Tools for Ensuring CAD Data Quality

Martin Wimmer

Head of CAD/CAM

wimmer@sf.com

PTC PartnerAdvantage

GOLD

PTC ServiceAdvantage
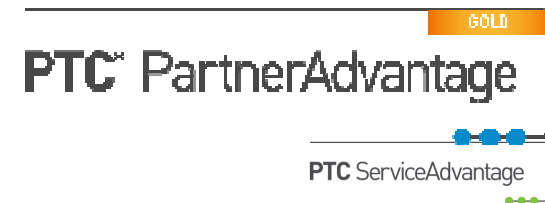
Agenda

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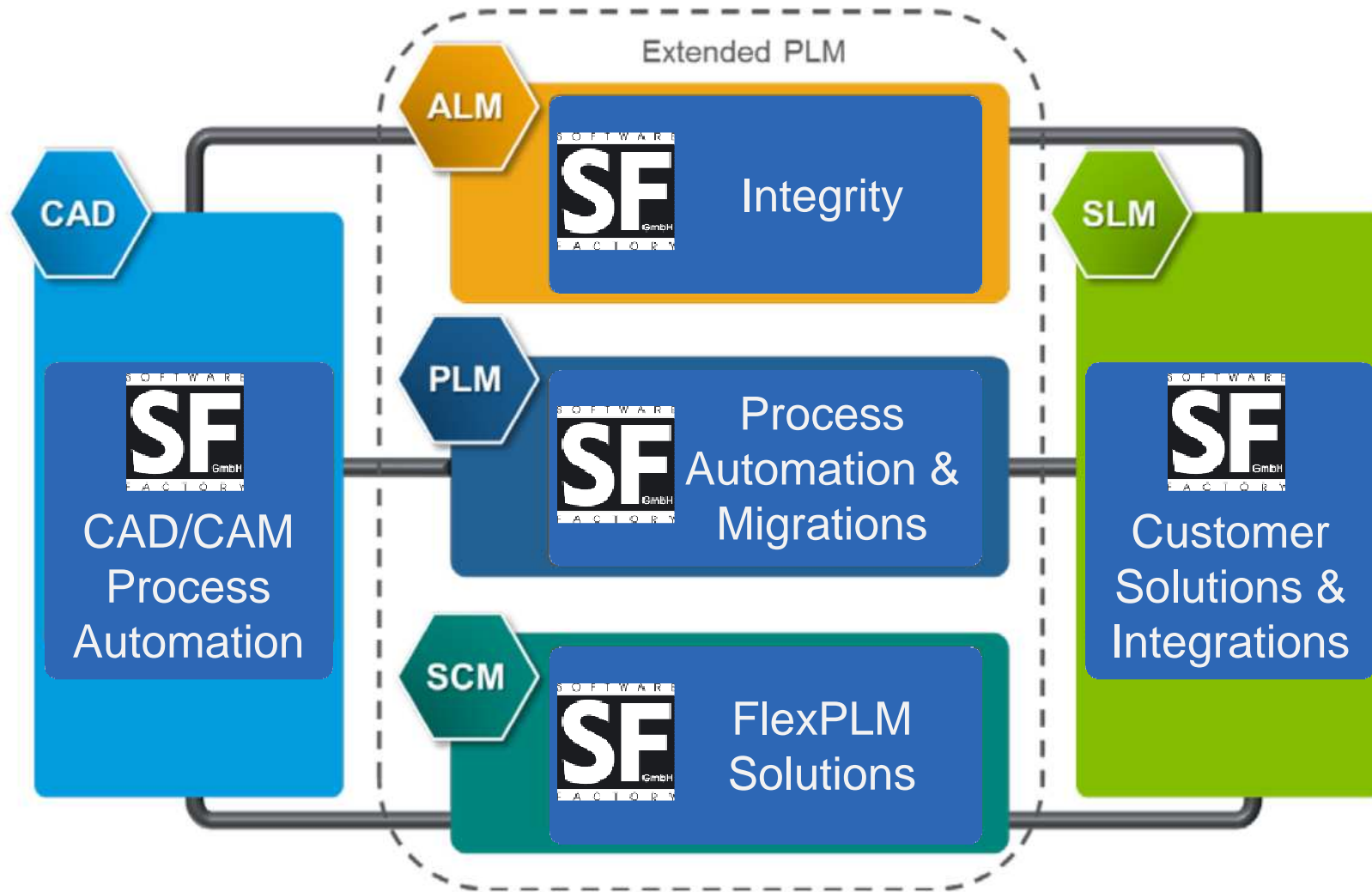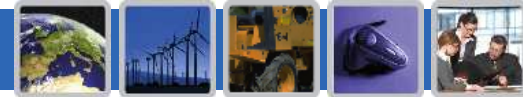- **Trainings for developers on PTC APIs (TOOLKIT, OTK, J-Link, …)**

Software Factory automates and integrates enterprise planning

Extended PLM

ALM — SF Integrity

CAD

PLM — SF Process Automation & Migrations

SLM

CAD/CAM Process Automation

SCM — SF FlexPLM Solutions

Customer Solutions & Integrations

SF CAD Expertise: Apps for Creo

Quality/Check apps

INSPECT for Creo	**WALLCHECK** for Creo	**GEOCHECK** for Creo	**QCHECK** for Creo
EXTENSION for Modelcheck	**VALIDATE** for Creo	**DIFF** for Creo	**DISTCHECK** for Creo

Complete solution

MBD for Creo

eSPEC for Creo

Interfaces between Creo and manufacturing

SHEETNC for Creo   **THERMCUT** for Creo

Freetools

Freetool **ISOTOL** for Creo

Freetool **GEN2PRT** for Creo

Freetool **PARAM** for Creo

eCad-Interfaces

eTRONIC for Creo   **eCONTOUR** for Creo

SF PLM Expertise: Apps for Windchill

Datamanagement-/Migrationstools

MERGE
for Windchill

VALIDATE
for Windchill

DOWNLOAD
for Windchill

UPLOAD
for Windchill

Framework for Export and Conversion

iPLOT/iEXPORT
for Windchill

PLOT/EXPORT
for Windchill

uWORKER
for Windchill

ERP-Interface

SAP Interface
for Windchill

Frameworks und CustomApps

R&D FRAMEWORK
for Windchill

CustomApps
for Windchill

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
  - …

EXTENSION *for Modelcheck*

QCHECK *for Creo*

GEOCHECK *for Creo*

WALLCHECK *for Creo*

DISTCHECK *for Creo*

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**
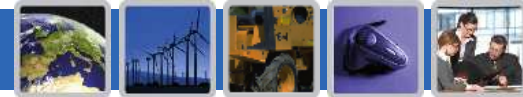
Use Cases for Data Quality Check Tools

- **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**

Solutions for
Organizational data quality

ModelCheck Extensions

ModelCheck framework

Configuration

Result display (browser)

Standard checks

Config files

Custom configuration

Result files

Custom result display/correction

TOOLKIT

Custom checks
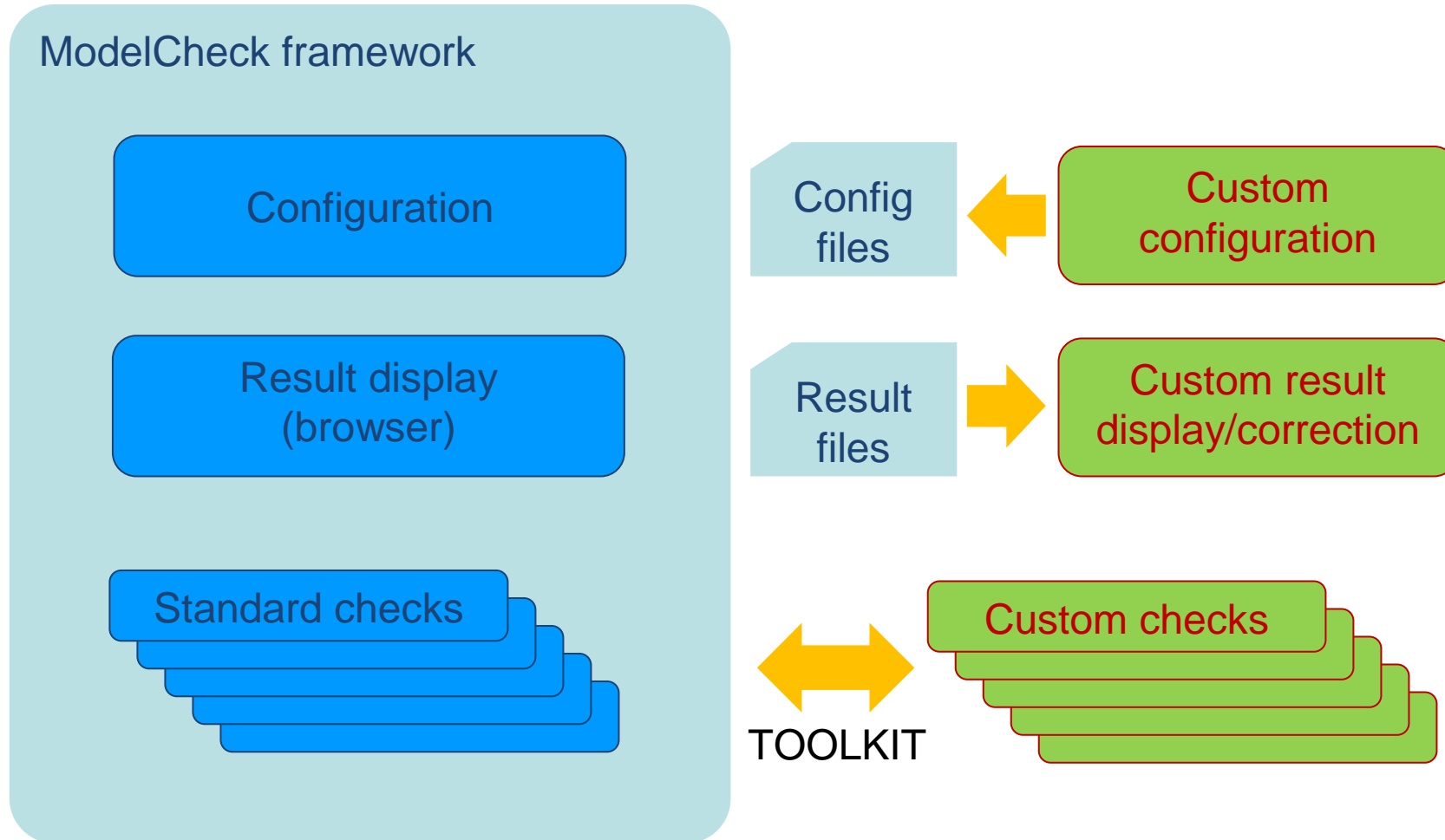
ModelCheck Extensions: ModelCheck Standard

- **Use ModelCheck Standard Configuration for Extensions**

ModelCheck Extensions: ModelCheck Standard GUI

- **Implement new checks using ModelCheck Standard GUI**
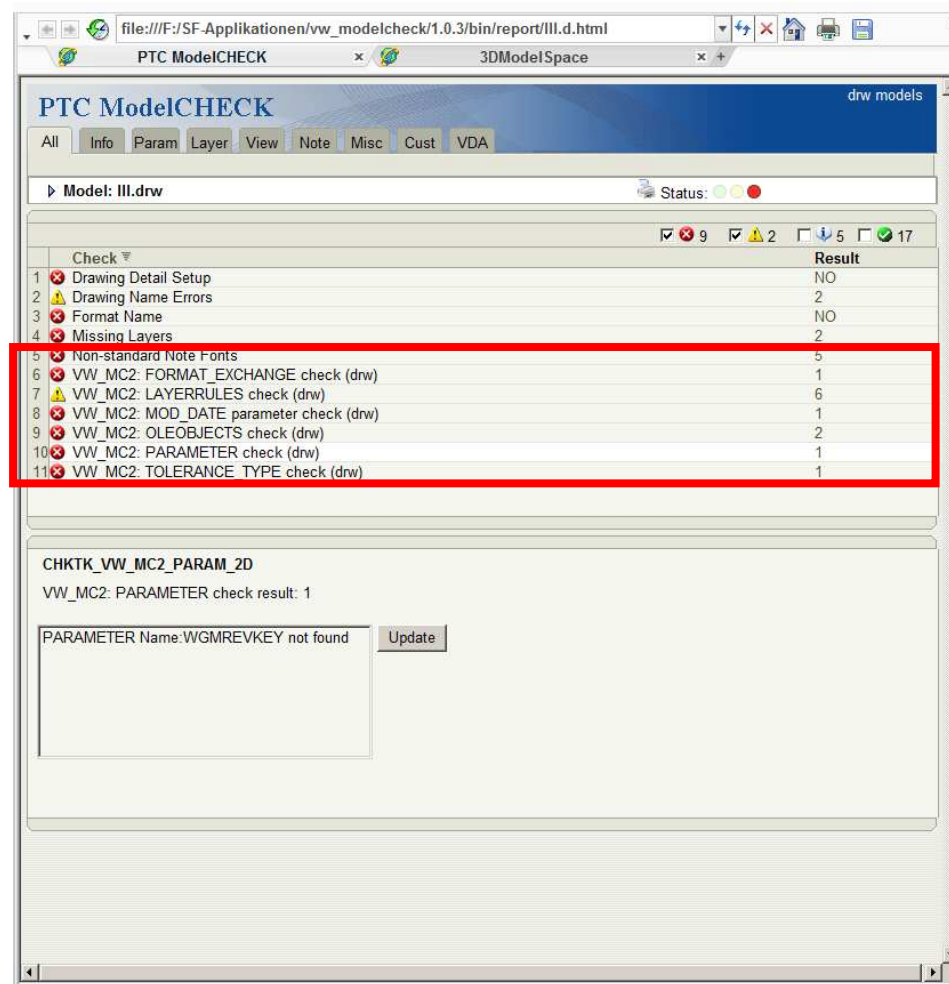
ModelCheck Extensions: Customer GUI

- **Display ModelCheck Results with customer specific designed GUI**

ModelCheck Extensions: Repair Functionality

- **Simple Repair Selection**

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

Assemblies:
- Template
- Assembly depth
- Assembly structure
- Assembly references
- Feature names
- Suppressed elements
- Coordinate systems
- Relations
- Model status
- Layer occupancy
- Non standard layers
- Merge layers
- Circular references
- Model name
- Name of simplified representations
- Model accuracy

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

- **In most cases violated check criteria can be automatically corrected.**

- **Possibilty to add easily additional company specfic checks (will be done with Pro/TOOLKIT)**

QCHECK for Creo: Check Mode Selection
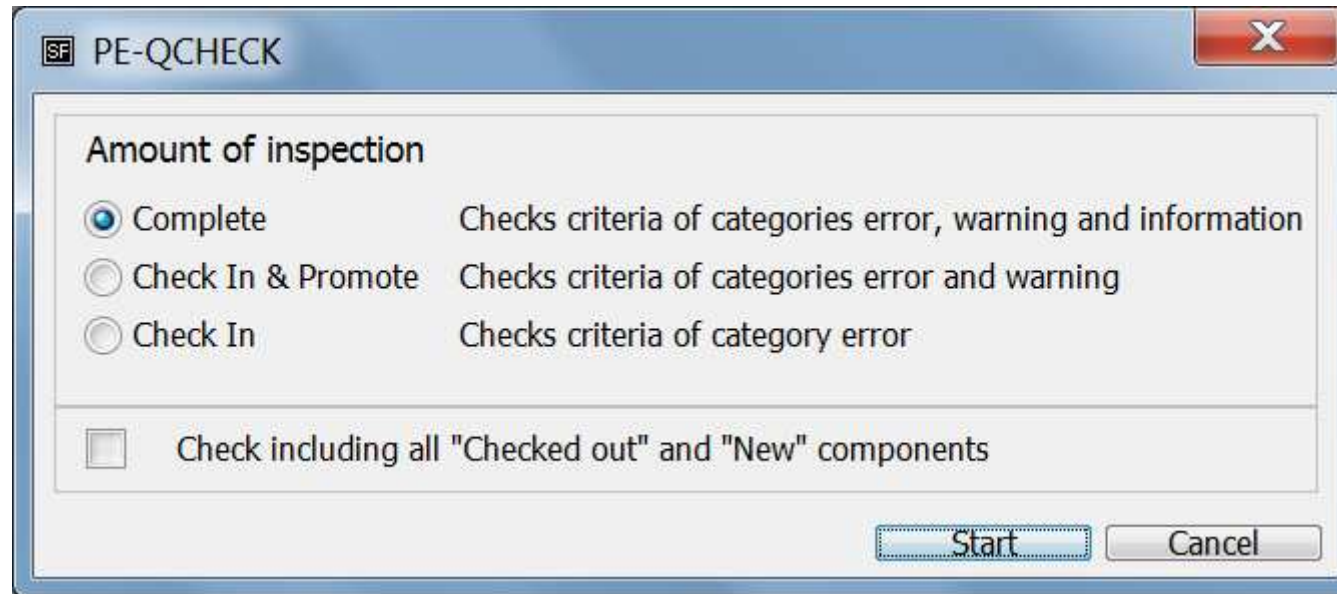
QCHECK for Creo:
Result Display

Solutions for
Geometric data quality
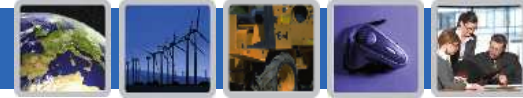
Product Data Quality Guidelines

- **Developed by SASIG for the automotive industry**

- **SASIG members:**
  - **AIAG, USA**
  - **GALIA, France**
  - **JAMA, Japan**
  - **VDA, Germany**
  - **FCAI, Australia**
  - **ODETTE, Sweden**

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.

G-SU-TI
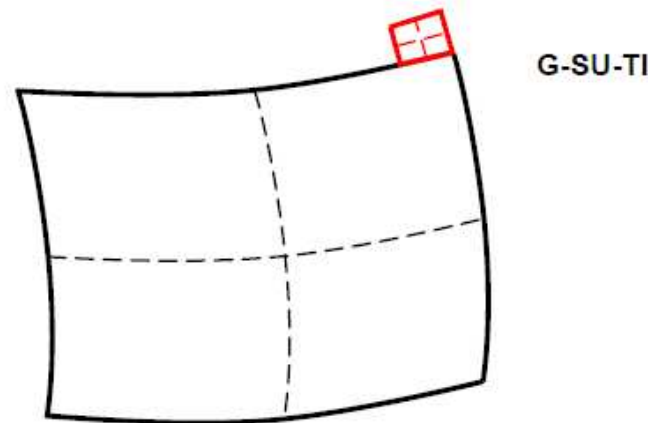
Example: Tiny surface or patch
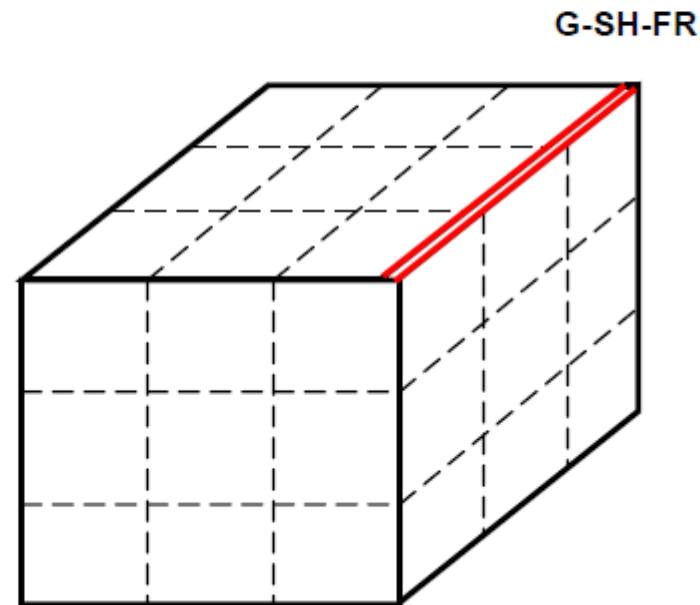
Example 2: Free Edge

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

Measurement: Whether edge is used by two faces.
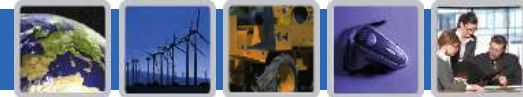
Supporting information: Shell has free edges that are not sewn together. This is not usable, for example, for trimming operations. Free edges may be intentional and require user interpretation. Examples of intentional free edges are outer boundaries, or holes within an open shell.

Recommendation: Recreate shell to eliminate undesirable free edges.

G-SH-FR

Example: Free edge

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, ...**
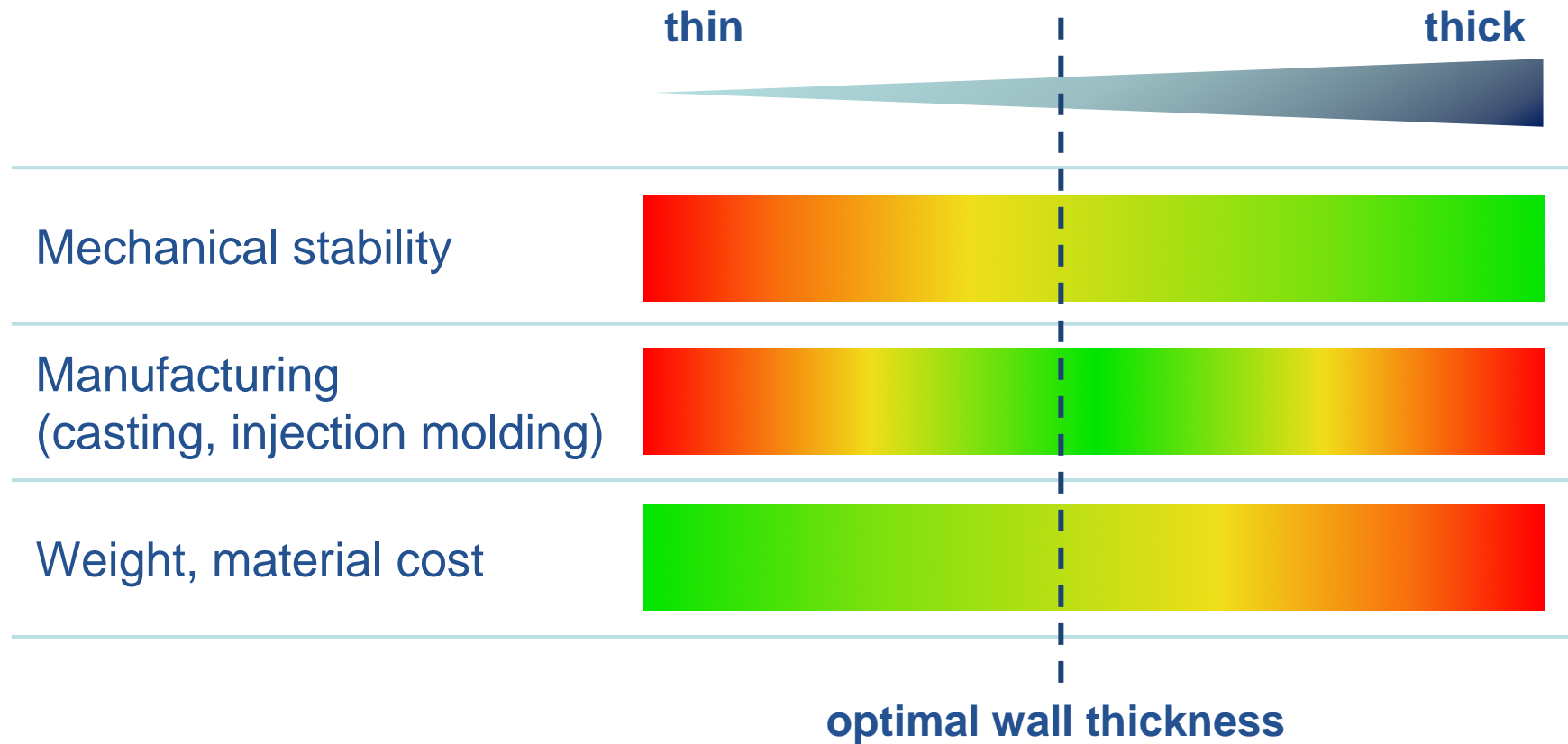
Solutions for
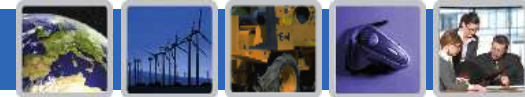# Specific checks

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?

| | thin | | thick |

thin | | **thick**

Mechanical stability

Manufacturing
(casting, injection molding)

Weight, material cost

optimal wall thickness

When does Wall Thickness Matter?

The obvious answer:

In the finished CAD model, of course!

But:

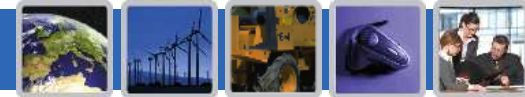Fixing issues is likely to be difficult in the finished model.

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

What Exactly is Wall Thickness? (1/2)

That's easy!

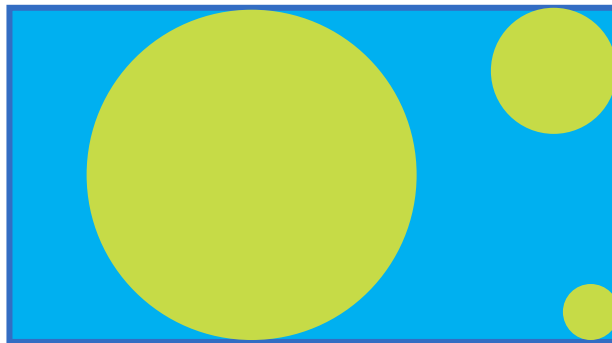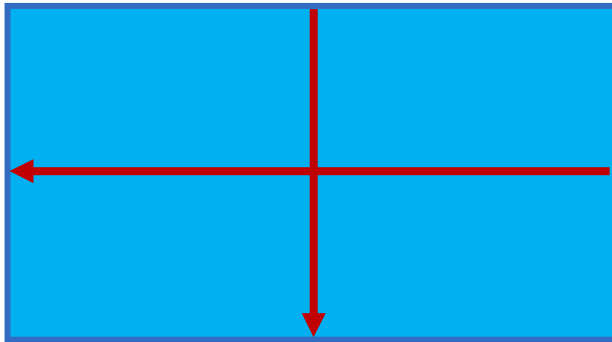The diameter of the largest sphere that is completely inside the material

The distance from a point on one surface to the closest point on the opposite surface
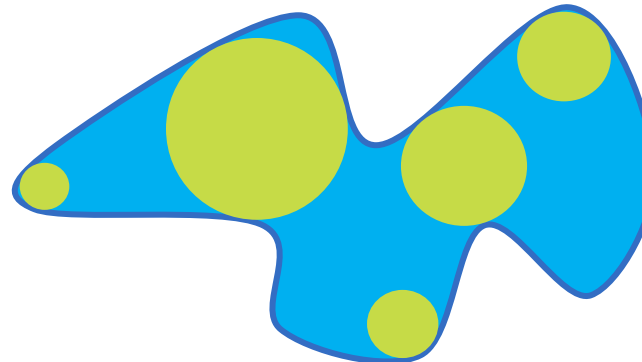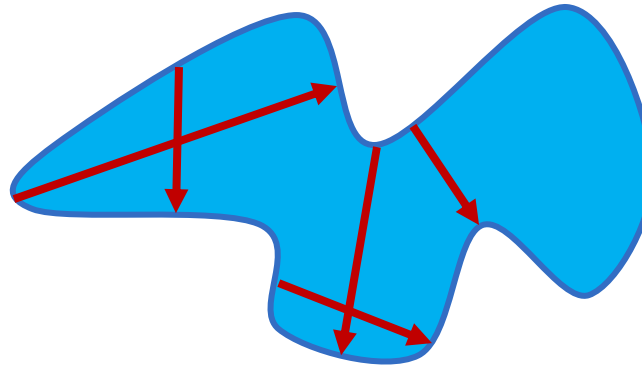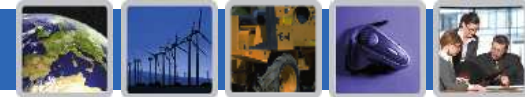
What Exactly is Wall Thickness? (2/2)

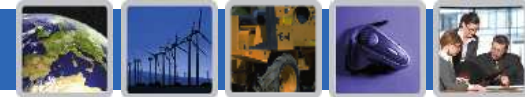But what about these parts?

This won't get better in 3D.

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
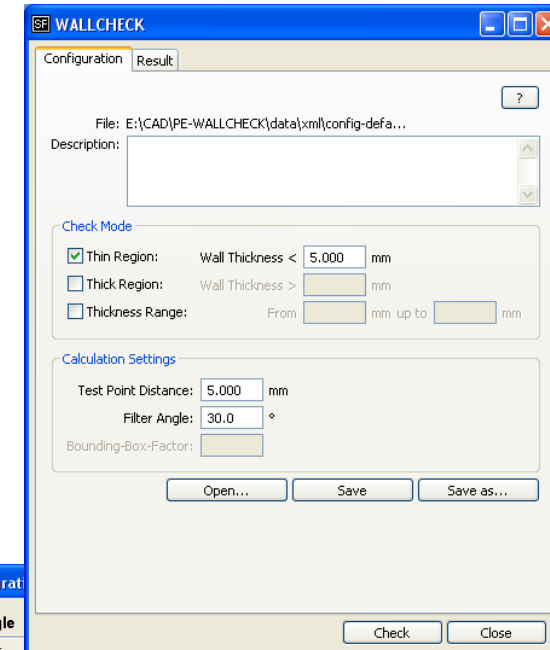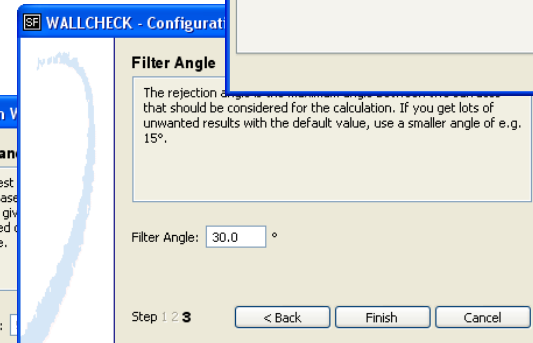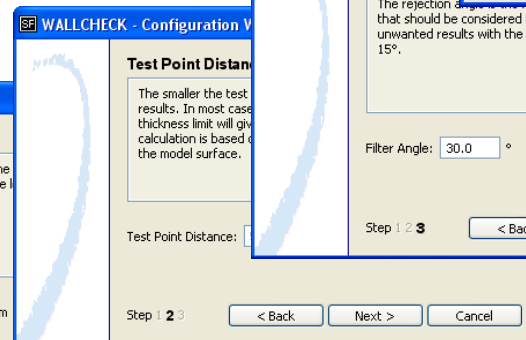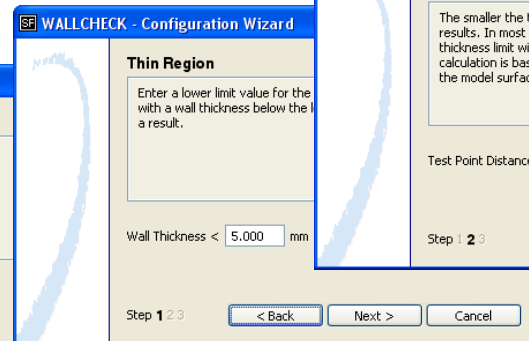 - Distance and collision checking in assembly mode

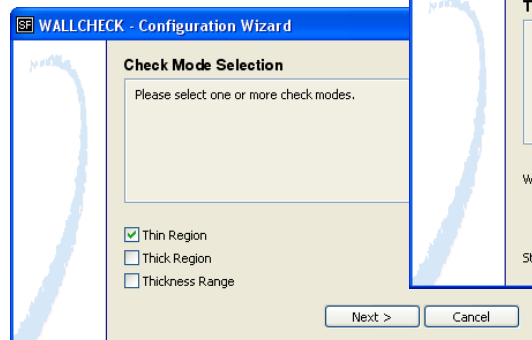# WALLCHECK Configuration

Direct input of
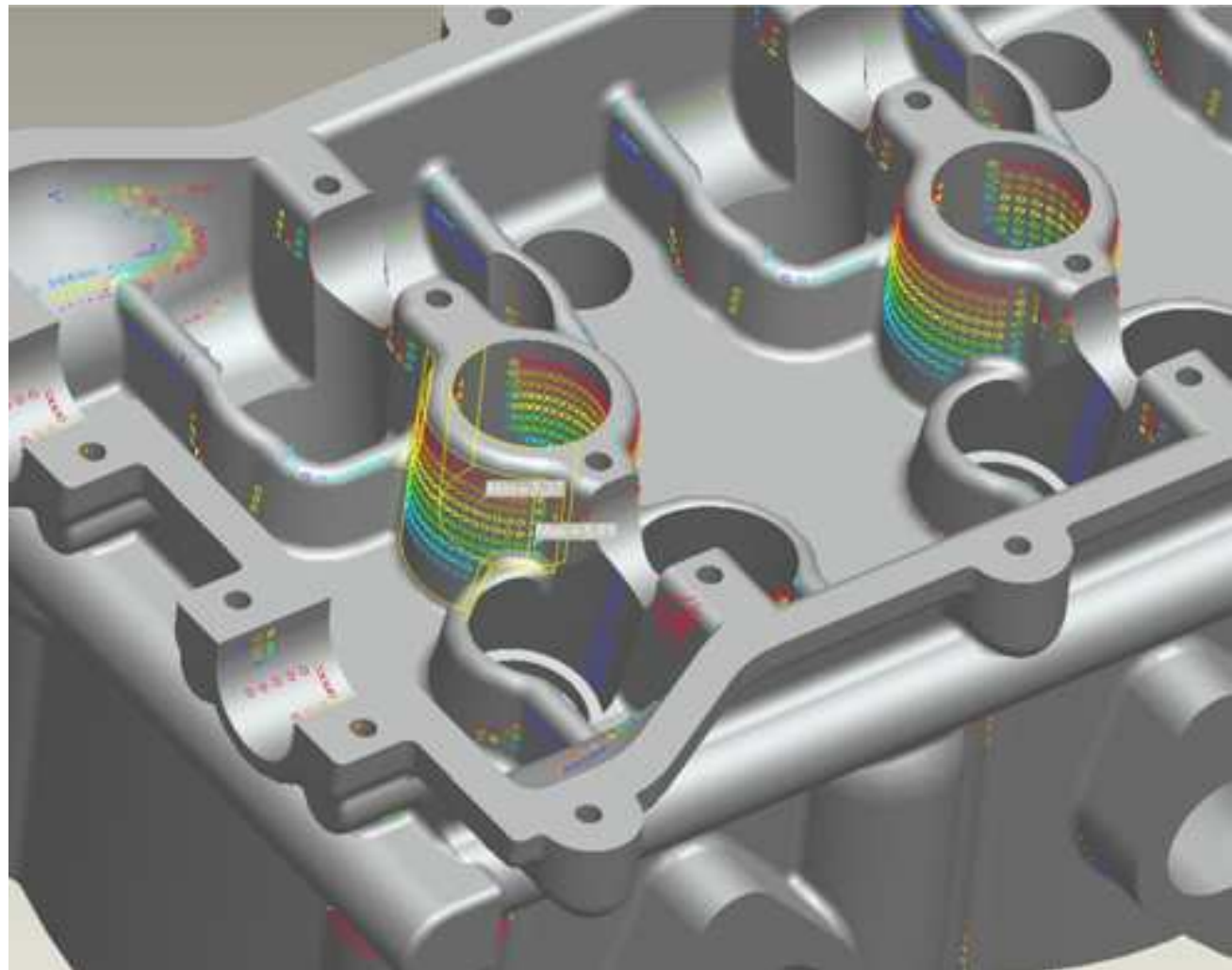configuration settings

Step by step configuration
via WALLCHECK Wizard

WALLCHECK Result Visualization

WALLCHECK Result Dialog

- **Sort results by different criteria**

- **Classify results (error, warning, ok, hide)**

- **Add comments to results**

- **Highlight results in CAD model**

- **Display detailed information (affected features and surfaces)**

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
ZF Friedrichshafen AG

Industrial

A. u. K. Müller GmbH & Co KG
ABB AG Transformatoren
AGCO Corp. & GmbH
Atlas Copco Construction Tools AB
Atlas Copco Rock Drills AB
August Küpper GmbH & Co. KG
Bosch Rexroth AG
BRP -Powertrain GmbH & Co. KG
Carl Zeiss AG
Dieffenbacher GmbH & Co. KG
Dr. Johannes Heidenhain GmbH
Eaton Corporation
Endress + Hauser Conducta GmbH
Ferromatik Milacron GmbH
geobra Brandstätter GmbH + Co.KG
Hager Electro GmbH & Co. KG
Hilite Germany GmbH
Hobart GmbH
Huber SE
Insight Technology Solutions GmbH
John Deere GmbH & Co. KG
KHS GmbH
Knorr Bremse AG
Komatsu Mining Germany GmbH
Krauss-Maffei Wegmann GmbH
L'Orange GmbH
Liebherr-Aerospace Lindenberg
Linak A/S
MagnaBDW Technologies GmbH

MAN Diesel
Mann + Hummel GmbH
Motorola Mobility LLC
MTU Onsite Energy (Tognum)
Nokia Siemens Networks Optical GmbH
Novo Nordisk A/S
Parker Hannifin GmbH
Pepperl+Fuchs GmbH
Robert Bosch GmbH
RTA Alesa Ltd.
Schaeffler Technologies AG & Co KG.
Schick/Wilkinson Sword
Siemens AG
Siemens AG Energy Sector
SKF Sverige AB
SMS Siemag AG
Steelcase Werndl AG
Stiebel Eltron GmbH & Co. KG
Swift Group Ltd
Teraport GmbH
Tetra Pak Packaging Solutions AB
Truma Gerätetechnik GmbH & Co. KG
Trumpf Werkzeugmaschinen GmbH
Valcon A/S
Voith Turbo Aufladungssysteme GmbH
Volvo Road Machinery, Inc.
Wabco Development GmbH
ZF Friedrichshafen AG
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

Software Factory GmbH

Parkring 4

85748 Garching near Munich

Tel.: 0049 89 / 323 501 – 0

Fax.: 0049 89 / 323 501 – 53

www.sf.com

cad@sf.com