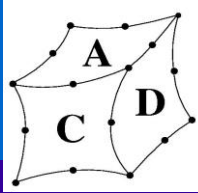
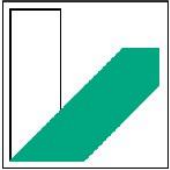


Übersicht

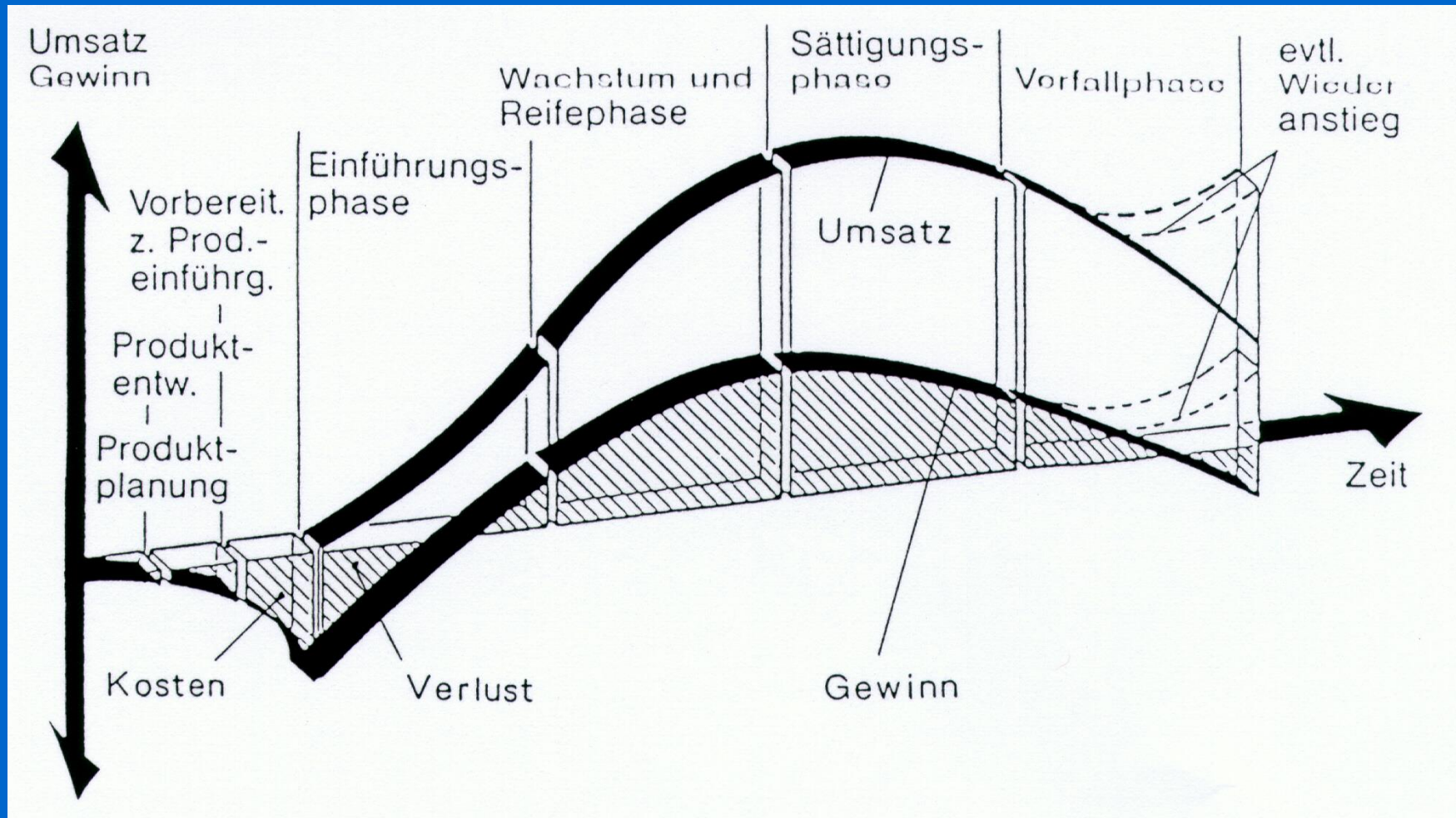
Numerische Simulation in der Produktentwicklung

Trends, Ausblicke, Beispiele

Dipl.-Wirtsch.-Ing. Reinhard Hackenschmidt
Lehrstuhl für Konstruktionslehre und CAD

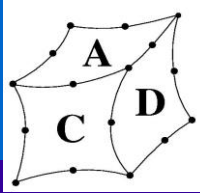


Produkt Lebenszyklus



Nach Pahl/Beitz



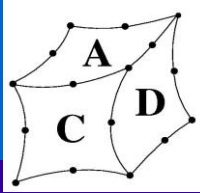


Der Konstrukteur



Berechnen,
Entwerfen,
Dokumentieren,
Ausarbeiten -
alles das macht
der Konstrukteur -
meist im Team.

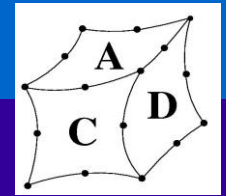
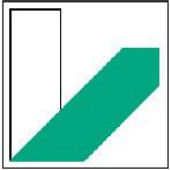
Rechts im Bild
Karl Maybach.



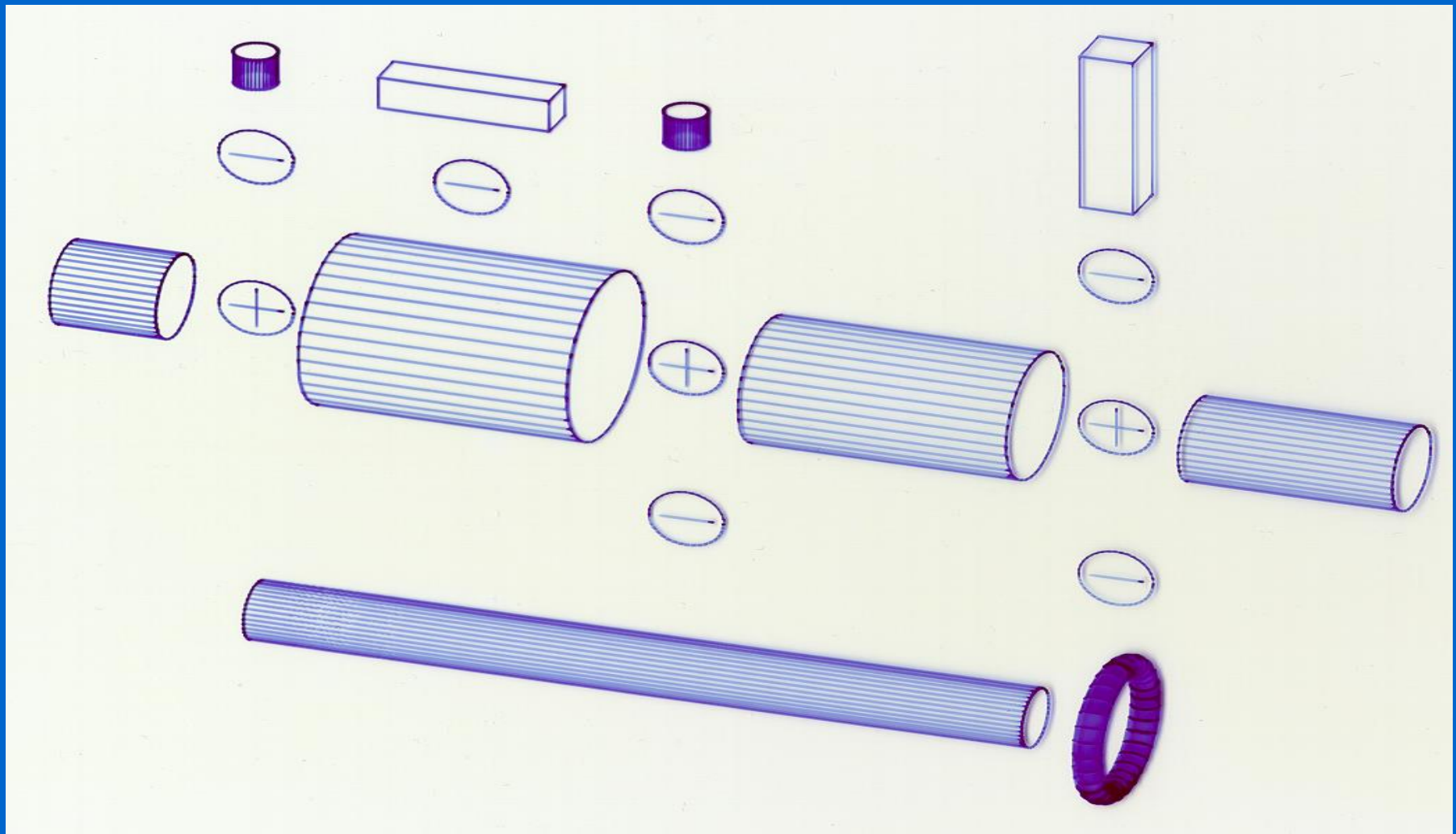
Der „neue“ Konstrukteur

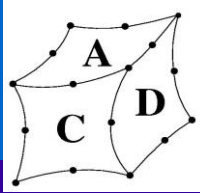
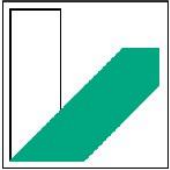


Dassault Systemes

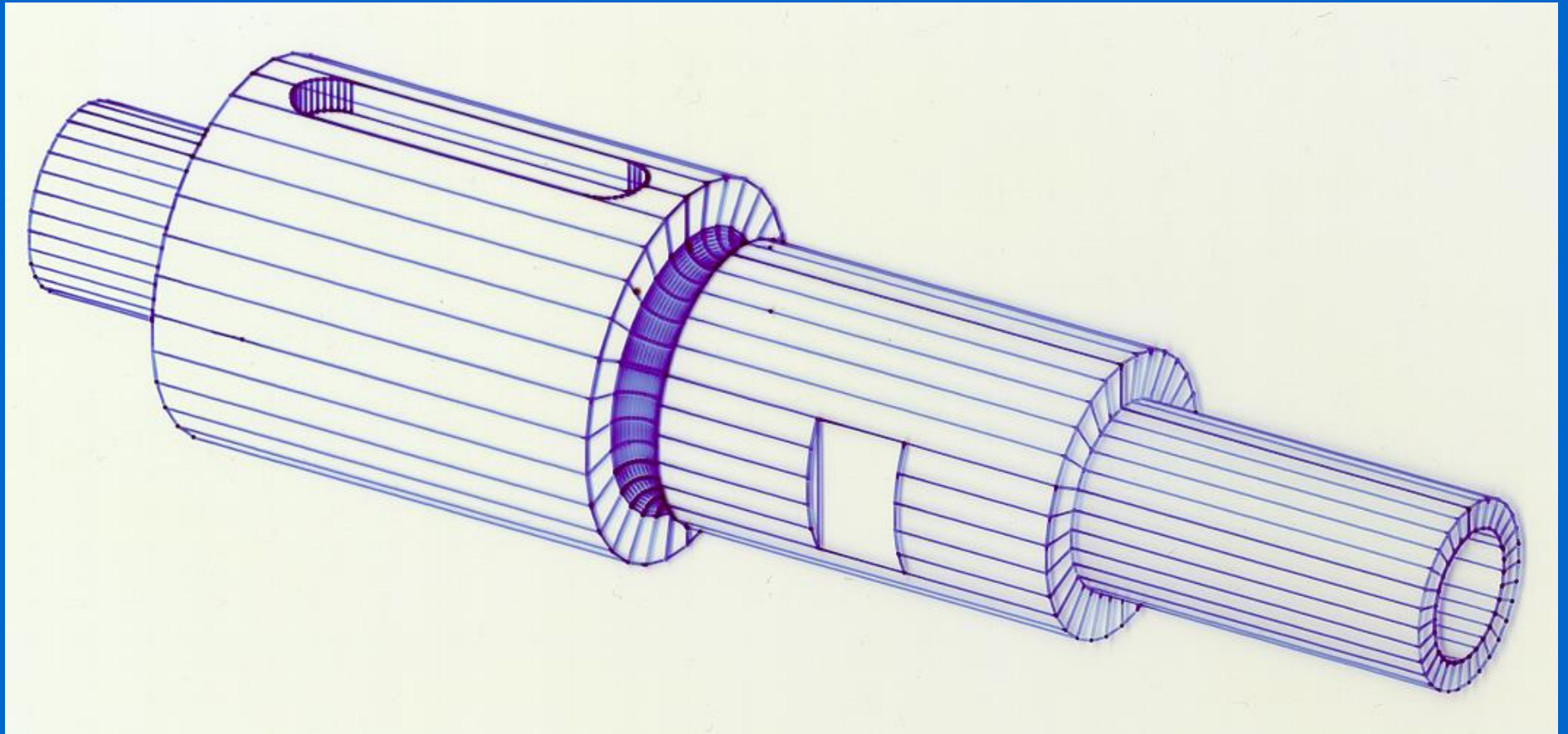


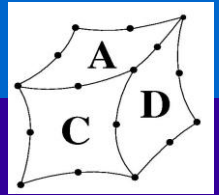
3D-CAD mit Boole - Operationen



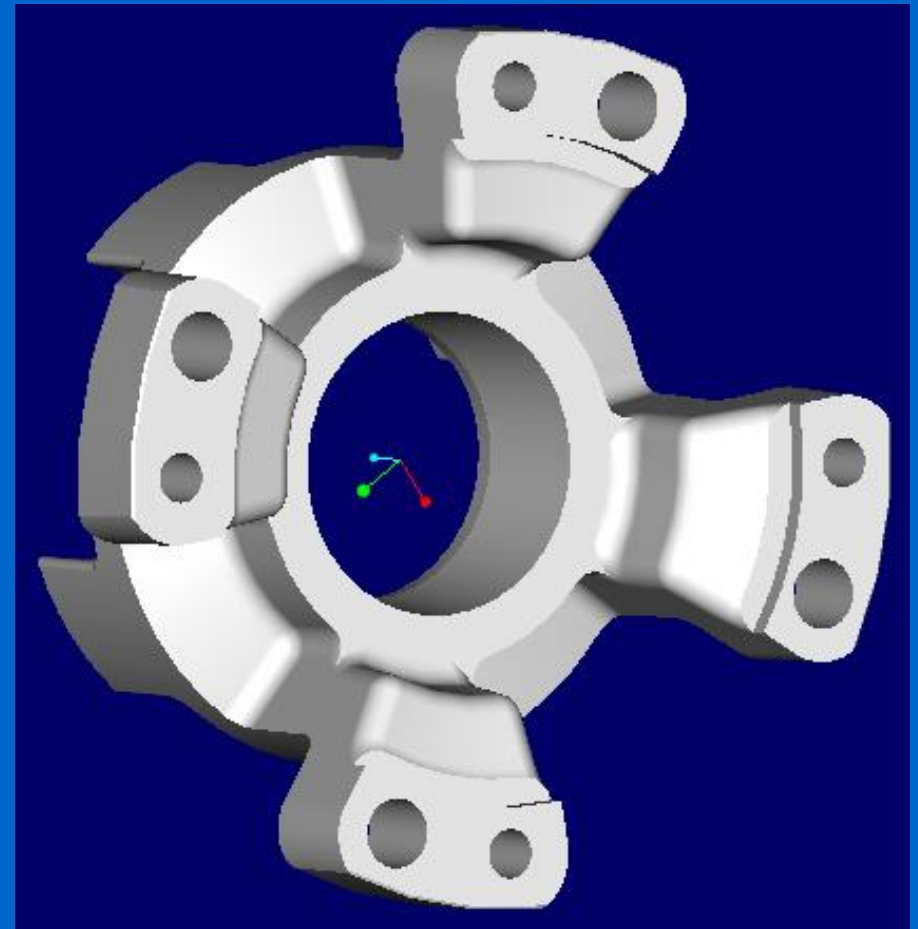
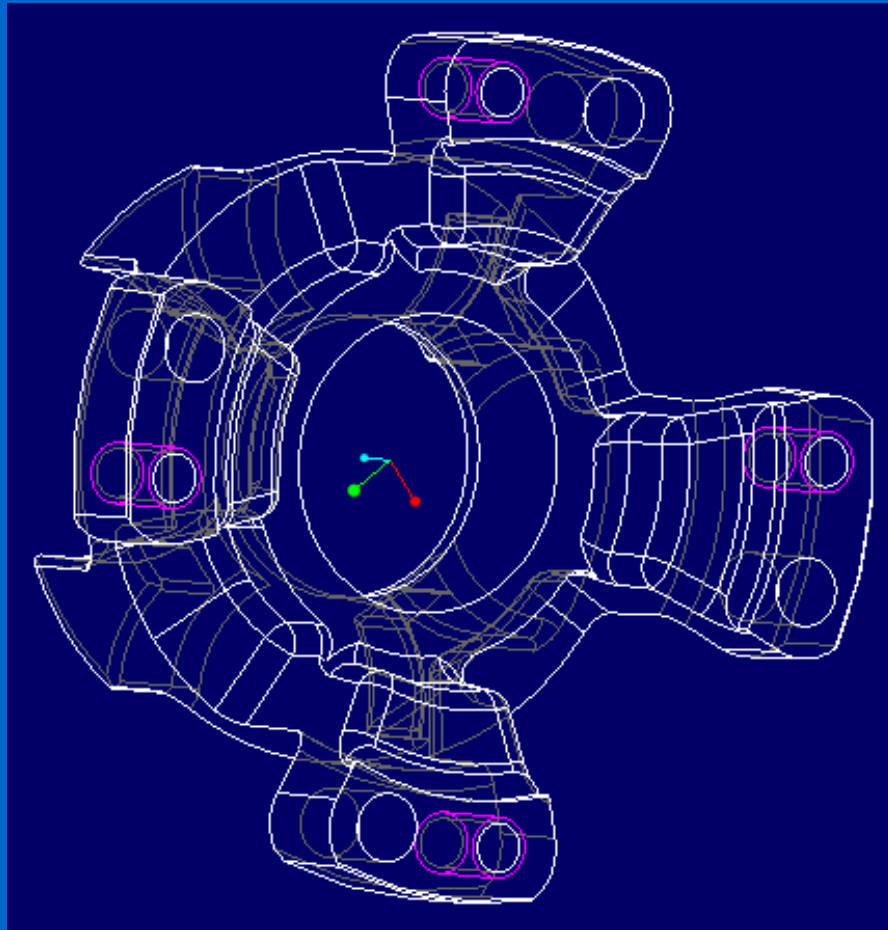


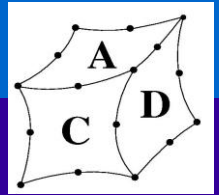
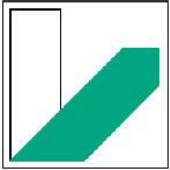
Frühes 3D-CAD ~ 1990



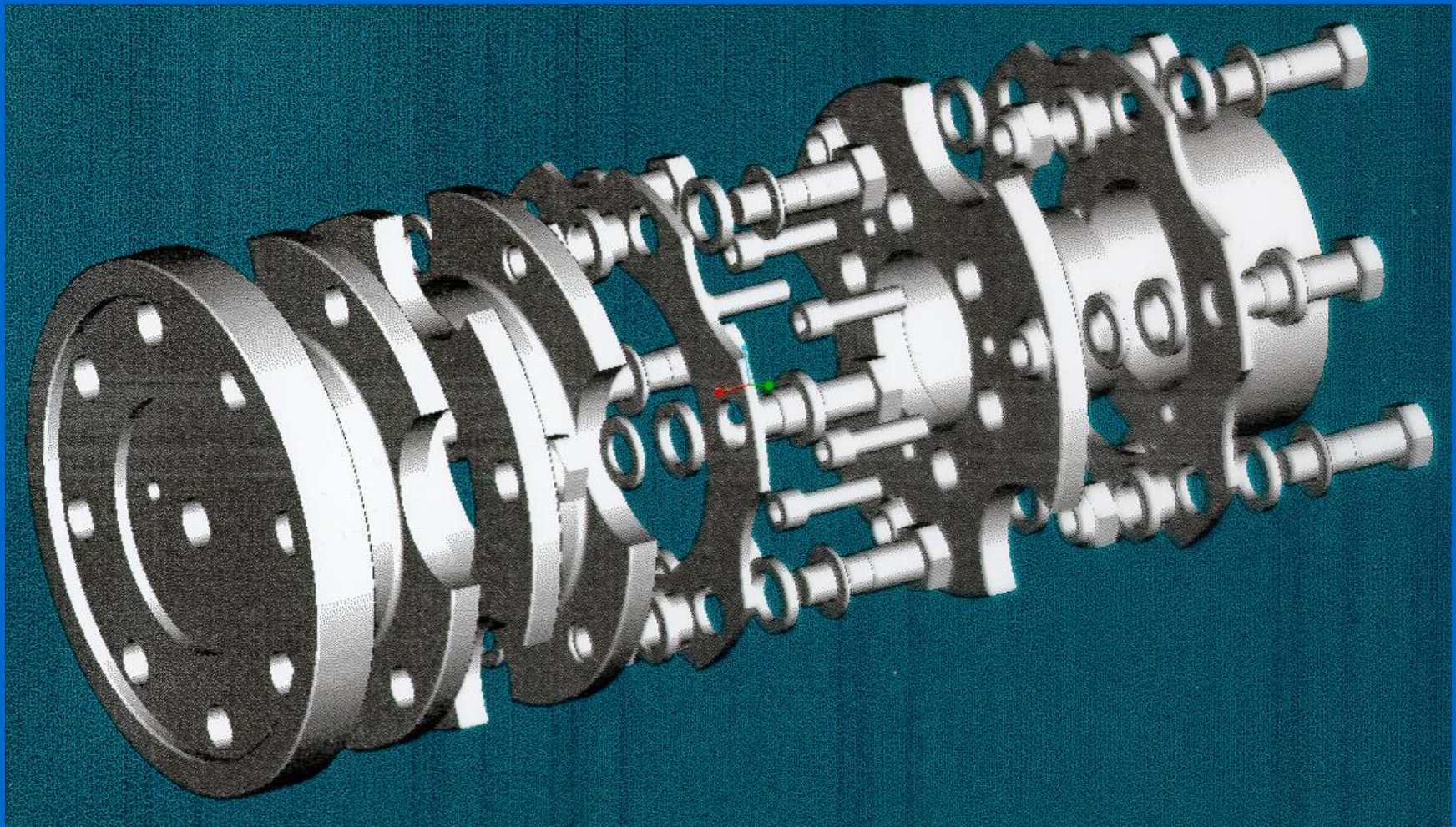


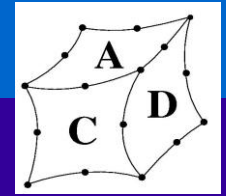
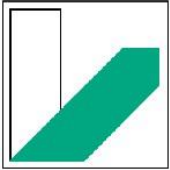
Bauteile 3D-CAD





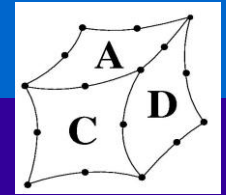
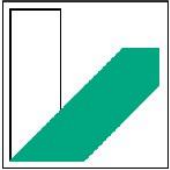
Baugruppe 3D-CAD



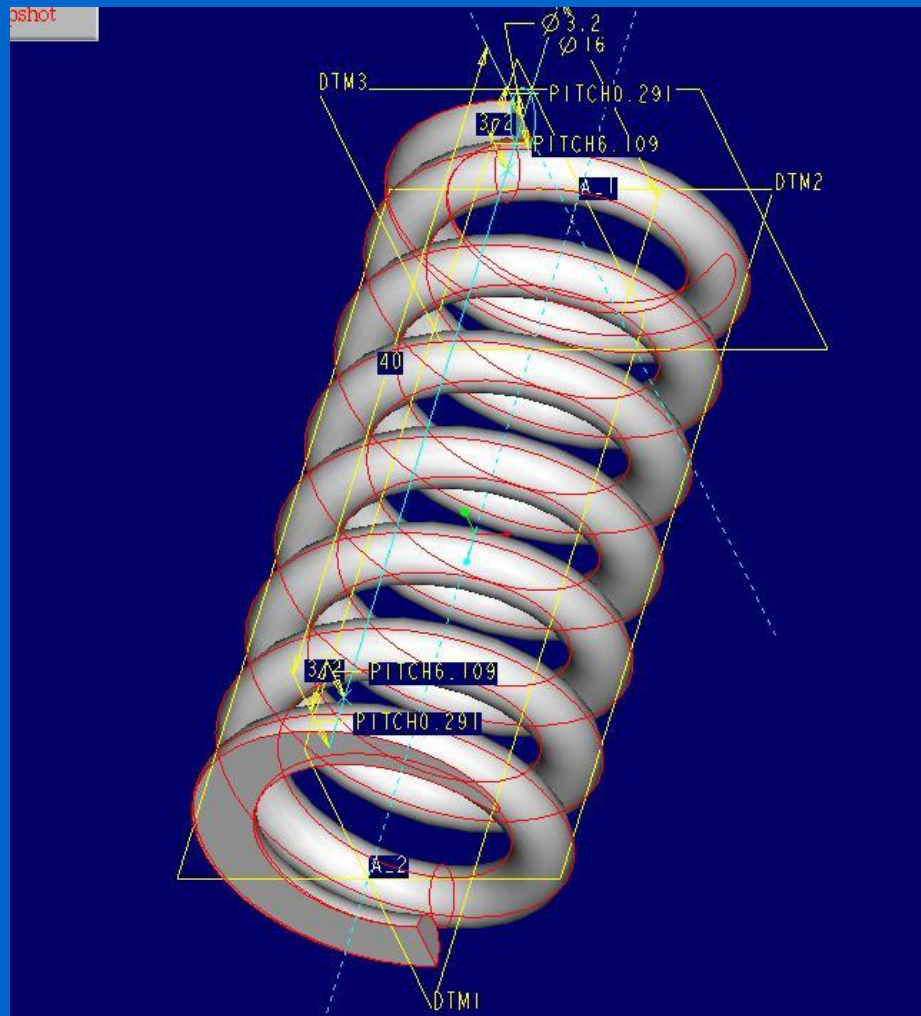


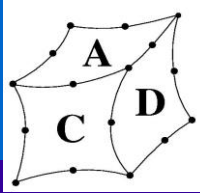
Nur mit 3D problemlos möglich

- durchgängige Parametrisierung
- Ableiten von Explosionszeichnungen
- photorealistische Bilder => Marketing
- Rapid Prototyping (Stereolithographie)
- Kollisionsprüfungen
- Virtuelle Realität
- Finite- Elemente- Berechnung
- NC- Datenaustausch

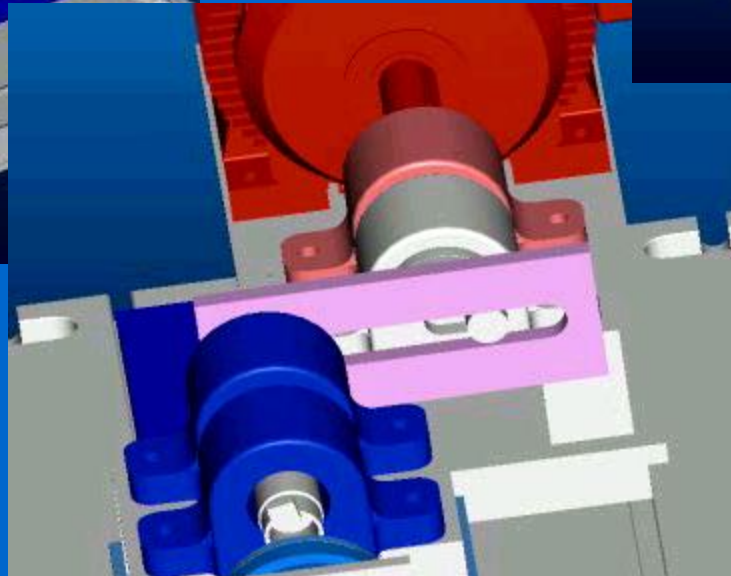
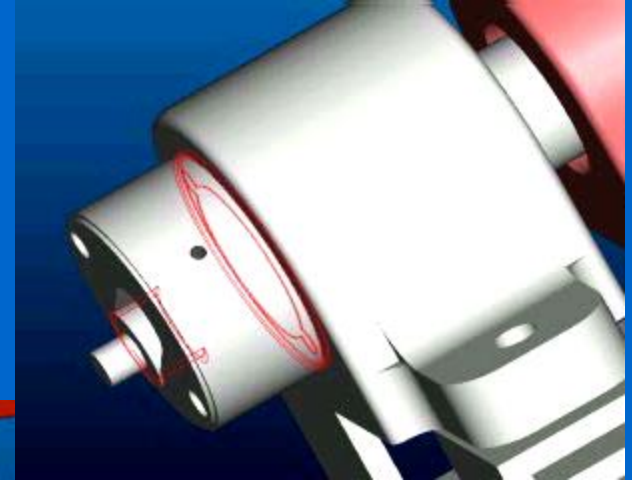
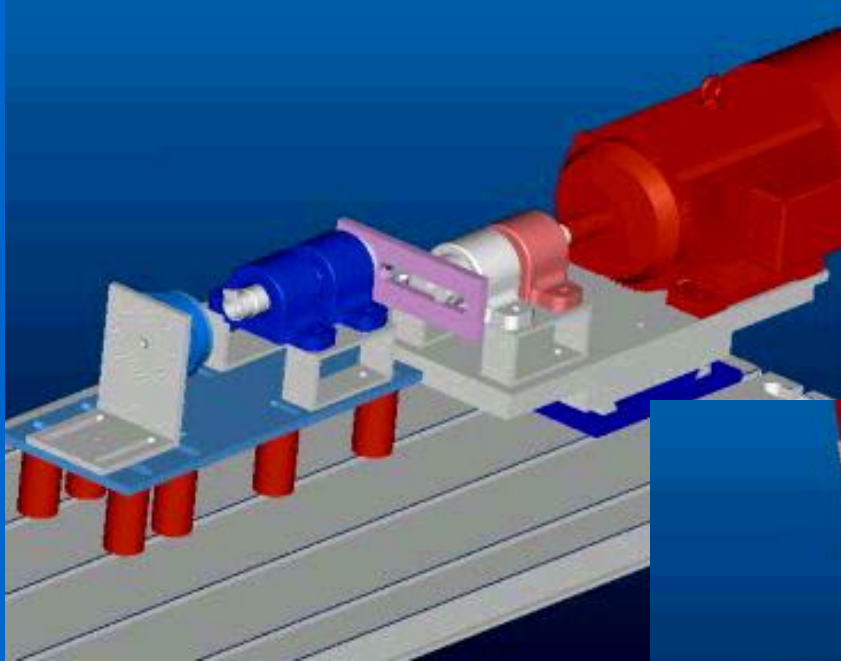


Parametrik 3D-CAD



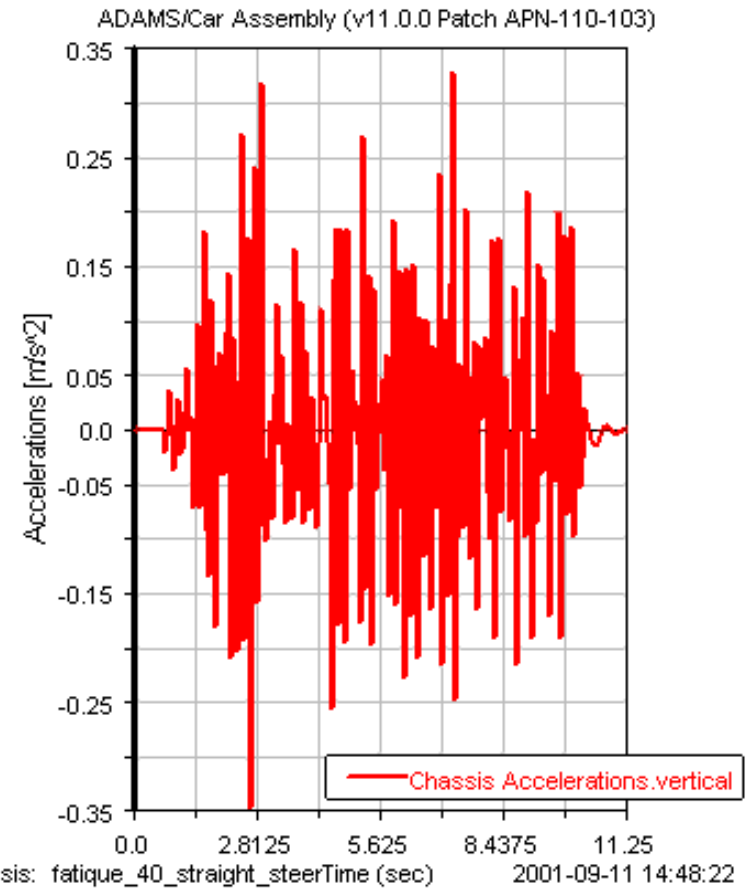


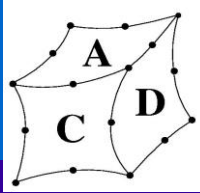
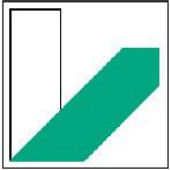
Digital Mock-up - Zusammenbausimulation



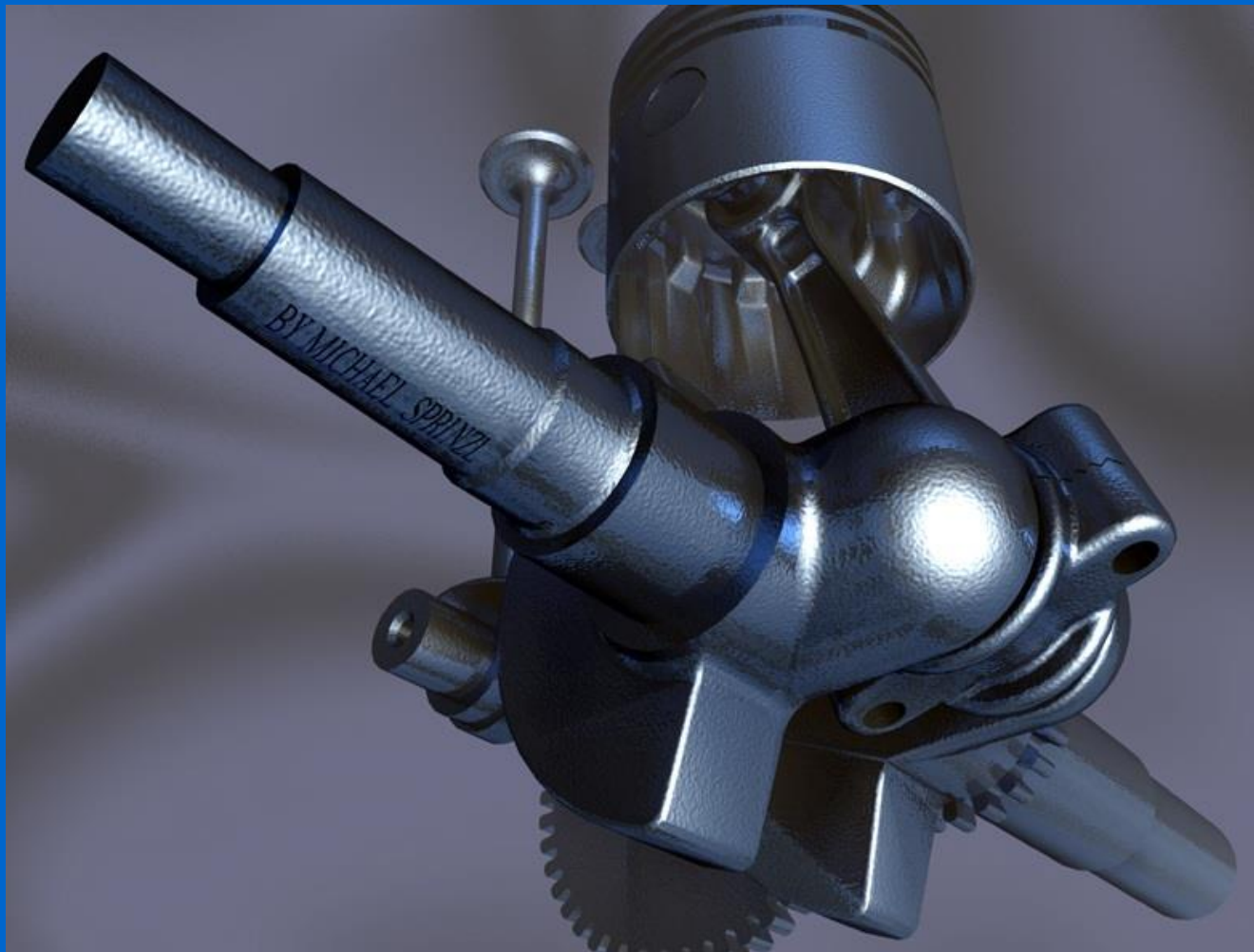
Kräfte-simulation

fatigue_40_straight_steer Equilibrium Frame=1

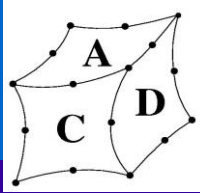
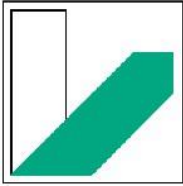




Photorealistische Darstellung



Diese Motor-
baugruppe
haben unse-
re Studenten
am Ende des
2.Semesters
mit Pro/
ENGINEER
konstruiert

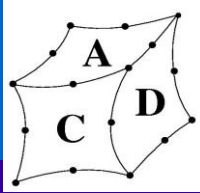


Computergrafik

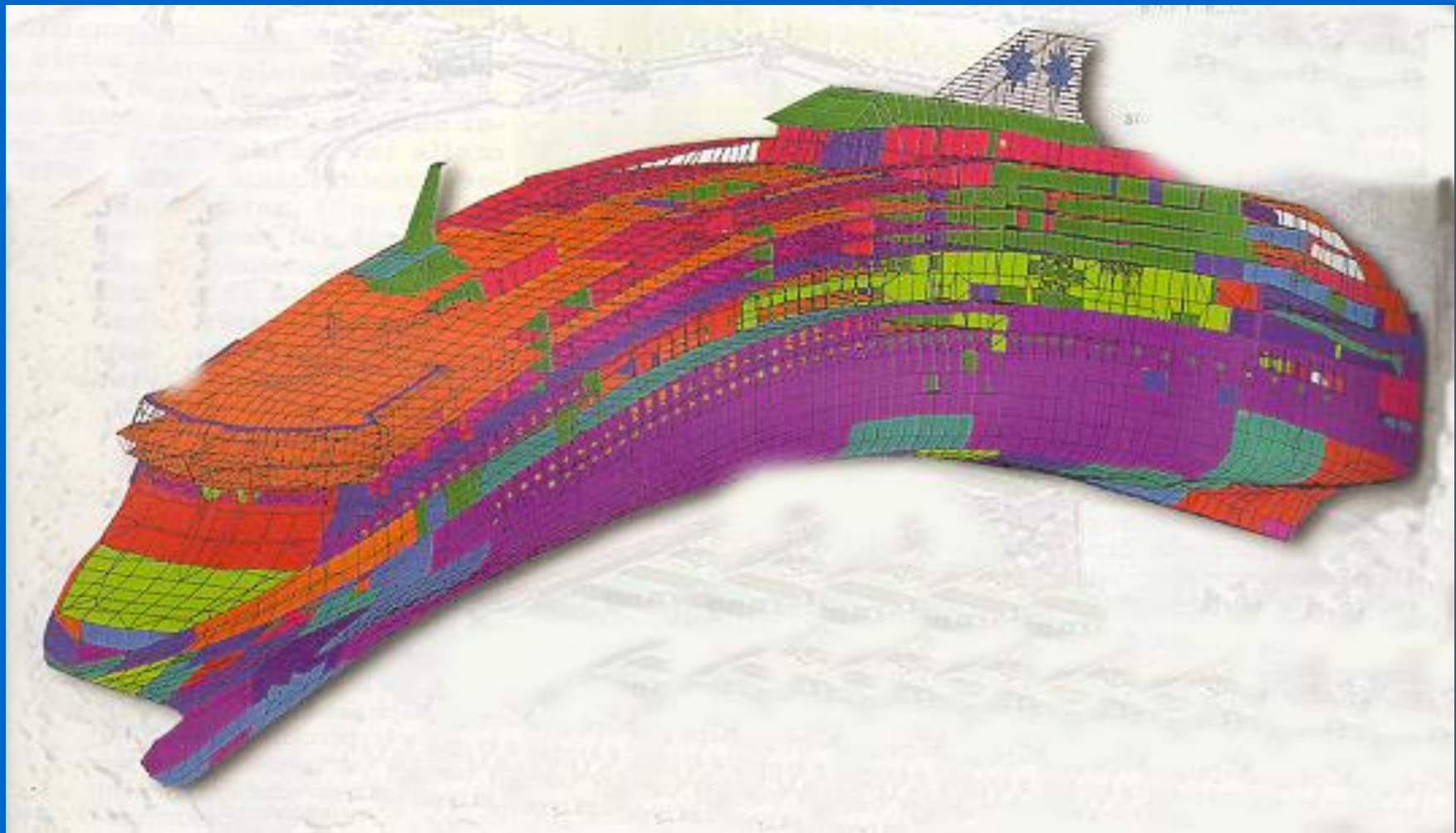


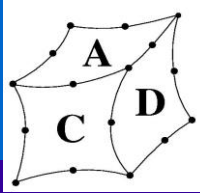
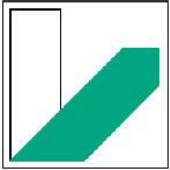
Gigantischer
Rechenzeitbedarf:
Phantasy- Filme
wie Herr der Ringe,
Krieg der Sterne.



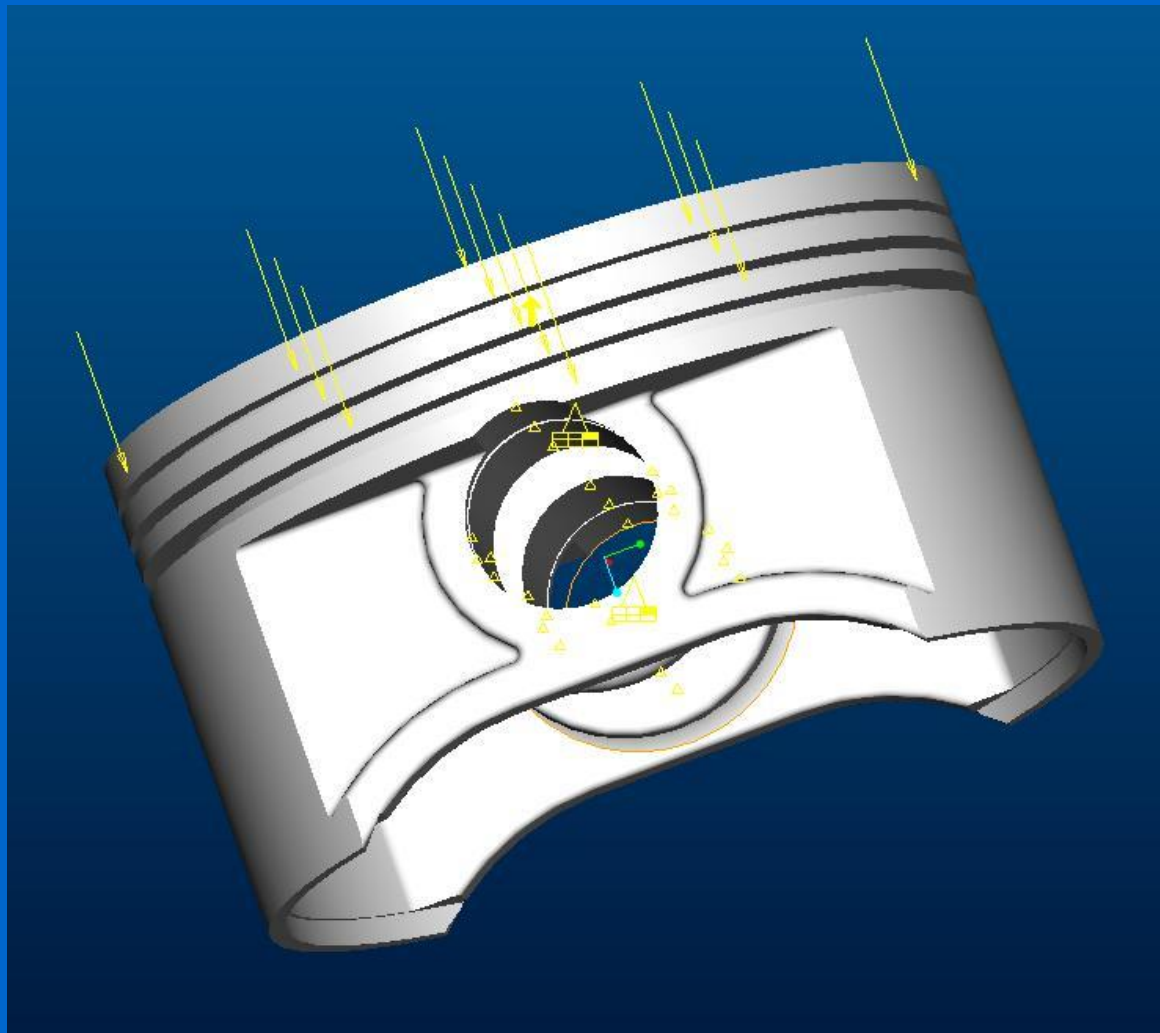


Finite Elemente Analyse

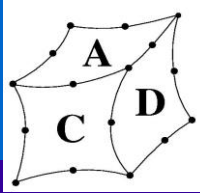
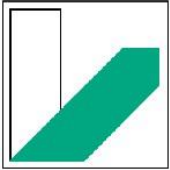




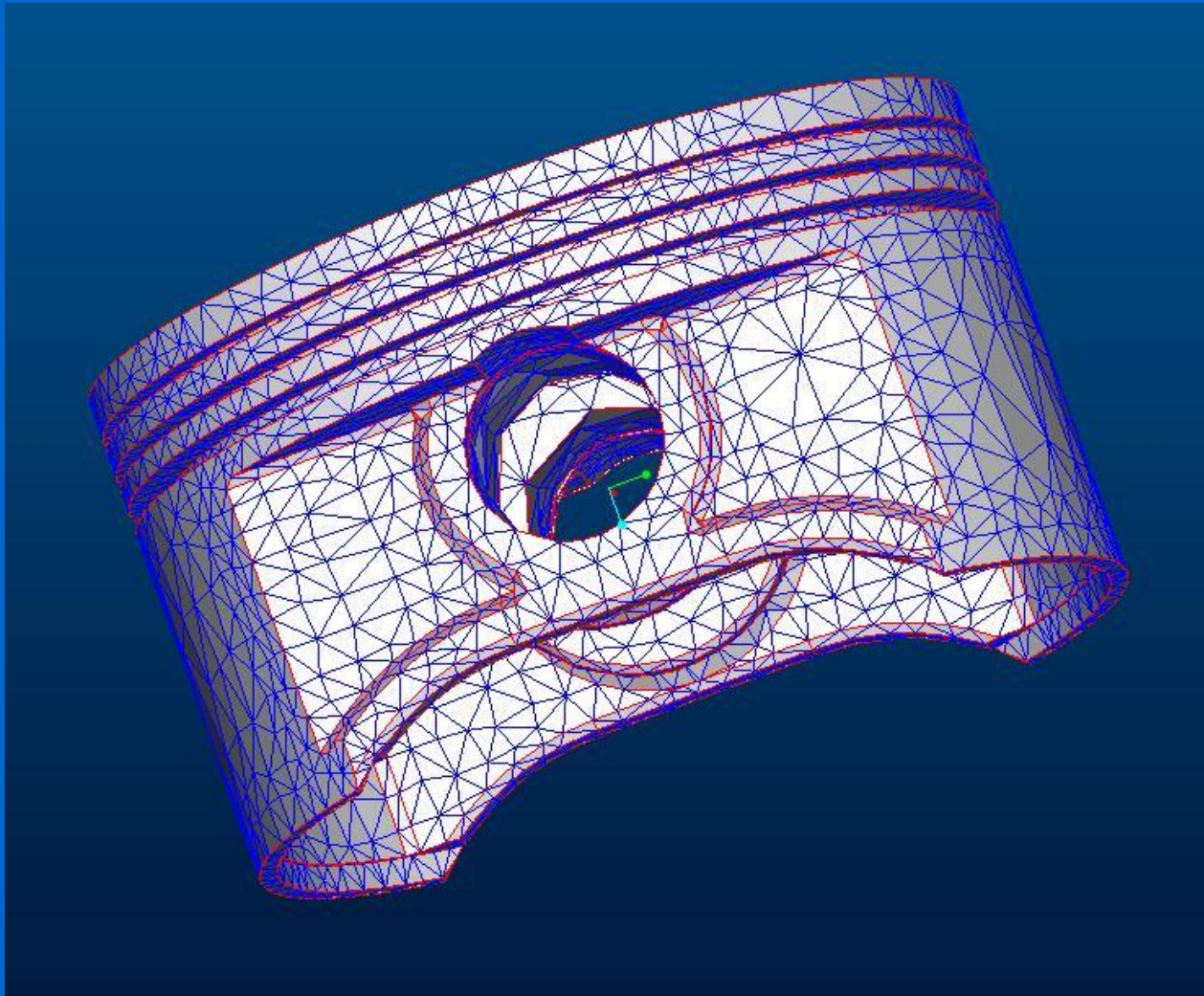
FEA eines Kolbens



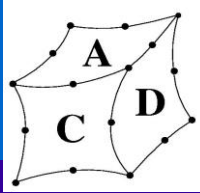
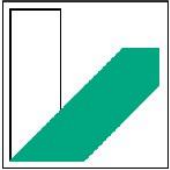
Kolben einer
BMW F 650
GS.
Konstruiert mit
Pro/ENGINEER



FEA eines Kolbens

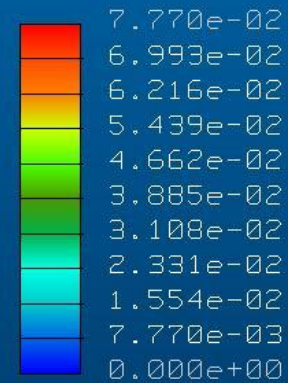
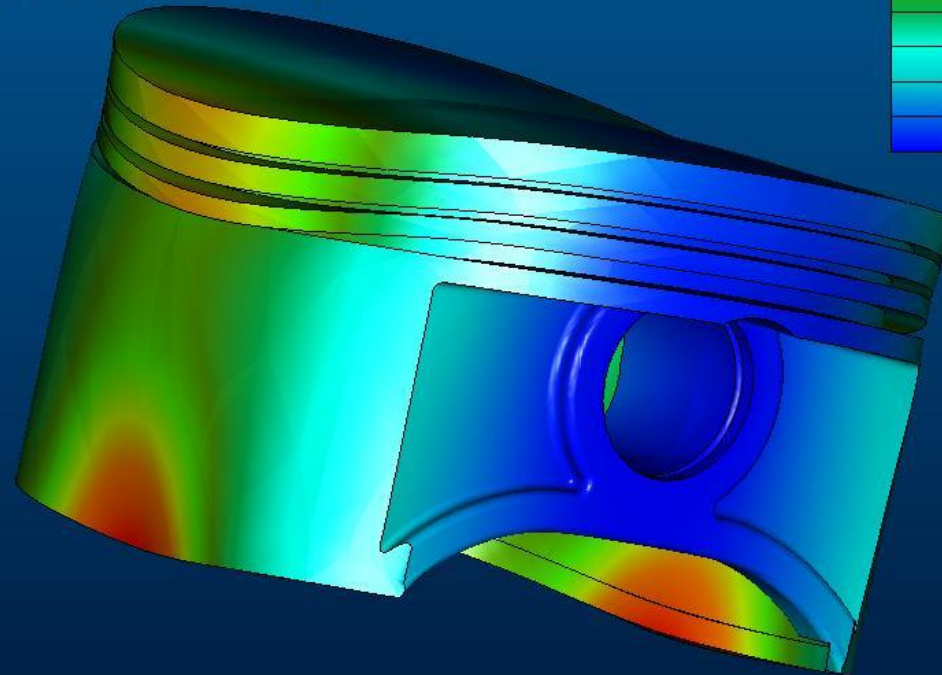


Kolben einer
BMW F 650 GS.
FEA- Netz mit
Pro/MECHANICA

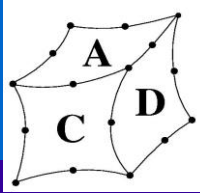


FEA eines Kolbens

Verformung Betrag
Verformtes Original Modell
Max Darst +7.770E-02
Skala 1.2870E+02
LoadSet1
Principal Units:
millimeter Newton Second (mmNs)



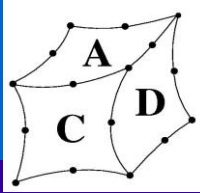
Kolben einer
BMW F 650
GS.
Gerechnet mit
Pro/ MECHA-
NICA



Z88- das freie FEA- Programm

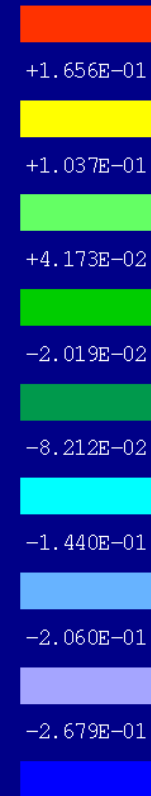
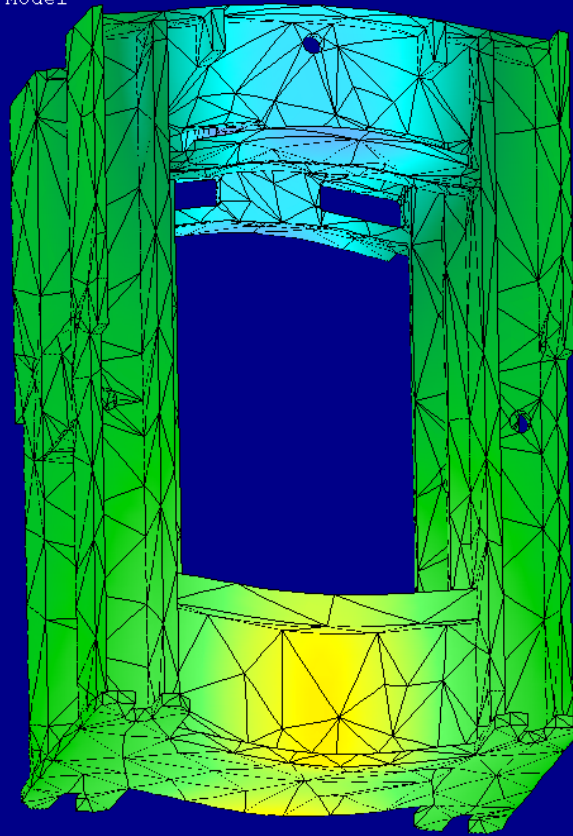


- Entwicklung seit 1985
- 20 Elementtypen
- programmiert in ANSI-C
- beliebig erweiter- und anpaßbar
- steht auf zahlreichen Internet- Servern
- ist Bestandteil der SuSE- LINUX- Distribution
- wird von mehreren Unis und FH eingesetzt
- Rückmeldungen u.a. von Boeing Missile & Defense und Freightliner

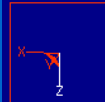


FEA eines Pressenrahmens

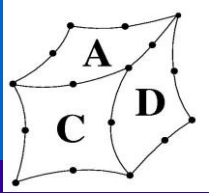
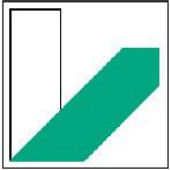
Displacement Z
Max +2.2750E-01
Min -3.2981E-01
Deformed Original Model
Scale 1.0181E+03
Load: Combination



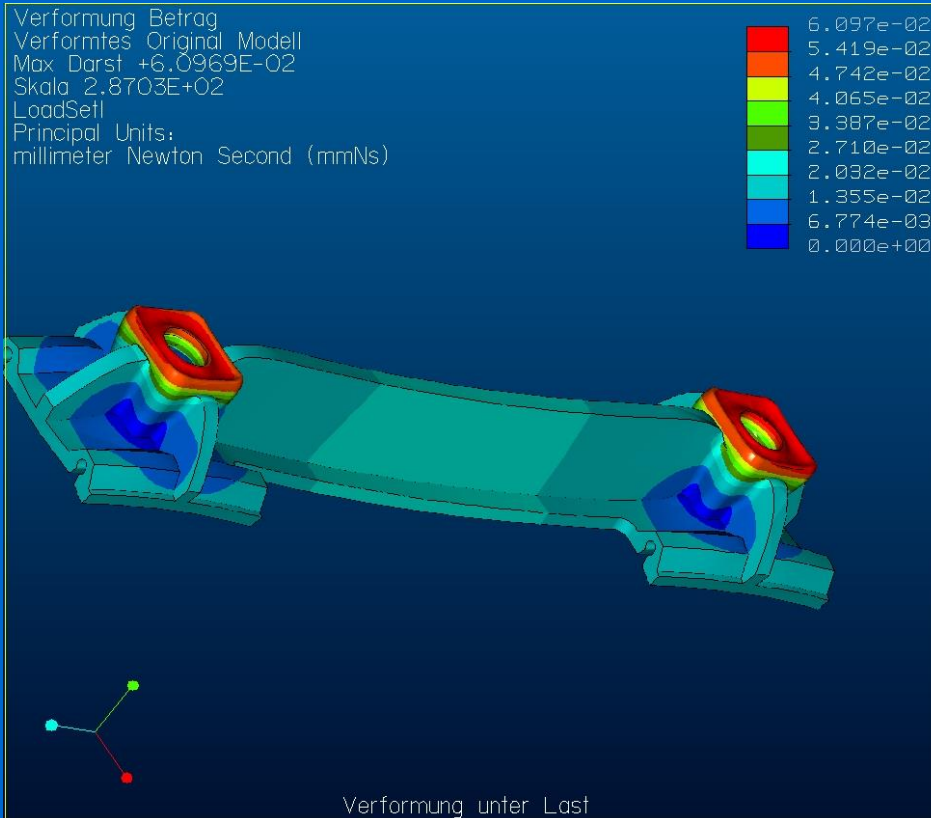
Fa. Burkardt,
Bayreuth



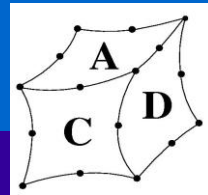
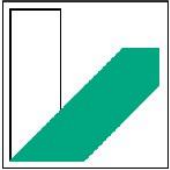
"window5" - study4 - anlys4



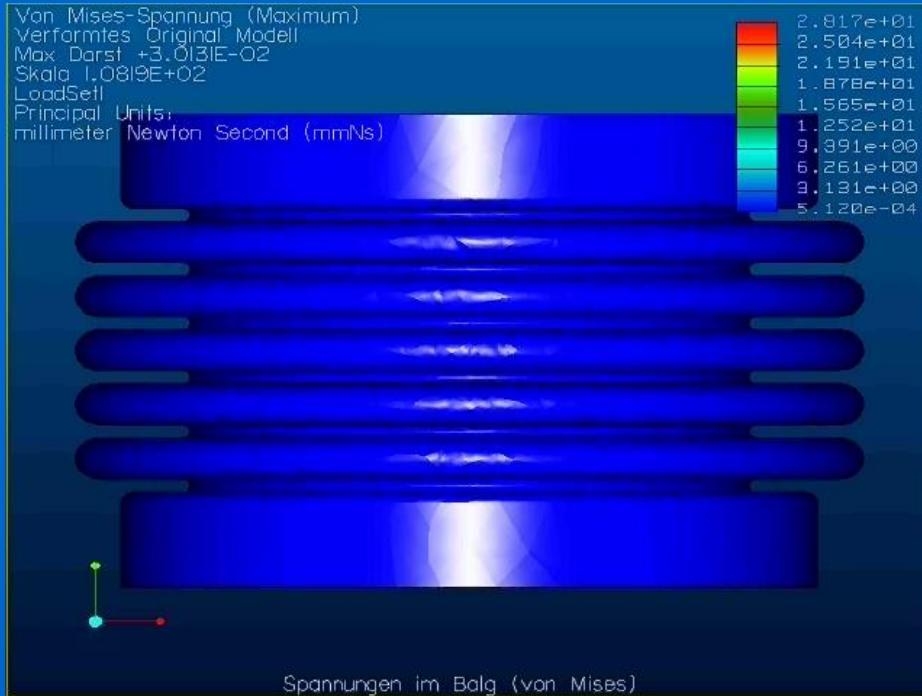
FEA Kunststoff



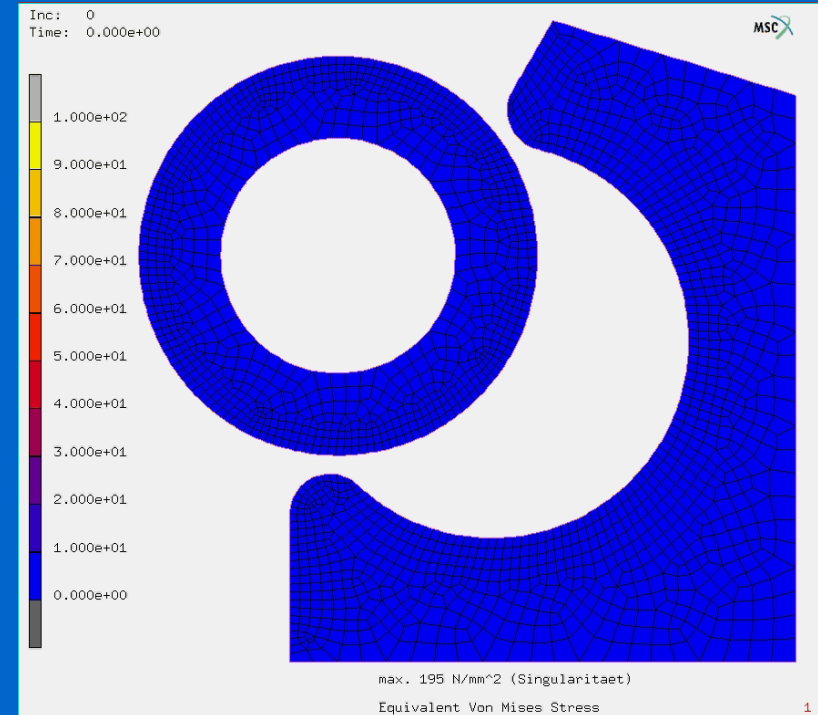
Schott Solarkollektorträger



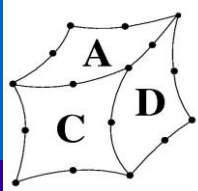
FEA animierte Simulation



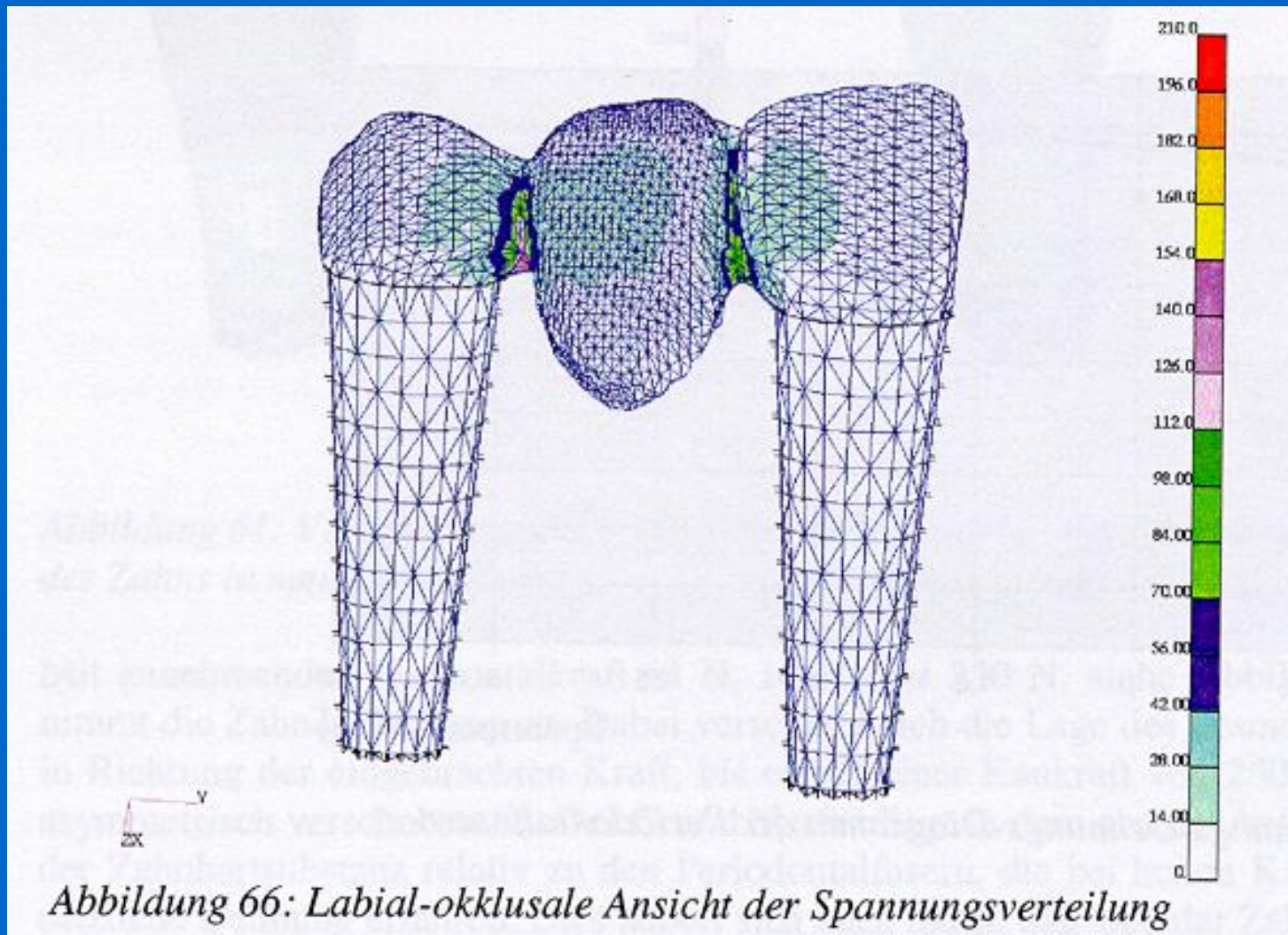
R+W Metallbalg

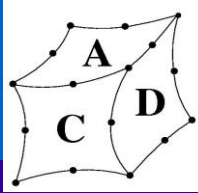
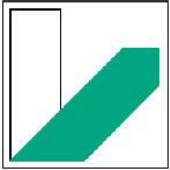


Loewe, Montagekräfte

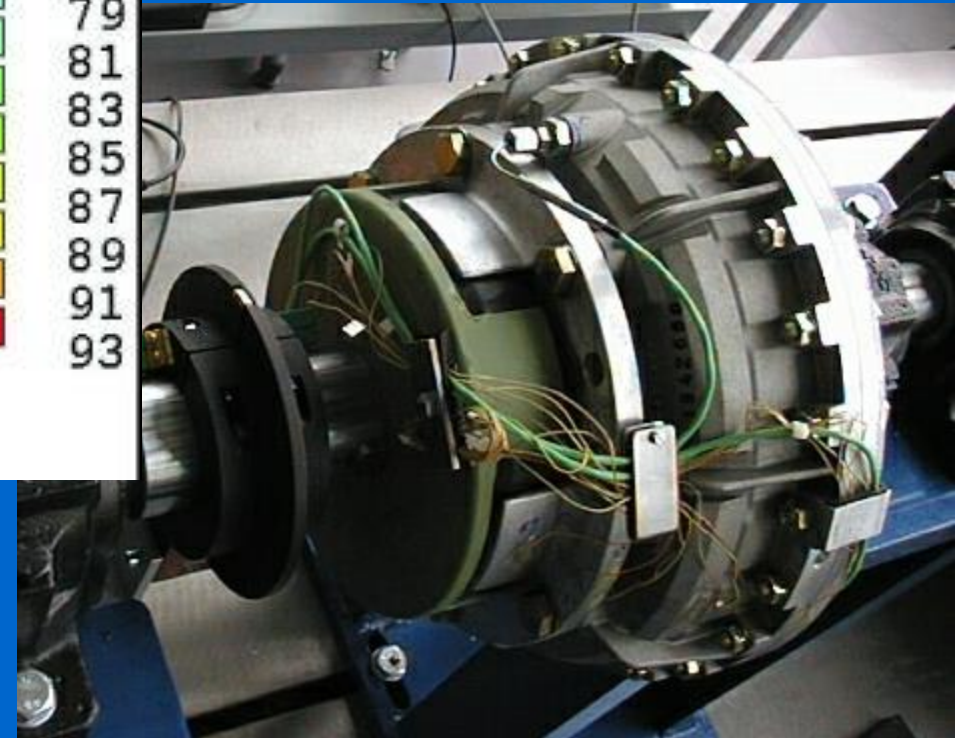
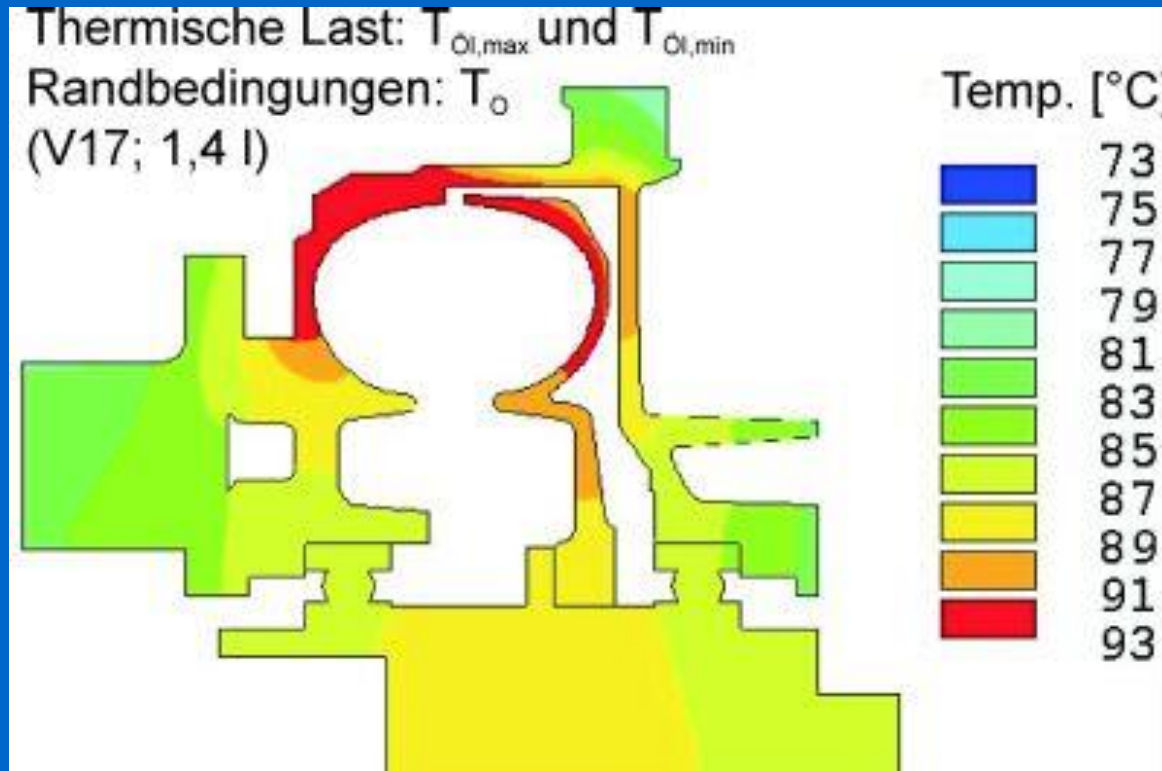


Finite Elemente und Gesundheit



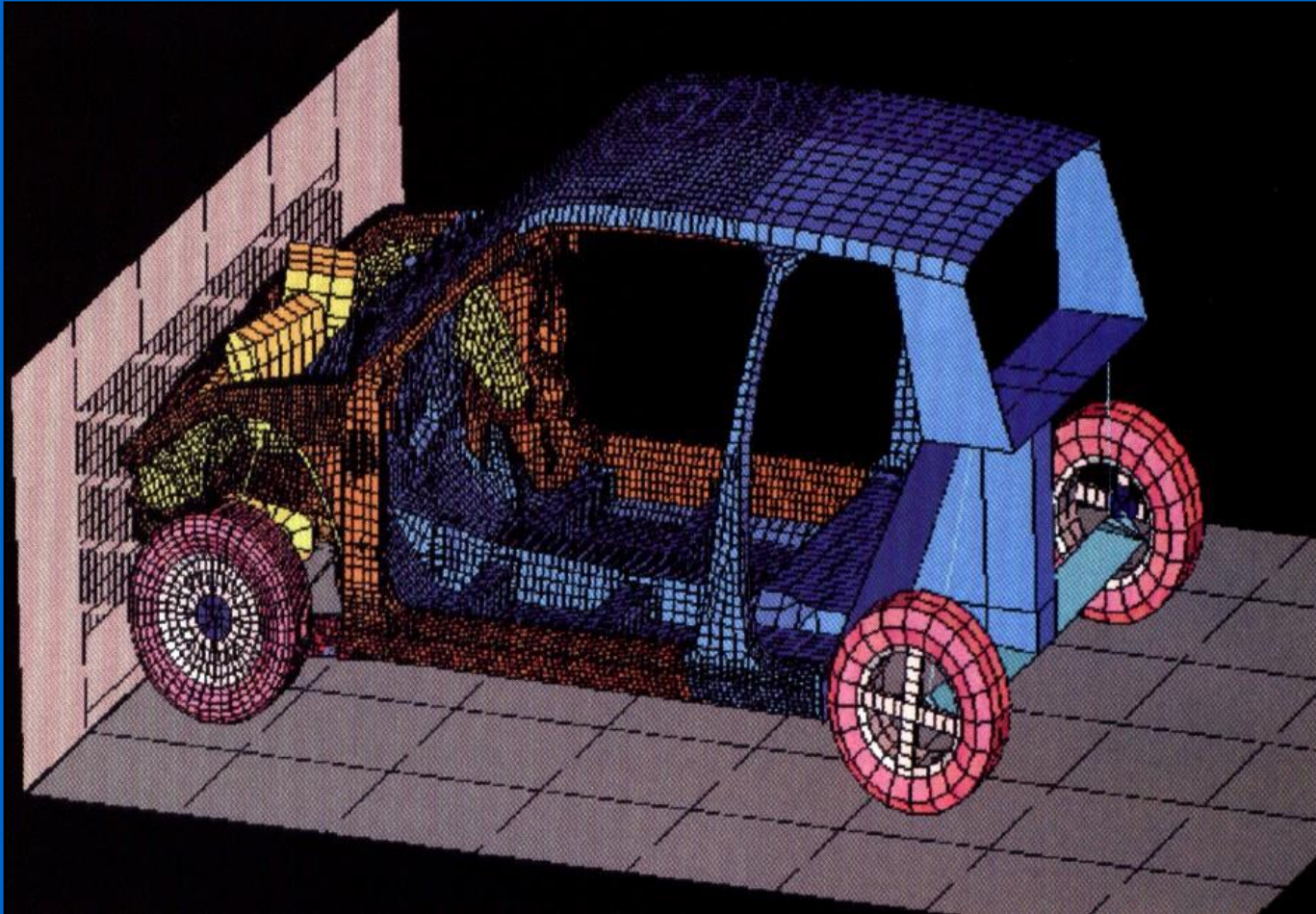


FEA Temperaturverlauf



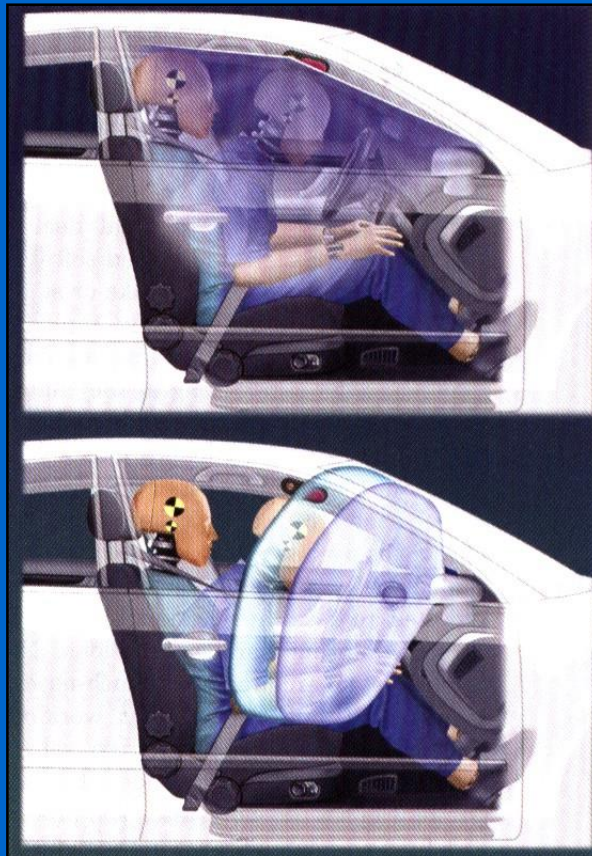
Voith Turbokupplung

Crash-Simulation



Quelle: Stiff Test,
Automotive Engineer,
10/2002

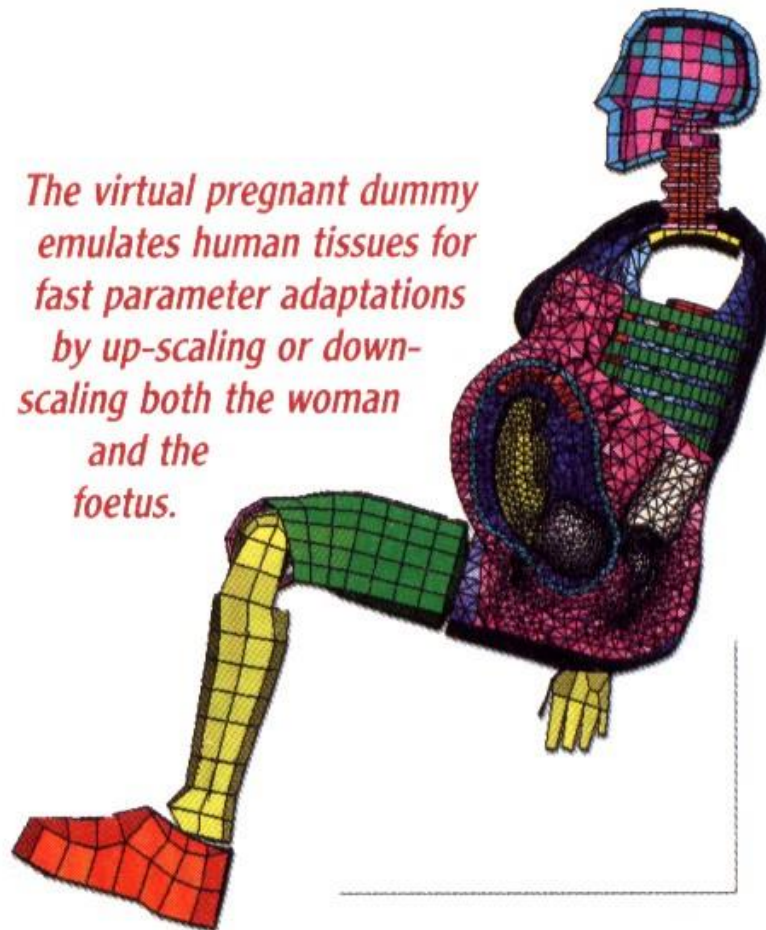
Crash-Simulation (2)



Following information fed back from a laser scanner, the inflated size of the passenger airbag depends on the distance between the passenger and the instrument panel

Quelle: Safety powered by
Electronics, Automotive Engineer,
05/2003

Crash-Simulation (3)

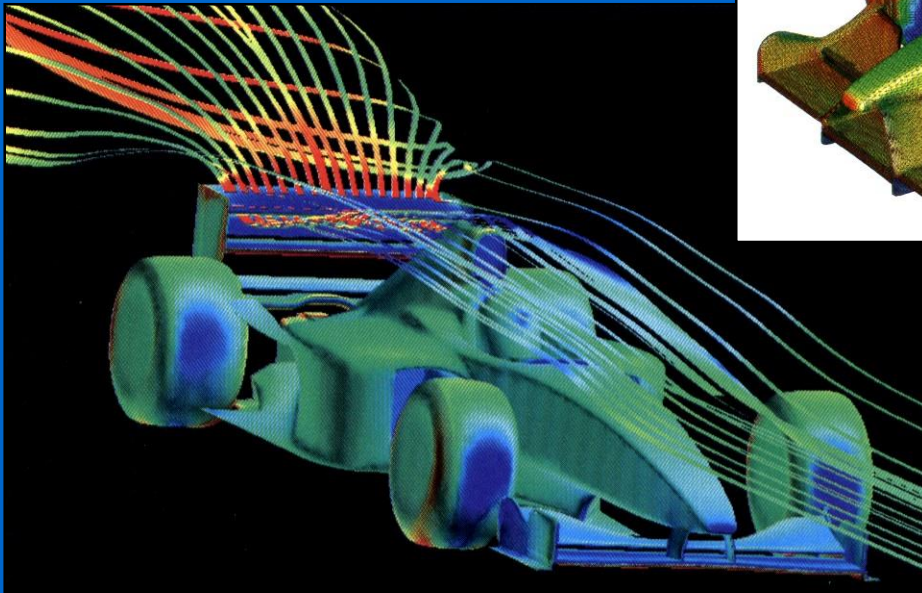
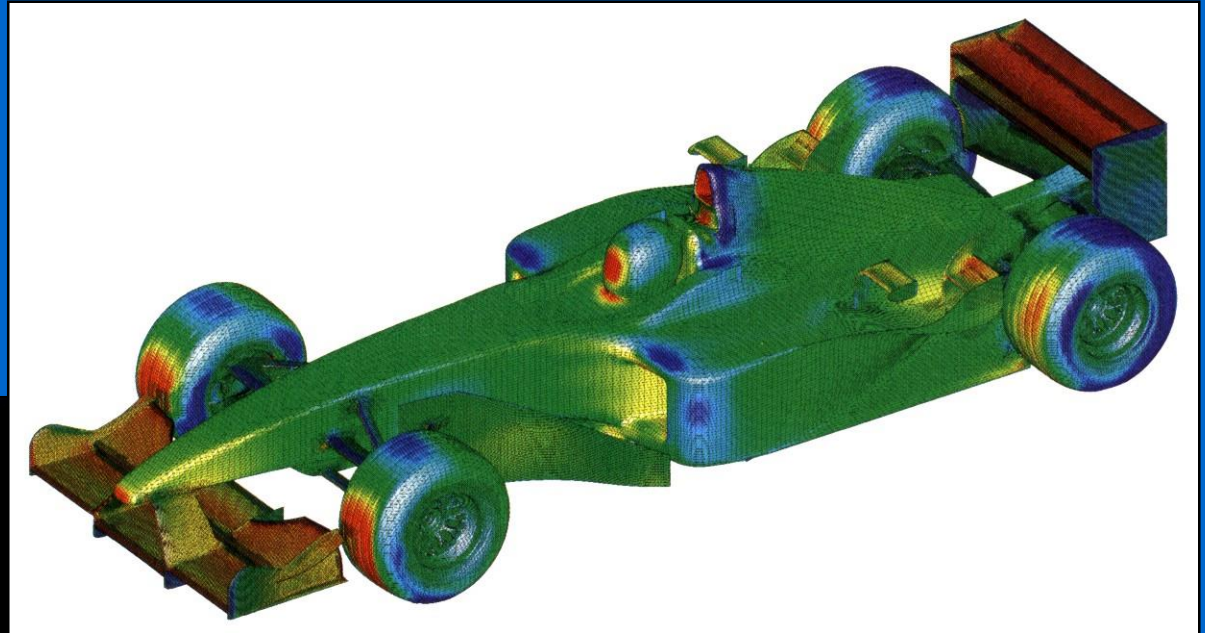


Quelle: Virtual Pregnant Crash Dummy, AutoTechnology, 04/2003

Strömungssimulation (1)

Formel 1

Quelle: Go with the Flow,
Automotive Engineer, 07-08/2001

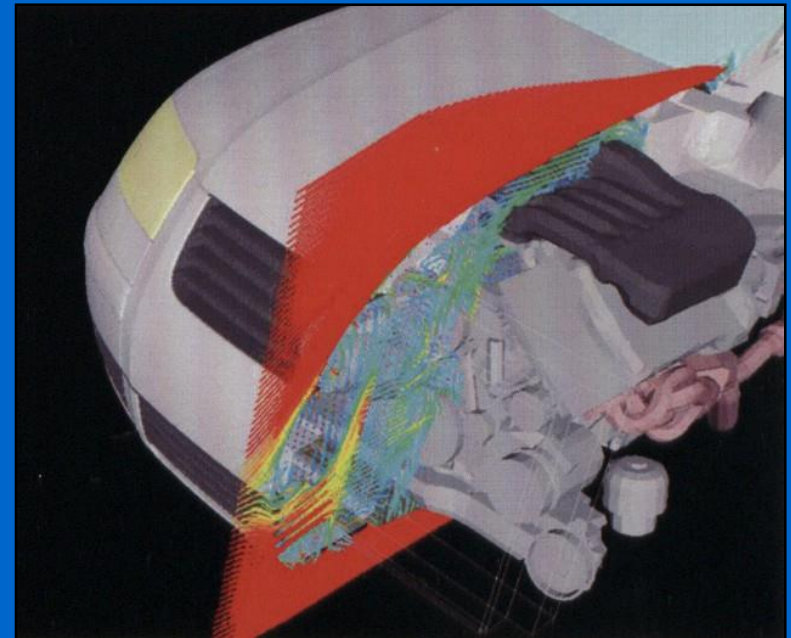


Quelle: Knowledge-Based Expert Systems for
Better Vehicle Aerodynamics Simulation,
AutoTechnology, 02/2003

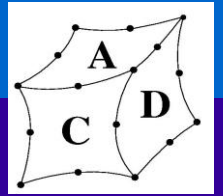
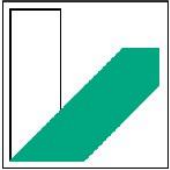
Volkswagen AG (2)

Der virtuelle Motor

- Schwingungsanalyse mit Hilfe von Mehrkörpersystem-Programmen
 - Bsp.: Modellierung von Nockenwelle und Ventilen des W8 – Dynamiksimulation über gesamtes Drehzahlband
- Struktur- und Festigkeitsanalyse
 - Bsp.: Kurbelwelle – Simulation von Höchstbelastungen über gesamten Drehzahlbereich am Rechner



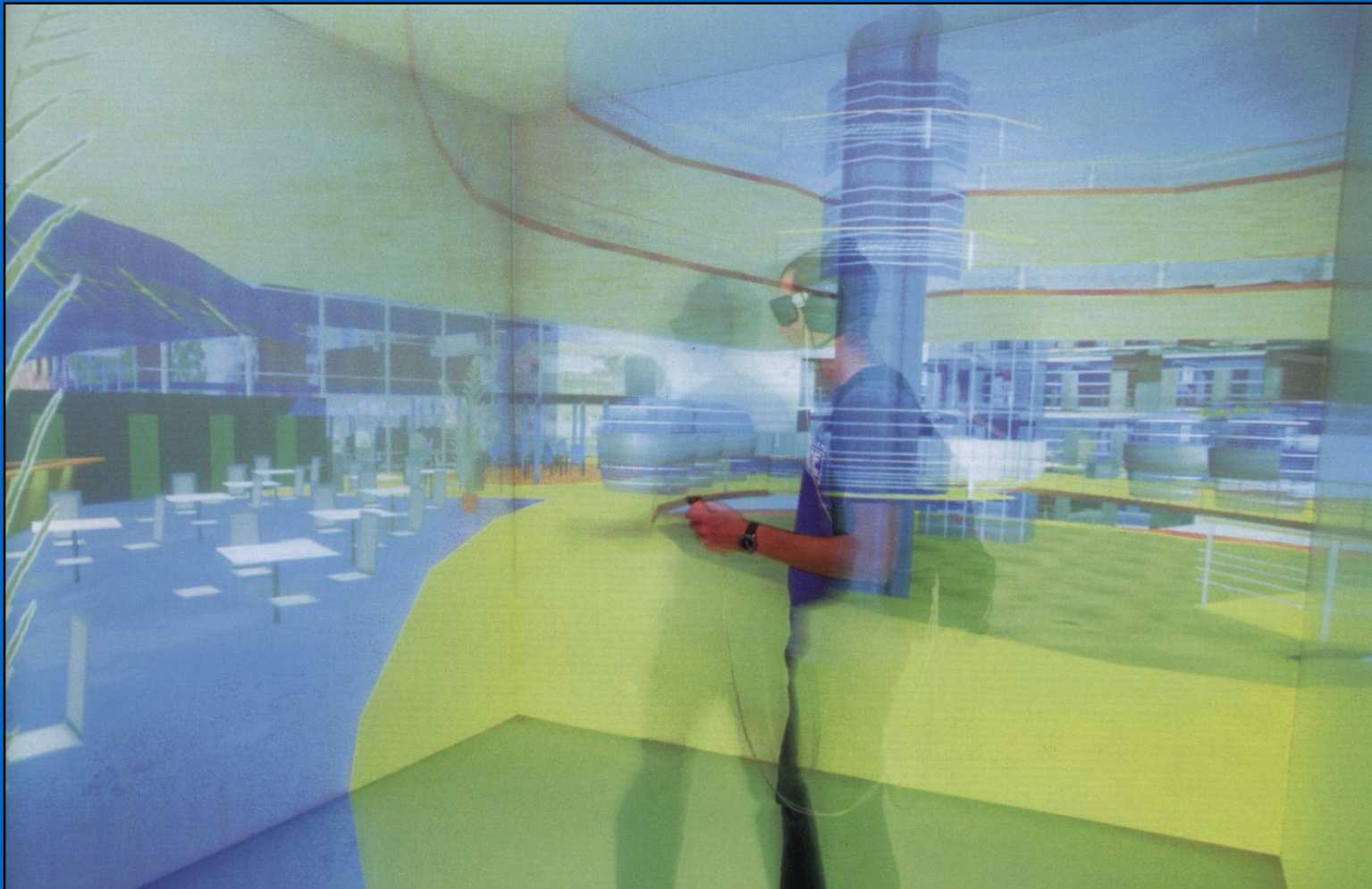
Quelle: Blick in die Zukunft,
VW Magazin, 12/2002



Trends

Virtual Reality

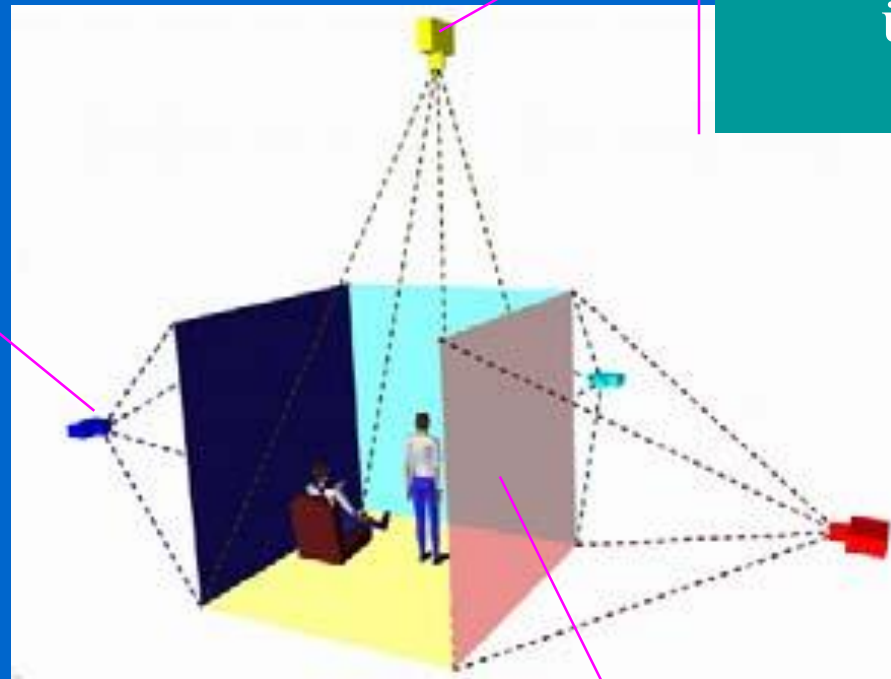
The Cave



Quelle: Wandern
durch virtuelle
Welten, VW
Magazin, 02/2003

The Cave (Aufbau)

Projektionswände



Bewegungserfassung
über Sender
(Tracking)

Projektionswände

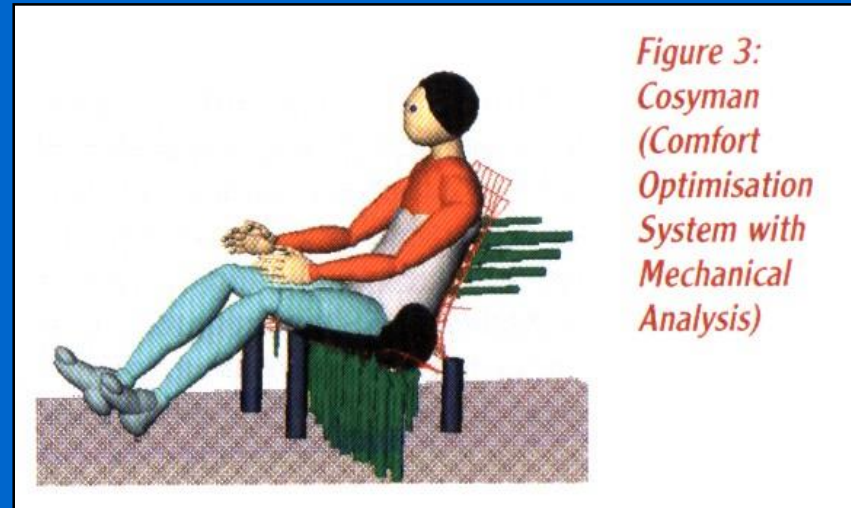
Interior Design



Quelle: Virtual Reality for
Industrial Applications, Dai,
1998

Interior Design (2)

Siemens VDO offers different systems for passenger classification. In the event of an accident, the airbags are activated on the basis of the collected data

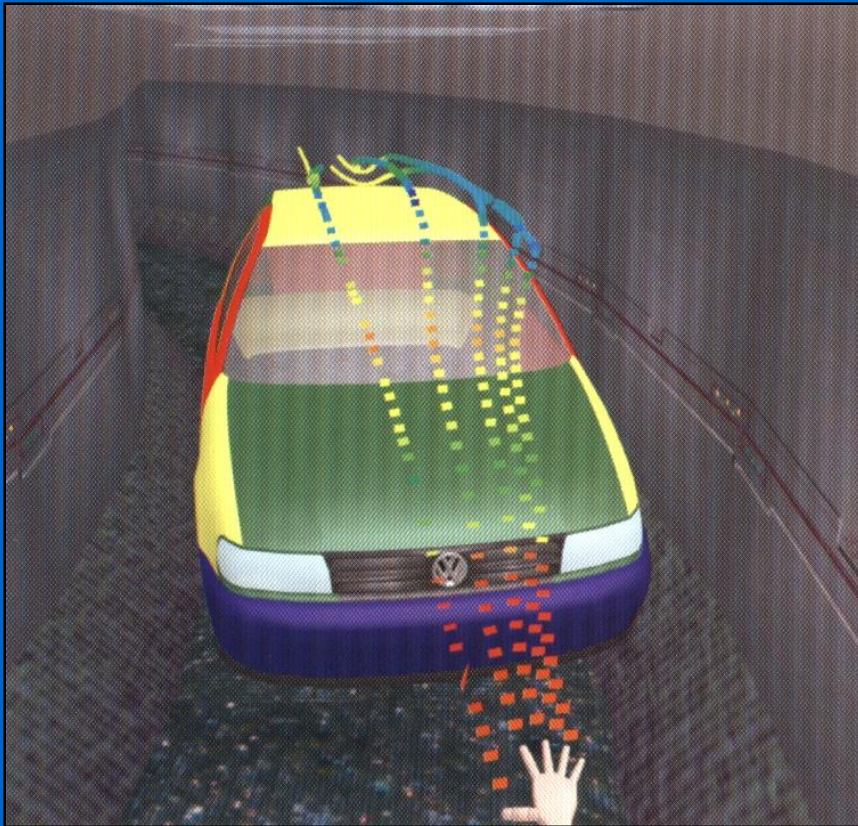


*Figure 3:
Cosyman
(Comfort
Optimisation
System with
Mechanical
Analysis)*

Quelle: Simulating Comfort Before the
Car Seat Exists, AutoTechnology,
08/2002

Quelle: Safety powered by
Electronics, Automotive Engineer,
05/2003

Volkswagen AG (1)



Quelle: Virtual Reality for
Industrial Applications, Dai, 1998



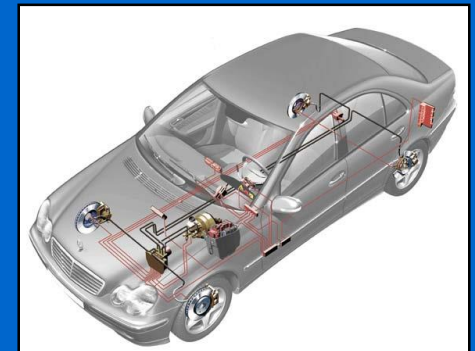
Quelle: Virtual Reality for
Industrial Applications, Dai, 1998

DaimlerChrysler AG

Virtual Reality Center bei DaimlerChrysler

- Powerwall: 7 x 2,5 m Visualisierungsfläche
- Cave: Würfel mit Deckel, Boden und drei Wänden von je 2,5 m Kantenlänge
- Rundprojektion: 7 x 4,4 m große, zylinderförmige Projektionsfläche
- Hochleistungssystem Onyx2 InfiniteReality 2 von SGI
 - Geclustertes System
 - 60 CPUs
 - 15 GB Hauptspeicher
 - 14 voneinander unabhängig arbeitende grafische Hochleistungspipes
 - Memorybandbreite: 22,4 GB/s
 - Etwa 200fache Leistung eines heutigen PCs

Quelle: <http://www.sgi.de>



Datenhandschuhe – „Gloves“

- Handbewegungen werden direkt interpretiert
- Position und Ausrichtung im 3D-Raum werden durch Tracking-Sensoren erfasst



Quelle: Wandern durch virtuelle Welten, VW Magazin, 02/2003

Datenhandschuhe – „Gloves (2)“

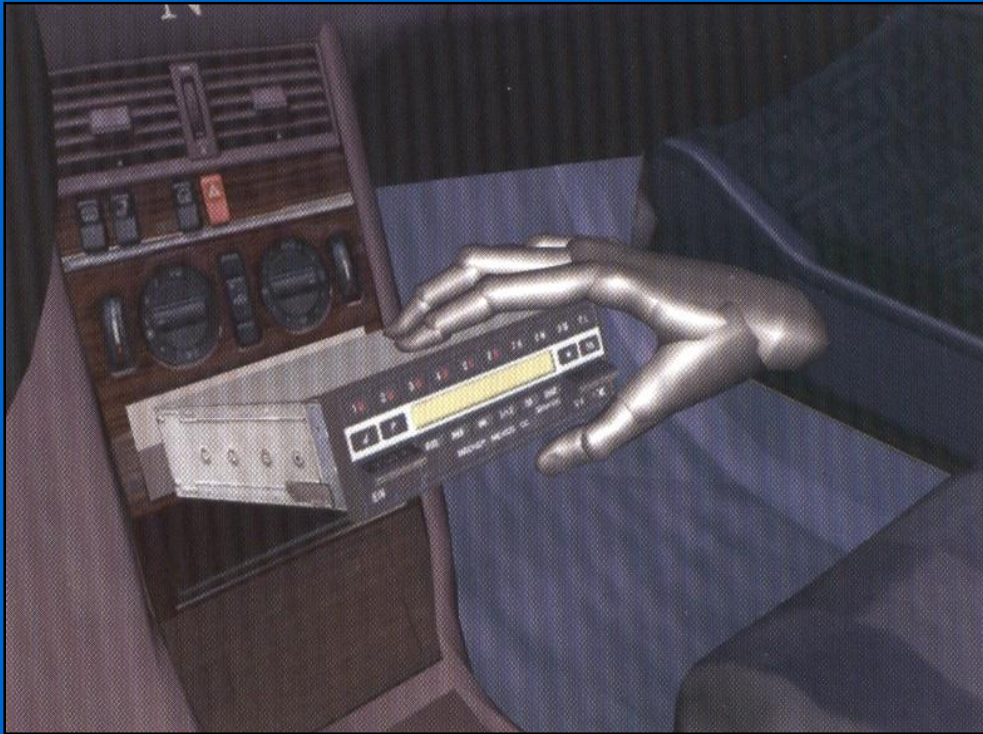


Quelle: Virtual Reality for
Industrial Applications, Dai, 1998



Quelle: Maschinen mit
Fingerspitzengefühl,
Innovation, 11/2003

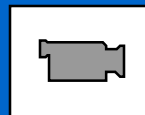
Datenhandschuhe – „Gloves (3)“



Quelle: Virtual Reality for
Industrial Applications, Dai, 1998



Quelle: Virtual Reality for
Industrial Applications, Dai, 1998



Beispiel

Volkswagen AG (2)



Quelle: Wandern durch virtuelle Welten, VW Magazin, 02/2003

Virtual Training Center

Quelle: Wandern durch virtuelle Welten, VW Magazin, 02/2003



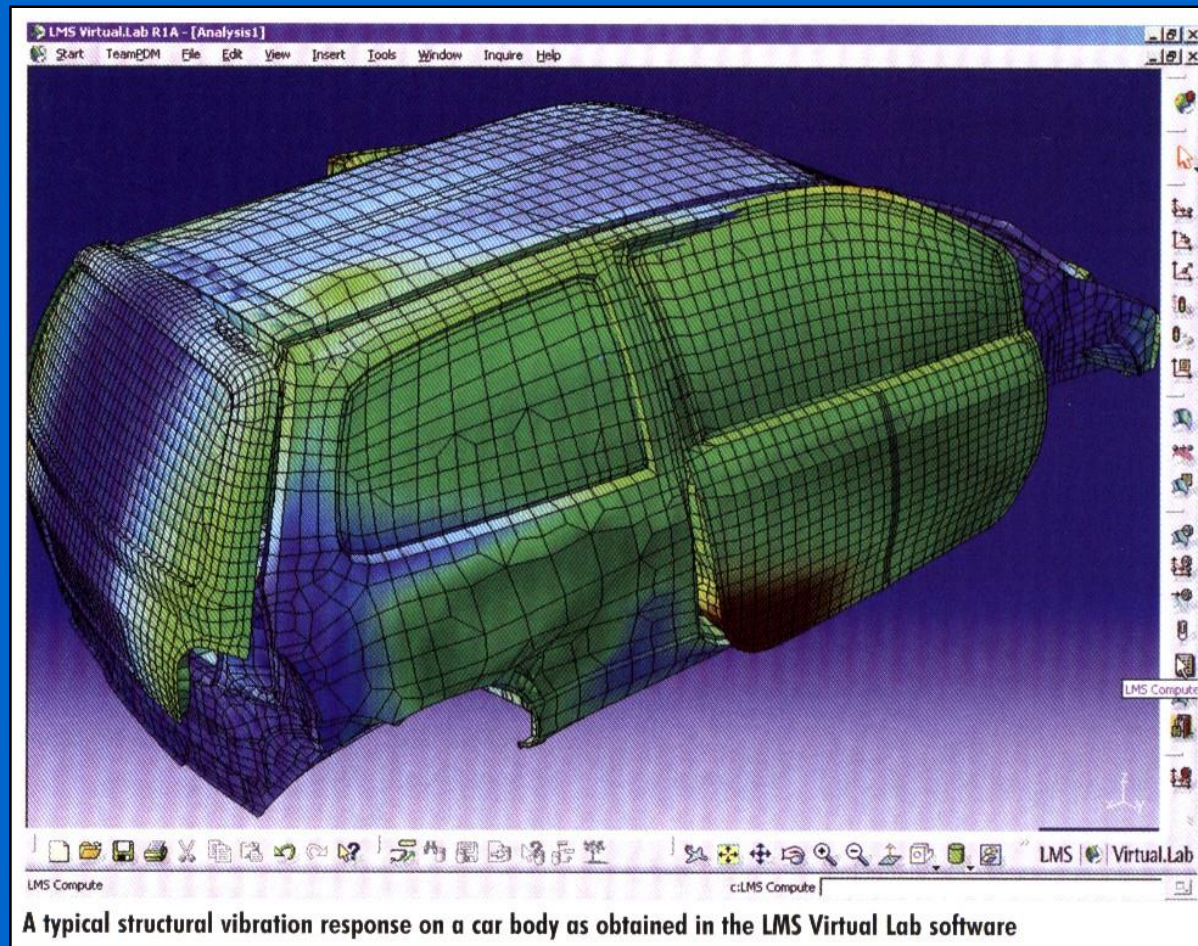
Virtual Reality in der Medizin



Quelle: Wandern durch virtuelle
Welten, VW Magazin, 02/2003

Schwingungsanalyse

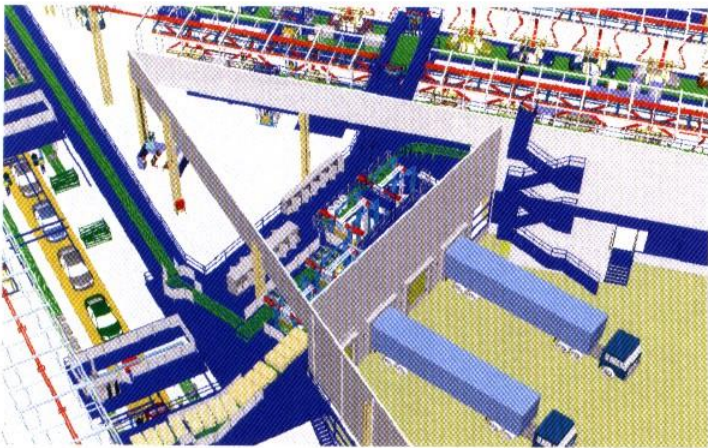
LMS Virtual Lab von Dassault Systems



Quelle: New light on
vibration analysis,
Automotive Engineer,
04/2003

Virtuelle Produktionsplanung (2)

Das Neue Opel Vectra-Werk in Rüsselsheim/D



The parts are delivered by truck directly to the respective docking stations for the final and finish assembly. These are located in the immediate vicinity of the assembly points on the assembly line, where 73 sequenced components and assemblies are immediately taken from trucks and installed.

Quelle: The New Opel Vectra-The World's Most Modern Car Production Plants, AutoTechnology, 02/2002



3D computer animation makes it possible to achieve an almost 100 % simulation of reality.

Quelle: The New Opel Vectra-The World's Most Modern Car Production Plants, AutoTechnology, 02/2002

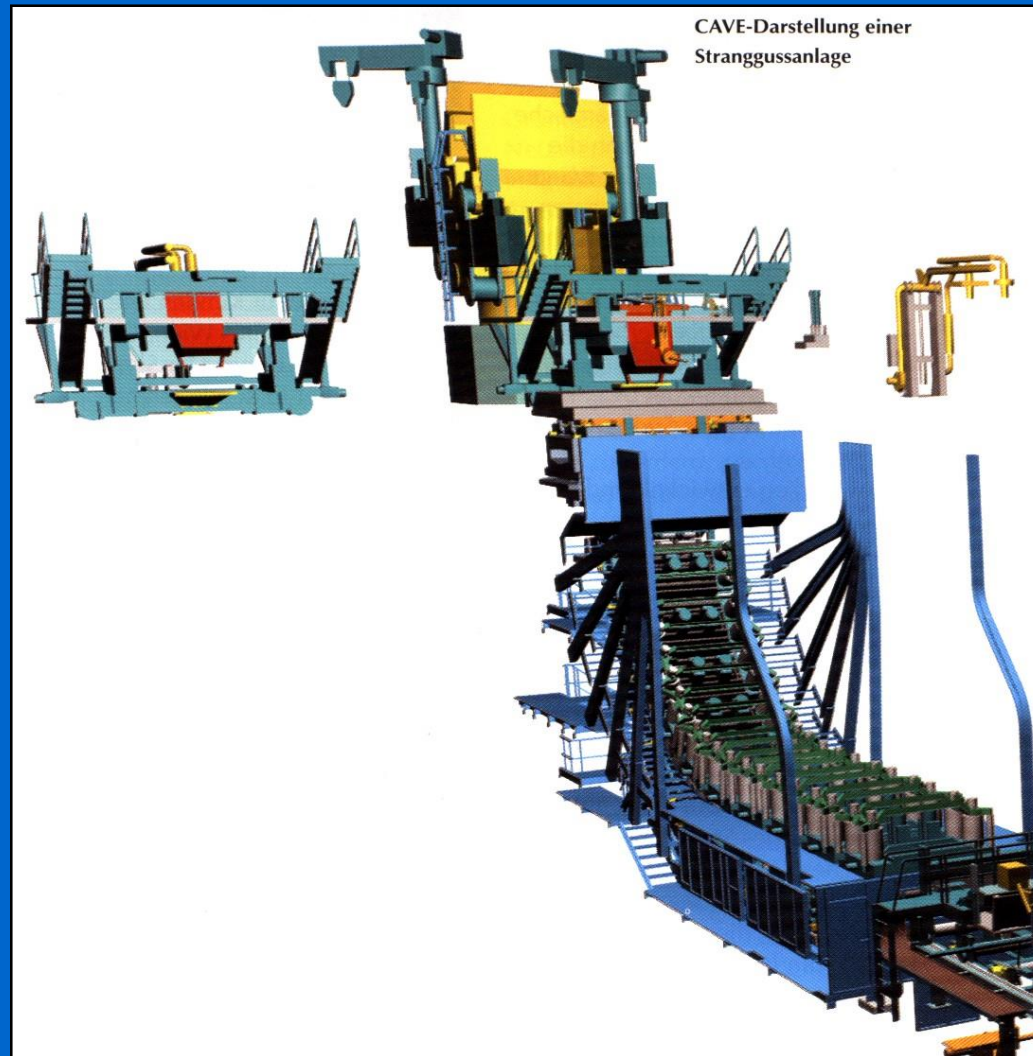
Virtuelle Produktionsplanung (3)



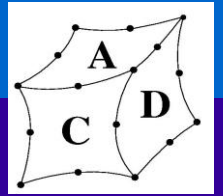
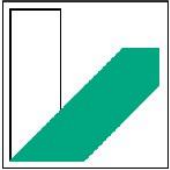
Fabriksimulationen aus dem Computer, wie hier im Karosserierohbau, geben den Planern Sicherheit bei der Gestaltung neuer Produktionsanlagen. Foto: imk Automotive

Quelle: Digitale
Planung bringt
Sicherheit, VDI
Nachrichten,
31.10.2003

Virtuelle Produktionsplanung (4)



Quelle: 3D-Visualisierung für
Maschinen- und Anlagenbau,
Technik in Bayern, 09-10/2003



Sind Sie überzeugt?

Numerische Simulation in der
Produktentwicklung -
Ein spannendes Thema!