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NEUTRAL DATA FORMATS IN PRODUCT DEVELOPMENT: FROM USE CASES TO A REQUIREMENTS PORTFOLIO

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1. Introduction

Today's globalized markets and accordingly distributed engineering networks ask for access and cost-efficient methods in providing product data to multiple departments and stakeholders. With multiple processes relying on native Computer Aided Design (CAD) files as a source, the large data size and conversion activities are both counterproductive issues, as are measures of intellectual property protection in enterprise comprehensive exchange scenarios.

1.1 Motivation

A study at the Institute for Virtual Product Engineering involving multiple companies primarily within the automotive industry has shown that the integration of heterogeneous data along the product lifecycle still remains a key challenge in the scope of implementing a Product Lifecycle Management (PLM) solution, as depicted in Figure.

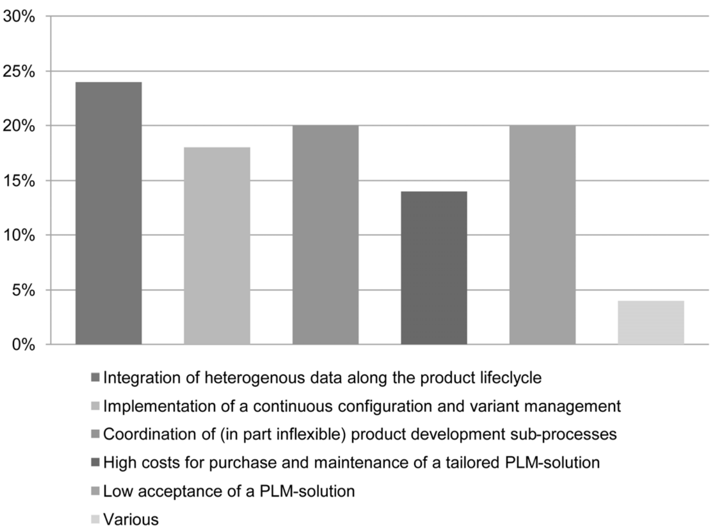

Figure 1. The key challenges in implementing a PLM-solution [VPE 2009]

The goal of our research activities is to establish a neutral data format (preferably one that is already highly accepted in multiple industries) within product development and the supply chain of an enterprise as an alternative to native CAD files acting as the primary information carrier, as previously mentioned in [Bitzer Eigner Gerhardt, 2009],[Eigner Gerhadt, 2009],[Gerhardt, 2009],[Eigner, Gerhardt, Langlotz, Mogo and Nem 2009]. We aim for the missing integration of heterogeneous data along the product lifecycle mentioned above, specifically in terms of supplier overhead caused by the need to deliver files native to a diversity CAD systems today (due to being contracted by multiple receivers). Independent of the supply chain we intend to reduce the number of CAD system licenses required in product development sub-processes by stating that files native to these systems should be situated within Design processes only, and not in follow-ups such as Digital Mock-Up (DMU), Computer Aided Engineering (CAE), etc. In the scope of the same study mentioned in the Figure caption, an average reduction of CAD licensing costs by approximately 25% is expected by integrating a neutral, lightweight data format as key information carrier within various processes.

1.2 Steps taken

There exist many lightweight data formats, such as 3D XML, JT, ProductView or the Project Reviewer Compressed (PRC) format used within Adobe's Portable Document Format (PDF). PDF is a format used for documentation and the former two represent industrial standards that are primarily used for the purpose of visualization, not as process-supporting formats. The JT specification in comparison to other lightweight formats is now going through an ISO (International Organization for Standardization) standardization process that is expected to be finished within this year.

The demand for integrating a neutral, lightweight format solution as a process-enabler along the product lifecycle is given, but so far there has been lack of a company-neutral driving force to determine and further document the full extent of exactly which processes can be supported by such a format. Recently and specifically over the past year, we have worked on establishing the JT data format as a primary data carrier within virtual product development alternatively to native CAD files. In close cooperation with two internationally renowned industrial boards (ProSTEP iViP association and Verband der Automobilindustrie), a foundation for a procedure model was layed by conducting a comprehensive process chain analysis at multiple Original Equipment Manufacturers (OEMs) and suppliers. Based thereon, Use Cases (UCs) regarding JT were specified in the scope of the so called JT Workflow Forum project group. In doing so and against the background of looking at neutral, lightweight data formats in general, transferability to other formats was kept in mind. This paper presents Use Cases independent of a specific data format. The list of here considered UCs and their contents slightly differs from the JT-based versions, in part because we continuously update our work. The UCs were utilized to particularize requirements, which were used within further activities, amongst others for benchmark purposes. Again generalizing to neutral formats, this paper addresses a requirements portfolio, in turn allowing an investigation and judgement of whether or not a specific format supports a given Use Case.

The remainder of this work is organized as follows: Section 2 gives an overview of work that is related to the here presented topic. Section 3 then illustrates the procedure defined and followed in order to retrieve a portfolio of requirements that a lightweight and neutral data format and its translators must meet in order to be applicable within certain UCs of product development.

2. Related work

We have adapted Dupperin et. al's impact matrix [Duperrin, Godet, 1973] in our approach to rule out less relevant UCs. Amongst others, that underlying method is also applied as content within Vester's sensitivity-model [Vester, 2002] and in various scenario-based, strategic projects, which is elaborated in [Gausemaier Plass Wenzelmann, 2009].

We have previously, but more abstractly called attention to the possibility of integrating a format like JT into PLM Architectures, in order to relieve native CAD files from being the primary information carrier within certain product development sub-processes [Bitzer, Eigner, Gerhardt, 2009]. Against the background of lightweight data formats now becoming more popular, Ding et al. have given an overview of different formats in [Ding Ball, Matthews, McMahon, Patel, 2009], introducing a method that aims at deriving lightweight content from CAD models, which are previously enhanced by various markup files to coordinate the generation of the lightweight files. While the mentioned work focuses more on the method and markup tool, our work is mainly driven from a process- and

requirements-oriented perspective, essentially aiming for a verified overview of which product development sub-processes can be supported by one neutral, CAD-derived lightweight format like JT.
In order to attain our fundamental process models, we have adapted pieces of Bitzer's process-oriented approach for planning and optimizing PLM solutions [Bitzer, 2008].
Information on our joint-cooperation with the mentioned boards can be consulted in [Gerhardt, 2009].

3. Derivation of a requirements portfolio

A process-oriented procedure model was determined and followed in order to create a requirements portfolio for the integration of a neutral format into product development sub-processes along the CAx chain, as depicted in Figure 2.

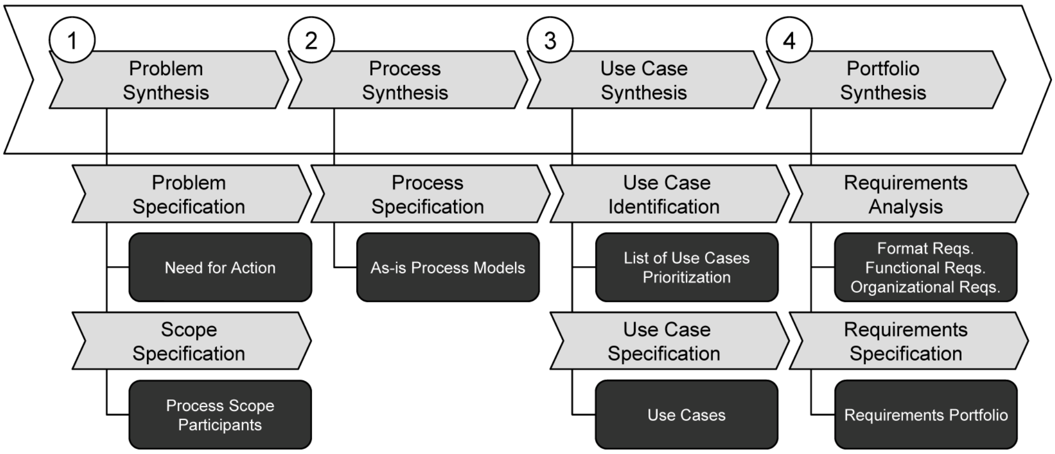

Figure 2. Requirements derivation procedure model

Disregarding Phase 1 (which was basically illustrated in Section 1), the foundation of the model was laid in the Process Synthesis. Accordingly, we will coarsely elaborate this phase, as well as the phases Use Case Synthesis and Portfolio Synthesis in the following.

3.1 Process Synthesis

We conducted a high-level but comprehensive process chain analysis at multiple Original Equipment Manufacturers (OEMs) and suppliers using the OMEGA method and tools ("Objektorientierte Methode zur Geschäftsprozessmodellierung und –analyse", UNITY AG). By workshop character with 5 to 10 employees, a physical process model was created for each participating company, creating an overview specifically of:

- which roles (within different divisions)
- exchange which product data (structure, geometry, properties)
- using which systems and interfaces within the CAx processes
- with which possible issues

The approach followed within the analysis was pragmatic and dynamic, giving the workshop participants the chance to decide themselves upon how they would like to lay out the CAx chain. The only guideline we integrated into our moderation was a set of questions we had developed up-front and referred to, in order to make sure we navigate from the design process, through validation and finally to digital factory related processes before manufacturing. Based on the created "as-is" processes, we discussed and denoted supposed potentials of integrating a neutral, lightweight data format into the underlying systems and activities. The process models were then digitalized, integrating the discussed potentials directly adjacent to the respective process steps, as depicted in Figure.
Potentials were numbered and process-steps color-coded, depending on a category they belong to: Design, DMU, validation in terms of a processing simulation, or Digital Factory. In addition to potentials, we also kept track of workshop statements that could be classified as initial requirements.

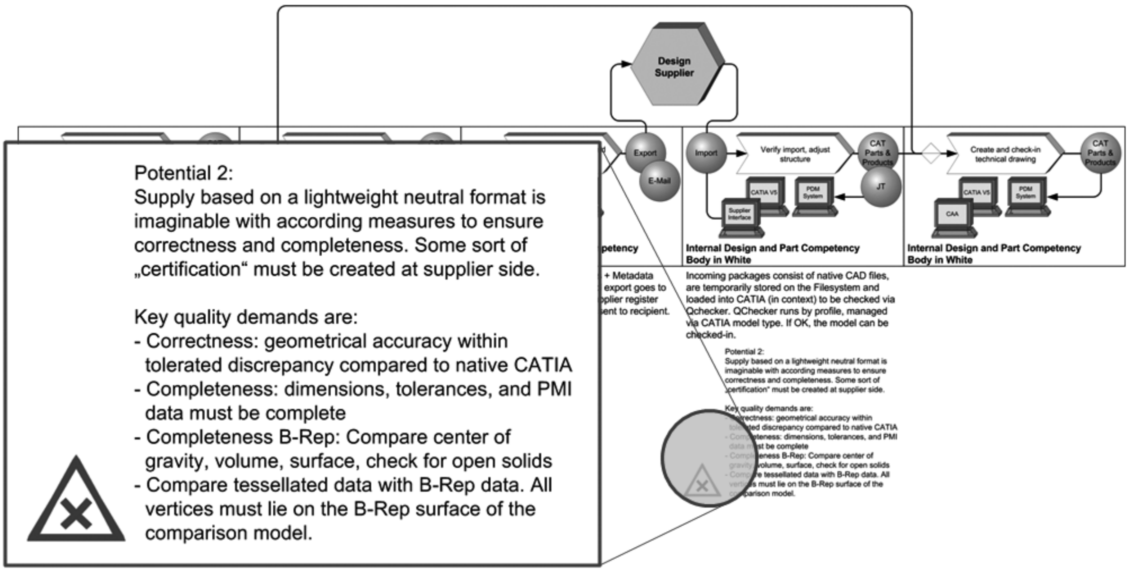

Figure 3. Exemplary process with potentials regarding a neutral format, using OMEGA representation

3.2 Use Case Synthesis

From the process models, including application potentials, denoted during the Process Synthesis, a list of 19 UCs was manually identified. From that list, only a subset was regarded for further consideration, each representing a generalized business process with associated activities running based primarily on a neutral, lightweight data format. This counts both for the JT-based UCs within the JT Workflow Forum and the generalized UCs within the paper at hand. Here, a more methodical approach for relevancy determination was chosen, borderlining the number of UCs down to 10. **The term neutral format is abbreviated by NF in the following.**

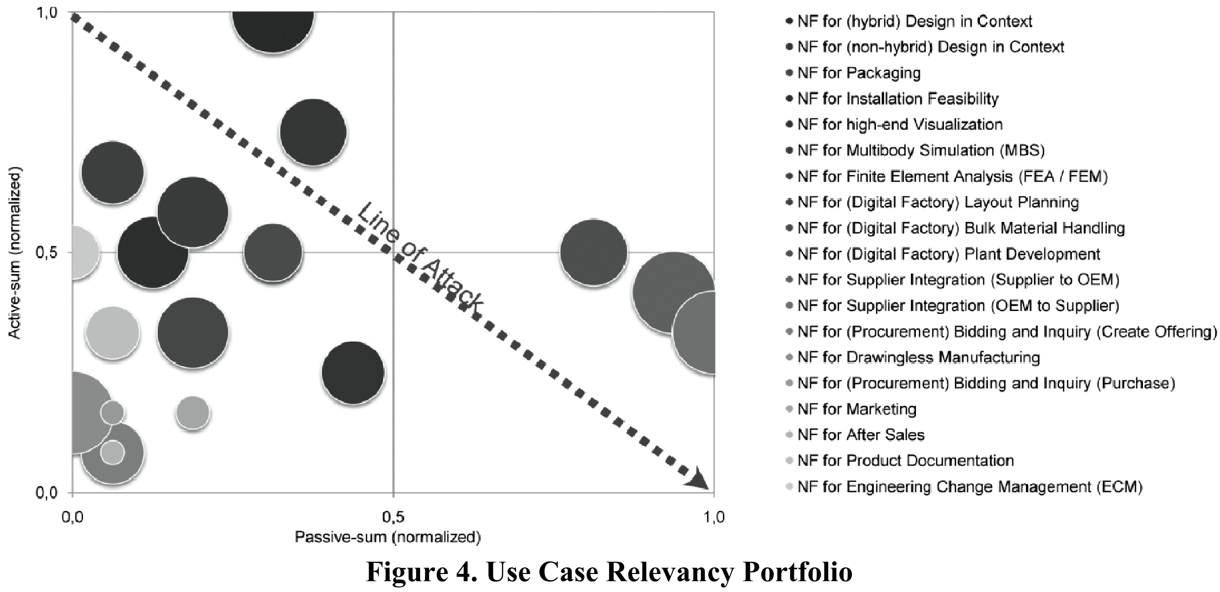

Figure 4. Use Case Relevancy Portfolio

For determination of relevancy, we created a relevancy portfolio as depicted in Figure, making use of an impact matrix that represents a mapping of how strongly UCs influence each other on a scale between 0 and 3, where the value 3 represents the highest possible influence.

Exemplary, the UC “Neutral Format for (hybrid) Design in Context” strongly influences “Neutral Format for Supplier Integration (Supplier to OEM)” for two reasons:

1. A continuous integration of hybrid display (neutral data format content parallel to native CAD data) technology within CAD-systems positively affects the desire to have a supplier provide product data based on the underlying format.
2. Designing in the hybrid context supplied product data based on a neutral format requires according interfaces and an adaption of coexisting supplier integration processes, e.g. quality-checking provided content

Figure illustrates the impact matrix that was created, including all 19 UCs. An “Active-sum” of a UC, represented by the UC’s row total, indicates how strongly the integration of a neutral data format into respective processes influences other (in-scope) areas of virtual product development. Determination of all “Active-sums” automatically provides “Passive-sums” for all UCs, each represented by a UC’s column total. These give hint regarding how strongly the UC is influenced by other areas.

	NF for (hybrid) Design in Context	NF for (non-hybrid) Design in Context	NF for Packaging	NF for Installation Feasibility	NF for high-end Visualization	NF for Multibody-Simulation (MBS)	NF for Finite Element Analysis (FEA)	NF for (Digital Factory) Layout Planning	NF for (Digital Factory) Bulk Material Handling	NF for (Digital Factory) Plant or Aggregate Development	NF for Supplier Integration (Supplier to OEM)	NF for Supplier Integration (OEM to Supplier)	NF for (Procurement) Bidding and Inquiry (Create Offering)	NF for Drawingless Manufacturing	NF for (Procurement) Bidding and Inquiry (Purchase)	NF for Marketing	NF for After Sales	NF for Product Documentation	NF for Engineering Change Management (ECM)	Active-sum	Normalized Active-sum (vs. max)
NF for (hybrid) Design in Context		2	0	0	1	0	0	1	0	2	3	3	0	0	0	0	0	0	0	12	1.00
NF for (non-hybrid) Design in Context	1		0	0	0	0	0	0	0	2	3	3	0	0	0	0	0	0	0	9	0.75
NF for Packaging	0	0		0	2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	4	0.33
NF for Installation Feasibility	0	0	2		0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	6	0.50
NF for high-end Visualization	0	0	0	0		0	0	0	0	0	1	0	0	0	0	1	0	1	0	3	0.25
NF for Multibody-Simulation (MBS)	0	0	0	2	0		1	0	0	0	2	2	0	0	0	0	0	0	0	7	0.58
NF for Finite Element Analysis (FEA)	1	1	1	0	0	1		0	1	1	1	1	0	0	0	0	0	0	0	8	0.67
NF for (Digital Factory) Layout Planning	0	0	0	0	0	0	0		2	2	1	1	0	0	0	0	0	0	0	6	0.50
NF for (Digital Factory) Bulk Material Handling	0	0	0	0	0	0	0	2		2	1	1	0	0	0	0	0	0	0	6	0.50
NF for (Digital Factory) Plant or Aggregate Development	0	0	0	0	0	0	0	2	2		1	1	0	0	0	0	0	0	0	6	0.50
NF for Supplier Integration (Supplier to OEM)	1	1	0	0	0	0	0	0	0	1		1	0	0	1	0	0	0	0	5	0.42
NF for Supplier Integration (OEM to Supplier)	1	1	0	0	0	0	0	0	0	1	1		0	0	0	0	0	0	0	4	0.33
NF for (Procurement) Bidding and Inquiry (Create Offering)	0	0	0	0	0	0	0	0	0	0	0	1		0	0	0	0	0	0	1	0.08
NF for Drawingless Manufacturing	1	1	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	2	0.17
NF for (Procurement) Bidding and Inquiry (Purchase)	0	0	0	0	0	0	0	0	0	0	0	1	1	0		0	0	0	0	2	0.17
NF for Marketing	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0		0	0	0	2	0.17
NF for After Sales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		0	0	1	0.08
NF for Product Documetation	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	1		0	4	0.33
NF for Engineering Change Management	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0		6	0.50
Passive-sum	5	6	3	2	7	3	1	5	5	13	15	16	1	0	1	3	1	1	0		
Normalized Passive-sum (vs. max)	0.31	0.38	0.19	0.13	0.44	0.19	0.06	0.31	0.31	0.81	0.94	1.00	0.06	0.00	0.06	0.19	0.06	0.06	0.00		

Figure 5. Use Case impact matrix

In addition to the impact matrix, we further specified the following metric to encode a significance weight, serving as the relevancy factor within our relevancy portfolio:

$$rel(UC) = \frac{\sum_{i=0}^{2} w_i \cdot rel_i(UC)}{\sum_{i=0}^{2} w_i \cdot \max(R_i)} \tag{1}$$

Hereby, the following conditions hold:

$rel_0(UC) \in R_0=\{0,1\}$	represents the simplicity index S (how simple is the UC?)
$rel_1(UC) \in R_1=\{0,1,2\}$	represents the relevancy index B, derived from the JT Workflow Forum
$rel_2(UC) \in R_2=\{0,1,2\}$	represents the relevancy index V, based on our experience
w_i	represents the weight of index $rel_i(UC)$

In the scope of the JT Workflow Forum activities, company representatives had prioritized Use Cases within group meetings. Mapping these priorities to Use Cases listed in Figure lead to $rel_1(UC)$.

Use Case	Simp. (S) [0,2]	Board Rel. (B) [0,3]	VPE Rel. (V) [0,3]	Significance weight (W) (S + B · 2 + V · 2) / 14	Normalized W vs. max
NF for (hybrid) Design in Context	0	3	3	0.86	1.00
NF for (non-hybrid) Design in Context	0	3	1	0.57	0.67
NF for Packaging	1	2	2	0.64	0.75
NF for Installation Feasibility	1	2	2	0.64	0.75
NF for high-end Visualization	1	2	1	0.50	0.58
NF for Multibody-Simulation (MBS)	1	2	2	0.64	0.75
NF for Finite Element Analysis (FEA)	1	2	1	0.50	0.58
NF for (Digital Factory) Layout Planning	0	3	0	0.43	0.50
NF for (Digital Factory) Bulk Material Handling	0	3	0	0.43	0.50
NF for (Digital Factory) Plant or Aggregate Development	0	3	1	0.57	0.67
NF for Supplier Integration (Supplier to OEM)	0	3	3	0.86	1.00
NF for Supplier Integration (OEM to Supplier)	0	3	3	0.86	1.00
NF for (Procurement) Bidding and Inquiry (Create Offering)	1	2	1	0.50	0.58
NF for Drawingless Manufacturing	0	3	3	0.86	1.00
NF for (Procurement) Bidding and Inquiry (Purchase)	1	0	0	0.07	0.08
NF for Marketing	2	0	0	0.14	0.17
NF for After Sales	1	0	0	0.07	0.08
NF for Product Documentation	1	0	2	0.36	0.42
NF for Engineering Change Management (ECM)	1	2	3	0.36	0.42

Figure 6. Significance weight for all Use Cases

The index $rel_2(UC)$ was documented primarily throughout the discussions held within the process analysis. With a specified weight distribution of $w_1 = 1$, $w_2 = 2$ and $w_3 = 2$, Figure shows the associated Use Case significancies, providing a holistic measure of relevancy. As mentioned, the relevancy portfolio was used to select a subset of UCs. These were then actually specified. Normalizing significancies against their maximum to an interval [0.0,1.0], a lower bound of $rel(UC)_{normalized} > 0.5$ was set to be met by a Use Case to be considered for specification and hence regarded for requirements derivation. Those considered were further filtered via the impact matrix. Use cases with active-sums
smaller than 0.2 were ruled out.

Figure gives a depiction of the context between processes and UCs, including the Swim-Lane diagram of an exemplary UC: Neutral Format (NF) for Packaging. In addition to excluding use cases via the relevancy portfolio, potentials were additionally filtered up-front by summarization.

3.3 Portfolio Synthesis

Based on the initial requirements denoted during the Process Synthesis phase, a manual mapping onto the derived UCs was conducted (requirements associated to processes, processes to Use Cases via an Excel-sheet), resulting in a portfolio to be used for following benchmark activities.
Figure illustrates an excerpt of the requirements portfolio in its state as of today. Requirements are associated with UCs. Because the same requirement can be associated with multiple UCs, a matrix-form of notation has been chosen for the depiction of the requirements portfolio.
Each of the listed requirements has been elaborated by textual description and in part images, in order to provide a common understanding und avoid ambiguity of some requirements. These descriptions are not further illustrated in this paper.
Note that only requirements relating to data format and accordingly expected translator functionality are listed and elaborated. This is because the essential goal was to evaluate the potential of an NF. An analysis of how individual software-systems can handle and deal with the provided content was considered important but beyond the scope of this paper.

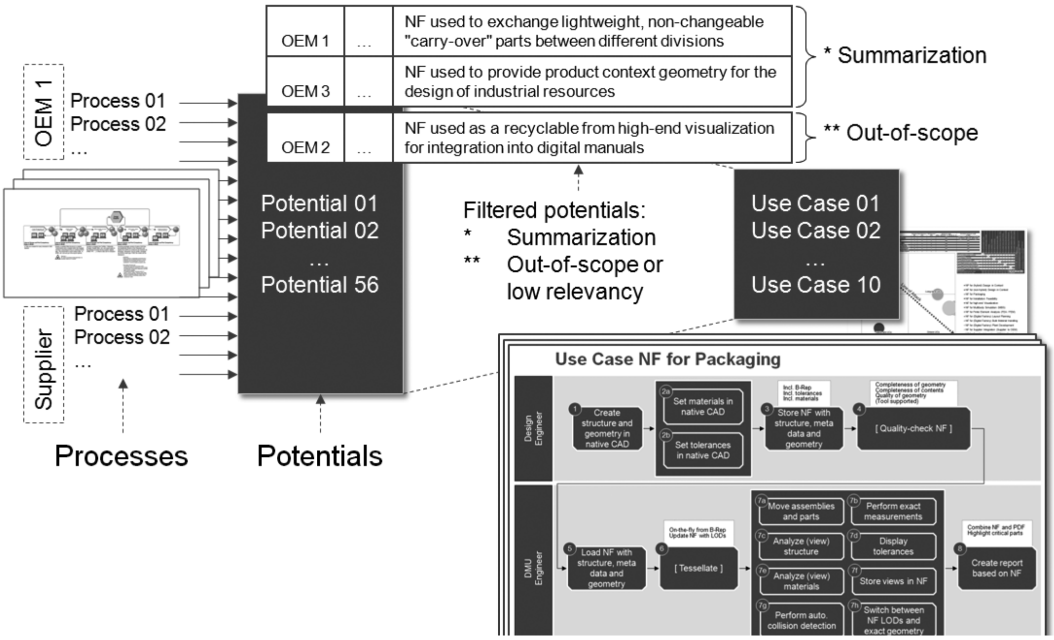

Figure 7. From Business Processes to Potentials to Use Cases

Req. #	Requirement	NF for (hybrid) Design in Context UC 01	NF for (non-hybrid) Design in Context UC 02	NF for Packaging UC 03	NF for Installation Feasibility UC 04	NF for high-end Visualization UC 05	NF for Multibody-Simulation (MBS) UC 06	NF for Finite Element Analysis (FEA) UC 07	NF for (Digital Factory) Plant or Aggregate Development UC 08	NF for Supplier Integration (Supplier to OEM) UC 09	NF for Supplier Integration (OEM to Supplier) UC 10
01	B-Rep information representing exact geometry must be provided.	X	X	X	X	X	⊙	X	X		
02	Auxiliary geometry must be provided, such as points, axes and planes.	X	X								
03	Product structure must be provided.	X	X	X	X	X	◇	◇	X	X	X
04	A consistent unit of measurement must be provided.	X	X	X	X				X	X	X
11	Mass must be provided per part.						X	X			
12	Density must be provided per part.						X	X			
13	Center or gravity must be provided per part.						X	X			
14	Fasteners must be provided.							X			
15	Kinematical connections must be provided.				X		X	X	X		
16	There must be a possibility to load and store a kinematical keyframe animation sequence.				X	X					
17	Features must be provided.								X		

Figure 8. Excerpt from the requirements portfolio

4. Results

This Section illustrates results achieved in the scope of following the presented procedure model.

4.1 Use Cases and requirements

A total of 34 requirements and 10 Use Cases were integrated into the requirements portfolio, nearly all information coming from the process analysis. The Use Cases considered are:

1. Neutral Format for (hybrid) Design in Context
2. Neutral Format for (non-hybrid) Design in Context
3. Neutral Format for Packaging
4. Neutral Format for Installation Feasibility
5. Neutral Format for high-end Visualization
6. Neutral Format for Multibody Simulation (MBS)
7. Neutral Format for Finite Element Analysis (FEA / FEM)
8. Neutral Format for (Digital Factory) Plant or Aggregate Development
9. Neutral Format for Supplier Integration (Supplier to OEM)
10. Neutral Format for Supplier Integration (OEM to Supplier)

The depicted requirements portfolio, or derivatives thereof, can now be used in order to determine whether or not a given data format supports the specified UCs. This can be achieved in multiple ways:

- Validation by theory, e.g. mapping data format containers to requirements
- Validation by practice, running tests and benchmarking activities

Regarding the first and relating to the JT format, we have created a correlation matrix suggesting that at their core, all but the UCs 4, 6, 7 and 8 are supportable as of today. Figure shows an excerpt, which we have complemented by textual descriptions, due to the fact that not all of the mappings seem straight-forward. However, this is not elaborated in the paper at hand.

Req.	JT containers																																										
	Product struct.			Geometry																	Metadata				Various																		
				Tessellated				Exact									Reference								Visual attributes										PMI								
				Shape				BRep		Primitive					Curve																												
	JtkAssembly	JtkPart	JtkInstance	JtkLineStripSet	JtkPointSet	JtkPolygonSet	JtkTriStripSet	JtkBrep	JtkXTEntity	JtkBoxSet	JtkCylinderSet	JtkPyramidSet	JtkSphereSet	JtkPrismSet	JtkAnalyticCurve	JtkNURBSCurve	JtkCoordSys	JtkRefAxis	JtkRefPlane	JtkRefPoint	JtkProperty				JtkLight		JtkMaterial	JtkShader	JtkShaderEffects	JtkTexImage	JtkTransform	JtkCaeVisual		JtkMotionExporter	JtkPMIStructs								
																					JtkSTRING	JtkINT	JtkFLOAT	JtkDATE	JtkInfiniteLight	JtkPointLight						JtkCaeColorbar	JtkCaeColorLegend		PMIAttrNote	PMIAttrDim (Dimesions)	PMIAttrLw (Line weld)	PMIAttrSw (Spot weld)	PMIAttrMp (Measurement point)	PMIAttrSf (Surface finish)	PMIAttrModelView	PMIAttrCoordinateSystem	Other
01								X	X																																		
02																	X	X	X	X																							X
03	X	X																																									
04																					X																						
05																																				X							X
06	X	X	X																																								
07				X	X	X	X																				X																
0				X	X																						X																

Figure 9. Excerpt of the JT correlation matrix

The other Use Cases in question are problematic because there exist no explicit containers in JT (or similar formats as a matter of fact) to hold kinematical connections or feature information. These are specifically addressed by requirements 15 and 17 (Figure). Nevertheless, there may exist ways to provide such data with the containers that do exist, e.g. via product structure and property content. We are working on such very solutions. For this purpose, the mentioned requirements need detailing. This is due to the existence of countless features and according feature types, as well as of various information related to kinematical content, such as a multitude of joints, mounts and forces.

Regarding validation by practice, Section 1.2 mentioned ongoing benchmark activities in the scope of two industrial boards that currently relate to the JT format.

4.2 Automotive Standard

There is still lack of guidelines regarding how the quality of data in a neutral, lightweight data format is to be ensured.

No matter which lightweight data format, we have identified three magnitudes of influence that we propose should be addressed when specifying a guideline for quality assurance: minimal required contents, general criteria and quality validation. These must be considered for the data format to be accepted within broad industrial application (exceeding visualization). For each influence (none refer to specific UCs), we have provided a first set of variables we propose to entail.

Table 1. illustrates an overview, which we are now, in cooperation with Daimler AG, using to develop a more detailed 'best practice' proposal of an Automotive Standard, particularly in terms of JT (in combination with PLMXML). This is not content of the here presented paper though.

Table 1. Influences on a quality assurance guideline

Influence	Proposed variables	Notes
1. Contents	- Product structure - Tessellated geometry with 3 LODs - Exact B-Rep geometry - Product and Manufacturing Information	Any lightweight format that is to be broadly applied within the product development process should feature tessellated (for fast visualization) and exact geometry. Since B-Rep is the most common form in the scope of CAD-oriented representation, the lightweight format should adapt respectively. Additionally, a product structure as well as data on Product and Manufacturing Information should be provided.
2. General criteria	- Fixed data format version - Consistent unit of measurement - Materials	Some data formats can be split into multiple physical files, asking for a common understanding in terms of version. Further, information on materials should be provided per part in order to allow derivation of attributes e.g. on density, weight, etc.
3. Quality validation	- Comparison NF B-Rep with original CAD - Comparison NF B-Rep with NF Tessellation - Check for missing geometry - Check for open edges	When the lightweight format is filled with geometry coming from native CAD, both exact and tessellated geometry should be cross-checked with the original. We can imagine exact geometry comparison based on volume, center-of-gravity and surface area. Tessellated vertices should in turn lie on B-Rep surfaces. Additionally, it should be made certain that no geometry is missing and that solids have no open edges.

The above list (table) does not represent a guideline or standard itself.

5. Conclusion and outlook

Coming back to an initial statement of ours -*there has been lack of a company-neutral driving force to determine and further document the full extent of exactly which processes can be supported*- , we have taken the necessary step into this direction. As an academic institute, we were able to communicate neutrally between different vendors and applying companies. The fact that formats like JT are additionally approaching standardization will soon lead to an even higher acceptance, and hence a more effective integration. Since standardization is an ongoing process, we will continuously try to incorporate knowledge and thoughts in this context as well.

While the results achieved during the Process Synthesis phase were satisfying, it would have been helpful to define a case example to be traversed within each workshop, e.g. the development of a piston rod. Compared to following a questionnaire that was not related to a particular product, this might have led to a more comparable result, which would have simplified the Use Case Synthesis.

For a process-supporting data format to satisfy its utmost potential it needs integration into preferably all UCs. Only then, supplier integration processes can be rearranged as a whole, disposing of bothersome CAD conversion overhead on the supplying end of the chain. Knowing of the lack of kinematical and feature containers in formats like JT or 3D XML, we intend to investigate matters of integrating such data in more detail. Moreover, an integration of unique feature ID and kinematical information within PDM-systems is being researched. We can imagine a less high-level analysis specifically of the Use Cases "Neutral Format for Plant or Aggregate Development" and "Neutral Format for Multibody Simulation (MBS)" in the scope of accompanying the development of a specific product like mentioned in the above paragraph. Hereby, we would suggestively take a closer look at the functionality of underlying tools, having at hand the requirements portfolio presented in this work.

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