Collaborative Product Visualization

RECOMMENDATION

Collaborative Product Visualization
PSI 2

ProSTEP iViP

Abstract

This recommendation serves to coordinate the exchange of visualization data for communication and information retrieval between collaborating companies. The exchange of visualization data is not restricted to a certain phase of the product life cycle.

Reference use cases are described for this purpose.

This recommendation does not deal with data protection and data security. Guidelines and agreements on data protection and data security should be observed and applied in a reasonable manner.

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Abbreviations, Definitions, References

Abbreviations:

CAD	Computer-aided design
CAM	Computer-aided manufacturing
DIN	Deutsches Institut für Normung, German Institute for Standardization
DMU	Digital mock-up
NURBS	Nicht-uniforme rationale B-Splines Non-uniform rational B-Splines
ODETTE	Organization for Data Exchange Through Teletransmission in Europe
PMI	Production and manufacturing information
SE	Simultaneous engineering
SME	Small and medium-sized enterprise
SOP	Start of production
VDA	Verband der Deutschen Automobilindustrie, German Association of the Automotive Industry
VDMA	Verband deutscher Maschinen- und Anlagenbau, German Engineering Federation

Definitions:

3D CAD dataset	A 3D CAD dataset is the three-dimensional representation of a product's CAD data. It contains geometric information as well as parametric, constraint and/or creation history information.
Contractor	A contractor is an enterprise which provides a certain product and/or service to a customer.
Customer	A customer is an enterprise which purchases a certain product and/or service from a contractor.
Multi-CAD environment	The term describes a situation in which the participants in a development network use different CAD systems.
Product Data Management (PDM) system	A PDM system administrates and manages design data.
Service	A service in terms of this recommendation can comprise the development of a part or assembly or the development of a tool and/or manufacturing of a part or assembly.

References:

This chapter provides an overview of auxiliary guidelines and recommendations. This is not intended to be interpreted as a complete list.

- DIN 66301 Computer-aided design – format for exchanging geometric information; industrial automation
- ISO/FDIS 16792 Technical product documentation-Digital product definition data practices
- ISO PAS 26183: Product Data Quality Guidelines for the Global Automotive Industry
- SASIG D-21 Guideline for Digital Engineering Visualization
- VDA-Recommendation 4900 Data transmission of ODETTE - Messages
- VDA-Recommendation 4914 Odette specifications for File Transfer
- VDA-Recommendation 4950 Agreement on the exchange of CAD/CAM data
- VDA-Recommendation 4951 Data transmission of CAD/ CAM data exchange
- VDA-Recommendation 4952 Exchange of pattern-data
- VDA-Recommendation 4953 Simplified CAD Drawing
- VDA-Recommendation 4956 Product Data Exchange
- VDA-Recommendation 4958 Long-Term Archiving (LTA) of digital Product Data
- VDA-Recommendation 4961 Agreements on Simultaneous Engineering (SE-Checklist)
- VDA-Recommendation 4965 Engineering Change Management (ECM)
- VDMA/VDA-Recommendation 66318 Computer-aided Design: Rules for CAD-data exchange

In addition to recommendation and guidelines, there are also a number of White Papers. Again, the list is not exhaustive.

- ProSTEP iViP Association White Paper – Analysis of Cross-Enterprise Exchange of Visualization and Assembly Data
- ProSTEP iViP Association Project Study to Evaluate the JT Data Format

1 Introduction

1.1 Preface

Increasing national and international competition is forcing companies to introduce new products at an ever faster rate by shortening the product development period, and to lower costs, improve product quality and improve innovative capabilities. To master these challenges, companies are pressing ahead with distributed development and collaboration with suppliers and service providers. This results in certain prerequisites relating to product development processes. Efficient product visualization provides a new method for communicating and exchanging information, this is referred to as "visualization data exchange".

1.2 Objectives of visualization data exchange

The objective of visualization data exchange is the improvement of information flow and communication throughout the product life cycle. It is an easy way to communicate complex, geometry-based product information to non-CAD-experts. Product visualizations can be used like screenshots from of a CAD system or as an alternative or in addition to telephone calls and conferences. The improved flow of information means that iteration loops can be avoided, and thus the product development can be accelerated.

This recommendation for collaborative product visualization is based on experience and the requirements relating to existing processes. Visualization data exchange is not intended to replace CAD data exchange but rather complement it in those cases where the recipient does not need all the information included in a rich CAD data set, e.g. in the role of a data consumer rather than a data creator (or updater).

With visualization data, non-technical applications can be connected to the information flow relating to the geometry. Appropriate viewers for visualization data allow information to be handled without any need for a CAD workstation.
The aforementioned references (auxiliary guidelines and recommendations) should be observed and used in an appropriate manner.

1.3 Compatibility to predecessor

Not applicable.

1.4 Structure of the recommendation

The recommendation first of all includes a section describing new issues that arise as a result of visualization data exchange as compared to geometric data exchange. This is followed by an introduction to a checklist for using visualization data exchange, which in turn is followed by a list of the reference use cases. The order in which these subjects have been dealt with is not any indication of their importance. The final section of the recommendation provides an outlook.

2 Preliminary remarks

The aim of this recommendation is to harmonize the exchange of visualization data. As it deals with a kind of geometry exchange, it also includes aspects relating to the exchange of geometry annotation, assembly data and data quality.

As guidelines and recommendations already exist for these particular aspects, they should be applied in an appropriate manner.

Visualization data offers the option of tessellation. It is a functionality which has not been dealt with in the aforementioned reference material. Depending on the application involved, tessellated data is often sufficient for the intended purpose. The accuracy of tessellation can differ depending on the tessellation settings. However, it is sometimes necessary to transfer the exact geometry, e.g. for tool manufacturing. There are usually specific reasons for exchanging tessellated data or exchanging exact geometry. During validation, experience was gathered with regard to what is best for which use case.

Another point to be discussed before exchanging visualization data is the matter of legal liability as it relates to the data, especially in cases in which decisions are made based on visualization data although CAD data is also available. The scope of legal liability regarding the data must be defined. Before collaboration based on visualization and CAD data is launched, an agreement regarding legal liability must be reached.

The reference use cases presented in this document are intended to support communication and information in cross-enterprise collaboration. Visualization file formats can support the exchange of information in all phases of collaboration and the product life cycle regardless of the types of collaboration defined. For example, as defined in VDA 4961.

This recommendation describes the reference use cases which are intended to improve the information flow concerning the “Inquiry/Bidding” and “Design Review” processes. Processes like “Engineering Change Information”, “Drawingless Design” and “Small Supplier Integration” are mentioned in the outlook as because they have not yet been validated.

3 Checklists for visualization data exchange

This section provides checklists for visualization data exchange. Application of visualization data exchange depends on two main criteria. Firstly, that the general agreement on the level of collaboration allows the exchange of visualization files. Secondly, that the operating personnel involved are familiar with visualization data exchange and want to use it.

3.1 Checklist for an agreement on visualization data exchange

A number of suitable collaboration checklists which include the exchange of data and information are already available. One such checklist is, for example, the "SE Checklist" included in VDA Recommendation 4961. Several points relating to data formats, data access, data exchange and reasons for data exchange have been defined in this checklist.

A checklist like the VDA SE Checklist should be used to define a general collaboration agreement for visualization data exchange that covers all the most important issues such as communication media, data exchange methods and media, data access, file format, tessellation accuracy, assembly and metadata, legal liability, etc. The following list includes four important points. The list is not intended to be regarded as being complete:

- Definition of the way in which the product assembly is to be exchanged
- Definition of the volume and appearance of the exchanged metadata
- Definition and exchange of a visualization data conversion log file for error logging
- Definition and documentation of quality checks

As a rule, experts on these topics are involved in defining a general collaboration agreement. They should be familiar with the most important issues regarding visualization data application and exchange as they relate to the definition of the general collaboration agreement.

3.2 Checklist for the staff involved

There are no suitable checklists relating to visualization data exchange for employees at operating level. It is important that these members of staff know what visualization files are and what purpose they serve. They should also have suitable software available to them and should be able to use this software. They should also be aware of the possible use cases for collaborative product visualization.

If this is the case, they can use the following checklist when using collaborative product visualization. A general collaboration agreement relating to the issues involved in visualization data exchange is assumed:

- ➡ Is the current work suitable for the application of a collaborative product visualization use case? If so, proceed with the checklist. Think of how you process visualization data (instead of other data).
- ➡ Determine legal liability with regard to the data set if you have to make decisions about product-oriented issues while processing the data. Does the defined scope of liability allow you to process the visualization file as desired?
- ➡ Is suitable software or software offering suitable functionality (import, export, measurements, sections etc. depending on use case) available? Do you have sufficient skills using that software? If not, please contact your local administrator responsible for engineering IT and/or visualization.
- ➡ How do you receive visualization files? Is it via offline access or via online access.
    - o In the case of offline access: Check how data exchange is started. Make sure that visualization files are transferred instead of other data. This can be done by making changes to some of the options in the data access system. If you have access to these options, you can do this yourself, or you can ask your collaboration partner to do it for you.
    - o In the case of online access: Check whether you have access to the visualization files. Ask your collaboration partner to grant you the appropriate permissions. Check whether your collaboration partner has guidelines regarding online access in general and on-line visualization file access in particular. Please observe these guidelines as they indicate company-specific solutions and include useful tips.

After performing data transfer:

- ➡ Did you receive all the data? Did you expect more data? Compare the data you received with the BOM of that specific design space. Geometry can not always be tessellated successfully. Can you read and work with the received assembly data and metadata?
- ➡ How is the visualization file quality? Is it good enough? Is the quality ensured by an accessible conversation log file (e.g. in the case of offline access), or is the quality otherwise ensured (e.g. in the case of online access), e.g. a stipulation in the general collaboration agreement?

With regard to performing your task:

- ➡ Check how you are allowed to disseminate your results. Refer to the general collaboration agreement and/or ask your collaboration partner. In the case of off-line data exchange, send your data via the appropriate channels (ask your local engineering IT department for details). In the case of online data exchange, please refer to the general collaboration agreement mentioned earlier.

This checklist is intended as an aid for the initial steps. It is not intended to be regarded as complete. This checklist must be adapted to company-specific environments.

4 Reference use cases

With regard to documentation of the reference use cases, the scope of the reference use case is described first. The exchanged information is also described, and examples are given for better understanding. Benefits are mentioned.

The following use cases were identified as being important:

- "Bidding/ Inquiry"
  - Subcase "Bidding"
  - Subcase "Inquiry"

- "Design Review"
  - Subcase "Design Space Request"
  - Subcase "Design in Context"
  - Subcase "Design Package Review"

- "Engineering Change Information"
- "Drawingless Design"
- "Small Supplier Integration"

The application of the use cases often requires the existence of a general collaboration agreement for visualization data exchange. The issues included in a general collaboration agreement are mentioned in section 3.1. In the use case description, certain requirements are mentioned which must be defined in the general collaboration agreement.

Only the two first use cases and their subcases have been validated in practice. These two use cases are described below. The other use cases are mentioned in the outlook.

Figure 1: Overview of use cases

4.1 Reference use case “Inquiry/Bidding”

4.1.1 Subcase “Inquiry”

4.1.1.1 Scenario

The aim of this subcase is to facilitate inquiry, i.e. the process of requesting a proposal. This scenario involves a customer wanting to order a service from a contractor.

In order to submit a proposal, the contractor requires preliminary information about geometry, assembly and other commercial data. The customer, on the other hand, is interested in protecting his intellectual property.

At this point of contact, it is not certain whether or not the contract will be awarded to this particular contractor. This means that neither the contractor nor the customer is interested in incurring substantial expenses at this point.

4.1.1.2 People involved

In this subcase, the people involved on the customer’s side are from the purchasing department, as well as from technical departments. The people involved on the contractor’s side are from the sales department, as well as from technical departments. The kind of the technical department involved depends on the kind of service involved. This could be product development, manufacturing, etc.

4.1.1.3 Points to be clarified before application

- Agreement on a common readable visualization file format
- If this initial data exchange is basis for the contract, the scope of its legal liability must be stated
- Definition of best practice technical settings for the application within this subcase, especially settings relating to tessellation

4.1.1.4 Process description

"Inquiry" is often referred to as "Request For Proposal" (RFP), a process in which the contractors are asked to submit a proposal.

In order to provide preliminary information about geometry and assembly data, it is not necessary that a full 3D CAD dataset be exchanged. Conversion in a multi-CAD environment, e.g. on the contractor's side, would generate unnecessary expense.

Exchanging geometry and assembly data in a visualization file decreases the volume of data exchanged. Reducing the level of accuracy by using tessellation provides the customer with a tool for protecting his intellectual property.

In order to request a proposal, the customer has to make it clear what he wants. Therefore the visualization files should be as accurate as necessary to give a rough idea of the size of the part or design space and any interfaces. The contractor is then able to analyze how much time and effort it would cost to provide the service without having to use a CAD workstation.

In addition to geometrical data, other information such as assembly or commercial data also has to be exchanged.

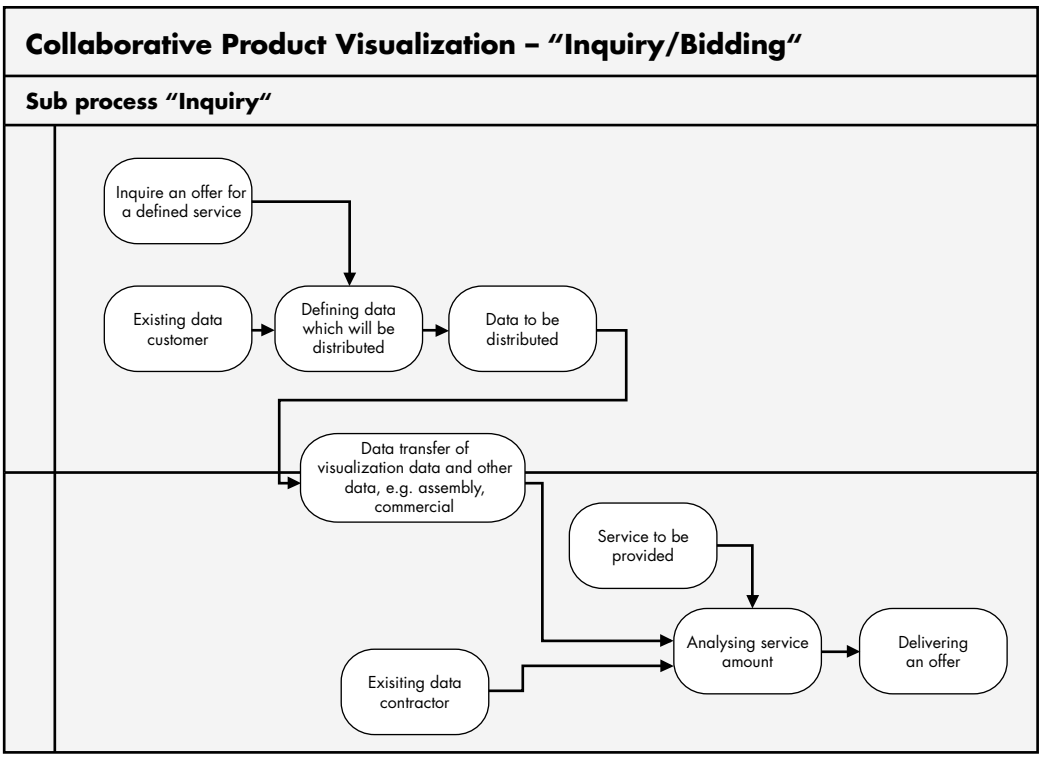


Figure 2: Process diagram "Inquiry"

4.1.1.5 Variations

Variations are possible, depending on the kind of collaboration involved and the service required.

4.1.1.6 Examples

- Requesting proposals for generators
- Requesting proposals for brake systems
- Requesting proposals for tool development and manufacturing
- Requesting proposals for the development and manufacturing of plastic parts such as electronics housing

4.1.1.7 Benefits

- Easier and faster exchange of geometric information when requesting proposals
- The use of tessellated data allows intellectual property to be protected
- Use of visualization data promotes better understanding, also in commercial departments

4.1.2 Subcase "Bidding"

4.1.2.1 Scenario

The objective of this subcase is to facilitate the bidding process. A customer wants to order a service from a contractor. Visualization data allows the 3D extension of the data in the proposal. It is used for better visualization of the contractor's solution. Visualization data with PMI can be used to replace proposal drawings.

4.1.2.2 People involved

In this subcase, the people involved on the customer's side are from the purchasing department, as well as from technical departments. The people involved on the contractor's side are from the sales department, as well as from technical departments. The kind of the technical department involved depends on the kind of service involved. This could be product development, manufacturing, etc.

4.1.2.3 Points to be clarified before application

- Agreement on a common readable visualization file format
- If this initial data exchange is basis for the contract, the scope of its legal liability must be stated
- Definition of best practice technical settings for the application within this subcase, especially settings relating to tessellation

4.1.2.4 Process description

When submitting a proposal, visualization data allows the contractor to communicate his concept and ideas better. The contractor is interested in protecting his intellectual property as it is not yet certain whether or not he will be awarded the contract. In addition to protecting intellectual property, neither partner is interested in incurring substantial expenses during the bidding phase. Visualization data, directly derived from CAD, can replace special proposal drawings.

When presenting his solution, the contractor can use the geometrical and assembly information provided by the customer to show how well his solution is suited to the given problem.

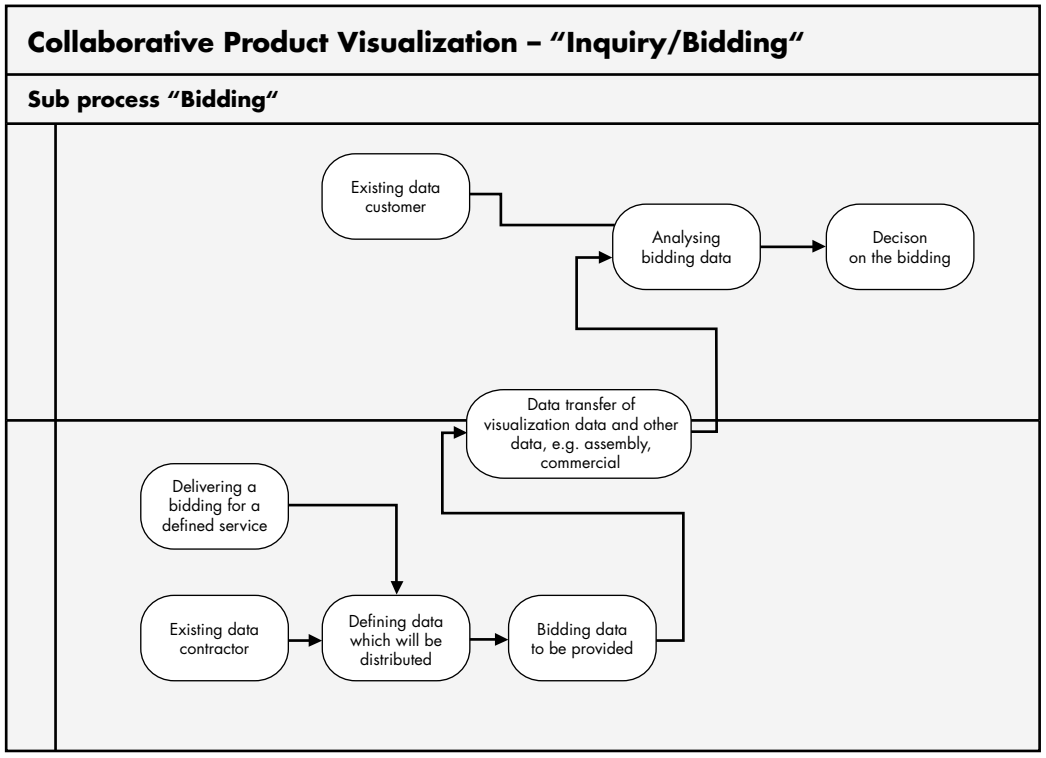


Figure 3: Process diagram "Bidding"

4.1.2.5 Variations

Variations are possible, depending on the kind of collaboration involved and the service required.

4.1.2.6 Examples

- Submitting proposals for generators
- Submitting proposals for brake systems
- Submitting proposals for tool development and manufacturing
- Submitting proposals for the development and manufacturing of plastic parts like electronics housing

4.1.2.7 Benefits

- Easier and faster exchange of geometric information when submitting proposals
- Potential replacement of proposal drawings
- The use of tessellated data allows intellectual property to be protected
- Including design space in the visualization files allows preliminary packaging without CAD when submitting a bid
- Use of visualization data promotes better understanding, also in commercial departments

4.2 Reference use case "Design Review"

4.2.1 Subcase "Design Space Request"

4.2.1.1 Scenario

The objective of this subcase is to allow the contractor to work in his required design space. Up until now, the contractor received a CAD data set for the item that was too rich. The level of performance offered by his CAD workstation might not be sufficient to process all this information. However, the contractor is not able to reduce the given information to only the information that he requires.

The use of visualization data means that the data set is much smaller and can be viewed. The contractor can sort through the data set supplied and identify the parts which he really requires. He can then request that the parts he really needs be supplied as CAD files.

4.2.1.2 People involved

In this subcase, the people involved on customer's side have to supervise data exchange and/or access (usually automated using PDM systems). On the contractor's side, engineers and data exchange/access specialists are involved.

4.2.1.3 Points to be clarified before application

- Data access and authorization of the people involved
- Common (visualization) file settings
- Representation of assembly and other non-geometric data
- Definition of best practice technical settings for this use case, especially settings relating to tessellation
- Definition of assembly data exchange for best practice in this use case. Definition of where the assembly data is best added to the geometric data in this use case (within PDM system, during export process)
- Definition of the scope of legal liability of the data set for best use within this subcase

4.2.1.4 Process description

The contractor may be responsible for obtaining the design space. If this is the case, he initiates a design space request. There are also other ways of initiating the initial design space exchange.

The customer then makes visualization and assembly data accessible either via data transfer or online access. The accuracy of the visualization files does not need to be exact if only used as a "preview". The contractor is responsible sorting through the data set supplied, reducing the given design space according to his requirements. The reduced data set allows a specified set of data to be requested. In the second request, a rich CAD data set is supplied. The customer makes the required CAD and assembly data accessible either via data transfer or online access. The contractor then receives the CAD data he specified. This allows him to load and work with only the CAD data he really needs without overloading his CAD workstation.

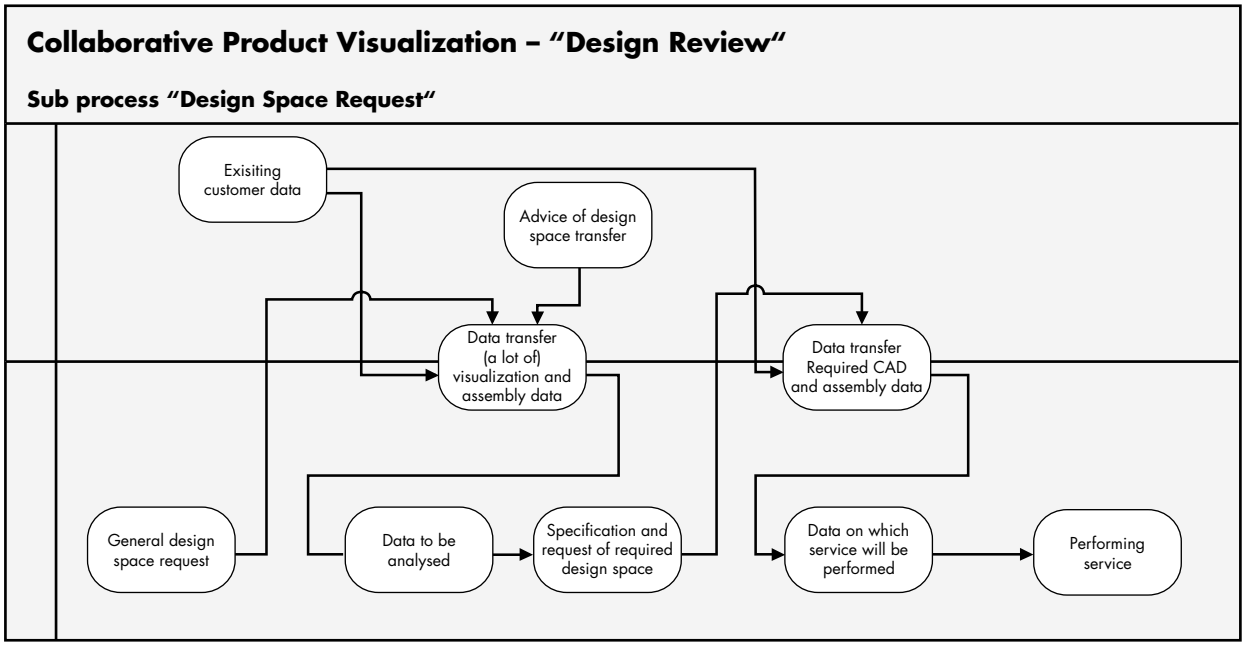


Figure 4: Process diagram "Design Space Request"

4.2.1.5 Variations

Depending on the general collaboration agreement, data exchange is either initiated by the customer or by the contractor. It is possible to combine this subcase and other subcases from the "Design Review" reference use case.

4.2.1.6 Examples

- ➡ Integration of a generator
- ➡ Customizing a generator
- ➡ Customizing a brake system
- ➡ Package analysis
- ➡ Assembly analysis
- ➡ Wire harness

4.2.1.7 Benefits

- Easier and faster selection of required design space files
- Reduced overall volume of exchange data
- Fewer hardware requirements in order to view complete visualization datasets compared to CAD

4.2.2 Subcase "Design in Context"

4.2.2.1 Scenario

The objective of this subcase is to use visualization data whenever read-only geometry data is exchanged.

Up until now, the design space was exchanged as a rich CAD data set including parametric and history data. On the contractor's side, no changes are made to the design space data. Conversion processes may be needed in order to use this data.

4.2.2.2 People involved

In this subcase, the people involved on the customer's side have to supervise data exchange or access (usually automated using PDM systems). On the contractor's side, engineers and data exchange/access specialists are involved.

4.2.2.3 Points to be clarified before application

- Data access and authorization of the people involved
- Common (visualization) file settings
- Representation of assembly and other non-geometric data
- Scope of legal liability relating to the visualization data
- Functionality offered by import filters and CAD software (import, measurement and referencing of this data) must support "Design in Context"
- Definition of best practice technical settings within this use case, especially settings relating to tessellation
- Definition of assembly data exchange for best practice in this use case. Definition of where the assembly data is best added to the geometric data in this use case (within PDM system, during export process)

4.2.2.4 Process description

The contractor's design engineer imports the visualization data into his CAD system. The import processor allows him to work with the visualization data, e.g. measuring or referencing geometry in order to work on his own geometry.

The use of visualization data means that there is no need for the physical exchange of rich CAD data. There are no disadvantages regarding the design on the contractor's side. This process requires visualization import processors for CAD systems which translate the geometric information into CAD elements.

Having finished the design, the contractor's design engineer transfers his product geometry to the customer.

Design space exchange from the customer to the contractor involves the transfer of visualization and assembly data. The visualization data can contain the precise geometry.

The transfer of data from the contractor to the customer includes a geometric description and the structure of the contractor's product. Depending on the general collaboration agreement, this data can be CAD and assembly data or visualization and assembly data.

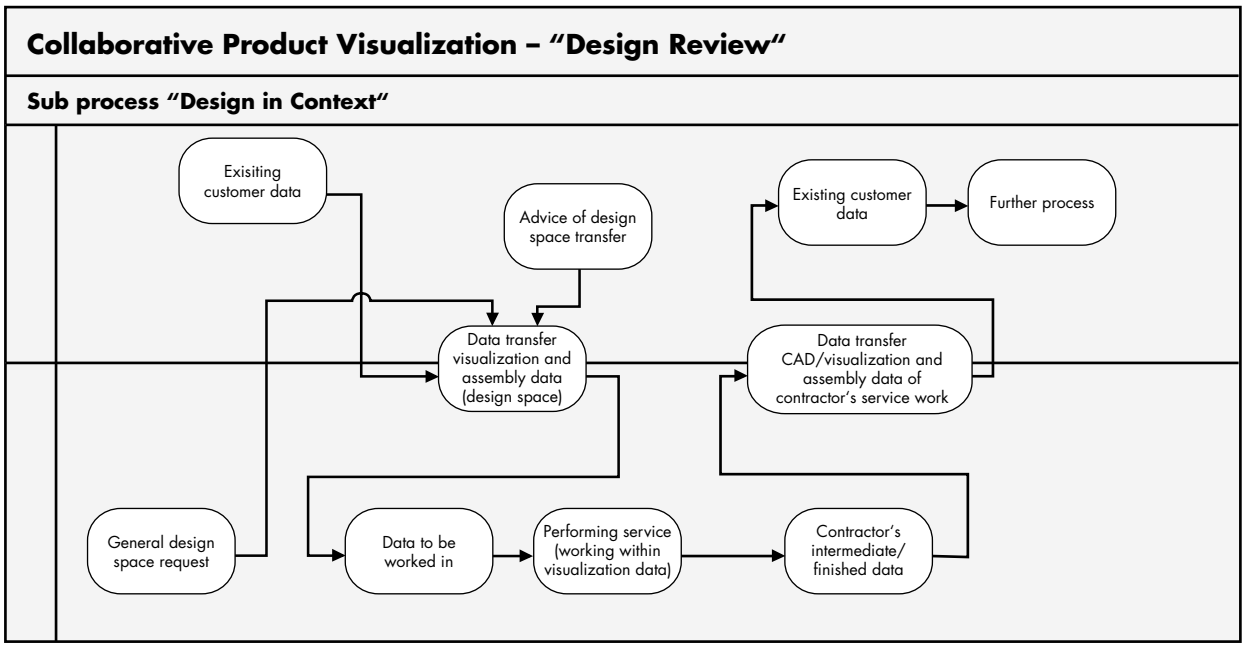


Figure 5: Process diagram "Design in Context"

4.2.2.5 Variations

Depending on the general collaboration agreement, data exchange is either initiated by the customer or by the contractor. It is possible to combine this subcase and other subcases from the "Design Review" reference use case.

4.2.2.6 Examples

- Integration of a generator
- Customizing a generator
- Customizing a brake system
- Package analysis
- Assembly analysis
- Wire harness

4.2.2.7 Benefits

- Ability to work more easily and faster in design space
- No or less CAD data conversion
- No additional processes required after the data has been received; design can start directly
- Reduced overall volume of exchange data
- Protection against changes to design space parts through the use of visualization data

4.2.3 Subcase "Package Review"

4.2.3.1 Scenario

The objective of this subcase is to reduce the amount of CAD data exchanged. The customer is responsible for package analysis. Therefore, he is interested in having the latest information. For performance reasons, package analysis and reviews are done in visualization systems. This means that contractors can deliver their latest models as visualization files, which are smaller and are created faster than customer-specific CAD files. These files can be directly integrated with other visualization files from different contractors for package review in a multi-CAD environment.

This subcase is not intended to replace a final exchange of CAD data, which is often required for legal reasons, e.g. enterprise agreement or documentation relating to product liability. The exchange of CAD data still takes place, but the volume of data is reduced or the data is only exchanged at certain stages of development.

4.2.3.2 People involved

In this reference use case, the people involved on the customer's side are those responsible for package reviews. On the contractor's side, engineers and data exchange/access specialists are involved.

4.2.3.3 Points to be clarified before application

- Common (visualization) file settings
- Representation of assembly and other non-geometric data
- Scope of legal liability relating to the visualization data
- Definition of best practice technical settings for this use case, especially settings relating to tessellation
- Definition of assembly data exchange for best practice in this use case; definition of where the assembly data is best added to the geometric data in this use case (within PDM system, during export process)
- Use of session files and redlining as an appropriate way of communicating results from reviews and changes issues

4.2.3.4 Process description

The contractor distributes the visualization files for his product to the customer. This allows the customer to perform design reviews on up-to-date models. The required degree of accuracy depends on the kind of review involved and can range from exact NURBS to sufficiently accurate tessellated geometry. Visualization files can be used for data exchange between milestones and can also be used for data exchange at milestones for design reviews.

The rich CAD data set still can be exchanged at specified milestones.

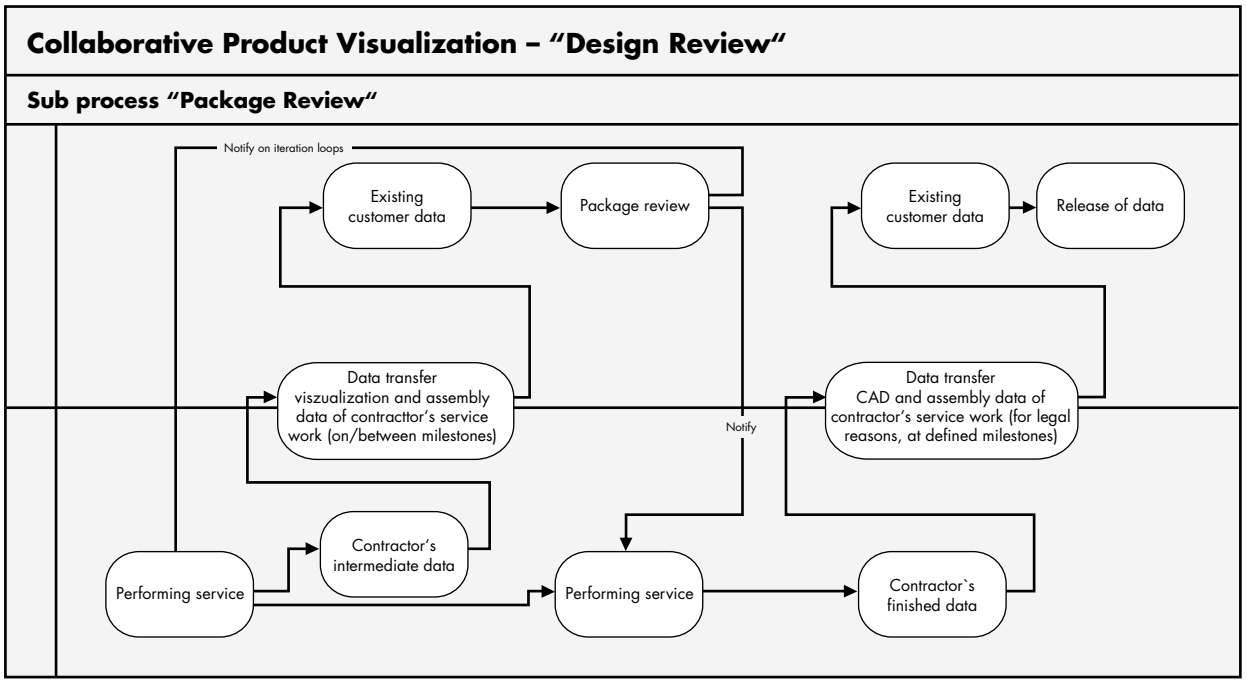


Figure 6: Process diagram "Package Review"

4.2.3.5 Variations

Variations are possible depending on the kind of collaboration involved and the required service.
It is possible to combine this subcase and other subcases from the "Design Review" reference use case.

4.2.3.6 Examples

- ➡ Integration of a generator
- ➡ Integration of a brake system
- ➡ Package review
- ➡ Assembly review
- ➡ Wire harness review

4.2.3.7 Benefits

- ➡ Easier and faster processing of contractor data on the customer's side without CAD conversion
- ➡ Reduced data exchange volume
- ➡ Data can be used directly in the review without any need for further conversion (CAD -> viewer) on customer's side

5 Outlook

This section describes use cases which have not yet been validated in practice. These involve the following three reference use cases: "Engineering Change Information", "Drawingless Design" and "Small Supplier Integration". These reference use cases will be validated in future efforts relating to collaborative product visualization.

5.1 Reference use case "Engineering Change Information"

5.1.1 Objectives

The communication of changes either as change requests or as change notifications is very important for collaborative product development. Today, meetings, written notes and screenshots are used for communication purposes, especially in early design stages. In the worst case, even the exchange of CAD data is required.

Visualization data associated with session information (e.g. predefined view, mark-up or measurement) is a useful addition to existing tools. In visualization files, all matters relating to changes are communicated without using rich CAD data sets. Session files allow the transfer of additional information related to the visualization geometry, e.g. redlining. This means that the changes can be associated with an element of a part.

Visualization files and session files are an addition to established engineering change communication. Like e-mails or phone calls, visualization and session files can be used for communication.

Note:
For information on engineering change management, please refer to the appropriate recommendations, such as VDA Recommendation 4965. This reference use case is not intended to (re)define engineering change management but rather to illustrate the possibility of using visualization data as additional information within the context of engineering change management.

5.1.2 Benefits

- ➡ Communication medium which associates messages with 3D content
- ➡ Easier and faster change communication based on 3D geometry
- ➡ The use of session files means that the exchange of 3D geometry is not necessary
- ➡ Redlining functionality to explain required changes

5.2 Reference use case “Drawingless Design”

5.2.1 Objectives

Visualization data can be used to establish a drawingless development process. Wherever a printed drawing is required today, visualization data could be used in future. This requires the integration of drawing information like PMI in the visualization data and in viewing functionality. Different drawing information has to be integrated depending on the drawing purpose involved.

Simplified drawings in particular often present a challenge to shop floor workers. The information they require is sometimes missing from the drawing, which means that they need to have access to the full set of 3D geometry.

5.2.2 Benefits

- With a 3D master concept, visualization data can be used as a substitute for drawings
- No CAD workstation is required to “read” technical information from the drawing substitute
- Better and faster updating of drawing substitutes
- No printouts required

5.3 Reference use case "Small Supplier Integration"

5.3.1 Objectives

Collaboration with small and medium-sized enterprises (SME) poses a challenge to the IT environment. Because of their size, SME often maintain only a mid-sized CAD environment. Data exchange with customers who use a "high-end" CAD environment is different each time. Therefore, each individual agreement/contract will be different.

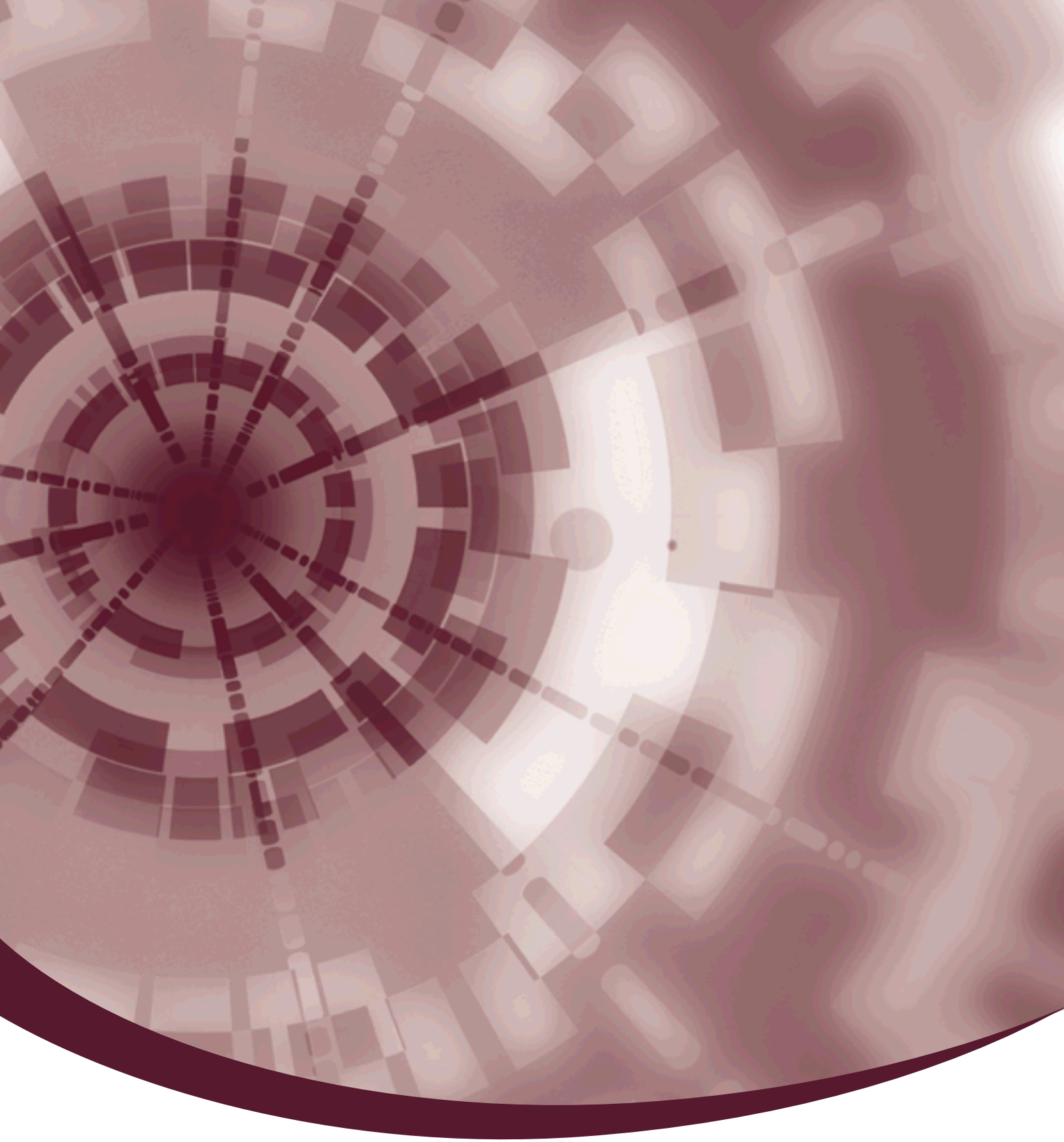
This use case is not intended to describe a particular process. Supporting the integration of SME by means of visualization files means that all the other aforementioned reference use cases and others should be used to improve communication with small suppliers.

Visualization files can be handled by conventional office workstations without any need for a CAD workstations. Like CAD data processors, visualization file processors are also available for mid-sized CAD systems. Even if there is no processor or CAD-system available at a contractor's site, a low-cost viewer allows the geometric data to be viewed and processed.

Interchange bandwidth can also lead to problems within the context of SME integration. Visualization and session files are smaller than rich CAD data so it is possible to transfer them using a low bandwidth.

5.3.2 Benefits

- 3D geometry exchange files for multi-CAD environments or for data exchange involving suppliers who have no CAD system
- Data exchange on low bandwidth possible
- Minimum level of integration through low-cost/no-cost viewer, but also visualization file processor for different CAD systems
- Also the benefits offered by the other reference use cases



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