

SDM-Solutions for Crash Simulations

Experience in Software Implementation

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DYNAmore GmbH

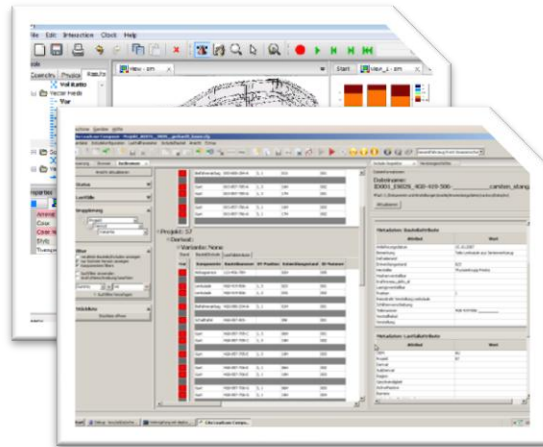
Branch Office in Dresden



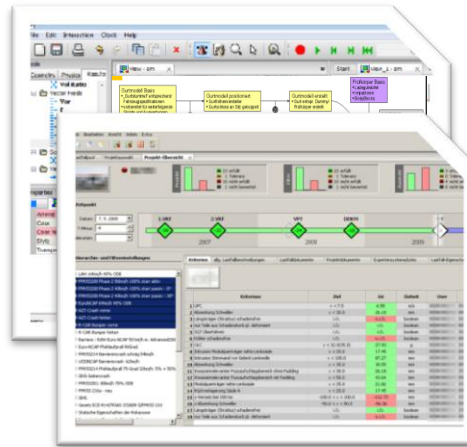
Branch office in Dresden...

- Since 2008
- Area: Software Engineering / Process automation / ...
- Team comprising of computer scientists and Engineers

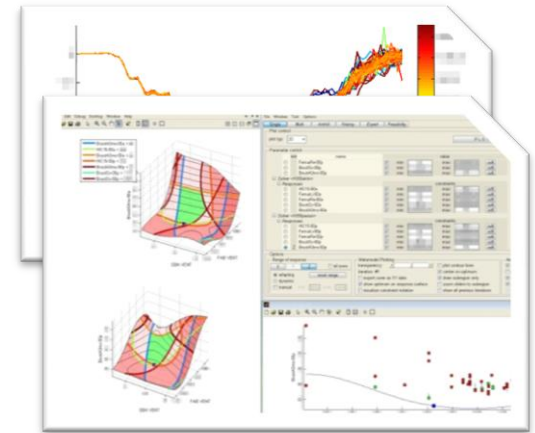
SDM-Solutions



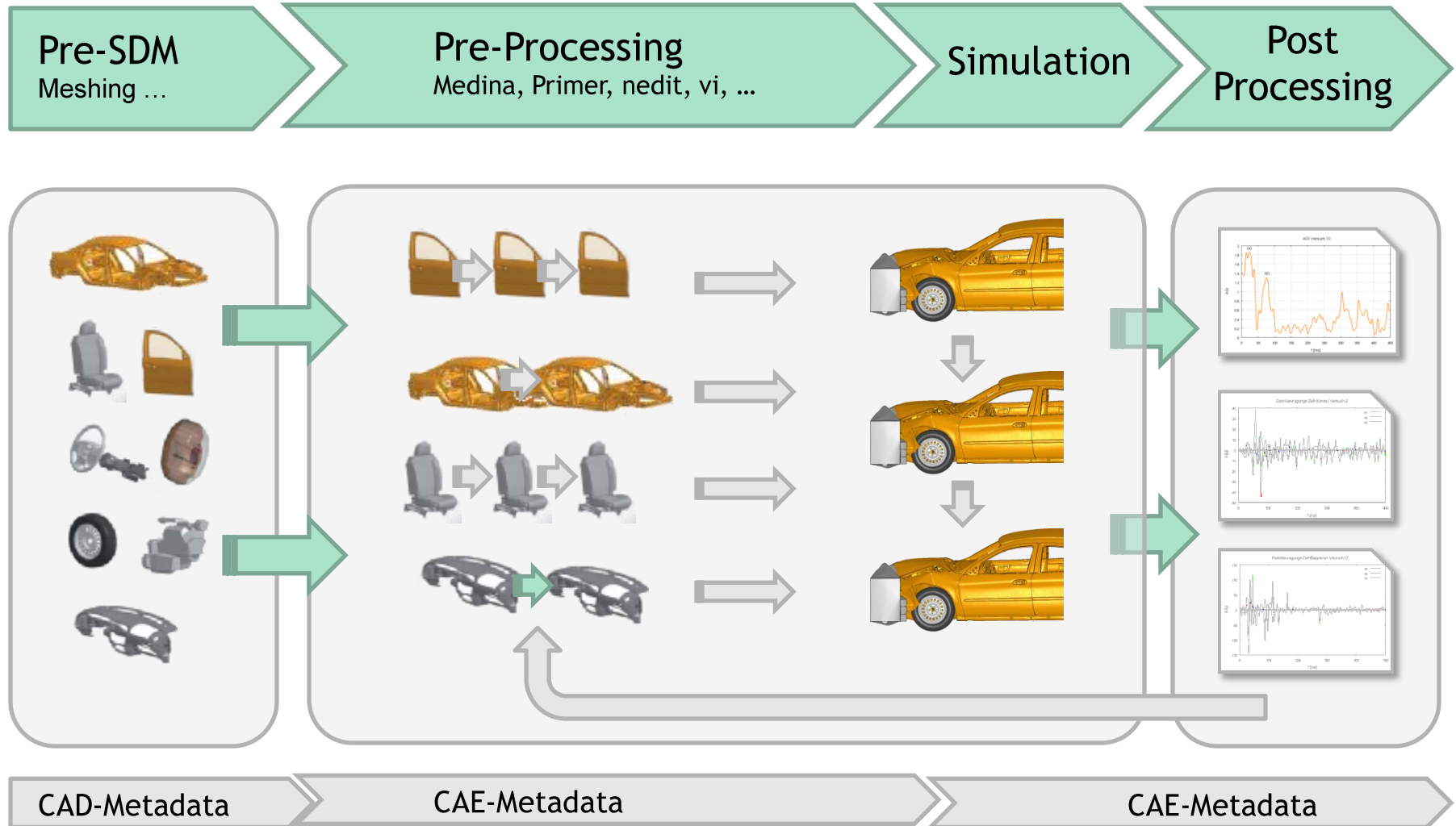
Processa.../Monitoring



Analysis/Optimiza...



SDM-Solution - Integration into the overall process



Development of models for crash simulations

...a few years ago



- One monolithic model
- Few load cases
- Very little variant investigations, optimization etc.

Today...



- Variety of load cases
- Frequent optimization and design variations
- Numerical simulations including basis for component approval
- No monolithic decks - breakdown in sub-models
- Teamwork
- Assembly of a specific input deck on demand
- Many load cases
- At the same level of development: Availability of parallel models for different solvers

Objectives of SDM Solution

Objectives...

- To facilitate e.g. Definition of a single work process.
- Automation of work processes
- Coherence and quality of the project data: Integrated content and timely documentation of processes
- Co-optimization; project- and interdisciplinary sharing of common parts
- Synchronus data distribution to project participants

Target groups...

- CAE Engineers
- Project Managers

Aspects of SDM solutions



Model management and -documentation

Includes data, Sub-models...
Metadata, History



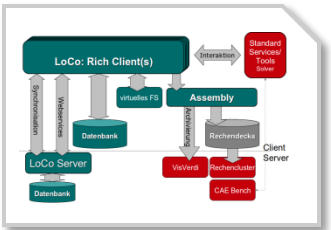
Generation of complete model / Assembly

Assignment, Scenarios, Attributes etc.
Assembler, Templates



Team work

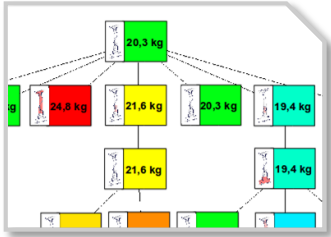
Data sharing, Local cache, Offline/Online working
Flags, Status, ...



IT-Integration

Tools, Optimization support
CAE-Bench, Status monitoring

Aspects of SDM solutions



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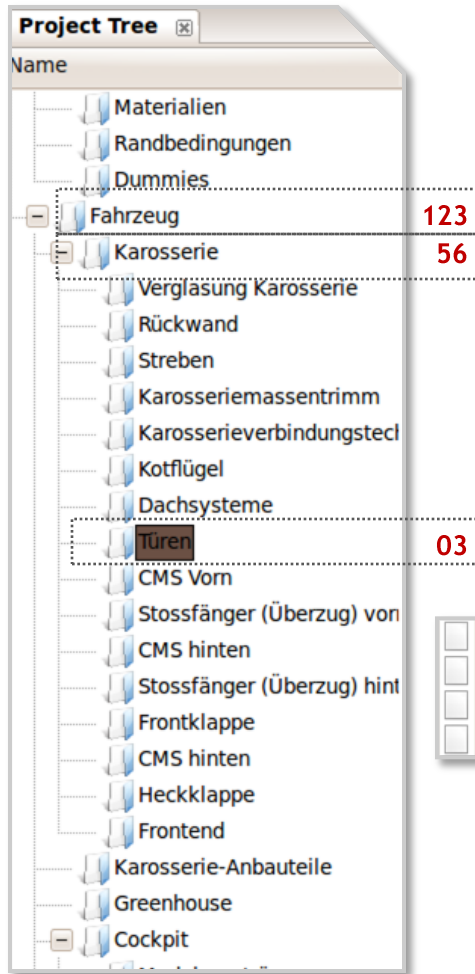


IT-Integration

Tools, Optimization support
CAE-Bench, Status monitoring

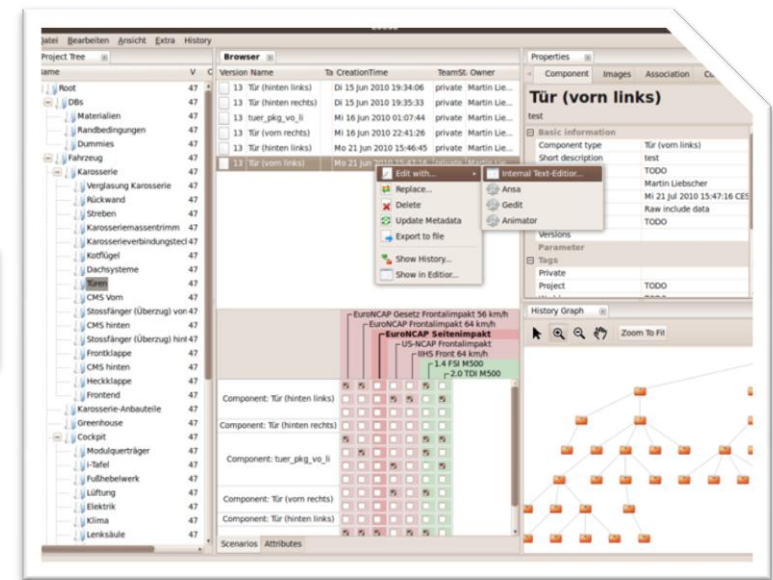
Model management and -documentation

Logically configurable structure



- Hierarchical structure of the complete vehicle
- Logical assignment into groups according to the functional Aspects and disciplines (Operating department)
- Simplified referencing / Handling
 - Used Cockpit status 83, Door status 03 etc.
 - Door status can be treated as an include

	Version			
<input type="checkbox"/>	Tür (hinten links)	03	Di 15 Jun 2010 19:34:06	private
<input type="checkbox"/>	Tür (hinten rechts)	12	Di 15 Jun 2010 19:35:33	private
<input type="checkbox"/>	tuer_pkg_vo_li	05	Mi 16 Jun 2010 01:07:44	private
<input type="checkbox"/>	Tür (vorn rechts)	02	Mi 16 Jun 2010 22:41:26	private



Model management and -documentation

Maintenance of Basic Information

Karosserie

Stand 16. Februar, B-freigegeben

[-] Basisinformationen

Includetyp	Karosserie
Datenformat	PAM Crash Include
Eigentümer	Torsten Landschoff
erstellt	12. Januar 2010
Formulierung	Rohdaten

Übersicht PID 4000-5000 PID 370000-370101

ANSA Report

Pam Checker

DATE		Mon ^
DECK		
FILENAME	/home/weg49ft/PROJEKTE/LoCo/meta	
APPLIED ON		

Material Querträger

Tim Peters, am 2010-03-01 11:53:09.771339

Die Materialbeschreibung haut so nicht hin. Bitte Rücksprache!

- Creator, Timestamp, ...
- Development status, Predecessor
- Submodel type (Solver/Formulation)
- Parameterization (which parameter, which default value)

- Automatic generation of previews
- Highlighted modified geometry/parts

- Generation of reports as additions
- Addition of Documents (PPTs, DOCs usw.)
- Addition of data source e.g. ANSA Data

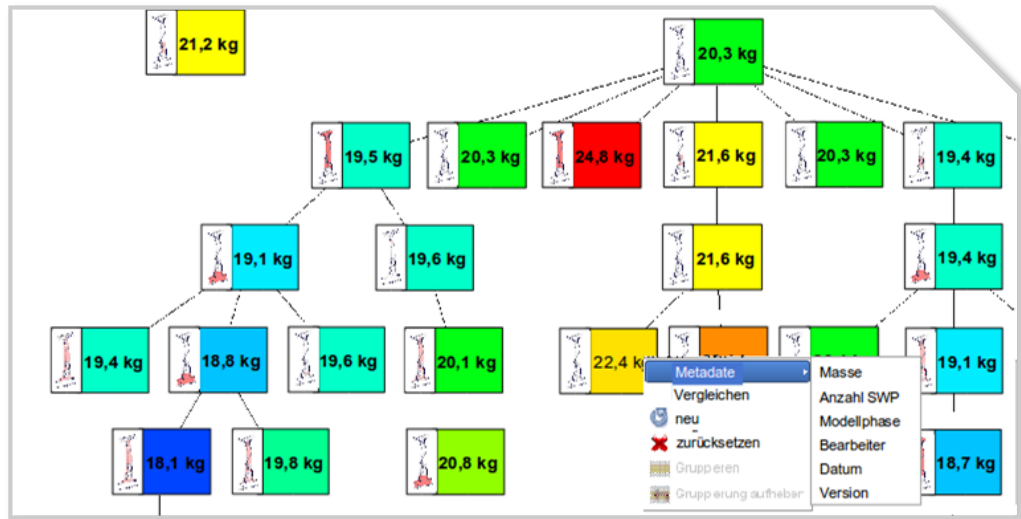
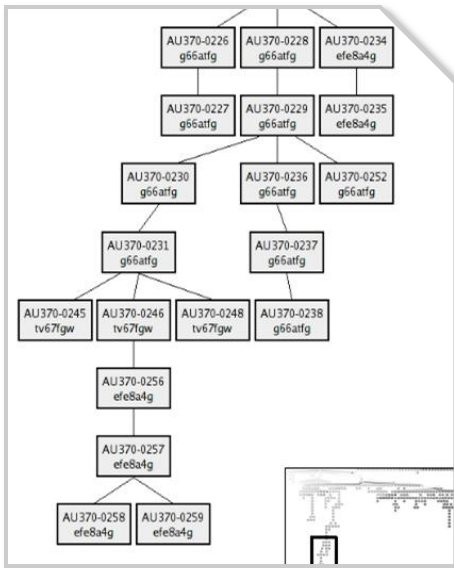
- Annotations on the development status
- Changes compared to the version

Model management and -documentation

Tracking of changes / History



- Comment history
- Graph of the predecessor / successor (all versions)
- Several predecessors/successors, especially through team work possible (at the same time)
- Tracking of changes to model parameters (e.g. Mass)
- Overview of Geometry changes (what changes where)



Model management and -documentation

Quality Assurance

Stand 16. Februar, B-freigegeben

Basisinformationen	
Includetyp	Karosserie
Datenformat	PAM Crash Include
Eigentümer	Torsten Landschoff
erstellt	12. Januar 2010
Formulierung	Rohdaten
Checks	6/21 nicht erfüllt
Parameter	

<	Include	Checks	Bilder	Zuordn
Elementqualitaet				
SHE:Quads < Minimum	Falsch			
SHE:SKEW [NASTRAN]	Falsch			
SHE:Total Shell Element	Falsch			
SHE:Trias < Minimum	Falsch			
SOL:Hexas > Maximum	Richtig			
SOL:Pentas < Minimum	Richtig			
SOL:Total Solids Elemen	Falsch			
SOL:WARP [PAM-CRASH]	Richtig			
Nummerierungskonvention				
CONTACT	Richtig			
ELEM	Richtig			
ELEM. BAR	Richtig			
ELEM. SHELL	Richtig			
ELEM. SOLID	Richtig			
ELEM. TETR4	Richtig			
FUNCTION	Falsch			
MATER	Richtig			
NODE	Richtig			
NODE_ELEM	Richtig			
PART	Richtig			
RIGID BODY	Richtig			

- Calculation of the quality index after each update
 - Enforce checks for numbering
 - Element quality
 - Prediction of timestep / timestep limit
 - ...
- Sub-model evaluation



Critical

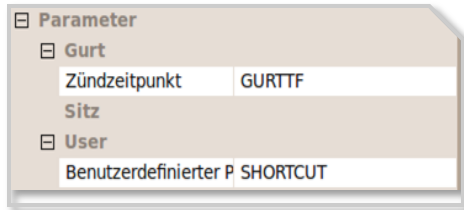
Acceptable

Ok

- possible disabling of the partial model for specified actions, e.g.
 - May not be used in a simulation model
 - May not have special status / obtain approval
 - ...

Model management and -documentation

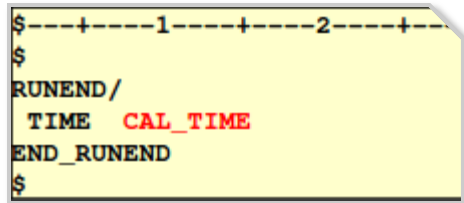
Parameterization



- Identification of parameters during update of a sub-model

Parameter can be e.g.:

- Ignition points
- Impact points
- Sheet thickness
- Material properties
- ...



- Parameters are defined, based on placeholders and/or in solver specific format in Include (before updates)
- Pre-definition of mandatory parameters is possible
- User defined parameters
- Provision of default values

Aspects of SDM solutions



Model management and -documentation

Includes data, Sub-models...
Metadata, History



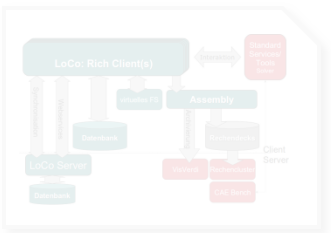
Generation of complete model / Assembly

Assignment, Scenarios, Attributes etc.
Assembler, Templates



Team work

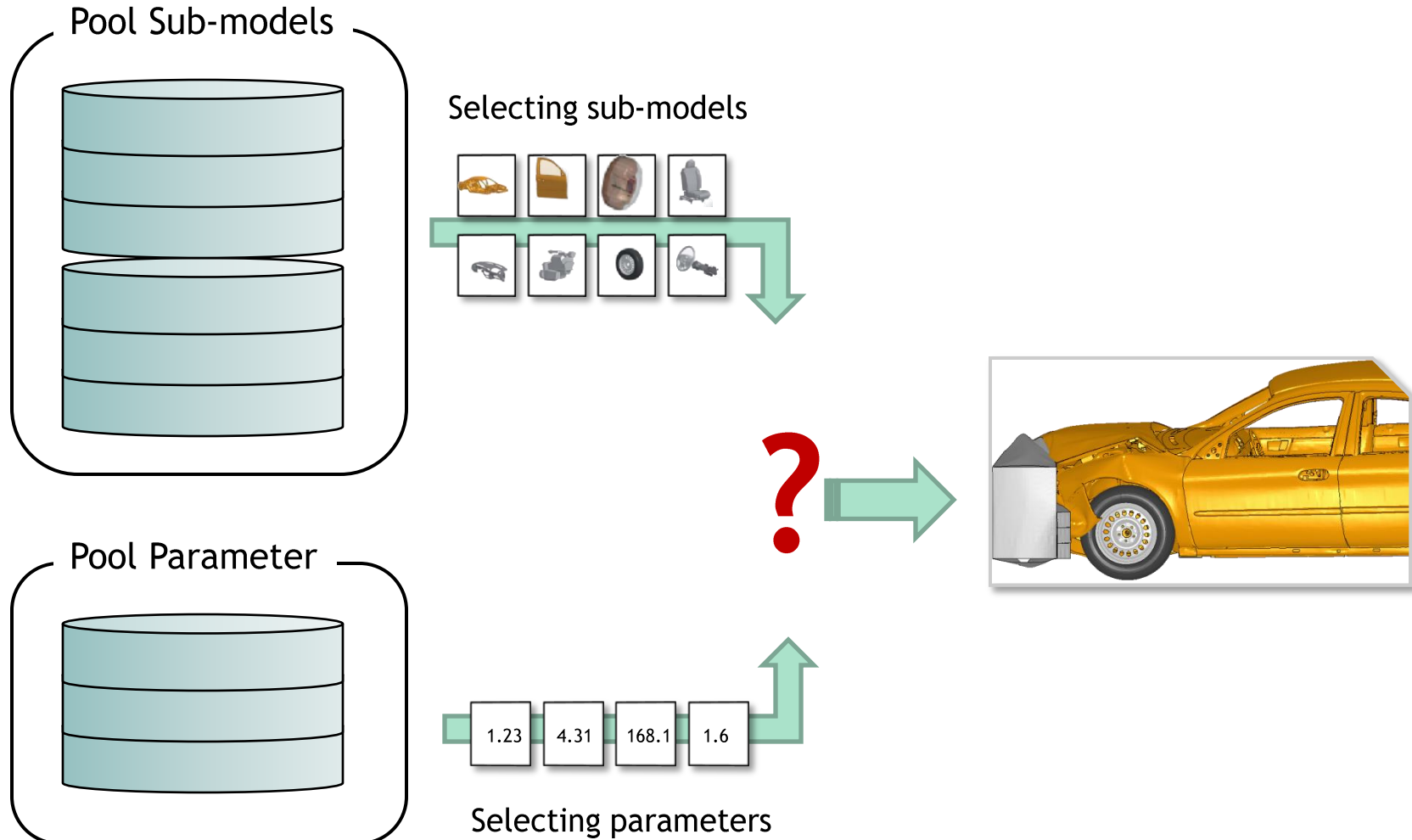
Data sharing, Local cache, Offline/Online working
Flags, Status, ...



IT-Integration

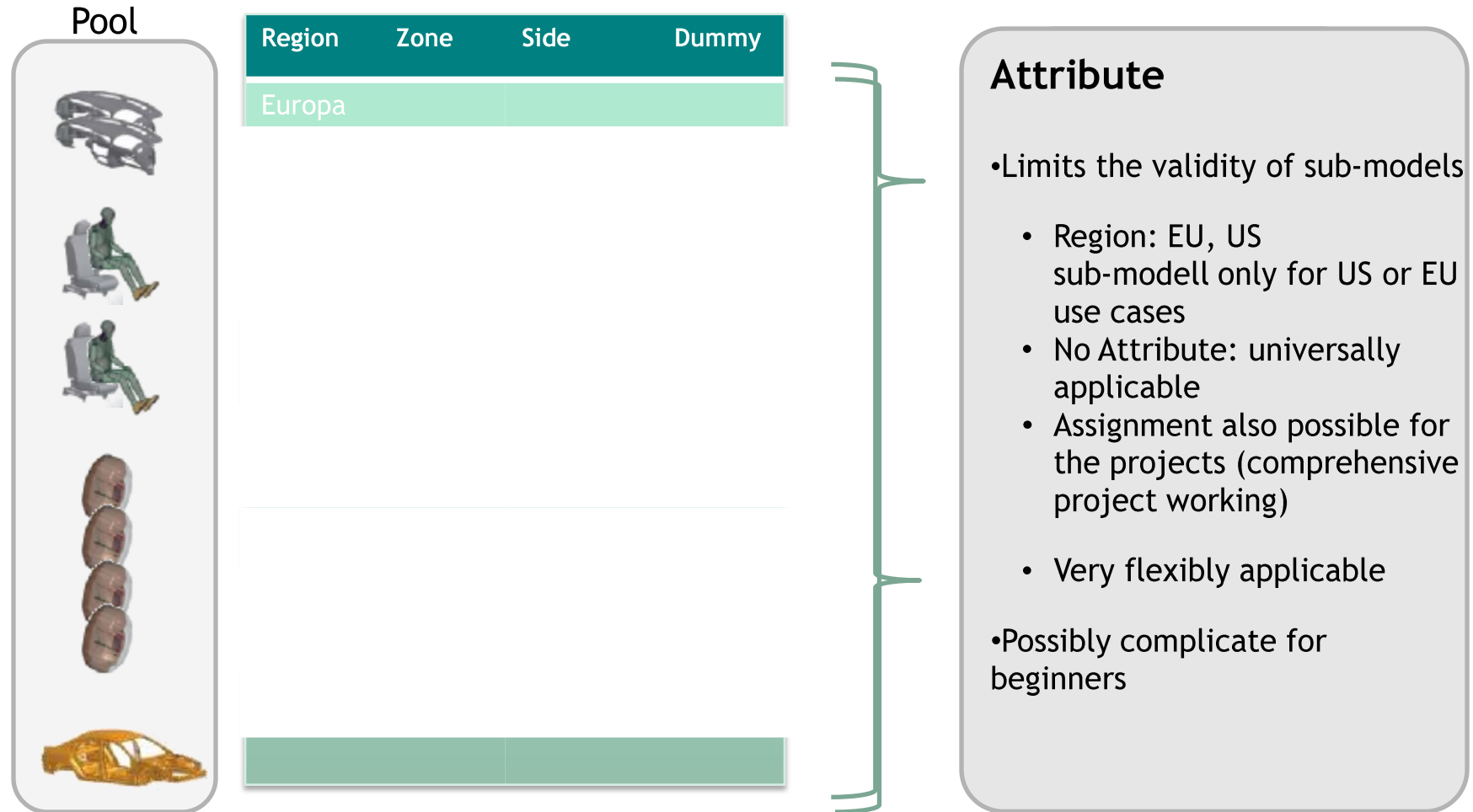
Tools, Optimization support
CAE-Bench, Status monitoring

Generation from Simulation models (Assembly)



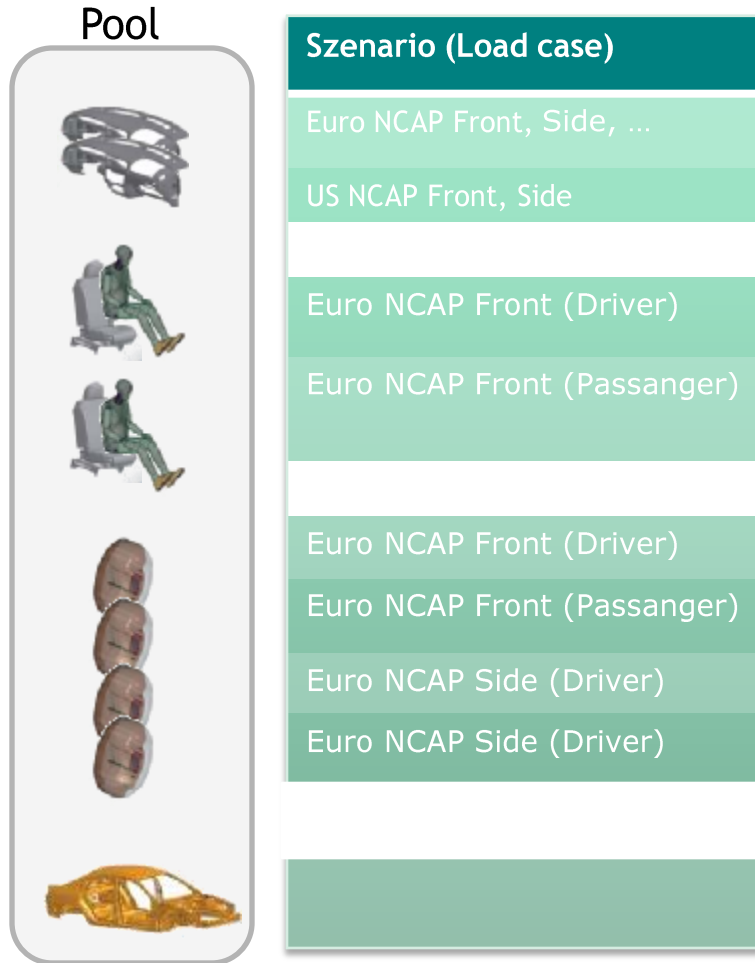
Generation from Simulation models (Assembly)

Sub-model assignment - Attribute based



Generation from Simulation models (Assembly)

Sub-model assignment - Scenarios based

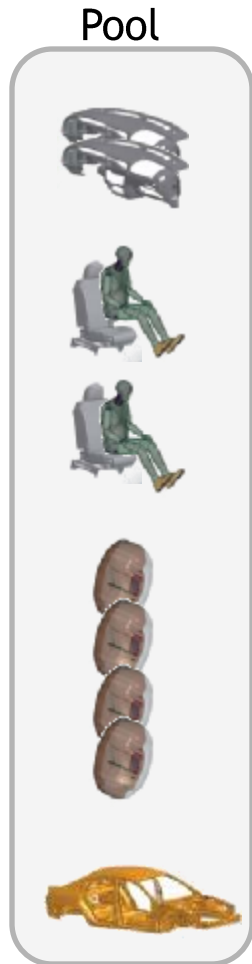


Scenarios

- Limits/reduces the validity of sub-models
- Commonly spoken labels; beginner friendly
- Flexibility is somewhat limited
- If necessary, many scenarios (all load cases, vehicle configurations etc.)
- Mapping by scenarios, possibly complex (Useability)

Generation from Simulation models (Assembly)

Sub-model assignment - Attribute and scenarios applicable in parallel



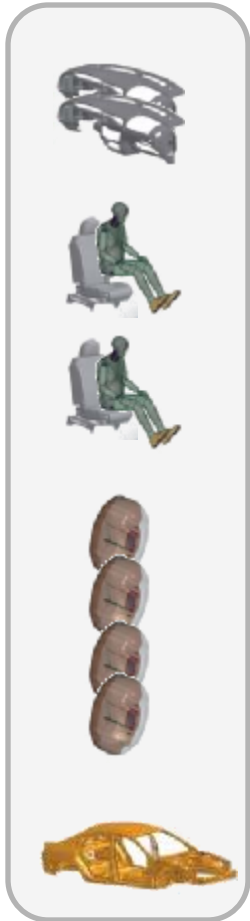
Region	Zone	Side	Dummy
Europa			
USA			
	Front	Fahrer	H3 50%
	Front	Beifahrer	H3 50%
	Front	Fahrer	
	Front	Beifahrer	
	Seite	Fahrer	
	Seite	Beifahrer	

Szenario (Load case)
Euro NCAP Front, Side, ...
US NCAP Front, Side
Euro NCAP Front (Driver)
Euro NCAP Front (Passanger)
Euro NCAP Front (Driver)
Euro NCAP Front (Passanger)
Euro NCAP Side (Driver)
Euro NCAP Side (Driver)

Generation from Simulation models (Assembly)

Sub-model assignment - Attribute and scenarios applicable in parallel

Pool

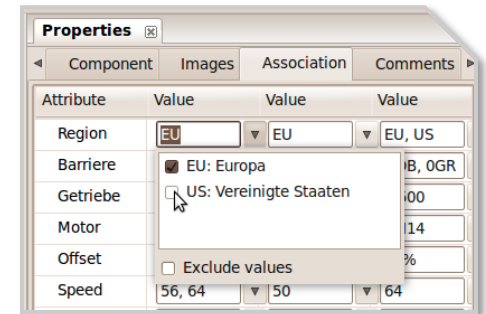
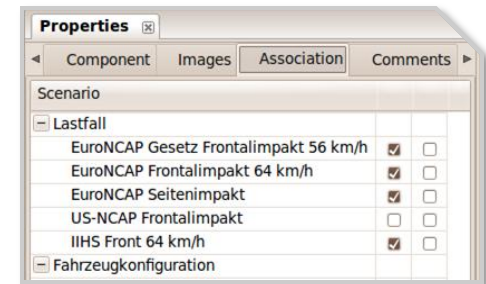


Euro NCAP Front = Region: Europe
Zone: Front
Dummy: H3

...

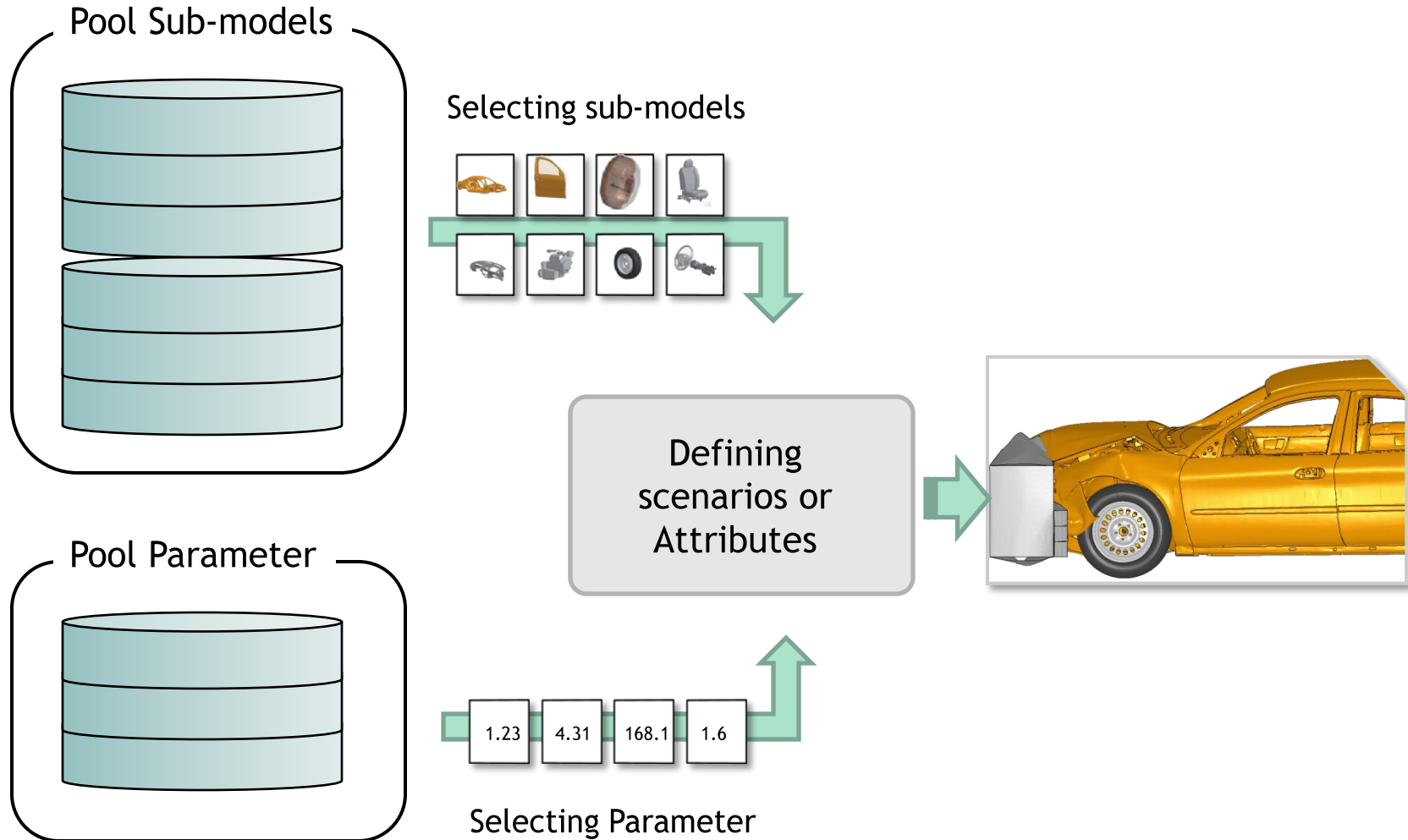
Euro NCAP Side = Region: Europe
Zone: Side
Dummy: H3

...



- Attribute representation / scenario representation interconvertible
- ..so that the application of both the cases is possible at the same time and can be swaped anytime

Generation from Simulation models (Assembly)



Generation from Simulation models (Assembly)

Software implementation/realization of the assembly process



Objective: uniform assembly process

- Partly very different requirements in departments
- Isolated special cases

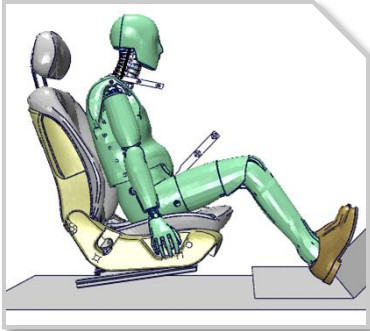
Multidisciplinary use / Acceptance is only possible when all requirements can be fulfilled

Flexible: Template based approach

- Deployment of assemblers for 90%-coverage of the requirements
- Assembler easily customizable via Templates - no new software release required; less dependence on the software house
- Key-User can extend/adapt the Assembler independently
- Template-based language provides very primitive commands; is freely extendable, thereby powerful

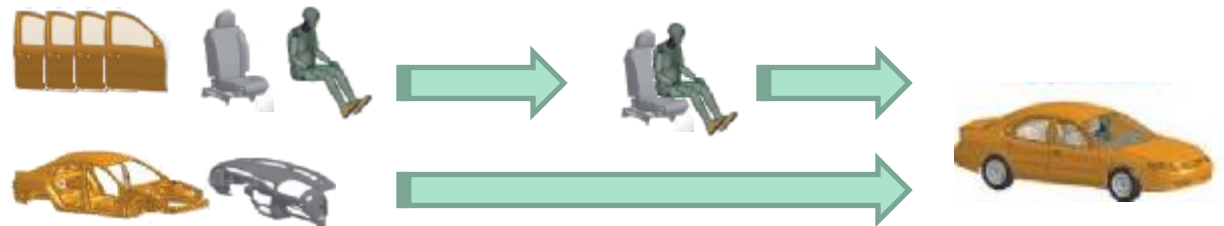
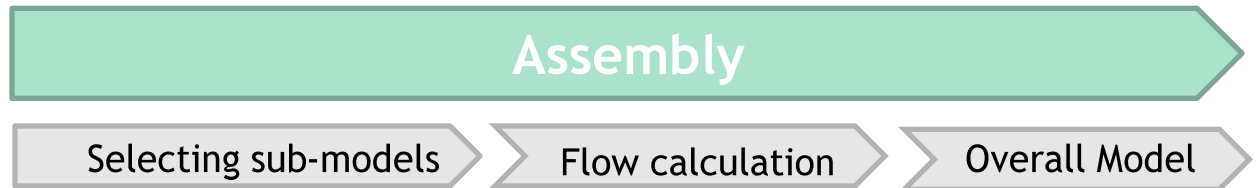
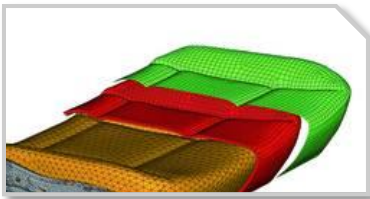
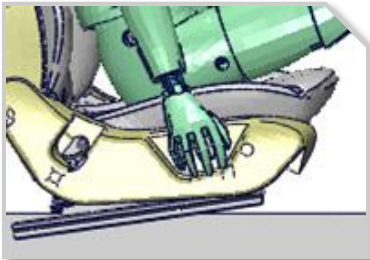
Generation from Simulation models (Assembly)

Extended possibilities of template based assemblers

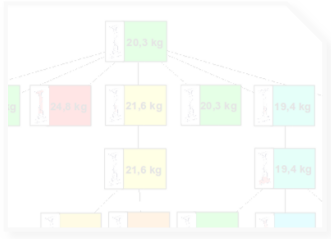


Update and Management of Seat, Belt und Dummies solely as base model versions

- Occupant and seat positioning is initialized by the assembler when assembling
- Specific Dummy-Belt-Seat sub-model is used in the overall simulation



Aspects of SDM solutions



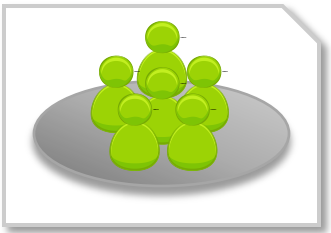
Model management and -documentation

Includes data, Sub-models...
Metadata, History



Generation of complete model / Assembly

Assignment, Scenarios, Attributes etc.
Assembler, Templates



Team work

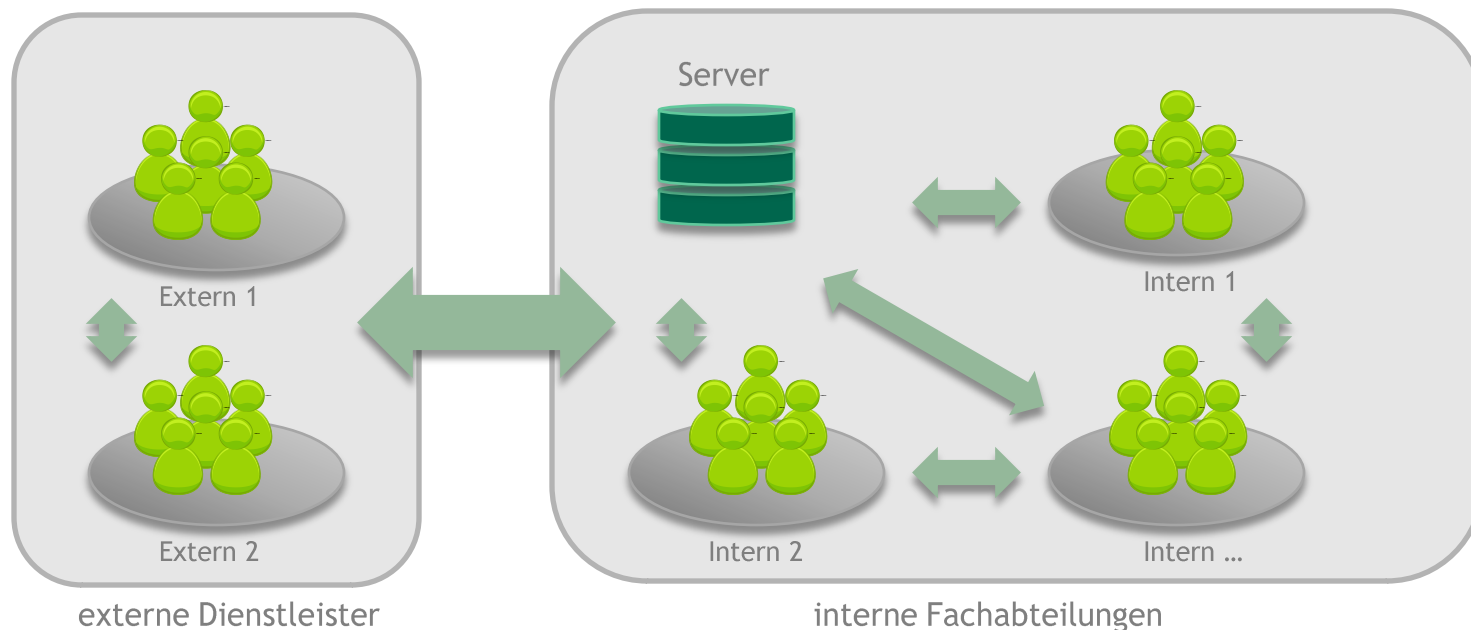
Data sharing, Local cache, Offline/Online working
Flags, Status, ...



IT-Integration

Tools, Optimization support
CAE-Bench, Status monitoring

Teamwork - Synchronisation Intern, Extern, Teams...



Sync
Centralized/
Decentralized

Offline/Online
Working

- Centralized data handling and synchronisation with central server (potential bottleneck); Server data status is the reference data set
- Decentralized synchronisation is also possible between the teams and within the teams
- Offline processing of the data (Rich Client) - person/teams are independent from server; avoids bottleneck and increases performance through lokal caches of data
- Internal/external transfer of data over Webservices (Standard protocols http/https)

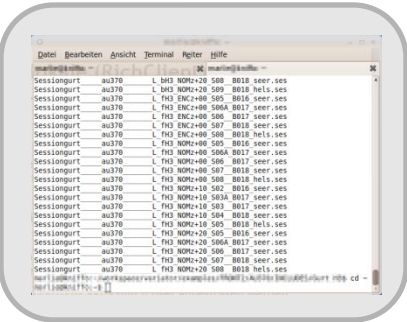
Teamwork - local Data Storage (Rich Client)

Possibility: Local data storage (cache) in file system



- ▷ Airbag_PAB
- ▷ Cockpit
- ▷ Dummy_H3
- ▷ Dummy_HF
- ▷ Dummy_HM
- ▷ Greenhouse
- ▷ Gurt_H3
- ▷ Gurt_HF
- ▷ Gurt_HM
- ▷ Header
- ▷ Karosserie
- ▷ Lenksaeule
- ▷ Materialdaten
- ▷ Mittelkonsole
- ▷ Motion

... in File system



```
Sessionart  au370  L  FH3  NOR+20  500  8018  seer.sea
Sessionart  au370  L  FH3  NOR+20  500  8018  heli.sea
Sessionart  au370  L  FH3  ENC+00  507  8016  seer.sea
Sessionart  au370  L  FH3  ENC+00  506A  8017  seer.sea
Sessionart  au370  L  FH3  ENC+00  500  8017  seer.sea
Sessionart  au370  L  FH3  ENC+00  507  8018  seer.sea
Sessionart  au370  L  FH3  ENC+00  508  8018  heli.sea
Sessionart  au370  L  FH3  NOR+00  505  8016  seer.sea
Sessionart  au370  L  FH3  NOR+00  506A  8017  seer.sea
Sessionart  au370  L  FH3  NOR+00  500  8017  seer.sea
Sessionart  au370  L  FH3  NOR+00  507  8018  seer.sea
Sessionart  au370  L  FH3  NOR+00  508  8018  heli.sea
Sessionart  au370  L  FH3  NOR+10  502  8016  seer.sea
Sessionart  au370  L  FH3  NOR+10  503A  8017  seer.sea
Sessionart  au370  L  FH3  NOR+10  503  8017  seer.sea
Sessionart  au370  L  FH3  NOR+10  504  8018  seer.sea
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Sessionart  au370  L  FH3  NOR+20  505  8016  seer.sea
Sessionart  au370  L  FH3  NOR+20  506A  8017  seer.sea
Sessionart  au370  L  FH3  NOR+20  500  8017  seer.sea
Sessionart  au370  L  FH3  NOR+20  507  8018  seer.sea
Sessionart  au370  L  FH3  NOR+20  508  8018  heli.sea
mar [adm] Ffo: /usr/share/vst/interexamples/Model/Airbag/Model/Gurt rdg cd -
mar [adm] Ffo: ~
```

... Shell

Pros

- Low threshold, little change in the operation for the CAE Engineer
- Access using OS tools (Terminal, File browser etc.)

Cons

- Data integrity must be constantly verified; Changes outside the application should be monitored; Data integrity cannot be ensured
- Performance not optimal (due to constant scanning, monitoring)
- Management of metadata is problematic



Data storage in the file system is not optimal

Teamwork - local Data Storage (Rich Client)

Possibility: Local data storage (cache) in database



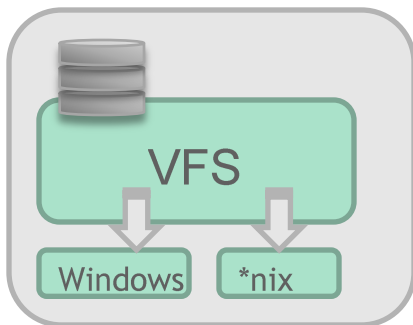
... in Database

Pros

- Performance
- Data integrity ensured
- Efficient management of Metadata is possible

Cons

- No direct access, only using application
- (particularly no access over file system)



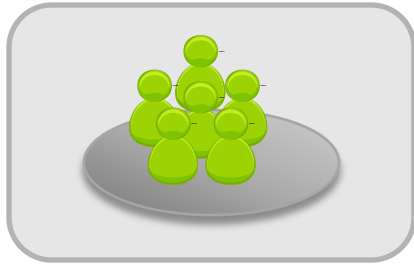
... virtuelles Dateisystem



Provides a virtual file systems

- Access is possible in a usual way using OS tools (Terminal, File browser etc.); Performance loss
- Comparable to a mounted network drive
- Data integrity is ensured using VFS

Teamwork - More Features



Rights management

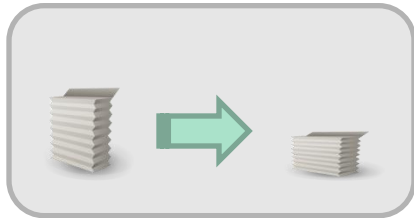
- Enabling (read/write) of sub-models / projects / sections for user, user groups
- Private/public status of one's own data



Tags

- Highlight data / assignment of properties

Examples: Status variant/Mile stones; obsolete, invalid, ..



Data compression

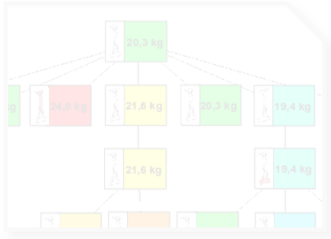
During the data transfer, only the difference from the previous version is conveyed



News / Comments

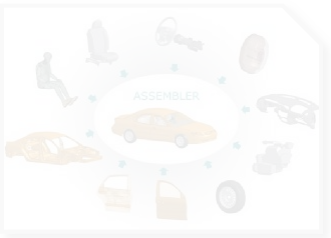
Addition of Status-Information to sub-models upon user actions

Aspects of SDM solutions



Model management and -documentation

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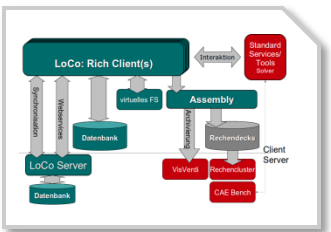
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Team work

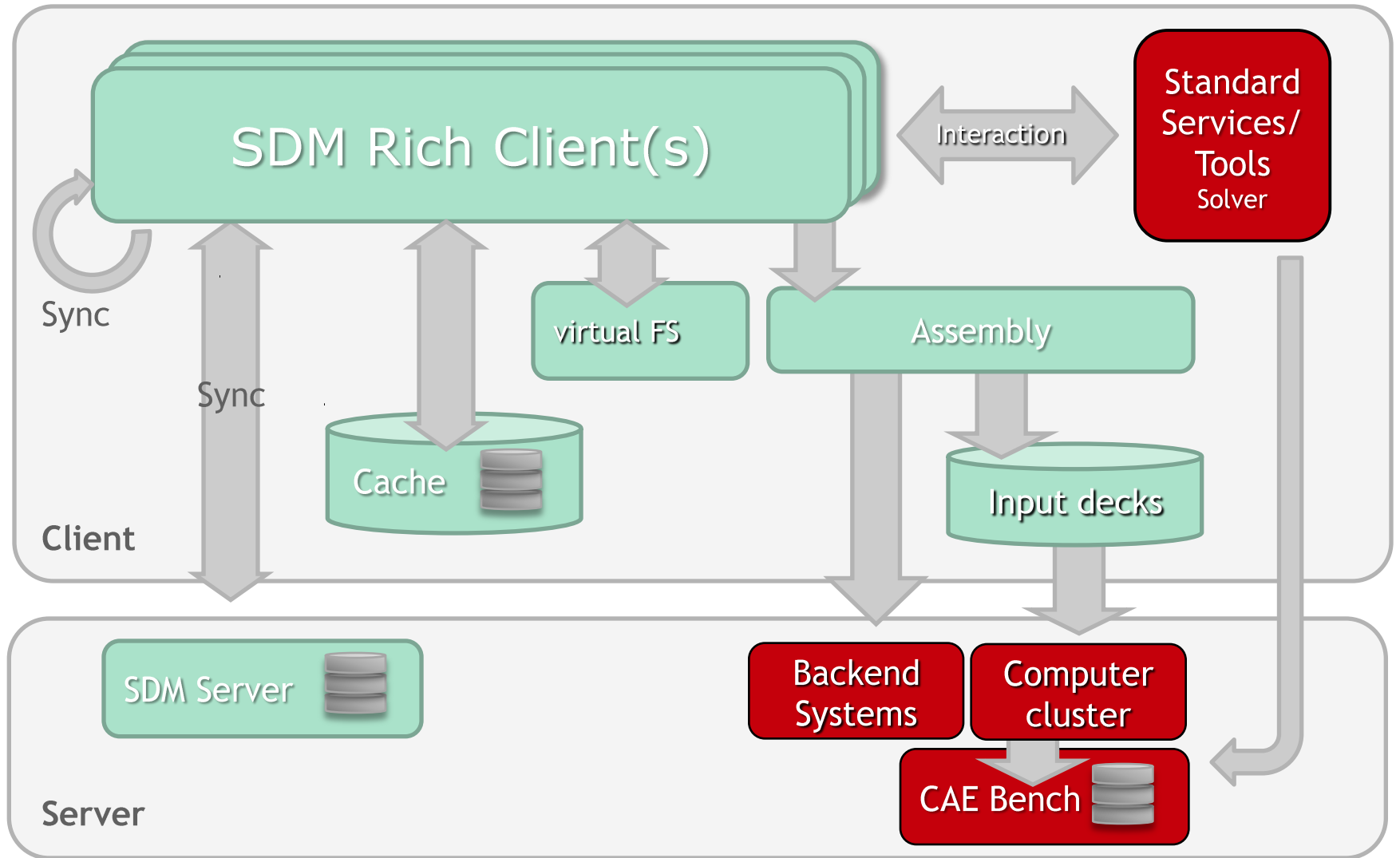
Data sharing, Local cache, Offline/Online working
Flags, Status, ...



IT-Integration

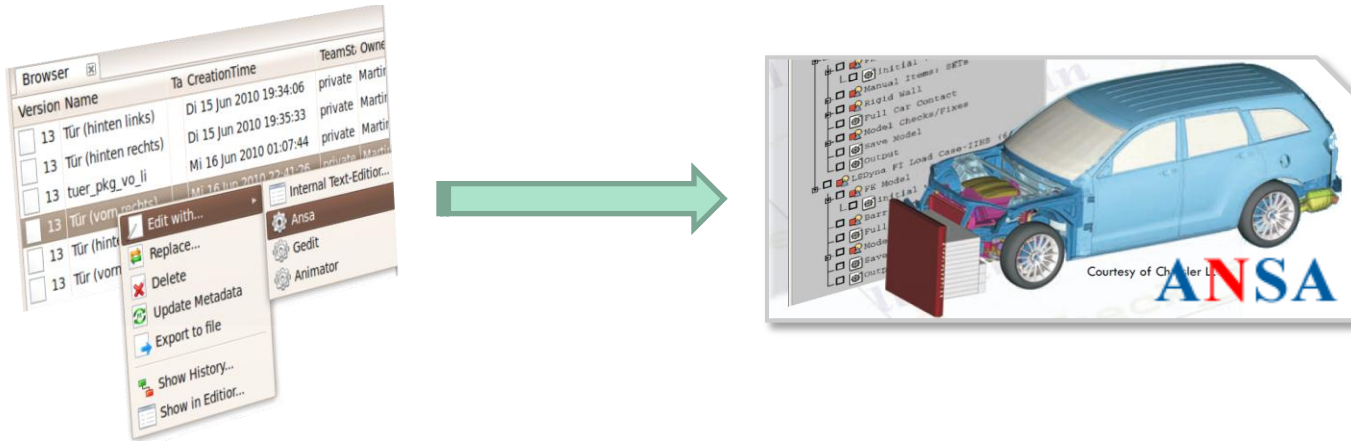
Tools, Optimization support
CAE-Bench, Status monitoring

IT-Integration / IT-Concept

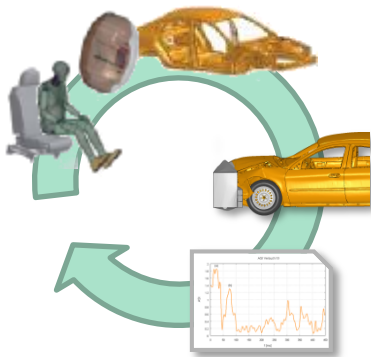


IT-Integration - Linkage Tools

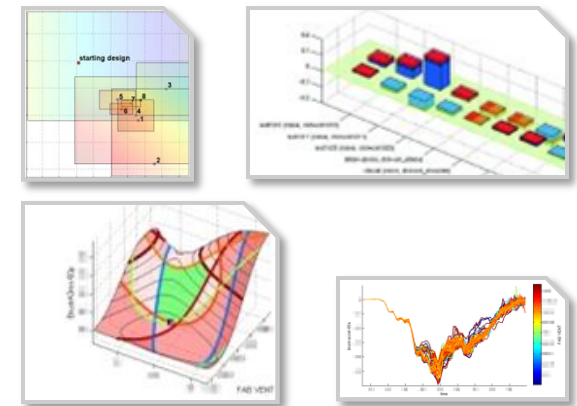
Direct calls to external tools, user scripts, link-up CAE-Bench



Integration optimization support

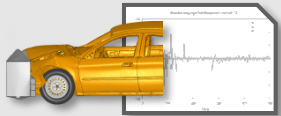
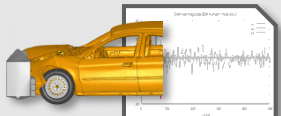
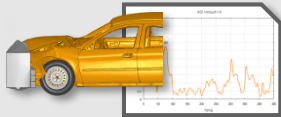


- Models are parameterized
- Simulation models are assembled automatically
- Linkage to Optimization software like LS-OPT



IT-Integration - Linkage Status monitoring

Simulation



Status.E

Datei Bearbeiten Ansicht Admin Extra

Lastfallpool Projektauswahl **Projekt-Übersicht**

Projekt: 23 erfüllt, 1 Toleranz, 10 nicht erfüllt, 1 nicht bewertet

Filter: 23 erfüllt, 1 Toleranz, 10 nicht erfüllt, 1 nicht bewertet

Auswahl: 3 erfüllt, 0 Toleranz, 4 nicht erfüllt, 0 nicht bewertet

Zeitpunkt

Datum: 7. 9. 2009

T-Minus: -8

Meilenstein:

1.VKF -39, 2.VKF -33, VPT -24, DDKM -18, FF 8

Hierarchie- und Filtereinstellungen

- LAH: 64km/h 40% ODB
- FMVSS208 Phase 2 56km/h 100% starr aktiv
- FMVSS208 Phase 2 40km/h 100% starr passiv - 0°
- FMVSS208 Phase 2 40km/h 100% starr passiv - 30°
- EuroNCAP 64km/h 40% ODB
- AZT-Crash vorne
- AZT-Crash hinten
- R-CAR Bumper vorne
- R-CAR Bumper hinten
- Barriere : RdW-Euro-NCAP 50 km/h m. Advanced200
- Euro-NCAP Pfahlaufprall 90Grad
- FMVSS214 Barrierencrash schräg 54km/h
- USSINCAP Barrierencrash 62km/h
- FMVSS214 Pfahlaufprall 75-Grad 32km/h: 5% + 50%
- IIHS-Seitencrash
- FMVSS301: 80km/h 70% ODB
- FMVSS 216a - neu
- IIHS
- Gesetz ECE-R14/TRIAS 37/ADR 5/FMVSS 210
- Statische Eigenschaften der ROKAROSSE

Kriterien

Kriterium	Ziel	Ist	Einheit	User	Dat
1 UPC	$x < 7.5$	6.55	m/s		
2 Absenkung Schweller	$x < 30.0$	26.18	mm		
3 Längsträger (Struktur) schadensfrei	i.O.	n.i.O.	boolean		
4 nur Teile aus Schadenskorb pl. deformiert	i.O.	i.O.	boolean		
5 SQT Überfahren	i.O.	i.O.	boolean		
6 Kühler schadensfrei	i.O.	n.i.O.	boolean		
7 OLC	$x < 32.0(35.0)$	27.93	g		
8 Intrusion Modulquerträger mitte Lenksäule	$x < 20.0$	17.45	mm		
9 Intrusion Stirnwand vor Gelenk Lenkwelle	$x < 100.0$	87.27	mm		
10 Absenkung Schweller	$x < 35.0$	30.55	mm		
11 Insassenrelevanter Fussaufschlagsbereich ohne Padding	$x < 30.0$	26.18	mm		
12 Insassenrelevanter Fussaufschlagsbereich mit Padding	$x < 50.0$	43.64	mm		
13 Modulquerträger mitte Lenksäule	$x < 25.0$	21.82	mm		
14 Rückverlagerung Säule A	$x < 20.0$	17.45	mm		
15 y-Versatz bei 100 ms	$-100.0 < x < 100.0$	-112.73	mm		
16 z-Absenkung Schweller	$-50.0 < x < 50.0$	-56.36	mm		
17 Längsträger (Struktur) schadensfrei	i.O.	i.O.	boolean		
18 nur Teile aus Schadenskorb pl. deformiert	i.O.	n.i.O.	boolean		

Fini

