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SASIG Product data quality guidelines for the global automotive industry

Principes directeurs SASIG relatifs à la qualité des données de produit pour l'industrie automobile mondiale

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ISO/PAS 26183 was transposed by Technical Committee ISO/TC184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*, in collaboration with the Strategic Automotive product data Standards Industry Group (SASIG) under the ISO/TC184/SC4 Harvesting Process, as defined in SC4 Standing Document (SC4N1198), *Procedures for Transposing Externally Developed Specifications into ISO Deliverables*.

At the time this document was created, SASIG member organizations included the following:

— Automotive Industry Action Group (U.S.)

— Federal Chamber of Automotive Industries (Australia)

— Groupement pour l'Amélioration des Liaisons dans l'Industrie Automobile (France)

— Japan Automotive Manufacturers Association (Japan)

— ODETTE Sweden

— Verband der Automobilindustrie (Germany)

This set of guidelines is a joint effort by the organizations that comprise SASIG. In particular, the following organizations contributed the major content of this work:

— Automotive Industry Action Group (AIAG)

— Groupement pour l'Amélioration des Liaisons dans l'Industrie Automobile (GALIA)

— Japan Automotive Manufacturers Association (JAMA)

— Verband der Automobilindustrie (VDA)

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SASIG

Product Data Quality

Guidelines for the Global Automotive Industry

Document Version 2 Revision 1, May 2005

(replaces Document Version 2.0, September 2004)

SASIG

Automotive Industry Action Group (U.S.), Groupement pour l'Amelioration des Liaisons dans l'Industrie Automobile (France), Japan Automobile Manufacturers Association (Japan) / Japan Auto Parts Industries Association (Japan), Odette Sweden AB (Sweden), and Verband der Automobilindustrie (Germany) are members of the Strategic Automotive product data Standards Industry Group- SASIG. These organisations are cooperating in the creation, distribution and use of joint documents, including PDQ (Product Data Quality), PDM Assembly Data Exchange, XMTD (Exchange and Management of Technical Data), DEV (Digital Engineering Visualization).

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Contacts information to SASIG is available on http://www.sasig.com

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CHANGE HISTORY V1.0 - V1.1, FEBRUARY 2003

ALL SECTIONS:

General editing and clean-up of terms, references and graphic samples.

SECTION I:

Add Criteria numbers to Table 5, rotate 90^0 and enlarge print for readability.

SECTION II:

Criteria 3.2.3.1 Change Non-Nurb to Analytical, all uses.

Criteria 3.2.1.12 inappropriate degree linear curve: G-CU-ID, added

Criteria 3.2.2.17 Multi-faced surface: G-SU-MU, added.

Criteria 3.2.2.17 Folded surface; G-SU-FO, deleted.

Criteria 3.2.5.2 Encoding modified.

Criteria 3.2.5.3, Non-nurbs face changed to Analytical Face; G-FA-AN.

Criteria 3.2.5.7, Multi-region face: G-FA-MU deleted.

Criteria 3.3.2 Identical elements changed to Embedded elements.

ATTACHMENTS:

Attachment A : Glossary

Applied approved Glossary changes.

Attachment C : Recommended Values

Table replaced with statement directing the reader to the websites of the respective organisations for recommended values to be used in evaluating model quality.

Attachment D : Formsheet

Changed non-nurb to analytical.

CHANGE HISTORY V1.1 - V2.0, SEPTEMBER 2004

ALL SECTIONS:

General editing and clean-up of terms, references and graphic samples.

Control of English UK usage.

Document reorganisation:

Section III becomes Attachment F (former Attachment F is Attachment G)

Former Section IV becomes Section III

SECTION I:

New chapter 1.7 How to use these guidelines

SECTION II:

Encoding has been modified to be compliant with the criteria reorganisation.

The former chapter 3.1 (Best Practices) has been deleted and its content has been dispatched into the Non-geometric criteria chapter.

Chapter 3.1.2 Surface : Two criteria added :

- "Folded surface"
- "Inappropriate degree planar surface"

Chapter 3.1.5 Face : Numbering correction

Chapter 3.1.7 Solid : The three first former criteria has been transferred to the Non-geometric criteria chapter.

Chapter 3.2.8 Model : The content has been transferred to the Non-geometric criteria chapter.

Non-geometric criteria chapter has been moved after the Geometric criteria chapter,and has been completed.

Drawing Quality Criteria chapter : twelve new criteria.

Chapter 4 CAE Data : Completed with thirteen families of criteria.

Chapter 9 Quality Stamp : new chapter.

Former chapter 9 Other Data becomes chapter 10.

SECTION III:

Chapter 11.11 Healing has been completed.

ATTACHMENTS:

Attachment A : Glossary
Unused words have been deleted.

Attachment B : Mapping between element types
Columns of Pro/E have been completed.

Attachment F : Business Case

Attachment G : Revision request

CHANGE HISTORY V2.0 - V2.1, MAY 2005

ALL SECTIONS:

General editing and clean-up of terms, references and graphic samples.

Control of English UK usage.

FOREWORD:

Paragraph regarding improvements updated.

SECTION I:

-

SECTION II:

Chapter 9 Quality stamp has been revised.

SECTION III:

-

ATTACHMENTS:

Attachment A : Glossary
New words have been added.

Attachment B : Mapping between element types
Columns of CATIA V4 and CADCEUS have been revised.
Column for CATIA V5 has been added.

Attachment H : XML Schema for the quality stamp has been added

Attachment I : XML File Example has been added

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EXECUTIVE SUMMARY

The global automotive industry is increasingly dependent on electronic product data to design and produce vehicles. Because of that dependency, problems with the quality of product data lead to problems developing and producing the products. When its member organisations recognised the problem, the Strategic Automotive product data Standards Industry Group (SASIG) decided the most effective approach would be to produce this common set of guidelines on the aspects of product data quality.

For the purposes of these guidelines, the term “product data” is defined as any and all product data required from product conception to manufacturing. Therefore, product data include not just computer-aided design (CAD) data but also computer-aided manufacturing (CAM) data, computer-aided engineering (CAE) data, product data management (PDM) data, and other kinds of data.

Following is the definition of product data quality, on which this set of guidelines is based:

> ***Product data quality*** is a measure of the accuracy and appropriateness of product data combined with the timeliness with which those data are provided to all the people who need them.

From this we can state that: Good product data quality means providing the *right data* to the *right people* at the *right time.*

During product development, many people depend on data describing various aspects of the product. The need for high quality product data is easy to describe at a high level: poor quality data costs money, delays product development, and can result in poor quality products. These entire costs can be increased even more by the need to spend extra money to meet a product development schedule and pay for overtime labour or bring in temporary contract personnel to assist. Unfortunately, connecting PDQ costs to their causes is rarely simple.

This set of guidelines provides a broad range of information captured in three main sections.

- Section I provides introductory and background material that frames the product data quality problem. Topics covered include the nature of product data, high-level product data quality issues, and how to use •this document.
- Section II contains specific product data quality criteria for users. In this version, the content focuses primarily on CAD geometry, though other topics are also at least partially addressed. The criteria describe specific problems that can occur and suggest how to measure them and what to do when they occur.
- Section III provides information and methods that will help improve product data quality. The topics covered range from readiness for change to reward systems to supporting technologies such as tools for checking data.

In addition to the main parts, a set of attachments provides further information.

This document can be considered a work in progress. SASIG chose to publish at this stage because delaying to fill in the gaps would keep valuable information out of the hands of those who need it.

Direct use of these guidelines by product data creators and users of all types is encouraged. The people most likely to make regular use of Section II of these guidelines will be those who are responsible for building and maintaining company product data guidelines or standards. Those most likely to use Sections III and Attachment F are the managers, team leaders, and other people responsible for business processes and results.

FOREWORD

The Strategic Automotive product data Standards Industry Group (SASIG) comprises automotive industry organisations from around the world. It was originally formed in 1994 to encourage the development and promotion of STEP, the international product data exchange standard (ISO 10303), within the automotive industry. Individually, the SASIG member organisations realised that if the quality of the product data being exchanged was poor, even the best data exchange processes would be of little value. They also realised that problems with product data quality were widespread and costly. Each organisation was, therefore, developing its own guidelines and recommendations for improving product data quality.

In 1999, the SASIG member organisations recognised their common interest in product data quality. Verband der Automobilindustrie (VDA) proposed a focused meeting to consider how SASIG could encourage greater collaboration in addressing this common issue. At that special meeting, the organisations decided to cooperate in developing a common set of guidelines based on VDA's existing CAD data quality guideline (VDA 4955 V2) and other organisations' documents. The intended result would encourage the most effective and broadly applicable product data quality for the global automotive industry. This commitment led to a series of workshops which, in turn, led to the collaborative development of this set of guidelines.

This is Version 2 of the product data quality guidelines. As such, it does not cover all the potential product data quality issues that have been identified. In the interest of putting useful information in the hands of those who can use it, the participating organisations have decided to move forward with Version 2 by gathering information already developed. The expected additional major topics for future versions are included as major sections with summary information about what will eventually be covered.

Revisions of the documents are published in case that corrections improve the quality of the documents itself. SASIG and its Product Data Quality Work Group encourage suggestions for improving this set of guidelines. Please use the form given with Attachment G.

SASIG encourages participation in this and its other activities by national automotive organisations from all countries.

Disclaimer and Explanation

At the time this document was created, Strategic Automotive product data Standards Industry Group member organisations included the following:

- Automotive Industry Action Group (U.S.)
- Federal Chamber of Automotive Industries (Australia)
- Groupement pour l'Amélioration des Liaisons dans l'Industrie Automobile (France)
- Japan Automotive Manufacturers Association (Japan)
- ODETTE Sweden
- Verband der Automobilindustrie (Germany)

The SASIG member organisations are expected to distribute these guidelines to their respective members and other interested parties in their countries. While the SASIG member organisations are free to translate these guidelines into other languages, this English version shall always be considered the master document in case of a dispute. While distribution of the guidelines will normally be done as a complete document, the SASIG member organisations are free to extract portions for use in other documents. In such cases, the original source of the information shall be clearly documented. SASIG member organisations may also distribute the guidelines through the SASIG PDQ Liaison Member organisations.

ACKNOWLEDGEMENTS

This set of guidelines is a joint effort by the organisations that comprise SASIG. In particular, the following organisations contributed the major content of this work:

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Though not SASIG member organisations, the Japan Automobile Parts Industry Association (JAPIA) and the Verband Deutscher Maschinen-und Anlagenbau (VDMA) also contributed to the guidelines. Direct contributors to the document include the following:

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SECTION I: INTRODUCTION AND BACKGROUND

This Section introduces product data quality and provides background that frames the rest of the document. It also provides guidance on using these guidelines.

1 Introduction

The global automotive industry is increasingly dependent on electronic product data to design and produce vehicles. Because of that dependency, problems with the quality of product data cause problems in developing and producing the products. When its member organisations all recognised the problem and were all working on some aspects of product data quality (PDQ), SASIG decided that the most effective approach would be to produce this common set of guidelines on the aspects of PDQ. Addressing product data quality is a complicated issue. One underlying problem is that each user of product data has different requirements for that data. The following are a few examples that focus on CAD data.

- *CNC programming* – A CAD model of a part or tool that looks good on the screen or when printed on paper may not contain the right set of information necessary for automatically programming a CNC machine tool to make the part. There may be excess geometry or incomplete geometry, either of which confuse the CNC programming software or result in an incorrect part or tool.
- *Structural finite element analysis* – A CAD model that represents a detailed design typically has far too much detail for structural analysis. The model needs to be simplified for a realistic chance of getting a useful simulation. Examples of details that can get in the way include fillets and radii added for such purposes as making the part more manufacturable.
- *Tooling design* – The original CAD model for a part that is going to be moulded or cast may not have the parting line identified or the necessary draft built in. The allowance for the inevitable shrinkage of a solidifying part may not be built into the model either. Similar allowances have to be built into stamping dies for over-bending to compensate for spring back.

When too much or too little information is provided or the information is incorrect, the result is increased cost and time. To be able to use poor quality data, someone must spend time, often extensive, putting the model in a usable form. Sometimes the required changes are so time-consuming and expensive that the recreation of a correct version of the model is more cost-effective. Recreating data leads to the potential for introducing further errors in the data.

1.1 Product Data

For the purposes of this set of guidelines, the term "product data" is defined as any and all product data required from product conception to manufacturing. Therefore, product data includes not just computer-aided design (CAD) data but also computer-aided manufacturing (CAM) data, computer-aided engineering (CAE) data, product data management (PDM) data, and other kinds of data. Examples of product data include:

- CAD models (solid, surface, or wireframe)
- Engineering and manufacturing bills of materials
- Process plans
- Model revision history and effectivity
- Product assembly structure
- Numerically controlled machine-tool programs

1.2 Define PDQ

The best way to characterise product data quality involves a base statement with two implicit themes. The definition of product data quality on which this set of guidelines is based is:

> ***Product data quality*** is a measure of the accuracy and appropriateness of product data combined with the timeliness with which those data are provided to all the people who need them.
>
> From this we can state that:
>
> Good product data quality means providing the *right data* to the *right people* at the *right time.*

The first theme implicit in this definition is the need for an appropriate set of metrics. To improve product data quality, one must be able to measure the level of product data quality and, after making a change, evaluate whether an improvement has occurred. Section II has some recommendations on metrics.

The second implicit theme is access. Regardless of how appropriate and robust a specific product model or set of data is, if it is not available in a timely manner to those needing it, then that model or data set is of no value. Examples of this include inappropriate data formats or systems, denied access to file servers, missing part numbers, and hidden data files. Issues that deal with how data are accessed fall in the realm of PDM systems. The primary access issues are who has access to what and when. Of course, the data created and maintained by PDM systems are also product data. Hence, those data are also subject to product data quality concerns. This view is driven by the requirements for concurrent engineering. The underlying principle of concurrency is that downstream activities start before upstream activities are complete. This principle requires consideration of which data are needed, at what time, and by whom. Thus, the information about where those models or bills of material are to be found as well as how and when to get them can, and should, also be considered product data.

1.3 Need for PDQ

The need for high quality product data is easy to describe at a high level: poor data quality costs money, delays product development, and can result in poor quality products. Unfortunately, connecting PDQ costs to their causes is generally not so simple. During product development, many people depend on data describing various aspects of the product, including:

- CAD users, who need data to help them develop related parts or other aspects of the product based (in part, at least) on the geometry.
- Engineering analysis specialists, who need data to build analysis models.
- Tooling and fixturing designers, who need accurate part geometry as a basis for the design of their manufacturing equipment.
- Numerically controlled machine tool programmers, who need to develop the program used to machine parts.
- Prototype builders, who need good representation of the products they have to make.
- Product quality inspectors, who need accurate representations of parts to ensure that they meet the design requirements.
- Testing laboratories, who must understand the nature of a product in detail before they can complete a test.

Problems in any of these or similar areas can generate substantial costs. The costs can be directly realised by the need to:

- Check data for problems, regularly and repeatedly.
- When they are discovered, try to fix (successfully or not) data problems that are discovered.

- Spend time re-entering problem data into a different system.
- Resend corrected data.
- Resend unsuccessfully or incompletely received data.

In addition, there can be indirect costs due to poor quality product data. These costs result from the effect of data problems on work done or products produced using the data, such as:

- Correcting errors that appeared during data re-entry or correction
- Modifying or re-creating tooling
- Fixing warranty problems
- Re-doing analyses
- Re-building prototypes
- Delay in bringing the product to market

All of these costs can be increased even more by the need to spend extra money to meet a product development schedule and by having to pay for overtime labour or bring in temporary contract personnel to assist.

1.4 Master Data

The extensive use of computer-aided design to create geometric part data has given rise to multiple representations for a component being provided to data recipients (for example, 3D solid, 3D wireframe, and 2D electronic drawings). When different representations of the same part do not agree, the recipient must decide which is correct. The lack of decision criteria has provided the opportunity for misinterpretation. The following hierarchy defines which type of data has precedence (overrules the others) in case of disagreement.

1. If a solid model is present, it should be considered the master data. Any other geometric representations that do not agree should be considered to be in error.
2. If there is no solid model, then a surface model, if present, should be considered the master data. Any other geometric representations that do not agree should be considered to be in error.
3. If there is no surface model, then a 3D wireframe, if present, should be considered the master data. Any other geometric representations that do not agree should be considered to be in error.
4. 2D data are to be assumed correct only if they are the only type of data available.

While these rules of hierarchy may cause the use of data that does not agree with the geometry creator's actual intent, having a commonly understood and accepted hierarchy will encourage consistency. When all parties involved understand the hierarchy, then the creator will know which data type must be correct.

Another problem arises from confusion due to too much information, where another hierarchical approach can help. Because what is necessary versus what is considered superfluous is situation-dependent, the way all geometry should be managed and presented must be defined.

Filtering the display of data elements to include only the most complex element types that define the physical attributes of the finished component (i.e., edges, holes, etc.) should be the highest order in the hierarchy. With this filter applied, the display would show the master data. Filters that include elements such as construction geometry, reference geometry, history, etc., would be filters of a lower order. If a conflict then exists in the other element data included in the data file, the non-master data would be considered, by default, to be in error. An example of these conflicts is when a centreline does not pass through the centre of a hole; the hole would be considered the master (see **Figure 1**). The hole is the physical attribute. The centreline is not a physical attribute of the part and would be filtered out by this requirement.

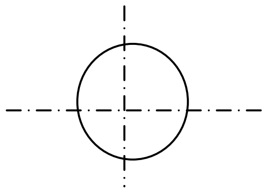

Figure 1. Non-master centrelines incorrectly positioned

Another example is wireframe elements that do not coincide with the edges of a solid. The solid would be considered a more complex element than the wireframe and therefore the solid would be the only element displayed with the required filter applied (see **Figure 2**). The solid would be considered the master and the wireframe would be considered in error.

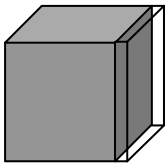

Figure 2. Non-master wireframe structure inconsistent with solid

1.5 Drawing Simplification and Elimination

One goal of any product data quality improvement activity should be to reduce the reliance on paper drawings and increase reliance on electronic representations of the product. This can be accomplished in a phased approach where the content of drawings is simplified and reduced, coupled with increasing reliance on electronic forms of the data. Hence, two companies negotiating CAD issues prior to contract should actively consider simplifying and reducing the content of their drawings. To simplify the overall process, a distinction should be made among **drawings**, **simplified drawings,** and **information drawings**:

Drawing – This term describes the technical drawing in the conventional, classical sense according to drawing standards such as DIN 199 or ISO 5457:1999. The corresponding drawing “represents an object in its intended finished condition;” whereby, “in its depiction and with subsequent details, it takes into account in a certain manner particular view points of the production.” This means it is possible to fabricate a product based on the component part drawings. In addition, an assembly drawing shows functional connections and, to a certain extent, the spatial relationship of several component parts to one another. This type of drawing must also satisfy the agreed-upon quality criteria.

Simplified drawing – The contents (scope) of supplementary CAD drawing data may be simplified appropriately given the prerequisite that a complete description of the component part through a 3D CAD data model exists. This simplified CAD drawing data, together with the associated 3D CAD data model, represent the complete data model. Taken together, the two forms of data must be adequate to produce the relevant component part. Both these types of descriptive forms must satisfy the agreed-upon quality criteria.

Information drawing – Information drawings are incomplete and, perhaps, non-scaled depictions of products or component parts. They only serve the purpose of providing supplemental information and generally do not fall under any release procedures or any change control services. Because they do not contain fundamental data needed for producing a part, information drawings need not undergo any quality checks. For data quality considerations, the drawing used to make an offer is, for example, considered to be an information drawing. Ultimately, all exchange of information, both master and illustrative, should be electronic representations, ideally 3D CAD. That is, no “hard copy” drawings or illustrations are needed.

1.6 PDQ Document Strategy

SASIG has determined that this set of guidelines will be published in a series of versions with increasing content.

Table 1. documents the PDQ strategy for developing the content of the different versions. The cell entries and their meanings are:

- A – The need to address the topic is well established and the PDQ criteria are well-defined.
- B – The need to address the topic is well established but PDQ criteria are not yet well-defined.

Suggestions for the improvement of these guidelines are encouraged through the use of the form provided in Attachment G - Revision request.

Table 1. PDQ document strategy

Content marked A appears in this version Content marked B is expected to appear in later versions				Process Chain							
				Define Product	Style Product	Design Product	Evaluate Product	Plan Production	Design Tool	Manufacture Production Tool	Test Tool to Control Quality
Data Class	**CAD data**	**Geometry**	Wireframe Model	A	A	A	A	A	A	A	A
			Surface Model	n/a	A	A	A	A	A	A	A
			BREP Solid Model	n/a	A	A	A	A	A	A	A
			CSG Model	n/a	A	A	A	A	A	A	A
		Drawings	2D Drawing	B	B	A	B	B	A	B	B
			Associative Drawing	n/a	B	B	B	B	B	B	B
		Non-geometry	Presentation	B	B	B	B	B	B	B	B
			Parametrics	n/a	B	B	B	B	B	B	n/a
			Features	n/a	B	B	B	B	B	B	B
			Assembly	n/a	B	B	B	B	B	B	B
			Tolerancing	n/a	B	B	B	B	B	B	B
			Surface Condition	n/a	B	B	B	B	B	B	B
			Material Properties	n/a	B	B	B	B	B	B	B
			Parts Information	B	B	B	B	B	B	B	B
	CAE data		FEA, BEA, …	n/a	n/a	B	B	B	B	n/a	n/a
			KIN	n/a	n/a	B	B	B	B	n/a	n/a
			ROB	n/a	n/a	B	B	B	B	B	B
	PDM data		Configuration Management	B	B	B	B	B	B	B	B
			Product Structure	B	B	B	B	B	B	B	B
			Product Management Data	B	B	B	B	B	B	B	B
	Inspection data		Measure Data	n/a	B	B	B	n/a	B	B	B
	Prototyping data		STL	n/a	B	n/a	B	B	n/a	n/a	n/a
	Manufacturing data		Process Plan	n/a	B	n/a	B	B	B	B	B
			NC	n/a	B	n/a	B	n/a	n/a	B	B
			RC	n/a	n/a	n/a	B	n/a	n/a	B	B
	Other data		System Property	B	B	B	B	B	B	B	B
			Technical Data	B	B	B	B	B	B	B	B

Table 2. Document sections

Section I – Introduction and Background	
1. Introduction	Introduces product data quality and this set of guidelines.
2. Data Applicability	Describes the types of product data this version of the guidelines covers as well as coverage expected in future versions. Section 2 also describes various general aspects of product data and the product data life cycle.
Section II – PDQ Criteria	
3. CAD Data	Provides the data quality guidelines associated with various aspects of CAD data such as solid models, assemblies, surface models, tolerance data, and drawing views.
4. CAE Data	Provides the data quality guidelines related to data used by and created by computer-aided engineering applications such as finite element analysis, kinematics analysis, and dynamic analysis.
5. PDM Data	Provides the data quality guidelines for the data stored in a product data management (PDM) system.
6. Inspection Data	Provides the data quality guidelines for the data created for, used, and stored in an inspection system.
7. Prototyping Data	Provides the data quality guidelines for the data created, used, and stored in a prototyping system.
8. Manufacturing Data	Provides the data quality guidelines for the data created, used, and stored in a manufacturing system.
9. Quality Stamp	Provides the guidelines for the PDQ check result.
10. Other Data	Provides the data quality guidelines for other kinds of data not captured in the previous sections.
SectionIII – Improving PDQ	
11. Improving Product Data Quality	Provides guidance on implementing PDQ improvements, including the use of appropriate tools and business processes in support of the direct creation of data.
Attachments	
A. Glossary	Glossary of terms
B. Mapping Between Element Types	Mapping between element types across various systems and standards
C. Recommended Values	Suggested values to use (by specific PDQ criterion) when checking for problems.
D. Formsheet	Example process and form to use between trading partners to agree on various aspects of the data they will exchange.
E. SASIG-ODETTE Cross Reference	Cross reference between this document and sections covering the same information in the ODETTE version 2 recommendations.
F. Business Case	Describes how to build a business case for addressing product data quality, complete with templates to help gather and process the data.
G. Revision Request	A form to be used to request a revision in this document.

1.7 How to Use These Guidelines

These guidelines provide a broad range of information. The people most likely to use these guidelines will be those who are responsible for building and maintaining company product data guidelines or standards. However, direct use of these guidelines by product data creators and users of all types is encouraged.

For any particular activity that uses product data, it is unlikely that this entire set of guidelines will apply. A person using these guidelines is, therefore, expected to apply all the parts of this set of guidelines that fit the particular circumstances. For example, when building surface models, the guidelines specific to solid models will probably not be of value, but at the least, the guidelines about wireframe models will apply.

In “real life,” the requirements of a particular activity may force a user to violate one or more guidelines. When that happens, the user being aware that he or she is doing so is of value so that potential downstream problems with the data can be identified in advance.

