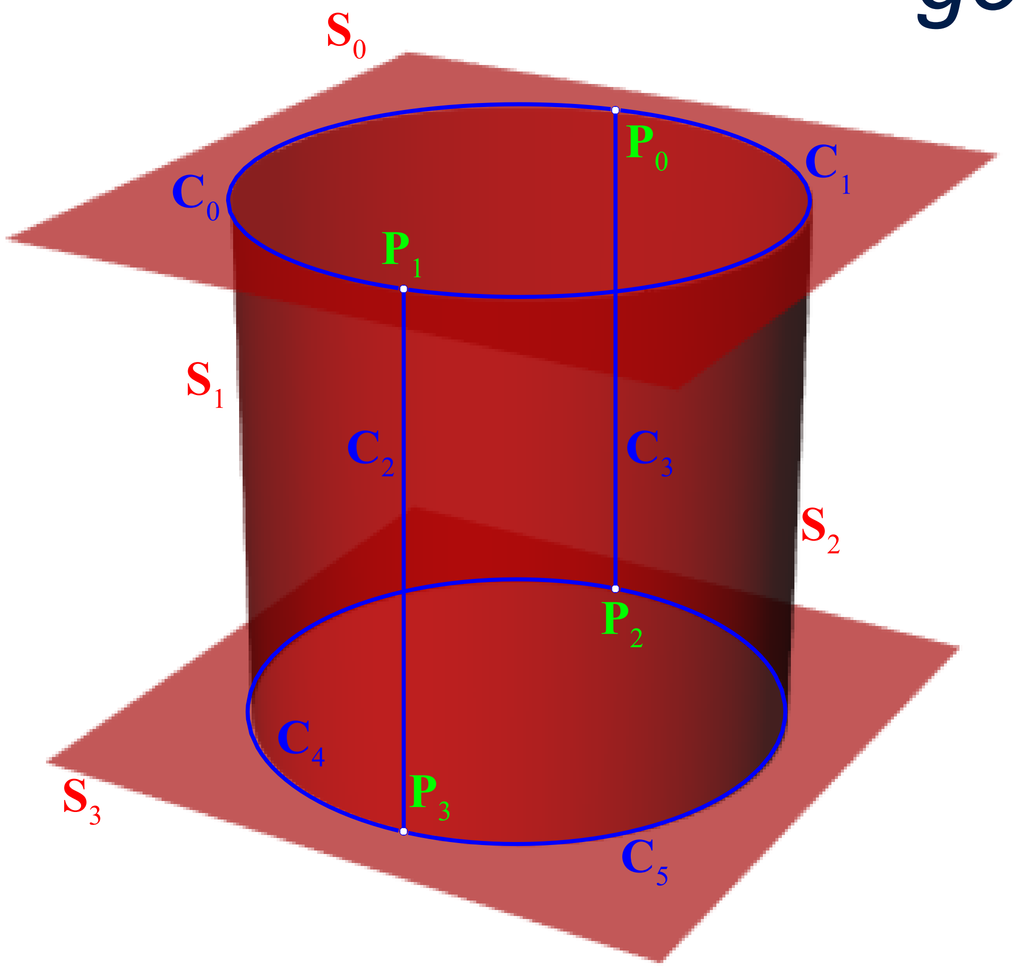
CAD MBD
(geometry exploded)

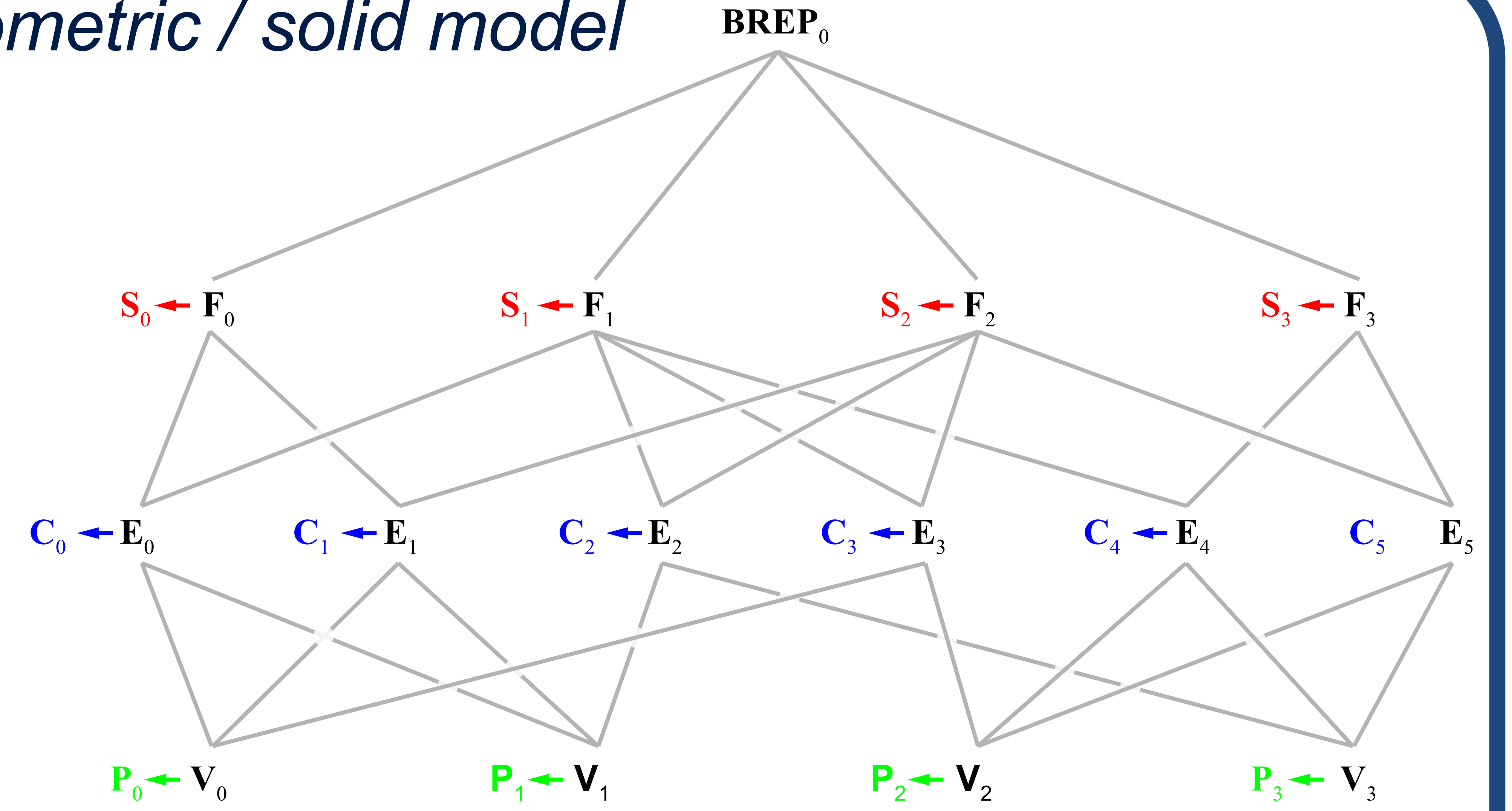
PDQ



B-rep
graphical rendering

geometric / solid model





B-rep
geometry

B-rep
topology

geometrically <u>non</u>-watertight:
lacking G^n, C^n continuity

topologically watertight:
graph ("face-edge-vertex") satisfying closure metric

*n*Variate

PDQ

- **PDQ** := “**P**roduct **D**ata **Q**uality”
- ASME Y14.41 – see new additions for model accuracy in next edition

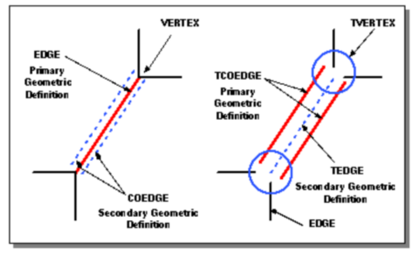
ACIS was developed as an exact modeler, because accurate models are both robust and reliable. A model's geometry, which contains the mathematical definitions describing the intersections, agrees with the topology, which shows how model elements are connected together.

Tolerant modeling does not assume that geometry agrees with the topology, and takes the geometric error in the topology into consideration during modeling operations and calculations.

ACIS uses SPAresabs as a tolerance value for all calculations on an exact model. Tolerant modeling assigns a tolerance value to each tolerant edge and tolerant vertex as part of the topology. This happens only when required to maintain model topology integrity.

For example, imagine a simple rectangular block. This has six faces, 12 edges, and 24 coedges. In an exact model, a coedge of one face references the same underlying geometric definition as a coedge of an adjacent face. There is one edge intersection for both. However, if one of the faces of the rectangular block isn't lined up properly with another adjacent face, the pair of associated adjacent coedges do not reference the same underlying geometric definition. The coedge(s) and edge do not represent the same geometric position, and the model is considered "leaky".

Figure 6-1 shows the difference between an exact edge and a tolerant edge. The left side of the figure illustrates the exact topology, where the EDGE contains the primary geometric definition and the COEDGE the secondary.



Tolerance Variables

Topic: *Precision and Tolerance

In order to maintain model integrity, the modeler must work to specified tolerances. Applying tolerances insures proper interpretation of positions, such as maintaining that the points of vertices lie on the curves of the edges they bound or correctly determining if a position is inside or outside a volume.

ACIS uses the tolerance variables SPAresabs, SPAresnor, and SPAresfit to control modeling operations. These are global variables defined in the system that affect modeling functionality. All modeling operations in ACIS use these tolerance variables to maintain consistency of mathematical operations. Although SPAresnor should not be changed by the application, SPAresabs and SPAresfit may be changed, with great care, as explained in this chapter.

SPAresabs

Topic: *Precision and Tolerance

SPAresabs is named for *resolution absolute*. It is the smallest meaningful quantity representable in ACIS. This can be interpreted as the distance below which ACIS considers two points to be coincident. If two points, *A* and *B*, are separated by less than SPAresabs, they are considered to be the same point.

SPAresabs also represents the smallest feature being modeled, since it is the smallest distance between two points. The default value is 10^{-6}. The default value was chosen assuming that at least an order of magnitude *guard band* around SPAresabs is required. Refer to the section *Dynamic Range* for more information.

SPAresnor

Topic: *Precision and Tolerance

SPAresnor is named for *resolution normalized*. This is the ratio of the smallest meaningful quantity representable in ACIS (SPAresabs) to the largest. This reflects the precision to which numerical values are calculated and stored. The default value is 10^{-10}.

From the definition SPAresnor = SPAresabs/largest, the largest quantity representable in ACIS is:

$$\text{largest} = \frac{\text{SPAresabs}}{\text{SPAresnor}} = \frac{10^{-6}}{10^{-10}} = 10^{4}$$

SPAresfit

Topic: *Precision and Tolerance

SPAresfit is named for *resolution fit*. This is used as a guide to the fitting algorithms for the fit tolerance of an approximate curve or surface. The default value is 10^{-3}.

Polynomial approximations are computed for some curves and surfaces in ACIS. The approximations are stored in the model together with their corresponding curve or surface definitions. The approximations are used:

- Alone when approximate geometry is sufficient (e.g., for drawing).
- Together with the curve or surface definitions when more precise geometry is required; using the two together can make algorithms faster than using the curve or surface definitions alone.

Some fitting algorithms are adaptive, and therefore may produce tighter fits than SPAresfit in certain circumstances; for example, in regions of high curvature.

3D ACIS Modeler

SPATIAL

SIEMENS NX

Tolerant modeling	Models imported from other applications may be less accurate (use lower precision) compared with the high-accuracy models created in Parasolid. As a result, errors may become apparent in the imported model, for example, gaps arising between edges that would be considered coincident in the lower accuracy modeler. Parasolid uses Tolerant Modeling to accommodate low precision data by applying local tolerance information. This enables downstream modeling operations to proceed without errors arising due to the inaccuracy of the imported data.

ptc

About Part Accuracy

The accuracy settings for parts control the accuracy of geometry calculations. The valid range of part accuracy is from `0.01` through `0.0001`. The default value of the `default_abs_accuracy` configuration option is `0`, which creates a new empty part with an accuracy of 0.00039 inches, unless another value is defined. The smaller the value of part accuracy, the longer the regeneration time.

The configuration option `accuracy_lower_bound` overrides the default lower limit.

There are two types of accuracy:

- **Relative**—The value should be set as less than half the ratio of the length of the smallest edge on the model to the length of the longest diagonal of the bounding box of the model. Use relative accuracy when you do not need to copy or import geometry from other parts or models.
- **Absolute** (default)—The value should be set as the smallest recognized size, measured in the current units. Use absolute accuracy when importing a part created using a different system or when copying geometry from one model to another. You must set a uniform absolute accuracy or select the smallest absolute accuracy value as the common accuracy value to make the parts compatible.

When matching absolute accuracy of two models defined with relative accuracy, determine the part sizes using **Tools** > **Investigate** > **Model Size** and multiply each by its respective relative accuracy. If the results differ, select a relative accuracy value that yields the same result for both parts. You may need to increase the part precision of the larger part by using a smaller relative accuracy value. For example, if the size of one part is `100` and its accuracy is `.01`, the product of these numbers is `1`. If the size of the other part is `1000` and the accuracy is `.01`, the product of these numbers is `10`. Change the the second part to `.001` to yield the same result.

CATIA

Model Size: the Bounding Box of the CGM Model

The factory defines the maximum box inside which the geometric objects must be. This box is defined by the *Model Size*, fixed to 10^6mm (10^5mm before R14). As the unit is the millimeter, all the objects must be inside the box [-1000m, +1000m] ([-100m, +100 m] before R14).

Resolution: the Lower Valid Length of an Object of the CGM Model

The *Resolution* defines the minimum length of a valid object. It is fixed to `10^-3.unit`. As the unit is mm, lines of length smaller than `1micro-m` are not valid.

The management of confusions ("Do two objects have the same geometry?") is a direct consequence of the resolution: if the distance between to geometric points is less than the resolution, the two points are considered to be geometrically at the same location.

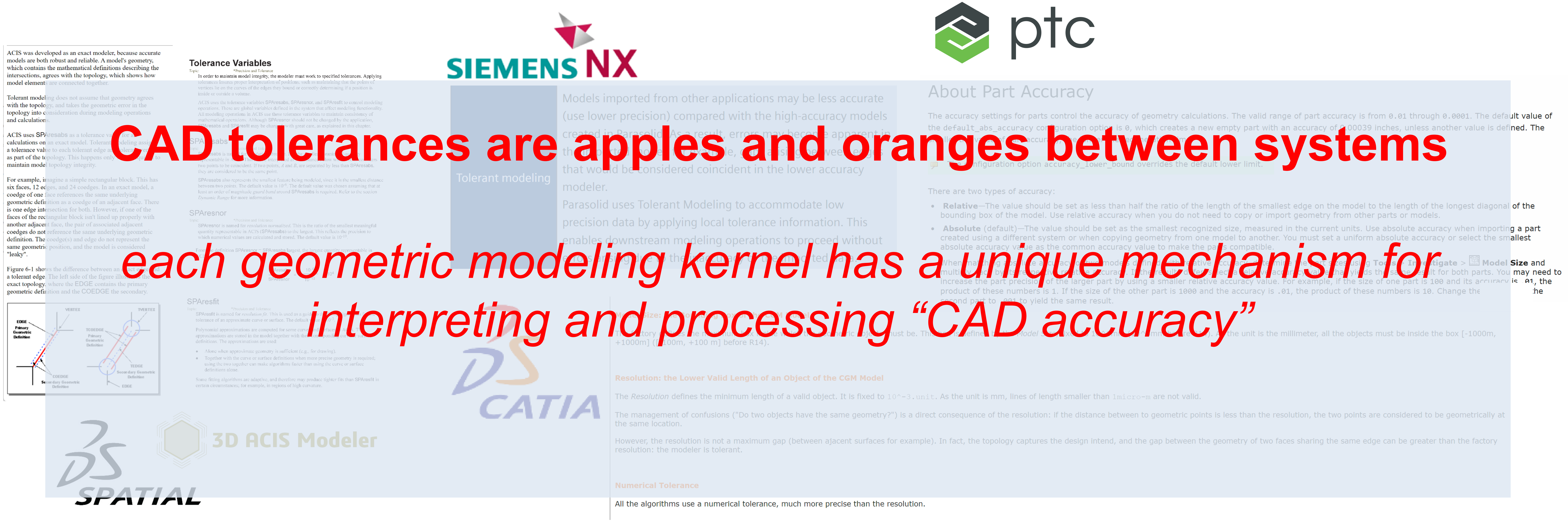
However, the resolution is not a maximum gap (between ajacent surfaces for example). In fact, the topology captures the design intend, and the gap between the geometry of two faces sharing the same edge can be greater than the factory resolution: the modeler is tolerant.

Numerical Tolerance

All the algorithms use a numerical tolerance, much more precise than the resolution.

PDQ

- **PDQ** := “**P**roduct **D**ata **Q**uality”
- ASME Y14.41 – see new additions for model accuracy in next edition

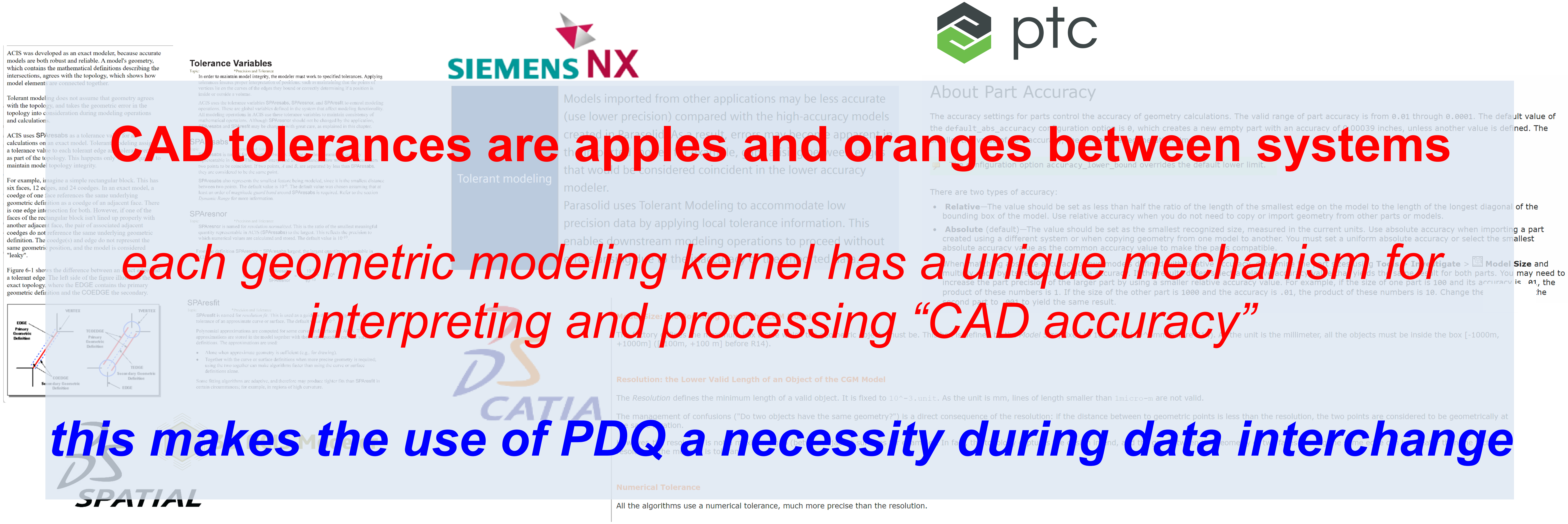


CAD tolerances are apples and oranges between systems

each geometric modeling kernel has a unique mechanism for interpreting and processing “CAD accuracy”

PDQ

- **PDQ** := "**P**roduct **D**ata **Q**uality"
- ASME Y14.41 – see new additions for model accuracy in next edition



CAD tolerances are apples and oranges between systems

each geometric modeling kernel has a unique mechanism for interpreting and processing "CAD accuracy"

this makes the use of PDQ a necessity during data interchange

PDQ

- a good reference on what PDQ is and what value it has in MBE

Proceedings of the ASME 2007 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference
IDETC/CIE 2007
September 4-7, 2007, Las Vegas, Nevada, USA

DETC2007-34748

PDQ (PRODUCT DATA QUALITY): QUALITY GUARANTEED PRODUCT DATA REPRESENTATION AND APPLICATION TO SHAPE MODEL

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Faculty of Science and Engineering,
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Fumiki TANAKA
Systems Science and Informatics Division,
Graduate School of Information Science and Technology, Hokkaido University

Kazuya G. KOBAYASHI
Department of Mechanical Systems Engineering,
Faculty of Engineering,
Toyama Prefectural University

Atsuto SOMA
ELYSIUM Co., Ltd.

PDQ

NIST

Search NIST

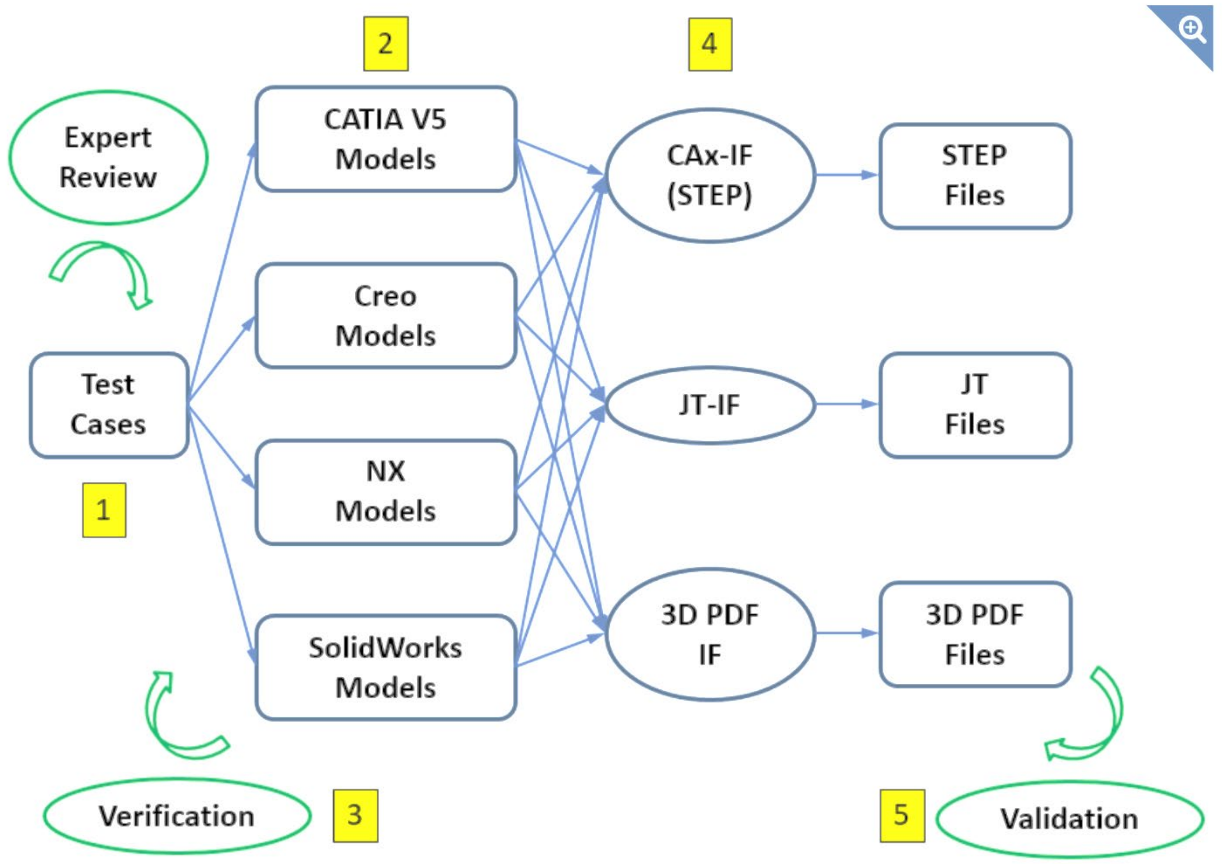
Menu

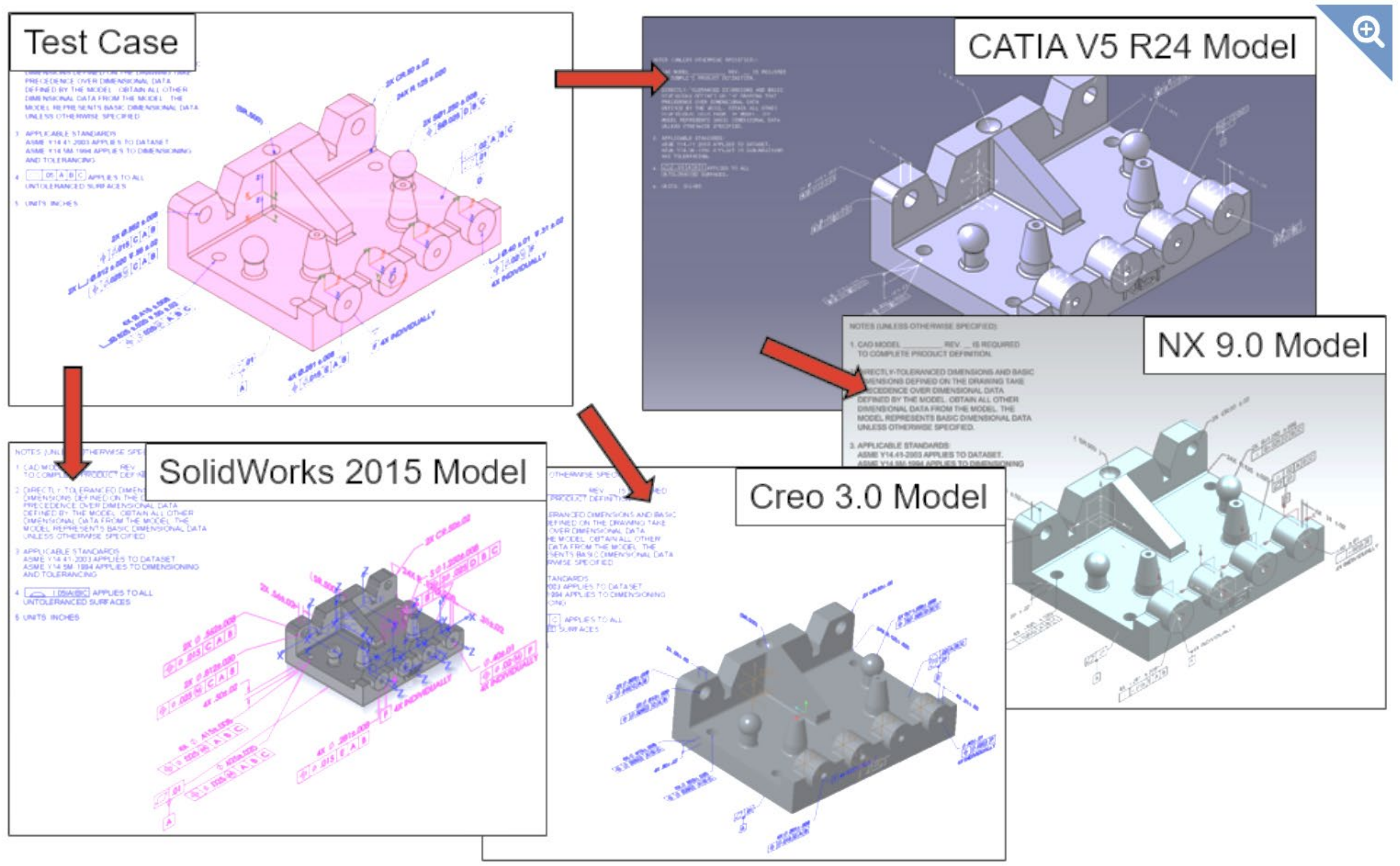
Communications Technology Laboratory / Smart Connected Systems Division

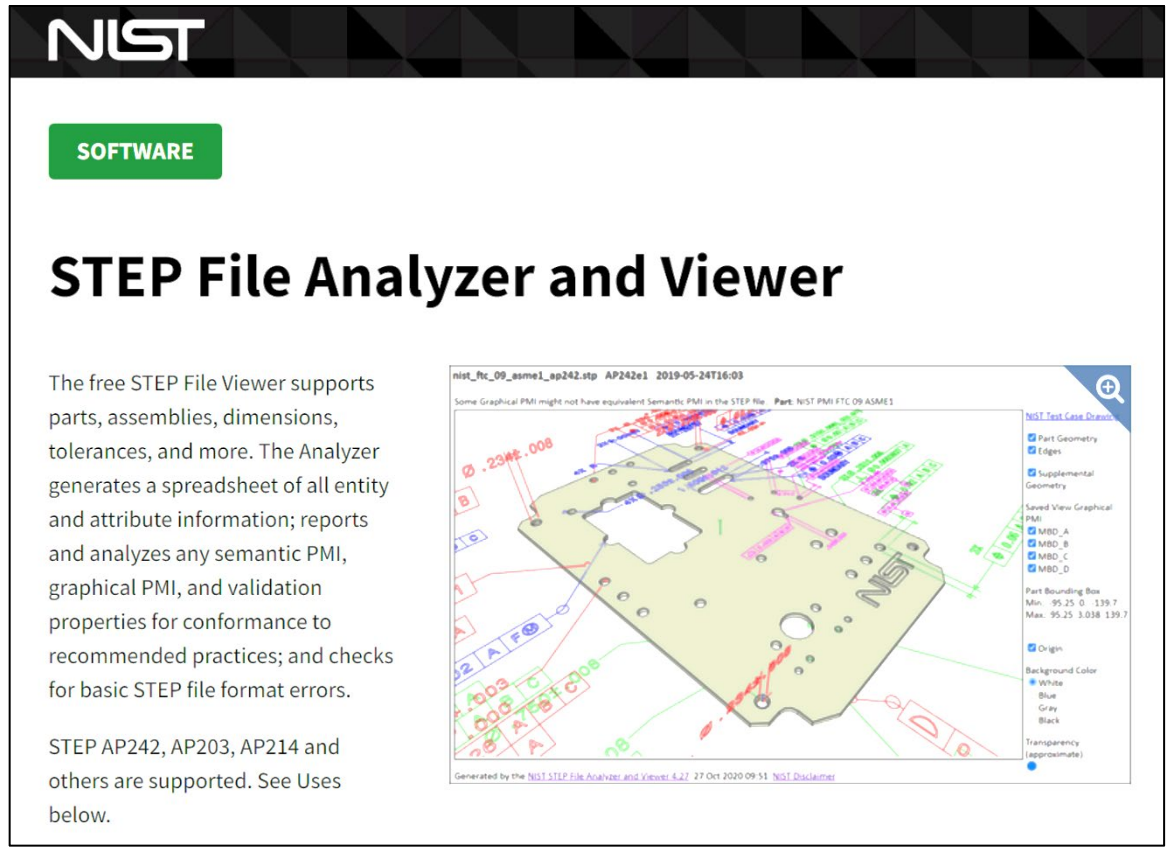
SMART CONNECTED MANUFACTURING SYSTEMS GROUP

MBE PMI Validation and Conformance Testing Project

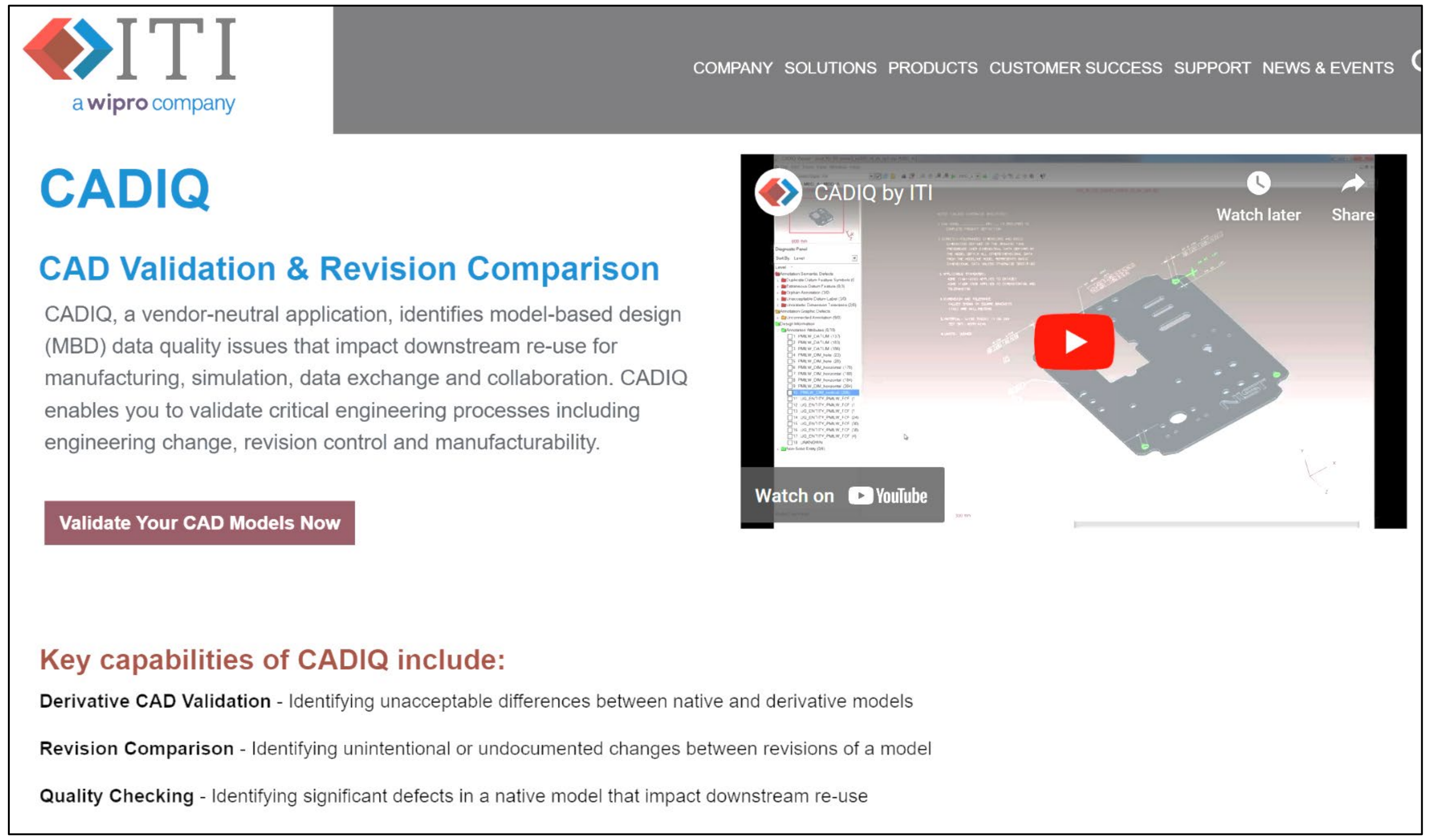
MBE PMI Validation and Conformance Testing Project

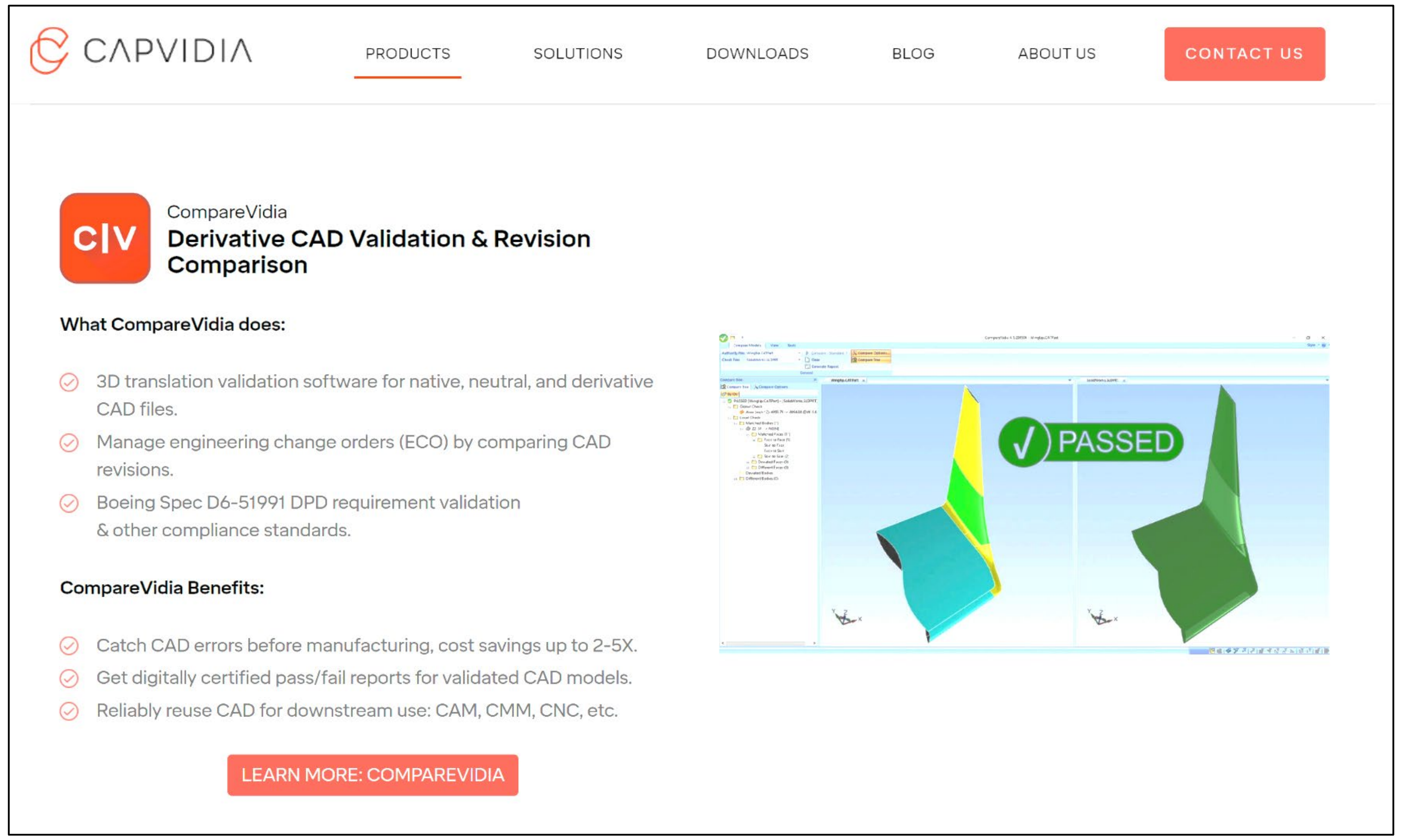




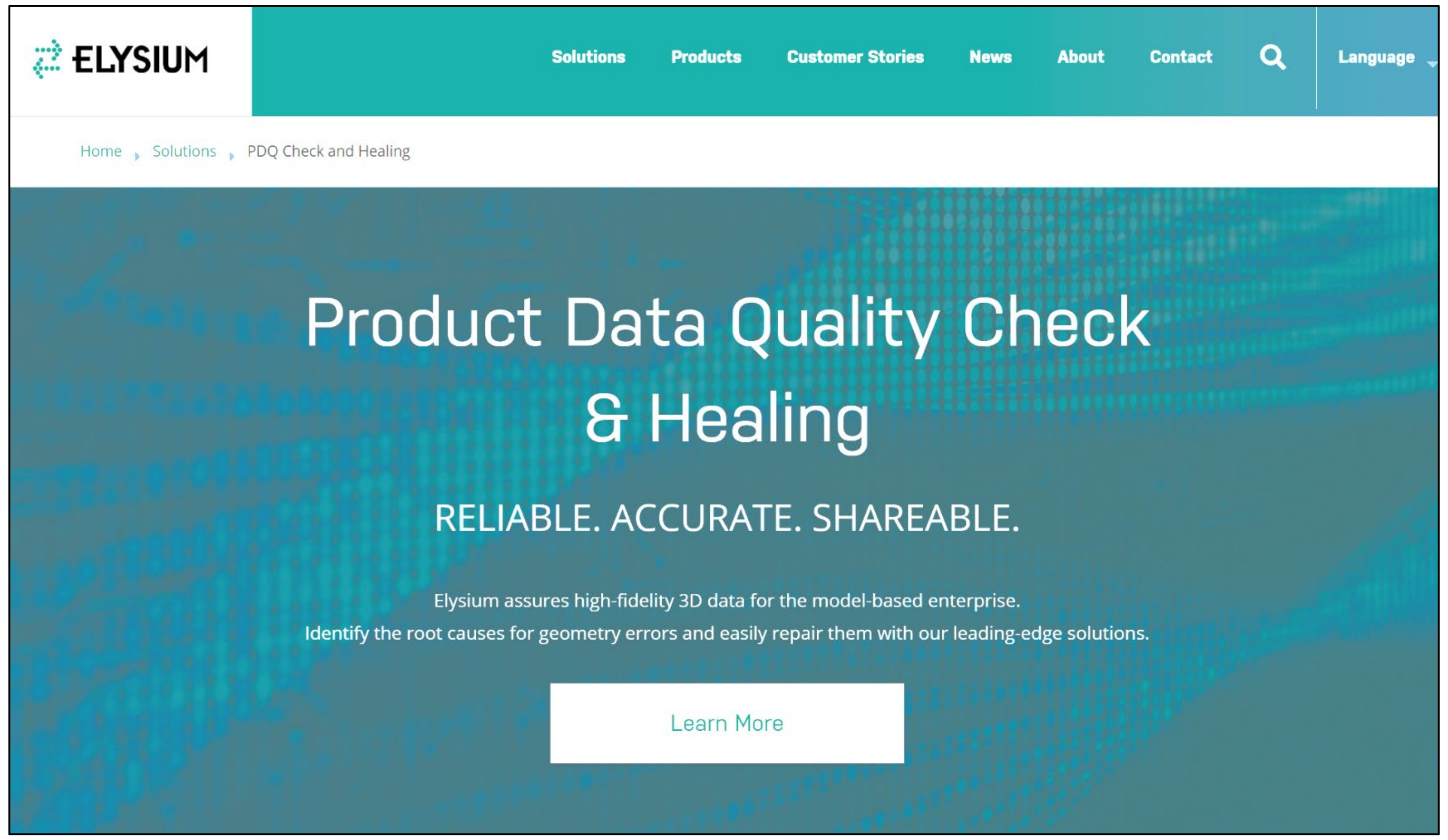


PDQ





ITI
a wipro company



CAPVIDIA

ELYSIUM

PDQ

- Generally **underutilized**; should be **ubiquitous in digital thread**

  (should ideally almost be running continuously in the background)
- Applies to both **MBD** and **PMI** (especially **semantic** checking!)
- PDQ criteria is ultimately driven by use-case / value-add

  *needs managed by personnel to be made **business specific***

UUIDs

UUIDs

- **UUID** := **U**niversally **U**nique **Id**entifier

  `909c0b15-c752-4f4b-864c-fe41dcd5b2a2`

UUIDs

- **IDs** (non-unique)

```
...
#23=OPEN_SHELL('',(#24));
#24=ADVANCED_FACE('',(#25),#54,.T.);
#25=FACE_OUTER_BOUND('',#26,.T.);
#26=EDGE_LOOP('',(#27,#28,#29,#30));
#27=ORIENTED_EDGE('',*,*,#46,.T.);
#28=ORIENTED_EDGE('',*,*,#47,.T.);
#29=ORIENTED_EDGE('',*,*,#48,.T.);
#30=ORIENTED_EDGE('',*,*,#47,.F.);
#31=PCURVE('',#54,#35);
#32=PCURVE('',#54,#36);
#33=PCURVE('',#54,#37);
#34=PCURVE('',#54,#38);
#35=DEFINITIONAL_REPRESENTATION('',(#39),#8130);
#36=DEFINITIONAL_REPRESENTATION('',(#40),#8130);
#37=DEFINITIONAL_REPRESENTATION('',(#41),#8130);
#38=DEFINITIONAL_REPRESENTATION('',(#42),#8130);
#39=B_SPLINE_CURVE_WITH_KNOTS('',1,(#7930,#7931),.UNSPECIFIED.,.F.,.F.,
(2,2),(0.,6.28318530717959),.UNSPECIFIED.);
#40=B_SPLINE_CURVE_WITH_KNOTS('',1,(#7990,#7991),.
...
```

STEP

```
...
<CylinderFeatureNominal id="4738">
  <Attributes n="2">
    <AttributeStr name="_3dv.DefaultFittingAlgo" value="LEASTSQUARES" />
    <AttributeStr name="_3dv.TrueGeomAlgo" value="Y14.5-2009" />
  </Attributes>
  <Name>Nominal 4738</Name>
  <FeatureDefinitionId>4737</FeatureDefinitionId>
  <Axis>
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    <Direction>0 0 1</Direction>
  </Axis>
</CylinderFeatureNominal>
<CylinderFeatureNominal id="9695">
  <Attributes n="2">
    <AttributeStr name="_3dv.DefaultFittingAlgo" value="LEASTSQUARES" />
    <AttributeStr name="_3dv.TrueGeomAlgo" value="Y14.5-2009" />
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    <AxisPoint>2.65 0.5 -0.75</AxisPoint>
    <Direction>0 0 1</Direction>
  </Axis>
</CylinderFeatureNominal>
...
```

QIF

UUIDs

- **UUID** := **U**niversally **U**nique **Id**entifier

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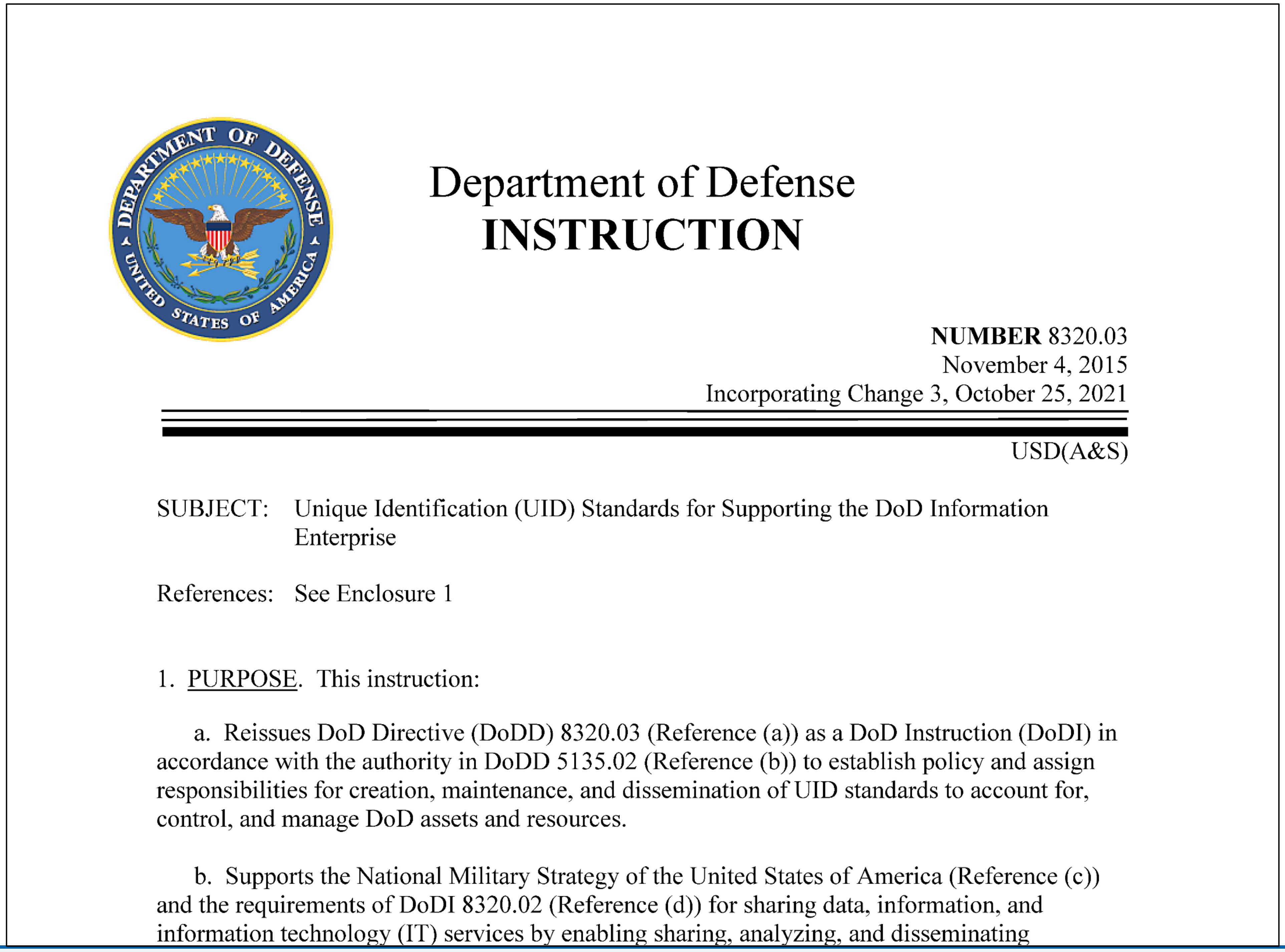

Department of Defense
INSTRUCTION

NUMBER 8320.03
November 4, 2015
Incorporating Change 3, October 25, 2021

USD(A&S)

SUBJECT: Unique Identification (UID) Standards for Supporting the DoD Information Enterprise

References: See Enclosure 1

1. PURPOSE. This instruction:

a. Reissues DoD Directive (DoDD) 8320.03 (Reference (a)) as a DoD Instruction (DoDI) in accordance with the authority in DoDD 5135.02 (Reference (b)) to establish policy and assign responsibilities for creation, maintenance, and dissemination of UID standards to account for, control, and manage DoD assets and resources.

b. Supports the National Military Strategy of the United States of America (Reference (c)) and the requirements of DoDI 8320.02 (Reference (d)) for sharing data, information, and information technology (IT) services by enabling sharing, analyzing, and disseminating

DoD warns of daily UUID conflicts when applied to all data generated

UUIDs

- **UUID** := **U**niversally **U**nique **Id**entifier

  `909c0b15-c752-4f4b-864c-fe41dcd5b2a2`

- UUID’s can be **expensive** (non-trivial costs involved)

  reference checking can be complex

  should not be employed indiscriminately or to every element in the data set; should be used where required

nVariate

UUIDs

- **UUID** := **U**niversally **U**nique **ID**entifier

```
...
#23=OPEN_SHELL('',(#24));
#24=ADVANCED_FACE('',(#25),#54,.T.);
#25=FACE_OUTER_BOUND('',#26,.T.);
#26=EDGE_LOOP('',(#27,#28,#29,#30));
#27=ORIENTED_EDGE('',*,*,#46,.T.);
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#33=PCURVE('',#54,#37);
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(2,2),(0.,6.28318530717959),.UNSPECIFIED.);
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```

STEP


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...
<CylinderFeatureNominal id="4738">
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  </Attributes>
  <Name>Nominal 4738</Name>
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    <Direction>0 0 1</Direction>
  </Axis>
</CylinderFeatureNominal>
<CylinderFeatureNominal id="9695">
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  <Axis>
    <AxisPoint>2.65 0.5 -0.75</AxisPoint>
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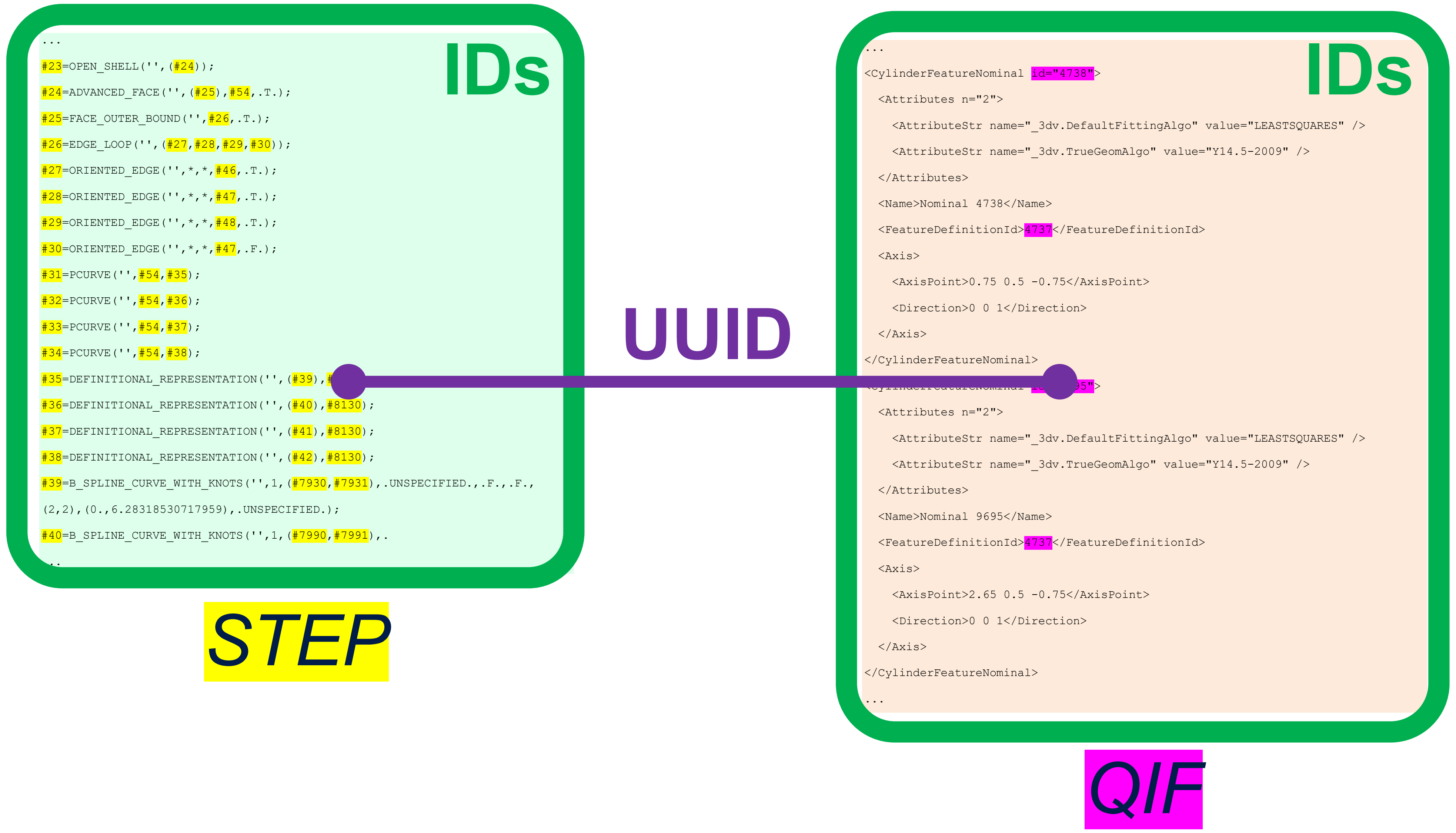
</CylinderFeatureNominal>
...
```


QIF

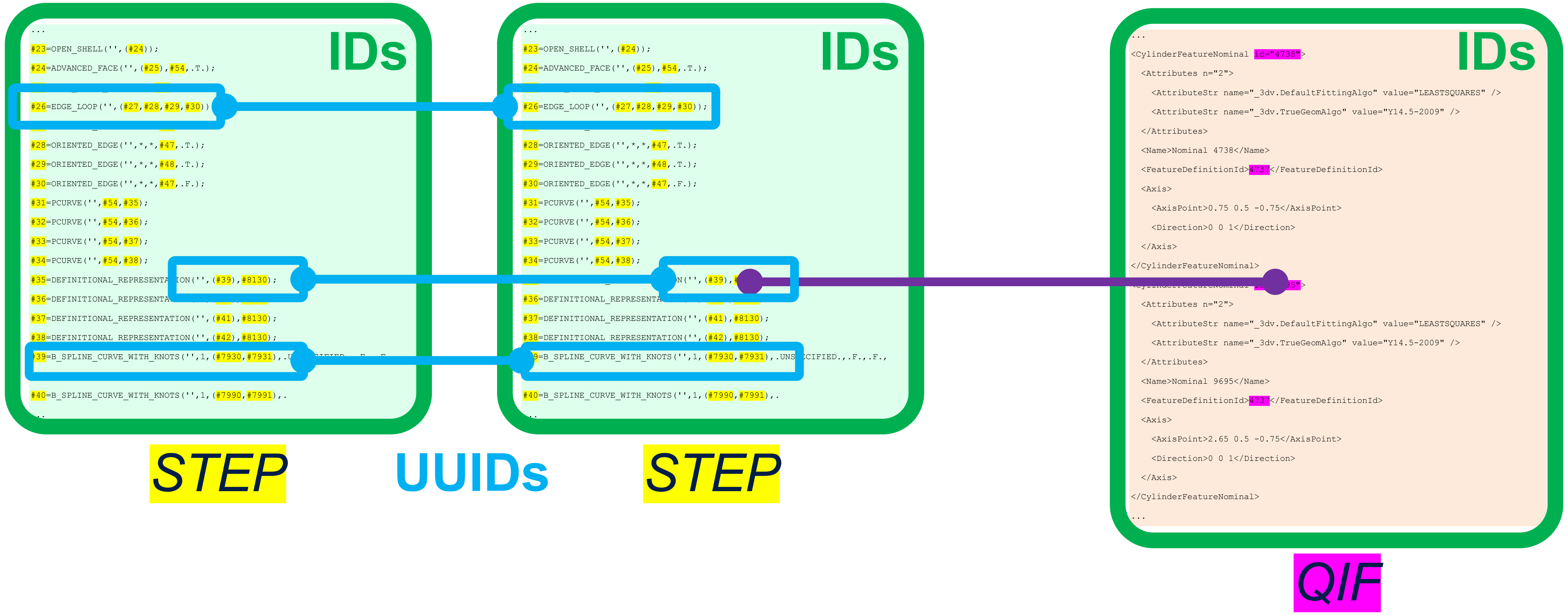
UUIDs

- **UUID** := **U**niversally **U**nique **ID**entifier
- **closed world** VS **open world** workflows / use-cases



UUIDs

- **UUID** := **U**niversally **U**nique **ID**entifier
- **closed world** VS **open world** workflows / use-cases
- diffs, changes, conversions, translations, and updates



UUIDs

- **UUID** := **U**niversally **U**nique **ID**entifier
- **closed world** VS **open world** workflows / use-cases
- diffs, changes, conversions, translations, and updates
- V4 UUID (random) VS V5 UUID (namespace)

better persistence,
link to authoring system namespace

UUIDs

- **UUID** := **U**niversally **U**nique **ID**entifier
- **closed world** VS **open world** workflows / use-cases
- diffs, changes, conversions, translations, and updates
- V4 UUID (random) VS V5 UUID (namespace)
- UUID necessity is ultimately driven by use-case / value-add

Summary

Summary

<u>Consistent theme:</u>

- Blind implementation / expectations of MBE technology
  - Unclear use-cases
  - Undefined value-adds

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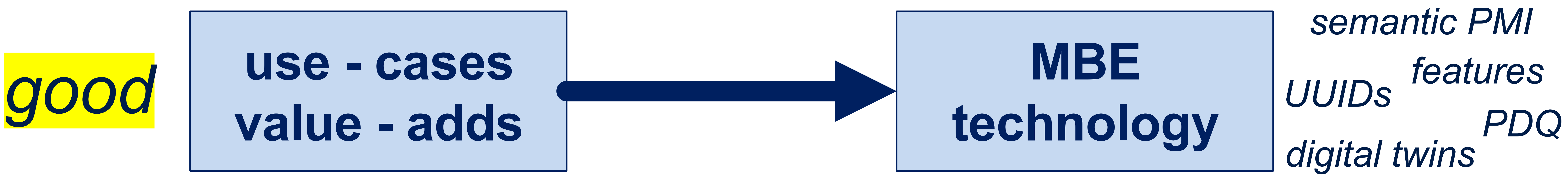
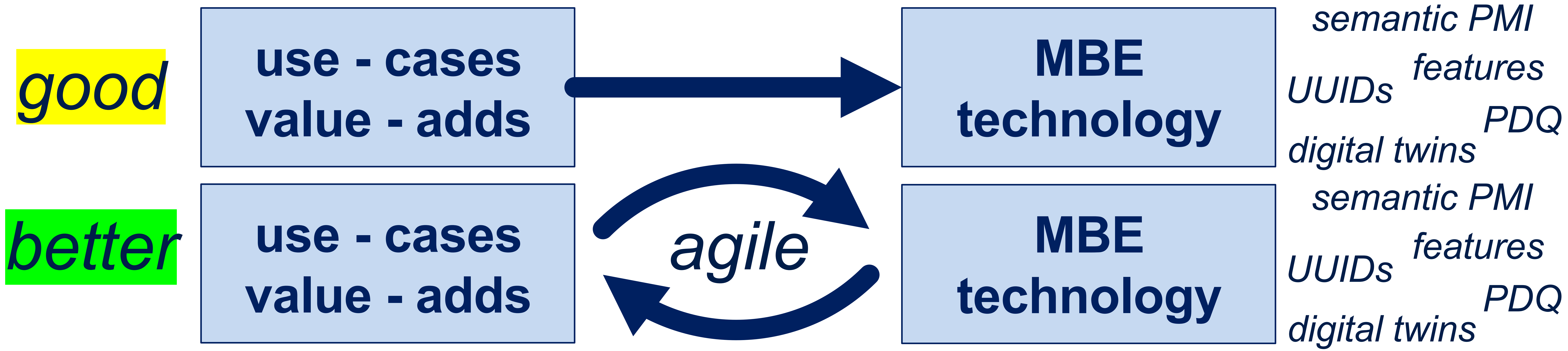


Summary

Consistent theme:

- Blind implementation / expectations of MBE technology
  - Unclear use-cases
  - Undefined value-adds



Questions? Comments?

Contact:

benurick@nvariate.com

dankeller@nvariate.com