DCSE

Delft Centre for Computational Science and Engineering

April 27, 2009
The DCSE is a collaborative effort between sixteen research groups from five different TU Delft faculties.

Alongside the mutual exchange of knowledge between the research groups and other universities, DCSE also acts as a clearing-house for research queries from major industry and Small and Medium-sized Enterprises (SMEs).

At this moment 50 faculty members are connected to the center. More than 150 PhD students are performing their research within DCSE, and several hundreds of master and bachelor students are educated each year by members of the groups.
### Participating Groups

Fostering cooperation, exchange of information and sharing of expertise.

#### Participating groups:

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<tr>
<th>P1</th>
<th>Computational electromagnetics</th>
<th>(EWI)</th>
<th>P.M. van de Berg</th>
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<td>P2</td>
<td>Numerical algorithms and applications</td>
<td>(EWI)</td>
<td>C. Vuik</td>
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<td>P3</td>
<td>Large scale systems</td>
<td>(EWI)</td>
<td>A.W. Heemink</td>
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<td>P4</td>
<td>Engineering mechanics</td>
<td>(LR)</td>
<td>R. de Borst</td>
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<td>P5</td>
<td>Computational aerodynamics</td>
<td>(LR)</td>
<td>B. Koren</td>
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<td>P6</td>
<td>Computational turbulence dynamics</td>
<td>(3mE)</td>
<td>B.J. Boersma</td>
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<td>P7</td>
<td>Structural optimization</td>
<td>(3mE)</td>
<td>A. van Keulen</td>
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<tr>
<td>P8</td>
<td>Engineering dynamics</td>
<td>(3mE)</td>
<td>D.J. Rixen</td>
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<td>P9</td>
<td>Computational mechanics</td>
<td>(CiTG)</td>
<td>L.J. Sluys</td>
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<td>P10</td>
<td>Mechanics of structural systems</td>
<td>(CiTG)</td>
<td>A. Scarpas</td>
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<td>P11</td>
<td>Simulation of environmental flow systems</td>
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<td>G.S. Stelling</td>
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<td>P13</td>
<td>Multiscale Physics</td>
<td>(TNW)</td>
<td>H.A.E. van den Akker</td>
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<td>P16</td>
<td>Nature inspired chemical engineering</td>
<td>(TNW)</td>
<td>Chr. Kleijn</td>
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<td>P17</td>
<td>Computational modeling of particulate flows</td>
<td>(TNW)</td>
<td>S. Luding</td>
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<td>P18</td>
<td>Virtual Materials Laboratory</td>
<td>(TNW)</td>
<td>B.J. Thijssen</td>
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<td>P19</td>
<td>Aerospace Structures</td>
<td>(LR)</td>
<td>Z. Gurdal</td>
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# Interdisciplinarity

Interdisciplinary cooperation stimulated by joint projects funded by DCSE

<table>
<thead>
<tr>
<th>Proj. nr.</th>
<th>Start/End date</th>
<th>Title</th>
<th>Faculty/Projectleaders</th>
<th>AIO fte</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>03-02-2004 / 03-02-2008</td>
<td>Interface for accurate an efficient coupling of multiple solvers</td>
<td>LR/3mE, H. Bijl, R. de Borst, D. Rixen</td>
<td>4</td>
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<td>4</td>
<td>01-08-2004 / 01-08-2008</td>
<td>Multi-scale modeling of plasma-assisted thin film deposition</td>
<td>TNW/3mE, C.R. Kleijn, B.J. Thijssse</td>
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<td>6</td>
<td>05-01-2004 / 05-01-2008</td>
<td>Simulation of a realistic industrial burner</td>
<td>TNW/3mE, H.J.J. Jonker, D. Roekaerts, B.J. Boersma</td>
<td>4</td>
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<td>7</td>
<td>01-01-2005 / 31-12-2006</td>
<td>Multi-scale modeling and geometrical optimization of catalysts-on-a-chip</td>
<td>TNW, M.O. Coppens, S.W. de Leeuw, C.R. Kleijn</td>
<td>2</td>
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<td>9</td>
<td>10-07-2003 / 10-07-2007</td>
<td>Numerical simulation of bone ingrowth for design of shoulder protheses</td>
<td>EWI/3mE, C.W. Oosterlee, F. van Keulen</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>01-01-2004 / 01-01-2006</td>
<td>Particle field interactions</td>
<td>TNW/3Me, S. Luding, D. Rixen</td>
<td>2</td>
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<td>16</td>
<td>01-05-2007 / 01-05-2011</td>
<td>Hierarchical Computational Methods for Scale Bridging in Composite Materials</td>
<td>CITG/TNW, Dr. S. Luding, Prof.dr.ir. L.J. Sluys</td>
<td>8</td>
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<td>17</td>
<td>01-11-2006 / 01-11-2010</td>
<td>Development of an Immersed Boundary Method, Implemented on Cluster and Grid Computers</td>
<td>L&amp;R/EWI/ Prof.dr.ir. B. Koren, dr.ir. M.B. van Gijzen</td>
<td>8</td>
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Perspective DCSE 2008

• Cooperative Seminars:
  November 14, 2007: TNW - DCSE  
  June 8, 2007: Microned – DCSE  
  December 12, 2006: L&R – DCSE
• Improvement of website DCSE
• Interaction IPP’s
• Organizing Customer Day DCSE
• New inventory of DCSE courses
• Proposal large project
• Writing book
P1
Computational Electromagnetics

• Faculty EWI
• Projectleader: P.M. van den Berg
Inversion

helicopter system

\[ H = (H_x, H_y, H_z) \]

large fixed-loop

3-axis induction coils

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Inversion

Flight Path

2D Image From Co-Planar Component (Tie 49020)
P3
Large Scale Systems

• Faculty EWI
• Projectleader: A.W. Heemink
Contaminant transport

- Finite volume solver
- Real life applications
- Environmental studies
- Large scale models
Real-time flow forecasting in the Dutch coastal waters for ships entering the North Sea channel to Amsterdam harbor using data assimilation

Grid of the 3D Coastal Flow model of IJmuiden
Results of the data assimilation:
Flow $u,v$, waterlevel $z$, salinity $r_p$
High Performance Computing & Grid Computing

• Large scale complex real world problems require ever increasing computing power to deal with
• Supercomputers $\rightarrow$ parallel & distributed clusters $\rightarrow$ Grid Computing Technology
• Grid Computing: next generation of Internet.
  Sharing of (passive) data&information on Internet versus sharing of both passive and active resources (computing power, storage, experimental instruments, and application services, etc)
• EU Asia Link project: development of a course module on HPC & GC.
  Partners: TU Delft (coordinator), Tsinghua Univ., UNL Lisbon, Graduate Univ. of Chinese Academy of Schiences. (example research project: Power System simulation, co-financed by Microsoft Research, Inc. USA)
P6
Computational Turbulence Dynamics

• Faculty 3ME
• Projectleader: B.J. Boersma
Real problem, jet noise

Validation

Scaling

Physical understanding

Modification

From application to the laboratory
Complex Flow: 
multiphase flow

liquid/liquid 
emulsion

Numerical Simulation

Experiment
P8
Engineering Dynamics

• Faculty 3ME
• Projectleader: D.J. Rixen
Domain decomposition

Reduction of dynamic models through substructuring
P13
Multiscale Physics

• Faculty TNW
• Projectleader: D.J.E.M. Roekaerts
OUTLINE

Turbulent combustion.

How to measure and compute the properties of the flame?

How to validate the computational model?

How to use in the context of industrial combustion (furnaces, gas turbines, engines, ...)

LIF measurement of OH radical
P16
Nature Inspired Chemical Engineering

• Faculty TNW
• Projectleader: Ch. Kleijn
Computation of pollutant spreading over urban valleys

(area of Sarajevo. XIV Winter Olympic Games, 1984)

wind created by heat islands

smog formation

Contact: Prof. Chris Kleijn, TNW-MSP
Computation of Sedimentation in Rivers and Canals

Contact: Prof. Rob Mudde, TNW-MSP