

| Industry Sector | RTD Thematic Area           | Date      |
|-----------------|-----------------------------|-----------|
|                 | Durability & Life Extension | 27-Feb-02 |

# **FENET- EU Thematic Network**

## **RTD 1 : Durability & Life Extension (DLE)**

### **Coordinators:**

**Prof. Adib Becker (University of Nottingham, UK)**

**Prof. Nicola Petrone (Padova University, Italy)**



## **FENET Workshop - DLE-01**

# **Finite Element Simulation of Contact Problems –1**

**27-28 February 2002  
Copenhagen**

**Chairman : Prof. Adib Becker (University of Nottingham, UK)**



## Contact Workshop Objectives:

- To present and review the existing set of contact benchmarks
- To obtain feedback from FE users on the contact benchmarks
- To identify more challenging contact benchmarks
- To identify limitations in the contact capabilities of commercial FE software
- To identify future desirable features in Contact simulation using FE
- To present cases studies reflecting modern FE contact analysis

## Day 1 - Wednesday 27 February 2002

### Morning Sessions

#### **Workshop introduction and objectives**

Prof. Adib Becker (University of Nottingham, UK)

#### **Keynote lecture: FE Contact simulation**

Albert Konter (Netherlands Institute for Metals Research, Netherlands)

#### **Keynote lecture: Overview of current NAFEMS contact benchmarks**

Dr. Nawal Prinja (NNC, Limited, UK)

#### **Evaluation of the current contact benchmarks by software vendors and FE users**

- Adrie Bout (MSC Software Benelux B.V., Netherlands)
- Dr.-Ing. Reinhard Helfrich (INTES, Germany)
- David Ellis (IDAC, UK)

## Day 1 - Afternoon Sessions

### **More challenging contact benchmarks**

Dr. Alan Prior (HKS (UK) Limited)

### **Coupling FE contact and heat transfer analysis in investment casting simulations**

Gottfried Laschet and L. Haas (Access e.V., Germany)

### **Solving contact problem using an augmented Lagrangian method**

Dr. Philippe Jetteur (Samtech, Belgium)

### **Alternative Technology: Boundary Element Contact Analysis**

Prof. Adib Becker (University of Nottingham, UK)

### **Paper Calendering: FE Simulation As An Optimisation Tool**

Dr Yasar Deger (Sulzer Markets & Technology Ltd, Switzerland)

### **Discussion and Overview of FENET Workshops on Durability and Life Extension**

Prof. Adib Becker (University of Nottingham, UK)

## Day 2 - Thursday 28 February 2002

15:30-16:30

### **Contact Workshop Conclusions/Discussion Forum**

Prof. Adib Becker (University of Nottingham, UK)



## Analysis of Contact workshop

### The Current Contact Benchmarks

- Limited in scope, but important as the first step in establishing contact benchmarks
- Limited to 2D contact only
- Limited to continuum elements
- Can be improved by a clear definition of data input
- Would benefit from showing solutions from two or more FE codes
- Useful to add a detailed “educational” description of the ‘difficult’ benchmarks.
- Should also consider the curved patch test
- Should show all FE mesh details (all nodal coordinates)

## More challenging contact benchmarks

- 3D contact
- Self-contact
- Multi-body contact
- Rotating shaft with no friction
- Compression of rubber
- Shell on shell contact
- Beam contact
- Explicit/Implicit comparison
- Linear vs. quadratic elements
- 3D tetrahedron vs. hex elements



## Challenges in FE modelling of industrial contact problems

- Loaded rigid surfaces
- Identification of unknown or unexpected contact regions
- Automation of contact analysis
- Re-meshing during contact analysis
- Visualisation of contact elements
- Informative post-processing diagnostic display
- Improved quadratic elements
- Better friction models
- Verification of FE contact solutions by experimental testing
- Coupled thermo-mechanical contact
- Heat conduction across interfaces
- Cemented joints
- Thin lubricating films

**Durability & Life Extension Issues raised at the  
First FENET Annual Workshop  
(13-14 November 2001, Wiesbaden)**

| Industry Sector | Topics relevant to Durability and Life Extension  |
|-----------------|---|
| (Generic)       | Terminology/glossary<br><a href="#">Contact mechanics</a><br><a href="#">Fracture and fatigue</a> of rubber and plastics<br><a href="#">Cracks in welds</a><br>Adaptive meshing in <a href="#">fracture and contact problems</a><br>Case studies on durability and life extension |
| Aerospace       | Damage assessment, damage tolerance<br><a href="#">Crack growth</a><br>Residual strength<br>Linking FE and Boundary Element Methods<br>Probabilistic analysis   |
| Land Transport  | <a href="#">Fracture, crack growth</a> , adaptive meshing<br>Residual strength<br>Characterization of composites  |
| Bio-Medical     | Wear modeling for prostheses<br>Modelling bone <a href="#">fracture</a><br>Interface modeling for implants biomaterials   |

**Durability & Life Extension Issues raised at the  
First FENET Annual Workshop  
(13-14 November 2001, Wiesbaden)  
/ Continued**

| Industry Sector          | Topics relevant to Durability and Life Extension  |
|--------------------------|---|
| Consumer Goods           | Abuse loads<br>Impact analysis<br>Life estimation   |
| Marine & Offshore        | <a href="#">Fatigue</a> , stochastic loading damage<br>Delamination, composites   |
| Power & Pressure Systems | Residual stresses<br><a href="#">Crack growth</a><br><a href="#">High temperature and damage assessment</a><br>Use of probabilistic fracture analysis<br>Extreme loads                    |
| Process & Manufacturing  | Extending product life through process optimization<br>Durability and wear of tools<br>Obtaining and applying <a href="#">failure criteria</a><br>Effect of manufacturing defects on life |

## Workshop FENET DLE-02

Title: **FE issues related to Structural Integrity (Fracture, Fatigue and Creep)**

Date: 13-14 June 2002

Venue: Zurich

Organiser: Prof. A.A. Becker, University of Nottingham, UK

*A questionnaire will be circulated to all FENET members to explore the main issues in structural integrity*

### **Objectives:**

- To provide an overview of the current state of FE technology in applications related to structural integrity
- To provide a discussion forum to identify the need for FE benchmarks in structural integrity
- To identify specialist workshop topics in structural integrity
- To provide feedback from industry on the Fatigue, Fracture and creep Questionnaire

## Workshop FENET DLE-03

Title: **Finite Element simulation of Fracture and Fatigue - 1**

Date: 11-12 September 2002

Venue: Trieste

Organiser: Prof. N. Petrone, University of Padova, Italy

### Objectives:

- To obtain feedback from FE users on the current state of FE technology in modelling fracture problems
- To identify the need for fracture and crack growth FE benchmarks
- To identify limitations in the fracture capabilities of commercial FE software
- To identify future desirable features in FE simulation of fracture and crack propagation
- To present cases studies reflecting FE analysis of fracture problems

## Workshop FENET DLE-04

Title: **Finite Element analysis of High Temperature Applications**

Date: February 2003

Venue: To be decided

Organiser: Prof. A.A. Becker, University of Nottingham, UK

### Objectives:

- To obtain feedback from FE users on the current state of FE technology in high temperature applications and life assessment
- To identify the need for creep and damage FE benchmarks
- To identify future desirable features in FE simulation of creep
- To present cases studies reflecting FE analysis of creep and life assessment problems

## Future DLE workshop topics

- FE simulation of Contact problems – 2
- FE simulation of damage
- Modelling fatigue of metals
- Modelling fatigue of rubber and plastics
- Structural integrity of welds
- Modelling wear and deterioration
- FE simulation of residual stresses

## Cross-RTD future workshop topics

- Implementing FE solutions in Design codes
- Alternative techniques: Boundary Element Technology
- Uncertainties in material properties