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### Tools for Ensuring CAD Data Quality

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### Agenda

- Software Factory
- Aspects of CAD data quality
- Tools for checking data quality
  - ModelCheck and ModelCheck extensions
  - QCHECK
  - GEOCHECK
  - WALLCHECK/DISTANCECHECK
- WALLCHECK demonstration





### Software Factory

Who we are:

- Founded in 1992
- PTC Partner since 1994
- Based in Garching near Munich, Germany
- 30 employees
- Areas of business and operation
  - IT Operations (Consulting/Services)
  - Software Engineering SE (Software Development)
  - CAD/CAM and PDM/PLM (Software Development)
  - PDM/PLM (Consulting/Services)
  - ALM/SCM/SLM (Software Development)
  - ALM/SCM/SLM (Consulting/Services)







### Software Factory

What we do in CAD/CAM and PDM/PLM :

- Add-ons for Creo Parametric and Windchill
  - Standard products
  - Customer specific projects
- Consulting/Services
  - Windchill Migrations/Splits/Merges
  - Services
  - • • •

• Trainings for developers on PTC APIs (TOOLKIT, OTK, J-Link, ...)

PTC<sup>\*</sup> PartnerAdvantage

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#### Software Factory automates and integrates enterprise planning



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**Complete solution** 

### SF CAD Expertise: Apps for Creo

#### Quality/Check apps



#### Interfaces between Creo and manufacturing



#### MBD eSPEC **Freetools** Freetool ISOTOL for Creo Freetool **GEN2PRT** for Creo PARAM for Creo

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### SF PLM Expertise: Apps for Windchill

#### **Datamanagement-/Migrationstools**





### Aspects of CAD Data Quality

- Organizational data quality
  - Model and feature naming
  - Standard parameters
  - Layers and Layer rules
  - Unit System/Tolerance Type
  - • • •
- Geometric data quality
  - Surface continuity (gaps, non-smooth connections, etc.)
  - Surface quality (waviness, patch number and size)
  - Mini elements (surfaces, edges, rounds)
  - ...
- Specific checks
  - Wall thickness
  - Part distance in assemblies, collisions





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### Some Effects of Poor Data Quality

- Data exchange with other systems fails
- Model fails to regenerate even after minor modifications
- Manufacturing fails
- Final product does not work
- Drawings look weird
- Customer does not accept data (of supplier)
- • • •



### Motivation for Using Data Quality Check Tools

- A first step towards better data quality
- If you do not monitor data quality, it is difficult to improve it
- In many cases, tools can automatically correct the issues
- In the other cases, the designer gets hints about what needs to be corrected



### Use Cases for Data Quality Check Tools

- Checks accompanying the design process
- Final check before release
- Check of incoming data (supplier models)
- Check of outgoing data
- Optimization of data exchange interfaces
- Quality metrics

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## **Solutions for**

# **Organizational data quality**

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#### ModelCheck Extensions







### ModelCheck Extensions: ModelCheck Standard

Use ModelCheck Standard Configuration for Extensions

	PTC ModelCHECK Config	juration Tool		×
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<ul> <li>Configuration settings</li> </ul>	Save Save as		Delete	
	Check Name	Options	Interact	Batch
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vw09mc01-drw.mch	CHKTK_VW_MC2_OLEOBJECTS_2D_DRW	YNEW	E	E
vw09mc01-prt.mch	CHKTK_VW_MC2_TOLERANCE_TYPE_2D_DRW	YNEW	E	E
vw09mc01-std.mch	CHKTK_VW_MC2_MOD_DATE_2D_DRW	YNEW	E	E
	CHKTK_VW_MC2_PARAM_2D_DRW	YNEW	E	E
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### ModelCheck Extensions: ModelCheck Standard GUI

• Implement new checks using ModelCheck Standard GUI

PTC ModelCHECK       x @ 3DModelSpace       x *         OTC ModelCHECK       drw models         ull       info       Param       Layer       View       Note       Misc       Cust       VDA         Model: Ill.drw       Image: Status:	PTC ModelCHECK x 2 30ModelSpace   PTC ModelCHECK      Param Layer View Note Misc Cust VDA   Info Param Layer View Note Misc Cust VDA   Model: Ill.drw   Model: Ill.drw   Status:   Check *   Result   Drawing Detail Setup   Drawing Name Errors   2   Pornat Name   Missing Layers   2   Non-standard Note Fonts   3   WW.MC2: FORMAT EXCHANCE check (drw)   4   VW.MC2: LAYERRULES check (drw)   5   VW.MC2: UCEOBLECTS check (drw)   6   VW.MC2: DLEOBLECTS check (drw)   7   0   WM.MC2: DLEOBLECTS check (drw)   1   VW.MC2: DLEOBLECTS check (drw)	+ + 😣	file:///F:/SF-Applikationen/	/vw_modelcheck/1	0.3/bin/report/III.d.html	<b>▼</b> <del>*</del> <del>1</del> ×	🏠 🖷 🗎
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#### ModelCheck Extensions: Customer GUI

• Display ModelCheck Results with customer specific designed GUI

			VW Modelcheck Re	sult: LLL.DRW			
E	<b>₽</b> _ <b>⊕</b>						
	Model A	Repair	Result	Regen.	Errors	Warnings	Info
	Σ		NOT OK		32	18	
$\checkmark$	LAGERBOCK12.PRT	æ	NOT OK	OK	11	4	0
$\checkmark$	LAGERBOCK_LAYER_SOLI	٦	NOT OK	OK	3	6	0
$\checkmark$	LLL.ASM	<b>a</b>	NOT OK	OK	9	6	0
$\checkmark$	LLL.DRW	(B)	NOT OK	OK	9	2	0
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**Repair Configuration** 

Create Standard Planes

Missing Start Features

Repeat VW Modelcheck

#### ModelCheck Extensions: Repair Functionality

• Simple Repair Selection

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	,	VW Modelcheck Re	sult: LLL.DRW				×	🗹 Layer Handling
								Delete unwanted Layer
: <u>-</u> •						4		Create Standard Layer and Layer R
Model 🛦	Repair	Result	Regen.	Errors	Warnings	Info		Change 'isolated' to 'show'
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LAGERBOCK12.PRT	٦	NOT OK	OK	11	4	0		✓ Fix Laver Status
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#### **QCHECK** for Creo

- Two types of companies
  - Using ModelCheck
  - NOT using ModelCheck (and don't want to use it)

#### **Check CAD Models against Standards and Design Guidelines**

Examining criteria for parts, assemblies and drawings:

Parts:

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- Template
- Feature names
- Suppressed elements
- Coordinate systems
- Relations
- External references
- Model status
- Layer occupancy
- Non standard lavers
- Merge lavers
- Model name
- Name of simplified representations
- Model accuracy
- Non standard layers Merge layers Circular references

Laver occupancy

Model name

Assemblies:

Template

Assembly depth

Feature names

Relations

Model status

Assembly structure

Assembly references

Suppressed elements

Coordinate systems

- Name of simplified representations
- Model accuracy
- In most cases violated check criteria can be automatically corrected.
- Possibility to add easily additional company specfic checks (will be done with Pro/TOOLKIT)

- Drawings:
- Template Additional dimensions
- Suppressed views
- Elements outside the drawing frame
- Unused drawing models
- Drawing name
- Character height
  - Examine 2D elements by groups
  - Model status
  - Model name
- Drawing format
- Drawing frame Used drawing models





#### **QCHECK for Creo: Check Mode Selection**

Amount of inspection	
Omplete	Checks criteria of categories error, warning and information
Check In & Promote	Checks criteria of categories error and warning
Check In	Checks criteria of category error
Check including al	"Checked out" and "New" components

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## QCHECK for Creo: Result Display

PE-QCHECK Results	5			X
Model: 🔲 PRT0002	_MB.ASM	•		
Revision: -	Checked on: 04.0	3.1 <mark>4</mark> 11:13		
Version: -	Checked by: Root	t		
Overview				
V S Error	Qualit	y level 0		
🔽 🔬 Warning	Check	in 🧶		
🔽 🤃 Info	Status	10/20 😁		
Chow all Chacked C	status status	30		
	Status	40 🙂		
Checkcriterion			Result	
CO01a: Standard P	arameter		4 Errors	
COULD: Standard L	ayer		7 Errors	
COO2: Assembly D	epth		OK	7
UNCOO4: Assembly R	eferences		25 Infos	
COOS: Feature Nan	1e Elemente		/ Infos	<b>F</b>
COOT: Placement C	Coordinate System		1 Info	
COO8: Relations	the second s		OK	
CO17a: Layer Assic	Inment		7 Warnings	
CO17D: Non Stand	ard Layers		4 warnings	
	er ences			
Details				
C001a: Standard Param	eter			
Number of Results: 4				
Object Type Object	Name 🔺	Feature No	Description	Correctable
Parameter RBCRES	SYSRELEASE		Wrong designation	yes
Parameter RBORG			Does not exist	Ves
Parameter RBVAL	DITY		Does not exist	yes
				Compation
				Correction
		Accept -	- Save Pro/E Data	Close

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# Solutions for Geometric data quality

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### Product Data Quality Guidelines

- Developed by SASIG for the automotive industry
- SASIG members:
  - AIAG, USA
  - GALIA, France
  - JAMA, Japan
  - VDA, Germany
  - FCAI, Australia
  - ODETTE, Sweden

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#### Overview of geometric data criteria

- Curve
  - Large segment gap (G0 discontinuity): G-CU-LG
  - Non-tangent segments (G1 discontinuity): G-CU-NT
  - Non-smooth segments (G2 discontinuity): G-CU-NS
  - High-degree curve: G-CU-HD
  - Indistinct curve knots: G-CU-IK
  - Self-intersecting curve : G-CU-IS
  - Fragmented curve: G-CU-FG
  - Embedded curves: G-CU-EM
  - Curve with a small radius of curvature: G-CU-CR
  - Tiny curve or segment: G-CU-TI
  - • • •
- Surface
  - Large patch gap (G0 discontinuity): G-SU-LG
  - Non-tangent patches (G1 discontinuity): G-SU-NT
  - Non-smooth patches (G2 discontinuity): G-SU-NS
  - Degenerate surface boundary: G-SU-DC
  - Degenerate surface corner: G-SU-DP
  - High-degree surface: G-SU-HD
  - Indistinct surface knots: G-SU-IK
  - Self-intersecting surface: G-SU-IS
  - • • •

- Edge
  - Analytical edge: G-ED- AN
  - Closed edge: G-ED-CL
  - Inconsistent edge on curve: G-ED-IT
  - • • •
- Edge Loop
  - Large edge gap (G0 discontinuity): G-LO-LG
  - Inconsistent edge in loop: G-LO-IT
  - …
  - Face
  - Large edge face gap: G-FA-EG
  - Analytical face: G-FA-AN
  - • • •
  - Shell

  - Solid
  - ....
  - Non-Geometric Quality Criteria Descriptions
  - •
  - Drawing Quality Criteria Descriptions





### Example 1: Tiny surface or patch

Problem description: Overall extent of surface or patch is too small.

Measurement: Area of surface or patch.

**Supporting information:** Elements that fall short of a particular size can lead to invalid elements and thereby to gaps. This can occur from particular geometrical operations (i.e., scaling, generation of offsets), by the exchange of data (in a system of lesser accuracy), or through further processing (finite element analysis, NC, etc.). Reworking these elements means a considerable increase in effort.

**Recommendation:** Eliminate tiny elements through an appropriate extension (extrapolation) of the elements to be joined and delete the corresponding small surfaces or patches. Alternatively, enlarge the tiny elements and join the corresponding element.



Example: Tiny surface or patch





#### Example 2: Free Edge

Problem description: A free edge is used by only one face within a shell.

Measurement: Whether edge is used by two faces.

#### Supporting information: Shell has free edges that are not sewn together. This is not usable, for

example, for trimming operations. Free edges may be intentional and require user interpretation. Examples of intentional free edges are outer boundaries, or holes within an open shell.

**Recommendation:** Recreate shell to eliminate undesirable free edges.



Example: Free edge

G-SH-FR





## **GEOCHECK Use Cases**

- Helping designers to meet data quality requirements during the design process
- Preparing and optimizing models for downstream use
- Diagnostics tool for key users
- Improving design methodology
- Tracking and monitoring data quality
- Checking data quality on incoming models
- Optimizing export/import configurations for IGES, STEP, ...





# Solutions for Specific checks

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#### Wall Thickness

- Wall thickness
  - Why does it matter?
  - What exactly is it?
  - How is it calculated?
- WALLCHECK for Creo
- Questions and answers





## Why does Wall Thickness Matter?







### When does Wall Thickness Matter?

#### The obvious answer:

In the finished CAD model, of course!

#### But:

Fixing issues is likely to be difficult in the finished model.

#### A better answer:

It makes sense to consider wall thickness during the whole design process.

#### **Conclusion:**

A wall thickness analysis tool should be

- ✓ Easy to use for the designer, no substantial training required
- ✓ Integrated into the CAD system
- ✓ Short analysis time





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## **Comparison of Calculation Methods**

#### Two surface points

- + Good calculation performance
- + Results relate to two points on the solid surface → easy to visualize
- Additional calculations required when checking for thick regions to avoid false diagnoses
- o Relatively simple handling of edges

#### Largest sphere

- Calculation difficult and time consuming when done accurately
- Results relate to a point inside the material → hard to visualize
- + Good at finding thick regions

- Special handling of edges required (sphere diameter converges to zero near edges)





### WALLCHECK for Creo – the Wall Thickness Tool by Software Factory

- Integrated in Creo Parametric
  - Runs in interactive Creo session
  - Result display directly in Creo model
  - Display of features and surfaces that cause a result
- Easy to use
  - Only 3 to 4 configuration settings required (depending on check mode)
  - Self explaining result display
- Special features
  - Checking of surface models and import geometry possible
  - Thread surfaces are considered
  - Batch mode
  - PDF report generation
  - Distance and collision checking in assembly mode





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#### WALLCHECK Result Visualization



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![](_page_36_Picture_0.jpeg)

### WALLCHECK Result Dialog

Sort results by different criteria

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- Classify results (error, warning, ok, hide)
- Add comments to results
- Highlight results in CAD model
- Display detailed information (affected features and surfaces)

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▶ Surface: 6         17918         cone <sup>1</sup> ▷ Surface: 7         17920         cone <sup>1</sup> ▷ Surface: 8         84266         plane	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	rface: 5	5 17919	)	cone	
⁵⊳ Surface: 7         17920         cone           ⁵⊳ Surface: 8         84266         plane         ✓	<sup>t</sup> ⊳ Su	rface: 6	5 17918	3	cone	
<sup>i</sup> ▷ Surface: 8 84266 plane 🔽	<sup>E</sup> ⊵ Su ► Su		7 17020	)	cone	
	<sup>L</sup> ⊳ Su ► Su <sup>L</sup> ⊳ Su	rface: 7	17520			

![](_page_37_Picture_0.jpeg)

![](_page_37_Picture_2.jpeg)

#### **Our customers**

#### Automotive

Audi AG AVL List GmbH BMW AG Borg Warner Turbo Systems Continental AG Robert Bosch GmbH DAF Trucks N.V. FEV Motorentechnik GmbH FFT EDAG Produktionssysteme GmbH & Co. KG **GKN** Walterscheid Getriebe Gratz Engineering GmbH IAV GmbH **IVECO Motorenforschung AG** LEONI Bordnetz-Systeme GmbH SHW Automotive Siemens AG, Siemens VDO Automotive ThyssenKrupp Presta AG TRW Airbag Systems GmbH Volkswagen AG ZE Friedrichshafen AG

#### Industrial

A. u. K. Müller GmbH & Co KG MAN Diesel Mann + Hummel GmbH ABB AG Transformatoren AGCO Corp. & GmbH Motorola Mobility LLC Atlas Copco Construction Tools AB MTU Onsite Energy (Tognum) Atlas Copco Rock Drills AB Nokia Siemens Networks Optical GmbH Novo Nordisk A/S August Küpper GmbH & Co. KG Bosch Rexroth AG Parker Hannifin GmbH BRP -Powertrain GmbH & Co. KG Pepperl+Fuchs GmbH Carl Zeiss AG Robert Bosch GmbH Dieffenbacher GmbH & Co. KG RTA Alesa Ltd. Dr. Johannes Heidenhain GmbH Schaeffler Technologies AG & Co KG. Schick/Wilkinson Sword Eaton Corporation Endress + Hauser Conducta GmbH Siemens AG Ferromatik Milacron GmbH Siemens AG Energy Sector geobra Brandstätter GmbH + Co.KG SKF Sverige AB Hager Electro GmbH & Co. KG SMS Siemag AG Steelcase Werndl AG Hilite Germany GmbH Stiebel Eltron GmbH & Co. KG Hobart GmbH Huber SE Swift Group Ltd Insight Technology Solutions GmbH Teraport GmbH John Deere GmbH & Co. KG Tetra Pak Packaging Solutions AB Truma Gerätetechnik GmbH & Co. KG KHS GmbH Knorr Bremse AG Trumpf Werkzeugmaschinen GmbH Komatsu Mining Germany GmbH Valcon A/S Krauss-Maffei Wegmann GmbH Voith Turbo Aufladungssysteme GmbH L'Orange GmbH Volvo Road Machinery, Inc. Liebherr-Aerospace Lindenberg Wabco Development GmbH Linak A/S ZF Friedrichshafen AG MagnaBDW Technologies GmbH Zumtobel AG

#### Healthcare

Bang & Olufsen Medicom A/S Dako A/S Hamilton Bonaduz Novo Nordisk A/S Radiometer A/S Synthes Stryker Tecan Widex A/S

#### **Public**

Landeshauptstadt München TÜV SÜD Industrie Service

#### **IT Services**

CAD-plus Cenit AG Systemhhaus GIA Informatik AG INNEO Solutions GmbH Life Cycle Engineers GmbH NET AG Parametric Technology (UK) PTC Sweden AB OFTWAR

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![](_page_38_Picture_2.jpeg)

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