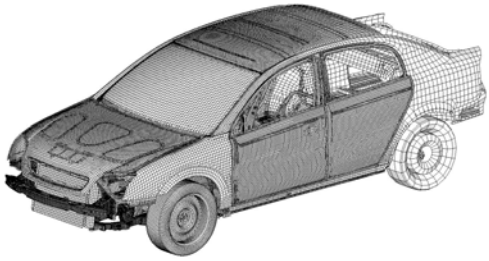
TECOSIM

LS- Dyna on MPP Platforms, Experiences and Practical Recommendations



4th European LS- DYNA Conference

23rd May 2003

Ulm, Germany

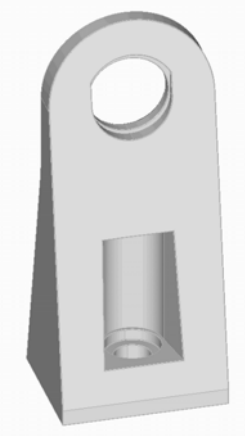
Rainer Emrich, Udo Jankowski

Tecosim GmbH, Rüsselsheim, Germany

Tecosim in brief

TECOSIM

- Company founded in 1992
- Strategic CAE Partner of Major Automotive Manufacturers
- CAE- Attributes:
  Crash-, Occupant simulation
  CFD
  S+D/NVH
  Durability/Optimization
  Powertrain (PT)
- State-of-the-Art IT Infrastructure
- Currently 77 Employees at 5 Locations
- Co-operative Venture with several design service suppliers



Locations and References

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Rüsselsheim

Köln

Leonberg

Basildon
Essex, UK

Coventry
West-Midlands, UK

- Audi AG
- Adam OPEL AG
- DaimlerChrysler
- Fiat
- FORD Motor Company
- General Motors
- Jaguar
- Landrover
- Nissan
- PORSCHE AG

- AMG
- Autoliv
- Bayer AG
- Bentler
- Bertone
- Bosch/ Blaupunkt
- Degussa-Hüls AG
- Dynamit Nobel
- EADS
- Faurecia
- Johnson Controls
- Karmann
- Lear
- Magna
- TKS/TKA
- Mahle
- MAN
- Mannesmann/Sachs
- Siemens VDO

Tecosim The Company for CAE Services

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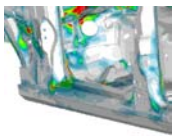
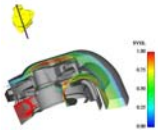
Application Fields & Distribution

30 % —— **Vehicle & Body CAE**
Attributes: NVH / Durability
Fatigue Analysis

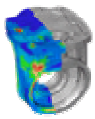


50 % —— **Vehicle & Body CAE**
Attributes: Crashworthiness /
Occupant & Pedestrian Safety

10 % —— **Computational Fluid**
Attributes: Thermal Management /
Propulsion / Aerodynamics



10 % —— **Component CAE**
Attributes: Topology
Optimisation, Powertrain
Analysis
Fatigue Analysis



Overview/ Agenda

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1. MPP in different domains
2. Boundaries of MPP
3. Market development of MPP Systems
4. HPC evolution @ Tecosim
5. Update on MPP Performance of LS Dyna
6. Load balancing on a cluster machine
7. Modelling recommendations to improve performance
8. Summary / Further Steps

MPP in different domains

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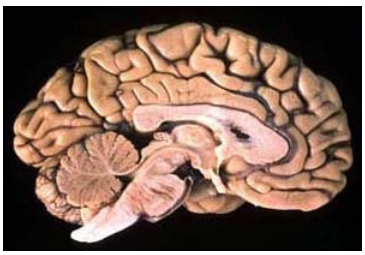
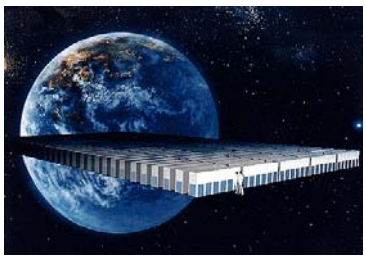
Comparison
of the performance of MPP machines



With 100 trillion connections, each computing 200 calculations per second we get 20 million billon calculations per second meaning:

20000 Tflop/s or 20Pflops/s

Faktor 550



The Earth Simulator is expected to have a maximum performance capability of 36 trillion calculations per second with5120 SX5 proc. meaning:

36 Tflop/s

MPP in different domains

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„I do not think parallelism is natural to the human brain (although without being accused of sexism, I would like to say that the female brain seems to incorporate a certain degree of parallel working, which is unfamiliar to a mere male). The programs we write are typically conceived as a string of sequential instructions which we expect to be carried out on a sequential computer. Just as a computer program may be interrupted, in order that the processor perform another task, so the human brain can cope with a few levels of interruption, switching between tasks, but not working on different tasks at the same time."

„Parallel Processing at CERN"by E. McIntosh, B. Panzer-Steindel (1996)

Boundaries of MPP

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Amdahl's Law

$$S \underset{\lim P \to \infty}{=} \frac{1}{s + \frac{1-s}{P}} = \frac{1}{s}$$

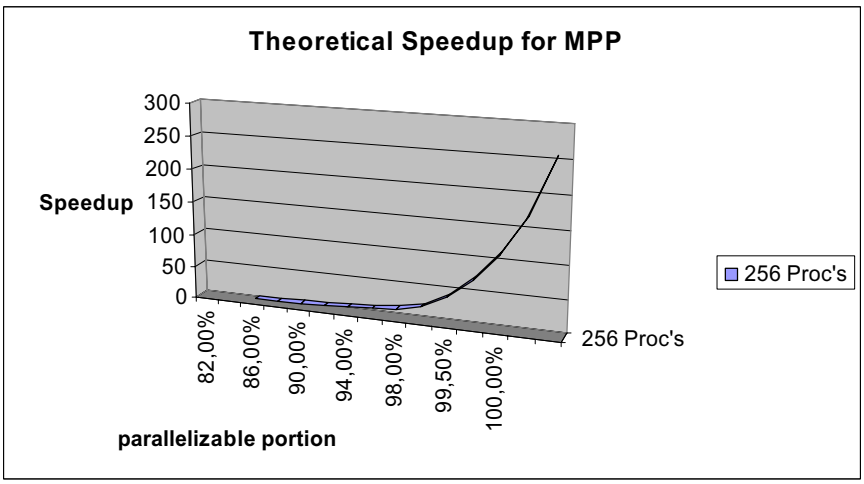
S = speedup which can be achieved with P processo

s = proportion of a calculation which is serial

P = Number of Processors

$1 - s$ = parallelizable portion

Boundaries of MPP



HPC Evolution for PC platforms

1991: October first "official" version, Linux 0.02. released

1992 –1994: Linux distrbutors like SUSE or RedHat SGI est.

1998: First PC versions of explicit crash codes on the market mainly SMP

2000: First release of LS Dyna Linux MPP

2001: Radioss Linux MPP Version release

2002: Pam Crash Linux MPP Version release

HPC Evolution @ Tecosim

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1996: SGI Powerchallenge 8 Processors SMP architecture

1997: SGI Power Challenge 16 Processors SMP architecture

1998: NEC SX4 with 2 processors vector machine SMP architecure

2001: First PC usage for numbercrunching

End of 2001: Purchase of NEC PC Linux cluster

May 2003 NEC PC Linux cluster with 48 CPU's